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JANUARY 1963

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FEATURING
Engineering Education in Canada
Part II

what's McAvity doing down there?

Could be so many things. The McAvity name appears on just about every type of municipal waterworks material. McAvity has been making main stops, curb stops, service boxes, valves and all the other vital pieces of water works equipment for well over one hundred years. They really know what they're doing. Take a McAvity fire hydrant (There are thousands in cities and towns across Canada). Next time you walk by one, have a look at the date on the hydrant. You'll see the year of manufacture. It will probably surprise you, it's been there so long. The point is this . . . it's just as ready now to go into immediate operation as it was the day it was installed. There's a similar story too about every piece of McAvity equipment. Only rarely do they need any more attention than a routine inspection. (That's probably what's going on in the photograph.) McAvity equipment really pays off with dependable long service.

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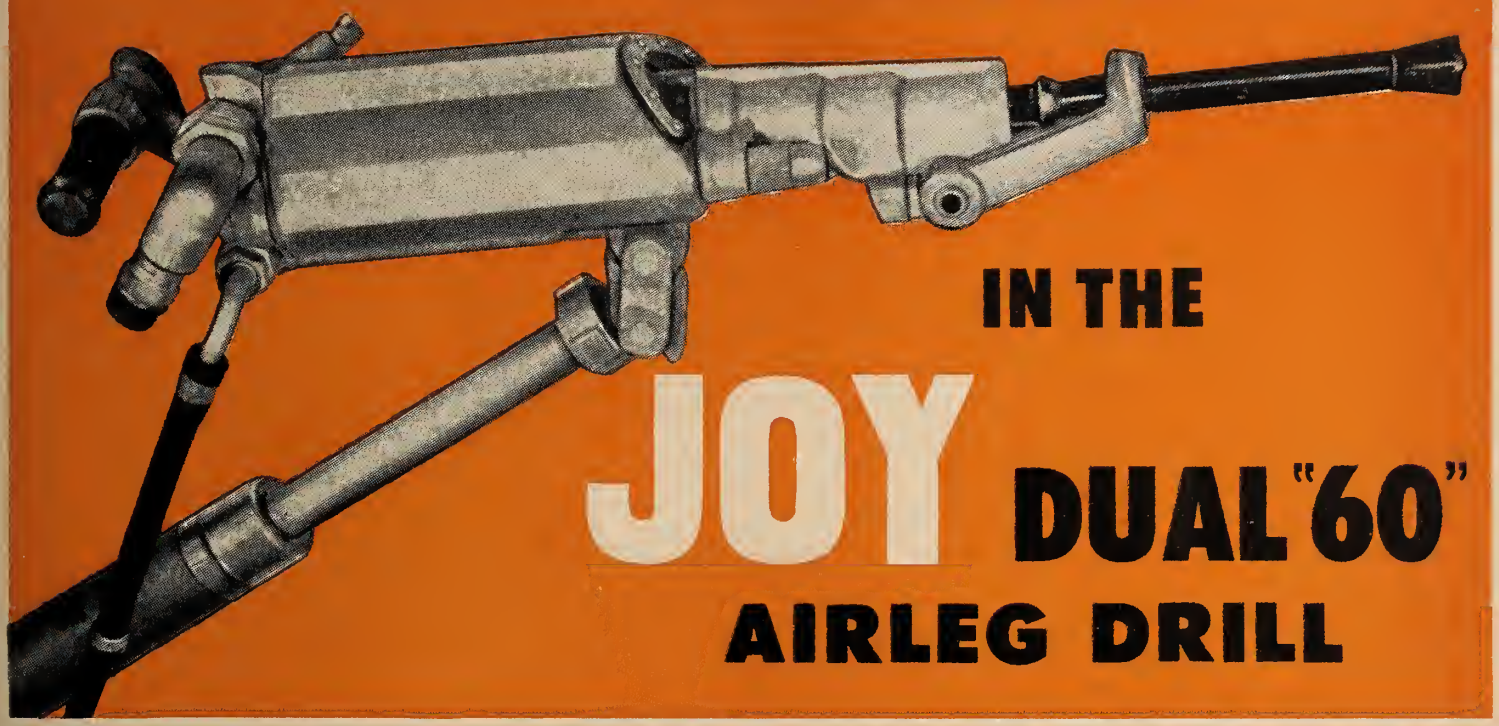

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Expands capabilities for serving process industries

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1962	110,000

In less than fifteen years, the Foxboro Company, Limited, has had to double and *re*-double its plant capacity to meet the requirements of the process industries of Canada and of export markets for its high-performance instruments and systems.

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New Small Parts Department for manufacturing sub-assemblies.

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THE
ENGINEERING JOURNAL

January 1963 - Vol. 46, No. 1

PUBLISHED MONTHLY BY THE ENGINEERING INSTITUTE OF CANADA

5 IN THIS ISSUE

COVER ILLUSTRATION

A feature of this issue of the Engineering Journal is the second part of a two-part series on engineering education in Canada. The cover illustration, pointing up this series, shows the engineering building at University of Alberta in Edmonton.
(Photo courtesy University of Alberta).

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MEMBERSHIP

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Indexed in The Engineering Index, Applied Science and Technology Index

A battery of 5 lengths of Goodyear Accordion Hose at The E.B. Eddy Co., Ltd., Hull, Que.

How an accordion solved a vibrating problem

The paper industry was faced with a costly problem . . . extreme vibration between suction boxes and vacuum header placed damaging strains on machine components. Ordinary hose just didn't do the job.

The solution to the problem proved to be an Accordion Type Hose developed by Goodyear Technical Service. Extremely flexible Accordion Hose provides multiple benefits . . . it efficiently handles liquids . . . it absorbs machine-killing vibration . . . it delivers long, dollar-saving service.

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INDUSTRIAL RUBBER PRODUCTS ENGINEERED FOR THE JOB

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THE GREATEST NAME IN RUBBER

IN THIS ISSUE

In his paper, *"Form Design for High Lifts"*, **Oliver Y. Barde, M.E.I.C.**, deals with some of the aspects of the design and economy of forms designed for high lift pours, namely a lock entrance wall, and large-size columns for an elevated expressway. The forms described were designed by the author. Mr. Barde was born and educated in Switzerland. After taking his Civil Engineering at the Polytechnique in Zurich, he worked on the Donzere Mon Dragon Power Plant Project in France and on various projects in Indochina. He came to Canada in 1955 to work on the St. Lawrence Seaway, and the Metropolitain Boulevard in Montreal. He is presently employed by Franki of Canada.

Stored away in the files of the Patent Office in Ottawa is a mine of scientific and technical information waiting to be tapped by Canadian industrialists and engineers. To date, 650,000 Canadian Patents have been issued, a figure which increases by 2,000 each month. Every year 7,000 patents fall into the public domain, and many patents still in force are available for licensing. In his paper, *"Patents — Another Engineering Tool"*, **Gordon Asher**, of the Research & Development Division, Department of the Secretary of State, Commissioner of Patents, Ottawa, deals with the most common inquiries about patents using fourteen basic questions and answers. He discusses the organization and operation of the Patent Office, the availability of patent literature, and explains how to file a patent application.

The main thread of **T. D. Northwood's** *"Rail Vehicle Noise"* is the rapid transit problem, although there are occasional references to comparable problems in railroad systems Mr. Northwood, Head, Building Physics Section, Divisions of Building Research, National Research Council, Ottawa, says there was a time when noise from rail vehicles, particularly from subway trains, was always placed at the top of the list of unpleasant noises. This has changed somewhat, as has the general attitude about underground systems. "The earliest ones were purely utilitarian," Mr. Northwood says, "and they looked it and sounded like it; today the customer expects to be transported not only rapidly but in reasonable comfort."

In their paper *"A Yardstick for Evaluating Costs of Electrical Energy in British Columbia"*, **J. F. Muir, M.E.I.C.**, Head of the Department of Civil Engineering, University of British Columbia, and **Eugen Ruus**, Assistant Professor in the Department, compare the estimated wholesale costs of electrical energy from three different sources in the lower mainland with costs of energy from the Columbia and Peace River projects. The authors discuss in detail the costs of energy from the Moran, Hat Creek, and Burrard plants. These costs should serve as a yardstick for evaluating costs of energy from the Columbia, Peace River and other power developments in the province. In emphasizing the benefits in the province from abundant sources of low-cost electrical energy for expansion of secondary industries, they quote, as follows, from the report of the Royal Commission on Canada's Economic Prospects: ". . . it is a fact that for every dollar spent on the construction of new generation, transmission and distribution of hydro-electric energy, two dollars have gone into the building of new manufacturing plants. For every employee engaged by the power companies, 50 have found jobs in secondary industry, and for each additional outlay on electric power as a cost of production, the nation's output of manufactured goods has increased a hundredfold."

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of the

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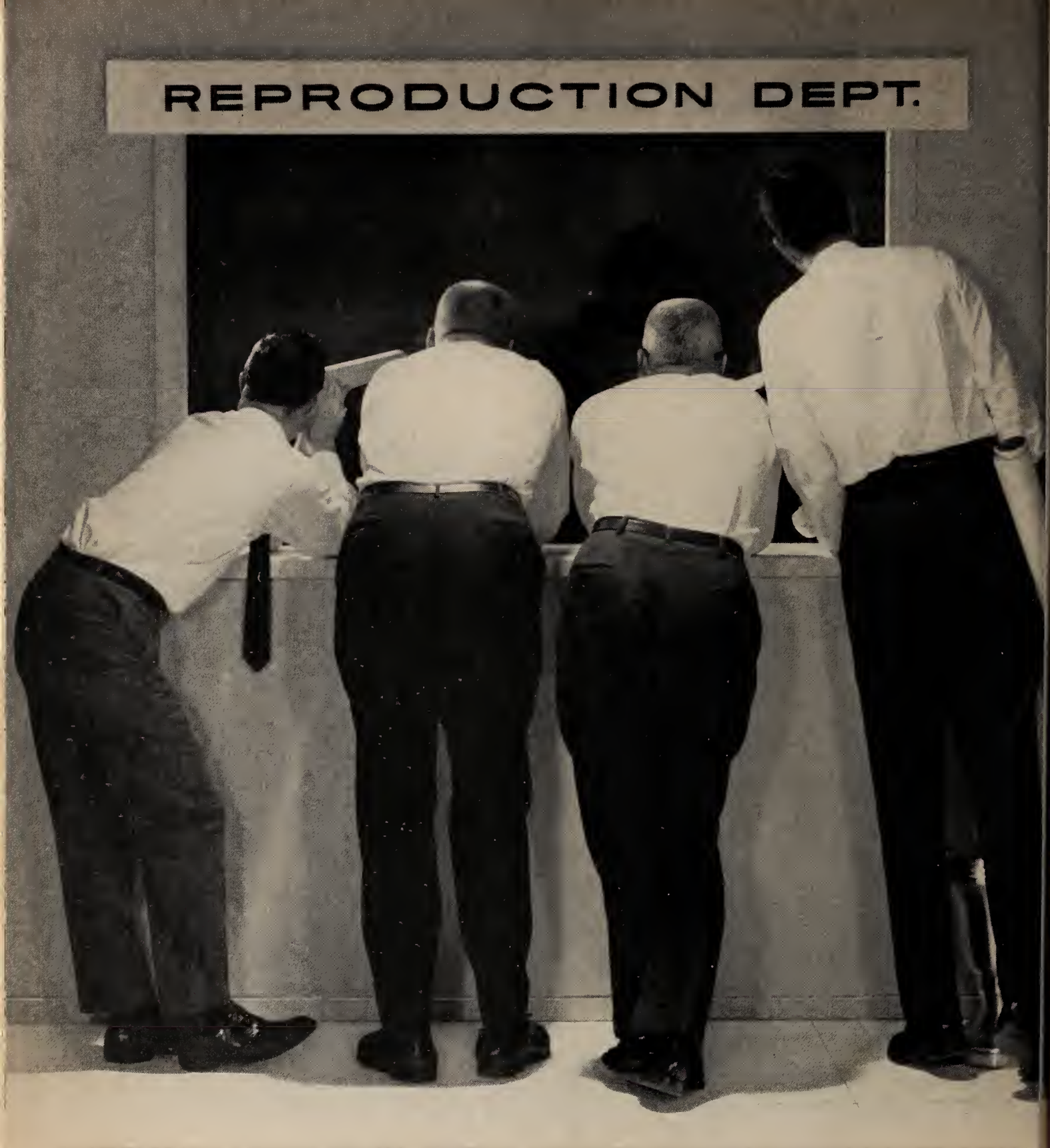
1963



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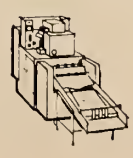

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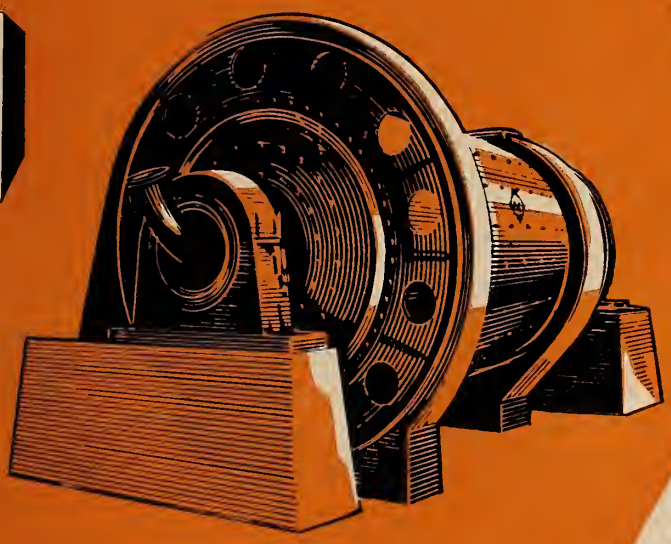
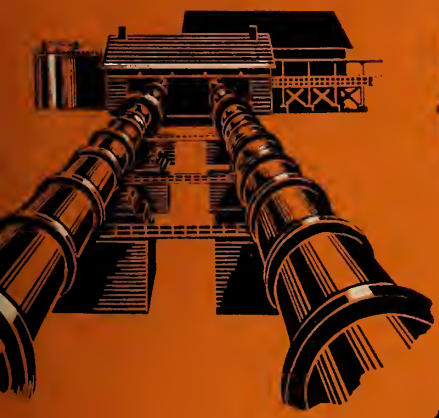
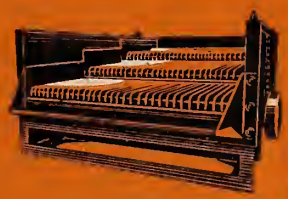


Grinding Mills

Valves



Rotary Kilns



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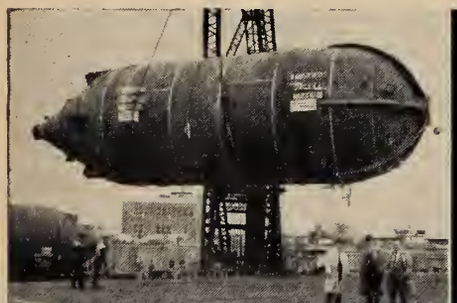
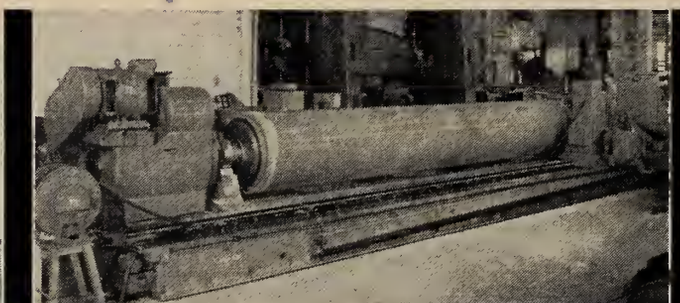
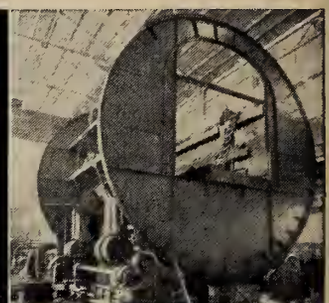


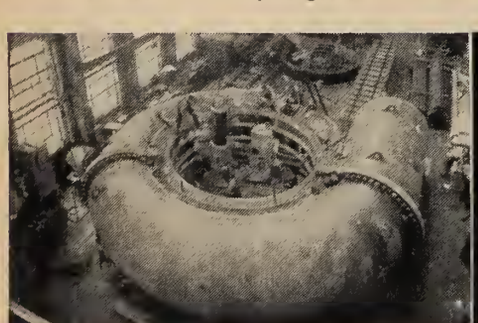
Stainless Clad Pulp Digester



Paper Machine Roll On Grinder

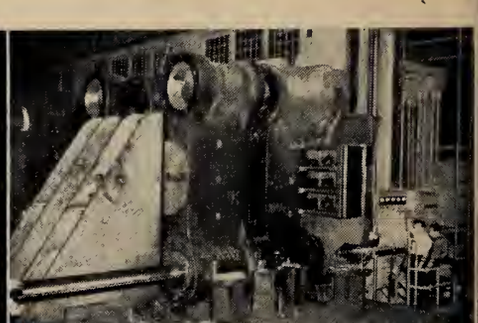


Car Dumper



Hydraulic Turbine Scroll Case

Stoker Fired Cross Drum Boiler



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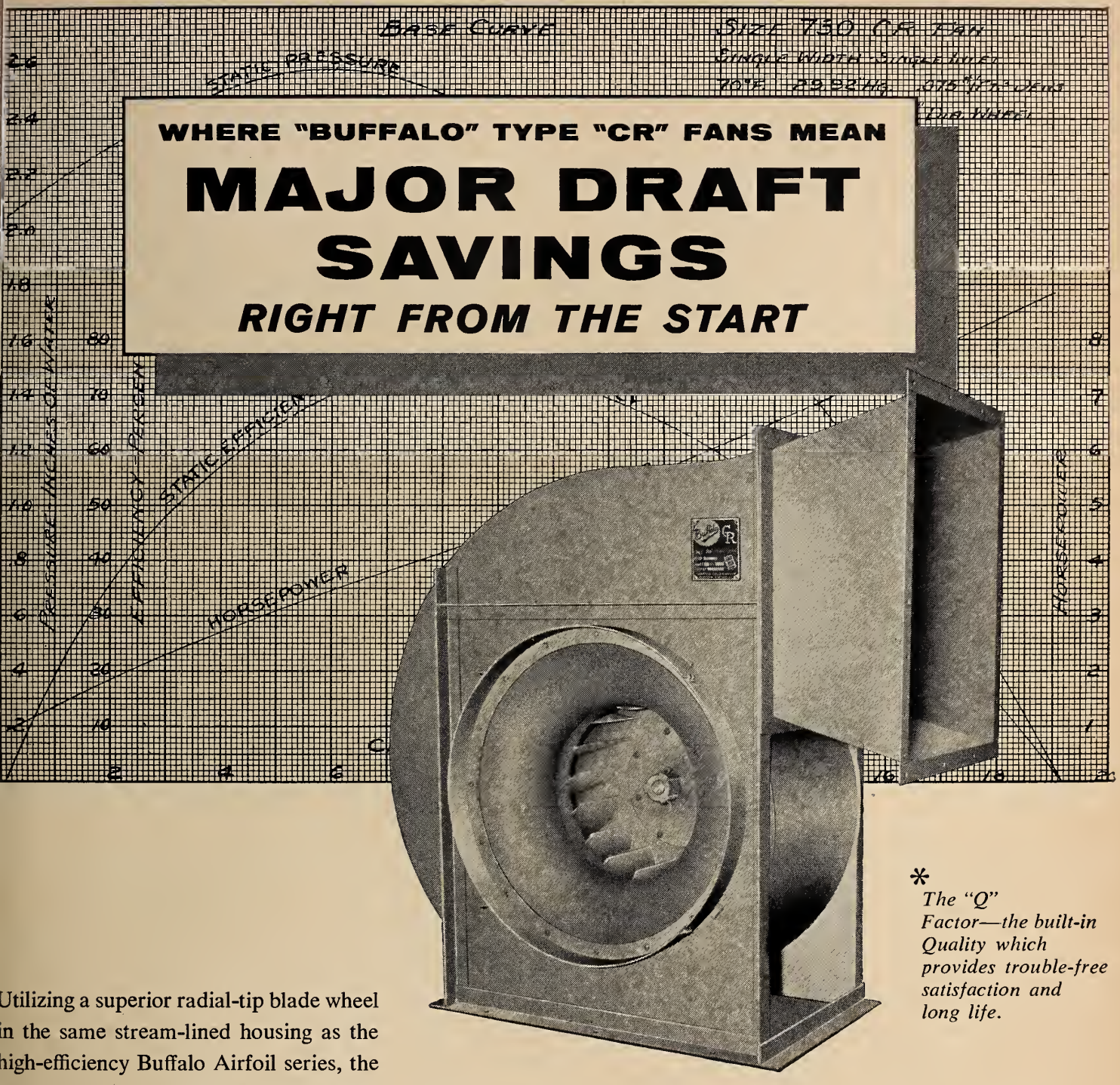

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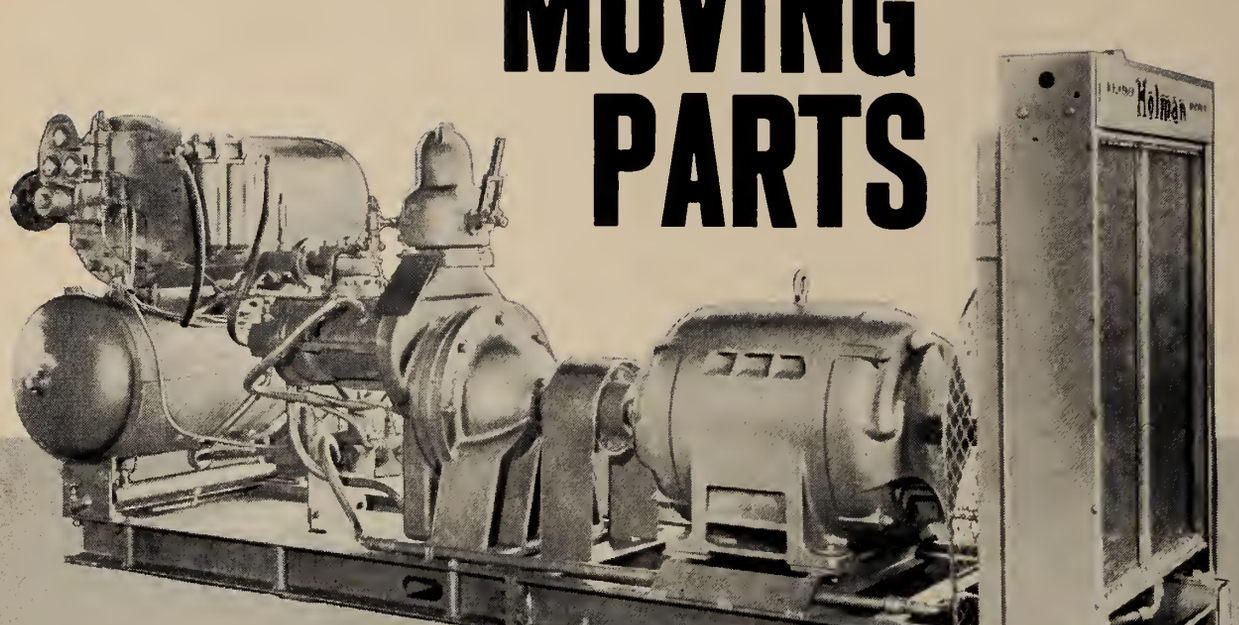

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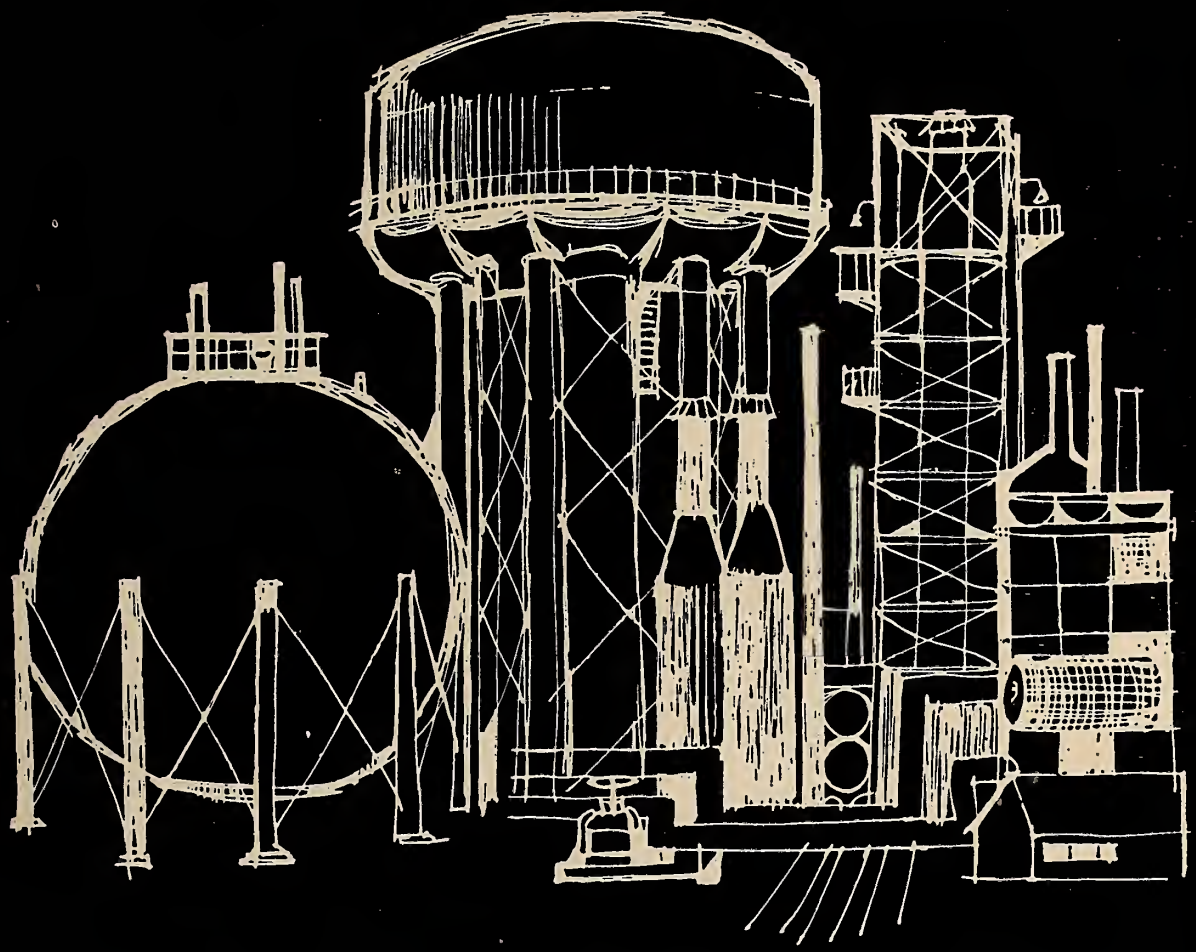

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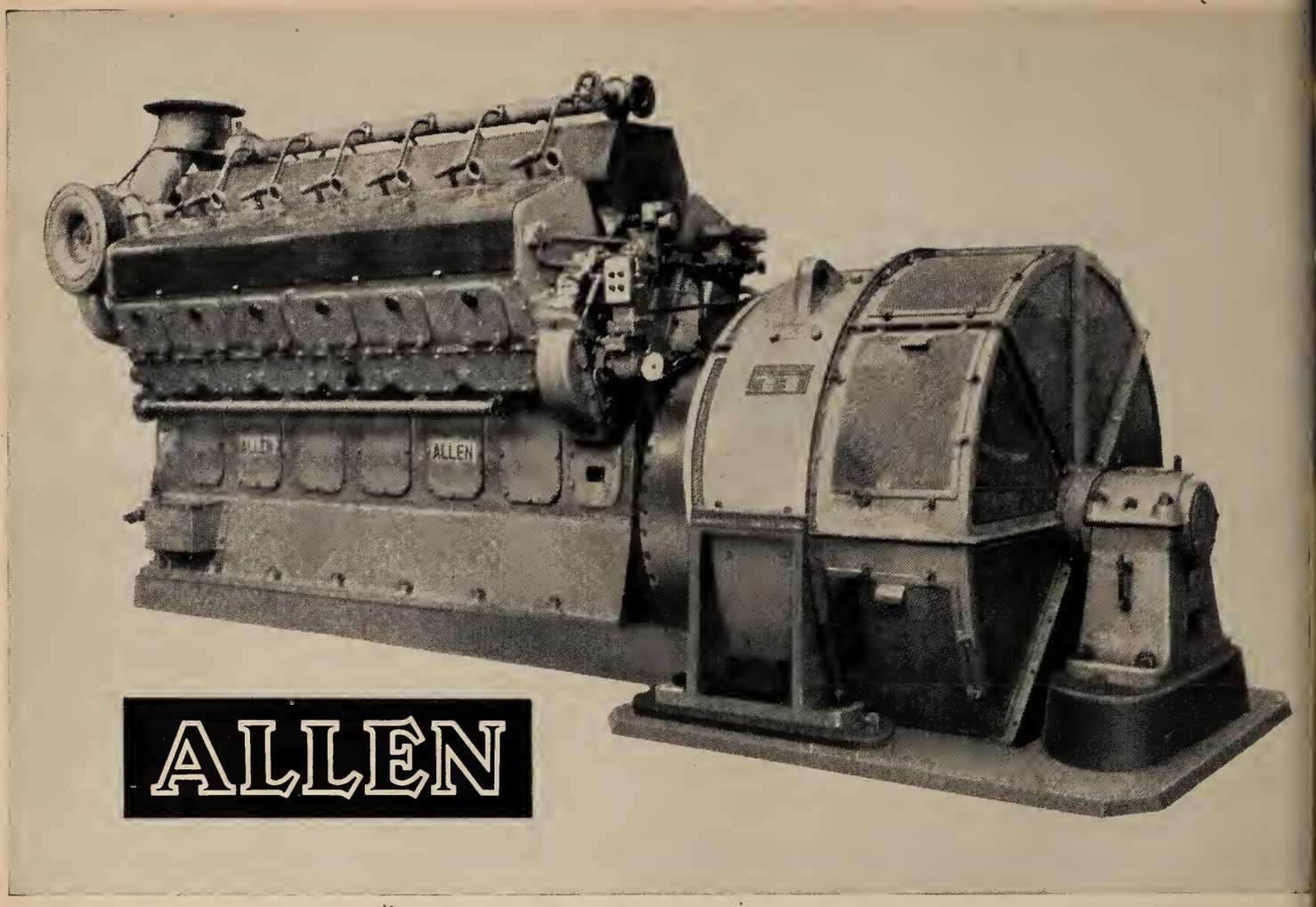

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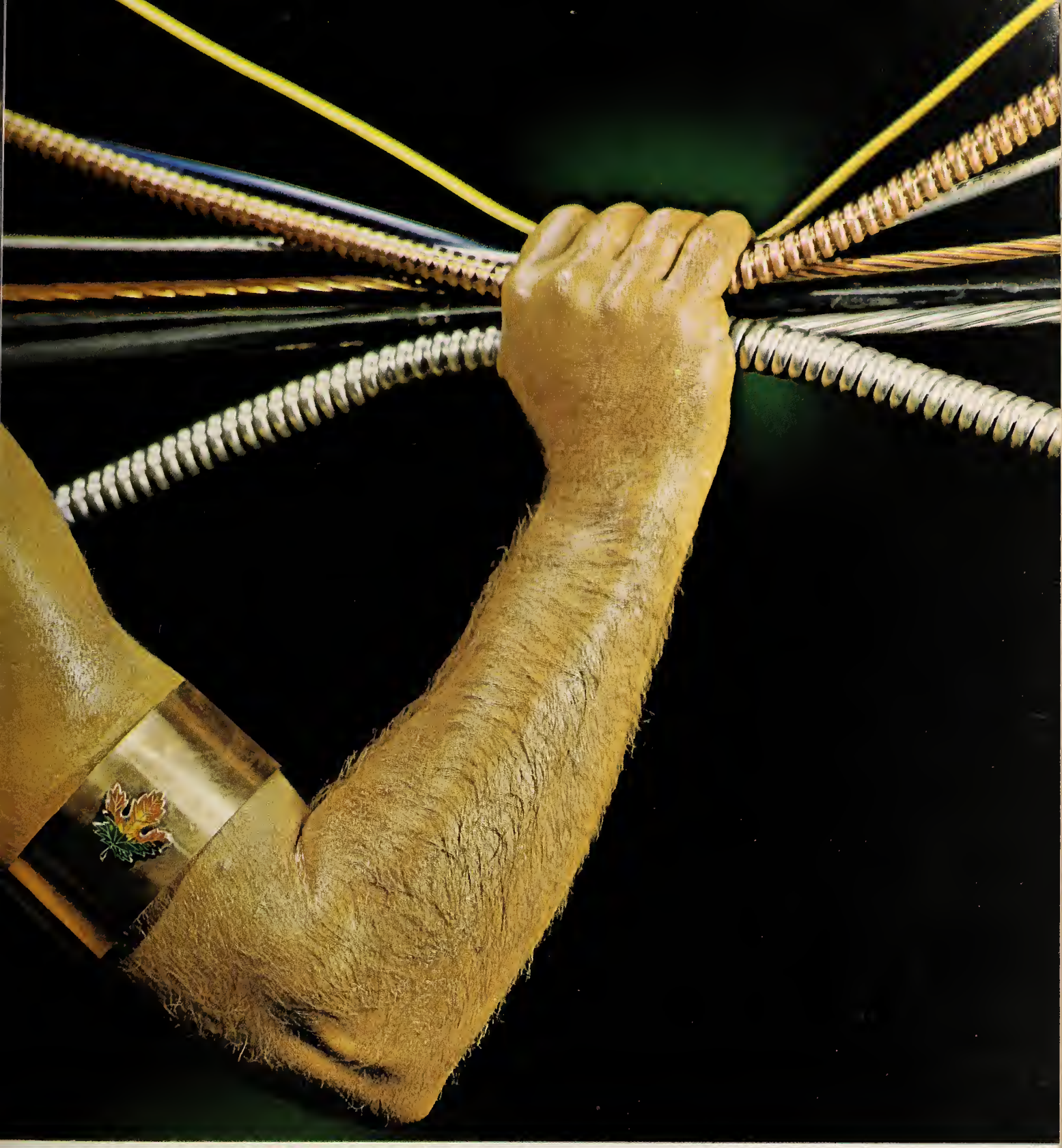

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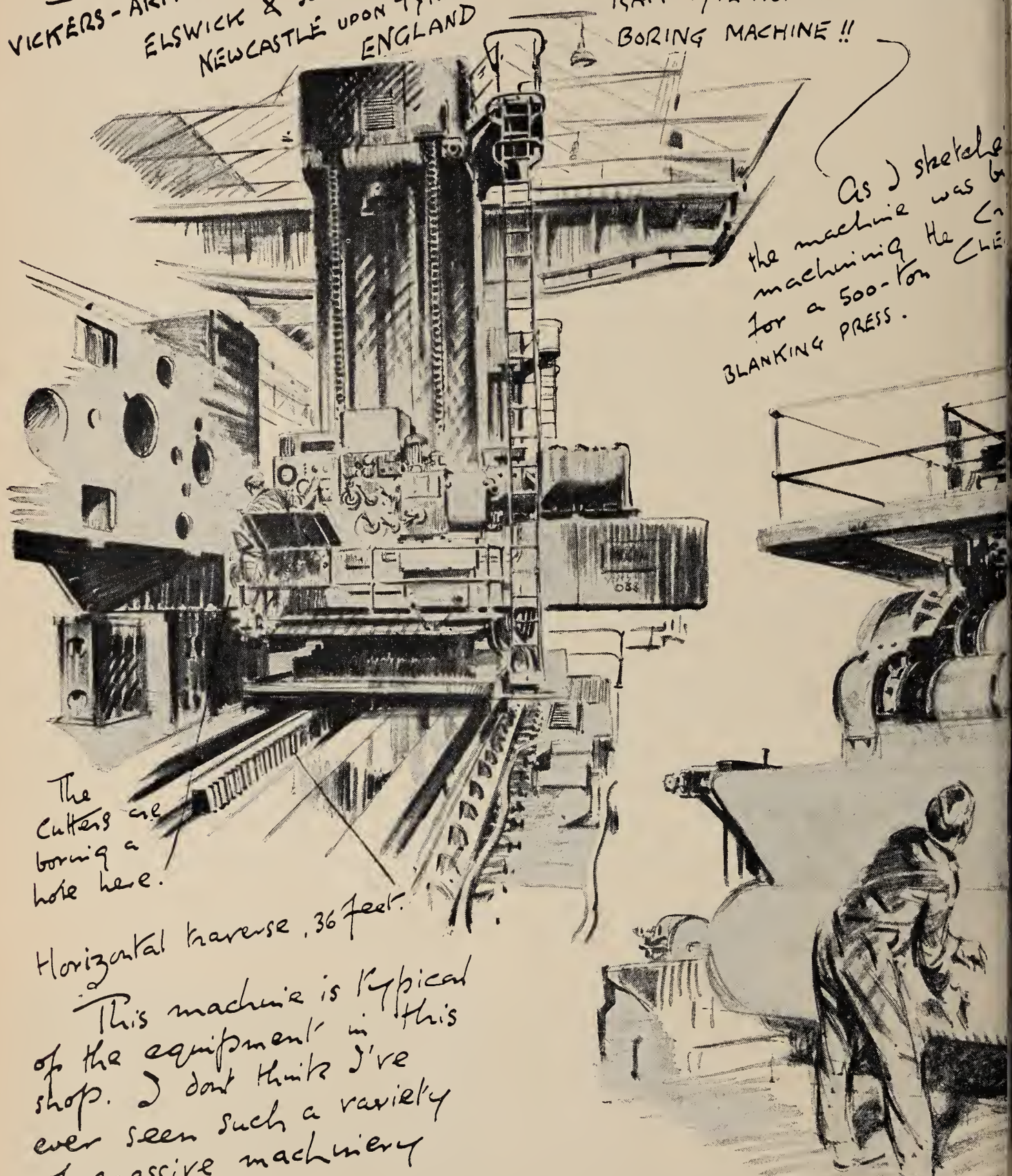
No XIV CONTINUED

THE VICKERS GROUP

VICKERS-ARMSTRONGS (ENGINEERS) LTD. This ponderous tower of painted st
ELSWICK & SCOTSWOOD WORKS, enjoys the humble title of :-
NEWCASTLE UPON TYNE. ASQUITH 7" DIAMETER SPINDL
ENGLAND RAM-TYPE HORIZONTAL MILLING
BORING MACHINE !!



As I sketche
the machine was b
machining the Ca
for a 500-Ton Che
BLANKING PRESS.

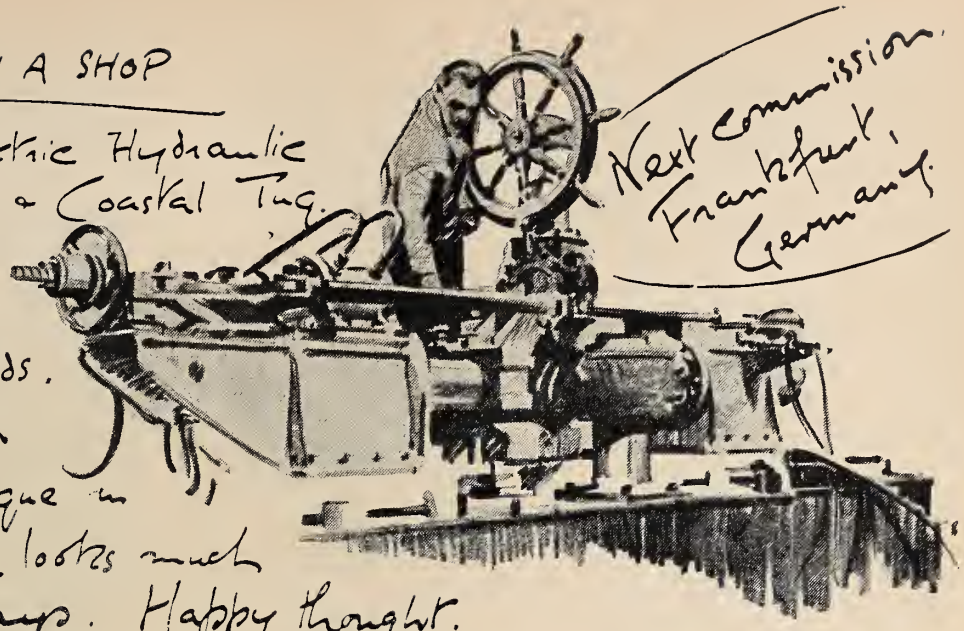
The cutters are boring a hole here.

Horizontal traverse, 36 feet.

This machine is typical of the equipment in this shop. I don't think I've ever seen such a variety of massive machinery

MEMBER COMPANY IN CA

STEERING A SHIP IN A SHOP



Next commission. Frankfurt, Germany.

Steering a Two-Ram Electric Hydraulic
ing Gear for a Harbour & Coastal Tug.
mum Torque of 15 tons ft
moving a KORT NOZZLE
through 50° in 12 seconds.
well !! Anyway, although
the very latest technique in
ing gear, the actual wheel looks much
did in Windjammer days. Happy thought.

A DUMMY RUN FOR THE BRISTOL "EVENING POST"

This 5-unit Scott Vickers Printing Press about to commence to roll, is driven by 55 H.P. D.C. motors & arranged to produce 90,000, 40-page Tabloid newspapers per hour ! Here are some features of the Press:-

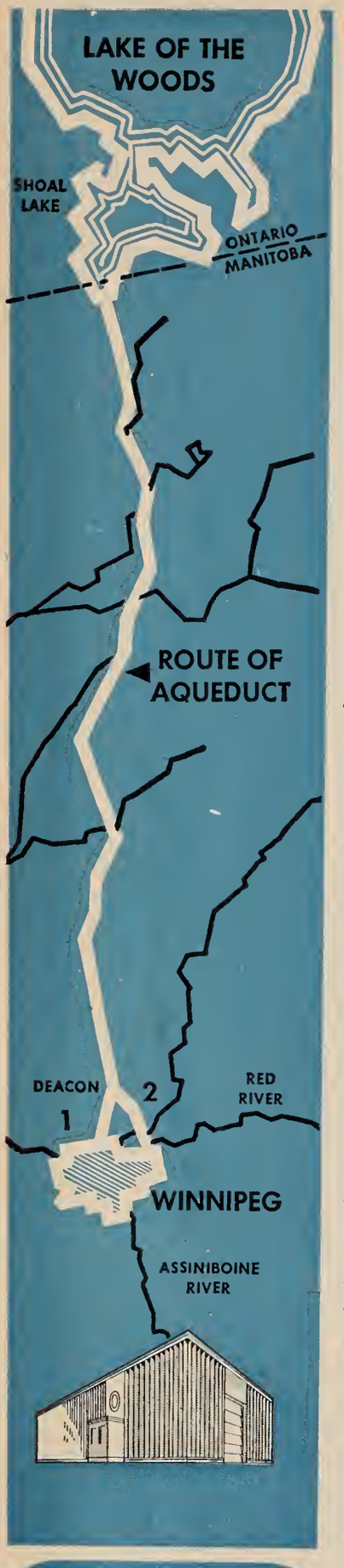
Chain Type Feed Mechanism
Pre-loaded Timken Glider Bearings.
Automatic Inlet Pumps.
Rotating Pump Rail.
Unit Mist Guards.
Running Fold Adjustment
Etc. etc. All in simple basic Chinese !!

"CUNEO"

Makeshift steps.

Reference was made last time to the wide range of engineering carried out at the Newcastle upon Tyne Works of Vickers-Armstrongs (Engineers) Ltd., and these further sketches by Terence Cuneo make this point extremely well. The steering gear assembly, incidentally links a previous activity of the Elswick Works which in the past built many fine ships. Now Vickers shipbuilding yards are at Barrow, Walker, Hebburn and Jarrow.

DIAN VICKERS LTD 4970 NOTRE DAME STREET EAST MONTREAL 4 QUEBEC

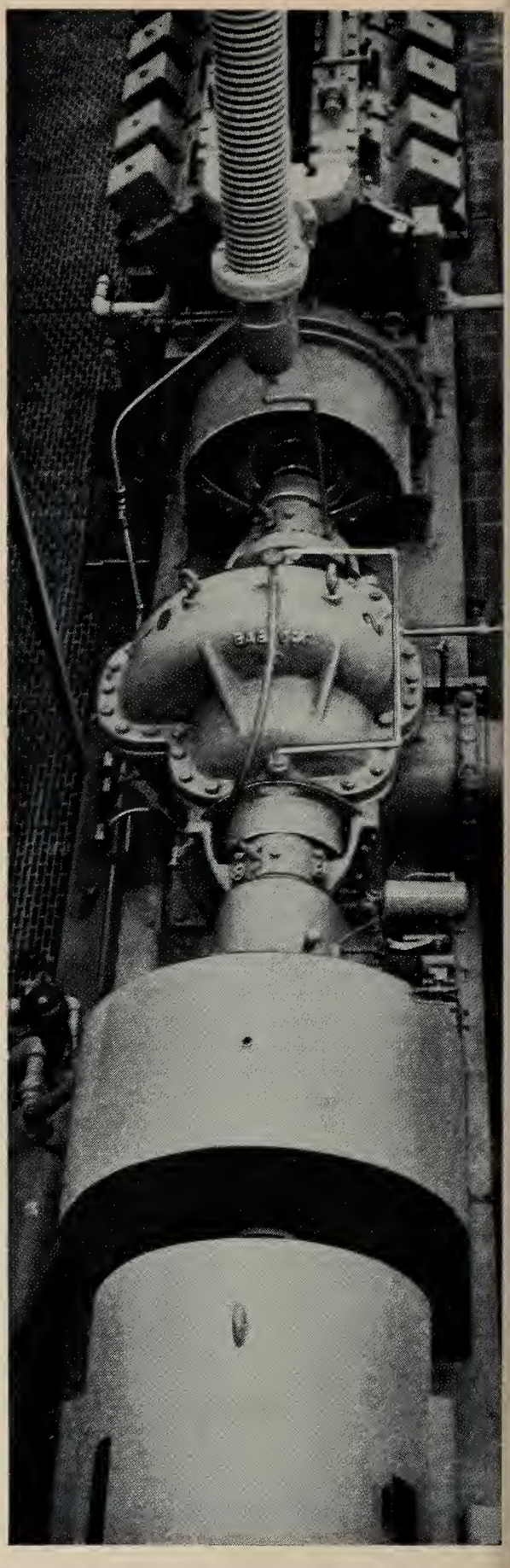


In step with expanding demands the City of WINNIPEG INSTALLED FIVE B&W PUMPS

The Metropolitan Corporation of Greater Winnipeg carries the responsibility of supplying pure water to the Cities of Winnipeg and St. Boniface and suburban municipalities. The water flows 97 miles from Shoal Lake to the city's reservoirs; from that point the City of Winnipeg disinfects and pumps the water to its distribution system and to the distribution system of ten suburban cities, towns and municipalities.

To assure adequate supply and pressure for present and future needs, 5 B&W pumps were installed in the modern, unattended W. D. Hurst Station... here a supervisory and automatic control system governs pressure, flow and other variables.

For information about pumps 'phone or write the nearest B&W Office ... there's a B&W representative qualified to discuss pumps for any application.



Illustrated: One of the dual driven B&W Pumps in the W. D. Hurst Station. Two pumps are constant speed motor driven, 12,500 USGPM capacity at 165' head. The other three pumps are variable speed; dual driven by motors (fluid drive) and natural gas engines; 8330 USGPM capacity at 165' head.

B&W

PUMP & TURBINE DIVISION

BABCOCK-WILCOX and GOLDIE-McCULLOCH LIMITED, GALT, ONTARIO

MONTREAL • TORONTO • CALGARY • VANCOUVER

Atlantic Provinces Agent—Foulis Engineering Sales Limited, Halifax, N.S.

EIC—63—CIV 1

FORM DESIGN FOR HIGH LIFTS

Olivier Y. Barde, M.E.I.C.

FORMWORK is one of the most important items of cost for most reinforced concrete structures, yet there is very little practical information available when a design has to be done.

Engineers are reluctant or too busy to write papers and describe their work in this field.

It is worth noting that out of the five locks built in Canada for the St. Lawrence Seaway, four were poured partly with specially designed forms, some 80 ft. in height. However, no information is to be found which could be useful should other jobs require similar forms.

A big obstacle in the use of high lift pour has been regulations concerning large mass pour in dams. However, in Canada high lifts were used very early, as for instance, during the construction of the Welland Canal[5] and on many jobs by the Ontario Hydro.

The most important element in the design of a form is the pressure of fresh concrete.

PRESSURE OF CONCRETE

Numerous publications deal with the pressure of fresh concrete of formwork, yet only but a few give practical information.

Theoretical treatment of the problem has been tried many times, however, the author feels that a satisfactory and practical solution has not yet been reached.

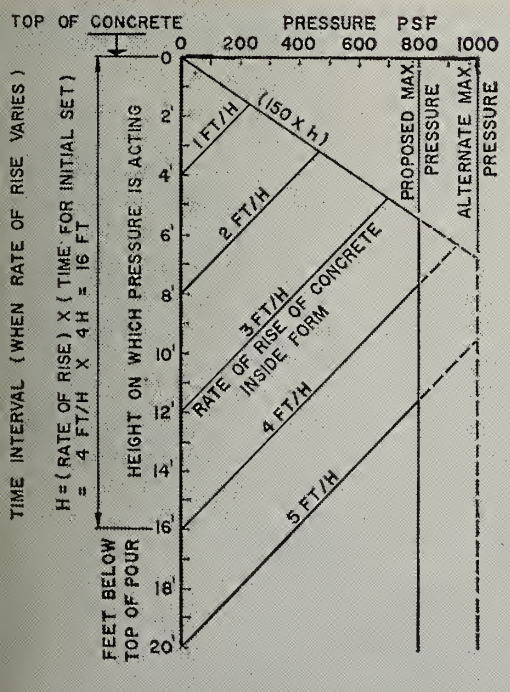
The factors generally considered are the slump, temperature, size of aggregates, amount of vibration and rate of rise of concrete inside the forms (the time element). One concept which is never considered in theoretical treatment is that of a maximum pressure which has been proved many times over in construction practice.

We could, in this instance, draw a parallel with the problem of bracing and sheething deep cuts in the ground. Observations made by construction engineers, such as Miller for the New York subway, led him to redesign his braces in a way unorthodox at the time, but which is now becoming standard practice.[6]

Another modern development which helps us to draw very useful conclusions is the slip-form method which consists of a short form some 4 ft. high, which is raised as the concrete is poured and which will, therefore, expose concrete surface which has been poured only a few hours earlier. This method proves that with a rate of pour of approximately one foot per hour (up to 20 inches per hour in summer) there is no need for lateral support four hours after the pour, in spite of vibration taking place 3 ft. to 4 ft. above.

This is a very important conclusion and allows designers to check formula or graphs giving concrete pressure. They will often find that very conservative figures will be obtained.

The writer had an interesting experience at Cote Ste. Catherine Lock (St. Lawrence Seaway) which led him to think that concrete behaves in a "lazy" way. There, in the middle of the pouring operation of a monolith, when the concrete was approximately 20 ft. above the bottom of the form, and anchor which had not been correctly placed gave way and the form opened at one edge. To everyone's surprise, only a limited amount of fresh concrete escaped. It was possible to remove it, close the form and proceed with the pour. It was felt that once the concrete was allowed to move slightly the pressure decreased rapidly. This phenomenom could be co-related to the use of slipforms where the inside dimension at the top of the form is usually ¼ in. to ½ in. less than the bottom dimension, thus allowing the concrete to move a frac-



RATE OF RISE OF CONCRETE IN FORM FT/H	MAX. PRESSURE AGAINST FORM PSF	HEIGHT EFFECTIVE PRESSURE FT
1	240	4
2	480	8
3	720	12
4	800 (960)	16
5	800 (1,000)	20
6	" "	24
7	" "	28

ASSUMPTIONS :

WEIGHT OF FRESH CONCRETE 150 LB/CU FT
INITIAL SETTING TIME 4 HOURS
PLACEMENT BY DROPPING CONCRETE
VIBRATION INSIDE CONCRETE
SLUMP UP TO 6"

SHADED TRAPEZOIDAL AREA ILLUSTRATES PRESSURE IN CASE OF A RISE OF CONCRETE OF 4 FT/H IN THE FORM SLOPE $\overline{AB}$ SUCH THAT $\overline{OB'} = \frac{40}{100}\,\overline{OA}$ (RATE CONSTANT)

FIG. 1 - PROPOSED MODEL FOR PRESSURE OF FRESH CONCRETE ON FORMS

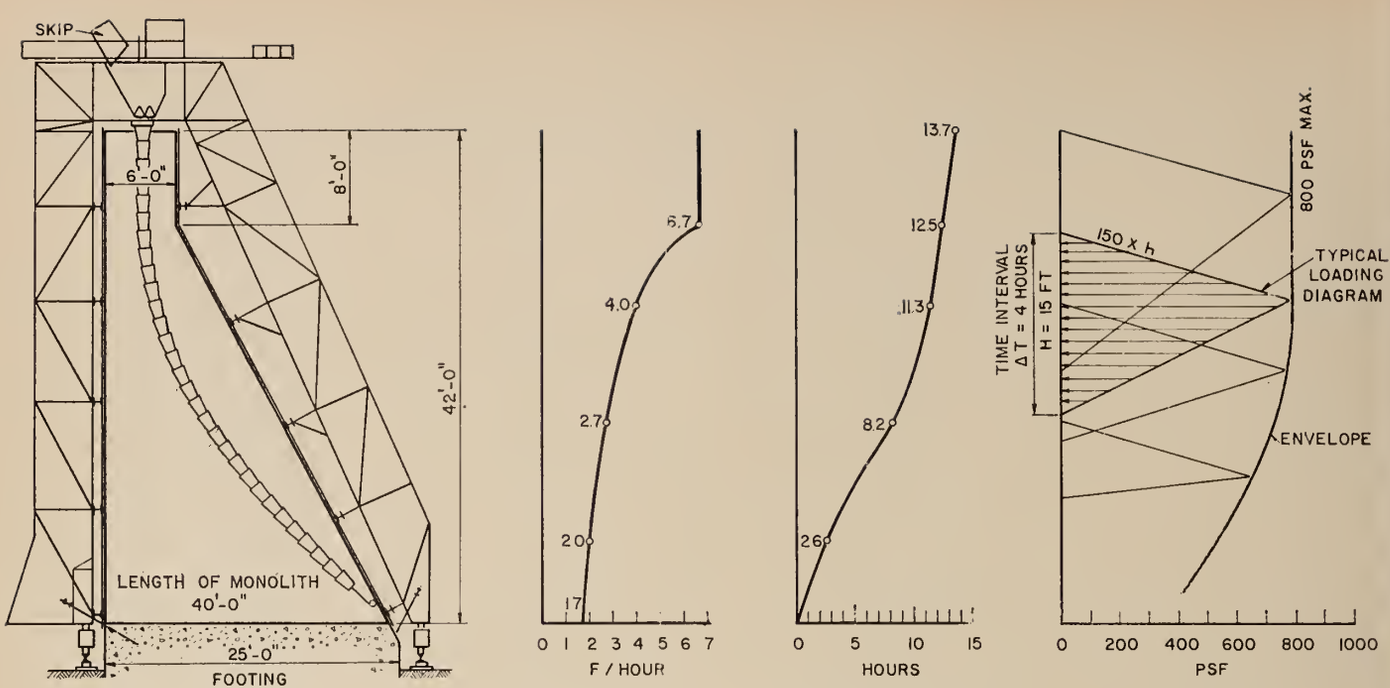


Fig. 2

tion of an inch as the form is raised. It should be pointed out that on a slipform job preceding quickly, there is no gap at the base of the form and that the concrete down to a foot below the form has still some plasticity as can be felt by rubbing it with a steel rod.

Further to the above remarks, the best information regarding the pressure of concrete was found in a publication of the Portland Cement Association[1] and in the recently published book by Gill.[2] It is a modified version of these graphs which is suggested in Fig. 1.

This proposed model for the pressure of fresh concrete on forms can be adapted to suit each designer's experience or special job conditions. The value of maximum pressure could be taken at some higher value than 800 p.s.f., say 1000 or even 1200, but it is believed that pressure in excess (such as 5600 in some publications) do not correspond to job conditions. The time needed for the initial set can be determined easily with the following field experiment. A set of slump cones will be filled in the standard way and lifted at regular intervals, say every half hour. When a zero slump is achieved, a measure of the time needed for the initial set is obtained. This will be a safe value

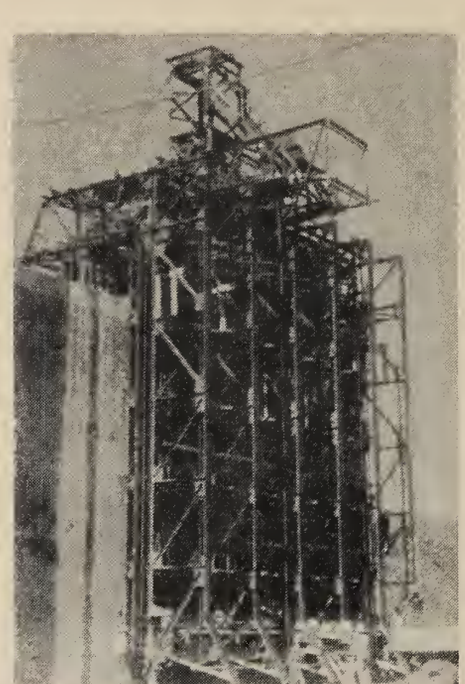


Fig. 3

as the heat dissipation is much larger here than in the form, where the mass of concrete takes more time to dissipate its heat.

Such an experiment was carried out by Dr. E. G. Swenson at the laboratory of Miron Co. in Montreal in April, 1961.

The following results were obtained; for a 3000 lb. mix, at 70°F:

CONE	No.	1	2	3	4	5	6	7	8	9	10
TIME	Hr.	0	½	1	1½	2	2½	3	4	5	6
SETTLING	In.	0	⅛	¼	⅜	⅜	⅜	⅜	⅜	⅜	⅜
GROSS SLUMP	In.	3½	2	1½	1¼	⅞	⅞	½	⅜	⅜	⅜
NET SLUMP	In.	3½	1⅞	1¼	⅞	½	½	⅛	0	0	0

Design of the travelling form for the entrance wall, Cote Ste. Catherine, St. Lawrence Seaway Lock

The design of these entrance walls called for some 90 independent monoliths, 40 ft. in length, approximately 40 ft. in height. The width at the base being 25 ft. at the top 6 ft.

It was decided to use one travelling form and to pour one monolith at a time, using the end of the monolit just completed as a form against which the new one could be poured. This way only one bulkhead was needed and the operation was continuous.

The concrete would therefore raise inside the form with a variable speed, which was approximately 2 ft. per hour at the bottom and almost 7 ft. per hour at the top. (Fig. 2).

The pressure of the concrete was established for the design of the frame by using a similar approach as the one described above. The maximum pressure was set at 800 p.s.f., and was obtained only in the upper part. The setting time was taken at four hours, which corresponded to the year-round condition in which the form was to be used.

The load on the frame was in the shape of a triangle, increasing as the pour progressed. The frame of the traveller was designed with two hinges, considering the various loading for each 5 ft. of raise of the concrete. The spacing of the frames was set at 8 ft. The front and back panels were built up with ¾ in. plywood covered with 24 gauge steel

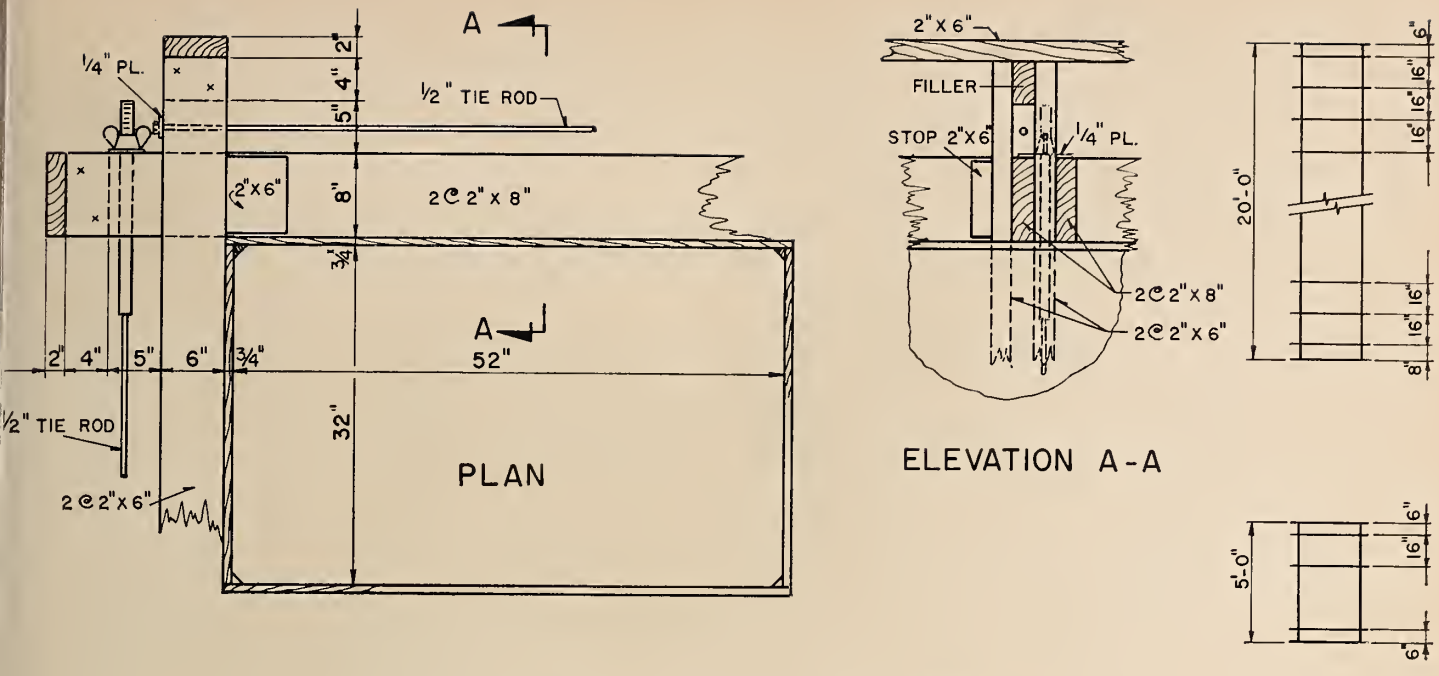


FIG. 4 - FORMS FOR COLUMN 32" X 52"

sheet. These panels were hanging under the frame. Wooden wedges were used to block it against the brackets extending from the trusses. The stripping was done by knocking off the wooden wedges and pulling the panels against the trusses with screw ratchets. (Fig. 3).

The lateral bulkhead was of similar construction, but built up as one piece with horizontal trusses attached to the panels. At the time of design, the pressure of the concrete against this bulkhead was figured and it was deemed necessary to provide anchors in the previously poured monolith to take up these forces. However, under job conditions the friction against fresh concrete proved so high that the bulkhead was simply pulling on the front and back panels, and no force was transmitted to these anchors. This was even true in an extreme case when a monolith only 8 feet long was poured. (In this case, the form was pulled only 8 feet from the previous monolith).

The pouring set up consisted of a tower rolling on top of the form which pulled a 2 cu. yd. skip between the front trusses. The complete form was self-moving on rails, with electric motors acting on two wheels.

The total weight (excluding the panels and the pouring set up) was 93 tons. Cost of this form was approximately $41,000.00. It was built by Lord & Co. on Montreal.

The performance of this form was very satisfactory, and a cycle of 24 hours for the complete operation (moving, set up, pouring and stripping) was obtained. Curing took place after stripping with water sprays.

Design of column forms for the Metropolitain Blvd., in Montreal

The design of this reinforced concrete expressway called for some 800 columns, 32 by 52 inches in section and averaging 22 feet in height. The General Contractor, Miron-Stirling-Walsh decided to build his own forms, using an all wood construction. (See Figs. 4 & 5).

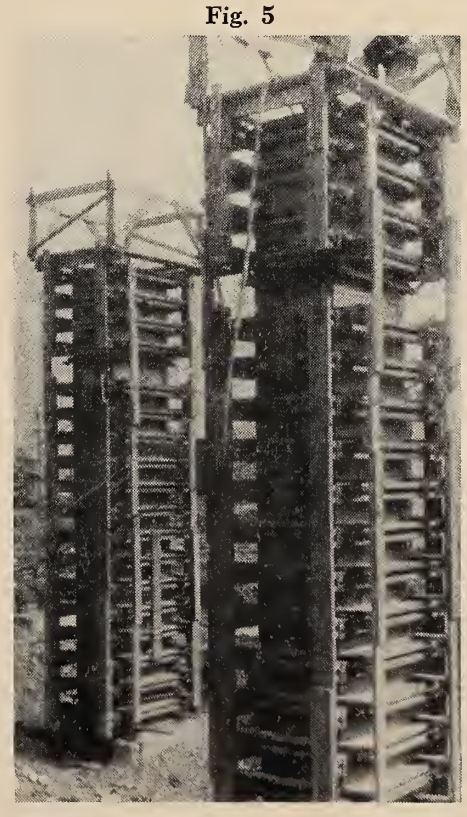
The maximum pressure taken at 800 p.s.f. on the full height as a fast pouring rate was expected.

Usually, four columns were poured in one operation. When the columns were 20 ft. in height or less, each column was filled completely in approximately one hour. When the columns were higher, about half the height was poured at a time, then men and equipment would be shifted to the next column. The pour of each column was therefore interrupted from three to four hours.

In a few instances, this rule could not be followed, but no failure was recorded.

Concrete was very liquid, with a minimum slump of 6 in. and was dropped from the top of the form, causing a very strong impact. Three vibrators were used simultaneously inside the form, but no external vibration was performed.

Fig. 5



CONCLUSION

The experience described above led the writer to think that, for the design formwork, it is safe and economical to assume a maximum value to the pressure of the concrete and unsign of formwork, it is safe and economical to assume a maximum value to the pressure of the concrete and unnecessary to consider any pressure after the initial set has taken place.

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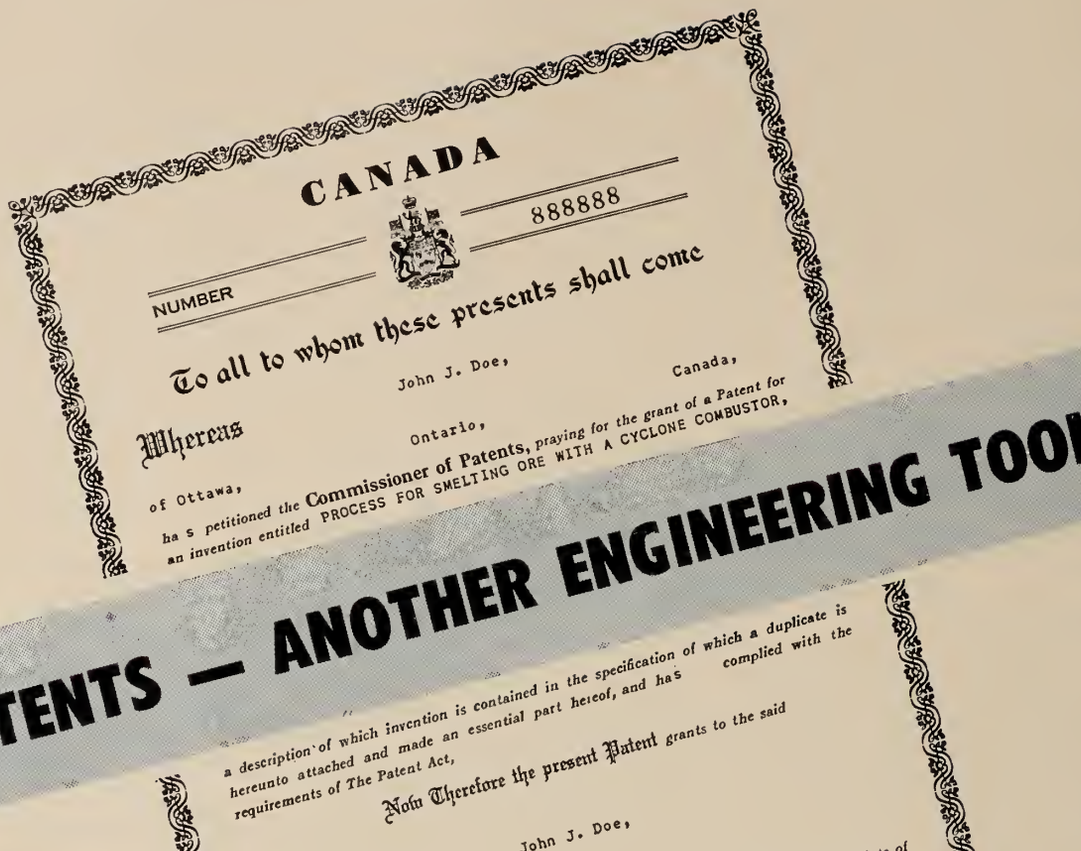
PATENTS — ANOTHER ENGINEERING TOOL



CANADA

NUMBER 888888

To all to whom these presents shall come

Whereas John J. Doe, of Ottawa, Ontario, Canada, has petitioned the Commissioner of Patents, praying for the grant of a Patent for an invention entitled PROCESS FOR SMELTING ORE WITH A CYCLONE COMBUSTOR, a description of which invention is contained in the specification of which a duplicate is hereunto attached and made an essential part hereof, and has complied with the requirements of The Patent Act,

Now Therefore the present Patent grants to the said

John J. Doe,

and his legal representatives for the period of Seventeen Years from the date of these presents the exclusive right, privilege and liberty of making, constructing, using and vending to others to be used in Canada the said invention subject to adjudication in respect thereof before any court of competent jurisdiction.

Provided that the grant hereby made is subject to the conditions contained in the Act aforesaid.

In Testimony Whereof, I have hereunto set my hand, and caused the Seal of the Patent Office to be hereunto affixed, at the City of Ottawa, in Canada, this second day of October in the year of Our Lord, one thousand nine hundred and sixty-two.

Commissioner of Patents.

Gordon A. Asher

Research & Development Division,
Canadian Patent Office,
Ottawa.

THE FORMAL WORDS quoted above serve as a preamble to each grant of a patent for invention issued in Canada. Their archaic form indicates the long tradition behind our patent system. Their obscurity reflects the general unfamiliarity of many Canadian engineers with the operations of our Patent Act. As our civilization advances it is increasingly important that this unfamiliarity be dispelled.

Stored away in the files of the Patent Office in Ottawa is a mine of scientific and technical information waiting to be tapped by our industrialists and engineers. To date 650,000 Canadian Patents have been issued, a figure which increases by 2,000 each month. Every year 7,000 patents fall into the public domain, free for the taking, and many patents still in force are available for licensing. The growing patent literature is a valuable fountain of information for those scientists, technicians, and manufacturers who wish to keep up to date on the latest technological advances.

Canada can ill afford to neglect any of the tools of progress available, and if it wishes to maintain its position as a leading industrial nation our engineers must become more familiar with our patent system. Other countries have long recognized the value of patent literature. To quote from a Russian publication, "SECRETS OF THE PATENT LIBRARY" by Valerii Agranovski, which appeared in the Ekonomicheskaya Gazeta, No. 3:

"What is the final product of any scientific and technical work? Scientific-technical information. The higher its level and the better the state of organization it reaches, the more rapidly scientific and technical progress grows. The patent serves as a source of this information, and at times the only source. This is the reason why it is so important to provide education in patent culture."

EXPLAINING PATENTS

For those unfamiliar with our patent system, the simplest introduction might well be to present fourteen basic questions frequently put to the Patent Office, together with answers to them. For brevity and simplicity some of the complicating factors that may arise are not discussed.

WHAT IS AN INVENTION?

It is some technological development or improvement that would not have been obvious beforehand to specialists in the technology being considered. Workshop improvements and simple changes or alterations to what has gone before do not amount to invention. An invention involves some obvious and unexpected result, the product of inventive ingenuity.

WHAT IS A PATENT?

A patent is a form of contract between the government and an inventor. In return for a full disclosure of his invention and the way in which it works, the inventor is given exclusive rights to his invention for 17 years. During that time only he can practise his invention. Afterwards, everyone is free to make full use of it.

WHAT IS PATENTABLE?

An invention that is new, useful, and has not been disclosed before is patentable. Patents are granted for processes, machines, and compositions of matter, including, for example, manufactured articles, manufacturing processes, chemical compounds, chemical processes, machinery, drugs, surgical supplies, and new products. Scientific theorems, or things with illicit or immoral purposes, are not patentable. Neither are new varieties of horticultural plants, though in some countries, notably the United States, they may be protected. New designs are subject to design protection, not patent protection. New works of art are subject to copyright protection, and are not patentable.

WHY DO WE HAVE A PATENT SYSTEM?

The main purpose is to encourage disclosure of new inventions. Before the patent system developed, inventors kept their inventions secret, to prevent others from stealing their ideas. When the inventors died, their inventions were lost to mankind. But with a patent inventors can obtain short term protection in their inventions without fear of others also discovering or stealing it. Because the invention is disclosed in the patent, others can make use of the new ideas revealed to develop further improvements, or better or different ways to obtain the same result. Free exchange of information promotes further advances. For example, once Kodak patented colored Kodachrome film, Ansco. Ferrani, Gaevert and others were encouraged to develop their own color films, each with particular advantages and uses not common to the other.

Furthermore people are encouraged to invent because of the possibility of patenting their invention and securing tangible reward for their efforts. Patents also encourage commercial exploitation of inventions by stimulating the flow of risk capital.

All the major industrial countries of the world, whether capitalistic, socialistic or communistic, have recognized the importance of a patent system in their industrial development, and grant patents.

HOW DO I GET A PATENT?

It is necessary to file a full disclosure of the invention with the Patent Office together with the necessary fees. The filing fee is $30 for each application. The form and manner of filing are prescribed in the Patent Act, and the Patent Rules. Copies of each may be purchased by writing to the Patent Office, Ottawa. The charge for each is 35 cents. The application for patent will be examined to determine if it meets all the statutory requirements and is in proper form.

If acceptable, the application will be allowed. There is a further fee of $30 upon payment of which the patent will issue. In some instances other incidental fees are required during prosecution.

ONCE I HAVE MY PATENT AM I FREE TO PRACTICE MY INVENTION?

Not necessarily. If, for example, the invention is an improvement on another invention protected by an unexpired patent, then you may infringe the prior patent by practising your invention. In such a case you must make arrangements with the prior patentee before manufacturing.

IS A CANADIAN PATENT VALID ELSEWHERE?

No. Each country issues its own patents. It may be necessary to obtain patents in several countries to protect an invention adequately. Each country has developed a different patent system to suit its own economic conditions and requirements. In Canada, for example, there are provisions for compulsory licenses in order to encourage manufacturing in Canada, while in the United States, which is already highly industrialized, this has not been considered necessary. New varieties of plants may be patented in the United States, but in Canada this form of protection has not been thought advisable. Switzerland grants patents in relatively few fields (watchmaking, for example), since in other areas patents have not been judged economically desirable. The term of a patent also varies in different countries, again because of economic and other considerations.

MUST I LIVE IN CANADA TO OBTAIN A CANADIAN PATENT?

No. Residents anywhere in the world may obtain a patent in Canada. Similarly Canadians can obtain patents in most other countries. Some Canadians, for instance, hold patents in Soviet Russia. An International Patent Convention to which Canada subscribes facilitates filing abroad by Canadians.

HOW OLD IS THE PATENT SYSTEM?

The first Patent for an invention granted in Canada was given to Samuel Hopkins in 1791 for a process to make potash. It was issued by the governor-in-council. The first patent act to provide a regular system for granting patents was passed in Lower Canada in 1824. The other provinces quickly followed suit. In 1869, after Confederation, the federal government passed a patent act applicable to the whole country. Periodic revisions have been made to it, the last major revision taking place in 1947.

The first United States patent was granted in 1790 over the signatures of George Washington and Thomas Jefferson. The British have had patents for even longer periods. Henry III granted one in 1236 to encourage the establishment of new industries in England. The ancient Greeks granted patents as far back as 500 B.C.

DO PATENTS INCREASE COSTS TO THE PUBLIC?

By stimulating research and industrial development the patent system promotes higher standards of living and lower living costs. At times

certain products could be manufactured more cheaply abroad and sold at a lower price in Canada if there was no patent protection, but the industrial development of Canada would suffer. Unscrupulous manufacturers who copy or steal the invention of another could produce more cheaply by avoiding the research charges involved in developing the invention. This, however, would inevitably lead to a return to the chaotic condition existing before the patent system developed when improvements were kept secret and disclosed to no one. Experience indicates that best results are obtained by permitting the inventor a fair return on his investment through the patent system. Fortunately the Canadian patent system contains special provisions to protect the public against abuse of patent rights. These are discussed in the next question.

WHAT PROVISIONS ARE THERE TO PREVENT ABUSE OF PATENT RIGHTS?

The Canadian Patent Act includes special provisions to protect the public against abuse of patent rights. If the patentee does not work his invention in Canada, or hinders manufacture in Canada by importation from abroad, if he does not supply the market to an adequate extent, or on reasonable terms, if he refuses to grant a license contrary to public interest, or unfairly prejudices any industry in Canada, then the Commissioner of Patents can grant licenses to others, or, in some cases, revoke the patent.

ARE NEW DRUGS PATENTABLE?

Yes. But in the case of new chemical compounds which are foods or drugs protection can be obtained only by way of the processes for preparing them. Others who develop new ways of preparing the same compounds would not be subject to the patents. Furthermore anyone who wishes to manufacture in Canada under any patent intended for or capable of being used for producing foods or medicines can obtain a compulsory license on reasonable terms to do so.

MAY I PROSECUTE MY OWN APPLICATION?

Yes. Though usually it is not advisable to do so. Drafting an application, claiming all you are entitled to while still avoiding pitfalls which could invalidate your patent, knowing how and when to amend, all these are tricky matters best left to an expert. Registered patent agents are available, and while their services cost money such money is usually well spent. Only registered patent agents are entitled to act as agents for others before the Patent Office. To register they must pass a stiff examination designed to weed out those unqualified to represent inventors. Before dealing with an agent, it may be advisable to write to the Patent Office to see if he is registered. The Office provides lists of agents registered to practice in various localities across Canada.

One of the duties of a patent agent is to advise whether an invention should be patented. He conducts searches of prior patents to determine if an invention is really new. If it is not new, filing an application for it would be a waste of good money. The agent will advise in which countries to file, prepare the application, and handle the prosecution. It may be desirable to obtain from him an estimate of the costs involved, since if the invention is complicated or the prosecution involved the charges can be considerable.

WHAT DOES "PATENT PENDING" MEAN?

Many manufacturers stamp their wares with the words "patent pending". This simply means that an application for patent has been filed. It does not mean that a patent has issued. Indeed the application may never issue to patent. Inventions are not subject to patent protection until the patent has actually issued. The invention may be copied and sold freely until the patent does issue. This marking does serve to warn others, however, that a patent may issue, and that it may be dangerous to become involved extensively in case a patent should be granted.

After a patent has been granted, patentees must indicate this on their wares. Hence the words "Patented, 1962," together with the patent number, or some similar marking, is stamped or printed on the patented articles sold. Remember, though, that U.S. patents have no force in Canada. Canadian patent numbers do not run higher than 650,000. Recent U.S. patents run from 2,000,000 to over 3,000,000.

ORGANIZATION AND OPERATION OF THE PATENT OFFICE

The Canadian Patent Office is located in Ottawa, and is part of the Department of the Secretary of State. It is administered by the Commissioner of Patents, J. W. T. Michel, and the Assistant Commissioner of Patents, F. W. Simons. The Patent Office administers the Copyright, Registered Design, and Timber Marks Acts in addition to the Patent Act.

On the staff are about 150 engineers and scientists employed as "Patent Examiners." Each examiner is a specialist in a particular field, and handles the prosecution of applications filed in his specialty. For example, some examiners specialize in radio communications, others in computers, turbines, automatic transmissions, or refrigeration. About 17% of all applications are electrical in nature, 30% chemical, and the remainder mechanical. The examiner must see that each application meets all the legal requirements of the Act and Rules, must determine if it is new, and must assess whether inventive ingenuity is present. This latter assessment is one of the more difficult aspects of an examiner's work. Every trick seems simple when you are shown the solution, and many inventions seem obvious by hindsight, though they may by no means have been so before. In a radio circuit, for example, a simple alteration may change the whole nature and function of the circuit, or it may amount to only a minor insignificant improvement. Only a skilled electrical engineer can tell just how obvious the change has been.

To decide if an invention is new, the examiner searches prior Canadian patents, technical literature, and foreign patents. The examiner does not test inventions to see if they actually work as described, nor that they possess the advantages attributed to them. Because an invention is patented does not necessarily mean that it is really worthwhile. In actual fact, only a small percentage of the patents granted each year are commercially successful. Many do not prove as useful or practical as the inventor had hoped. Others are quickly superceded by better inventions. Others fail to win public acceptance.

Examination, in some instances, may carry on over several years. If the application is not acceptable the applicant is given the opportunity to amend it, or to try to pursuade the examiner to change his view.

In the event that two applicants claim the same invention, special conflict proceedings are instituted to determine inventive priorities. Rejections and other decisions of the examiner may be appealed, ultimately to the Exchequer and Supreme courts if necessary. Last year 25,000 applications were filed, 22,000 allowed, and 3,000 rejected by the examiners or abandoned by the applicants.

The Patent Office does not police patents. Patentees must protect their rights by means of legal action against infringers.

USING THE PATENT LITERATURE

Existing patent literature holds the answers to many of the technical problems facing industry today. Many a research program has duplicated earlier work already reported in patent specifications of one country or another. Even when a specific problem does not require a solution, reviewing patent literature frequently shows ways to improve existing processes and techniques, or will generate further ideas leading to improvements, new inventions, or savings. But one must know how to get at this information. It provides a means of keeping industry posted on the latest advances, reveals where competitors are moving, and may prevent lawsuits which could arise when patented processes are being used.

Copies of all Canadian Patents issued are on file in the Patent Office, classified by subject matter to simplify searching and to permit restricting a search to specific fields of interest. This saves reviewing all the patents issued. All records of issued Canadian Patents are open to public search at the Patent Office, free of charge. Printed copies of each patent issued since 1948 may be purchased for $1.

Copies of most foreign patents are also on file at the Patent Office, where they may be studied. Australian, Austrian, Belgian, British, French, Italian, Japanese, Netherland, Swedish, Swiss, and United States patents are included. Photocopies of them may be ordered for a small charge. The U.S. patents are also classified as an aid in searching.

Each Tuesday the Canadian Patent Record is published. It lists and describes all the inventions patented during the week. Copies of these are available at most provincial, university, and large municipal libraries across Canada. Single copies sell for $1, and annual subscriptions for $40 Foreign patent offices publish similar gazettes, copies of which are filed in the Patent Office library.

HOW TO FILE AN APPLICATION

It is impossible in a short article to describe all the details of prosecution of an application for patent before the Patent Office. However some important features can be discussed briefly.

An application consists of a petition, a specification in duplicate, including disclosure and claims, a third copy of the claims, drawings to illustrate the invention and the filing fee.

The disclosure gives a full description of the invention. The claims do not, as is sometimes thought, list the supposed advantages of the invention. Instead they provide a short synopsis or definition of the invention actually patented and in which an exclusive property is granted. A copy of patent 554,808, one of the shortest Canadian patents, illustrates the general nature of a disclosure and claims. It does not, however, include drawings, which are required to illustrate most inventions. By contrast, one of the longest specifications, patent 580,556, has 204 pages of printed text, and 166 sheets of drawings showing 376 figures.

The application must be filed within two years of the first publication of the invention, and within two years of its first public use or sale in Canada. If the inventor, or anyone else, has published a description of the invention anywhere in the world, or made public use of it in Canada more than two years before the application is filed, then a patent may not be granted. Only an original inventor may obtain a patent (this rules out copying inventions patented elsewhere to file here). Other important statutory requirements must also be met.

Ownership of applications and patents may be sold, in whole or in part, to others. Such assignments of interest should be registered in the Patent Office to protect the purchaser.

AUTOMATED INFORMATION RETRIEVAL

Searching the prior patent literature can be a tedious and time-consuming task. In fact, the growth of this literature could bury the patent examining system by virtue of its sheer size and overwhelming bulk. Recognizing this problem, leading patent offices throughout the world are cooperating in developing automated information retrieval techniques to their searching problems. The United States is taking the lead in this work, using punched card sorters, and computer tapes. Canada, too, is investigating the problem, experimenting with punched cards in chemical arts, and Batten Cards in electronic fields. Though these efforts are directed primarily to patent office problems, the final results may prove of inestimable value to industry generally.

CANADIAN INVENTIVE INGENUITY

Today's inventions, reflecting as they do the modern technological research of industry and government, have advanced in complexity and ingenuity over the simpler inventions of earlier days. That is not to say, of course, that there is no longer room for the small independent inventor to improve our material comforts and pleasures, as many Canadians, — farmers, housewives, fishermen or mechanics — are doing. Their contributions include new agricultural instruments, kitchen utensils, fishing lures, hydrometers, curtain hangers, carton, floor polishers, and the like. But each year a greater proportion of the new inventions are directed to plastics, electronics, computers, nuclear reactors, antibiotics, alloys, jet engines, or interplanetary rocket fuels. Typical are the patents of the transistor, radar, streptomycin, nylon, the hovercraft and the vertical take-off plane. Though Canada is a small nation, it has made significant contributions to these more important inventions. Names such as Bell, (the telephone); Banting and Best, (insulin); Dempster, (uranium 233); Hellier, (the electron microscope); Honroteau, (television cameras); Green, (the cobalt bomb); George Wright, (explosives); Wilson, (carbide chemistry); Lemieux, (ustilagic acid); Asselberg, (instant flake potatoes); and J. G. Wright, (the R. Theta Computer), merely serve to introduce any list of important Canadian inventors.

We cannot rest on our oars. Our country has been blessed with an abundance of natural resources that give promise of a bright future, but without a continuing ability to originate new ideas and to put them to use that promise will not bear fruit. Stuart M. Finlayson, president of the Canadian Marconi Company made the point, at the 1962 meeting of the Patent & Trademark Institute of Canada, that we will lose our leadership and the benefits of our heritage to the emerging nations of Asia and Africa if we do not develop to the fullest our inventive talents, and promote those talents with a healthy patent system. An American, Lockheed Vice-President Kelly Johnson, who led the development of the U-2 spy plane, put it this way: "We are not lacking in the capability to invent. Where we have trouble is in the incentive to invent".

We must turn to the technological specialists, — the engineers and scientist, — not only to play the leading role in creating the important advances of the future, but in improving the incentive to invent, our patent system.

EIC—63—MECH 1

RAIL VEHICLE NOISE

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THERE WAS a time when noise from rail vehicles — especially subway trains — was always placed at the top of the list of unpleasant noises. In recent years the picture has changed somewhat. On the one hand even more noisome noises such as jet aircraft have become commonplace; and on the other, there has been a substantial effort to reduce rail vehicle noise. The worst offenders have been retired and what is more the whole category of street cars has been largely replaced by buses or underground systems. The general attitude about underground systems has changed too. The earliest ones were purely utilitarian, and they looked it and sounded like it; today the customer expects to be transported not only rapidly but in reasonable comfort. The main thread of this discussion will therefore be rapid transit problems, although there will be an occasional reference to a comparable problem in railroad systems.

What constitutes a noise depends on your point of view. A passenger on a rapid transit system has a vested interest in it — he wants to be transported somewhere rapidly — and he will tolerate a certain amount of noise in the accomplishing of this. The dweller in an adjacent apartment, on the other hand, has no such interest, and will not appreciate hearing trains passing through his bedroom or living room. Measures for the control of noise also depend on whether you consider occupants of subway trains or of adjacent buildings. Hence it will be necessary to distinguish between the two viewpoints when discussing noise control problems.

CRITERIA

It has been suggested that the subway passenger tolerates a reasonable amount of noise. It would be more precise to say that he prefers a certain optimum amount of noise. Certainly the level must be kept below the range of discomfort or pain. Somewhat below this is the level at which speech communication becomes possible. The passenger will wish to be able to talk to his nearest neighbours, say at a range of two to four feet, in a raised voice if necessary. This marks the upper limit of the optimum range. The lower limit is determined by the fact that he does not ordinarily wish to talk or listen to all the rest of his fellow travellers. One can express rather precisely the noise requirements that will permit conversation, perhaps in a raised voice, at two to four feet but make communication increasingly difficult beyond that range.

Speech intelligibility depends mainly on the middle frequencies (about 500 to 2000 cycles/sec). This is also the range of maximum sensitivity of the ear, and hence the region that matters most in determining the subjective impression of loudness of a complex sound. The two factors, loudness and speech communication, are both found to govern the acceptability of noises and the well-known noise criteria, or NC curves, which take both factors into account are useful in classifying complex noises. Fig. 1 shows the application of these criteria to the subway noise problem. A suitable objective is the range NC-55 to NC-65; the NCA-65 contour is equivalent to NC-65 from the viewpoint of speech intelligibility, but is less acceptable from the viewpoint of loudness. A further requirement in applying these criteria is that the noise have a continuous frequency characteristic with no discrete frequencies, which have a more disturbing effect than can be judged simply by their intensity. Such noises as the whine of a motor-generator or the clatter of a compressor are in this category. The lower limit of the optimum range is actually below NC-55, perhaps NC-50 or NC-45; this is an appropriate objective for railroad coaches which travel at high speeds for long periods. But in a subway system maximum speed is reached only for a minute or so at a time between stations, and at every stop there is a shuffle of incoming and outgoing passengers that raises the level to about NC-55 in any case.

Also shown in Fig. 1 are two noise spectra for the Toronto Transportation Commission subway, corresponding to operations with open and closed windows. These measurements were taken at normal speed and on a curve, and represent about the maximum that occurs. It will be noted that the closed-window condition meets the objective fairly well, but the open-window condition is somewhat high.

For comparison Fig. 2 shows similar spectra for the interiors of other vehicles. The top curve is for commercial passenger aircraft. This is said to be "accepted" by passengers, but not, I might say, without some grumbling. As a result the newer aeroplanes, especially the jets, are a little quieter.

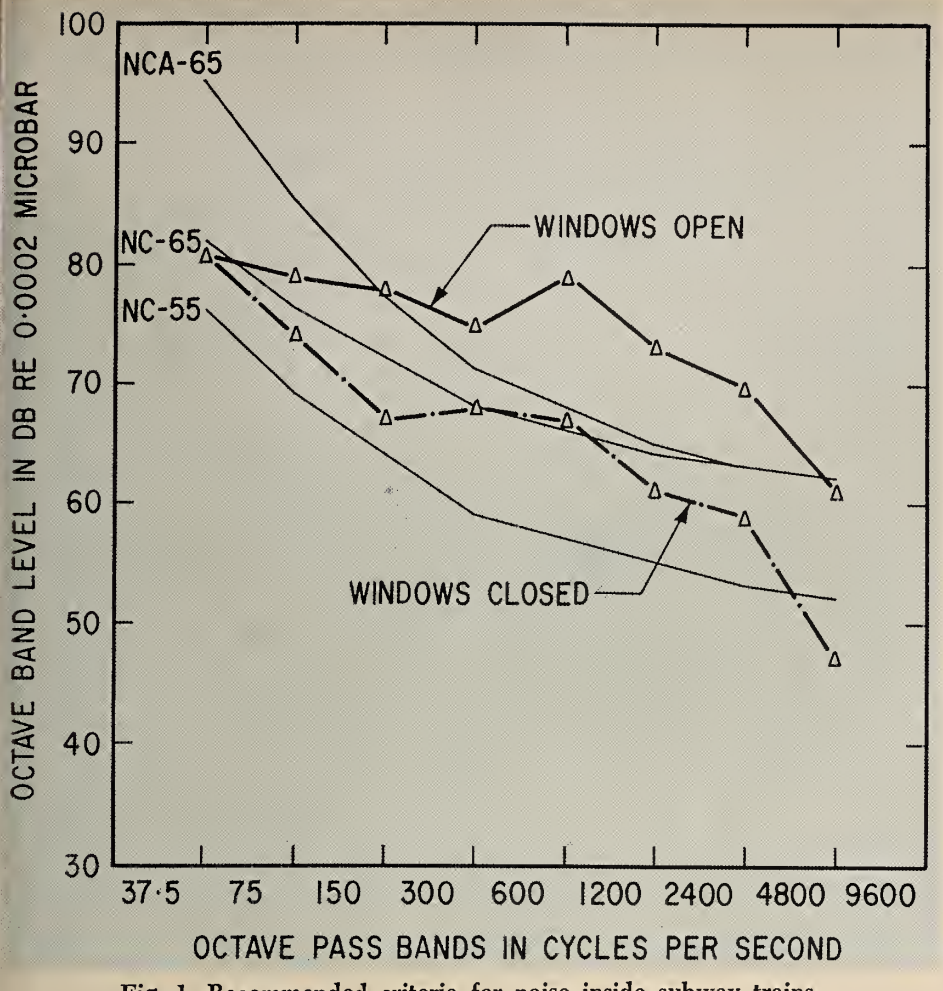

Fig. 1. Recommended criteria for noise inside subway trains.

Also shown are curves for an old streetcar and for the PCC streetcar developed in the U.S. during the thirties. The curve for modern railroad coaches shows that their designers have done a good noise reduction job. This is for a mid-coach position; there would be more low frequency noise toward the ends, over the wheels.

It is more difficult to establish an acceptable level for noise transmitted to adjacent buildings. A conservative objective is to keep intruding noise below the ambient level in each frequency band and thus imperceptible. The ambient level is a highly fluctuating thing and it will usually suffice to reduce subway noise to the same order as other frequently occurring noises.

If a subway line is built below a busy thoroughfare the chances are that it will not add significantly to the total noise produced by traffic. If it traverses a quiet neighbourhood, and especially if it passes under houses, apartment buildings, or special buildings such as theatres or concert halls, there will be a lower ambient level to contend with and a more critical group of listeners.

In dwellings the ambient level will be quite low during the night, and this is the condition to be designed for. The peak ambient level will probably still depend on street traffic, although in winter time it might be determined by internal noises such as that from an oil burning furnace or in the case of a theatre by the ventilating system. An example of the importance of ambient noise is the Royal Festival Hall in Britain. The noise of the subway line beneath it is quite discernible in the empty hall. Fortunately it is no longer noticeable when the ventilation system is on and an audience is present.

Noise Sources and Control

Turning now to the sources of rail vehicle noise, we shall first deal briefly with half a dozen minor ones, leaving to the last the major problem of noise produced by the contact of metal wheels on rails. A frequent problem is brake noise, which in a well-designed system is an unpitched hissing sound, but which in some circumstances becomes a chattering or intense squealing sound. Chattering usually results from play in the brake-block mountings. A high-pitched squeal usually is caused by the excitation of a resonance in the wheels. In both cases the excitation is caused by the friction properties of the brake system. Usually the coefficient of friction increases as the

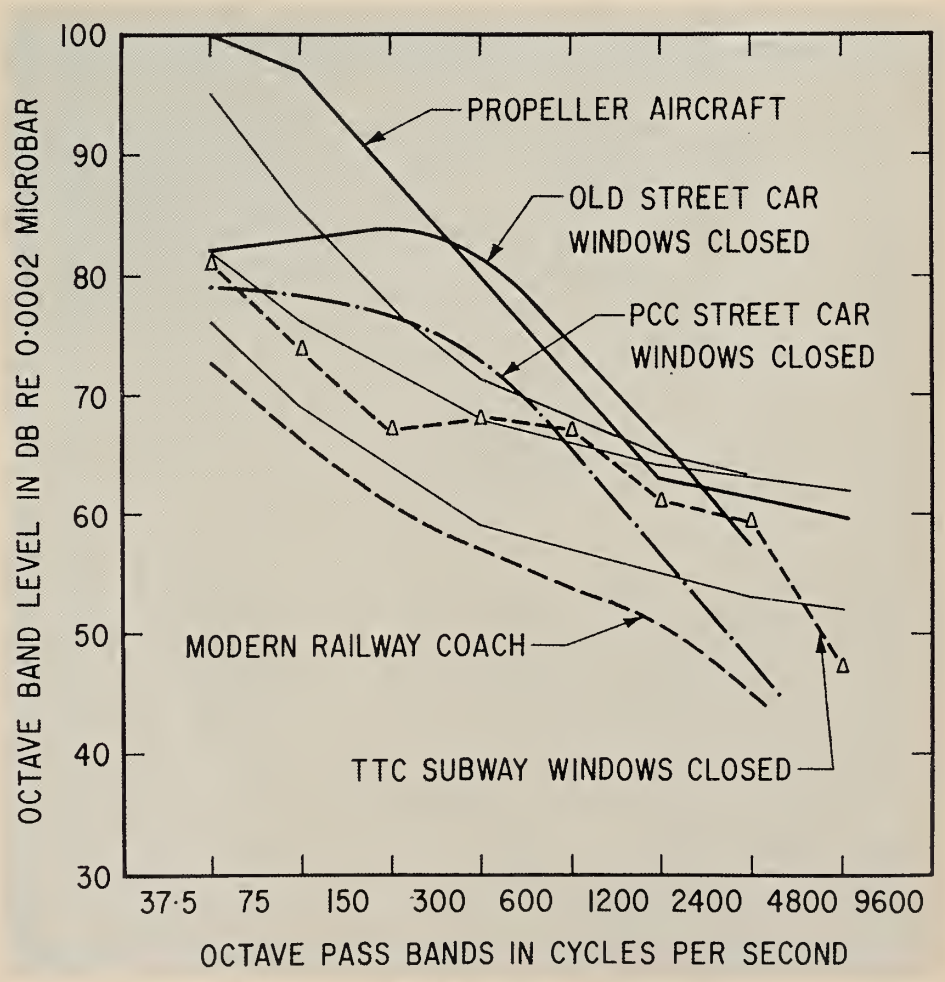

Fig. 2. Typical noise levels inside public vehicles.

relative velocity of the sliding surfaces decreases; if this variation is too rapid the brakes tend to grab and then release, in what is known as a stick-slip process. By a suitable choice of brake material it can usually be avoided. Torontonians may recall the intense brake squeal characteristics of the original subway cars here. This was reduced by using a different type of cast-iron brakeshoe and eventually disposed of completely by using a lining similar to automobile brake lining.

One can enumerate smaller but frequently troublesome noise sources. On some of the older vehicles there used to be a substantial contribution from a primitive spur gear drive, but this is not characteristic of vehicles built in the last 30 years. Nevertheless, even fairly modern vehicles are equipped with noisy air compressors, fans and motor generators. The cures for these problems are simple and well known and will not be dwelt upon here.

Let us now return to the principal noise-producing mechanism: the contact between rolling metal wheels and rails. Noise results from the series of impacts developed because of small irregularities on wheels and rails. Obviously one of the first steps in controlling the noise is good maintenance, the elimination of such major irregularities as flat wheels and corrugated tracks. Open rail joints used to be a problem, now usually disposed of by welding.

Apart from providing smooth-running surfaces the other means of limiting noise at the source is to reduce the weight of the unsprung elements associated with the wheel rim: the intensity of impact and noise is closely related to this weight. In this respect the PCC car design, used extensively for streetcars in North America — and also I believe in the Chicago subway — represents the ideal: the only unsprung weight is the wheel rim connected to the hub by layers of rubber. The motors are separately suspended so as not to add to the axle weight. The main suspension consists of rubber springs introduced between axle and bolster.

A more drastic approach is to use a rubber-tired vehicle as has been done experimentally on one line of the Paris Métro. This has some obvious practical difficulties: metal bogie wheels may still be necessary for guiding the vehicle in a narrow tunnel and for power connections. Hence, if one were not careful, the rail noise problem might still be present.

It has perhaps been implied that the rail, which forms the other half of the noise-producing mechanism, is a rigid unyielding surface. This is roughly true if it is clamped solidly to a concrete base, but if it is resiliently supported then it also becomes a mass-spring system. If the vehicle has solid wheels rigidly attached to an axle, the rail, in fact, becomes the smallest mass in the system, and its mounting becomes critically important in determining the noise level in the tunnel. It is also important, of course, for determining the transmission of vibration to the underlying structure and to adjacent buildings. The two most important steps in reducing rail noise are to reduce the unsprung portion of the vehicle to a minimum, and to introduce the maximum amount of resilience in the rail mounting. Both measures are important for control of noise in the tunnel and vibrations transmitted to adjacent property.

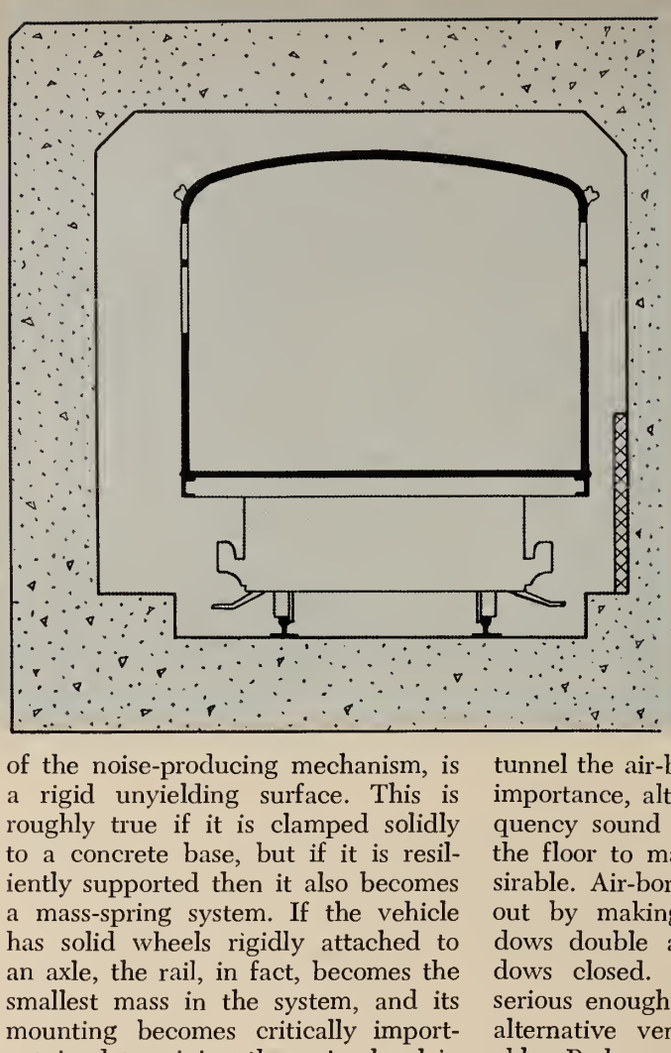

Fig. 3. Application of absorption treatment to subway tunnel.

Apart from modifications to the source, the other approach to noise control is to dispose of the sound before it reaches the passenger. Rail noise is radiated as air-borne sound from the point of contact of rail and wheel. This sound may be transmitted through the floor and walls of the vehicle and through the windows, especially if they are open. Some of the sound is also transmitted directly through the car structure.

In railway coach design air-borne sound is not important — chiefly because the windows are sealed. Structure-borne sound is the major problem, and in the best designs the interior walls and floor — especially the floor — are of double construction, with a resilient link between the inner layers and the main frame.

In the enclosed space of a subway tunnel the air-borne sound is of major importance, although enough low frequency sound is still transmitted via the floor to make a double floor desirable. Air-borne sound can be kept out by making the walls and windows double and keeping the windows closed. Open windows are a serious enough drawback to make an alternative ventilating system desirable. Perhaps, instead of open windows, separate openings could be provided with built-in sound-attenuating sections. The most elegant solution, of course, would be air-conditioning, as in railroad coaches.

Finally, we may consider what can be done with sound absorption treatment in the tunnel. The geometry of a tunnel with a train present is shown in Fig. 3. Peripheral space around the car can be treated as if it were a flat duct, with noise originating at the bottom and getting into the car chiefly through the windows, part way up the side. Lining one side of this duct, especially at the bottom corner, is an effective way of reducing the sound arriving at the window.

The quantitative effects of some of these measures are illustrated in the next few figures. Fig. 4 shows the reduction gained by adding a double floor — this is actually for a bus, for which "before" and "after" data were available, but similar reductions have been achieved for railway coaches.

Fig. 5 shows the value of absorption treatment in a subway tunnel. The first treatment was on one side only and covered only about four feet in height. The new proposal entails treatment of a six-foot strip on each side. Note again the desirability of keeping windows closed.

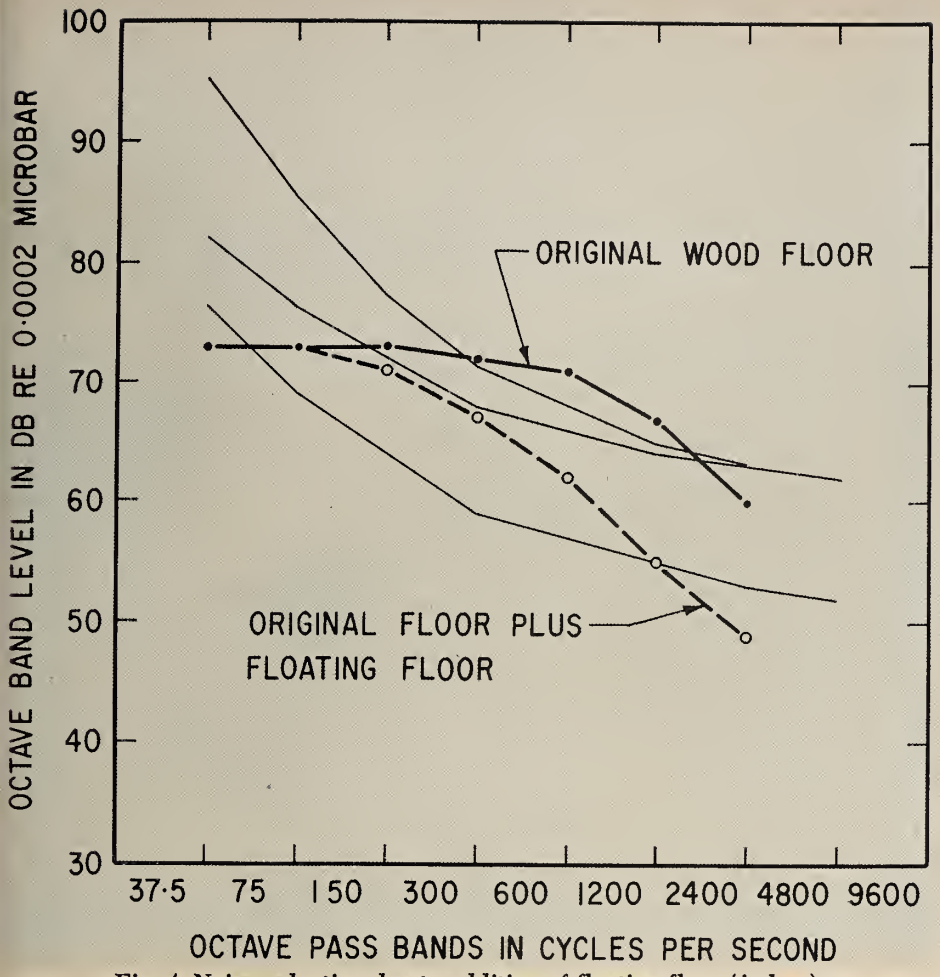

Fig. 4. Noise reduction due to addition of floating floor (in bus).

Two special problems remain to be discussed. First of these is noise in subway stations. Here the people on the platform are not protected by the car body, and here also the noise of an approaching train is augmented by brake noise. It is desirable to shield as much as possible the noise-producing areas from the station platform and to provide thorough absorption treatment of the station enclosure.

The second special problem is the increased noise and squeal that frequently occurs on curves. In part this is simply the result of the tendency of cars to bear to the outside of a curve until the flanges of the outer wheels rub on the rails. One could take care of this, perhaps, by increasing the elevation of the outer rail, but the matter is complicated by a more basic difficulty; since the inner and outer wheels are rigidly connected to a common axle there must be some slip to compensate for the difference in path length of inner and outer rails. The squeal that develops is similar to brake squeal. Again a wheel resonance vibration is induced by a stick-slip phenomenon. Possibly it could be eliminated by making the rails, for curves at any rate, from a slightly different material with different friction properties. A simple but inelegant solution is to spray the rails with water.

In this presentation I have tried to comment on the major sources of rail vehicle noise, and to indicate how much can be done by various methods of noise reduction. It may be seen that when some of these noise reduction techniques are applied a subway train compares favourably with other types of public travel, and in fact meets the objective of providing a noise level low enough for comfortable conversation with one's nearest fellow passenger. The remaining problem, of course, is to determine how far it is profitable to go in the effort to make the customer comfortable. With this problem in mind I have been as quantitative as possible about the engineering aspects. My only comment about the economic aspect is that noise control measures are most economical when incorporated in the initial design.

Noise in adjacent buildings is not as clear-cut a problem; but when the ambient noise level in the region is low it becomes critically important to provide a resilient support for the track and/or to provide a resilient layer in the vehicle wheels.

Acknowledgment

This paper is a contribution from the Division of Building Research, National Research Council, and is published with the approval of the Director of the Division.

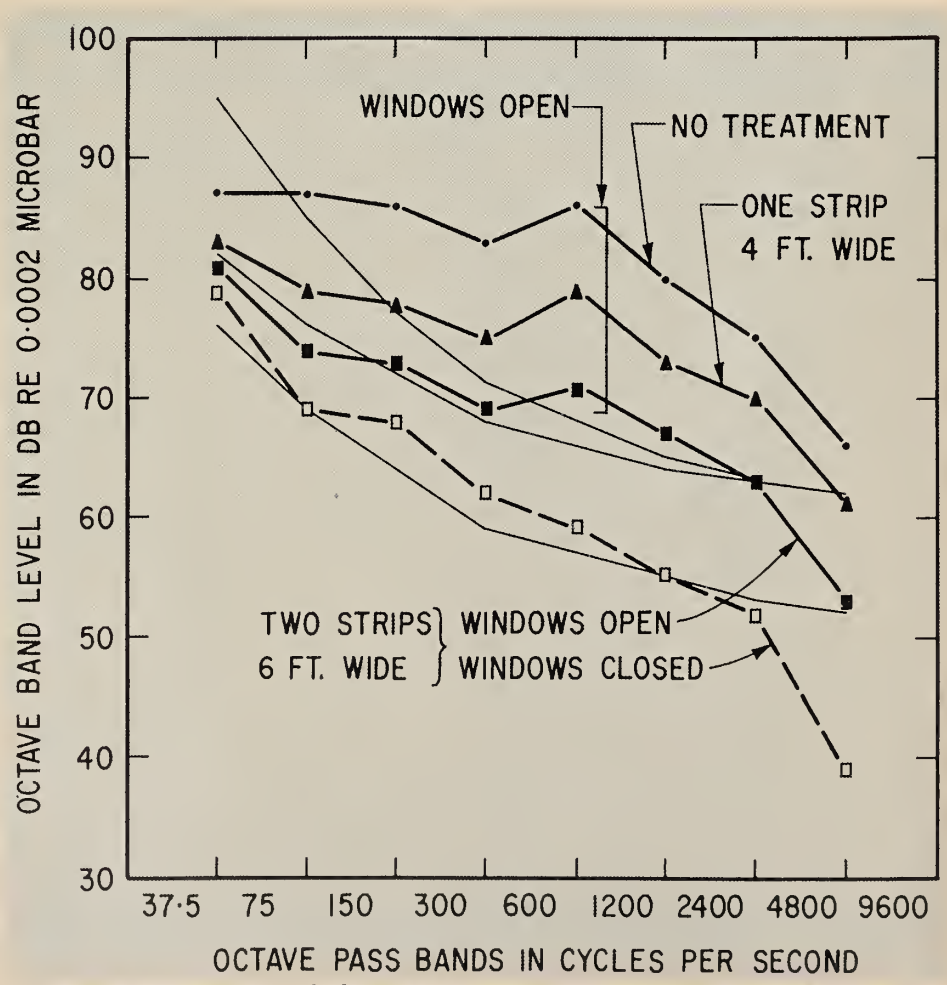

Fig. 5. Effect of tunnel absorption treatment on noise inside subway trains.

EIC—63—ELEC 1

A YARDSTICK FOR EVALUATING COSTS OF ELECTRIC ENERGY IN B. C.

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ESTIMATED wholesale costs of electrical energy in the lower mainland from three different sources are compared with costs of energy from the Columbia and Peace River projects. Table 1 summarizes the cost estimates: table 2 gives the reported costs for the Columbia and Peace River projects.

A proposed four million kw. hydro-electric plant at Moran on the Fraser River could deliver energy to the lower mainland for about 2½ mills/kwh. at 60% capacity factor. The cost of energy from Moran would be substantially less than reported cost of energy from either the Columbia or Peace River projects (Table 2). The first cost of the Moran project would be substantially less than the first cost of any other hydro-electric projects combined to give comparable output in British Columbia.

Electrical energy can be delivered to the lower mainland from steam-electric plants at Hat Creek and Burrard Inlet (the latter plant now under construction near Vancouver) at an estimated cost from 3¾-4 mills/kwh. at 60% capacity factor.

In this paper, the authors discuss in detail the costs of energy from the Moran, Hat Creek, and Burrard plants. These costs should serve as a yardstick for evaluating costs of energy from the Columbia, Peace River, and other power developments in the province.

The benefits from abundant sources of low-cost electrical energy for expansion of secondary industry in the province cannot be too strongly emphasized. The Royal Commission on Canada's Economic Prospects states in its report[4]: ". . . It is a fact that for every dollar spent on the construction of new generation, transmission, and distribution of hydro-electric energy, two dollars have gone into the building of new manufacturing plants. For every employee engaged by the power companies, 50 have found jobs in secondary industry, and for each additional outlay on electric power as a cost of production, the nation's output of manufactured good has increased a hundredfold."

Secondary industries requiring large amounts of electrical energy for manufacturing would flourish in British Columbia if low-cost electrical energy were assured. The Fraser River Board[5] predicts a compound rate of growth at 9.6% annually in use of electrical energy for the period 1955-1975. The Board bases its prediction on the assumption of a great expansion of electric-process industries, especially non-ferrous metals and chemicals, including petroleum and natural gas. By 1975, the electro-process industries are expected to account for over 50% of all electrical energy required for manufacturing.

Vigorous expansion of electro-process industry in British Columbia requires the cheapest possible energy. A realistic appraisal of the costs to be met is afforded by the example of Ontario which, like British Columbia, is richly endowed with water power. The remarks of H. A. Smith,[6] Assistant General Manager, Ontario Hydro-Electric Power Commission, relative to Ontario energy costs are illuminating: . . . "We have hydraulic plants in our system that produce energy all the way from not much over one mill per kilowatt-hour to as much as four. Probably a good figure for hydraulic energy delivered to the load centers is a shade over 3 to 3.3 mills per kilowatt-hour."

TABLE 1

Type of Plant	*Location*	*Capacity in millions of kw. at load center*	*Capacity factor in %*	*First cost of project in millions of dollars*	*Cost of prime energy in mills/kwh. at load center*
Hydro-electric	Moran (initial development)	3.0	60	650	2.74
Hydro-electric	Moran (2nd-stage development)	4.0	60	765	2.43
Coal-fired steam-electric	Hat Creek	1.9	60	350	3.71
		1.9	85	350	2.83
Hydro and steam-electric (combined operation)	Moran (second stage development) and Hat Creek	7.0	60	1,200	2.75
Gas-fired steam-electric	Burrard Inlet	0.9	60	108	4.04

TABLE 2

Source of Information	*Columbia River energy costs in mills/kwh. at 60% capacity factor*	*Peace River energy costs in mills/kwh. at 60% capacity factor*
Canadian negotiators of Columbia River Treaty[1]	4.0	
Montreal Engineering Co.[2]	4.2 — 4.9*	
B.C. Energy Board[3]	4.03 — 4.40*	4.20 — 4.37*

*Depending on assumed rate of load growth.

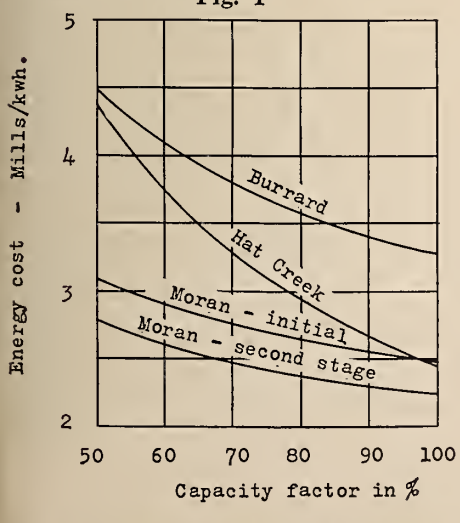
Figure 1 gives wholesale costs per kwh. of energy from three possible British Columbia power developments that could serve industries at tidewater in the lower mainland. The chart gives average costs per kwh. over the useful lives of the power plants, based on current prices and government financing.

One of these projects, a dam and four million kw. power plant at Moran,[7,8,9,10] could deliver energy to the lower mainland at costs per kwh. competitive with those in Ontario. The 170 mile long reservoir upstream from the dam and a storage reservoir at McGregor could provide usable storage of 16 million acre feet and could eliminate the hazard of disastrous Fraser River floods which have caused extensive damage to homes and property from Hope to Vancouver.

Unfortunately, too little fisheries-engineering research has been done to determine with sufficient exactness the effects, beneficial or otherwise, of the Moran dam on the Fraser River salmon industry. It is possible that a controlled release of water from the Moran reservoir in years of low spring runoff at the mouth of the Fraser would reduce mortality among young seaward migrating fish and prevent the recurrent of future disastrously low runs of adult salmon as predicted by Royal[11,12] for 1962 and 1963.

Fig. 1 shows a plot of estimated energy costs per kwh. vs. capacity factors for the Burrard plant.

Fig. 1



Cost Chart

The following assumptions are made in preparing the chart (Fig. 1):

The first cost is the cost of construction of all elements of the power plant and the transmission line. This figure includes financing charges and compound interest on the investment during construction capitalized to the time when power is delivered. The first cost divided by the maximum power output in kw. at the plant gives the first cost per kw. of capacity.

The interest rate is assumed as 5½%. Amortization or depreciation charges are calculated by the sinking fund method at 5½% interest. The average life of all elements of a hydro-electric plant is assumed as 50 years. The corresponding figure for a steam-electric plant is 30 years. Taxes, other than property taxes, are assumed as zero.

The capacity factor is defined as the number of kwh. used per year divided by the number of kwh. available if the turbine and generators could be operated at full rating for a year.

The annual operating and maintenance charges for the hydro-electric power plant at Moran are assumed as $0.50 per kw. of installed capacity. The corresponding figures used for the gas-fired plant at Burrard Inlet and the coal-fired plant at Hat Creek are $1 and $2 respectively. Fully automated plants are assumed.

The fuel cost per kwh. generated in a steam-electric plant is assumed

Fig. 2 (Damsites on Columbia Fraser Rivers)

TABLE 3

Fuel required per kwh. generated

Gas of 1,000 B.t.u. content/cu. ft.	9.6 cu. ft./kwh.
Oil of SG .95 and 19,000 B.t.u. content/lb.	0.0535 Imp. gal./kwh.
Coal of 12,000 B.t.u. content/lb.	0.80 lb./kwh.
Coal of 6,000 B.t.u. content/lb.	1.60 lb./kwh.

independent of the capacity factor. In other words, the thermal efficiency of the plant is assumed independent of load. This assumption is reasonable for the normal variations in loads expected in practice. The average thermal efficiency of the plant is assumed as 35½%. Table 3 gives the amounts of fuel burned to generate one kwh. at the switchboard.

THE MORAN DAM AND POWER PLANT

The Fraser River system (Fig. 2) is the largest single source of water power in British Columbia. Recent studies by the Fraser River Board[5] have indicated a reasonable expectation of more than eight million kw. installed capacity as the potential of the river and its tributaries. More than six million kw. can be developed within 200 miles of Vancouver.

The Board has proposed three alternative systems of development of the Fraser River basin for power and flood control. Although the three systems differ from one another in detail, overall development costs differ by less than 10%. For a cost analysis the authors have chosen a high dam at Moran one of the sites investigated by the Board.

Moran lies about 228 miles upstream from the mouth of the Fraser but only 120 miles, via the P.G.E. Railway right of way, from the salt water port of Squamish which is approximately 30 miles north of Vancouver. It is worth noting that the length of the transmission line to Vancouver would be approximately 150 miles compared with 600 miles for the Peace River project.

The high Moran dam would raise the water level about 730 ft. to create a reservoir about 170 miles long and make possible a minimum regulated flow of about 38,000 c.f.s. The normal prime capacity of the initial development would be about 1.89 million kw. For operation at 60% capacity factor, turbines and generators of 3.15 million kw. rated capacity would be required; for operation at 85% capacity factor, turbines and generators of 2.2 million kw. capacity would be required.

Additional storage in tributaries of the Fraser upstream from Moran would add to the installed capacity at Moran approximately 200,000 kw. (for operation at 60% capacity factor) for each additional million acre feet of storage.

The authors have revised the Fraser River Board's estimate of first cost for Moran to allow 60 million for the transmission lines to Vancouver and to add $120 million for the following fish-passage facilities:

1. A fish-collection system along the downstream face of the power houses.
2. Two fish ladders.
3. A 170 mile long artificial channel (from the dam to the upper end of the reservoir) in which is maintained a velocity attractive to adult fish proceeding to the spawning grounds.
4. A structure at the upper end of the reservoir to divert young seaward migrants into the upper end of the artificial channel.
5. Temporary fish passage facilities during construction.

Table 4 gives the revised estimate. The estimate of total cost (Table 4) is more conservative than the $512 million estimate prepared in 1956 by J. L. Savage,[10] consulting engineer. Savage's estimate included two transmission lines to Vancouver and an allowance of $50 million for fish passage devices.

In the estimate of total cost of the Moran project, interest charges during construction are capitalized assuming a relatively slow rate of expenditure during the first two years, followed by a uniform rate of expenditure for the next three years when construction is assumed 50% complete. Thereafter, construction proceeds at a slower uniform rate until the last generator is installed one year before it is required to carry full load.

The rate of load growth is assumed uniform, starting from zero five years after construction begins, increasing to a maximum 15 years after construction begins. The total allowance for accumulated compound interest during the construction period is about 20% of construction costs, or $110 million (Table 4).

Table 5 gives estimated energy costs of the Moran project.

Fig. 1 shows a plot of estimated energy costs vs. capacity factors for the initial development of the Moran project.

For the second-stage development at Moran the authors suggest that the Fraser River Board's proposal[5] for a dam across the McGregor River (about 15 miles from Prince George) could provide additional usable storage of about 6.5 million acre-feet. This would increase the capacity of the Moran plant to 4.2 million kw. (for operation at 60% capacity factor). The estimated cost of the McGregor project (without on-site power initially) is approximately $50 million and the cost of energy from the 4.2 million kw. Moran plant delivered to the load center in the lower mainland is estimated as 2.43 mills/kwh. at 60% capacity factor.

Fig. 1 shows a plot of estimated energy costs per kwh. vs. capacity factor for the second stage development at Moran.

It is worth noting that for the initial and second-stage developments, the plant is designed for the year of lowest river flow in 20 years. During other years additional amounts of water power would be available. The amount of secondary energy available during a year of average river flow would be approximately 10% of the primary energy.

This is one of a number of benefits of the Moran dam that has not been included in the cost analysis given above.

Other benefits that would add to the value of the Moran dam and reservoir are flood control, river regulation for future downstream power

TABLE 4

Moran Project

Clearing and relocation	$ 7,000,000
Diversion works and power conduits	67,000,000
Dam, spillway and powerhouses	188,000,000
Generating units and powerhouse equipment	98,000,000*
Transmission lines to Vancouver	60,000,000
Fish passage facilities	120,000,000
Interest during construction	110,000,000
Total	$650,000,000

*The Fraser River Board's estimate is $108 million for a 3.6 million kw. installation at 52.5% capacity factor. This estimate is for a 3.15 million kw. installation at 60% capacity factor.

NOTE: Allowances for engineering and administration costs and contingencies have been included in the individual items in the table.

TABLE 5

Moran Project (Initial Development)

First cost per kw. of installed capacity (at 60% capacity factor) $= \frac{650,000,000}{3,150,000}$	=	$206.00	%
Annual interest charges per kw. of capacity = 5½% of $206	=	11.33	5.50
Annual depreciation charges per kw. of capacity = 0.41% of 206	=	.84	0.41
Annual taxes and insurance per kw. of capacity = ½ of 1% of 206	=	1.03	0.50
Annual operating and maintenance charges per kw. of capacity	=	.50	0.24
Total annual cost per kw of installed capacity	=	$ 13.70	6.65

$$\text{Cost per kwh.} = \frac{\text{Total annual cost as above}}{(\text{No. hours/year})(\text{capacity factor})}$$

$$\text{Cost per kwh. at 60\% capacity factor} = \frac{13.70}{(8760)(.60)(.95^*)} = 2.74 \text{ mills}$$

*Allowing 5% energy loss in transmission line to Vancouver.

plants, irrigation by using cheap energy and reduced lift, and improvements to navigation on the Fraser River between New Westminster and Sumas.

The proposals of the Fraser River Board for orderly development of the maximum potential of the Fraser River basin have been postponed because of opposition by fisheries organizations wishing to reserve the river for spawning and migration of anadromous fish. Nevertheless, the economic advantages of multi-purpose development of the Fraser River for fish and power, flood control, irrigation, and recreational facilities are very great. Bruce Hutchinson[13] in discussing this problem says ". . . A government has to consider the relative values of various resources. If it has to decide between a million horsepower of electricity operating a gigantic tidewater industry, and a portion of the salmon run, its choice is obvious. In developing the Fraser it will be necessary to use every known device to lift salmon over dams and get their young down again, to invent new devices and when these are unworkable, to divert the spawning of the fish, by regulation and by artificial reproduction, to rivers where no obstructions are required."

Moran is on the main branch of the Fraser about 65 miles upstream from Lytton at the junction of the Fraser and Thompson Rivers. A great run of adult sockeye salmon leaves the Fraser River at Lytton and proceeds up the Thompson River to spawn. The remainder, averaging about 40% of the total, passes Moran on the way to spawning grounds in tributaries of the main branch of the river. Pink and chum salmon do not reach Moran; coho and spring salmon pass there in limited numbers.

Potter[10] shows that during an eight-year period from 1951-58 inclusive an average of 14.1% of the total B.C. salmon catch of all species were Fraser and Thompson River sockeye. This percentage ranged from a minimum of 7.3% in 1955 to a maximum of 32% in 1958.

Table 6, prepared by Potter,[14,15] gives for a four-year cycle, 1951-54, the ratio of sockeye salmon passing the Moran site to the total B.C. pack of sockeye and the total pack of salmon of all species. The figures are not necessarily a measure of the potential of the Fraser River. Catches were much larger prior to the time when a rock slide constricted the Fraser River at Hell's Gate in 1913.

Elsewhere, the authors[16] have pointed out that the multi-purpose development of the Fraser River system is a major economic problem demanding the initiation of a co-ordinated fisheries-engineering research program. Recent events have emphasized the need for a great expansion of the present sporadic research effort.

Royal[11,12] predicts that the 1962 and 1963 Fraser and Thompson River sockeye salmon runs will be failures. These forecasts are based on (1) an extremely low return of three-year-old 'jacks' in 1961 and (2) low discharge at the mouth of the Fraser in May 1960 and 1961 when the 1962 and 1963 adults, as young fish, were migrating seaward.

Jacks are precocious sockeye adults that return to spawn a year ahead of the normal four-year cycle. Ratios between returning jacks and four-year old fish as determined from previous runs indicate that the 1962 run could be so small that minimum escapement required for spawning could preclude commercial fishing.

Marine survival records show that a high spring run-off of the Fraser results in high survival rates of seaward migrants. When the run-off is low, the survival rate is low.

Royal suggests that the destruction of the 1962 and 1963 Fraser and Thompson River runs may have occurred when the young migrant salmon were leaving the mouth of the Fraser River for a new salt water environment. During years of high spring run-off, fresh water stretches far out into the Straits of Georgia. When the transfer from fresh to salt water is gradual the fish can readily adjust themselves to the change. When the transfer is sudden as in 1960 and 1961 the metabolism of the fish is unable to adjust and the mortality rate is high.

The authors suggest that survival rates of the seaward migrants could be increased by releasing, at the proper time, water stored in the Moran or McGregor reservoir or elsewhere in the upper reaches of the Fraser or Thompson River systems. This would assure that the spring runoff could be substantially greater than the abnormally low flows in May 1960 and 1961.

TABLE 6

Year	*% Fraser & Thompson River sockeye of B.C. sockeye pack.*	*% Fraser & Thompson River sockeye passing Moran site*	*% B.C. sockeye passing Moran site*	*% B.C. salmon passing Moran site*
1951	34	50	17	4
1952	30	70	21	7
1953	37	72	27	8
1954	73	10	7	3

A COAL-FIRED STEAM-ELECTRIC PLANT AT HAT CREEK

The Hat Creek coal deposit is unique. More than 400 million tons of low-grade lignite coal, of 6,000 B.t.u. content per lb., are contained on approximately one square mile. The overburden is thin, permitting open-pit mining methods. Sufficient coal is available in the deposit to supply a two million kw. power plant for more than 45 years.

Large-scale material moving methods applied to the Hat Creek deposit should result in excavating costs perhaps as low as 50c per ton. The authors, however, have adopted a more conservative estimate of 85c per ton to include cost of mining, waste disposal, and ash disposal.

Hat Creek lies approximately 15 miles east of Lillooet and 120 miles from the salt water port of Squamish, via the P.G.E. Railway right of way.

TABLE 7

Hat Creek Plant

Annual interest charges per kw. of capacity	=	5½% of $175	= $ 9.63
Annual depreciation charges per kw. of capacity	=	1.38% of $175	= 2.42
Annual taxes and insurance per kw. of capacity	=	½ of 1% of $175	= .88
Annual operating and maintenance charges			= 2.00
Total annual fixed costs per kw. of capacity			$14.93

$$\text{Fixed cost per kwh. at 60\% capacity factor} = \frac{14.93}{8760(.60)(.95^{**})} = 2.99 \text{ mills}$$

$$\text{Fuel cost per kwh.} = \frac{1.6^{*}(85c)}{(2000)(.95^{**})} = 0.72 \text{ mills}$$

Total cost per kwh. at 60% capacity factor = 3.71 mills

*See Table 3.
**Allowing 5% energy loss in transmission line to Vancouver.

The length of transmission line from Hat Creek to Vancouver would be about 150 miles.

Preliminary studies for a two million kw. steam-electric power plant to contain eight 250,000 kw. units have been made. The authors have estimated the cost of such a plant as $150 per kw. of capacity. The total cost including the transmission lines to Vancouver is estimated as $175 per kw. of capacity.

Table 7 gives estimated costs of electrical energy from the Hat Creek Plant.

Figure 1 shows a plot of estimated energy costs per kwh. vs. capacity factors for the Hat Creek plant. A significant feature of energy costs is the steep slope downward of the cost curve as the capacity factor increases. This plant, while operating at 100% capacity, could carry a base load of nearly two million kw. at a cost of about 2½ mills/kwh. Hydro-electric plants in an integrated system could very likely carry peak loads more economically than the Hat Creek plant. For example, if the Hat Creek and Moran plants were designed for co-ordinated operation, turbines and generators could be added to the second-stage development at Moran for overall plant operation at 45% capacity factor. Then the Hat Creek plant could carry a base load of 1.75 million kw. at 87½% capacity factor and Moran could carry the peak load up to 5.75 million kw. at 45% capacity factor. The combined plants, operating at an overall capacity factor of 60%, could deliver seven million kw. to the load center in the lower mainland for about 2¾ mills/kwh. (Fig. 1).

A GAS OR OIL-FIRED STEAM-ELECTRIC POWER PLANT NEAR VANCOUVER

The B.C. Electric Company has built a gas-fired steam-electric power plant at Burrard Inlet. The first two turbo-generators, each of 150,000 kw. capacity, were installed in 1962. Six such units are planned for the fully completed plant, giving a total capacity of 900,000 kw.

The authors have estimated the first cost of the completed installation as approximately $120 per kw. of capacity.

It is worth noting that for future steam-electric plants in Vancouver, the first cost per kw. of capacity could be lowered by installing turbo-generators of capacity greater than 150,000 kw. This will very likely be considered when incremental load increases greater than 150,000 kw. become economically feasible.

The principal fuel for the Burrard plant is natural gas. Provision is made for burning high viscosity oil as a standby fuel.

Fuel cost is assumed 22c per million B.t.u. Although coal burning equipment is not contemplated, coal prices are included for comparison with competitive prices of gas and oil in table 8.

Table 9 gives estimated costs of electrical energy from the Burrard plant.

TABLE 8

Competitive Prices of Various Fuels

Gas of 1000 B.t.u. content/cu. ft.	22c/1000 cu. ft.
Oil of SG = .95 and 19,000 B.t.u. content/lb.	3.97c/Imp. gal. or $1.39 per bbl. of 35 Imp. gal.
Coal of 12,000 B.t.u. content/lb.	$5.28/ton
Coal of 6,000 B.t.u. content/lb.	$2.64/ton

TABLE 9

Burrard Plant

Annual interest charges per kw. of capacity	=	5½% of $120	= $ 6.60
Annual depreciation costs per kw. of capacity	=	1.38% of $120	= 1.66
Annual taxes and insurance = ¾ of 1% of $120			= .90
Annual operating and maintenance charges per kw. of capacity			= 1.00
Total annual fixed costs per kw. of capacity			= $10.16

$$\text{Fixed cost per kwh. at 60\% capacity factor} = \frac{\$10.16}{8760(.60)} = 1.93 \text{ mills}$$

$$\text{Fuel cost per kwh.} = \frac{9.6^{*}(22c)}{1{,}000} = 2.11 \text{ mills}$$

Total cost per kwh. at 60% capacity factor = 4.04 mills

*See Table 3.

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WHAT TO LOOK FOR WHEN BUYING TECK CABLE

As cable manufacturers, we are frequently asked how a customer can assess the quality of a cable without performing the battery of tests which we carry out. Even with thorough testing it is difficult to predict the relative service life of two high quality cables, but distinguishing poor from good quality is sometimes easily done by a visual comparison. Knowing what to look for can save you money in reduced maintenance and longer cable life. Here, for example, are some of the things to keep in mind when you buy a Teck cable.

CSA CERTIFICATION

The Canadian Standards Association certify only cables which meet basic standards of quality established as a protection to the user. When buying cables, such as Teck cables, for which certification is available from the CSA, it is a wise precaution to insist on this guarantee of basic quality.

Every length of CSA-certified Teck Cable must carry a CSA label signifying certification. Also, all CSA-certified Teck cable has the grade of insulation printed on one of the conductors and the word 'TECK' printed on the outer surface or on a tape under the armour. CSA-certified Teck cable assures you of the following characteristics:

1. Guaranteed minimum thickness of insulation, jacket and corrosion protection.

This means: no thin spots in the insulation to cause premature failure; uniform protection of insulated conductors and cushioning of armour by the jacket; no vulnerable thin spots in the over-all protection to be damaged and permit corrosion of the armour.

2. Insulation, jacket and corrosion protection which meet stringent test requirements.

Heat and aging tests guarantee satisfactory service. Special tests such as resistance to oil, bending, and impact at sub-zero temperatures, are performed on jacket or corrosion protection to ensure their ability to cope with adverse conditions.

3. The grade of insulation printed on the surface of one of the conductors.

You are assured that the cable will operate under the conditions indicated.

4. Colour-coded conductors to permit rapid identification.

5. A built-in ground conductor of specified minimum size to provide adequate protection and safety.

To be sure that you are obtaining all of these advantages look for three things in every length of Teck cable: The CSA label, the grade of insulation printed on one conductor, and the word 'TECK' on the over-all covering or on tape under the armour.

DIAMETER IS IMPORTANT:

The smaller the Teck cable for a given set of operating conditions the less expensive will be the original cost of the installation because all associated hardware will probably be smaller and less expensive. Unfortunately, small diameter can sometimes be achieved only at the expense of characteristics vital in the performance of the cable. When cables of this type are used, the initial savings are rapidly wiped out with cost of maintenance, cable replacement and machine shut-downs.

There are a number of ways to tell whether cable quality has been sacrificed to obtain a small diameter.

1. Are the locking edges deep enough to provide armour strength?

The armour is primary protection against physical abuse and must be capable of being bent as required for installation. Where the interlocking edges are not sufficiently deep the armour will pull apart under tension or when bent and the protective value of the armour will be lost.

Armour on Teck cable should be expected to meet the same 300 pound tension test as is used on the armour of AC or ACL cable.

2. Has small diameter been achieved by applying the armour too tightly?

Applying the metal armour with excessive compression produces one or more of several undesirable effects:

(A) flexibility of the cable is reduced.

(B) when the armour is forced into the jacket it may reduce jacket thickness below acceptable limits.

(C) compressing the jacket tends to cause adhesion between insulated conductors and between conductor and jacket. When the jacket is stripped off and the conductors are separated the coloured coating of the conductor is pulled off, making them difficult to identify.

(D) The excessive compression causes distortion of conductor insulation with resultant thin spots and danger of electrical failure.

3. Has small diameter been achieved by using too thin a wall of insulation, jacket, or protective covering?

Minimum dimensions specified by Canadian Standards Association are the result of field experience and careful study. Because Teck cable is designed for rugged use, skimping on insulation, jacket, or protective cover to make a smaller cable is exposing the user to needless risk of failure.

THERE IS A 'RIGHT' TECK CABLE FOR YOUR JOB:

The CSA recognize two different types of insulation and two different types of inner jacket for Teck cable. This permits the user to choose the combination best suited to his job.

1. RW60 and R75 insulation:

This can be operated at 60°C in wet locations or 75°C in dry locations.

2. RW75 and R90 insulation:

This can be operated at 75°C in wet locations or 90°C in dry locations. Its use may be dictated by economy or by the conditions or service. Similar size cables with this high-temperature insulation (and high-temperature jacket) are slightly more expensive, but because of their high ampacity a smaller size conductor may frequently be used. This, of course, results in a less expensive cable and installation. Again a high ambient temperature may make this insulation necessary to carry a given current. A further advantage in using high-temperature Teck cable stems from the inherent flexibility of use of Teck cable. It is not uncommon to remove a length from one location and use it in another. When it is high temperature Teck cable you have much more latitude in choosing its new operating conditions.

3. Neoprene inner jacket:

This is the 'work-horse' jacket — rugged and dependable. It is resistant to chemicals, oil and flame. Where no corrosion-protection is used over the flexible armour and the cable is subject to occasional accidental splashings of oil, gasoline or grease, the chemical resistance of the neoprene jacket may be essential to the service-life of the cable. In the event of fire, the neoprene jacket will stop burning as soon as the flame is removed. On cables with RW75 and R90 insulation, a special neoprene jacket is used, compounded to provide added heat-resistance.

4. Butyl rubber inner jacket:

Where oil- and flame-resistance are not important factors and where the ultimate in heat- and moisture-resistance is required, a butyl rubber jacket is recommended.

NORTHERN ELECTRIC TECK CABLE

Northern Electric Teck cable is CSA-certified and designed to operate satisfactorily under rigorous conditions of service.

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THE NOMINATING FUNCTION

What do I mean by the nominating function? I mean that role which is assumed by anyone asked to, ordinarily in consultation with others, pick out and advance the names of an individual for an elective or appointive position. The role is one which appears simple to many people but which, in reality, is complex. It involves weighing carefully tangible and intangible evidence bearing on the capability of the individual nominated to serve well in the capacity for which chosen, if he be elected or appointed.

The responsibilities inherent in the nominating function, whether for elective or appointive office, are very great. Upon the extremely careful exercise of the function may well rest the difference between a vital, glowingly-alive institution or any one of its component organs, on the one hand, and a moribund institution lacking lustre and leadership, on the other hand. In effect, careful exercise of the nominating function is requisite to ensure continuity of that quality of leadership, that ability to inspire others, which is so vital to any large organization, particularly one with a membership approaching 24,000.

There is another responsibility inherent in the effective exercise of the nominating function. I refer to the fact nomination for either an elective or an appointive post carries with it the obligation to assess the probable ability of the individual selected to advance to greater, more onerous responsibilities.

In the President's message which appeared in the December issue of the Enginering Journal, eleven Divisions of the Committee on Technical Operations were listed. This ever-increasing total was 15 at press time and other additions are expected. The present list:

Bridge and Structural
Chemical
Civil
Communications, Electronics and Automation
Electrical
Engineering Education
Geotechnical
Hydro-Electric
Management
Mechanical
Mining
Oil and Natural Gas
Research
Thermal
Welding

How can the responsibilities of the nominating function be effectively carried out? This requires examining the requirements of the position for which an individual or individuals are being considered. Do the abilities of the potential candidate or candidates match these requirements? Can they take time off to do the work demanded of them, with their superior's concurrence? Can they afford the travel involved? If not, will their employer support their travelling as required? Will they put the obligations of the position before their personal convenience? Can they move on to more responsible positions, if nominated, later?

In fact, the prime consideration is that the office seek the man. However, the man selected must be able to serve effectively. There is nothing more detrimental to the vitality of a membership society than those officers and committee members who look on election or appointment as involving an honour, without responsibility.

The office should seek the man, whether the office be that of a committee member, vice-chairman or chairman; whether the office involves Branch or Institute responsibility. This criterion applies equally to the position of a member on a Branch Executive Committee, any Committee responsibility within the authority of a Branch Executive, any Institute Committee, of a Councillor, of a Vice-president or of the President.

The criterion that the office should seek the man is a very valid one because ability to serve embraces many subsidiary criteria, which I have previously mentioned. All these are perhaps summed up to best advantage in two criteria. These are:—

1. The individual must be physically, spiritually and financially able to serve in the capacity for which nominated.

2. The individual must possess the qualities of leadership and be capable of assuming even greater responsibilities than those of the position for which he is being nominated.

An important consideration is that the individual selected be capable of working constructively and harmoniously with others. He cannot be an office seeker or "empire builder".

A further important desideratum is that the individual selected must be capable of working effectively with diverse groups, older as well as younger engineers, with both racial groups which make up the Canadian people, and with regional groups.

Proper and efficient exercise of the nominating role, on the part of all those called upon to exercise the role and contribute to the selection of candidates for election or appointment, is necessary to the continued vitality of the Institute, of its Branches and of all activities of whatever nature in which it participates.

I have dwelt at some length on the necessity of sound selective processes in the choice of candidates for election or appointment. There is, however, another vital factor.

I refer to the election process itself. This process is one too often neglected by too many members. Each one who fails to cast his ballot, when called upon to do so, is failing to play his part in the nominating function.

F. L. Lawton, President.

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ENGINEERING EDUCATION IN CANADA

The first part of this two-part series on Engineernig Education in Canada was published in the September issue of the Engineering Journal. This second part of the series includes many major and minor schools which have made, and are making, a vital contribution to Canada and the engineering profession. In the near future the Institute will make available a single reprint of the entire series.

University of Alberta

In a little over 50 years, the staff of the University of Alberta has moulded one of the largest engineering schools in Canada. The people of the Province have reasons to be proud of its faculty, students, buildings and equipment at its combined campuses, the central campus in Edmonton and the new campus in Calgary.

The story of engineering at the University of Alberta began with the plans for the creation of the University in 1908 just after the birth of the Province of Alberta. The first President, Dr. H. M. Tory, looked for a staff of three professors in the humanities. In addition to them he chose an engineer, W. M. Edwards, as Professor of Civil and Municipal Engineering. Professor Edwards was responsible for eliminating the cause of a serious typhoid epidemic in Edmonton by re-designing the water system intake. He lost his life during the influenza epidemic of 1919, contracting the disease as he served as Admissions Officer at the University residence which then was used as a hospital.

Other early appointees in the applied sciences gave long and distinguished service. The first one was J. Adam, who later headed the Department of Drawing and served until his retirement in 1938. Dr. C. A. Robb was appointed for Mechanical Engineering in 1912 to serve until 1940. I. F. Morrison was engaged in 1912 for Civil Engineering and contributed greatly to the young faculty; he organized and taught the first courses offered in Canada in soil mechanics. He was honored by the University with the LL.D. degree before his retirement in 1954. Then came C. S. Burgess, who later headed the Department of Architecture until his retirement in 1940, when Architecture was discontinued.

In 1913, the Department of Civil Engineering and its allied subjects were constituted into a new Faculty of Applied Science. Two important appointments were those of A. E. Cameron in Mining Engineering and later Professor of Metallurgy (1928), a post which he held until he became Deputy Minister of Mines for Nova Scotia in 1937; and Dr. H. J. MacLeod in Electrical Engineering. During World War I Dr. MacLeod organized the local company of the 196 Western University Battalion, C.E.F. Eighteen years after the war he moved to the University of British Columbia as Head of the Department of Mechanical and Electrical Engineering and later became Dean there. In 1919, N. C. Pitcher was appointed to head the Mining Department, a post which he held for 24 years.

In 1921, the Applied Sciences obtained its first Dean, Dr. R. W. Boyle. He had joined the University in 1912 as Professor of Physics and later was Head of the Department of Electrical Engineering. He was on leave during the War for research in ultra-sonics and submarine detection in the United Kingdom. After his return he guided the Faculty for eight years until his appointment as Director of the Division of Physics and Electrical Engineering at the National Research Council.

The second Dean of the Faculty was R. S. L. Wilson. After extensive experience in construction and railway engineering he had taken the post as Professor of Civil and Municipal Engineering. He became Dean in 1929 and retired during World War II. Dean Wilson augmented the staff with such prominent persons as H. R. Webb in Civil, W. E. Cornish in Electrical, R. M. Hardy (later Dean) in Civil, E. O. Lilge in Mining (presently Head of Department), E. G. Cullwick in Electrical, Dr. K. A. Clark, who pioneered research in Athabasca oil sands and who taught Metallurgy and later became Head of the Department of Mining and Metallurgy; G. W. Govier (presently Dean) in Chemical, L. E. Thorssen and L. E. Gads (presently Associate Dean) in Civil, W. W. Preston, Professor of Drawing.

In 1944, after 14 years in the Civil Engineering Department, R. M. Hardy became Dean of Applied Science. During his term the name of the Faculty was changed to the "Faculty of Engineering". Dr. Hardy has an international reputation in the field of soil mechanics. He enlarged the Faculty bringing to it T. Blench in Civil, J. A. Harle, Head of the Department of Electrical Engineering, D. B. Robinson in

University of Alberta

Chemical (presently Head of Department), J. G. Parr in Metallurgy, G. Ford in Applied Mechanics (presently Head of Department of Mechanical Engineering), S. R. Sinclair in Civil (presently Head of Department) and many others. Dean Hardy resigned after 15 years to devote full time to his consulting practice.

The present Dean of Engineering, Dr. G. W. Govier, took office in 1959 following 19 years in the Faculty, including five years as Head of the Department of Chemical and Petroleum Engineering. He is also the Chairman of the Oil and Gas Conservation Board of Alberta. In planning for tomorrow, he proposes multi-building engineering centres for both the Edmonton and Calgary campuses.

The story of Engineering at the University of Alberta would not be complete without a reference to the growth of its physical facilities. In the beginning classes were held in the Queen Alexandra Public School but after one term were moved to Strathcona High School. In 1911, Athabasca Hall, the first building on the Edmonton campus, was completed to provide a dormitory, offices and class rooms. In 1915, the Arts and Science Building was finished. At the conclusion of World War I the North and South Engineering Laboratories arose. During World War II many temporary huts were built and an old school building was used for Drafting and Mathematics laboratories. In the post-war expansion, Chemical Engineering gained quarters in a new wing of the Medical Building. A four-storey building went up for the Civil, Chemical and Petroleum Departments in 1953 and there was an extension to the Metallurgical section of the North Laboratory. A six-storey extension to the main Engineering Building was added in 1960 for Electrical and Mechanical Engineering and was officially opened on September 1962. At the same time a separate Hydraulics Building was erected. Near it a Structural Engineering Laboratory is being started this year. These two buildings will later become part of the multi-building Engineering Centre in Edmonton.

In 1957, a class of first year Engineering was started in Calgary in temporary university buildings on the campus of the Institute of Technology and Art. Three years later the present Calgary campus was opened and first and second year Engineering are now offered there. The first building of the Calgary Engineering Centre is scheduled to start in 1962.

Paralleling the growth in buildings has been the growth in laboratory equipment. The Provincial Government and industry have been generous in providing funds and apparatus.

The Faculty currently offers four-year programs leading to the B.Sc. degree in the fields of Chemical, Civil, Electrical, Mechanical, Mining, Metallurgical, and Engineering Physics. The first two years of these programs are common and are available at both the Calgary and the Edmonton campuses; the third and fourth years are offered in Edmonton only. The administrative organization involves five departments, those of Chemical and Petroleum, Civil, Electrical, Mechanical and Mining and Metallurgy. Courses special to the various programs are offered by the related departments whose members assume chief responsibility for the programs. In case of the Engineering Physics program, the administration is handled largely by a committee.

Registration in Engineering which started with three in 1908 was 1,013 in the B.Sc. program in 1962-63. Of these, 173 were enrolled in the first two years at the Calgary campus.

Memorial University of Newfoundland

An extensive program of research is underway in the Faculty. Much, but not all of this, is carried out in conjunction with graduate student programs. Graduate work leading to the M.Sc. degree is offered through all departments and work leading to the Ph.D. degree is currently available in Chemical, Civil, Mechanical and Metallurgical Engineering. In Civil Engineering and in Mining and Metallurgy cooperative and sponsored research programs involve special professionally qualified research staff. Graduate registrations in Engineering have grown rapidly over the past few years. In 1962-63, 92 students were registered in various graduate programs in Engineering.

Memorial University of Newfoundland

The Engineering Department of the Memorial University College was established in 1930 with a staff of one lecturer and an enrolment of six students. The course established then, and still being given, is a three-year Engineering diploma course. From the beginning, as a University College, the institution has been an affiliated College of Nova Scotia Technical College, being represented on its Senate by the Head of the Engineering Department and on its Board of Governors by the President.

This affiliation continues even though Memorial University College was, in 1949, raised to the status of a degree-conferring institution under the name of the Memorial University of Newfoundland. At that time the Head of the Engineering Department, S. J. Carew, became Dean of Applied Science.

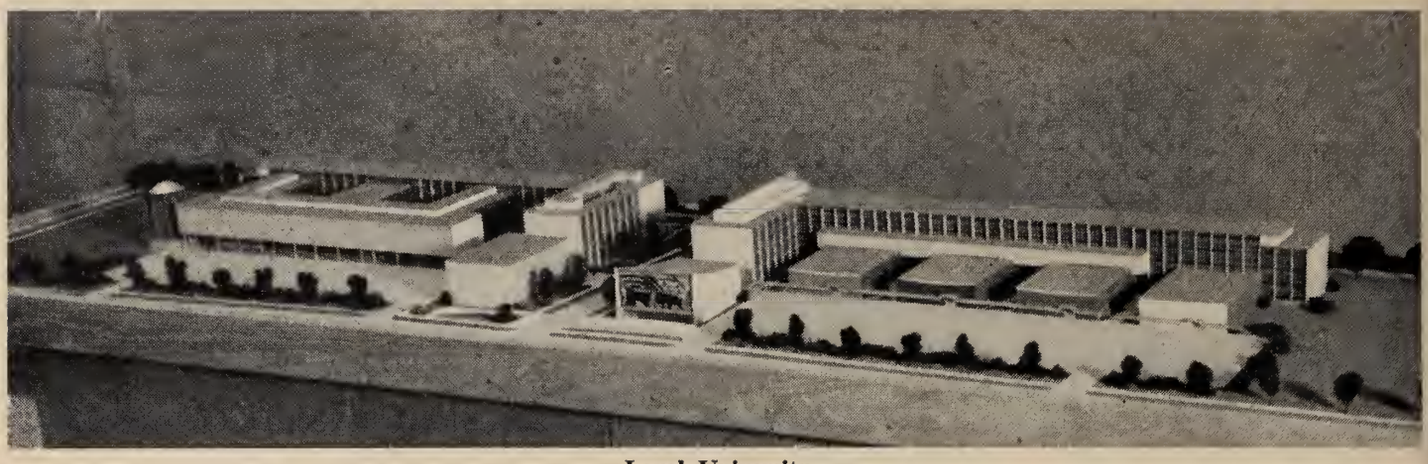
Because of the affiliation with Nova Scotia Technical College the majority of the graduates from Memorial go there to complete their engineering degree, but they are not precluded from going elsewhere. An interesting number are going on to McGill, and graduates have gone on to Toronto, Michigan, University of New Brunswick and Massachusetts Institute of Technology to finish their engineering degree.

The enrolment in the Department of Engineering increased at a fairly even rate, with a slight peak after the war, until about eight years ago when the increase accelerated. Enrolment reached a peak of 154 in 1957-58. This same rapid rate of increase obtained in all faculties with the result that existing facilities, although enlarged by the addition of temporary buildings, became rather strained. Because of this a decision was taken to make admission more selective thus keeping total enrolment static until in 1961, with the move to the new campus, restrictions on admissions were removed and the enrolment in Engineering increased to a new high of 187.

As enrolment increased the staff of the Department was expanded by the addition of one new member in 1946, another in 1954 and another in 1960. Space allocated to the Department was also increased in 1954, again in 1957, and quite considerably increased with removal to the new buildings in 1961. The Department now has a floor area of some 12.000 square feet with two well-equipped drafting laboratories capable of accommodating 100 and 55 students respectively and a well-equipped materials testing laboratory capable of carrying out tests on nearly all engineering materials.

The Applied Science Department, of which Engineering is the major part, was expanded in 1956 by the institution of a pre-Forestry course closely geared to the requirements of the University of New Brunswick. A further expansion came in 1961 by the institution of a pre-Architecture course. There has been a trend since the granting of university status, for the better students to spend four years at Memorial and obtain a general B. Sc. degree as well as the engineering diploma. In this degree course a certain amount of credit is given for the purely engineering courses.

As at other Engineering schools the engineering curriculum has been kept under continuous review. Probably the most drastic change came in 1962 when a new Engineering diploma course, which included a number of courses, came into effect. Among the courses included were Mechanics of Fluids, Thermodynamics, Electric Circuits, and Strength of Materials. These had previously been part of the final two years of an engineering degree, and were included in the Engineering diploma course.



Laval University

Laval University

With a student body of 1,200 spread over 12 departments and a teaching staff of 155, of whom 98 are full time, the Faculty of Science has experienced a phenomenal development since its foundation in 1937.

It is an outgrowth of the "Ecole Supérieure de Chimie", first institution of higher learning in the field of science at Laval. Created in 1920 for the training of professional chemists, this School was to occupy for 15 years an isolated building near the Quebec City limits. A rather small student body was then in attendance; the staff of six professors understood at once the great importance of a thorough training in mathematics and in the basic sciences, rather than one limited to narrow professional requirements.

Such an approach provided a solid foundation which called for a healthy expansion, and it soon proved to be most fruitful. Indeed, through the helpful guidance and dynamic efforts of Mr. A. Pouliot, an engineer among the original six professors and Dean of the Faculty from 1939 until 1956, the scope of the first School was considerably expanded by the addition, in 1937, of the "Ecole des Mines, de la Géologie et de la Métallurgie". Thus came into being the Faculty of Science which was to provide for the training of engineering students at Laval. By that time the student body had reached 37, more than half of them in first year engineering. The number of professors was up to 12 full-time and six part-time.

As the rate of development started growing and gathering speed, a second building was added, mostly for engineering students. One department after another was formed, taking into account such divergent factors as the financial means available and the ever growing number of students leaving after their second year to complete elsewhere their studies in branches of engineering not yet available at Laval.

After the original engineering departments of mining and metallurgy, dating back to 1937, the others came into being as follows:

Chemical Engineering	—	1940
Electrical Engineering	—	1942
Geological Engineering*	—	1945
Civil Engineering	—	1950
Mechanical Engineering	—	1954
Engineering physics*	—	1957

(* Not as a separate department.)

At one point in this period of development, in 1945-46, the Silver Jubilee of "Ecole Supérieure de Chimie" was the occasion for a thorough, University-wide stock-taking. The staff of the Faculty had then increased to 73, of whom 30 were part time, and the student body of 370 occupied space which had been planned for only three hundred. The future needs of the Faculty were not only apparent but they were looming as an obvious problem and burden for the University, considering the extensive developments it had to face in other Faculties as well.

Looking boldly at the future it was realized that the only logical solution was to move progressively the whole University to a completely new campus, over a mile square, beyond the city limits. Once the decision to implement such a move was taken, it meant that all future expansion was to take place on the new campus, barring any measures which would have been taken normally to expand on the site of already existing buildings. Yet, developments at the Faculty in the following years kept taking place and new departments were added, with the result that all facilities were strained to a point such that the basic minimum requirements were threatened unless urgent measures were taken.

Some relief was obtained by moving students in first and second year to temporary quarters on the new campus for their lectures. Still, overcrowding presented more and more of a problem as the number of students in the last three years kept increasing and requirements for research activities were expanding. In this field alone there are at present 59 graduate students in engineering, 46 of them working toward a Master's degree and 13 toward a Doctor's.

A solution to the problem came in a long hoped-for announcement made almost three years ago. The Faculty of Science was to be provided with two large buildings designed to accommodate over 2,000 students. They have been a-building for over two years now and are nearing completion. The accompanying Figure illustrates the general view that will be presented by the two buildings. The engineering building, on the right, exhibits individual wings for mechanical, chemical, mining and metallurgy, and civil engineering. Electrical engineering is located in that part of the main building which parallels the wings, while geology occupies the top floor.

A very active participant in all phases of elaboration and construction of this vast project has been an engineering graduate from the Faculty, L. P. Bonneau, who was Dean in 1960-61 before becoming Vice-Rector of the University. Through his unrelenting efforts the buildings will soon be ready for occupancy and the long expected move should be over by September 1st at the least.

Relying on its past experience and with the goodwill of its 1692 graduates, 1036 in engineering, the Faculty of Science faces the future with confidence and holds great expectations for the new phase of its life which is beginning.

St. Joseph University

The French-speaking population of New Brunswick has continually increased over the years to the point that today, almost 40% of its citizens are French Canadians, or Acadians, as they are more often called.

Until recently, however, the French-speaking universities of New Brunswick were unable to keep pace with the needs of the ever-expanding Acadian population. As late as 1943, two small liberal arts colleges formed the core of Acadian higher education. Since then, one of these institutions, St. Joseph's University, has emerged to fill the gap by establishing Departments of Commerce, Science, Education and Engineering, in addition to its near-century-old Arts Department.

Engineering is the most recent initiative, having been inaugurated in 1956. As in all universities of the Atlantic Provinces, save two, the three first years of engineering are given at St. Joseph's. Courses are offered to students interested in Civil, Mechanical, Electrical and Chemical Engineering. So far, most students completing their three years at St. Joseph's have chosen to continue at the University of New Brunswick.

Though a great improvement over the past two decades, current facilities are still quite inadequate. This was sensed by the recent Deutch Royal Commission on Higher Education in New Brunswick. Among other things, the Commission has recommended the establishment of a single major Acadian university, which would be the outgrowth of St. Joseph's University, aided financially by the Provincial Government. The latter has approved this recommendation and plans are well under way. The first building has been completed on the new campus and construction of the Engineering Building is expected to begin this year.

This Acadian university, though situated on a new campus, living within new walls and even labelled under the new name of the "Université de Moncton" will nevertheless appear on the scene of higher education in Canada with a century of experience and tradition inherited from St. Joseph's University.

Royal Military College of Canada

Three years after Confederation all British regular army units were withdrawn from Canada except those at the naval base at Halifax. It was the Honourable Alexander Mackenzie who made the decision to establish a military college. In 1874, an Act was passed providing for the establishment of "an institution for the purpose of imparting a complete education in all branches of military tactics, fortification, engineering and general scientific knowledge in subjects connected with and necessary to a thorough knowledge of the military profession to be known as the Military College, and to be located in some one of the garrison towns of Canada." Kingston was chosen as the site. It had always been an important military and naval post and it was still a garrison city. The disused Dockyard on Point Frederick was an excellent site for a college and the old Stone Frigate could be used for accommodation until college buildings could be built.

The College opened with the first class "The Old Eighteen", in 1876. The first Commandant was Lieutenant-Colonel (later Lieutenant-General) E. O. Hewett of the Royal Engineers. The courses in military instruction followed the British pattern of the Royal Military Academy, Woolwich. For the first six years all of the military and engineering instructors were supplied from the British Army.

The academic courses followed the West Point pattern, a four-year course with civil engineering as the core of the curriculum. From early in the century the only engineers trained in America had been from West Point. The emphasis on engineering at West Point and RMC was a natural consequence of the need for engineers to help open up the frontiers of these growing countries. Although science and engineering formed the core of the curriculum, it was strongly supported by courses in the humanities, English, French, German and history. This emphasis on the important place of the humanities in a science or engineering curriculum has been a characteristic of the engineering courses at RMC from the beginning.

The professors in engineering on the first course, 1876-1880 were: Capt. E. Kensington, RA, Professor of Mathematics and Artillery; Capt. G. W. Hawkins, RA, professor of Survey; Maj. J. R. Oliver, RA, Professor of Survey; Lieut. G. R. Walker, RE, Professor of Military Engineering; Prof. F. Day, Drawing; Prof. R. Carr-Harris, Civil Engineering; and Prof. H. A. Bayne, Chemistry.

After World War I more electrical and mechanical engineering was introduced into the course. In 1936 specialization was introduced in chemical, civil, electrical and mechanical engineering. A large fraction of the class graduating in 1938 completed an engineering degree in one year at Queen's, McGill, and the University of Toronto. The whole of the graduating class of 1939 entered the Armed Forces. In 1939 the course was shortened from four to two years and in 1942 the College was closed for cadet education and training.

R.M.C. was reopened in 1948 as a Tri-Service College. In fact it had provided officers for both the R.C.N. and the R.C.A.F. since 1924. The post war faculty was organized into three divisions, Arts, Science and Engineering under Colonel W. R. Sawyer as Director of Studies. Engineering Physics was added to the engineering options. In 1959 a degree-granting charter was obtained from the province of Ontario and degrees were offered in Arts, Science and Engineering. The engineering course was lengthened to 4½ years from four years (from senior matriculation) to maintain the high content of the humanities. Lieutenant-Colonel G. W. Holbrook (now President of Nova Scotia Technical College) was the first Chairman of the Division of Engineering. The first graduates with the degree B.Eng. graduated in 1962. The present capacity of the Engineering Division is 100 graduates per year.

St. Francis Xavier University

It is generally conceded that the first school of Engineering in Nova Scotia came into being at St. Francis Xavier University, Antigonish, in 1899. It is also accepted that from the mid 19th century, as Nova Scotia began to move from an all-agricultural economy to something approaching industrialization, the then-established colleges were looking closely at this field of education. In actual fact, while colleges had been established in half a dozen centres, applied science was semi-dormant until the later days of the nineteenth century.

In the case of St. F. X., coal mining in Cape Breton, gold mining in Guysboro County and the establishment of iron works in Cape Breton and at Trenton undoubtedly sparked interest in this area. It was first thought that men of practical experience could handle the tasks connected with these developments, but progress soon dictated more explicit training. The University, aware of developments, pressed for scientific education and the fortunate existence of a strong arm of the Department of Public Works in the area made it possible to enlist personnel for a beginning. Accordingly, in the fall of 1899, courses were offered in Civil and Mechanical Engineering. About the same time, a new wing was added to the University and its facilities included a draughting room, laboratories and shops. Instructors were hired on a full-time basis for Civil and Mechanical courses.

In the same year, the much venerated Dr. Hugh MacPherson returned from the University of Lille after completing engineering studies. A public announcement was made regarding the establishment of a School of Engineering with Dr. MacPherson as Head of the School.

At the turn of the century a number of St. F. X. graduates who had completed the program entered the profession, and the most notable example was one young man who completed the program and proceeded to qualify for the Bachelor's Degree at Massachusetts Institute of Technology in a single year (1903).

The first science graduates of the institution appear listed in the University Calendar of 1904.

The early institution and success of the

Royal Military College

program was recognized by the Nova Scotia Department of Education. In his report of 1899, the Superintendent of Education for Nova Scotia reported that St. F. X. had done more to provide science education than had any other provincial institution.

Early in 1901, citizens in the eastern counties circulated a petition asking the Government to subsidize a full-scale school of Engineering at St. F. X. It is interesting to note that the amount requested was $6,000 annually. It is, however, not surprising that the Government did not act on the request in view of the existence of other denominational colleges.

The remainder of the story properly belongs in the history of the Nova Scotia Technical College because this institution was set up largely at the request of the Mining Society of Nova Scotia which urged the province to establish such a school and confine the activities of other colleges to the initial three years. This seemed an admirable solution then and has continued to be so. In the intervening years St. F. X. has sent a steady stream of diploma recipients to Nova Scotia Technical College, McGill University, and to other Engineering Schools.

Lack of space and facilities hampered the work here as it did in other Universities and the situation did not become thoroughly satisfactory until the erection of a new Physics and Chemistry building in 1957. This permitted the original McNeil Science Hall to be completely converted to an Engineering building which is connected to the new million-dollar science structure.

After World War II, the young men enrolled in Engineering courses numbered one in four of the total campus population. This has decreased in the past few years and now stands at one in nine of the 1.550 students at the University. This past fall, however, has again seen enrollment begin to turn upward.

The Department is headed by Rev. W. P. Fogarty, just returned from a sabbatical year, and he is assisted by a staff of three.

Canadian Services College, Royal Roads

Royal Roads is one of three Canadian Services Colleges, the oldest being the Royal Military College of Canada, Kingston, Ont., founded in 1876, and the youngest Le Collège Militaire Royal de Saint-Jean, Saint-Jean, Que., founded in 1952. Each of these Colleges is tri-service, having as its purpose the instruction and training necessary to impart the knowledge, to teach the skills and develop the qualities of character, loyalty and leadership which are essential to well educated and efficient young officers of all three services.

Officer Cadets may begin their military careers at any one of the three Colleges but must complete their studies and training by the addition of two further years at the Royal Military College, Kingston. Upon satisfactory completion, a Cadet who has specialized in Engineering is granted one of the following Bachelor of Engineering Degrees: Chemical, Civil, Electrical, Mechanical or Engineering Physics.

The intention in this article is to describe Royal Roads—its history, location and, since at present 65% of those who qualify annually choose to follow an engineering career, to outline briefly the curriculum applicable to Engineering Cadets.

In November, 1940, the Government of Canada purchased, from the estate of the late Sir James Dunsmuir, the 650-acre Hatley Park, situated some eight miles from Victoria on wooded slopes overlooking the offshore anchorage in the Straits of Juan de Fuca known as "Royal Roads" (which name is derived from the situation, lying as it does between Victoria and Albert Head). The purchase price for the magnificent grounds, together with the "Castle", houses and other buildings, was $75,000.

Royal Roads

The original purpose of this acquisition was a wartime Naval Training Establishment for the training of short-term probationary R.C.N.V.R. Sub-Lieutenants. In 1941, H.M.C.S. ROYAL ROADS came into being and, during the two years of its existence, the establishment provided an intensified course for some 600 officers.

In August, 1942, the former Royal Naval College of Canada was re-established in H.M.C.S. ROYAL ROADS. Thus after a lapse of 20 years, the training of Naval Cadets was resumed in Canada. In the same year a major addition to the buildings was made. Named the "Grant Block", it contains lecture theatres and class rooms, laboratories, staff offices, Mess Hall and a fine "Quarter Deck" panelled in oak. Originally this building also provided dormitories on the third floor for all cadets; this space is now converted into additonal theatres and classrooms, Chemistry, Engineering Drawing and Descriptive Geometry Laboratories.

Five years later, in 1947, the Royal Canadian Naval College became the R.C.N.-R.C.A.F. Joint Services College and in the following year, with the admission of Army Cadets, Royal Roads assumed its present function as a College for the training of Officer Cadets of all three services.

A selection board interviews all applicants for entry. A selected entrant must have

(a) Senior Matriculation or equivalent,
(b) Physical fitness standards in conformity with those of the service chosen,
(c) Potential officer-like qualities,

and must be a Canadian citizen or a British subject resident in Canada, single and remain single while retaining cadet status, and between the ages of 16 and 21.

The residential capacity of the College automatically controls the enrolment. The Nixon Block, containing Senior and Junior "Gun Rooms", Recreation Rooms and cabins, was opened by H.R.H. the Princess Royal on October 17, 1955. The capacity of this building is 220 Officer Cadets. The cabins are designed for double occupancy, but the figure 220 allows each second year Cadet to occupy a cabin to himself.

"All cadets of the first year at Royal Roads take the same course. At the conclusion of the first year's work a decision is made regarding each cadet's academic progress, assessing his capabilities and probable success in undertaking in subsequent years an Arts, Science or Engineering Course. If Arts, certain Engineering subjects are dropped and extra English, Economics and History substituted. Otherwise a cadet who is permitted to proceed in engineering continues to more advanced work in most of the subjects taken in his first year. These subjects (and training) are divided into three groups with time allotments approximately in the proportions: Science 12; Arts 5; Military 2.

Science: Chemistry, Engineering Graphics, Mathematics, Physics, Surverying (2nd Year only).
Arts: English, French, History, Economics (2nd Year only).
Military: Military Training, Military Studies, Physical Training.

The two-year course at Royal Roads is more than equivalent to the First Year Engineering Course at any Canadian University plus a group of cultural subjects so often regretted as missing from the usual engineering courses plus a training in military discipline, leadership and character building.

The academic year extends from September to early June and is followed, each summer, by three months of specialized training, either afloat with the R.C.N., or at Canadian Army or Air Force Stations, according to the service in which each cadet is enrolled.

Officer Cadets of the Canadian Services Colleges are part of the Regular Forces and receive, throughout their training, basic pay at the rate of $63 per month. In addition, of course, they receive board, lodging, uniform and other clothing, books and instruments, free of charge.

The enrolment for 1962-63 is:

1st Year: 130.
2nd Year: 82 (Arts 9; General Science 18; Honours Science 2; Engineering 53).

The present Commandant of the College s Group Captain A. F. Avant, D.S.O., D.F.C., C.D., B.Sc. M.E. (Sask.), M.E.I.C., M.C.A.I.

St. Dunstan's University

Instruction in Engineering was begun at Saint Dunstan's University in 1954. The courses offered cover the first three years of a five year course. The final two years are usually taken at Nova Scotia Technical College, with whom a working agreement has been arranged. In a few instances students have transferred to other institutions.

A Diploma in Engineering is given to successful candidates at the end of three years. However, some students work on a four year plan and qualify for a general science degree as well as the Engineering Diploma in that time.

The basic content of the three years is the same for all departments. Minor adjustments are made for students intending to pursue certain branches. A survey camp is conducted on the University Campus each spring.

The laboratory facilities for the general science courses are used for these subjects. In the science building space has also been made available for a draughting room and instrument room.

The number of students enrolled in Engineering at St. Dunstan's has remained relatively small. The average has been about 40 students. Most classes are small and hence students receive much individual attention.

Despite the small numbers, Engineering students have made and are still making a significant contribution to student life on the campus at St. Dunstan's.

University of Ottawa

The first major attempt to teach engineering as a fully separate discipline at the University of Ottawa was made at the turn of the century and a building was erected in 1900 for instruction in Pure and Applied Science. However, the engineering curriculum had to be abandoned three years later, when a fire almost wiped out the entire university campus.

It was not until 1946 that the teaching of Engineering was resumed, due chiefly to the energetic efforts of the Rev. R. Lavigne, O.M.I., who persuaded the authorities of the University to permit him to undertake the foundation of a School of Applied Science. Aided by Dr. Louis Cloutier of Laval University, who acted as part-time Director of the School, he succeeded in bringing together a small nucleus of dedicated teachers. In the fall of the same year, the School of Applied Science opened its doors to a class of 18 students and its course was approved by the Engineering Institute of Canada. Regular courses in the first two years of an engineering curriculum were offered by the School, leaving the two final years for a Bachelor's degree to be completed at another university.

The need for more educational facilities to match the nation's economic and demographic growth became evident, and the University of Ottawa decided to launch its own expansion program as a contribution to the nation's requirements. One of the

University of Ottawa

first steps in this program was the establishment in 1953 of the Faculty of Pure and Applied Science.

The new Faculty was comprised of professors from the School of Applied Science, the Mathematics, Physics and Chemistry departments of the Faculty of Arts and of professors from the Biology department of the Faculty of Medicine. The direction of this newly formed group and the task of expanding it to a "full-fledged Faculty" status was given to a most dynamic and efficient leader, Dr. P. R. Gendron. Dean Gendron's first move was to extend the courses in the existing Pure Science departments so as to offer Honour's B.Sc. curricula and graduate work in all of the departments. At the same time, he initiated planning of a Chemical Engineering department which was to open the following year. In the endeavour to build up the Faculty, Dr. Gendron formed an Advisory Council comprised of eminent personalities in research and industry and no effort was spared to attract prominent scientists. He was lauded by the late Dr. E. W. R. Steacie, then President of the National Research Council, at the official opening of the Chemical Engineering Laboratory "for having gathered such an excellent staff of professors who, by their teaching and research, have already brought an enviable reputation to the faculty".

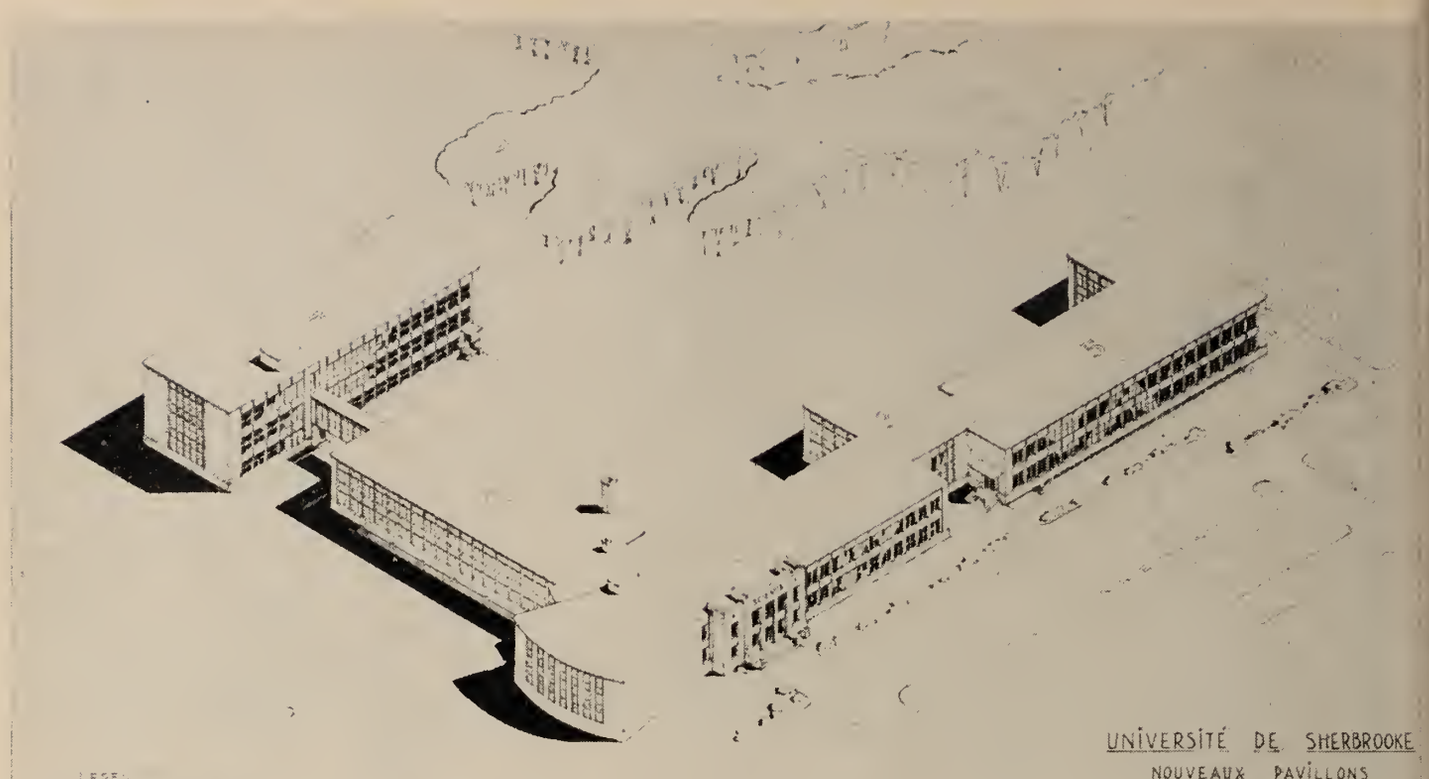
The planning stage for the Chemical Engineering laboratory continued during the fall and winter of 1953 and construction of the building was started in March 1954. The following July, Professor L. A. Madonna was appointed to supervise the installation of the laboratory facilities and to organize a curriculum for the teaching of the two final years of a B.Sc. course in Chemical Engineering. The laboratory was officially inaugurated in October 1955. As an indication of the progress of the department, an extension has already been added to the original building to accommodate increased research facilities and a second major expansion of the building is scheduled for 1965. Dr. Benjamin C.-Y. Lu was appointed in January, 1961, to replace Professor Madonna as Chairman of the Chemical Engineering Department.

In view of the increased importance attached to nuclear power, the University organized and offered in 1956, in collaboration with Atomic Energy of Canada Ltd., a course in Nuclear Engineering for graduate engineers. This course consisted in six months of instruction in the theoretical aspects of Nuclear Engineering and four months of practical training at Chalk River under the supervision of Atomic Energy's scientists and engineers.

In 1956, the second engineering department was organized with the appointment of Col. R. A. H. Galbraith, O.B.E. (then visiting professor at the Rice Institute of Technology in Texas) as Chairman of the Electrical Engineering Department. A course leading to a Bachelor's degree in electrical engineering was offered in the following year. The modern building presently occupied by the department of Electrical Engineering was first occupied in September, 1957. In 1959, Professor Galbraith handed over the chairmanship of the department to Professor G. S. Glinski. It should be noted that in each of the above departments, research and graduate courses were organized immediately after the undergraduate programs were established. The Electrical Engineering department now has 20 graduate students and it is already apparent that some expansion will be needed soon to accommodate the increase in enrolment.

For the benefit of those students wishing to specialize in other branches of engineering, the Faculty still offers the first two years of a general engineering course which requires that the final two years for a Bachelor's degree be completed at another university. At present, Professor R. P. Rowe is responsible for this curriculum. A committee was formed recently to draw up plans for the formation of new departments offering curricula leading to degrees in the civil and mechanical branches of engineering.

Owing to the fact that the Faculty of Pure and Applied Science at the University of Ottawa is still in the formative years, it does not have the usual backlog of history and precedents of a long established institution. However, looking back at the rate of expansion of this Faculty under the guidance of the first dean, and at the present continuing enthusiasm inspired by his successor Dr. L.-P. Dugal, appointed dean during the Summer of 1962, one can look forward to the future of the Faculty of Pure and Applied Science at Ottawa with pride and optimism.



University of Sherbrooke

The Faculty of Science of the University of Sherbrooke can trace its beginning to 1951 when the Catholic School Commission of the City of Sherbrooke instituted the first year of engineering at the Ecole Superieure, which was then directed by the Brothers of the Sacred Heart.

In September, 1954, date of the foundation of the Université de Sherbrooke, the second year of Engineering was added, followed by a third year in 1956. In September of 1957, the Faculty of Science moved to its own new building at the Cité Universitaire, the site it occupies now. The first graduating engineering class, numbering 23, received its diplomas in June 1959.

The following table traced the increase in the modest size of the student body:

	Eng.	Sc.
1954-55	66	7
1955-56	77	11
1956-57	114	10
1957-58	177	11
1958-59	222	25
1959-60	205	27
1960-61	223	28
1961-62	268	37
1962-63	220	53

It was soon realized, early in 1960, in view of the rapid acceptance of the school by the surrounding population, that additional space would be needed. It was felt that the Faculty should offer courses in pure science as well as in engineering. Construction was thus started in the winter of 1960-61 on a new wing for classrooms, and in the winter of 1961-62, on a new wing for the laboratories. The accompanying shows the extent of the present installation; there are 2,500,000 cubic feet of breathing space, which can accommodate up to 600 students. The Faculty can boast of fairly well equipped laboratories in strength of materials, hydraulics, soil mechanics, energy conversion, electronics, thermodynamics and mechanics in addition to the physics, chemistry and biology laboratories.

Both pure and applied science students are admitted; the first year is common to both disciplines, except for Biology. This gives the student more time to discover which branch suits him best. Those deciding to go into engineering (applied science), undergo four additional years of schooling; they must decide at the end of the second year which one of the three options available, electrical, mechanical or electrical engineering, they will select. Until this year, the pure science students, at the end of the second year had to complete their studies at another university. The Faculty has now undertaken a complete program of studies in chemistry and biology, and will see its first graduates in 1964.

The University has been studying for sometime the cadres of a school of Graduate Studies and may soon come forth with something tangible. Only then shall it be felt that the University of Sherbrooke has reached the status of a full-grown house of education.

Saint Mary's University

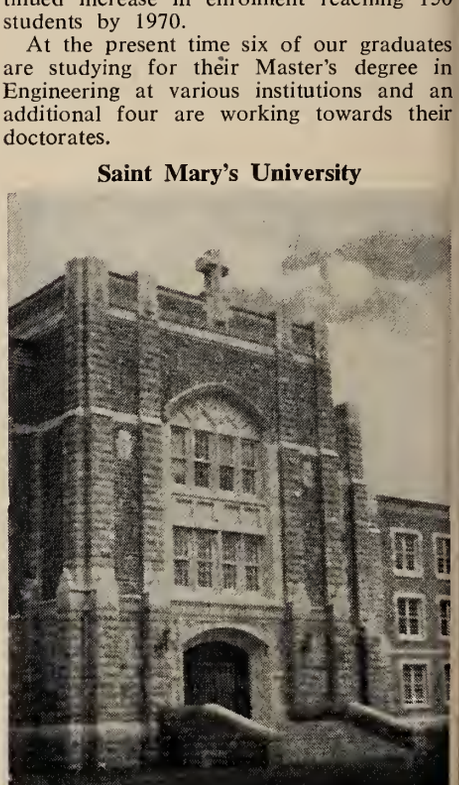
University records show that in September, 1944, two students enrolled for Engineering. This was within a few years of the founding of the Nova Scotia Technical College with which we, in common with other universities in the Atlantic Provinces, are in association inasmuch as the Associated Universities offer the first three years (after Junior Matriculation) of a five-year course leading to degrees in Civil, Mechanical, Electrical, Mining, Chemical and Metallurgical Engineering. In 1960 a School of Architecture was opened at the Nova Scotia Technical College, and students who have completed the first two years of the Uniform Course may, in general, elect to enter the final four years of Architecture at the Nova Scotia Technical College.

From the original two students, and one part-time instructor, the enrolment has grown to 87 students and six professors and instructors, some of which are part time. On moving to our new campus on Robie Street in 1950, we experienced an appreciable increase in students from outside the City and Province.

As a result of projected building expansion in the immediate near future the Engineering Department is preparing to occupy expanded facilities and plans a further increase in teaching staff. The additional space will permit, for the first time, professors to engage in Engineering Research. We anticipate and are planning for a continued increase in enrolment reaching 150 students by 1970.

At the present time six of our graduates are studying for their Master's degree in Engineering at various institutions and an additional four are working towards their doctorates.

Saint Mary's University



College Militaire Royal de Saint-Jean

College Militaire Royal

In June, 1952, to the great satisfaction of French-Canadians, the Department of National Defence announced the founding of a bilingual Services College at Saint-Jean, Que. This College was to prepare in one year cadets for admission at Royal Military College of Canada and Royal Roads where senior matriculation is a prerequisite. However, the course of study was extended to three years even before the arrival of the first cadets.

Colonel Marcelin Lahaie. D.S.O., was appointed Commanding Officer of this institution, arriving in Saint-Jean on July 12, 1952. Setting down at work with a handful of collaborators, he succeeded in less than two months in preparing the College for the arrival of the first draft of recruits. It is only fitting to pay homage to those pioneers who, through work and devotion, fulfilled a task that seemed almost impossible at the time.

The first class of recruits numbered 129 cadets, 81 French-speaking and 48 English-speaking. A staff of 40 officers and professors was on hand to teach the academic subjects together with the principles of military life. From a modest beginning, the College grew steadily so that two years after its opening there were 280 cadets and the staff had doubled.

However, this rapid growth had its shortcomings and the inadequacy of quarters soon became an acute problem. To remedy this situation and anticipating future needs, the Department of National Defence bought in 1955 and 1956 a certain number of lots adjacent to the College. During those two years, two large dormitories, two chapels and a spacious parade square were added to the existing accommodations. In the spring of 1957, there was inaugurated yet another imposing building which was to shelter classrooms, laboratories, the library and offices for the professors. It was named De Lery Hall after Chaussegros De Lery, an engineer who drew the plans of the second fort of Saint-Jean in 1748.

It is without a trace of regret that cadets and professors moved from the old Army barracks into these commodious and comfortable buildings. A few months later, a Sports Centre comprising a gymnasium, swimming pool, skating rink, theater, canteen and stores was opened to the delight of all cadets.

Thanks to such accommodations and to the initiative of the founding Commandant and his successors, the College grew up in age and importance. In September of the 10th year of its existence, a staff of 91 members welcomed 414 cadets, 85 of which were to be promoted to Royal Military College.

At the moment, College Militaire Royal de Saint-Jean is under the command of Captain M. Jette, R.C.N. Dr. G. B. Gauthier is Director of Studies and Dean of the Faculty. Although CMR has no graduate students, financial support from the Defence Research Board provides research budget for the teaching staff in Physics and Chemistry.

Many ex-cadets from the College left their mark in Canadian Universities where they studied after leaving Royal Military College. College Militaire Royal de Saint-Jean already numbers among its former cadets two Rhodes scholars as well as one Ford Foundation scholar. Others distinguished themselves in sports, either during the Annual Services Colleges Tournaments or in sports meets with other colleges or universities.

Cadets are recruited all across Canada; they have to comply with stringent conditions of physical fitness, scholastic achievement and officer-like qualities. Recruits sign a contract with the Government of Canada in which the Department of National Defence provides all material facilities for the obtention of a Royal Commission in one of the Services and a university degree; each recruit promises to serve a minimum of three years after completion of his studies. A limited number of Reserve cadets may apply for admittance. The essential difference in this method of entry is that Reserve cadets are required to pay nominal fees to defray the cost of tuition, clothing, books, laundry, meals and accommodation during the academic year. Regular Officer Training Plan cadets, on the other hand, receive these benefits at public expense and, in addition, an allowance of $63 a month, all the year round. An academic failure breaks the contract between the Government and a cadet.

The Canadian Services Colleges grant degrees according to the pattern of the Faculty of Arts and Science and Faculty of Applied Science in fields of interest to the Canadian Services. In Engineering those fields are Mechanical, Civil, Chemical, Electrical Engineering and Engineering Physics. Recruits enter College Militaire Royal after junior matriculation. The first two years, called Preparatory and First Years, intend to give a general education in Physics, Chemistry, Mathematics, French, English and History. In Second Year, cadets choose either an option in Science and Engineering with some subjects of Humanities, or Arts with some subjects of Science. When they transfer to Royal Military College of Canada for their Third and Four Years, cadets specialize fully in one Honours course. Lectures and laboratory exercises are conducted in small groups of 25 students in the cadet's own mother language, so as to develop resourcefulness and judgement. Second language classes are given to groups of 10 or 12. Everywhere, each student is given personal guidance for maximum efficiency.

Carleton University

The Ottawa Association for the Advancement of Learning, under the chairmanship of Dr. H. M. Tory, established Carleton College in the summer of 1942 to offer evening courses of instruction in the first two years of University work. Registration in the first academic year exceeded 500 students, and rose to just under 1,000 in the 1944-45 session. At this time, and until September, 1946, the activities of the College were conducted in a variety of rented

(Continued on page 62)

Carleton University

E.I.C. News

EXECUTIVE COMMITTEE WORKS THROUGH HEAVY AGENDA AT MONTREAL

The Executive Committee of the Institute met at Montreal on November 17 and worked through a heavy agenda. President Lawton was Chairman of the meeting attended by 16 Councillors.

Finance

Finance Committee Chairman G. N. Martin reported that there had been no serious deviations from the Budget to that time. He said a Sub-Committee is studying the sale of advertising in E.I.C. publications.

Phases I and II of the conversion to Electronic Data Processing were nearing completion, and Phase III was well underway.

Concern was expressed about arrears in membership fees. Mr. Martin reported that voluntary contributions totalled more than $12,000.

Confederation

No new developments were reported since the September 29 meeting except that all constituent associations of the C.C.P.E. had agreed to conduct a letter ballot. The Council's Committee is preparing a report on this matter for the membership.

Administration

The President and the Vice-Presidents reported on their activities since the last meeting. Particular attention is being paid to an examination of the present organization of the Montreal Branch in an effort to bring important services to members in the more distant areas.

The first Regional Information and Coordination Centre meeting held in Regina jointly for Regions I and II was highly successful. Similar meetings will be held in all Regions prior to the 1963 Annual Meeting.

There is some urgency in preparing a draft model agreement between the Institute and provincial associations. The Committee on Co-operative Agreements will do this as quickly as possible. The boundaries of the Toronto and new neighbouring Branches were recommended for approval by Council.

It was resolved that the Institute investigate how it might best participate in the 1967 World's Fair.

The resolutions and recommendations of the Conference of Engineering Institutions of the British Commonwealth were received for transmission to Council.

Technical Operations

The technical program for the 1963 Annual General Meeting was near completion. A plan for reorganization of the Committee on Technical Operations was endorsed and recommended for Council's approval.

The Institute was represented at a meeting of the Technical Advisory Council of the Emergency Measures Organization in Ottawa on November 8.

The President and the Chairman of the C.T.O. were to investigate the suggestion that the Institute provide short, highly-concentrated refresher courses in engineering.

Membership

The Committee on Membership was progressing with its plans for activity in every Branch. The President urged that all Branches form active Membership Committees and establish useful membership practices and targets for achievement.

A recommendation that a biannual news letter be sent to E.I.C. student conference delegates, was approved. Also approved was recommendation that the Institute provide certificates for two winners of Canadian Science Fairs.

The meeting discussed a recent seminar sponsored by the University of Toronto Engineering Society and requested further information.

The meeting asked Council to review the Institute's policy regarding admission by examination.

Professional Development

The Committee on Planning for the Future is investigating the Institute's relations with technicians.

Publications

Plans were well in hand for inaugurating the new publications policy in January, 1963. A guide to authors was being prepared. A new review procedure for technical papers was approved. Efforts were being made to meet the wishes of a group concerned with geotechnical engineering, who desire a separate publication.

"Engineering Careers in Canada" is to be published in February, 1963, and will serve anticipated needs until mid 1964.

Annual Meeting

Arrangements were well in hand for the 1963 Annual Meeting to be held in the Chateau Frontenac, Quebec City, from May 22 to May 24.

Engineering Education

The resolutions of the 1962 Meeting of Deans were received for consideration by Council.

Committees

The President was empowered to appoint members to a Committee on Public Relations, a Committee on the Young Engineer, and a Committee on Vocational Guidance.

ASME—EIC INTERNATIONAL COUNCIL MEET IN NOVEMBER

The ASME-EIC International Joint Council met November 29 in New York City with the Institute being represented by President Lawton, J. A. Thomas, and the General Secretary. Representing the ASME were President C. H. Shumaker, R. S. Sproule, David F. Quan, R. Nelsen, and O. B. Schier II.

LAKEHEAD TECHNICAL CONFERENCE, R.I. & C.C. MEETING SUCCESSES

The Lakehead Technical Conference and an R.I. & C.C. Meeting held in Port Arthur early in December were extremely useful and successful.

Four fine papers were presented during the day-long technical session. The papers and their authors were:

"Buried Cable Techniques" by R. M. Cruikshank, M.E.I.C., Outside Plant and Construction Supervisor, Western, North Division Bell Telephone Company of Canada, Toronto;

"Missile and Rocket Metallurgy'" by Dr. H. P. Tardiff, Canadian Armament Research and Development Establishment, Defence Research Board, Quebec City;

"The Lakehead Expressway, Traffic Planning and Functional Design" by A. Harvey, M.E.I.C., Vice-President, De Leuw, Cather & Company of Canada, Limited, Consulting Professional Engineers, Toronto;

"Ice Movements in the Lower St. Lawrence" by D. F. Caveen, M.E.I.C., Assistant District Engineer, Department of Public Works, Rimouski, Que.

President Lawton, addressing the luncheon meeting, spoke of the role of the learned technical society.

The Regional Information and Coordination meeting was held the follow-

(Continued on page 52)

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E.I.C. News

(Continued from page 50)

ing day. Among those attending were President Lawton, Col. G. E. Humphries, Vice-President for Zone III, and the General Secretary.

GENERAL SECRETARY APPOINTED TO IMPORTANT NATIONAL COUNCIL

On November 1 Mr. Garnet T. Page, The General Secretary was appointed by the Privy Council as a member of the National Technical and Vocational Training Advisory Council.

The purpose of the Council is to advise the Minister of Labour on matters relating to the whole area of supply of, demand for, and training of skilled artisans and technicians. The Council includes representatives of employers, organized labour, provincial governments, certain learned technical societies and the federal government.

Concurrently Mr. Page was named Chairman of the National Advisory Committee on Technological Education. This Committee was established by the Minister of Labour at the request of the Advisory Council to provide advice to the Advisory Council on matters pertaining to the education and training of technicians. EIC

COMING EVENTS

Technical Association of Pulp and Paper Industry. 48th Annual meeting. New York City. Feb. 17-21.

American Standard Association. 13th National Conference. New York City. Feb. 18-20.

Institute of Radio Engineers, American Institute of Electrical Engineers. Solid State Circuits Conference. Philadelphia. Feb. 19-23.

American Institute of Mining, Metallurgical and Petroleum Engineers Inc. 92nd Annual and International Symposium on Unit Process in Hydrometallurgy. Dallas. Feb. 24-28.

American Society of Civil Engineers. Environmental Engineering Conference. Atlanta, Ga. Feb. 25—March 1.

American Concrete Institute. 59th Annual Convention. Atlanta, Ga. March 4-7.

Engineering Institute of Canada, 77th Annual Council Meeting, Quebec City. May 22-24.
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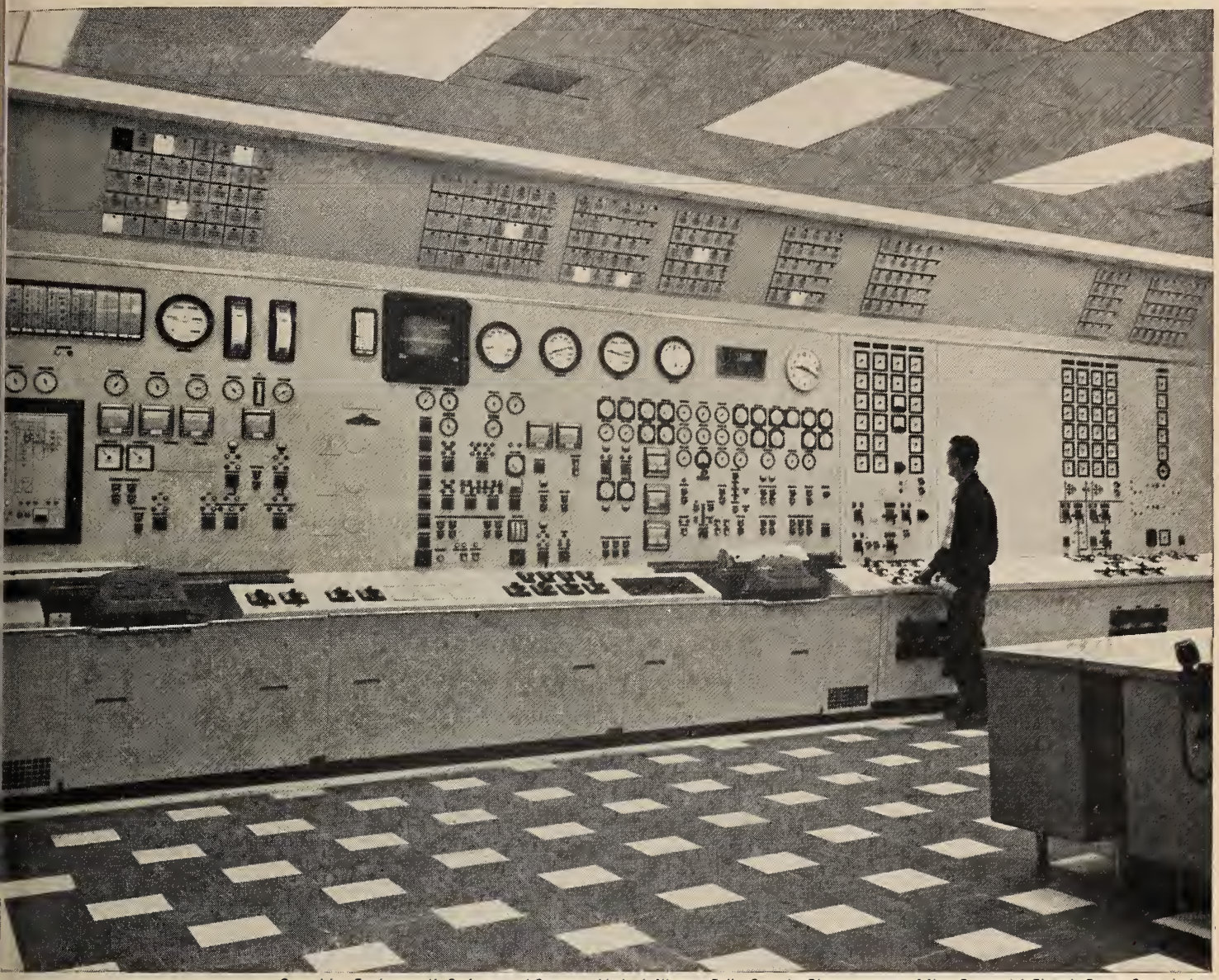

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First unit in New Courtenay Bay Station uses Bailey

Built for the New Brunswick Electric Power Commission, the first unit at the Courtenay Bay Generating Station produces 50 megawatts, and has a steam rating of 500,000 pounds per hour at 1475 psig and 1000°F. Careful engineering and system design have resulted in ease of operation and greater safety, coupled with more efficient use of operating personnel. The flexibility of Bailey Instrumentation has assisted in achieving these goals. The Station makes use of local fuel availability, firing high-viscosity oil from a nearby Refinery. Bailey controls maintain correct oil viscosity for safe, steady firing. In addition to the Central Control Room panels pictured, Bailey has supplied local transmitter panels. Full Combustion Control features continuous fuel-air ratio trim, based on oxygen in the exit gases. Steam temperature and three-element feedwater systems are used, and important indices of performance are calculated. Supervision of instrument installation and start-up was provided by Bailey engineers and technicians in the New Brunswick area. For fuel control information, write to— Bailey Meter Company Limited, 5010 St. Catherine Street West, Montreal 6, Quebec.

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ABSTRACTS

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EIC-63-BR & STR 1

"Long Columns of Reinforced Concrete",
E. M. Rensaa

This is a discussion of long columns of such considerable slenderness that buckling becomes important. Reinforced concrete walls are also dealt with to some extent. The use of slender reinforced concrete columns has increased considerably the last few years and there is still some scarcity of information about their practical use and limitations.

EIC-63-CIV 3

"Some Aspects of Wind Loading",
A. G. Davenport

Discussed are three aspects of wind loading not commonly considered, and their amplifications for structural design. These are the dynamic effects of gusts, the climate of extreme winds and the probabilistic aspects of wind loads. Properties of the spectra of atmospheric turbulence and their spatial correlations are considered Against this background the aerodynamic and dynamic response of various structures are considered qualitatively including the modern welded curtain wall skyscraper. The factors affecting both the local and continental patterns of climate are examined as well as the importance of the rate of failure in the rationalization of wind loading.

EIC-63-GEOTECH 2

"The Treatment of a Landslide Problem in British Columbia by the Relief of Pore Pressure",
R. C. Thurber

British Columbia is a province which has been well noted for the occurrence of landslides, particularly in connection with its railways and highways. Many bridges have similarly been affected by slope instability. It has long been recognized that pore pressures are one of the more important contributing factors to slope instability and part of the cause of many landslides. The techniques of computing the effect of pore pressure in the stability analysis of slopes are well covered by existing papers on the subject. This paper uses a case history of a landslide on the Pacific Great Eastern Railway to illustrate firstly the gained stability which can be achieved by reducing pore pressures, and secondly the use of piezometers to indicate initially the need for pore pressure reduction and finally to indicate the success of the installation.

EIC-63-MECH 3

"The Temperature Under Heated or Cooled Areas on the Ground Surface",
W. G. Brown

Equations and graphical methods are presented which allow calculation of the steady or unsteady temperature in the ground under flat areas of any shape on the ground surface. The equations, some of which are derived by superposition, are applicable to structures such as basementless buildings, shallow lakes and rivers, street intersections and ice rinks.

EIC-63-MECH 4

"The Calculation of Surface Temperature and Heat Flux from Subsurface Temperature Measurements"
D. G. Stephenson and G. P. Mitalas

This paper presents an analogue and a numerical method of computing surface temperature and heat flux from subsurface temperature data. The basic equations used by both methods are as shown below.

k, α are thermal conductivity and diffusivity respectively. These calculations differ from the usual finite difference heat conduction calculations in that they require the data to be differentiated rather than integrated. Methods are presented for differentiating data that have been recorded in either analogue or numerical form. The advantages of each method of recording the data are discussed. The errors inherent in the calculation of surface conditions are discussed and illustrated by examples.

EIC-63-MECH 5

"Liquid Insulation of Organic-Cooled Reactor Pressure Tubes",
J. T. Rogers

The organic-cooled heavy water-moderated power reactor concept under study in Canada has the hot organic coolant flowing through fuel channels in pressure tubes surrounded by the cool heavy water moderator. One method of reducing heat losses from the coolant to the moderator is to provide insulation by means of a laminar flow of the organic coolant itself in a narrow annulus outside the fuel channel. Experiments have been carried out to choose an annulus configuration which gives the best insulation effectiveness. A systematic investigation has been made of the most promising configuration, a narrow annulus interrupted by fairly widely-spaced rings with small clearance over the rings. This paper gives the results of the latter experiments.

An analytical method is developed for the prediction of heat flow across the annulus. The method allows for the effects of natural convection, of variation of property values with temperature drop across the annulus and of the thermal stabilization length.

The analytical method gives results for the annulus conductance which compare quite well with the measured results for the conductance of narrow annuli (of the order of 0.025" to 0.035" thick) interrupted periodically by circumferential rings and through which organic liquid is flowing.

Theory and experiments indicate that the annulus conductance will decrease with increasing ring pitch and with decreasing clearance gap over the ring. For an internal main organic flow temperature of about 700 degrees F and an external water temperature of about 180 degrees F, and a fuel channel pressure drop of about 15 psi per foot, annulus conductances of less than 50 Btu/hr. sq. ft. degrees F should be obtained with annuli about 0.025 to 0.035 inches thick.

EIC-63-MECH 6

"Temperature Distribution in Homogeneous Slabs During Fire Test",
T. Z. Harmathy

The solution of the equation of heat conduction for a case similar to that met in fire endurance tests is presented both graphically and in tabulated form. The application of these results to the calculation of thermal fire endurance and of the temperature history of test specimens during standard fire exposure is shown.

EIC-63-MECH 7

"The Energy Budget Approach to Heat Transfer at the Surface of the Earth",
R. E. Munn and E. J. Truhlar

From the principle of conservation of energy, without any knowledge of the properties of the underlying surface, it may be stated that, with the appropriate sign conventions preserved,

$$Q_T - Q_R - Q_{L\uparrow} + Q_{L\downarrow} = Q_H + Q_G + Q_E$$

where

- Q_T is the short-wave radiation from sun and sky (absent at night).
- Q_R is the short-wave radiation reflected from the earth (absent at night).
- $Q_{L\uparrow}$ is the long-wave radiation emitted by the surface.
- $Q_{L\downarrow}$ is the long-wave radiation received by the surface from the atmosphere.
- Q_H is the transfer of sensible heat to the atmosphere.
- Q_G is the transfer of sensible heat through the underlying surface.
- Q_E is the transfer of latent heat of evaporation.

A knowledge of six terms in the equation will permit estimation of the seventh. This paper will discuss theoretical, empirical and experimental methods for determining the various components of the energy balance. Some practical applications in the fields of geophysics, agriculture, hydrology and forestry will be mentioned briefly.

(Continued on page 67)

$$T_{\text{surface}} = 2T_{\Delta x} - T_{2\Delta x} + 2\left\{\frac{\tau T^{\bullet}_{\Delta x}}{2!} + \frac{\tau^2 T^{\bullet\bullet}_{\Delta x}}{4!} + \frac{\tau^3 T^{\bullet\bullet\bullet}_{\Delta x}}{6!} + \dots\right\}$$

$$q_{\text{surface}} = \frac{k}{\Delta x}\left\{\frac{3T_{\text{surface}} - 4T_{\Delta x} + T_{2\Delta x}}{2}\right\}$$

where $\tau = \dfrac{(\Delta x)^2}{\alpha}$

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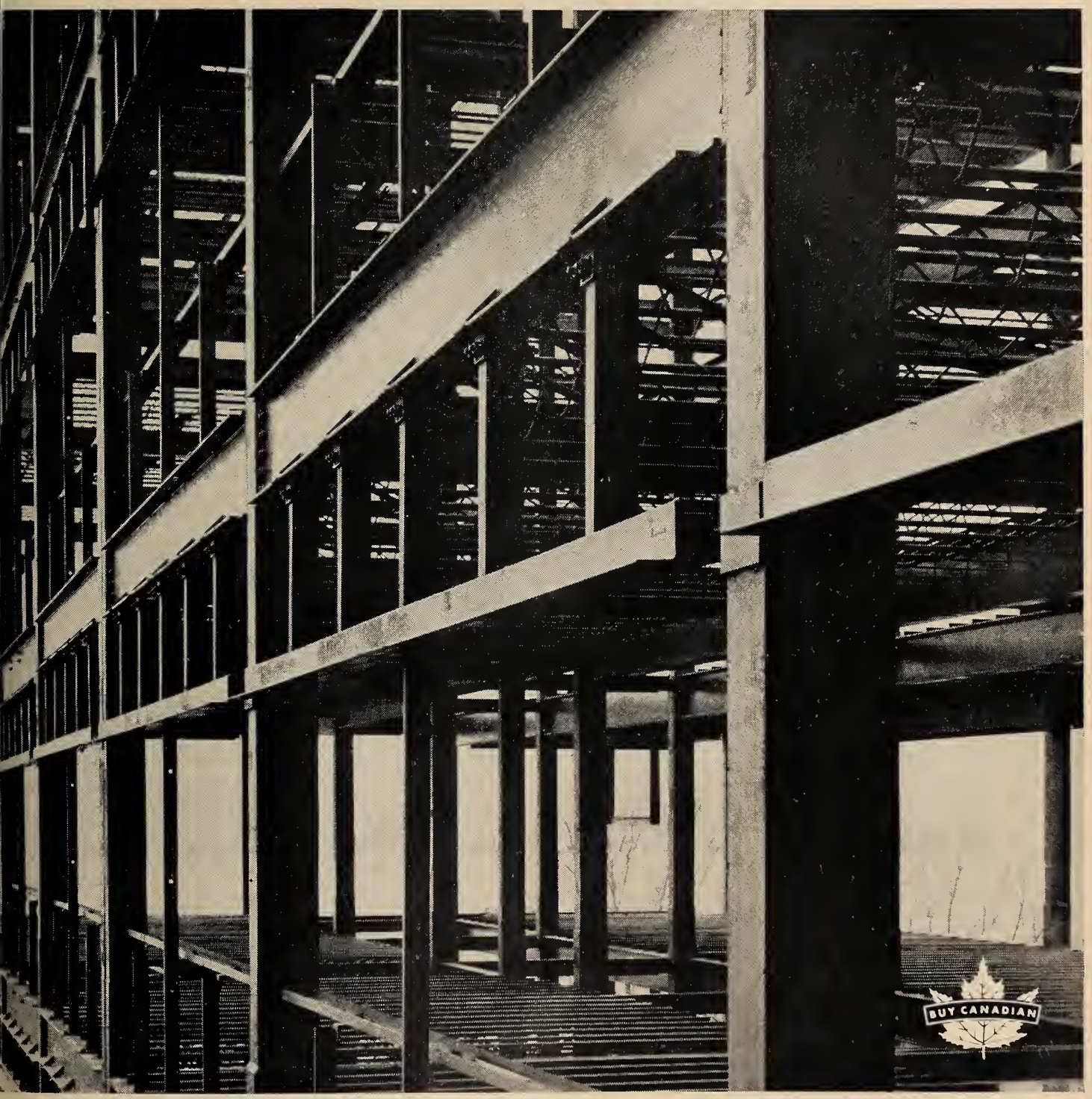

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Personals

W. A. Wyszkowski, M.E.I.C.

R. S. MacKay, M.E.I.C.

R. S. MacKay, M.E.I.C. (U.B.C. '50) has joined Overseas Developments (Canada) Ltd., as Vice President. In 1953, Mr. MacKay joined the John Inglis Company, after having completed post graduate studies, specializing in hydro-electric power at the Imperial College in London, England. He became the company's Hydraulic Engineer in 1957. Mr. MacKay will travel extensively overseas from his Toronto office, investigating engineering-construction projects for the firm's clients.

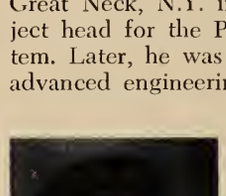
W. A. Wyszkowski, M.E.I.C. (Warsaw '30), deputy head of the civil engineering division of Ewbank Tupper & Associates Limited, Toronto consulting engineers, has been elected to the company's board of directors. Mr. Wyszkowski has been with the company as chief civil and structural engineer since 1961.

H. G. Burbidge, M.E.I.C. (Queen's '44) has been elected a Director, representing Active Membership, of the Aluminum Company of Canada, in the National Association of Corrosion Engineers.

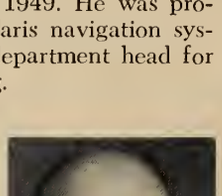
Robert E. Evans, M.E.I.C. (U.N.B. '45) have been appointed Manager of Development at the Henry J. Kaiser Company (Canada) Ltd., Montreal. Prior to his appointment, Mr. Evans had been associated with Canadian Allis-Chalmers Limited since 1947 where he acquired broad experience in the pulp and paper, mining, cement manufacturing, and hydro-electrical industries in Canada. In his new position, Mr. Evans will be responsible for the furthering of Kaiser Canada's activities in the several branches of industry which the organization is equipped to serve.

Mervyn A. Upham, M.E.I.C. (Queen's '41), operations manager at the Saskatchewan potash mine and refinery of International Minerals & Chemical Corporation (Canada) Ltd., has been promoted to the new post of General Manager of the company's Agricultural Chemical Division. Mr. Upham has been with IMC since 1960.

Gordon J. Watt has been appointed chief engineer of Sperry Gyroscope Company of Canada, Ltd. Mr. Watt joined the marine division of Sperry Gyroscope in Great Neck, N.Y. in 1949. He was project head for the Polaris navigation system. Later, he was department head for advanced engineering.



M. A. Upham, M.E.I.C.



G. J. Watt

John W. Argo, M.E.I.C. (Toronto '29), Vice President of the Toronto consulting engineers firm of Gore & Storie Limited, has been elected a Trustee of the Canadian Institute on Pollution Control. Mr. Argo joined Gore & Storie in 1929 as an assistant engineer. He became a partner in 1943 and a director in 1954. During this time, Mr. Argo has worked on large pollution control projects including the main treatment plants for Edmonton and Toronto.

Donald D. Dick, M.E.I.C. (Alta. '49) has been appointed Chief Engineer and Director of Construction of Canadian Breweries Limited. Prior to his appointment, Mr. Dick was Vice President and General Manager of Power Corporation Designers and Consultants Ltd., Montreal. In his new capacity, Mr. Dick will be responsible for the design and construction of plants, installation of major equipment, and for the co-ordination of overall construction engineering practices for the company's Canadian subsidiaries.

Lt. Col. Leonard Martin, M.E.I.C. (Clarkson Coll. of Tech. '34), a sales engineer at Sperry Gyroscope Company of Canada, Ltd., Montreal, has been elected president of the Royal Canadian Electrical and Mechanical Engineers Corps Association.

C. F. Whittaker, formerly General Manager, Home Instrument Merchandising Division, has been appointed to General Manager, Sales in the Consumer Products Division at RCA Victor Company, Ltd. In this capacity, Mr. Whittaker will be responsible for all sales activities and for the administration of the Distribution Division of Consumer Products.

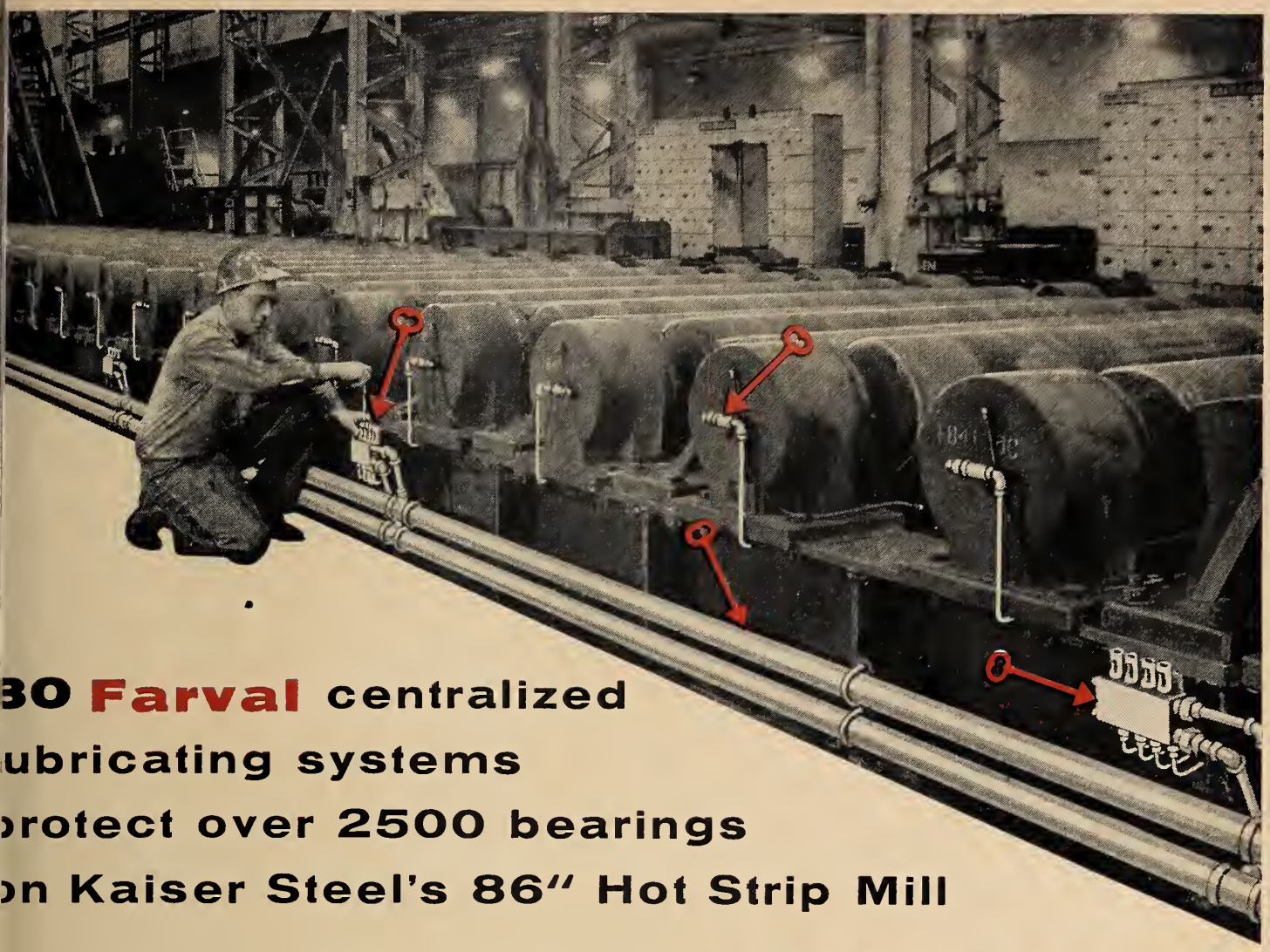
A. M. Armand has been appointed manager of sales of the switchgear and control department of Canadian Allis-Chalmers Limited. Mr. Armand has 15 years of sales and engineering experience in the electrical and utility industries.

D. A. Coape-Arnold has been appointed general manager of Massey-Ferguson Limited's North American Operations. Mr. Coape-Arnold joined Massey-Ferguson in May as a vice-president. He brings to his new position a broad background and a wide experience in international trade, corporate and plant management, sales, engineering and manufacturing.

M. A. Leishman has been appointed Vice President and General Manager of the Dominion Structural Steel Division of Canada Iron Foundries, Limited. Mr. Leishman was General Works Manager, Finishing Plants at the Steel Company of Canada, Limited prior to his appointment. He brings to his new position more than 20 years' experience in the steel industry.

D. A. Coape-Arnold

M. A. Leishman



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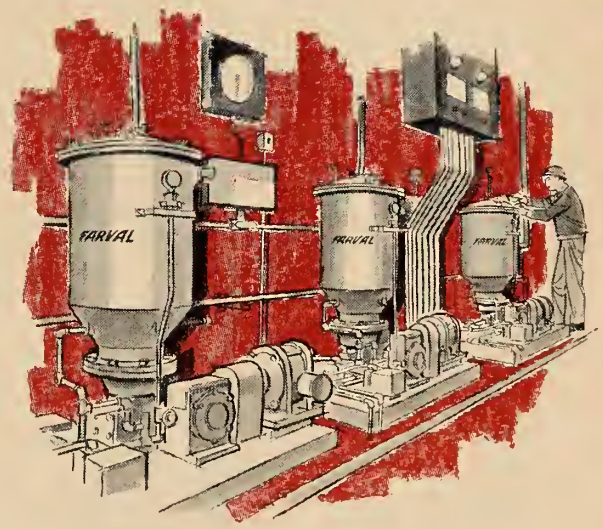

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Branch News

BAIE COMEAU
G. W. Scott

T. J. Hobson, M.E.I.C., Project Engineer with the British Newfoundland Corporation, Twin Falls, Labrador, and A. Cockerill, former Project Manager and now Power Plant Superintendent at Twin Falls were the guest speakers at the Branch's October 25 meeting. The title of the talk, given by both speakers, was, "The Twin Falls Power Development". Mr. Hobson was the first speaker. He dealt with the background, development and construction of the Twin Falls project. This 12,000 hp. hydro-electric project is located on the Unknown River, a tributary of the Hamilton River some 12 miles southwest of Grands Falls. In his talk, Mr. Hobson emphasized the various economic factors which led to the establishment of the Twin Falls project. This project was established to meet the limited requirements of the mine and concentrator installations of the Iron Ore Company of Canada, and those of the Wabush Mines located at Wabush Lake some 110 miles from the power plant.

Mr. Cockerell's talk followed Mr. Hobson's. In it, he outlined the problems associated with operation and maintenance of an isolated plant such as Twin Falls which is about to experience its first winter under load.

The plant comprises two 60,000 hp. Francis-type turbines operating under 290 foot head at the end of an uncovered steel penstock measuring 13 feet 6 inches in diameter and 513 feet long. The chief problem results from isolation and the extreme weather conditions of the central Labrador-Ungava area during the winter. Some 12 to 13 inches of ice lining is expected in the steel penstock. Although a high degree of automatic control is employed in operating the plant, problems of personnel and supply are substantial. Stocks of spare parts and stores which come via Wabush and Labrador City, are based on a closed winter

(Continued on page 78)

One of the highlights of the Presidential visit to Winnipeg Branch was a tour of the Grand Rapids Project. When the $140 million project is complete, it will generate 450,000 horsepower for Manitoba Hydro. Shown in the photograph are President Lawton (left), and J. R. Rettie, M.E.I.C., Director of Engineering at Manitoba Hydro.

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ENGINEERING EDUCATION IN CANADA

(Continued from page 49)

Carleton University

quarters throughout the city of Ottawa. An Institute of Public Administration, conjoint with the College, was established in 1943. The College created a Department of Journalism in 1945 and, in this same year, in response to requests from discharged Service personnel, offered its first day classes of instruction in the subjects of First Year Applied Science and Engineering.

In 1946 the College, for the first time, occupied a building which it owned, a four-storey structure on First Avenue, originally the property of Ottawa Ladies College. The building had been used, during the war, as a barracks of the Canadian Women's Army Corps. In April 1947, the College received, from private donors, a gift of some 40 acres of land in the vicinity of Dow's Lake to be used as a building site in future development. This area became part of the Rideau River campus in 1958.

With the opening of term in September 1947, the College offered four and five-year programs of study in Pass and Honours courses leading to the Bachelor's degree in Arts, in Science, in Commerce and in Journalism. Simultaneously, the College offered courses in the second year of Engineering and, in 1948, appointed Ernest W. Stedman as the first full-time member of faculty in Engineering. A second appointment, that of S. G. Tackaberry, the present Assistant Director of the School of Engineering, was made in 1949.

Successful candidates for the Diploma in Engineering, attained by two years of study after Senior Matriculation, normally continued on to Queen's, McGill or Toronto where they qualified, after two additional years, for a degree in Engineering. The Diploma Program became a Certificate Program in 1952, without any substantial change in its content, and continued to be offered until 1957. The first year, common to all branches, covered such basic material as Mechanics, Drawing, Surveying, English, Physics, Chemistry and Calculus. In the second year a candidate was required to elect between one option, directed towards Civil, Mechanical and Electrical Engineering, and another, directed towards Chemical Engineering, Mining, Metallurgy and Geology. As an alternative to leaving the College to gain a degree in Engineering, a successful candidate could transfer to a course leading, after a further two years, to the degree of B.Sc. with Honours in Applied Physics.

The early 50's produced steady growth in the College. The first post-graduate degree was conferred in May, 1955, and, by May, 1956, the alumni numbered more than 800 graduates. Enrolment in 1956-57 session included just under 600 full-time and 700 part-time students in courses offered for academic credit. In 1953 the College acquired additional property in the Dow's Lake area bringing the total holding to some 130 acres. By the Carleton University Act of April 1957, Carleton College became Carleton University. Under the presidency of Claude T. Bissell, development of the Rideau River campus began, reaching fruition in 1958.

The School of Engineering, created in 1957, offers a full four year program after Senior Matriculation. The first three years of the program are common, and are devoted to the foundations of Engineering: Mathematics, Physics, Physical Chemistry, Geology, and the Engineering Sciences: Mechanics, Fluid Mechanics, Thermo-dynamics, Metallurgy and Electric Circuit Theory. One course in the Humanities or Social Sciences is offered, as an elective, in the second, third and fourth years. The program has been developed under the guidance of the present Director of the School, John Ruptash, appointed in 1959. In the fourth year, options in Civil, Electrical, Mechanical Engineering and in Engineering Physics are currently offered. All four options were recognised, for purpose of accreditation, by the Association of Professional Engineers of Ontario in the Spring of 1961, just prior to the convocation at which the degree of Bachelor of Engineering was conferred on Carleton's first group of 17 Engineering graduates. The School has been gratified by the award, to its graduates, of an Athlone Fellowship and substantial fellowships and assistantships for post-graduate work, from such institutions as M.I.T., Carnegie Institute, Purdue and Northwestern Universities.

With the belief that a sound undergraduate program demands a concomitant graduate program, the School has initiated courses of study leading to the Master's degree in Engineering, with specialisation in the Aeronautical, Electrical, Electronic and Mechanical Sciences. These courses provide opportunity for both full-time and part-time studies. Current enrolment comprises some 50 full and part-time degree candidates with a similar number enjoying special student status.

The School is presently accommodated on the first and fifth floors of the Science Building. Architectural plans for the first two units of a separate Engineering Building are complete. The School expects to move to new quarters in the Spring of 1964, and, with additional space, to develop its

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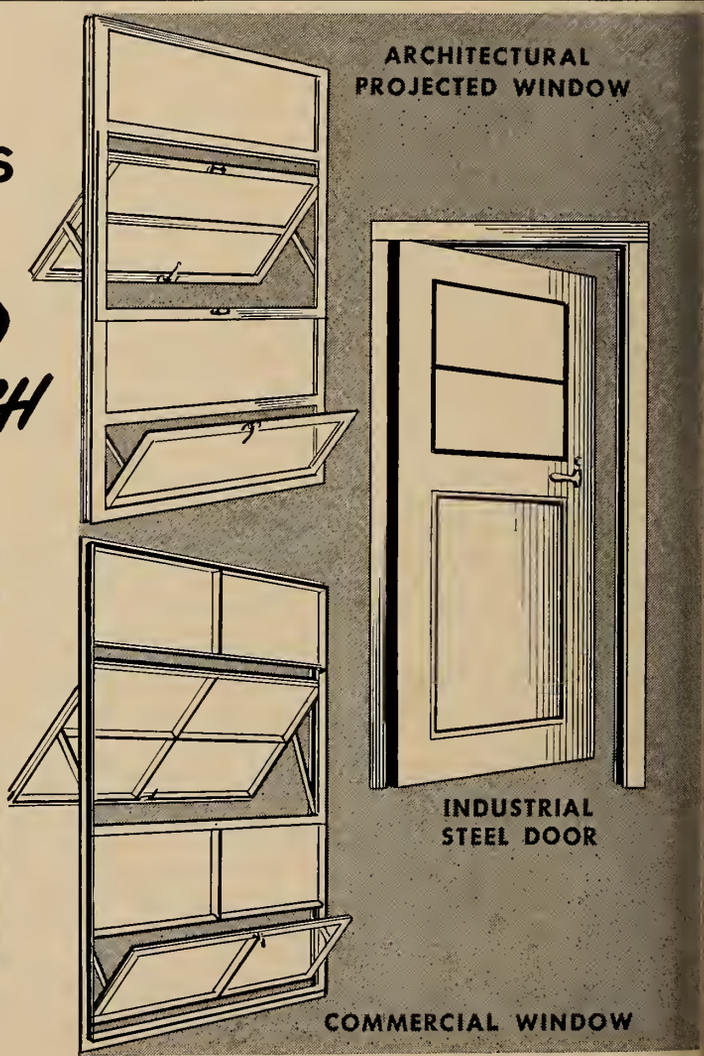

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Carleton University

activities, particularly at the post-graduate level, with greater vigour. The Carleton University Computing Facility, created in November 1961, is currently under expansion to contain both tape and card input-output and 40,000 decimal digits of core storage around a basic IBM 1620 system. Engineering students use the Facility in Second, Third and Fourth Year undergraduate work and may use it, at the graduate level, for thesis activities.

Laurentian University

The Laurentian University of Sudbury is a non-denominational and bilingual institution, established by an Act of the Ontario Legislature which received Royal Assent on March 28, 1960.

Its facilities for instruction in engineering are located in the University Building on Elgin Street in downtown Sudbury. These include chemistry and physics laboratories, one drafting room, and lecture halls. A surveying field school is conducted on a city park following final examinations in May.

Since its inception, the Engineering Department of Laurentian University has offered instruction in the first year of a four year course leading to a Bachelor of Applied Science degree. The engineering teaching staff has consisted of three members. The average student enrolment in first year engineering during the past five years has been 14. A student having successfully completed the first year engineering course at Laurentian University may be accepted to the second year at the University of Toronto, and other Canadian Universities, on individual merit.

Work now is underway for the development of a second year engineering curriculum together with the planning of the necessary facilities for engineering in the proposed new Science Building for Laurentian University. The construction of this Science Building on the newly acquired University campus is scheduled to start early in 1963. Future plans call for the introduction of a third and fourth year in the main branches of engineering and the construction of a fully equipped engineering building.

Acadia University

Courses in Applied Science at Acadia were established shortly after the turn of the century, chiefly through the efforts and enthusiasm of Dr. Thomas Trotter, Acadia's President at the time. Alexander Sutherland, who had been an instructor in Manual Training at Horton Academy, was appointed instructor in Drawing and Manual Training. Special arrangements were made with McGill and with Oxford University whereby students completing the Applied Science course at Acadia were admitted to the third year of Applied Science at those institutions. Following the establishment of the Nova Scotia Technical College in 1907, a similar arrangement was made with that institution.

During the years, affiliation has been maintained with the Technical College and with McGill. Although the majority of Acadia's engineering students enter the Nova Scotia Technical College to continue their studies toward the Bachelor of Engineering Degree, each year a few enter McGill. Over the years an occasional Acadia student has gone to the Massachusetts Institute of Technology, and a number have attended Queen's University.

The first Dean of Applied Science was Prof. Francis Haley, whose appointment was made by President G. B. Cutten shortly after his presidential inauguration in 1910. Prof. Haley, who had been appointed Alumni professor of Physics in 1891, retired as Dean of the Faculty of Applied Science in 1917, but continued to teach at Acadia until his retirement in 1929.

In 1912, Mrs. Nelson Rhodes gave funds to erect a building to house the department, which building became known as Rhodes Hall. At present the building contains a lecture room, five drafting rooms, staff offices, a surveying instrument room, darkroom, and small workshop for the department. In addition there is a clubroom for the use of engineering students, which was established about 20 years ago through the efforts of the Engineers' Class of '33. The basement and part of the first floor of Rhodes Hall provide workshop space and office accommodation for Acadia's Maintenance Department.

In 1913, R. P. Clarkson became professor of Engineering and Alexander Sutherland became acting Ivan Curry professor of Engineering, an appointment made possible by a generous gift to Acadia by Senator Nathaniel Curry of Amherst and Montreal. Following Prof. Haley's retirement as Dean, Dr. F. E. Wheelock came to Acadia in 1917 as professor of Physics and Dean of Applied Science. At about this time Karl Borden, a graduate of Mount Allison who later became superintendent of grounds and buildings at Acadia, was appointed instructor in Engineering.

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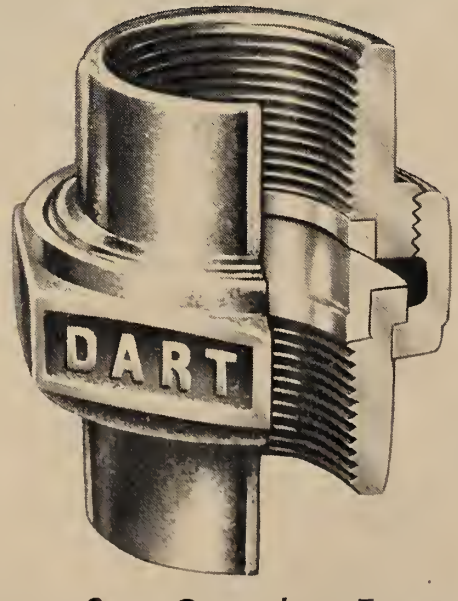

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Acadia University

In 1923 Alexander Sutherland became Dean of Applied Science, a position he held until forced by ill health in 1937 to give up his teaching position. He was honored by his alma mater during the Acadia Centennial Exercises in 1938 when the degree of Doctor of Science was conferred upon him at a special convocation held at that time.

Since the establishment of the department, student registration has varied over the years with changing conditions. The first year saw only four students enrolled in engineering subjects. There followed a sharp increase to a total of 38 in 1911. World War I caused a gradual decrease in registration, then a sudden drop in 1916 to nine students. This was followed by a spectacular rise to a total of 86 in 1919, due to the influx of veterans who were encouraged and assisted by Federal financial aid to obtain university training. Following the graduation of this group, engineering registration dropped again to a low of 26 in 1923. From this time until the end of World War II, there was considerable fluctuation in student registration in the department but with less drastic changes than had been experienced in the past.

Prior to the academic year 1926-27, the Applied Science course was a two-year program following Junior Matriculation, which covered almost as much as the present three-year course. There were 22 separate subjects with no options. In 1926-27 the three-year program was introduced and has continued in somewhat varied form to the present.

In 1928, R. T. Steeves joined the staff, became head of the department following Dr. Sutherland's retirement, and later was appointed Dean of Applied Science. Following the end of World War II, there was a heavy influx of veterans. Classes which had hitherto been confined to 20 or 30, swelled to three or four times their normal size. The record number of engineering students was attained in 1946-47, when 208 students were registered in this department, 160 being ex-servicemen. There were 101 new students in that year, imposing a considerable burden both on the staff members and on the teaching facilities.

Registration gradually diminished following the wave of veterans, dropping to a low of 60 in 1951-52. In that year only 26 new engineering students were registered. The adverse propaganda that had been freely distributed across the country regarding the excess of engineering students over available jobs that would occur in the near future, contributed along with other factors, to this decline in engineering registration which was evident in all Canadian universities offering instruction to such students. It appears likely that with Canada's expanding industrial economy and the continued development of her natural resources, ample opportunities for engineering graduates will be available for some years to come.

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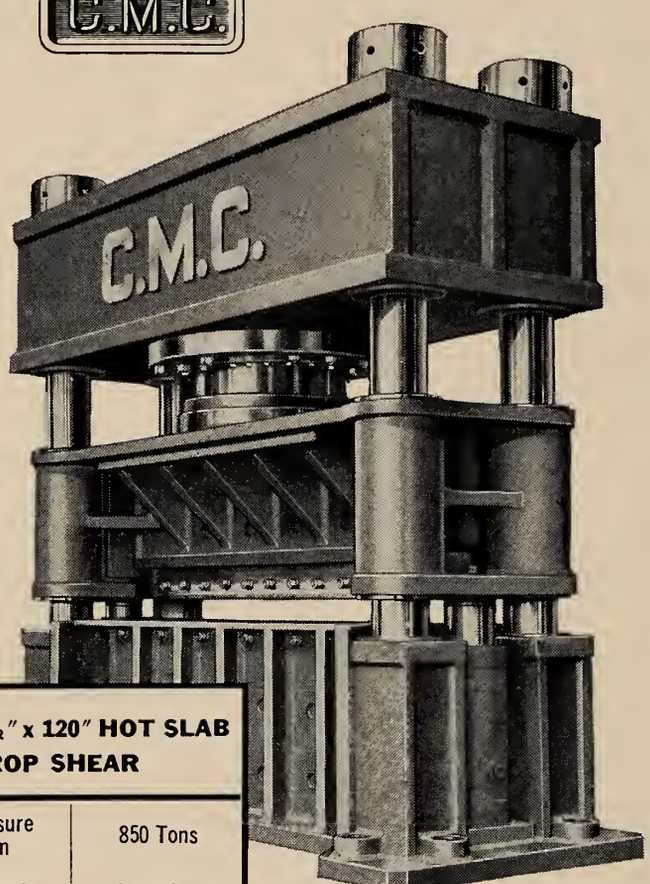

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McMaster University

In comparison with the 76 years of history spanned by the Engineering Institute of Canada, the engineering school at McMaster is a callow youth, for the Faculty was ratified by the Senate in 1957. Prior to that time, one year of engineering studies had been offered on this campus for nearly 25 years, with the students proceeding to Queen's University for the balance of their engineering education.

As a natural evolution of the burgeoning of activity in physical sciences at McMaster, planning was started in September, 1956, for an engineering faculty appropriate to the particular time in our technological history, the surrounding industrial environment, and the facilities already available on the campus. Several convictions dictated the character of the school which has evolved. In recognition of the growing breadth of technology and of the consequent need for interdepartmental liaison, the engineering departments are all housed under one rather large roof. At the very outset a decision was taken that the courses were to emphasize the technical rather than the economic or sociological aspects of engineering—this is not a suitable school for education in management techniques or labor relations. Pursuant to this concept, it was seen to be mandatory that the graduate programs and research facilities be planned and provided at the same time as those for undergraduate studies. This has two main advantages—research-oriented staff can be attracted and retained, and the undergraduate students are exposed daily to engineering research and development in almost every field of specialization.

The first class of 50 students was enrolled in September, 1957, and 25 graduates emerged at the first engineering convocation in 1961. Enrolment has built up steadily, although slower than anticipated, and 95 freshmen were enrolled in the

McMaster University

autumn of 1962. All the facilities have been planned for an ultimate undergraduate population of 500, and a graduate enrolment of about 85.

Four-year courses leading to the degree Bachelor of Engineering are offered in chemical, civil, electrical, mechanical, and metallurgical engineering, and engineering physics. All courses with graduating students have been fully accredited by the Association of Professional Engineers of the Province of Ontario. All departments now offer graduate work to the Master's level, and chemical and metallurgical engineering have students proceeding to the Ph.D. The graduate population (including Metallurgical Science students) is 28, of whom seven are doctoral candidates.

The engineering building was planned during the summer and autumn of 1957, construction was started in April, 1958, and occupancy was achieved in May, 1959. Throughout the summer of 1959, furniture and equipment were installed and the facilities were ready as planned, in October of that year. The gross floor area is 185,000 square feet, divided among five departments.

Assembly of staff, begun in 1958, was continued in pace with the evolution of the program, until in 1962, the academic staff numbers 30 (25 with the Ph.D. degree), 22 supporting technical staff, and 17 administrative and maintenance personnel.

Most of the assumptions made at the outset have been borne out in practice. Canada's economy has been more sluggish than anticipated in 1956, and the amount of indigenous engineering design, research and development is far in arrears of respectability; it is hoped that she can use our graduates in positions closer to their potential in the next decade. The assembly of all of the engineering activities under one roof has had several noteworthy advantages. Ideas move across departmental boundaries freely, and great economies in research equipment have resulted. For example, joint use is made of our materials testing equipment, the nuclear reactor, the high speed camera, and the liquid helium supply. A significant number of interdisciplinary research programs are well under way.

This short history in review has, of necessity, a very contemporary aspect; it is hoped that when a similar submission is made on the occasion of the E.I.C. centenary, a distinguished chapter can be added to Canada's engineering history.

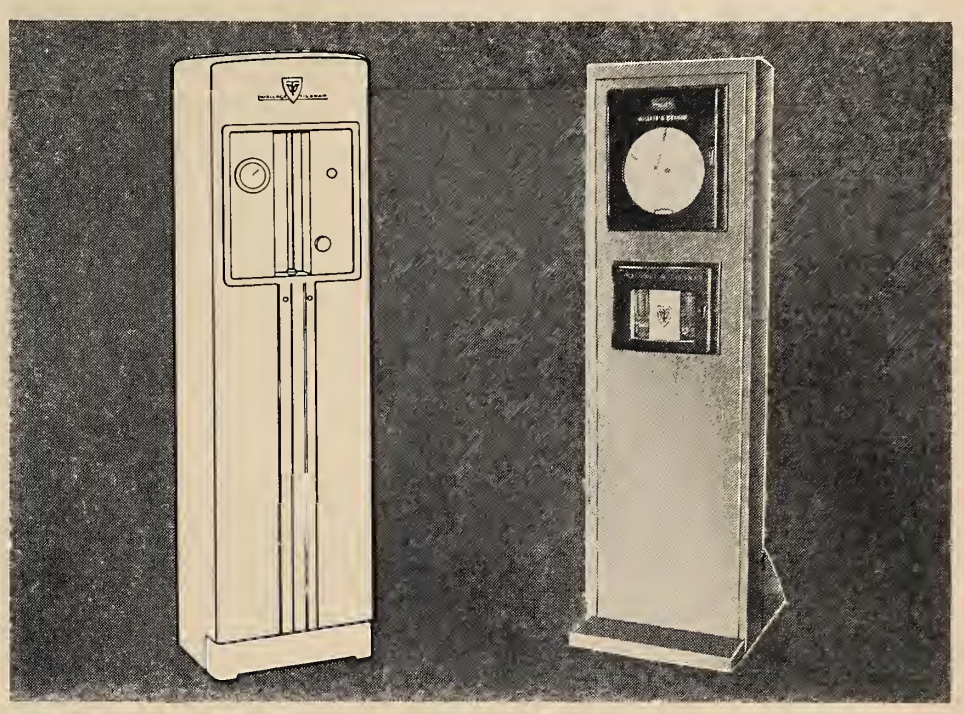
Mount Allison University

The McClelan School of Engineering, or of Applied Science as it was originally called, was established in 1903. Its foundation was largely due to the generosity of the Hon. A. R. McClelan, former Lieutenant-Governor of New Brunswick who supplied most of the funds required for converting the "Old Lodge" into suitable classrooms, laboratories, draughting rooms, and work shops, and providing the necessary furniture and equipment. The School was named in recognition of his interest and assistance.

Instruction in the new course began in September, 1904. The plan was to give only the first two years of an engineering degree course, and an arrangement was made with McGill University whereby students who completed the two years could enter the third year in Civil, Mechanical, Electrical, or Mining engineering. Consequently the curriculum for the two years at Mount Allison was made to conform as closely as possible with that of the first two years at McGill. A similar arrangement was made with the Nova Scotia Technical College in 1909, and later with various other universities. At the present time affiliation with universities other than the Nova Scotia Technical College has virtually ceased because of the difficulty of completely meeting their requirements for the first two or three years of the course.

Between 1904 and 1925 changes in the course consisted chiefly of adjustments in existing courses. The only new courses introduced were a course in Graphical Statics and a course in Geology. In 1925 all the Shopwork courses, (Carpentry, Wood Turning, Forging, Chipping and Filing, and Foundry Work), were discontinued.

In 1926 the course was extended to three years, to conform with the decision of most of the engineering schools in Canada to add an additional year to the course. These changes were made to broaden the education of the engineer by the introduction of a number of courses from the Social Sciences and the Humanities, and at the same time better prepare him for the work of the last two years. Since 1926 there have been many changes in the curriculum; many courses have been re-adjusted; a number of courses have been discontinued; a few new courses have been added. It is interesting to note that to give more time to the sciences the humanities and social science courses have been reduced from five to three. From 1904 to 1958 the number



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Mount Allison University

of students who registered for the course was 1929; 843, or 43.7%, of them completed the work.

It was mentioned at the beginning of this article that the "Old Lodge", a three-storey wooden building, had been converted into suitable accommodation for the classes in engineering. In March, 1933, this building, and all engineering equipment, was destroyed by fire. Temporary quarters for the remainder of the year were found in the attic of the new Science Building. The next summer this attic was converted into suitable draughting rooms, offices, an instrument room, and at blue print room. It continued to be used by the Engineering department until 1958 when the Physics and Engineering Building was opened and the School moved to new quarters. The fine accommodation in this building will probably be adequate for many years.

When the School was founded in 1903, it was decided to organize the staff as the Faculty of Applied Science under the direction of a Dean. This arrangement continued until 1936, when, because of increasing administrative loads, it was deemed necessary to divide the University into two faculties, Arts and Science. The Faculty of Applied Science was discontinued and the McClelan School of Engineering—renamed at that time—became a part of the Faculty of Science. The chief administrative officer of the School was given the title Director. The organization set-up in 1936 has continued to the present time.

Some mention must be made of those who through the years have been chiefly responsible for the development and administration of the School and also for whatever success it may have had. In addition to those named, many others have assisted.

W. J. Sweetser, B.S., a graduate of Massachusetts Institute of Technology, joined the staff in 1903 as Professor of Mechanical Engineering. The preliminary arrangements for facilities, equipment, and curriculum were largely the work of Prof. Sweetser.

In 1906, J. W. Crowell, B.S., C.E., was appointed Professor of Civil Engineering. He was a graduate of Dartmouth College. Prof. Crowell was responsible for the initial courses in Surveying and for the further development of Shopwork courses.

Professor Sweetser resigned in 1907 to accept a position at the University of Maine. He was succeeded by Lawrence Killam, M.A., B.Sc., who was a graduate of Mount Allison in Arts and of McGill in Mechanical Engineering. Prof. Killam was largely responsible for the administration of the School from 1907 to 1913. In 1912 he was appointed Dean of Faculty. He resigned in 1913 to accept a position elsewhere and was succeeded by H. W. McKiel, B.A., B.Sc., a graduate of Queen's University in Arts and in Mechanical and Chemical Engineering. Professor McKiel served on the faculty of the School from 1913 until 1956. He held the appointment of Professor of Mechanical Engineering until 1920, and then as Professor of Engineering until 1956. He was appointed Dean of the Faculty of Applied Science in 1924, and Dean of the Faculty of Science in 1937. This position he held until 1949 when he was appointed Vice-President of the University. He retired in 1956. Professor McKiel was an excellent teacher, a fine administrator, and intensely interested in the welfare of engineering education and of the engineering profession. The McClelan School of Engineering was indeed fortunate to have him on its staff.

Prof. Crowell found it necessary to resign in 1919 because of ill health. F. L. West, M.A., B.Sc., who had graduated from Mount Allison in Arts and from McGill in Civil Engineering was engaged to succeed him, as Professor of Engineering. Over many years Professor West has had much to do with the work of the School. He served as Director of the School from 1937 to 1949, as Dean of the Faculty of Science from 1949 to 1957, and, since 1956, has been Vice-President of the University. He retired in June 1962.

In 1957 Professor West was succeeded by Professor R. A. Boorne, B.A. Sc., a graduate of Toronto in Engineering Physics, as Director of the School. Professor Boorne still holds this appointment. He has associated with him Assistant Professor G. R. Pond, B.E., and G. W. Hannah, B.Sc., B.E. Both are graduates of the Nova Scotia Technical College.

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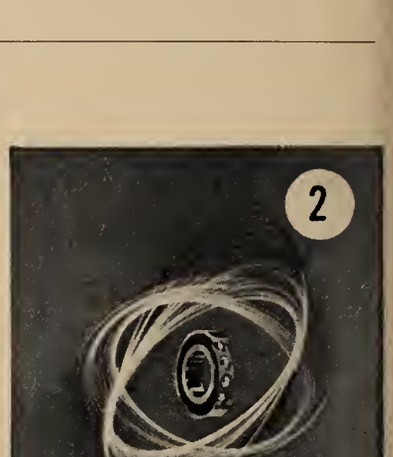

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Abstracts

(Continued from page 56)

EIC-63-MECH 8

"Studies of the Departure from Nucleate Boiling in Some Organic Mixtures",
R. O. Pelham and D. G. Andrews

Current interest in organic-cooled reactors has led to the need for information concerning the heat transfer properties of organic liquids. Of particular importance is the need for accurate prediction of the heat-flux at which burnout, or departure from nucleate boiling (DNB) will occur, since above this point the failure of the fuel element will undoubtedly take place.

It has been known for some time that the point of DNB for a mixture of organics is usually higher than would be predicted from the DNB points of pure components. Since a high DNB point is very advantageous, this preliminary study has been undertaken to investigate the variation of DNB with composition in organic mixtures, using a simple pool-boiling apparatus and relatively simple, pure organic liquids. Investigations covered eight binary systems and one ternary.

EIC-63-MECH 9

"Heat Transfer Coefficients on Finned Surfaces",
J. W. Stachiewicz and A. R. MacKay

Flow within an array of longitudinal fins has been studied and analysed. Heat transfer results indicate that fin spacing is an important parameter in determining the film coefficients on fin surfaces and a flow behaviour is postulated which explains, at least qualitatively, the experimental results. Further work is in progress to confirm these results quantitatively.

EIC-63-MECH 10

"Laboratory and Field Studies of Radiation Instruments",
J. R. Latimer

This paper discusses methods for determining the various radiation terms of the energy balance equation. A brief description is given of several instruments currently in use by the Meteorological Service. These include the Eppley 180 degree pyrheliometer, Kipp Solarimeter, Funk net radiometer and an experimental model of the Suomi (et al) improved ventilated net radiometer. A detailed account then follows of the many instrumental and observational errors that can enter the data.

EIC-63-MECH 11

"Laminar Heat Transfer of Bingham Fluid in Flat Duct with or without Heat Source",
Chi Tien

The Graez-Nusselt Problem is extended to the case of Bingham Plastic flowing in a flat duct. The exact solutions, asymptotic solutions and approximate solutions, based on momentum integral method for the temperature distribution, Nusselt modulus and average temperature are presented. Considerations are also given to cases where certain types of heat sources are present.

EIC-63-MECH 12

"Thermal Contact Resistance",
T. W. MacDonald

Considerable research and study has gone into the problem of trying to predict the magnitude of the thermal contact resistance of joints. It was towards this end that a series of experiments was started at the University of Saskatchewan four years ago with financial assistance from the Defence Research Board of Canada.

The approach used in solving this problem was to first determine the mode of heat transfer at the joint, then determine the effect of various factors on the component parts contributing to the resistance. The work completed to date considers the effect of the type and degree of surface finish and the thermal properties of the solids in contact as well as of the surrounding fluid for contact pressures between 5 and 15 psi.

EIC-63-MECH 13

"Heat Transfer to Particles in High Temperature Surroundings",
W. H. Gauvin and T. W. Hoffman

This paper discusses a number of experimental studies performed at the Pulp and Paper Research Institute's laboratory during recent years in the field of particulate heat transfer, in an attempt to present a unified approach to the subject based on general boundary layer concepts.

Departure from the general behaviour due to stream turbulence and to particle shape and orientation are considered but systems involving inter-particle contact, such as fluidized beds, are not discussed. Since most high temperature applications involve mass transfer in the form of evaporation, drying or chemical reaction, consideration is given to the effects of natural convective currents arising from the particle motion. Because of its importance to engineering design, the problem of calculating the heat flux to a cloud of particles conveyed in a radiation-absorbing atmosphere and of predicting the temperature distribution in such a system is discussed in some detail.

EIC-63-ELEC 2

"Compensated Dynamic Braking of Three-Phase Wound-Rotor Induction Motors",
G. Hausen

To meet certain load conditions, it is necessary that drive motors produce brake torques. If the drive motor is an induction motor this can be accomplished by exciting its stator winding with direct current and thereby operating the motor as an alternator. The inherent problems of such a control scheme are the danger of run-away conditions due to under-excitation of the stator and the danger of motor overheating caused by over-excitation. Both problems are eliminated in the compensated dynamic braking system, which employs feed-back control methods to adjust the DC-excitation of the induction motor automatically as a function of existing load conditions. Performance and design of compensated dynamic braking control systems are discussed in this paper.

EIC-63-CE&A 2

"Controls for the N.A.E. Supersonic Wind Tunnel",
L. J. P. Tillson and G. F. Kelk

A new high speed serodynamic facility at the National Aeronautical Establishment in Ottawa comprises a five foot by five foot supersonic blowdown wind tunnel and all ancillaries. It is currently one of the largest and most versatile of its type. The control systems of this facility are the subject of the present paper. Control requirements for this type of apparatus are severe since permissible variations are small, energy flux and flow rate are massive and operating intervals are of only a few seconds duration. Indeed the whole concept of the "blowdown" wind tunnel, where a large accumulation of stored air is released over a short interval of tunnel operation, is made possible only by advances in the technologies of controls and high speed data processing.

EIC-63-MGMT 2

"Life Estimation and Cost-Depreciation of Physical Assets",
L. I. Szabo

Life estimation of physical assets plays an important role in engineering, economics, accounting, finance, insurance and taxation. It is important in many cases that a reasonable estimate of the average service life of groups of units of industrial equipment, structures, etc., be made to determine annual and accrued depreciation; to evaluate physical property; to calculate rate base in regulated public utilities; to settle insurance claims; and so on. Described are two methods of life estimation of group properties. First, when detailed historical facts are available; and second, when such detailed data is not available, or the expense to secure it is prohibitive for the prospective plant account. The estimations of the depreciation reserve and the annual depreciation expense based on the survival curve of the group units are also shown.

EIC-63-EDUC 1

"The First Five Years of the Co-operative Engineering Program at the University of Waterloo",
D. T. Wright

The paper first sketches the history of the development of higher education at Waterloo. Since the co-operative system is unique in Canada, some idea is given of the scope, scale and significance of co-operative education and its parallels in the U.S. and U.K. Particular attention is given to the Edison/Ford Foundations' study of co-operative education in the U.S. The organization of the Waterloo program is described, with some comparisons made between practices in the U.S. and U.K. and those in Canada in respect of student-industry relations. Also discussed are: development and evolution of undergraduate curricula; postgraduate study and research; professional graduate study; physical development, planning and objectives of the facilities; prospects for future developments in Canada in engineering education from the point of view of the frame of experience presented in the paper.

EIC-63-CHEM 2

"The Pipeline Flow Characteristics of Crude Oil",
G. W. Govier and R. A. Ritter

Many crude oils discovered in Western Canada display unusual flow properties in the temperatures encountered during storage and pipeline transportation. Careful consideration of deviations from Newtonian behavior is essential to the accurate design of most flow systems associated with these liquids. The characteristic behavior of Newtonian, pseudoplastic and time dependent or thixotropic crude oils is reviewed with particular attention given to the techniques involved in the measurement and interpretation of the rheological data. Several examples of each type are presented to demonstrate the rather wide variations which are possible within each of the three classifications. Application of laboratory data to the design of crude oil pipelines is discussed. The complications arising from the shear rate and time dependence of thixotropic crude oils is considered under both laminar and turbulent flow conditions.

(Continued on page 77)

(Continued from page 60)

season of seven months when no movement is possible. The automated plant requires skilled maintenance personnel, but it is impracticable to recruit staff from the urban areas since they would not stay at the isolated Twin Falls project. Only those willing to remain in Labrador in relative isolation were chosen and trained by the company.

BELLEVILLE
J. E. Tomlinson

The Operations Manager of Lake Ontario Portland Cement Company Ltd., F. C. Stevens, was the guest speaker at the Branch's November 12 meeting. Mr. Stevens gave a brief outline of the company's history, its construction and processing layout. The construction of the plant, one of the most modern on this continent, was completed in 1958, and reached its full output capacity during 1961. Various types of cement and crushed limestone are produced. All mixing, grinding, blending and conveying of materials is carried out in a dry state rather than in a slurry. Following Mr. Stevens' talk, the members were conducted by plant officers, on an informative tour of the plant.

A field trip to the RCAF Station at Trenton was held October 1. Flt. Lt. J. W. Stockdale was program director for the tour and provided a briefing on the Yukon Simulator at the station. There are two general purpose simulators and one operational flight trainer for Yukon aircraft. The general purpose simulators are used mainly for training in navigational radio aids including TACAN which is manufactured in Belleville by the Northern Electric Company. The second simulator, which duplicates Yukon flight conditions, is used for training in the operation of Yukon aircraft.

Left to right: J. N. Raftis, Chairman of the Branch; G. E. Humphries, Vice President; C. H. Hantho the guest speaker; and Hugh Judges, Branch Secretary-Treasurer.

SUDBURY
J. N. Raftis

The monthly business meeting of the Branch was held November 15. Charles H. Hantho, of the Plastics Division, Canadian Industries Limited, was the guest speaker. He spoke on the role of plastics in industry, and supplemented his talk with samples of plastics used in underwater cables, and industry.

The Institute's Vice President for the Sudbury area, G. E. Humphries, was also a guest at this meeting.

EDMONTON
A. J. Allman

The Branch was host to the President of the Institute at a dinner meeting October 25 at the Seven Seas Restaurant. In his talk, "The Iron Curtain in Engineering", Mr. Lawton said that an iron curtain exists in engineering and acts as a barrier to development. This iron curtain is woven by engineers who do not follow through in their field of endeavor, but allow others to do this for them. He suggested that engineers should broaden their engineering outlook and thus eliminate this barrier to development which they create. Mr. Lawton expressed his belief that during the next 75 years we will see changes in engineering which may dim those accomplishments of the past 75 years. He spoke briefly on the anticipated developments in the fields of transportation, energy, automation and food. In the field of power generation, he anticipated the wide-spread use of an aqueous coal slurry to provide an inexpensive and readily available fuel for power plants. Mr. Lawton said that the day would come when, in newsprint production, the cellulose would be used instead of being wasted as slash. He anticipates significant strides in automation which will reduce the work load and allow time for more productive endeavors. Mr. Lawton ended his talk with the belief that the iron curtain in engineering would be lifted and that those developments anticipated for the next 75 years will be of great benefit to mankind.

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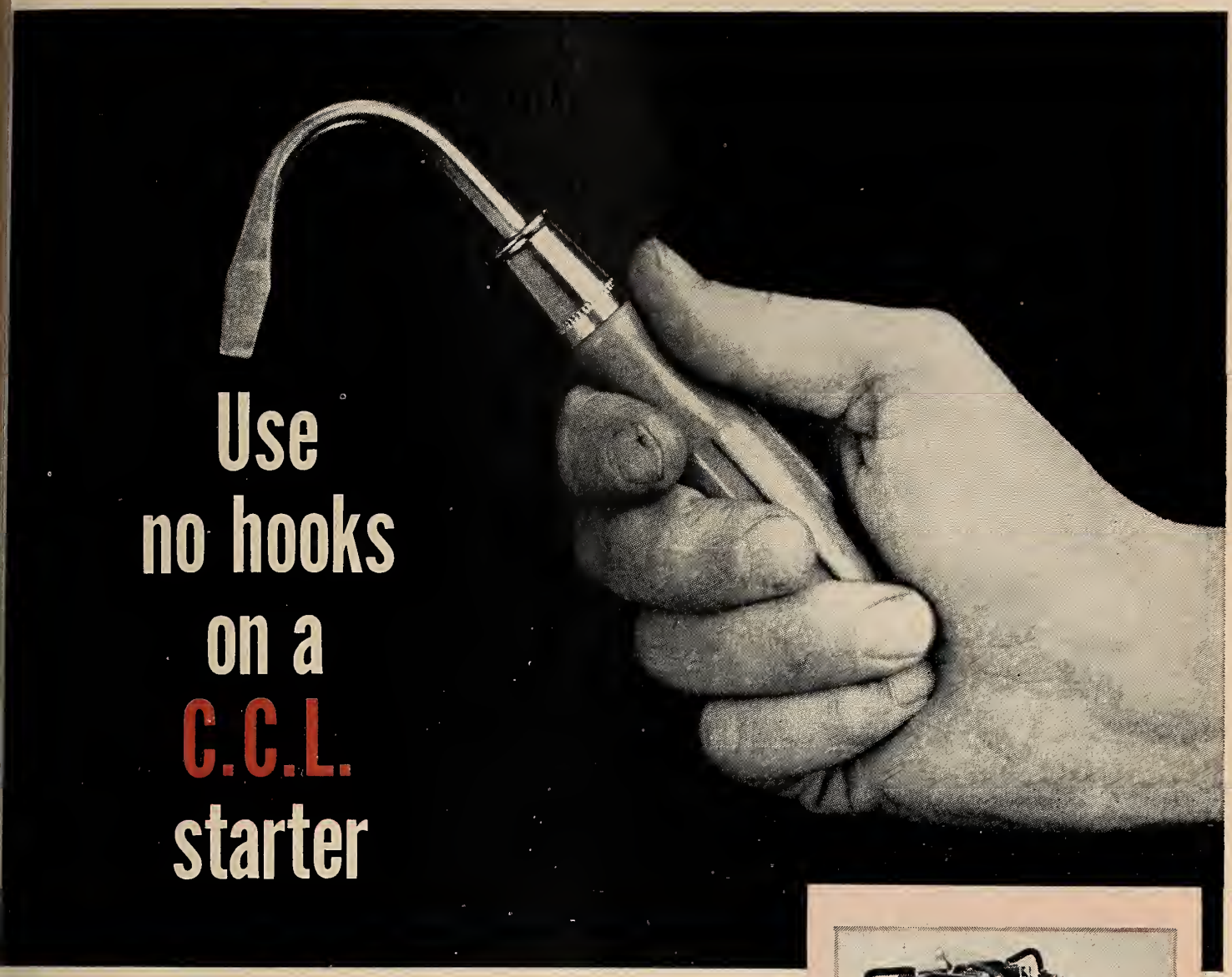

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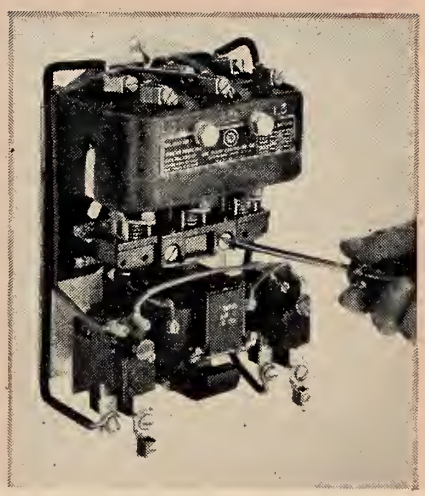

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ELECTRONICS, A BIBLIOGRAPHICAL GUIDE, C. K. Moore & K. J. Spencer, MacDonald, London, 65s.

THE ELECTRON MICROSCOPE, THE PRESENT STATE OF THE ART, M. E. Haine, & V. E. Cosslett, Wiley, N.Y., $9.25.

INTRODUCTION TO ELECTROMAGNETIC FIELDS AND WAVES, D. Corson & P. Lorrain, Freeman, San Francisco.

ELEKTRISCHE MESSUNG NICHTELEKTRISCHER GROSSEN, H. F. Grave, Akademische Verlag, Leipzig, DM 54.

ELASTIC ANALYSIS OF SHELLS BY ELECTRONIC ANALOGY, C. B. Wilby & N. W. Bellamy, Arnold, London, $5.40.

THE ENGINE TESTING OF CRANKCASE LUBRICATING OILS, Editors—G. Sell & M. J. Wells.

THE DYNAMICS OF AUTOMATIC CONTROL SYSTEMS, E. P. Popov, Translated from Russian by A. D. Booth, Addison-Wesley, Reading, Mass., $10.75.

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DESIGN OF HYDRAULIC CONTROL SYSTEMS, E. Lewis & H. Stern, McGraw-Hill, $14.50.

DAS KALT-BIEGEN VON ROHREN, W. D. Franz, Springer-Verlag, Berlin, DM 22:50.

DAM GEOLOGY, R. C. S. Walters, Butterworth's, Washington, D.C., $13.50.

AIR SAMPLING INSTRUMENTS FOR EVALUATION OF ATMOSPHERIC CONTAMINANTS, American Conference of Government Industrial Hygenists, New York, $8.

ASYMPTOTIC METHODS IN THE THEORY OF NON-LINEAR OSCILLATIONS, VOL. X, N. N. Bogoliubov & Y. A. Mitropolsky, translated from Russian. Gordon & Breach, N.Y., $25.

INTRODUCTORY PRACTICAL METALLOGRAPHY, A. R. Bailey, Metallurgical Services, Surrey, Eng., 12/6.

THE ALUMINIUM-COPPER-SILICON SYSTEM, D. L. Thomas, Metallurgical Services, Surrey, Eng., 12/6.

THE ANALYSIS OF TITANIUM, ZIRCONIUM AND THEIR ALLOYS, W. T. Elwell & D. F. Wood, Wiley, N.Y., $7.75.

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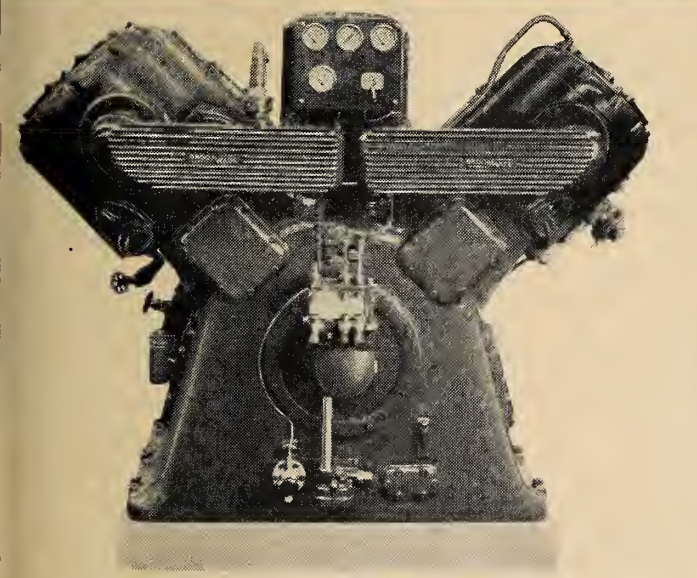

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Replies to advertisements should be addressed to the file number, Employment Service, 2050 Mansfield Street, Montreal. Interviews with the Employment Service may be arranged by calling VI 2-8121 at the above address.

SITUATIONS WANTED

CHEMICAL ENGINEER, M.E.I.C., P.Eng. B.Eng. (McGill '56), M.B.A. Dipl. (McGill '59), age 28, single. 3 years plant engineering and product development; 3 years market research, sales development, and sales. Desires position in marketing, product promotion, in plastics and/or chemicals field. Montreal or Toronto area location preferred. Resume and references available. File No. 342-Ch.

CIVIL ENGINEER, M.E.I.C., P.Eng., B.Sc., (1958). M.Sc. (Structures, 1962), 4 years experience in design of bridges and buildings. Seeks position in structural field, Western Canada. File No. 402-C.

CIVIL ENGINEER — A.M.E.I.C., P.Eng., B.Sc., Manitoba '60. Age 24, single. 2½ years post-graduate experience in highway engineering, soils, asphalt, concrete. Carried out numerous special research projects in lab. and field. Additional 5 summers pre-graduate experience surveying, highway construction, inspection, and supervision. Desires position with progressive organization. Preferably Western Canada. File No. 403-C.

CHEMICAL ENGINEER — M.E.I.C., B.Sc., B.Eng., N.S.T.C. 1951. Age 36, married. 11 years experience in technical and production field in textile fibres and pulp & paper industry. Desires challenging position with responsibility and promising future with a new or expanding chemical company. Maritimes location preferred, but will consider any Ontario location. File No. 401-Ch.

CIVIL ENGINEER — R.M.C. 1959, B.Sc. Alberta 1960, one year post-graduate night school studies in soils engineering at McGill. Age 27, single, almost bilingual. Desires technical sales position leading to management or marketing. Available March 1963 with 3 years experience as Construction Engineering Officer, RCAF. Good background in man management, job supervision and administration. Anxious to further business education. Resume on request. File No. 398-C.

CIVIL ENGINEER, M.E.I.C., P.Eng., age 34, married. 8 years experience in bridge work involving the construction of timber, concrete and steel bridges. One year varied experience in general contracting work and public works. Prepared to locate anywhere, available on two weeks notice. File No. 399-C.

ELECTRICAL ENGINEER — M.E.I.C., 1951 graduate. Varied experience including 6 years in utility; seeks position preferably in Eastern Canada. Resume on request. File No. 397-E.

ELECTRICAL ENGINEER — A.M.E.I.C., Jr. P.Eng. (Que.), B.Sc. (U.N.B. '60). Age 26, single. 2½ years experience in testing, designing, budgeting, estimating, and generating station operation and maintenance with a large private electrical power utility. Desires position in an electrical utility or manufacturing industry. Active in community affairs and sports. Presently located in Quebec; willing to relocate anywhere. File No. 406-E.

CIVIL ENGINEER — A.M.E.I.C., B.Eng. (Sask. '61). Age 24, married. Desires summer position in structural design field with possibilities of future permanent employment. Now working towards M.Sc. in structural engineering and will be finished academic requirements in April '63. Will return to university in fall to do research towards thesis and graduate in spring '64. File No. 405-C.

CIVIL AND MINING ENGINEER, M.E.-I.C., P.Eng. Years of experience in all phases of management, production, heavy construction, and public relations. Excellent administrator, problem-solver, trouble-shooter. Wide contacts in business, construction and engineering fields. B.Sc., B.Eng., married, prepared to travel or relocate for a challenging job. File No. 311-C.

ELECTRICAL ENGINEER — P. Eng. U.B.C. '59. Overseas fellowship recipient during which experience gained in England in electrical manufacturing; foundry, welding, machine shop schools, on construction and as assistant to Works Manager. In Canada, motor and switchgear engineering; construction and production as undergraduate. Montreal or B.C. Plant, installation or project engineering. File No. 376-E.

CIVIL ENGINEER — A.M.E.I.C., B.Sc. Alberta, married, age 31. Experienced in plant engineering design involving major installations, general plant engineering and research projects in pulp and paper mill. Desires technical or administrative position, preferably in Western Canada. File No. 407-C.

ELECTRICAL ENGINEER, P.Eng., M.E.-I.C., B.Sc.E.E., University of New Brunswick '35. Age 48. 4 years experience electrical construction, maintenance in Gold Mines. 23 years Naval experience in electrical engineering, training electrical personnel, ship construction and repair, production, administration and technical supervision of ship electrical design and control group. Ex-Electrical Officer retiring and available August '63. Seeks employment in Ottawa or vicinity. File No. 395-E.

ELECTRICAL/MECHANICAL ENGINEER, M.E.I.C., A.M.I.E.E. Married, age 37. Wide experience technical sales, U.K., Eastern & Western Canada, sales promotion; presently district sales manager with proven sales record; requires responsible position offering greater scope and advancement in import/export sales Canada, U.S. or Europe. Resume on request. File No. 404-E.

ELECTRICAL ENGINEER — M.E.I.C., P.Eng., 1955 graduate in power. Desires position commensurate with following experience: 8 years generation, transmission, distribution and industrial plant layout experience with both public and private industry. No location preference. File No. 6099-E.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., age 38, married. Six years experience in Canada: Two, with manufacturer of heavy industrial equipment, preparing quotations to customers' specifications; two, in plant maintenance for distillery and bottling equipment; two, in air conditioning design. Previous five years with earth-moving equipment, diesel engines, etc. in repair and maintenance shop. Seeks position in maintenance or production, preferably in Montreal. File No. 384-M.

MECHANICAL ENGINEER — McGill 1940, age 46, married, 2 children. Experience as manager plant facilities including plant engineering, maintenance, design of process equipment, tooling and mechanical equipment. Experience in quality control, material control, assembly supervision and product design. Experienced supervisor and budget responsibility. Seeks employment as plant engineer, industrial engineer or plant superintendent, preferably a process type industry such as petroleum, paper or food in Ontario, Quebec or B.C. File No. 385-M.

GRADUATE MECHANICAL ENGINEER, M.E.I.C., P.Eng., M.I. Nuclear E., age 38, married. Wide experience in supervisory and managerial capacity in medium heavy engineering. Maintenance, production, project, design, commercial. Excellent record, hard working, good ability, initiative. Seeks progressive position with executive prospects. Preferred locations Ontario or Alberta, B.C. File No. 170-M.

MECHANICAL ENGINEER — A.M.E.I.C., R.M.C. Graduate, B.A.Sc. University of Toronto 1960. Age 26, married, 2 children. Presently serving in Royal Canadian Navy. Experienced in man management and technical administration. Prefers position in administrative or managerial aspect of engineering firm, but will consider any field where background and experience will be of benefit. Location preferences, Central or Western Canada. Resume on request. File No. 400-M.

MECHANICAL ENGINEER, M.E.I.C., G.I. MECH.E. Age 33. Married, 1 child. Seeks position as Production Engineer, Manufacturing Engineer, Tool Engineer, or other supervisory position in manufacturing. 17 years diversified experience in industry, shop work, drafting, tool design, product design and development, machine design, estimating, methods, equipment selection and purchase, budgetary and cost control, supervisory and administrative experience. Preferred location, Ontario. File No. 277-M.

SITUATIONS WANTED

PROMOTION OF FOREIGN OPERATIONS — PROJECT ENGINEER, P.Eng., Mechanical, 5 years experience in thermal power plant projects and coordination, wishes to join or assist organization dealing with general industrial projects, surveys and promotion in foreign countries. Fluent in Spanish and German, understands French. File No. 337-M.

RETIRED ENGINEER — M.E.I.C., P.Eng. (Que.). Desires position, either full or part time, where past diversified experience can be an asset. Qualified Mechanical and Structural Engineer. Well versed in construction and maintenance. In excellent health. Do not want to stagnate. Montreal area preferred. File No. 356-M.

CIVIL ENGINEER—M.E.I.C. P.Eng.(Alta.). Just returned after 5 years with Canadian Consulting firm in Pakistan. Widely travelled. Excellent contacts in Pakistan, India, Malaya, Hong Kong. Desires position requiring Technical Sales Promotion in these areas. Age 28. Well versed in relative trade regulations and export techniques. File No. 347-C.

STRUCTURAL ENGINEER — available April 1963. Competent designer and good organiser of design, drafting and procurement. Experience of fabrication and erection of steelwork and heavy equipment. Fifteen years in electric power and chemical plant fields. Prefer non-metropolitan city. File No. 396-Str.

SITUATIONS VACANT

CHEMICAL

CHEMISTS OR CHEMICAL ENGINEERS — Required for a leading manufacturer of building materials and industrial products, for challenging work involving product development assignments. Candidates should be university graduates with a knowledge of rubber and/or paint technology. Preference will be given to applicants with several years industrial experience on related work. Attractive starting salary. Permanent position with growth possibilities. Liberal employee benefits. Excellent recreational and educational facilities in a modern community centrally located. Apply in writing to: Employment Manager, Canadian Johns-Manville Co. Limited, Asbestos, Que.

CIVIL

SOILS/FOUNDATION ENGINEER required by consulting engineering firm expanding its specialized services in Civil Engineering fields. Applicant must be experienced in soils investigation and advanced design of structural foundations for buildings and bridges. Present workload includes civil engineering works such as high embankment fills and deep cuts, dams and roads. Must be capable of specifying and supervising laboratory test programs including triaxial tests with porewater pressure measurement. Opportunity for senior engineer interested in entering consulting field as an associate. Reply in confidence to File No. 335-V.

ELECTRICAL

ELECTRICAL ENGINEER required for firm in Quebec City. Must have a minimum of three years experience in one or more of the following lines: Motors, generators, transformers, repairing and rewinding; testing; maintenance of motors and controls; sales of electric equipments; sub-station construction; electrical construction in industries; field engineer. Salary depending upon qualifications. Must be bilingual. Good opportunities for the right man. Reply giving complete resume of training and experience and state marital status, to File No. 340-V.

Nitrogen Production Opportunities in Trinidad

FOR CHEMICAL, MECHANICAL & ELECTRICAL ENGINEERS

We are seeking competent engineers who can help advance a program of expansion and the operations of a pioneer ammonia and urea facility in Trinidad.

OPENINGS EXIST IN THE FOLLOWING AREAS:

TECHNICAL SERVICES MANAGER

Graduate Mechanical or Chemical engineer with approximately eight years chemical or petrochemical experience with particular strength in mechanical design. Responsibilities will include operation of Technical Services Department, direction of process and mechanical design work and equipment inspection.

SENIOR CHEMICAL ENGINEER

Graduate Chemical Engineer with six to eight years experience with either ammonia or petrochemical plant. Mechanical engineer will be considered for position provided he has sufficient experience. Responsibilities will include study and improvement of existing plant processes, and for the process design of new or improved plant process equipment.

SENIOR MAINTENANCE ENGINEER

Graduate Mechanical or Electrical Engineer with five to eight years experience, most of which must have been concerning plant maintenance. Duties will include all details of construction in plant as well as liaison with all Engineering Department and outside contractors working in plant. Will install and maintain preventative maintenance and supervise Control and Stores Section of Maintenance Department.

CHEMICAL ENGINEER

Graduate Chemical Engineer with three to five years experience in the process engineering field in Chemical or Petrochemical Plants with specific experience in process design. Responsibilities will include study and improvement of existing plant and process design of new or improved plant and process equipment.

PROCESS ENGINEERS

Graduate Chemical or Mechanical Engineers with two to three years experience in a Chemical or Petrochemical plant. Responsibilities will include planning and execution of general plant testing, efficiency of process runs and interpretation of data and other specific or assigned projects.

AREA MAINTENANCE ENGINEER

Engineer with three to five years plant experience. Responsibilities will include technical quality of all maintenance work, planning and scheduling, supervise construction in cooperation with Senior Maintenance Engineer and special projects at request of Maintenance Superintendent.

The above positions require individuals with a record of accomplishment and potential for growth in an increasingly expanding worldwide chemical organization.

Resumes including present and anticipated salary requirements should be directed in strictest confidence to: W. F. Rochford.

FEDERATION CHEMICALS LIMITED

FEDCHEM

AFFILIATE OF W. R. GRACE & CO.

3 HANOVER SQUARE
NEW YORK 5, NEW YORK, U.S.A.

SITUATIONS VACANT

MECHANICAL

GRADUATE MECHANICAL ENGINEER required by consulting firm in Montreal, with about ten years experience in the industrial field. Must be able to take responsibility for organising and running a full job, and be interested in actively developing business. Association and eventual partnership is contemplated. Reply File No. 337-V.

MINING

METALLURGICAL ENGINEERS — Large progressive Corporation with subsidiary Companies in several provinces in Eastern Canada requires Metallurgical Engineers. Excellent opportunities for advancement. Reply in confidence to: File No. 292-V.

MISCELLANEOUS

A rapidly expanding medium-size manufacturing company seeks: **RESEARCH PROJECT MANAGER** — To manage and carry out research and development work in particular on high pressure valves and related control equipment. Must be a graduate mechanical engineer and have a minimum of 5 years experience in this field. **TWO MECHANICAL DESIGN ENGINEERS** — Must have at least 5 years of specific experience in the design of high pressure valves and related control equipment. Please send confidential resume indicating education, age, experience and present salary to: **VELAN ENGINEERING COMPANIES**, 2125 Ward Ave., Montreal, Que.

MISCELLANEOUS

RESEARCH ENGINEERS — Large progressive iron ore mining company has openings for Mining, Metallurgical and Chemical Engineers interested in iron ore beneficiation and research. Work includes metallurgical problems associated with pyrometallurgical processes, including pelletizing, sintering and magnetic roasting. Mineral dressing problems concerning flotation, gravity separation, electrical separation and development of new beneficiation processes will be investigated on both laboratory and pilot plant scales. Work will be conducted in a modern well-equipped research centre at Schefferville, P.Q. Applicants should apply in writing, giving full particulars, to: Personnel Department, **IRON ORE COMPANY OF CANADA**, Office No. 306, 810 Cote de Liesse Rd., Montreal 9, P.Q.

ENGINEERS FOR MANAGEMENT—project, design, sales, research, development and control. Graduates of most types and ages required by clients of the Technical Service Council, a non-profit, industry-sponsored placement service. Write 2 Homewood Ave., Toronto 5, Ontario or 1500 Stanley Street, Montreal 25, Que. for an application. There is no charge for work done on your behalf. File No. 6648-V.

SALES ENGINEERS — Due to expansion we require additional Sales Engineers to service our accounts in our paper, pulp and converting machinery divisions. Preferably graduates with field or technical experience in paper mills or allied backgrounds. We also have openings for junior graduate engineers in our expanding Engineering Department. Send full details to: The Manager, **BLACK CLAWSON-KENNEDY LTD.**, 3300 Cavendish Blvd., Montreal 28, P.Q.

POST-DOCTORATE FELLOWSHIP

We have a post-doctorate fellowship available to investigate the use of non-destructive methods in the field of metals deformation. Please write details of qualifications and experience to the Personnel Officer.

ONTARIO RESEARCH FOUNDATION
43, Queen's Park Crescent
Toronto, Canada

GRADUATE ENGINEER — If you have had three or more years of experience in a pulp or paper mill, then we have an opening in our engineering department that could be interesting to you. We are a well-established manufacturer of pulp and paper mill equipment. Living conditions in our centrally-located city are considered very desirable. This is a position of responsibility and challenge to an ambitious young engineer. Your communication outlining your background will be treated in confidence. Salary open. Apply to File No. 338-V.

TEACHING

McMASTER UNIVERSITY — Applications are invited for appointments in the Department of Electrical Engineering. Candidates should have an interest in one or more of the following: Network Theory; Non-linear Circuits; Communications; Control Systems; Digital Systems. A Doctorate in Electrical Engineering is required and industrial research or development experience would be an advantage. Duties include teaching at undergraduate and graduate levels, conducting research and supervising graduate students. Salary according to qualifications and experience. Assistant Professor $7020-$8730; Associate Professor $9000-$11,310. Additional stipends for summer research work. Applications and inquiries should be addressed to The Chairman, Department of Electrical Engineering, McMaster University, Hamilton, Ontario.

ROYAL CANADIAN AIR FORCE

requires

GRADUATES IN ENGINEERING, APPLIED SCIENCE HONOURS MATHEMATICS OR PHYSICS

Employment will be initially in field or station engineering duties to assume managerial, executive and technical responsibilities. Subsequent assignments will normally involve staff, supervisory and planning duties at higher formation headquarters in Canada and overseas.

Successful applicants will be enrolled in the RCAF (Regular) with the rank of Flying Officer in one of the following technical branches commensurate with educational qualifications:

AERONAUTICAL ENGINEERING
CONSTRUCTION ENGINEERING
TELECOMMUNICATIONS

Applicants must be resident in Canada and be Canadian citizens or British subjects with the status of landed immigrant; single or married, not over 34 years of age. They may elect either a short service commission of five years duration or a permanent commission on a full time career basis.

Further details may be obtained from the nearest RCAF Recruiting Unit or by writing to:

THE DIRECTOR OF PERSONNEL MANNING
AIR FORCE HEADQUARTERS
OTTAWA, ONTARIO.

THE CITY OF PRINCE ALBERT, SASKATCHEWAN
(POP. 24,000)

REQUIRES AN ASSISTANT TO THE CITY ENGINEER.

DUTIES: To assist in all phases of Municipal projects and operatian of the department.

QUALIFICATIONS: Must hold a degree in Engineering, preferably Civil, from a recagnized University.

Position affers varied experience, future security and an opportunity for advancement.

SALARY: Minimum $6000.00 per year plus two annual increments.

Apply in writing stating age, experience and relevant information ta the undersigned:

S. E. PARKER,
PERSONNEL OFFICER,
CITY OF PRINCE ALBERT,
SASKATCHEWAN.

NOTICE TO ADVERTISERS

DEADLINE — Pleose note that requests for insertions must be submitted in writing not later than the **15th of the preceding month.**
Cancellations: same as above.

SITUATIONS VACANT — Classified rate: $6 per column-half-inch per insertion. Display rates: Per insertion — 1/12 page — $100; 1/8 page — $120; 1/6 page — $195; 1/4 poge — $215; 1/3 page — $285; 1/2 page — $345.

DATE IN CIRCULATION — 20th of month.

SITUATIONS WANTED — Accepted free of chorge from Members of The Engineering Institute of Conado only.

Abstracts

(Continued from page 67)

EIC-63-CIV 2
"Gagnon — A New Town",
W. H. Beaton and Edouard Fiset

One of the dominant visions in present-day Canada is the development of our northern regions, and of equal interest are the communities which form the living environment of the people engaged in such enterprise. The town of Gagnon, situated within the sub-arctic along with its contemporaries — Schefferville, Kitimat and Thompson, is an example of the way new place names are coming into being in formerly desolate country as companions to the effective use of our natural resources. In this paper an attempt is made to present a general picture of the planning and construction, which at Gagnon was to transform a square mile of wilderness into what now is a modern town of 3,000 persons.

EIC-63-GEOTECH 1
"Earthdam on Compressible and Pervious Foundation",
C. F. Ripley and D. B. Campbell

A wide buried channel several hundred feet deep exists beneath the earth structures at Seymour Fall Dam, a composite concrete and earthfill dam. The buried channel contains both pervious and compressible deposits. In 1926, the site was rejected as unsuitable for a contemplated 50 to 100 foot high dam because of the pervious foundation. Consequently the height of the first dam built at the site in 1928 was limited to 22 feet.

DIVISION PAPERS

EIC-63-BR&STR 2
"Orthotropic Design in Modern Bridge Engineering",
M. S. Troitsky

This long, detailed paper presents a general review of both the concept and the technical details of the development and application of the orthotropic system and its influence on modern bridge engineering. Accordingly, the paper is divided into six parts: concept and development; orthotropic system; structural analysis; design criteria; current trends and research; conclusion.

EIC-63-CHEM 1
"The Engineering Operation of Large Pipe Lines",
C. D. Bailey

Principles and procedures for the safe and economic operation of large high pressure pipe lines have been developed in Canada and other countries. These are significant and it is hoped that their presentation will be of benefit to safety and economy in the organization of efficient pipe line systems. Included are discussion of: effect of terrain on route; safeguards and planning; high test line pipe; surge considerations; pumping pressure; cold weather operations; contemporary developments for increasing efficiency and reducing operating costs. However, to meet increased demands for water, a detailed re-appraisal of the site for a higher dam was made in the light of modern advances in soil mechanics. While the investigations revealed even more difficult conditions than had been known in 1926, the re-appraisal indicated that a higher dame could be built safely and economically at the site provided the design included: upstream impervious blankets to reduce the leakage to tolerable limits; measures to accommodate large settlements; and drainage facilities to control the substantial seepage flow.

EIC-63-HYDEL 1
"Red Rock Falls Project",
R. A. Forrester

Red Rock Falls Generating Station is a hydro-electric station of 53,000 hp., located on the Mississagi River about 20 miles northwest of Blind River. It was completed in January, 1961 at a cost of approximately $17 million. The main features of the project are the concrete gravity dam, sluiceways, log chute, intake and powerhouse containing two turbine generator units. Novel features are the electric governor, the spillway ski-jump energy dissipators and the remote control equipment. The paper deals with engineering and construction aspects, covering such items as site description, geology, hydrology, project layout, equipment installation, unit capacity, design highlights, construction progress and project organization.

EIC-63-MECH 14
"The Alignment of Large Diesel Engines",
R. A. Stenberg

In 1957 the B.C. Power Commission installed 11 3,000 kw. generating sets, the

(Continued on page 80)

SPERRY

ELECTRONIC ENGINEERS

THIS IS A UNIQUE OPPORTUNITY to fully utilize your present knowledge — to expand that knowledge and broaden your scope and experience.

Expansion and diversification of product lines have made available positions at supervisory, senior, and intermediate levels, working on highly interesting projects.

These projects involve the application of radar, gyros, servo systems, digital circuitry, logic, switching and analogue circuitry on both a system and a detailed basis.

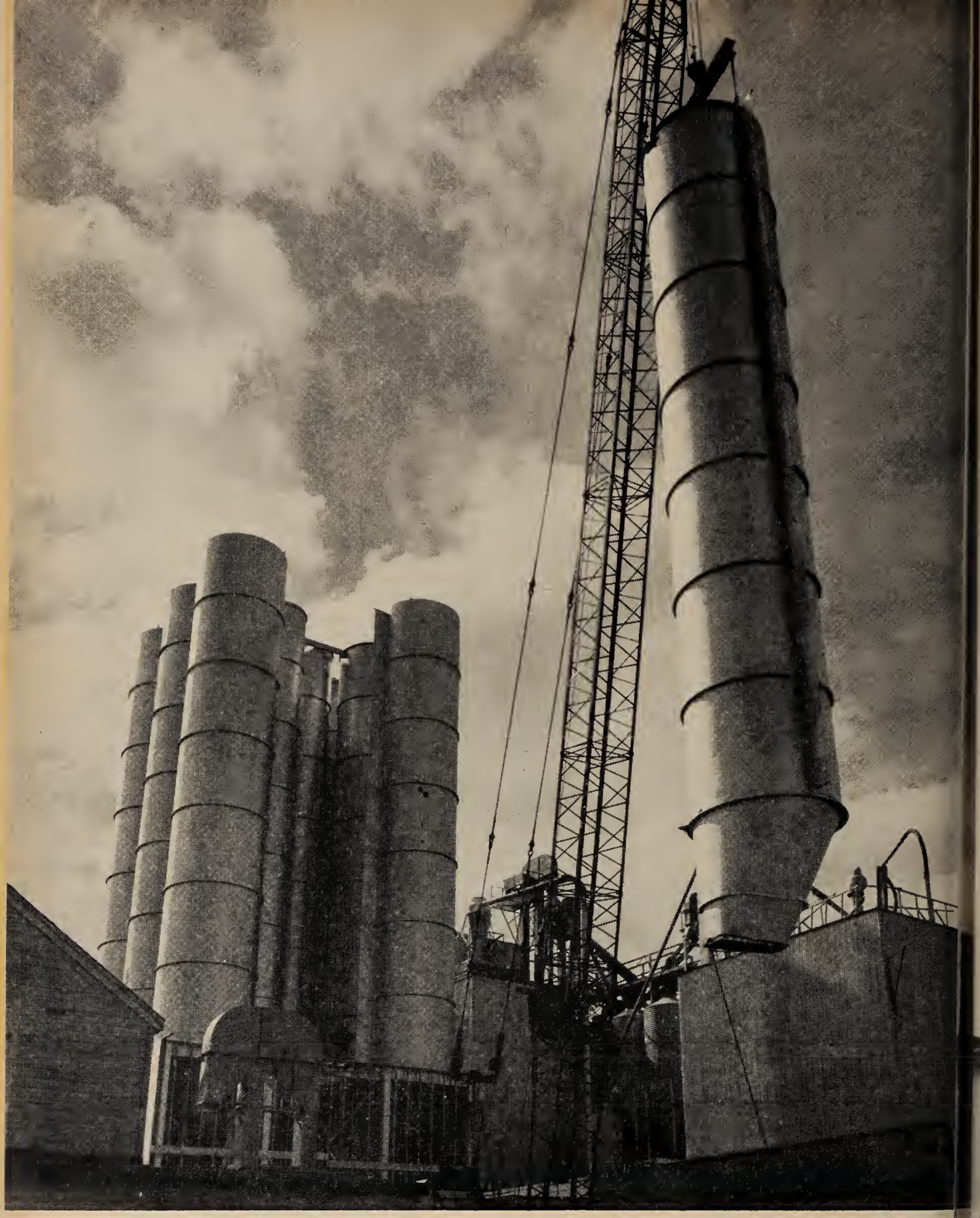
A university degree in electrical engineering or engineering physics, 3 to 10 years' experience in the electronics field, together with a strong desire to create and learn are the major prerequisites.

You are invited to discuss these positions with us. Please forward your resume, or telephone for information.

Industrial Relations Manager

SPERRY GYROSCOPE COMPANY OF CANADA, LTD.

P.O. Box 710 Montreal 3, Que.



for storing feed

Ten steel ingredient bins, each with a capacity of 60 tons, were designed and fabricated in Winnipeg by Manitoba Bridge to specifications laid down by the consulting engineers.

the simple and the complex...

Both are shown in this round-up of contracts from D.B. plateshops across the country. Large fabricators build up experience and take many complex jobs in their stride but every once in a while a problem comes along. When this happens new techniques are developed. This is a big responsibility for failures in the field not only cost a fortune, they can be dangerous.

When you buy welded fabrications be very sure of your supplier's ability. The Platework Division of Dominion Bridge maintain well equipped shops from coast to coast* and their total experience is unmatched in Canada.

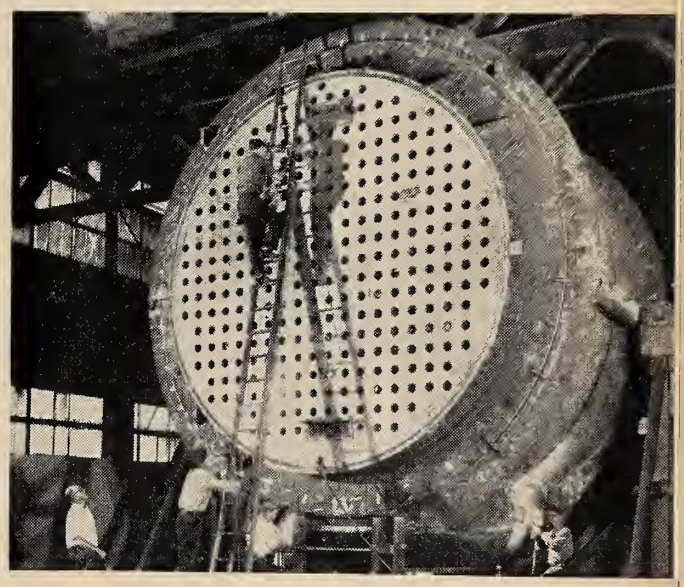
*In Winnipeg: Manitoba Bridge & Engineering Works.

130

PLATEWORK DIVISION
DOMINION BRIDGE

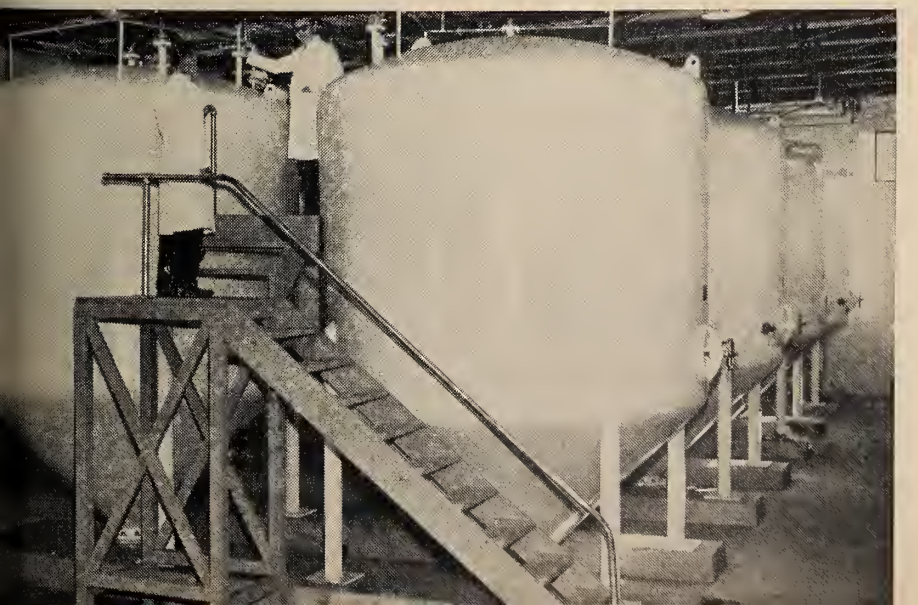
for chemical processing

One of five catalytic reformer reactor shells being made in Montreal from 1-¾ inch monel clad chrome-nickel steel. Special welding techniques were necessary to provide a satisfactory result.



for nuclear power

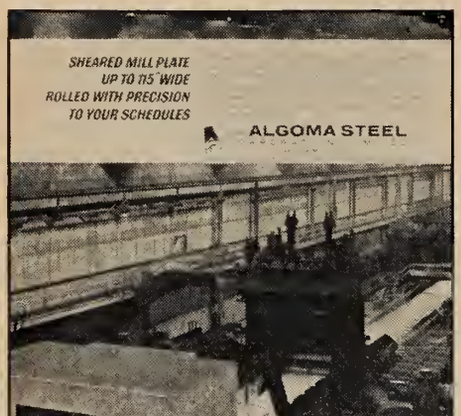
This is the calandria for E.C.L.'s new Candu reactor as it appeared during fabrication at the Dominion Bridge plant in Montreal. It is one of the most precise fabrications ever undertaken by the Company.



for making wine

These eight 5,000-gallon fermentation tanks were made by Dominion Bridge in Vancouver on very short delivery to meet the customer's needs. The material is mild steel lined with epoxy resin.

EIC CERTIFICATE OF ADVERTISING MERIT



The Algoma Steel Corporation Limited has captured the Journal's monthly award for October, 1962, for the best advertisement in that issue. And although the copy has varied from advertisement to advertisement, this is the fourth time the same illustration has been used to win the award since December, 1961. Small wonder. The dramatic, full colour, bleed photo of white hot steel passing through their new wide flange rolling mill has incredible "stopping" power.

From the initial announcement of the mill's opening, successive advertisements have talked about the versatility of the product—wide flange beams—in construction. In this new ad another product of the same mill is introduced. The heading reads: "Sheared Mill Plate Up To 115" Wide Rolled With Precision To Your Schedules"

The advertising of Algoma Steel is under the direction of Mr. L. Brown, Administrative Assistant to the President. The winning advertisement was produced by the Toronto office of Cockfield, Brown & Company Limited, Mr. F. D. Adams, Account Executive.

Each month a different panel of fifty Journal readers from across Canada is asked to nominate an award-winning ad of their choice from the viewpoints of ACCURACY—INFORMATION—ATTRACTION.

FOURTH SOUTHWESTERN ONTARIO REGIONAL TECHNICAL CONFERENCE

SATURDAY, MARCH 23, 1963

PARK PLAZA HOTEL, TORONTO

A PRELIMINARY PROGRAM AND FURTHER DETAILS WILL BE PUBLISHED IN THE FEBRUARY ISSUE OF THE ENGINEERING JOURNAL

Abstracts
Division Papers

(Continued from page 77)

prime movers of which were Cooper-Bessemer LSV-16 gas-diesel engines, at Quesnel, Prince George and Dawson Creek. These units were mounted on flat concrete bases and were grouted in a conventional manner using grout containing non-shrink additives containing iron particles and some calcium chloride. In Febuary, 1959, a crankshift broke on No. 4 unit at Prince George. The breakage was a fatigue failure originating at a forging flaw, but because difficulty had been encountered in maintaining alignment of the engines, it was felt that misalignment had accelerated the failure. The crankshaft failure precipitated the decision to investigate the problem of recurring misalignment of the engines. This paper gives a brief history of the problem, theory of the cause, the method of investigation to prove the theory, solutions investigated to solve the problem, solution chosen, execution of the solution and results obtained.

EIC-63-MECH 15

"Gas Turbines in Canada",
E. R. Signer

The first industrial gas turbine to be installed in Canada was commissioned in 1952. From then until the end of 1961 a total of 700,000 hp. was installed or ordered. This total must be among the largest installed in any single nation and the reasons behind this fact include: enlightened engineering acceptance of the gas turbine by Canadian engineers; the many relatively small and in many cases isolated or lightly connected systems; cold weather conditions in Canada; ample oil and natural gas supplies at competitive prices with other fuels.

EIC-63-RES 1

"Research in Britain on Current Ratings for Cables and Overhead Lines",
E. E. Hutchings

The basic current rating formula for solid-type cables is given, and it is shown how account may be taken of the particular features of high-voltage cables of other types. The thermal resistance external to the cable surface is dependent on environment. For buried cables this depends on the thermal resistivity of the soil, methods for determining which are described. Reference is made to a system of soil classification which has been developed for use by cable engineers. Details are given of investigations into seasonal variations and the onset of runaway conditions due to drying of the soil by the cable. Some observations are made on the use of special back-fills and on the possible adoption of different ratings for summer and winter. Effects of short-circuit currents on cables are described and criteria established for short-circuit ratings for certain types. Thermal ratings for overhead line conductors and their significance are dealt with briefly and experimental work described.

Engineering Information Service

(Continued from page 73)

ADVANCED MATERIALS, C. Z. Carroll-Porczynski, Chemical Publishing, N.Y., $11.75.

ABSORPTION, DISTILLATION AND COOLING TOWERS, W. S. Norman, Longmans, London.

CASEBOOK IN PRODUCTION MANAGEMENT, R. J. Ziegler, Wiley, N.Y., $3.95.

BIBLIOGRAPHY OF PUBLICATIONS IN LIGHTWEIGHT CONSTRUCTIONS AND RELATED FIELDS, IN GERMAN AND ENGLISH, FROM 1955 TO 1959, H. Winter, Springer, Berlin, DM 80.

BALLISTIC MISSILE AND AEROSPACE TECHNOLOGY, 6th Symposium, Edited by: C. T. Morrow, Academic Press, N.Y., $8.

NEWNES CONCISE ENCYCLOPEDIA OF ELECTRICAL ENGINEERING, Edited by: Professor M. G. Say, Newnes, London, £7.

CONCISE CHEMICAL AND TECHNICAL DICTIONARY, 2ND EDITION, Edited by: H. Bennett, Chemical Publishing Co., N.Y., $15.

CHIMIE, AIDE-MEMOIRE, J. Jousset, Dunod, Paris.

MECHANIQUE-PHYSIQUE GENERALE, AIDE MEMOIRE, M. D. Papin, Dunod, Paris.

ROUTE SURVEYING, THIRD EDITION, C. F. Meyer, International Textbook, Scranton, Pa., $9.75.

DIRECT STANDARD COSTS FOR DECISION MAKING AND CONTROL, W. Wright, McGraw-Hill, Toronto, $8.60.

LES SYSTEMES ASSERVIS ECHANTILLONNES, J. R. Ragazzini & G. F. Franklin, Dunod, Paris, 58 NF.

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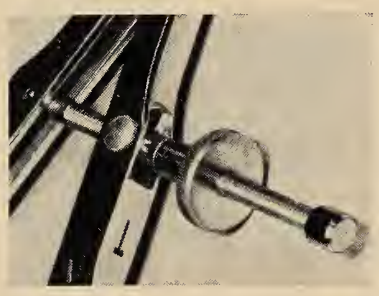

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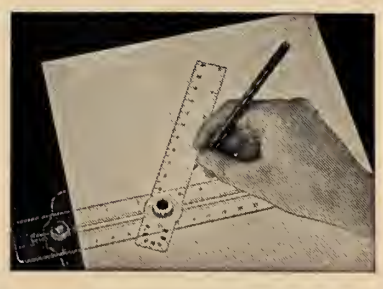

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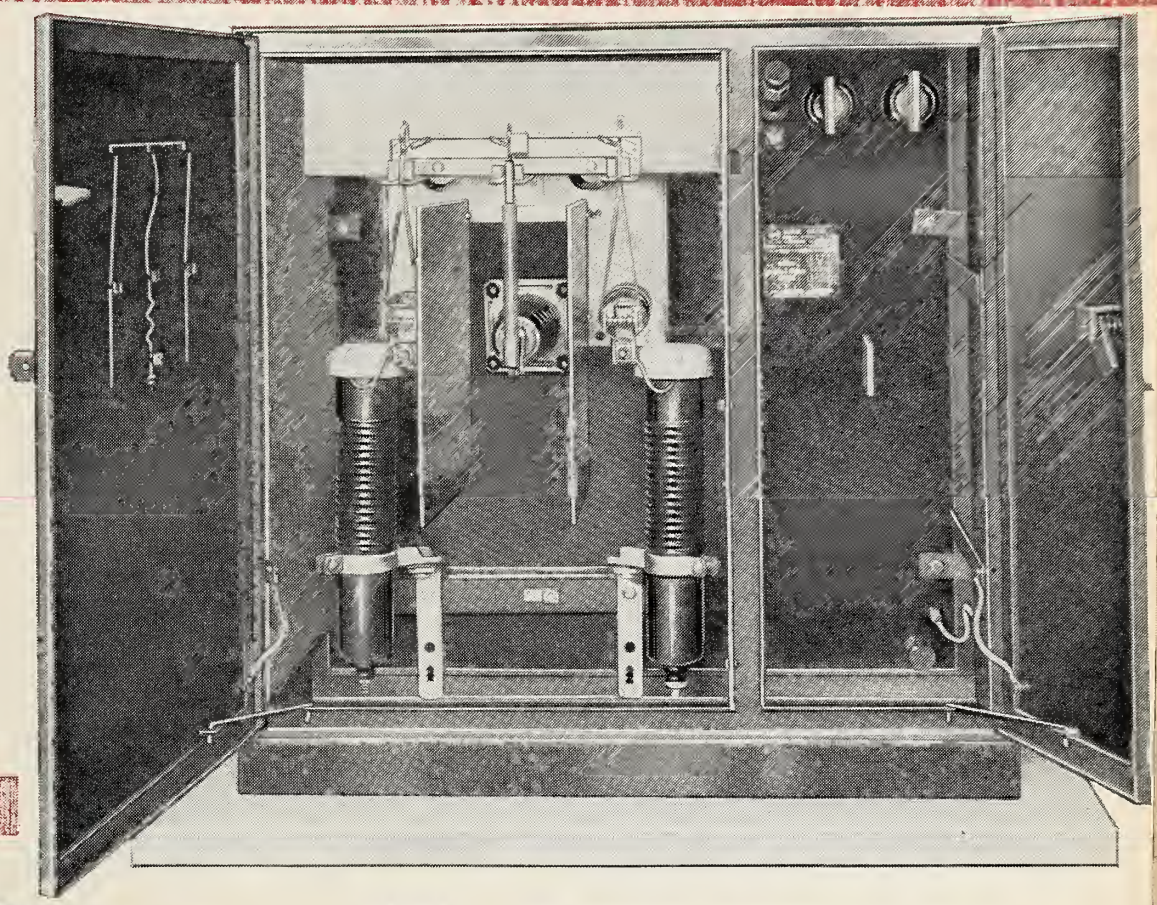

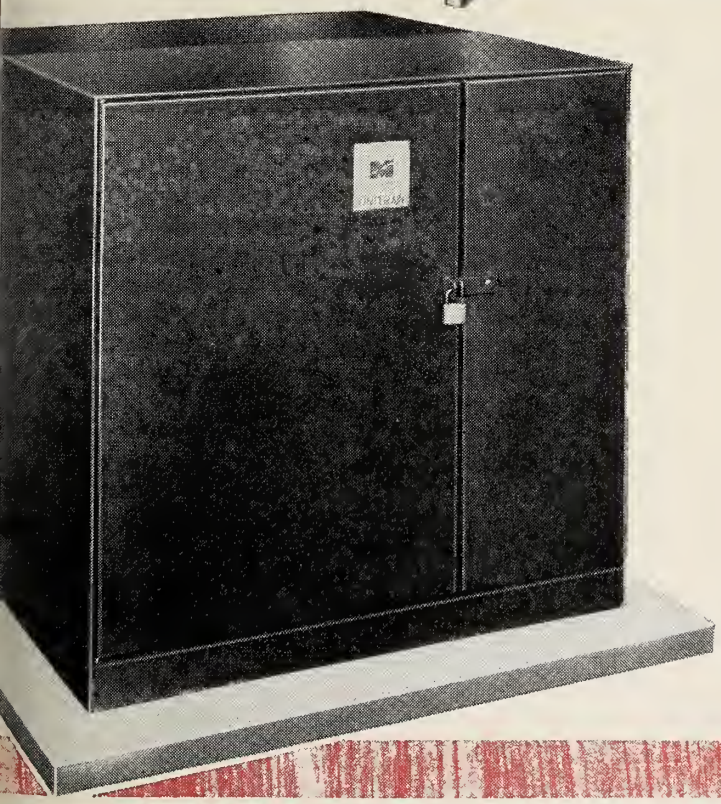

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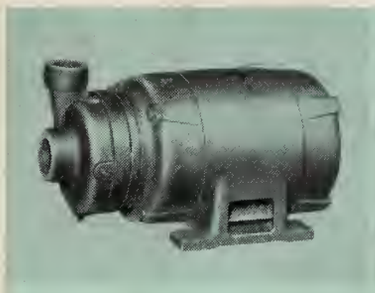

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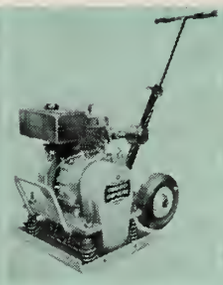

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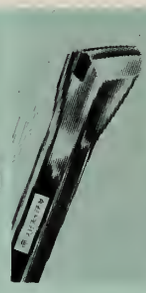

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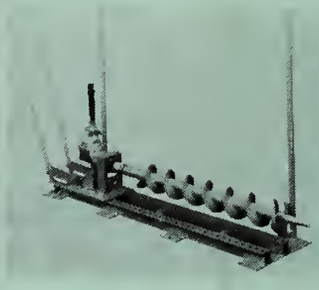
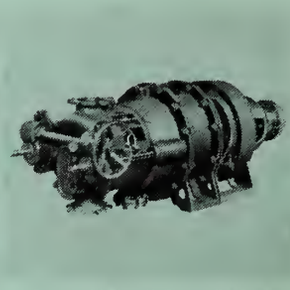


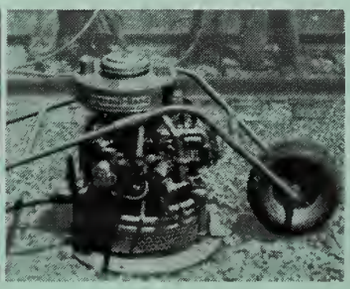
"Gyro-Dril" Earth Auger



"Stock Maker" Pulp Refiner

"405" Impactool

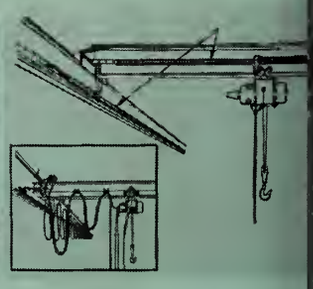
"Quick Change" Electric Impactools



36 CFM. "Spot-Air" Compressor

Rapid Automatic Drill

"300" Stoper, Jackdrill, Jackhamer



"Travel Air" Hose Carrier

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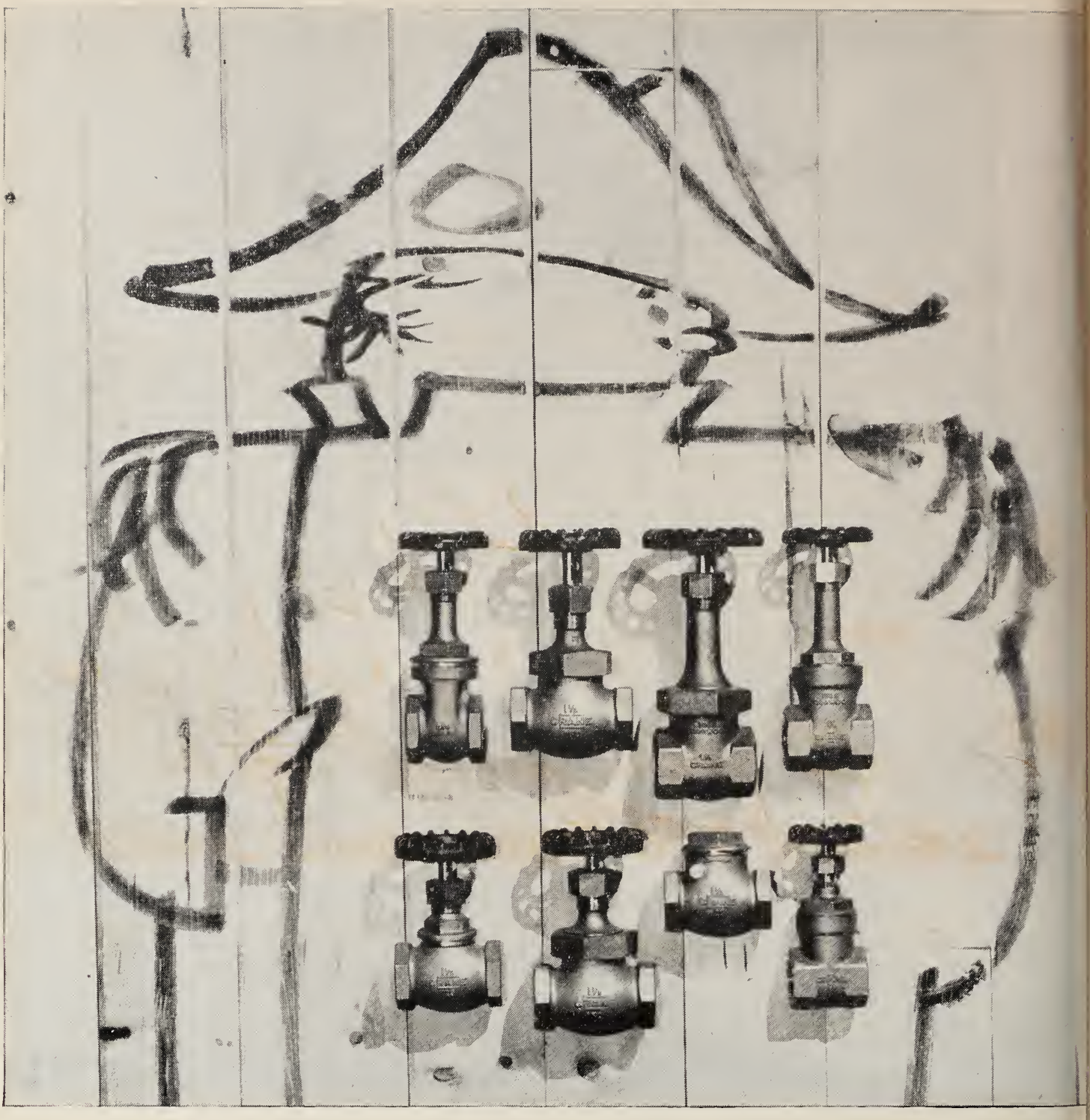
Y 1963

IGINEERING URNAL

FEATURING

The Effect of Exterior Building Construction Upon the Cost of Heating and Air Conditioning Systems



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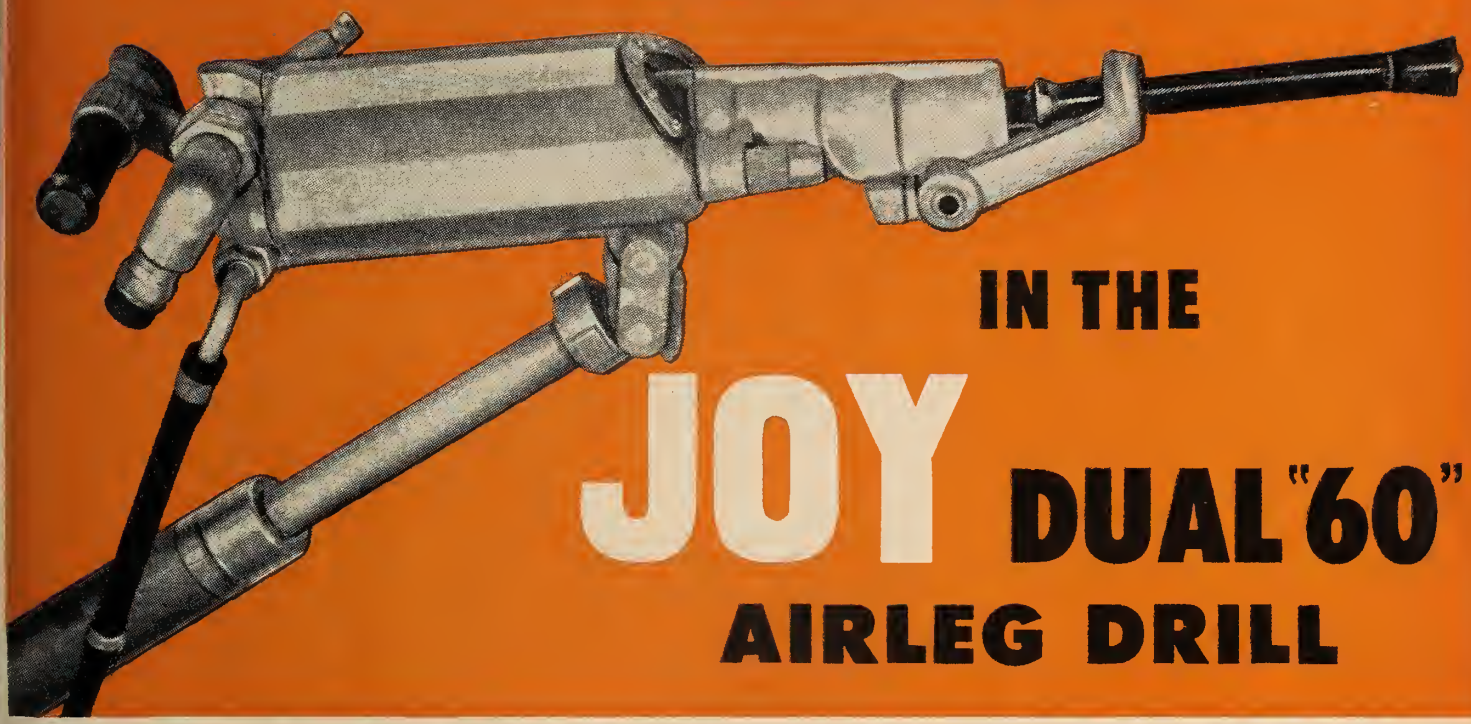

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BECAUSE IT'S QUIETER!

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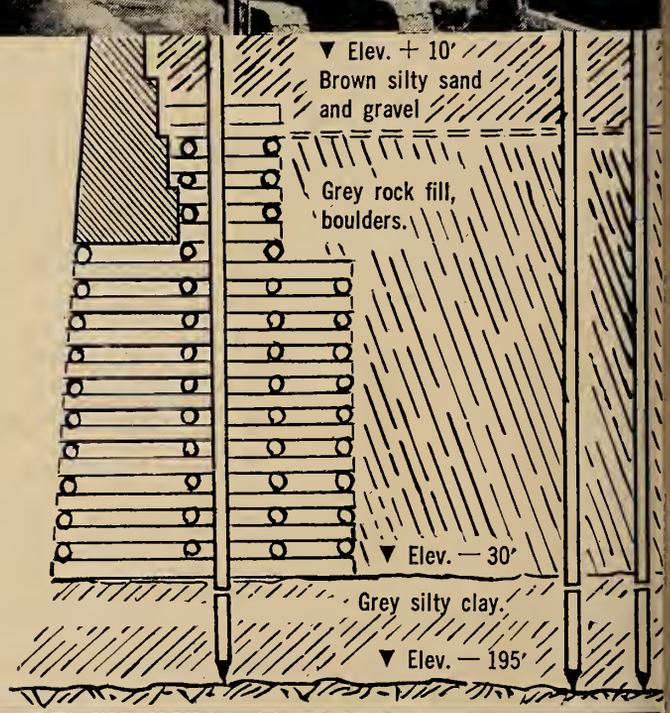

Owner: North American Elevators Ltd., Sorel, Que.
Consulting Engineers: Morrison, Hershfield, Millman & Huggins Ltd., Toronto, Ont.
Contractor: Cuyler Contracting Co. Ltd., Fort William, Ont.
Foundation Consultants: H. Q. Golder & Ass. Ltd., Toronto, Ont.

Technical booklet in French and/or English mailed upon request.

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THE

ENGINEERING JOURNAL

February 1963 - Vol. 46, No. 2

PUBLISHED MONTHLY BY THE ENGINEERING INSTITUTE OF CANADA

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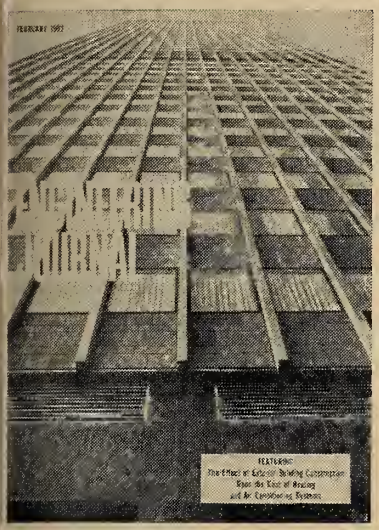

COVER ILLUSTRATION

The lead paper in this month's Journal deals with the effect of building walls on the cost of heating and air conditioning systems. Illustrating this theme is the cover picture of a wall of the Canadian Imperial Bank of Commerce Building in Montreal.
(Photo courtesy Atlas Steels Limited).

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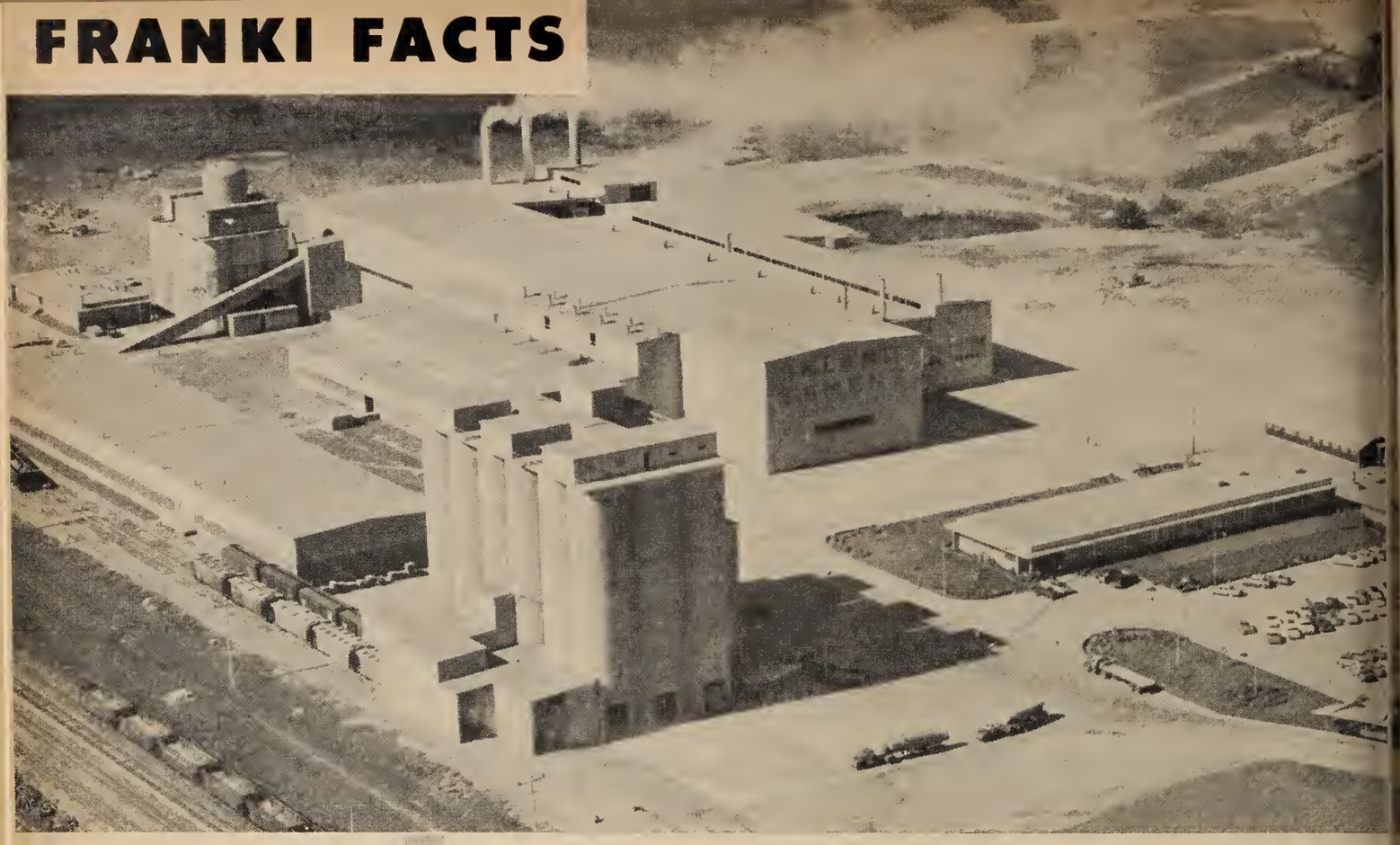
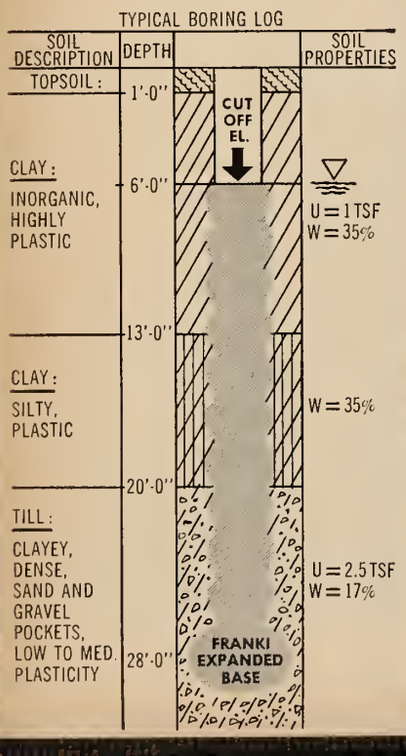


CLIENT:
Inland Cement Company Limited
LOCATION:
Edmonton, Alberta
ENGINEERS:
Foundation of Canada Engineering Corporation Limited
CONTRACTORS:
Burns & Dutton Concrete & Construction Co. Limited
SOILS CONSULTANTS:
R. M. Hardy & Associates Ltd.
TYPE OF STRUCTURE:
Cement Plant
NUMBER OF FRANKI UNITS:
1902 Franki Displacement Caissons
WORKING LOAD:
90 tons maximum
DEPTH OF CAISSONS:
Average Driven Length: 27' - 11"
Average Concreted Length: 21' - 9"



THE PROOF IS IN THE PERFORMANCE

Problem

The Inland Cement Company chose the Edmonton area for their Western operations and c menced construction in 1955. While this location provided all the necessary raw mater labour and utilities required by a modern industrial plant, the site posed foundation prob which needed careful study.

The ground water table, reported at an average depth of 6 feet, necessitated excavc n drainage. The nugget structure of the upper plastic clay layers indicated the susceptibilit this material to large volume changes with variations in soil moisture levels. The lower l of silty clay possessed settlement characteristics which would produce intolerable movem in the structure.

Below 20 feet, however, there existed a dense glacial clay till of low plasticity, containing s and gravel pockets and having a low compressive index, Cc = 0.24. Its recommended carrying capacity was 5 TSF.

Solution

The designing engineers looked for a type of foundation which would carry high loads thrc h the poor overlying soil to the glacial till layer. A piling system was needed which could ha e the water problem, provide uniform bearing and have sufficiently high unit capacities to k p the foundation dimensions within tolerable limits.

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Literature - This series of job highlights, as well as other descriptive literature, will be sent to you upon request to Franki of Canada Ltd., 187 Graham Blvd., Montreal 16, P.Q.

IN THIS ISSUE

G. H. Green, M.E.I.C., Associate Professor, Mechanical Engineering Department, University of Saskatchewan, directs his paper, *"The Effect of Exterior Building Construction upon the Cost of Heating and Air Conditioning Systems"*, mainly to architects, managers and owners of buildings to show them how the selection of exterior wall construction affects the cost of heating and air conditioning systems.

Tables are prescnted to show what various types of exterior construction contributes towards the initial cost of systems. In particular, the effect of glass is studied and it is concluded that glass area must be carefully used in a building since it can contribute from $1.50 to $7.50 per square foot of window towards the cost of the air conditioning system.

Canadian General Electric has for many years studied systems for various industries on the electronic analogue computer. W. A. Wyeth, of the Canadian General Electric Company Limited, Peterborough, in his paper, *"Analogue Computer Simulation of Ship Propulsion Systems"*, describes the analogue computer, and shows how it is applied specifically to a diesel-electric system for ship propulsion.

F. E. Ayers, Director of Planning and Works, City of Ottawa, in his paper, *Plotting Underground Public Utilities in the City of Ottawa"*, shows how Ottawa, with the co-operation of utility agencies, is preparing plans for all utilities beneath Ottawa streets. Mr. Ayers demonstrates how, for the first time, the City is securing a comprehensive picture of the network of pipelines and ducts which exist throughout the city. Prior to 1960, when this work began, there was no co-ordinated plan showing the sub-surface plant of all utilities in their proper relation to one another. Some of the underground utility plans were more than 100 years old. Some records were lost or their accuracy was questionable. Others were lacking in detail. This lack of composite accurate plans has complicated the execution of city projects and has led to avoidable expenditures. An accurate city plan was direly needed.

The modern high speed digital computer is one of the most recent inventions of mankind, but already a new generic type must be added to its predecessors, the scientific and business computers of the 1950's. This new member of the family is the on-line process control computor, or the "computor in overalls" as it has been termed.

In his paper, *Automation Through the On-Line Process Control Computer"*, J. Scrimgeour, M.E.I.C., of the Industrial Systems Engineering Department, Canadian General Electric Company Limited, deals with the features, characteristics and capabilities of this new tool. He discusses some of the requirements which the process must meet for a satisfactory application. Emphasis is placed on the need for a thorough knowledge and understanding of the process before any application can be properly undertaken. This usually requires an extensive analytic and application engineering study involving close co-ordination of process knowledge, physical and statistical analysis, instrumentation and sensing devices, computing equipment and techniques, regulating systems, control and power devices. The importance of the total systems approach is illustrated by examples.

Discussions

C. G. Smallridge's paper, *"Tailrace Improvements at the Beaumont Hydro-electric Development"* is discussed in this issue by: T. R. Anand, M.E.I.C. Engineer, The Shawinigan Water and Power Company, Montreal. Mr. Anand formerly was with the Shawinigan Engineering Company where he was associated with the Beaumont Development. Other discussers of this paper include J. A. Randle, M.E.I.C., H. S. Watson, M.E.I.C., and J. L. Gordon, M.E.I.C.; John C. Godsland, M.E.I.C., Manager of Projects with Shawinigan Engineering Co. Ltd., and, Simon Ince, M.E.I.C., employed in the Hydraulics Laboratory of the National Research Council, Ottawa.

"Economics of Heavy Water Reactors", by J. R. Dickinson is discussed in this issue by Dr. D. G. Hurst.

"Progress in Power Distribution", by R. E. Jones is discussed in this issue by Archie Benjamin, M.E.I.C., Distribution Engineer, Quebec Hydro-Electric Commission. E. A. Stanger, Vice-President, Planning, Southern Canada Power Co. Ltd., is another discussor. P. A. Duchastel, M.E.I.C., and G. H. de Witt, M.E.I.C., Chief Engineer, Commercial and Distribution Department, The Shawinigan Water and Power Company, Montreal, also contribute to the discussion of this paper.

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MAY 22-24

1963

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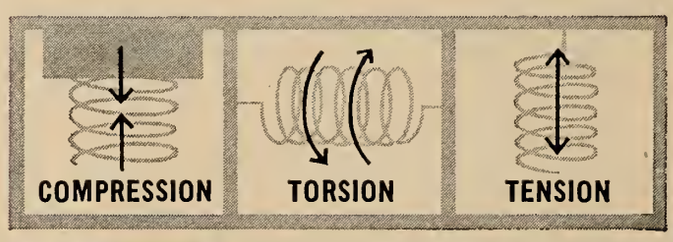

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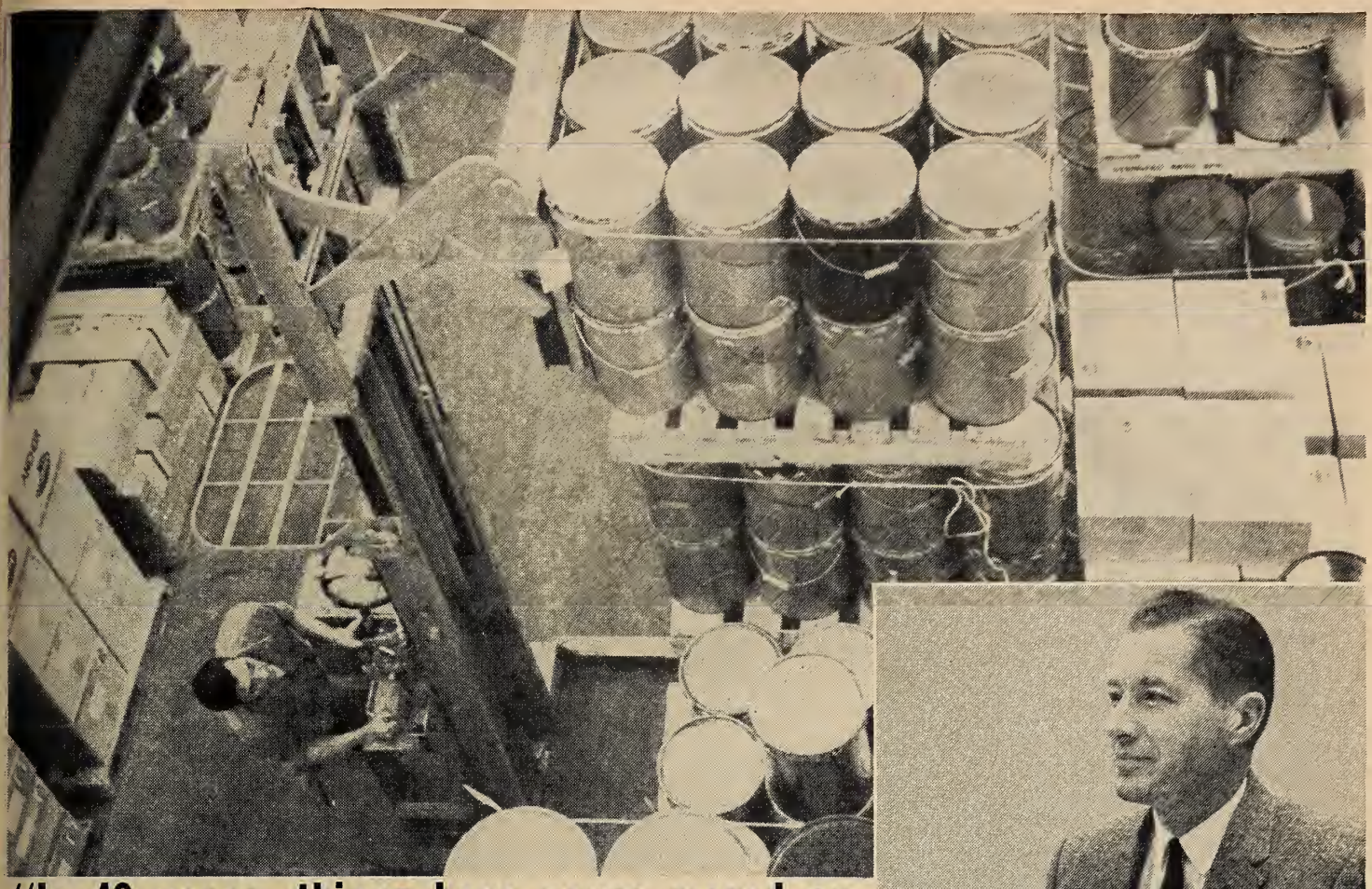

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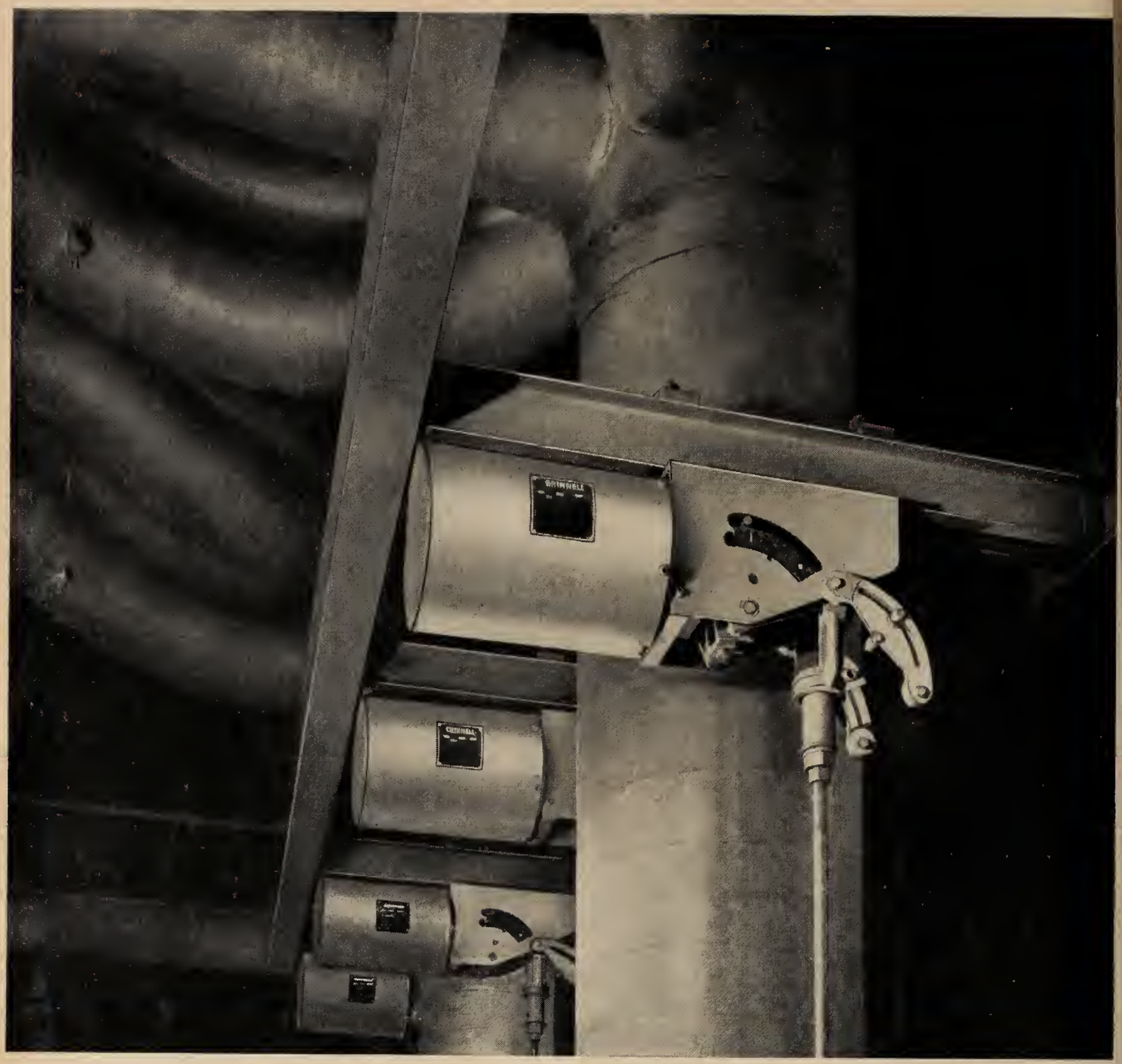

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Grinnell Engineered Hangers "baby" massive piping at new Eddystone Station

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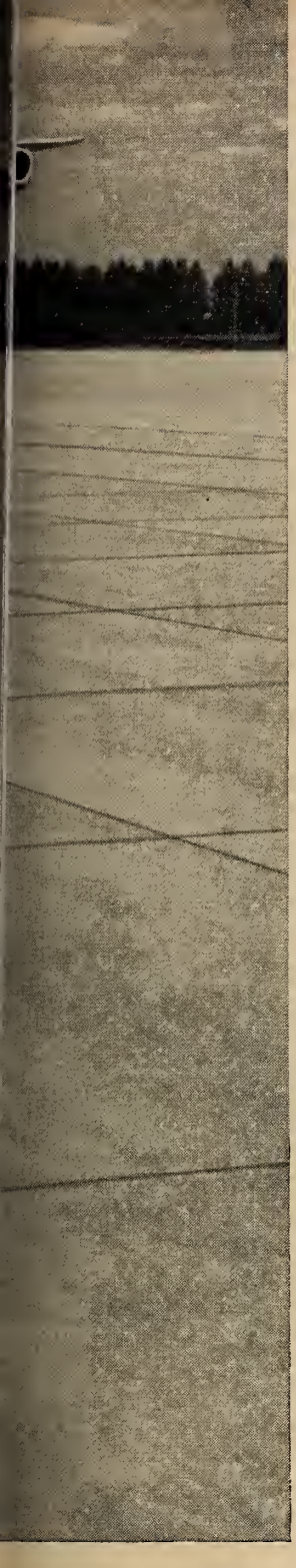

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2″ thick.
contractor: **Tallman**
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General contractor: **Pigott Construction Co. Ltd.**
Concrete paving by: **The Highway Paving Co. Ltd.**

BOTTOM RIGHT:
Concrete Taxiway at Winnipeg International Airport, paved in 1960.
General contractor: **Tallman Terminal Construction Co. Ltd.**

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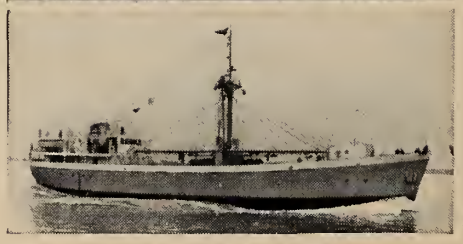
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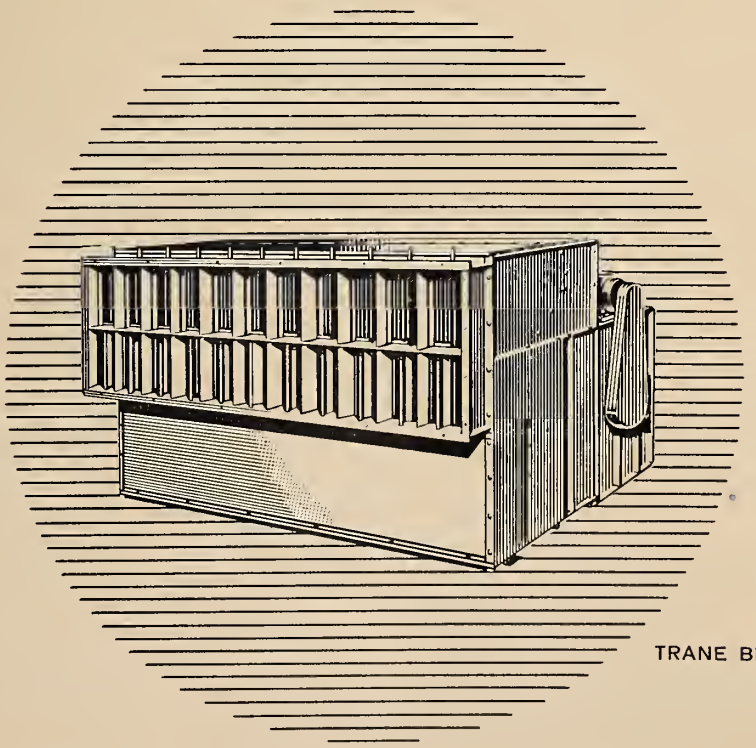

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A copy of this new Hamilton Gear Right Angle Spiral Bevel-Helical Reducer catalogue No. 117 will be sent on receipt of your request stating company connection and your title. If you have not already received your copy of catalogue No. 113A, we would be also pleased to send this on request.

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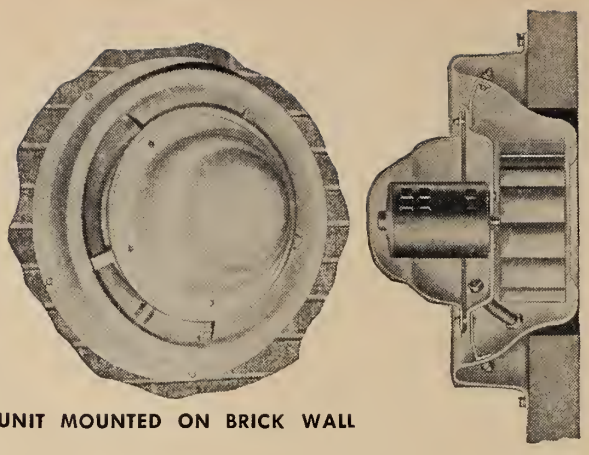

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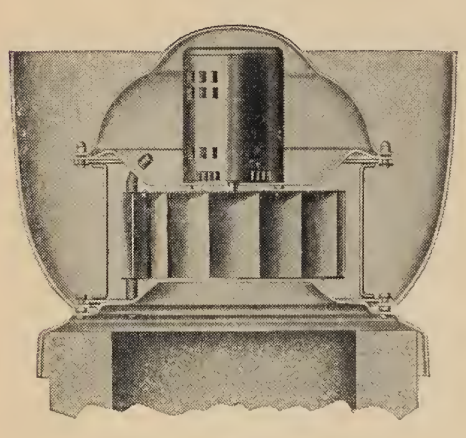

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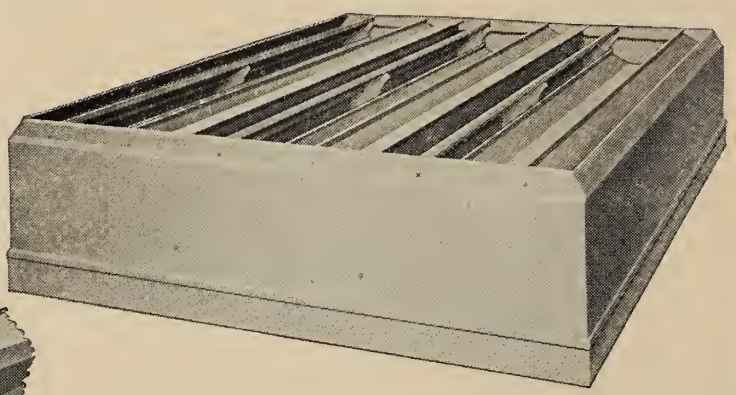

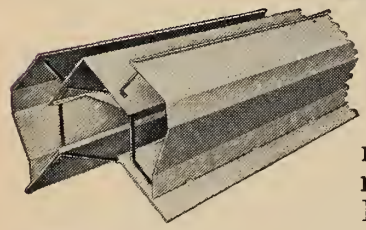

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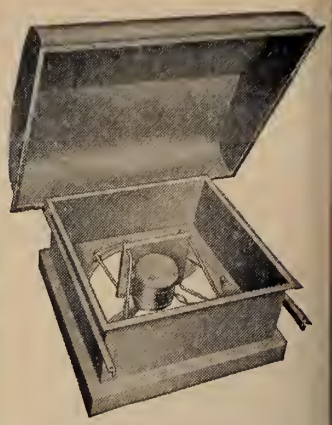

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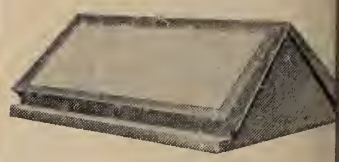
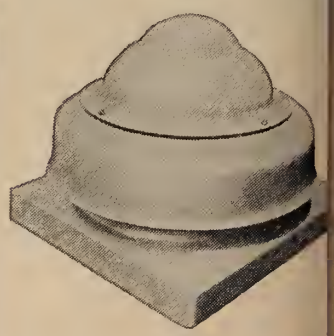
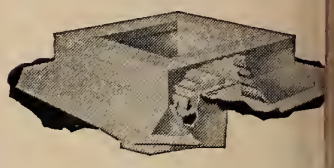


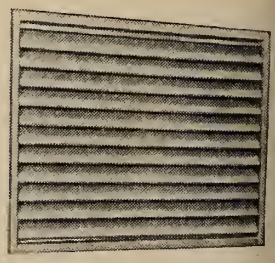
Sky-Lite Pyrojector — this unit which features emergency relief plus skylighting opens automatically in case of fire or explosion.



Fiber-Aire — indestructible molded-in Sky Blue Fiberglas* housing is virtually impervious to weather, salt spray, chemicals and fumes. Direct drive, belt drive and axial units available.



Insta-Curb — high quality prefabricated roof curb for fast installation — no sharp corners to tear roofing materials — wood top with all welded steel construction.



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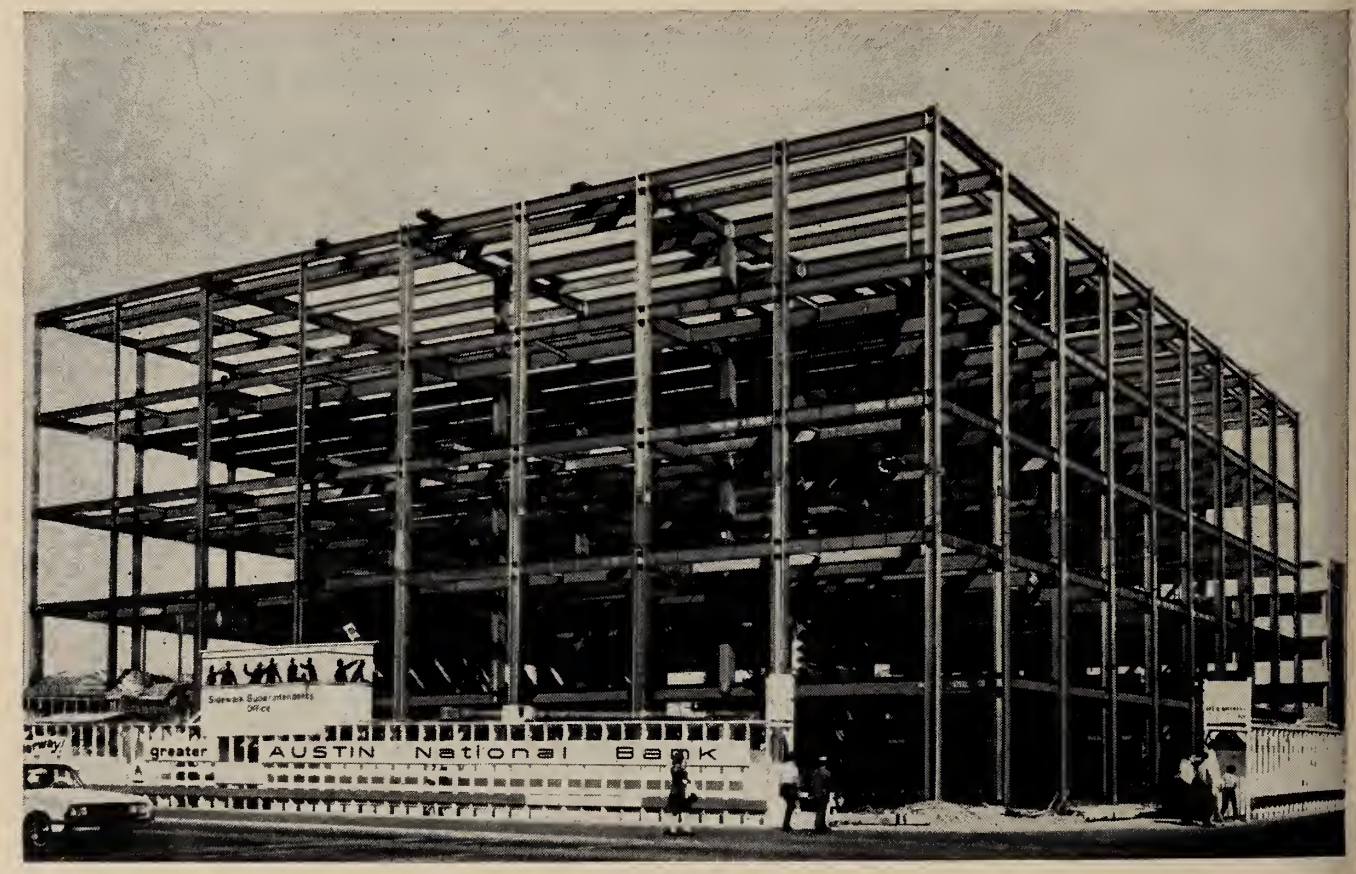
New second story is hung

All-steel second-story addition includes high-strength-bolted 460-ton structural frame, steel joists, Slobform for roofing and flooring, and exterior steel panels. Bethlehem supplied most of the steel for this job.

Designed in steel to grow



Scheduled for completion early in 1963, the Austin National Bank Building will be sheathed with natural color aggregate sections and vertical metal sun shields.

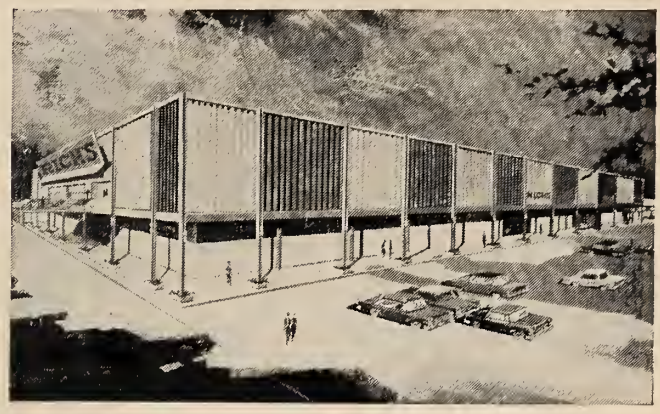
rom steel trusses

ıe original one-story Belvedere Plaza branch store of Rich's, c., Atlanta, wasn't designed with expansion in mind. But pand it must . . . vertically . . . and without interfering th the normal operation of the store.

How to do it? First thought was to strengthen the exist- g foundation and frame to carry the weight of the new cond story. But this proposal proved too expensive.

It was then decided to put a new building in the air ımediately above the old building. So they (1) went outside e old building with new foundations, (2) erected steel lumns to support steel trusses over the existing structure, ıd (3) hung the new second story from the trusses (the w roof is at the top chord of the trusses).

Everything worked out fine. No additional load was put ı the old building. The store added 47,000 sq ft of floor ace—*economically*. And it stayed open for business all rough the new construction; all the steelwork was erected night and on Sundays in less than two weeks.



Architects: Stevens & Wilkinson.
Engineer: Jock K. Wilborn.
General Contractor: Botson-Cook Company.
Fabricotor: Trojon Steel Corporotion.
Erector: Jimmy Hurst Steel Erectors, Inc.

Steel

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from 5 to 22 stories

he Austin National Bank Building is the first multi-story ructure to be built in Austin, Texas, in 20 years with a steel ame, rather than on a reinforced concrete skeleton.

Reasons for return to steel: (1) economy, thanks to igher-strength A36 steel, Bethlehem lightweight shapes, and continuous welded frame, (2) "thinner" steel columns, hich will provide maximum usable floor space in the future ulti-story portion (three-column two-bay framing system), nd (3) the ease and economy of adding on to a steel frame.

Although the building will have only five stories in its rst phase of construction, the foundation and the steel frame re designed to support 22 stories. It will be a simple matter tie in the new steel to the existing structure at a later date.

Architects and Engineers: Poge, Southerlond & Poge.
Associote Architects: Fehr ond Gronger.
General Contractor: Rex D. Kitchens Construction Co.
Fobricator: Tips Iron & Steel Co. (1,035 tons).
Erector: F. B. McIntire Erection Co., Inc.

Bethlehem Steel Export Company of Canada, Ltd.:
- Dominion Square Bldg., Montreal, P.Q.
- 170 University Avenue, Toronto 1, Ontario.

A. L. Murray, Marine Building, Vancouver, British Columbia.

James G. Crawford, St. Johns, Newfoundland.

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1. A view of the communications research laboratories, near Ottawa.
2. One of three manufacturing locations in Montreal, producing telephone exchange equipment and associated apparatus.
3. The Belleville Works, where electronic equipment is engineered.
4. Lachine Plant where wire and cable for power transmission and communications is produced.
5. London Works—manufacturing plant for telephone apparatus.

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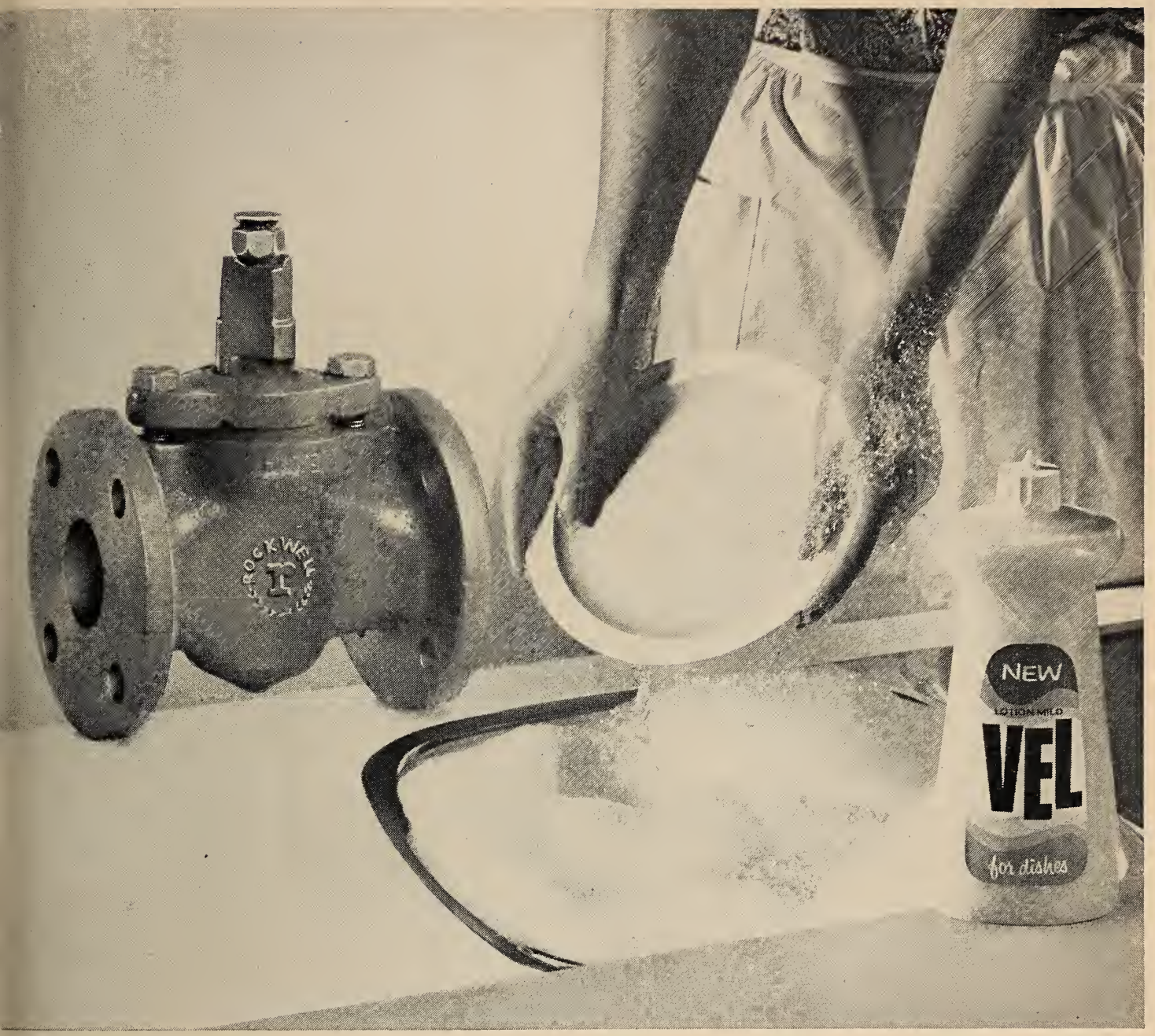

Pink Lotion Vel and

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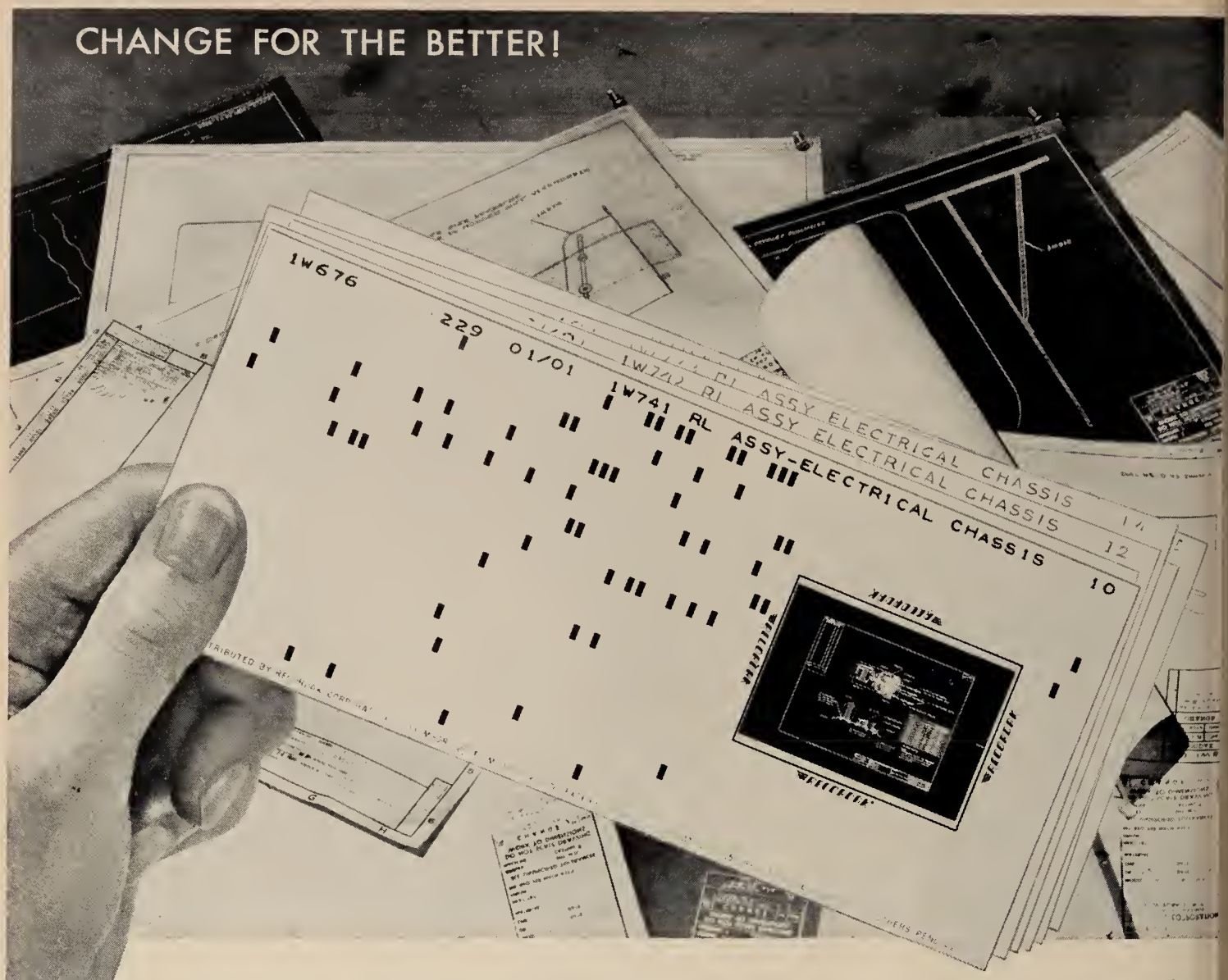

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THE EFFECT OF EXTERIOR BUILDING CONSTRUCTION AND AIR CONDITIONING SYSTEMS UPON THE COST OF HEATING

G. H. GREEN
Associate Professor, Mechanical Engineering Department
University of Saskatchewan

MAN BUILDS BUILDINGS to create an environment within which he can perform some function he desires and one of the purposes of the exterior construction is to provide the thermal barrier between the outdoors and the space. The wall is one of the major factors in determining the cost of producing that environment by means of heating and air conditioning systems. A. J. Jaros, in a recent article[1] compares two similar New York office buildings and shows that the installation of air conditioning in one instance was done at $4.50 per square foot compared to $7.50 per square foot of usable area for another building and that the exterior wall construction, particularly the glass, was the major factor causing the difference. Also, the annual cost of operation of the higher initial cost system was substantially greater than the other office building.

The purpose of this paper is to give to owners, architects and engineers a better understanding of the

TABLE I.

Initial Cost of Heating Systems

Dollars per square foot of building exterior

Initial Cost	*Building Exterior Overall Coefficient of Heat Transmission "u"*						
$/MBh. "U"	0.10	0.20	0.30	0.40	0.50	0.60	0.70
10.00	$0.10	$0.20	$0.30	$0.40	$0.50	$0.60	$0.70
12.00	0.12	0.24	0.36	0.48	0.60	0.72	0.84
15.00	0.15	0.30	0.45	0.60	0.75	0.90	1.05
18.00	0.18	0.36	0.54	0.72	0.90	1.08	1.26

Double Glass "U" = 0.45

Based upon a 100°F design temperature difference. For other design temperature differences the costs are in direct proportion.

influence of the exterior construction upon the costs of heating and air conditioning systems. The data is presented in terms of dollars rather than heat gains or losses, so that comparisons may be more easily made with respect to cost. An attempt has been made to keep the material as general as possible so that general principles are apparent and can be applied as required.

Initial Cost

The comparisons of initial cost of systems are based upon using figures of dollars per thousands of Btu per hour (MBh) heat loss for heating and dollars per ton (12000 Btu per hour) for air conditioning. These figures are subject to considerable variation owing to the fact that cost of labour, ventilation, length and complexity of pipes and ducts, controls and filtering are partially independent of heat gain or loss. Nevertheless, these methods[2] are used to estimate the initial costs of systems and are used in this paper to compare how the various types of exterior constructions contribute toward the initial cost of a system. A wide range of costs per MBh and ton have been included to cover the many types of both heating and air conditioning systems.

Annual Cost

Annual costs are the sum of the interest and taxes on investment, depreciation, maintenance, labor, fuel, water, electricity and other costs. The fixed annual costs are usually expressed as a percentage of the capital expenditures and so are directly related to the initial cost and hence the exterior construction. Maintenance, labour and some other operating costs such as filtering are independent of the type of exterior wall construction. Fuel, electricity, and water operating costs are directly dependent on the daily heating and cooling loads and are affected by the exterior construction.

The Effect of Exterior Construction Upon Costs of Heating

Let us examine how the initial costs of a heating system are influenced by the building exterior construction. Table I presents the calculations obtained by determining the heat loss in MBh per square foot of exterior construction for a 100°F. design temperature difference and multiplying this by the initial cost per MBh.

The Effect of Glass Area Upon the Initial Cost of a Heating System

The significance of glass area is shown by comparing the costs at the various overall coefficients of heat transfer "U". If a wall with a "U" value of .10 which corresponds approximately to construction containing 2 in. of common types of wall insulation is compared to a sheet of sealed double pane glass "U" = .45, each square foot of glass will require 4½ times the initial cost of the heating system a square foot of wall will require. Any comparison of the overall initial cost involves the relative amount of glass and wall and Table II shows a comparison for the percentages of glass in an exterior of a building.

TABLE II.

Initial Cost of Heating System

Dollars per square foot gross exterior wall

% Glass	*10$/MBh*	*18$/MBh.*
0	0.10	0.18
25	0.187	0.336
50	0.275	0.495
75	0.363	0.654
100	0.450	0.810

Wall "U" = 0.10
Window "U" = 0.45

One can think of this applying to the entire exterior of a building including roof if the roof "U" is the same as the wall, and could apply the percentage of window as a percentage of the entire exterior area. Generally the insulation of a roof is greater than the wall so that in practice the comparison is only approximate. In a multistorey building, say of eight or more storeys, often the roof area is a small proportion of the total exterior surface and the comparison is valid. Increasing the glass area from 25% of the exterior area to 75% of the exterior area doubles the portion the exterior contributes to initial cost of the heating system. How this affects the total cost of a heating system depends upon the shape and other factors, but a multistorey building usually has over 50% of its heat loss due to the vertical exterior and the change of 50% in glass area would mean a 25% change in total cost of the system. Whether or not the variation of glass area in the facade will significantly affect the total building cost per square foot of usable area can only be determined accurately if the building shape is known. However, it is apparent that the use of glass does significantly affect the initial cost of heating systems for a building.

The Effect of Glass Area Upon the Operating Costs of a Heating System

The portion of the annual costs of heating systems dependent upon the exterior construction are the fixed annual cost, and the fuel costs and these usually constitute the major portion of the annual cost. The fixed annual cost is usually expressed as a percentage of the initial cost of the system and the influence of the exterior construction on initial cost is shown in Tables I and II.

The fuel cost is mainly dependent upon the heat loss from the building, and, therefore, the exterior construction has a major influence. Calculated fuel costs using the "U" value of the exterior wall are not representative of the actual fuel costs since there are heat gains from the sun, lights, occupants and miscellaneous sources. The direct solar radiation received through any glass area heats the building and reduces the fuel bill; however, not all of the solar radiation received is usable because there are outdoor temperatures above which the the sun's heat gain overheats the building. At the lower outdoor temperatures the entire sun gain can be utilized. Whether the seasonal solar gain of a window will offset the additional heat loss of the lower heat transfer resistance will have to be another study. At present one can only say that glass areas increase the fixed annual costs but the extent to which glass area changes fuel cost is not definite.

TABLE III.

Initial Cost of Air Conditioning System

Dollars per Square Foot of Building Window

	South 1.00 p.m.					8.00 a.m. East and West 4 p.m.					6.00 p.m. North			
Initial Cost per ton	*Single Common Glass*	*Double Common Glass*	*Heat Absorbing Outdoor Reg. Plate Indoor*	*Double Common Inside White shade*	*Double Common Outside awning*	*Single Common Glass*	*Double Common Glass*	*Heat Absorbing Outdoor Reg. Plate Indoor*	*Double Common Inside White shade*	*Double Common Outside awning*	*Single Common Glass*	*Double Common Glass*	*Heat Absorbing Outdoor Reg. Plate Indoor*	*Double Common Inside white shade*
Heat gain Btu/sq. in.*	100	83	52	50	18	132	114	65	70	25	33	25	18	15
800	$ 6.60	$ 5.52	$3.46	$3.32	$1.20	$ 8.80	$ 7.60	$4.34	$4.67	$1.67	$2.20	$1.67	$1.20	$1.00
1000	8.33	6.92	4.33	4.16	1.50	11.00	9.50	5.42	5.84	2.09	2.75	2.09	1.50	1.25
1200	10.00	8.30	5.20	5.00	1.80	13.20	11.40	6.52	7.00	2.50	3.30	2.50	1.80	1.50
1400	11.68	10.08	6.07	5.83	2.10	15.40	13.30	7.60	8.15	2.92	3.85	2.92	2.10	1.75
1600	13.32	12.65	6.92	6.62	2.40	17.60	15.20	8.68	9.32	3.33	4.55	3.33	2.40	2.00

TABLE III Based upon 50° North Latitude; 95° F. Outdoors design temperature; 80°F. Indoors design temperature. Maximum Gain at times indicated.
*Assumed actual gain is 0.65 of instantaneous gain.

The Effect of Exterior Construction Upon the Costs of Air Conditioning

Table III was prepared using selected maximum values for the N, E, S, W, orientations of various types of windows. The values are calculated from data given in the American Society of Heating, Refrigerating and Air Conditioning Engineers Guide and represent values that the majority of engineers in Canada would use to calculate the air conditioning cooling loads of windows and walls. Table V was similarly prepared for building walls.

The exterior construction of a building is again studied in its two major components, glass area and wall area. The first thing evident from Tables III and V is the considerably higher cost per thousand of Btu. per hour for air conditioning. Heating costs ranged from $10. to $18. per MBh while air conditioning costs are $66. to $133. per MBh. With such higher costs the exterior construction of a building becomes increasingly important.

In calculating the cooling load of a building the designer selects a time of the day at which the cooling load is at a maximum and selects his equipment to suit this maximum load. The tables have been calculated at selected times, corresponding to hours at which the maximum loads are likely to occur for that orientation. The time is usually in the middle afternoon, although east and west faces of buildings may have their load occurring in the early morning or late afternoon. In the case where the cooling load is caused by the solar gain on different facades of the building the installed refrigeration compressor capacity will be less than the sum of the peaks because of the diversity. The room distribution units and ducts will still have to be sized for the peak of that facade so that the initial cost of the system is not reduced proportionally to the diversity of the load.

Glass Area Initial Cost

TABLE IV.

Initial Cost of Air Conditioning Systems

Dollars per square foot gross exterior wall

Orientation	*S*	*E & W*	*N*
% Glass			
0	$0.13	$0.08	$0.06
25	1.17	1.52	0.35
50	2.14	2.96	0.65
75	3.55	4.58	1.06

Table IV based on
Wall "U" = 0.10 Light Construction; Window—Double Common Glass, Inside white shade; Cost = $1000/ton.

Consideration of Table IV shows the results of varying the area of glass in a facade. The values for the East and West facades may be considered as being somewhat high since they are selected for the 8 a.m. and 4 p.m. time respectively and the diversity of the load may reduce these figures. Again, as in the heating system initial cost we find an increasing initial cost of air conditioning systems when a greater percentage of unshaded glass is used in a facade. The magnitude of the cost is quite substantial and should be a consideration in the selection of construction and orientation of a building. It is evident that the exterior shade reduces very materially the initial cost of an air conditioning system, indicating the importance of shading devices. The cost of south face shading devices would be offset by the saving of approximately $2.50 per square foot of glass area based on an initial cost of $1000. per ton.

Exterior Wall and Roof Construction Initial Cost

Table V shows that the wall of almost any type of construction does not increase the initial cost of an air conditioning system to any great extent and the heavier construction results in the lower loads and costs.

Table VI compares the cost of the system using various constructions of flat roof. The comparison with a wall shows the expected increase due to the higher solar heat gain on a horizontal surface.

Exterior Construction Operating Cost

Based upon water costing $1.00 per 1000 gallons, electricity, 1c per kwh and 1000 hours of operation per

TABLE V.

Initial Cost of Air Conditioning System

Dollars per square foot of building wall

	CONSTRUCTION											
	Light				*Medium*				*Heavy*			
Orientation	S	E	N	W	S	E	N	W	S	E	N	W
Heat Gain BTU/hr./sq. ft.	20	12	10	12	14	12	6	8	4	10	2	6
Initial cost per ton												
$ 800.00	0.13	0.08	0.06	0.08	0.09	0.08	0.04	0.05	0.03	0.06	0.02	0.04
$1000.00	0.17	0.10	0.08	0.10	0.12	0.10	0.05	0.07	0.04	0.08	0.02	0.05
$1200.00	0.20	0.12	0.10	0.12	0.14	0.12	0.06	0.08	0.04	0.10	0.02	0.06
$1400.00	0.23	0.14	0.12	0.14	0.16	0.14	0.07	0.09	0.05	0.12	0.02	0.07
$1600.00	0.26	0.16	0.11	0.16	0.18	0.16	0.08	0.10	0.06	0.11	0.02	0.08

Table V based on 95°F outdoor design temperature; 80°F indoor design temperature. Maximum gain at Light Construction 2 p.m.; Medium Construction 4 p.m.; Heavy Construction 6 p.m.
Light Colour exterior—"U" value = 0.10.

TABLE VI.

Initial Cost of Air Conditioning Systems

Dollars per square foot of exposed roof

Dollars per ton	*Light (2 p.m.) Construction*	*Med. (4 p.m.) Construction*	*Heavy (4 p.m.) Construction*	*Light Roof with water spray*	*Flat Skylight* Double Common Pane (2 p.m.)*
800	$0.41	$0.34	$0.28	$0.10	$ 8.20
1000	0.52	0.43	0.35	0.13	10.30
1200	0.61	0.51	0.41	0.16	12.30
1400	0.72	0.60	0.49	0.19	14.30
1600	0.82	0.68	0.56	0.21	16.20

Table VI based on—*0.65 storage factor applied; maximum load at times shown; "U"—overall coefficient of heat transfer—0.10.

season, the cost of operating a system runs from $60.00 to $100.00[4] per ton. A double pane south-facing window with inner white shade costs approximately $0.33 per square foot per year and a shaded or north-facing similar window costs about $0.10 per square foot per year.

Building Shape Initial and Operating Cost

A sphere would be the ideal building shape if a minimum exterior surface per unit volume were the only factor to be considered. However, we select a cube as our standard because it is closer to practice, and we can compare other building shapes to this from,

Per cent geometrical thermal efficiency[5] $= \frac{\sqrt[3]{(\text{Volume}^2 \times 5)}}{\text{outside surface}}$

A. J. Maher compares four buildings, each with the same volume and floor area and shows that compared to a 100 ft. cube building, a building 50 ft. x 200 ft. x 100 ft. high has an efficiency of 83% and a building 50 x 400 ft. x 50 ft. high has an efficiency of 77%. The building shape may be a significant factor in the initial and operating cost of the heating or air conditioning system but often the shape is decided by the building use or property lines.

Total Exterior Construction Cost

When thinking of the total cost of constructing the exterior it is necessary to consider the cost of both the materials and labor, etc., plus the cost of the heating and air conditioning system. A wall of brick, or brick and concrete block and other masonry walls have construction costs in the range $2.00 to $5.00 per square foot and the additional cost of the heating system or air conditioning system is roughly 15 to 20 cents per square foot. Then the system's cost from 3% to 10% of the cost of the wall construction itself.

South facing windows, double pane with white interior shade, require an air conditioning system at $4.16 per square foot at $1000.00 per ton which is approximately equal to the cost of installing windows which is estimated at $3.00-$5.00 per square foot. For the south facade, using unshaded glass, it would appear glass is a fairly expensive building material because it contributes so significantly to the cost of an air conditioning system.

Comparison of Building Exteriors

An architect or owner will often ask of the engineer: "Is this system efficient?" An engineer could ask of the building exterior construction design: "Is this efficient?" The costs presented in this paper may help classify an efficient exterior, but a better determination would be based upon a square foot of building floor area. If we use the external construction heat gains or losses expressed on a per square foot of building floor area, they become a measure of the thermal resistance of the exterior construction of a building expressed in a fashion which takes all exposures, roof and other factors into account simultaneously.

An engineer with an accumulation of such heat gain or loss values is in a position to make comparison between building exteriors. Then if the building costs are higher than budgeted for he can back up his arguments that his heating or air conditioning design was not unduly expensive but the increased cost was the result of the exterior construction having a low thermal resistance. So that instead of deleting or modifying the air conditioning, as is sometimes done, it is to be hoped the exterior construction would be modified to reduce the cost of the system. Better yet, if the contribution of the exterior construction to the cost of the system is pointed out by the engineer early in the design, the difficulty might not occur.

Summary

Typical insulated exterior walls require heating systems costing from approximately 10 to 36 cents per square foot of exterior wall and from 20 cents to 52 cents approximately per square foot of exterior wall for air conditioning. This is in contrast to the initial cost of heating systems required by glass areas where double glass costs from 40 cents to $1.00 per square foot. Glass areas in the exterior walls of air conditioned buildings contribute very heavily to the cost of air conditioning systems. South-facing glass areas unshaded, double pane and inside venetian blinds cost from $3.50 to $7.00 per square foot for air conditioning and west facing windows have somewhat lower value per square foot of glass because of the diversity of load. Glass area air conditioning cost for south facade may be reduced to the $2.00 range by using shading devices.

It is apparent that the use of glass areas in the facade of a building can increase the initial cost of both heating and air conditioning systems but the influence on heating system initial cost is much less than that of the air conditioning system. In fact, very substantial changes in air conditioning cost such as were quoted in the introduction, that is from $4.50 to $7.50 per square foot of usable area or 67% increase, can occur because of the use of unshaded glass in the building facade. Not all the increase is due to increased heat gain as some of the increase is caused by a more involved ducting and piping layout to avoid passing in front of windows. It is hoped the tables presented herein will be used to estimate the influence of the exterior construction upon the initial costs of systems.

The influence of exterior construction upon the operating cost of a heating system is not clearly defined, but with an air conditioning system the operating cost is increased with exteriors having a lower thermal resistance. Fixed annual costs in both heating and air conditioning depend upon initial cost and therefore upon the nature of the exterior construction of a building.

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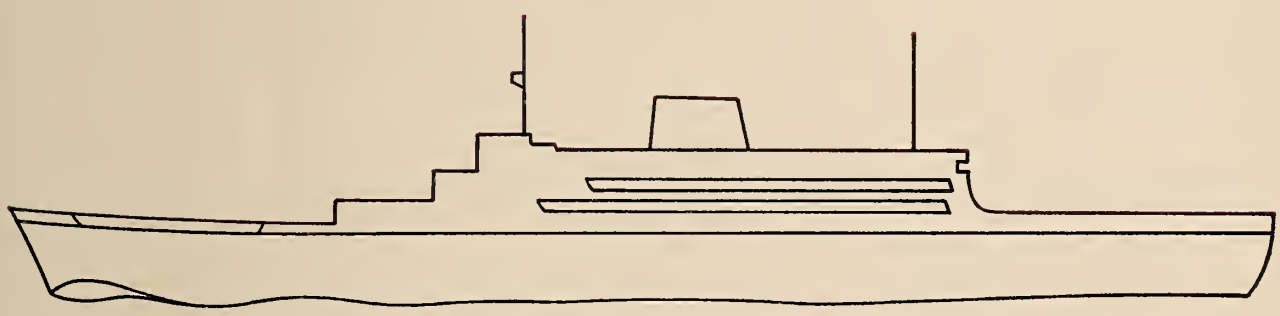
EIC-63-CE&A 3

Analog Computer Simulation of Ship Propulsion Systems



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FOR MANY YEARS Canadian General Electric has studied systems for various industries on the electronic analog computer. This paper is a brief description of the analog computer and how it is applied specifically to a diesel-electric system for ship propulsion.

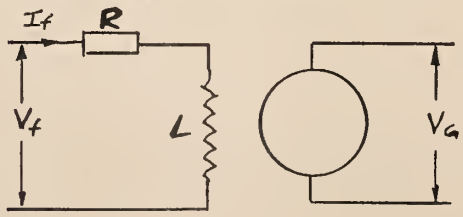
The Analog Computer

The analog computer is a machine which solves a set of simultaneous equations that are similar in form and analogous to the set of equations describing the dynamic behaviour of the system under study. In this fashion the computer simulates the system. The computer solution, which can be recorded on strip charts, reveals the transient and steady state behaviour of the system. The variables are represented by d-c. voltages which vary with time, while time itself is used as the independent variable.

The computer consists basically of operational amplifiers and co-efficient setting potentiometers, other units such as multipliers and function generators can be used to extend the capability.

Method of Simulation

Using a d-c. generator as an illustration we get the diagram as shown.



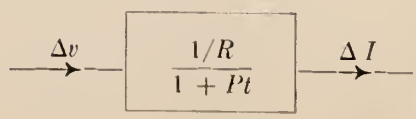
First considering the field circuit we have the differential equation.

$$L\frac{di}{dt} + iR = V$$

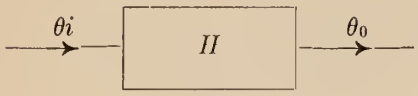
When this equation is solved by operational methods we get

$$\Delta I = \frac{\Delta V}{R(1 + Pt)}$$

We can express this diagramatically as

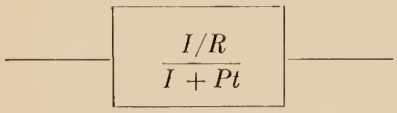


The expression inside the block is known as a transfer function. In general a transfer function can be written

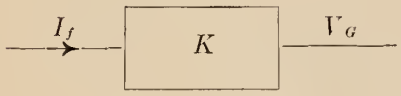


Here $\Theta_o = H\ \Theta_i$ where Θ_o is the change in output quantity resulting from a change in Θ_i input quantity. It will be realized that H will have the dimensions Θ_o/Θ_i. For instance, it could be volts per ampere turn or LB. FT. per amp. or even perhaps simply volts/volt.

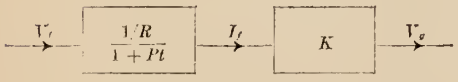
Returning to the generator diagram we have the transfer function for the generator field as



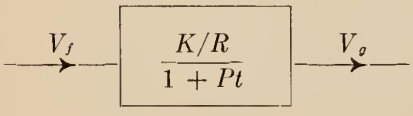
Next we can show the relationship between I_f and V_G. It is a simple constant K (i.e. the slope of the generator saturation curve).



We can make a transfer function follow another.



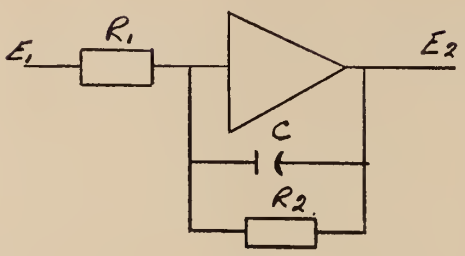
It is evident that such a move is equivalent to multiplying the transfer functions and therefore we may combine the two blocks, thus



Notice that the numerator is the d-c. voltage gain of the generator and the denominator is the field time constant.

The next step is to represent this transfer function with an operational amplifier.

With an amplifier connected as shown



The relationship is

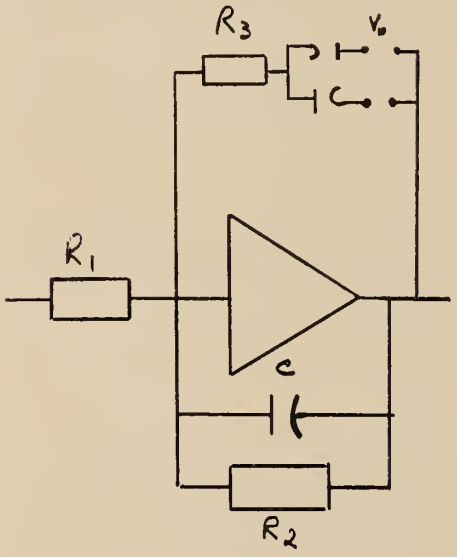
$$\frac{E_2}{E_1} = \frac{R_2}{R_1}\left[\frac{1}{1 + R_2Cp}\right]$$

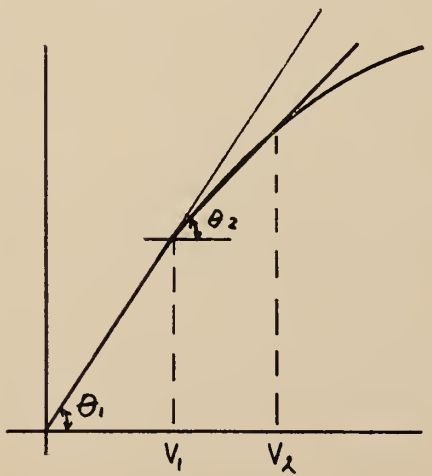
$$\therefore \quad \frac{R_2}{R_1} = k = \frac{K}{R}$$

and $\quad R_2C = t$

So far this is only a partial representation of a generator, saturation effects have not been taken into account.

An approximation to the saturation curve is made by using a device connected to the operational amplifier. The device is called a limiter and its effect is as follows:





The generated voltage has a gain of K_1 and a time constant of t_1 from 0 to V_1. From V_1 to V_2 the gain and time constant are changed in the relationship of Θ_2/Θ_1.

With the limiter connected as shown, when the output of the amplifier exceeds the voltage V_1 the diodes conduct and connect an additional parallel path. This modifies the gain and time constant in the desired ratios. In this way the straight line approximation to the curve can be constructed.

It is in the area of equation solution that computers are invaluable. They shrink the time and effort involved to solve those equations that can be solved by hand and they bring into the realm of feasibility a host of equation solutions which by hand calculations are for practical purposes unsolvable.

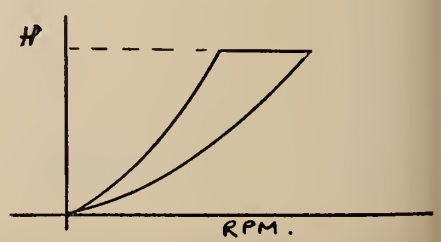
Paper analysis and computers compliment each other. Hand calculations provide a check on partial solutions which can be used to ensure correct computer operation.

Ship Propulsion

The diesel-electric drive is usually used on special purpose ships, e.g. ice breakers, ferries, tugs. In other words, diesel electric is used where the required characteristics cannot be obtained by a direct drive.

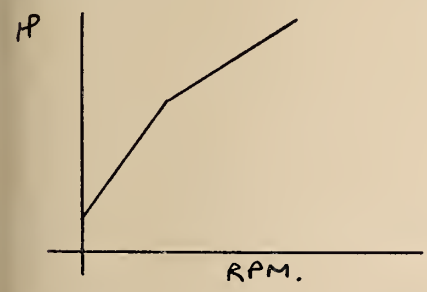
The ice breaker is a vessel that requires rapid manoeuvering as well as a wide power usage as basic requirements. Therefore I would like to use the ice breaker as an example to show first some of the steps in designing the system to provide the characteristics and then the computer diagram of such a system.

The propeller is designed to produce maximum thrust over a range of propeller speed from free running to bollard condition.



Where free running represents a maximum propeller speed for maximum ship speed at rated horsepower. Bollard condition is when propeller is absorbing rated horsepower when ship is held stationary in the water.

The diesel engine has fixed characteristics, and cannot supply the constant horsepower range required. To get this the propulsion motor is designed with a base speed corresponding to the propeller bollard speed and with a field range up to the propeller free running speed, thus the constant horsepower.



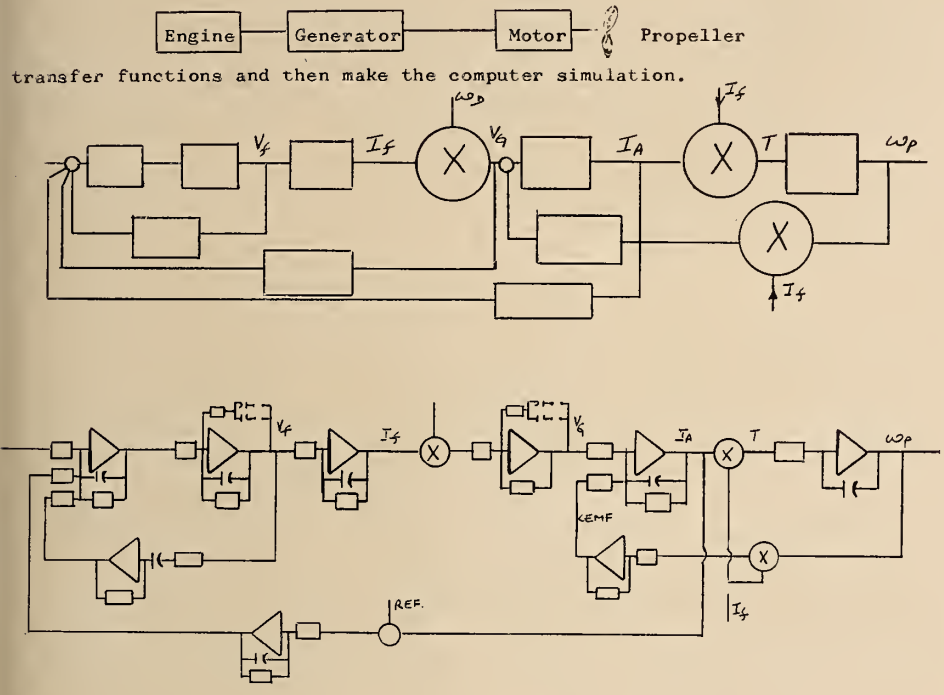
Usually the motor is set to operate in the weak field condition and a constant horsepower regulator is applied to increase motor field current as the propeller loading increases.

Speed control of the motor is by variable voltage obtained by generator field control and by change of engine speed.

In most industrial systems the power source is quite often at the least very large compared to the drive requirements. On a ship the power source, the engines, is rated to the drive. Another characteristic of a diesel engine is that it has very little overload capacity, therefore the generator has a current limit regulator that not only provides better control but protects the engine from overload.

With the two regulators in the electrical system and the engine governor, another regulator, we have three regulators affecting performance.

We then start from the block diagram of the system and construct the: (see diagram)



The whole system is first represented by transfer function. Where this is not practical because of computer space function equations are used, from the diesel engine to the propeller.

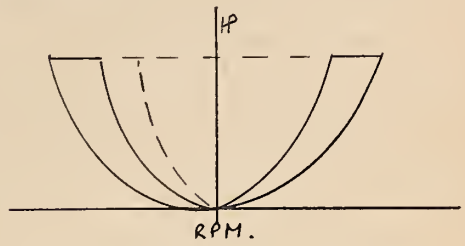
Partial calculations are made and are used to check the computer setup. When the results agree the complete system study can then be started.

This then is a basic system for computer study, the action and reaction of the three regulators on the system can be studied, changes are made to the system if required for the transient response and for stability.

The rapid manoeuvering requirement while so readily available with the electrical system sets up a range of conditions for the system, these conditions are now so easily studied and any adverse affects can be corrected.

For example rapid reversal is from full ahead to full astern but this can be from bollard speed to bollard speed up to full ships speed ahead to full ships speed astern.

In the latter case the propeller is reversed long before the ship stops and due to the way on the ship another propeller horsepower curve is applicable.



But before this other horsepower curve is reached the propeller must be reversed and also due to the way on ship there is energy in the propeller and water that must be absorbed.

This is but one example of the type of duty cycle that can be studied so easily on the computer but presents many difficulties for a hand solution.

The studies are not limited to actual expected operation, more service duties can and are imposed on the simulated system.

Whys and Wherefores

As can be appreciated the analog computer is being used as an important design tool.

A system can be conceived and tested and an optimum design can be produced. Over or under designing for new conceptions are largely avoided. Performance under which the equipment must operate is also established which allows for more intelligent design by the product engineers.

As I have said before, studies are made that are for practical considerations impossible to calculate. Ideas that look good on paper can receive the acid test without having to resort to experiments in the field.

This is not perfection, there are limitations with the use of a computer. The computer is only as good as the data used and the operating conditions studied.

Precise accuracy is not considered important, accuracy of the computer is between 2-5% while accuracy of machine data is often only within 10%. The main purpose is to design a system within adjustable limits.

Records taken on installations are compared to computer results, this gives a cross check on the validity of the computer and of the scope of the study.

A side effect with this type of study is due to the computer being actually a model of the system, a familiarity and understanding of the whole system is generated that is invaluable when it comes to putting the equipment into service. EIC

EIC-63-MGMT 4

PLOTTING UNDERGROUND PUBLIC UTILITIES In The City of Ottawa

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City of Ottawa

THE CITY of Ottawa, in co-operation with utility agencies, is preparing composite plans for all underground utilities beneath Ottawa streets, and thus for the first time is securing a comprehensive picture of the great network of pipelines and ducts which exist throughout the City.

Previous to 1960, individual records of the public utilities and City services were kept on file in the offices of each utility concerned. Although a good deal of information was available, there was no real co-ordinated plan showing the sub-surface plant of all utilities in their proper relation one to the other. In addition, as some underground works are now more than 100 years old, some of the earlier records were either lost, or their accuracy was open to question, or the plans left a lot to be desired in the matter of detail.

This lack of composite accurate plans has rendered the planning and execution of projects difficult and has resulted in some avoidable expenditures.

Although both the City and the utility companies were aware of the situation and were working towards its solution, the 1958 explosion on Slater Street in Ottawa pointed out very vividly the need for such plans. Had such plans been available, the investigation of this explosion would have been simplified; the differences of opinion between utility agencies and between the City and a utility would have been more easily resolved, and a good deal of time, involving senior employees and large expenditure of money, would have been saved.

The need of such plans has been amplified by the great increase in underground plant which has occurred in the last decade. The sewer mileage increased from about 202 miles in 1950 to 567 miles at the present time. The watermain mileage jumped from 210 miles in 1950 to 480 miles at the present time. Bell Telephone underground plant had reached 180 miles with as many as 36 three inch ducts in a location; Ottawa Hydro underground plant increased to 49 miles with as many as 30 three-inch ducts in a location; and while we have no record for gas mains in 1950, it is known with the introduction of natural gas the mileage of pipe increased from 137 miles in 1958 to 220 miles in 1961.

Therefore, in summing up, there are more than 1,400 miles of underground plant beneath City streets at the present time, which in the case of pipe would vary from six inches to six feet in diameter and for conduit which may occupy a cross-sectional area of up to three feet square. As would be expected, this mileage of underground plant is more congested in the older parts of the City's 458 miles of streets. This congestion will be more pronounced with the execution of plans now being considered to place pole line services underground when it is realized that pole line plant of the Bell Telephone Company and the Ottawa Hydro-Electric Commission amounts respectively to 363 and 691 miles. Moreover, the figures quoted do not include a considerable mileage of pole line and underground plant of the Fire Alarm Service, Canadian National and Canadian Pacific Telegraph services, the Dominion Electric Protection Service, traffic lights and street lighting, nor does it include heating ducts and various tunnels under streets which carry services to Government and private agencies.

This growth in underground plant is attributable to new housing on land annexed from adjacent municipalities and the replacement of single family units, business, commercial and office premises and apartments, with modern buildings. As more of these types of construction, including urban renewal, can be anticipated it is reasonable to expect that there will be a steadily increasing demand for new and larger capacity sewers, both storm and sanitary, water and gas mains and for telephone and electrical services which, to an increasing extent, must go underground.

In 1957, the City in co-operation with Ottawa Gas Company, proposed that an underground utility committee be formed, which would be composed of representatives of all utilities, including Ottawa Gas, Bell Telephone Company, Ottawa Hydro-Electric Commission, Design, Roadways, and Sewerage Branches of the Department of Planning and Works, Water Works Department, Fire Alarm Service of the Ottawa Fire Department, Department of Traffic Engineering Services, Recreation and Parks Department together with the Ottawa Transportation Commission. The purpose of the committee, which was to be formed somewhat along the lines of a similar committee which has operated in the Metropolitan Toronto

area for some years, would be firstly to devise an ideal location for the various utilities; provide an area where discussion of utility problems could occur and lastly, if possible, to co-operate in the production of composite plans of existing underground plants.

This committee was formed with the approval of the Board of Control and has been meeting on a regular monthly basis with the exception of the summer months, and the results have exceeded expectations.

The first work undertaken by the committee was the development of the ideal location plan, allocating space under the streets to the various utilities. Ideal location plans have been developed for streets of various classifications and of various widths and have been followed since 1958.

In addition, new methods of processing applications for underground plants have been developed which ensure that all utilities are in a position to concur with the location of each new plant, regardless of the originating utility.

These meetings have been evidenced with frank discussion which has developed a spirit of mutual trust and confidence, which would pave the way for a satisfactory solution of many common problems.

In the fall of 1959, it was proposed that the committee proceed with the development of the composite underground plans and after considerable study, it was decided that the most advantageous method of approaching this problem within the City of Ottawa would be for the City to set up a separate section within the Department of Planning and Works, which would undertake this work.

After reviewing the existing underground plant, it was decided that an acceptable division of cost of the operation of such a central agency would be on a percentage basis for each agency, according to the volume of their underground plant. This principle was accepted by the City and all utilities and resulted in a formula whereby Ottawa Gas and the Water Works Department would share 20% each of the total cost, Bell Telephone and Ottawa Hydro would share 10% each of the total cost, the Department of Planning and Works with its combined network of both storm and sanitary sewers would share 38% of the total cost and the Ottawa Fire Department and Traffic Engineering Services Department 1% each. It was agreed that the billing would be made quarterly to the utilities by the City which would supervise the operation and financing of the central registry.

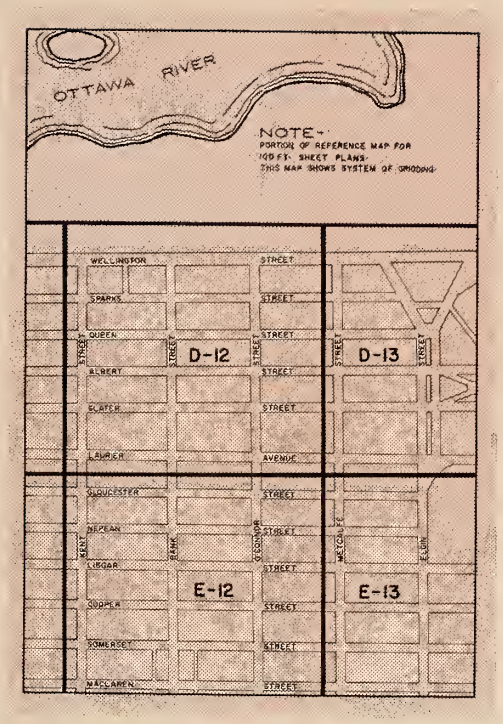


Fig. 1

The City gave its approval and provided funds in its 1960 Budget for office, draughting and surveying equipment, a panel truck and 10 positions, namely, a senior engineer, technical assistant, four draughtsmen and a four-member survey staff.

The providing of this establishment envisaged that the development of working methods for surveys and the production of plans, the utilization of supplementary data available from the utilities and the supervision of the project, would be the responsibility of the senior engineer who would also act as secretary of the Underground Public Utility Committee, operating under the Design Branch of the Department of Planning and Works.

The functioning of the central registry started May 2, 1960, with the appointment of the senior engineer and technical assistant. Further appointments in June, July and August completed the establishment.

The months of May and June involved the organizing of the central registry, the laying down of work methods and the completion of arrangements with the utility agencies. In July, 1960, survey operations began.

The City had previously compiled sheet plans from the various registered plans at a scale of one inch equals 100 feet. There had been some 234 plans which were already prepared representing rectangles on the ground approximately one-half mile to the side. These are shown super-imposed on a plan of the City of Ottawa in Fig. I. It was decided to use these as the basis of the new utility plans at a scale of one inch equalling 20 feet. It is estimated that the number of such utility plans to cover existing underground utilities within the City would amount to 2,800. Each utility sheet would be 42 inches by 24 inches and would show all existing underground utilities within the street limits, at a scale of one inch equals 20 feet with at least two cross-sections of each street to a vertical scale of one inch equals 10 feet. It was determined that up to 35 of these utility plans each representing a rectangle of 443 feet by 566 feet on the ground could be gridded on a sheet plan as shown on Figure II.

Operations started in the area bounded by the Ottawa River, the Rideau Canal, Dows Lake and Preston Street. Surveys were first made to determine the exact location of roadway curbs with reference to the property lines. These curb lines were then used as a base-line to locate and plot on plans all visible ironwork of underground plant of the various utilities, such as, manholes and valves and surface plant, including utility poles, street and traffic lighting standards, fire alarm fixtures, hydrants and trees. In addition the depth of all underground plant was obtained wherever possible through available covers, manholes, etc.

In this work it was found that direct plotting using a plane-table was more expeditious and less liable to errors than the use of field-books. These survey determinations permitted the fitting in of plan information of underground plant received from private and public utilities. The actual plotting of the plans is done on 0.003 inch draughting film because of its low co-efficient of expansion and contraction and other qualities which were considered superior to that of tracing linen.

After the plans have been completed and checked against the best available plan information the sheets are then sent to each utility who carefully check the plans from their knowledge of the system and any records they might have and make any amendments to the drawings. After each utility has checked the drawing, it is then completed and signed and circulated to each member utility for their ready reference and file.

A typical utility plan thus produced is shown as Fig. III.

After the first five months of operation ending December 31, 1960 the equivalent of 148 utility plans had been completed at a unit cost of $168.11. However, with improved techniques it is anticipated that an equivalent of 400 plans will be com-

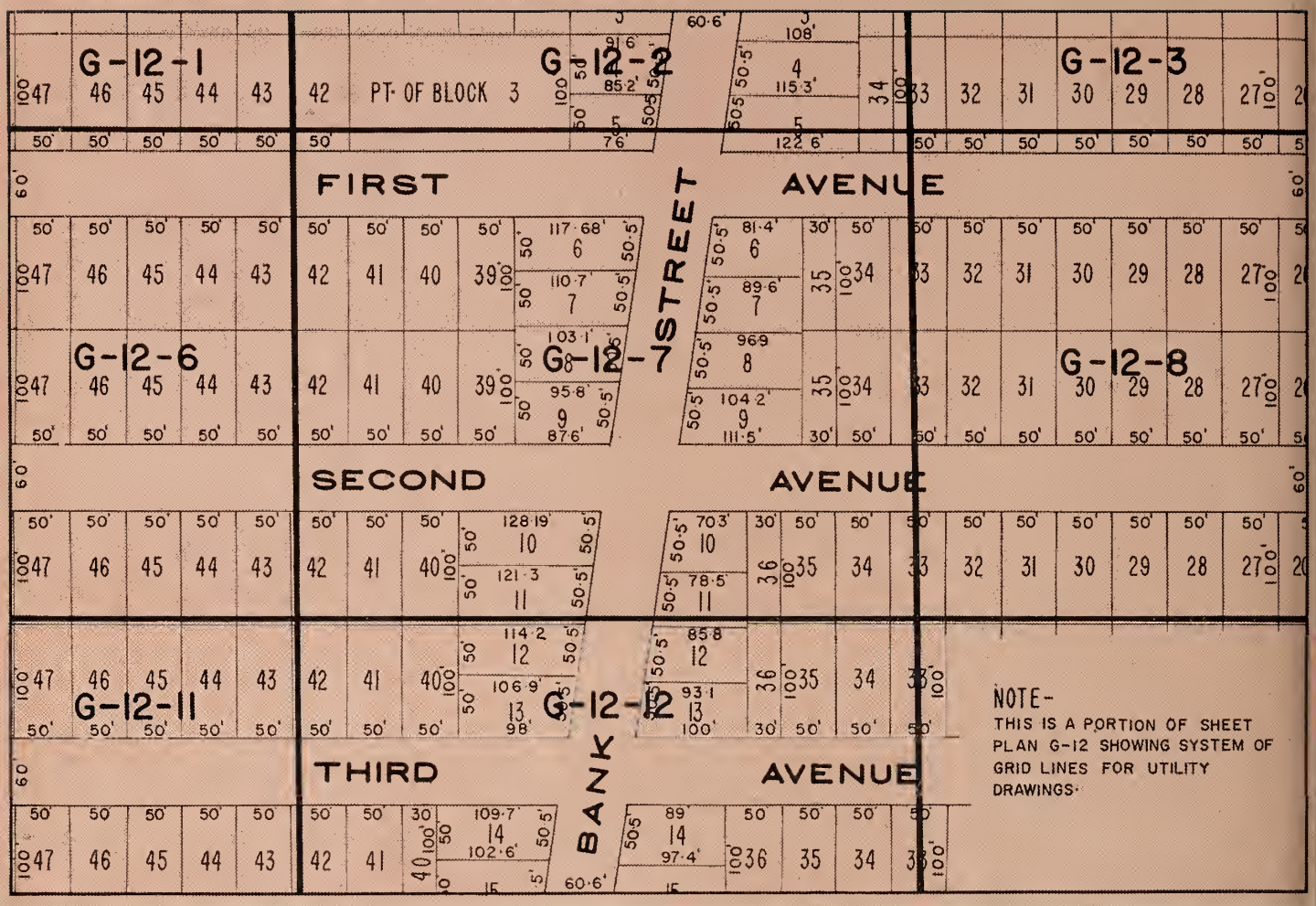


Fig. 2

pleted in the 12 months ending December, 1961, at a unit cost of some $116.

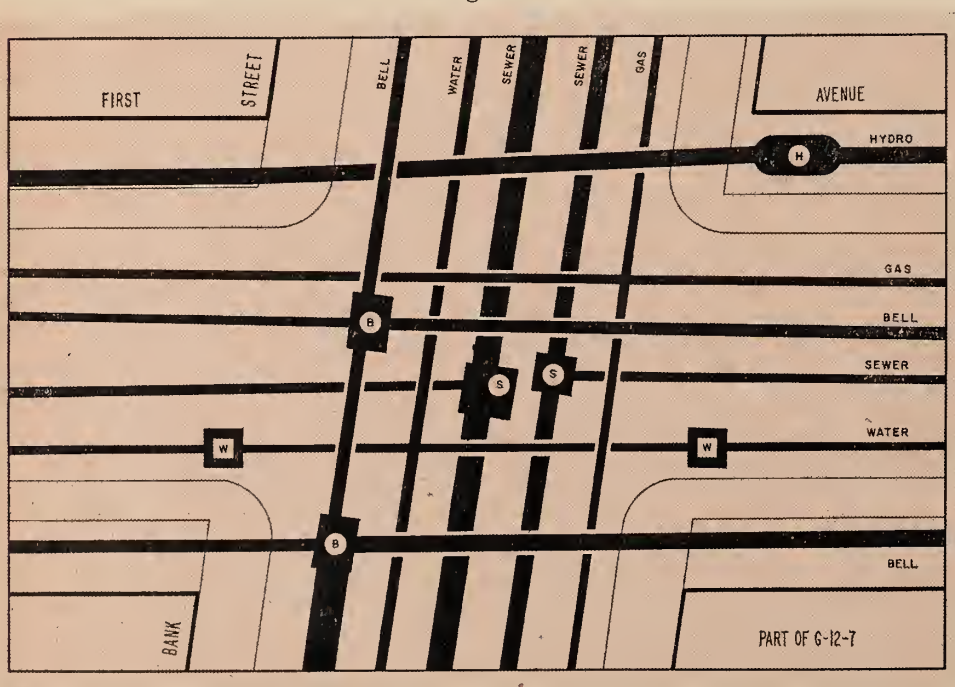
During this past year the initial area has been completed and operations have been extended easterly to the Rideau River north of Mann Avenue and westerly past Island Park Drive and easterly to the Rideau River, east and west of Bank Street.

The contributing agencies are kept informed of the progress of the work by monthly reports and coloured prints of the individual plans as they are completed. In turn as-built plans of new construction are supplied by each utility which permits the continual revision of the composite plans so that the contributors are always in possession of an up-to-date plan. The usefulness of these plans is recognized as a "time" and "dollar" saver in connection with utility plans as base plans for the development of many other projects.

Much good has come from the deliberations of the Underground Public Utilities Committee which now functions under a revolving chairmanship. The chairman for 1961 was a representative of Ottawa Gas, and in 1962 it was a representative of the Water Works Department. Many problems have been dealt with to the satisfaction of the utilities and the City, and it would be remiss to overlook the spirit of mutual trust and confidence that has been engendered through frank discussion of utility distribution problems.

On the basis of some 2,800 plans being required to provide an accurate plan record of the underground and surface utility information for all streets now laid out in the City of Ottawa, it is estimated that it will take some five to six years to complete the project. Following this, a small staff will be in a position to keep the plans revised as new construction is carried out from time to time.

Fig. 3



AUTOMATION THROUGH THE ON-LINE PROCESS CONTROL COMPUTER

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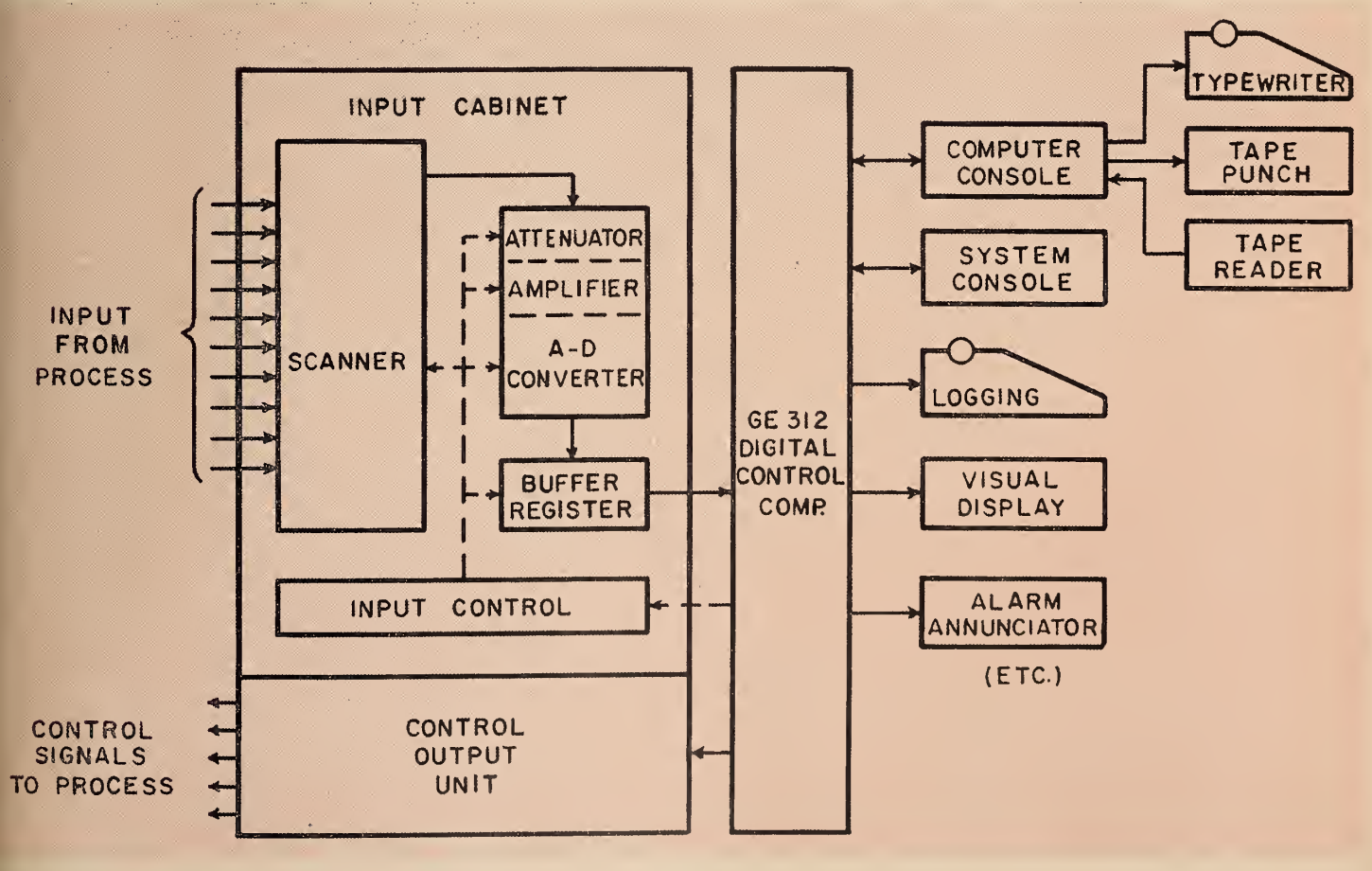
IT IS ONLY a few short years since the first high speed digital computers came into being and yet their area of application is enlarging at such a rate that they will soon have entered almost every realm of scientific endeavour—if this has not already occurred. Fast on the heels of the first digital computers, which initially were mostly scientific computers developed and built by the universities, came the business data processor. Differing principally in the flexibility and speed of its input-output equipment and possessing a memory capacity capable of handling the large files of information characteristic to business data processing problems, industry has been quick to recognize the gains to be made in the cost and speed of processing business information. Thus a

Fig. 1—Typical Process Control Computer Configuration



whole new technology of business systems information has already emerged.

The latest and one of the most potent additions to the computer family has only just arrived. The first applications are only just reaching completion in many industries and are being closely watched by all concerned. This new member is the process control computer, or the "computer in overalls" as someone has aptly named it.

Thus we now have three board types of digital computers at our disposal.

Scientific Computers
Business or Data Processing Computers
Process Control Computers

Just what is this new tool? What can it do? How does one prepare for a computer control system? How much does it cost? How long does it take? What benefits can be expected? These and other similar questions must be answered in order to satisfy the need for understanding by both technical personnel and those with management responsibility.

Characteristics of Process Control Computers

The process control computer differs from its brothers, the business data processor and the scientific computer in one very important respect. The input data for these other computers, be it labor vouchers for a factory payroll application or construction dimensions for an engineering application, are always prepared by human beings on some medium such as punch cards, punched paper tape or magnetic tape. The process control computer on the other hand, contains hardware which permits it to select and obtain reading directly from the process. Suitable sensing devices permit it to receive direct readings concerning the process variables such as temperature, voltage, pressure and speed. Similarly, by sending output signals (usually to the set points of convenional controllers and regulating systems) it can control the process operation. Because of its ability to communicate directly with the process the process control computer and its program become an integral part of the plant and process under control.

A typical configuration for a system designed expressly for use in industrial computing and control systems is shown in Fig. 1. The central computer is a serial, binary, stored program digital computer which is completely transistorized and uses solid state circuitry throughout in order to meet the requirement of high reliability which all process control applications demand.

The input signals from the process are supplied as DC voltage signals with full scale values anywhere from 10 mv. to 250 volts. The scanner for sampling the input signals is a mercury-wetted relay matrix. This permits each input to be individually and randomly addressable by the computer program.

When an input is sampled by the scanner, it passes through a combination attenuator and amplifier for scaling to the proper level for input to the analog-to-digital converter which follows. In the electronic analog-to-digital converter, the signal is converted to a digital binary number which is accepted as input to the central computer. All input operations are under control of the computer program which is permanently stored in memory, and once the data has entered the computer, it is processed according to instructions in the computer program.

To complete the data link for closed loop control, the control output unit may be added. This takes the output data from the control computer, converts it back to an analog signal if necessary and distributes the setpoint control signal to the selected process controller.

What Can the Computer Do in Process Control

By virtue of its input-output equipment, its arithmetic and decision making ability, and its own internally stored program, a process control computer can:

1. Collect process data.

2. Locate and identify abnormal or dangerous conditions by means of high-low limits stored in the program.

3. Add, substract, multiply and divide and otherwise complete any other arithmetic operations such as square root, log, cosine or the evaluation of any algebraic expression.

4. Compare, analyze, make logical decisions or otherwise carry out any series of routine operation in a precisely programmed manner.

5. Compute and print out data concerning the process and its operation in forms most convenient for the operators and the factory accounting system.

6. Solve equations describing optimum operation of the process and produce output signals to control the process accordingly.

7. Alert the operators for appropriate actions during the process operation requiring knowledge or judgment beyond its programmed capabilities.

Types of Application

Naturally not all applications embrace all these capabilities and thus applications have already been typed according to the functions which they emphasize most. The total number of process control computers now installed (May, 1962) is nearing 100 with an equal number more on order.

Data Logging

Data logging applications, as the name implies feature the generation of reports on process operation, such as engineering, experimental or production data.

Start-up or Shutdown Procedures

Control the start-up or shutdown of large and expensive equipment such as boiler turbine generator systems to ensure that every phase of the established procedure is followed exactly and no step commenced until all the prerequisites have been completed and confirmed.

Open Loop Control

Here the computer is used in real-time to print operating guides for the guidance of the operators who in turn control the process accordingly.

On-Line or Closed Loop Control

This exists when the computer is in direct control of the process by means of its output signals. This is called supervisory or indirect control when the computer output signals are fed to the setpoints of conventional local loop controllers and regulating systems. It is called direct control when the local controllers are eliminated, as in some very recent installations, and the computer itself is used as a time shared regulator in addition to its other duties.

Hot Strip Mill Application

At this point it will be helpful to describe some one application in more detail. An example has been chosen from one of the several possible areas of application in the iron and steel industry, namely the hot strip mill. First it will be necessary to give a brief description of the process.

The Process

The overall function of the hot strip mill is to take cold slabs of steel, about 5 in. thick and 20 ft. long from a slab storage yard and roll them down to a finished coil. The thickness is reduced to somewhere in the range of .050 to .150 in. and the length therefore increases in inverse proportion from 700 to 2000 ft.

The first step in the operation is to place the cold slabs in a reheating furnace where they are reheated to a temperature just below the melting point. The slabs are then discharged onto a transfer table and carried to the first rolling operation.

This section, referred to as the roughing mill, reduces the slab thickness by a series of rolling passes to about .7 in. Each pass reduces the thickness up to 1¼ in. with a peak rolling horsepower around 10,000-15,000 hp. supplied from a large DC motor.

While it is still red hot the elongated slab is now passed to a series of six rolling stands spaced about 18 ft. apart and referred to as a continuous finishing mill. Here the head end of the slab is rapidly passed through all six stands, each of which reduces it in thickness by some 20 to 50% so that it emerges at the final desired thickness in one operation and at a speed ranging from 1200 to 1800 f.p.m.

The fast moving strip now traverses a long runout table where it is cooled by water sprays and then coiled.

The weight of a typical coil is around five to six tons. The total length of the mill from reheat furnaces to coiler is about 800 ft. It takes about two to three minutes for a hot slab to complete the total journey from the furnace, through the reversing roughing mill, on to the continuous finishing mill and down to the coiler.

Because the slabs are generally obtained cold from a storage yard, and because the finished coils are discharged to a buffed inventory supply before further processing (if required), the overall hot strip mill is reasonably well isolated from the preceding and succeeding operations and thus constitutes a "logical package" for computer control.

Furnace Control

The computer can be given the task of tracking the slabs through the several reheat furnaces, controlling the furnace temperatures to give uniform heating and signalling which slabs are ready for rolling next.

Roughing Mill Control

The computer can be given the task of optimizing the rolling passes on the reversing rougher. How many passes should be taken? How much reduction should be taken on each pass? At what speed should each pass be rolled? How much reduction in thickness should be taken on the roughing mill before the slab is passed on to the finishing mill? These are all questions that the process control computer can answer taking into account the grade of steel, the temperature of the steel and the state of the mill at the moment.

Finishing Mill Control

The finishing train of a hot strip mill is one of the most profitable areas in which to extend the "automation ring". Considerable effort has been expended therefore in studying the various problems which must be overcome in order to secure not only automatic operation but also optimized performance of a hot strip mill. These problems have been solved to the point where a six stand finishing mill with a GE312 control computer for closed loop automatic control is now in successful operation in the U.S.A. Early in 1963 a GE412 computer will be installed in the new RTB hot strip mill in Wales for even more complete control embracing all mill functions from reheat furnaces to strip coilers.

Here in detail is how the finishing mill program operates.

1. The computer receives a contact closure indicating the preceding reversing rougher is on its last pass.

2. The computer reads the analog incoming thickness and incoming width signals from precision potentiometers geared to the rougher-edger screw drives.

3. If this is the first slab of a new schedule, the computer reads the following manual digital inputs:

(a) Assumed incoming clab temperature.
(b) Desired delivery gauge.
(c) Desired delivery speed.
(d) Desired delivery width.
(e) Desired last stand draft.
(f) Stand load distribution.
(g) Stand roll diameters.
(h) Location of interstand x-ray gauge.

4. With this information, the computer proceeds to make the first of several separate program. Stored data include such items as mill power curves, stand drive ratings, mill housing spring constants, and draft corrections gathered from the preceding slabs. This initial "Coarse 1" calculation is made using an assumed average incoming slab temperature.

5. Upon completion of the Coarse I calculation, initial settings are fed from the computer serially to temporary buffer storage in the coordinated control equipment. Only as the tail end of the preceding slab leaves each stand are the newly calculated references fed to the analog regulators associated with that stand. The calculated references include the following:

(a) Individual stand information:
   1. Stand speed in r.p.m. for each stand.
   2. Stand unloaded roll opening for each stand.
   3. Stand loaded roll opening for each stand.

(b) Miscellaneous information computed for the first bar of a new schedule only includes.
   1. Sideguard opening.
   2. X-ray gauge composition.
   3. Delivery x-ray gauge thickness.
   4. Interstand x-ray gauge thicknesses.

6. This completes the coarse calculation based on the assumed entry temperature. The computer now receives a contact closure from a hot metal detector indicating that the head end of the slab is beneath the pyrometer.

7. The computer reads the analog signal from the pyrometer denoting the actual incoming slab temperature.

8. The computer now makes a second calculation to derive a new and more accurate set of stand speed and screw position settings based upon the actual incoming temperature. The actual incoming slab temperature on which the second calculation is based, is measured with a pyrometer located immediately before the first stand.

9. These stand settings are fed from the computer to the control equipment which takes action stand by stand, as the tail end of the preceding strip progresses through the mill.

10. The slab threads the entire mill and is rolled under closed loop gauge control. As the stand screws are adjusted to maintain gauge, looper regulators operate to maintain proper speed correspondence.

11. The computer receives a contact closure from the hot metal detector located a sufficient distance down the delivery table to allow all transients caused by regulator action to decay.

12. The computer scans the mill for "playback" information. Such items as stand speeds, stand roll openings, stand loading separating forces, stand loading and delivery x-ray gauge deviation are read along with other inputs needed for calculating correction factors to be applied to the subsequent slab's calculation. Thus the program is adaptive in nature and has the ability to learn from experience and thus upgrade its performance.

13. The computer scans and stores all the remaining data required for subsequent log printout.

14. The computer prints out the coil log and accounting log for the strip just rolled.

What Are Its Functional Characteristics?

We have listed, in simple terms, what a computer can do and taken a brief look at some applications. There are certain inherent functional characteristics in any digital control computer that must always be considered before applying a computer system to an industrial process. These are limiting characteristics. If they are ignored, a computer control system may do all that it is designed to do, but the installation may still be a failure.

There are three basic limiting characteristics:

1. Time

Because it has only one program register, a digital computer can only initiate one operation at any instant in time. These operations are performed sequentially one after the other. The digital computer's operational speed is so high that it may appear to be performing a number of operations simultaneously but this is only an illusion, except for time overlap which may be possible over a portion of some operations. The time required to complete any single input, arithmetic or output operation is measured in microseconds but the time is still finite.

It may be difficult, in the early stages, to accurately estimate whether or not the computer is capable of performing all of the desired operations in the time available. In many cases this cannot be known until the computer program has been prepared. Problems are most apt to arise when the computer is asked to perform timed cyclic operations and is also expected to perform actions at random intervals on demand. Although many small operations within the program may be performed very quickly, these apparently infinitesmal times do add up to an appreciable total.

2. Signal Noise

The digital computer, like any other type of digital data acquisition system, does not continuously monitor any one analog signal but only samples the inputs. It will record the value of each signal at the instant it is read. Conventional analog recorders and indicators have enough inertia to damp out a great deal of noise or signal fluctuations.

This averaging, or digital signal filtering can be done by the computer, but the requirements of many industrial applications may not provide time for the multiple scan readings required to average a reading. The input signals fed into the computer should therefore be as stable as possible and well shielded from stray pickup.

3. Noncontinuous Action

Since all inputs are sampled at a fixed and programmed rate, a digital computer cannot provide truly continuous real time control of any process operation. The response time of any directly regulated variable must be several times the sampling time of that variable.

4. Reliability

Process control applications demand the utmost in computer reliability—even more so than normal engineering or data processing applications due to the continuous operation of the process and the impossibility of screening the output before it is used. There is every indication however, that the computer manufacturers have met the requirement of 99% reliability or better, by using refined manufacturing processes, rugged construction, derated components and a minimum of circuit elements.

Application Considerations

The following principals govern the selection of applications where the digital computer can show its economic and operational advantages and remain within its capabilities.

1. In the present state of the art, the computer is generally restricted to programmed decision-making functions and not normally used to directly regulate a process variable. Instead local analog type regulating loops receiving commands or reference signals from the computer should be used. Regulating stability requirements may otherwise require the computer to devote an excessive proportion of its time to a task better performed by conventional regulators. However, his practise may well reverse with even still further increases in computer speed and reliability.

2. The computer's ability to prepare accounting data such as pay and production records should be considered in every application even though the primary purpose of the installation is in the area of process control. These functions may add little to the cost, but often produce large and readily calculated savings.

3. Select processes having a number of variables affecting process operation, product quality and production rate. The ability of the computer can then be used to select the proper operating level for each variable to achieve optimum process performance, provided the process optimization equations have been previously established.

4. Select processes for which the necessary sensors are available or can be developed.

Selecting a Process

A digital control computer cannot be fully applied to any process that is not economically, physically and analytically ready to accept it. Often however, an evolutionary approach is needed with installation of the computer required for experimental control and data gathering in order to

ater achieve complete control.

The equipment to be offered must nclude everything required to let the omputer see, feel, and steer the pro- ess. If this requires extensive me- hanical and electrical modifications, he cost can be prohibitive.

Bearing this in mind, as well as the omputer's capabilities and limita- ions, the following process character- stics need to be considered.

The process should be:

1. Continuous, with a high through- ut and significant contributed value.

2. Mechanically automatic, requir- ng no manual handling of the prod- ct.

3. Process variables controlled by ast accurate regulators.

4. Complex, having several vari- bles affecting production rate and uality.

5. Operated on proved scientific rinciples or well defined empirical nethods.

6. Capable of improvement.

Programming Process Control Application

Process control applications are dif- icult to program and demand the ut- most experience and skill of the rogrammer. There are a number of ogical reasons for this and although o reasonable effort should be spared o make any possible improvement, rocess control programming will robably continue to be more difficult han scientific or data processing pro- gramming because:

1. The demand for equipment reli- bility requires that the simplest com- uter circuitry with the minimum omplexity and number of parts hould be used. Any additional cir- uitry which would be put into a gen- ral purpose computer only to make ife easier for the programmer would ikely be omitted in a process control omputer.

2. Computer programming for gen- ral purpose computers continually ccupies an appreciable amount of the ustomers' time and money. The an- ual programming cost is roughly qual to the computer rental cost, which is usually about one-quarter f the purchase price). With process ontrol computers there tends to be nly one program per computer. For his reason the manufacturer and the sers do not have the same incentive to develop utility routines, automatic programming languages and other tools to the same degree of sophistication as programmers in the general purpose computer field enjoy.

3. The timing requirements are usually severe and require great skill in program organization and optimization if the program is to meet all the specified requirements — particularly when difficult conditions in the process attempt to place simultaneous demands on the computer.

4. The programs are large—often requiring 16,000 to 32,000 memory locations and occasionally up to 50,000 words of memory.

5. Once an order is obtained there is a strong incentive to have the programmers and process analysts complete their job in the same time, or less time, than it takes the factory to build the hardware—but due to the intimate relationships within the program it is difficult to subdivide the work between more than a few people.

Process Control Applications

Process control applications differ from scientific, engineering or business data processing applications in a number of very important ways.

Not the least of these is the need for a very complete understanding of the process to be controlled. A knowledge is required of exactly what the computer is to do for every conceivable condition which can arise, and for every minute step of its program. This usually requires a co-operative study by the user whose process is to be controlled and the computer control system manufacturer.

The work of planning a computer control system can be thought of as dividing itself into four phases.

a) Feasibility and Definition of the Problem

How much of the process should the computer control? What area of the total plant constitutes a "logical package" for delegation to one computer. What additional functions can be added with little extra cost or complexity? What functions must be avoided or handled by other means in order to keep the application practical? How should the implementation phase be planned and scheduled? Providing the answers to these and other similar questions, constitutes the feasibility and problem definition phase.

b) Implementation and System Engineering

This involves the detailed study of the process, the construction of a satisfactory mathematical model and the definition of the optimizing criterion by which the process can be operated better through computer control than by manual control. Both analog and off-line digital computing equipment may be required in this phase for development and testing of the mathematical model and optimizing criterion. In fact a basic decision is often involved as to how far to go with off-line computations before an on-line process control computer becomes necessary. Data logging may be necessary as an interim step in order to acquire process knowledge. Terms such as computer simulation, mathematical modeling, operations research, regression analysis, linear programming, adaptive systems and system engineering creep into the vocabulary at this phase.

c) Component Design and Manufacture

This includes the actual design and manufacture of all hardware and preparation of the computer programs. Although the computer manufacturer is able to standardize the central computer fairly well, there is usually much detail concerning the control input and output portions that is peculiar to the application at hand.

d) Installation, Start-up and Evaluation

This involves the final check out of the entire system including the computer program and its gradual connection to the system. Worthy of special mention is the provision for introducing future changes or improvements as process changes are made or new concepts become available.

Throughout all phases there is a marked need for the total systems approach and close coordination of all the project elements of process knowledge, instrumentation, control details, regulating system design, mathematical and statistical analysis and computing techniques. There must be a continuous evaluation of the incremental cost and complexity of each system goal.

Project Team

The need for a project team of skilled personnel working with a minimum of conflicting interests and organization ties is obvious. Usually this results in the formation of a joint

project team between the process owner and the computer control systems manufacturer. While no general rules can be made to fit all applications, the importance of the personnel calibre chosen for the team should not be under estimated. The situation can be likened to that of commissioning a composer and orchestra to compose and record a new work of major proportion. The range of the results which may be produced in this instance is tremendous and can vary from trivial and worthless to a magnificent work of real stature. The computer control system planned is an integral part of the customer's plant and its operation and the range of returns is analogous to the above situation.

Benefits

Just why is this activity being so closely watched? What benefits are expected from the application?

Again just as no single application is likely to require all the abilities of a computer control system, no single application is likely to embrace all possible benefits, but the following rank high among those generally discussed: improved efficiency; increase in potential output; more consistent or quality product; reduction of errors or catastrophes; reduced operating personnel; reduction of cost per unit; generation of production control and accounting data; calculation and display of production incentives; reduced plant start up time; reduced inventory (through flexibility and ability to handle smaller batch orders).

Conclusion

The computer control concept has opened an exciting new avenue of improvement by which the industrial process engineer can help minimize production costs. The question before industry is not whether to go ahead or not, but to determine how fast to proceed.

The process control computer has a virtually instantaneous ability to diagnose system operation and to dispatch corrective action. Its speed, reliability, and memory capacity allow it to overcome the natural limitations of human operators. The introduction of the industrial process computer can be truly regarded as a significant step forward in this rapidly changing age.

The sudden and often dramatic application of digital computers to engineering and business data processing problems is often referred to as the second industrial revolution. Many process control applications will prove just as dramatic, but "evolution" may be a better word than revolution because it appears that it will be a more gradual process. Although those who are fortunate enough to do so are pressing rapidly ahead, it will take considerable time in many industries to fully apply this new tool, however beneficial it may be. This time will be necessary in order to bridge the gulf between the customer who has the process knowledge and the computer control systems manufacturer who is intimate with the control and computer techniques.

Acknowledgment

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25. J. M. Tucker Jr. — **Evaluation of Computer Installation.** Proceeding 17th annual engineering conference, TAPPI & CPPA, Montreal, Oct. 15-18, 1962.
26. S. S. Levers — **Taking the Art out of Papermaking.** Control Engineering, Dec., 1961. A brief description of the IBM — Potlach Forests and G. E. — Southern Land Paper Company orders for computer control in the pulp & paper industry.
27. C. C. Collins — **Factors to be Considered in Planning for Computer Applications** — Proceedings, 17th Engineering Conference, TAPPI and CPPA, Montreal Oct. 15-18, 1962. Emphasizes the need for total systems planning in applying computer control and indicates potential savings in pulp and paper applications.
28. L. I. Dickinson — **Computers Utilities and Fuel Dispatching** — Iron & Steel Engineer, Oct., 1962. Describes GE312 control computer installation at Bethlehem, Lackawanna, N.Y. steel plant.
29. L. Casciato — **The Control of Traffic Signals with an Electronic Computer** — International Federation for Information Processing (IFIP) Congress, Munich, 1962. Describes system being installed in Metropolitan Toronto.

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Discussion

TAILRACE IMPROVEMENTS AT THE BEAUMONT HYDRO-ELECTRIC DEVELOPMENT

C. G. Smallridge, M.E.I.C.,
Hydraulic Engineer
Shawinigan Engineering Co. Ltd.,
Montreal

The Engineering Journal,
October, 1962, page 35

Discussion by T. R. Anand, M.E.I.C., Engineer, Shawinigan Water and Power Company, Montreal (formerly of Shawinigan Engineering where he was associated with the Beaumont development)

The use of the correct value of Manning's "n" has an important bearing on quantities of excavation and anticipated losses in head. Preliminary studies indicated that the roughness coefficient of the natural channel would be 0.036, and backwater-curves for this value were developed for natural conditions. The resulting profiles were inconsistent with gauge readings and a series of backwater-curves with various values of "n" was investigated. A coefficient of 0.055 ultimately was chosen for natural conditions and 0.045 adopted as a first approach in the case of the excavated channel.

As far as the bend, the western bank of the river is mostly solid rock which dips under the river-bed to the east bank and, in this reach, the river is much narrower than is the case downstream where the cross-section is wider and shallower. The tailrace channel was designed to fit these conditions. The lower 8,500 ft. is 175 ft. wide, with shallow side slopes and with a bed level higher than in sections which are farther upstream and which are 50 ft. narrower with more abrupt side slopes. The two lengths are joined by a reverse slope, so that the channel bed rises 3½ ft. between sections 16 and 15A. These dimensions were developed in such a way that the channel would have the same carrying capacity throughout (as measured by the values of $AR^{2/3}$ indicated in Table No. I) and with a water surface profile which would show no dip. This particular design feature eliminated expensive rock excavation of the banks and bed of the river, thus effecting substantial savings.

Original plans were to extend the excavation up to section "O" but, in deriving anticipated water-levels, it was found that the backwater-curves tended to converge at the dam site, even though starting elevations at section "O" varied by a foot or so. This peculiarity was taken advantage of to save excavation by shifting the end of the channel upstream, and the final length was reduced by nearly 1,500 ft. by eliminating excavation between sections "O" and 2A.

Discussed in this issue
Smallridge's paper
"TAILRACE IMPROV
AT THE BEAUMONT
ELECTRIC DEVELOPM

Following the above
cussions on the pa
"ECONOMICS OF H
WATER REACTORS",
Dickinson, and "PRO
POWER DISTRIBUTIC
R. E. Jones

Another feature of the utilization of excavated materia both sides of the new channel these restricted river-width, h ditions actually were improve ating flows over shallow po considerable saving in haulin effected. The dike originally w

FIGURE I.

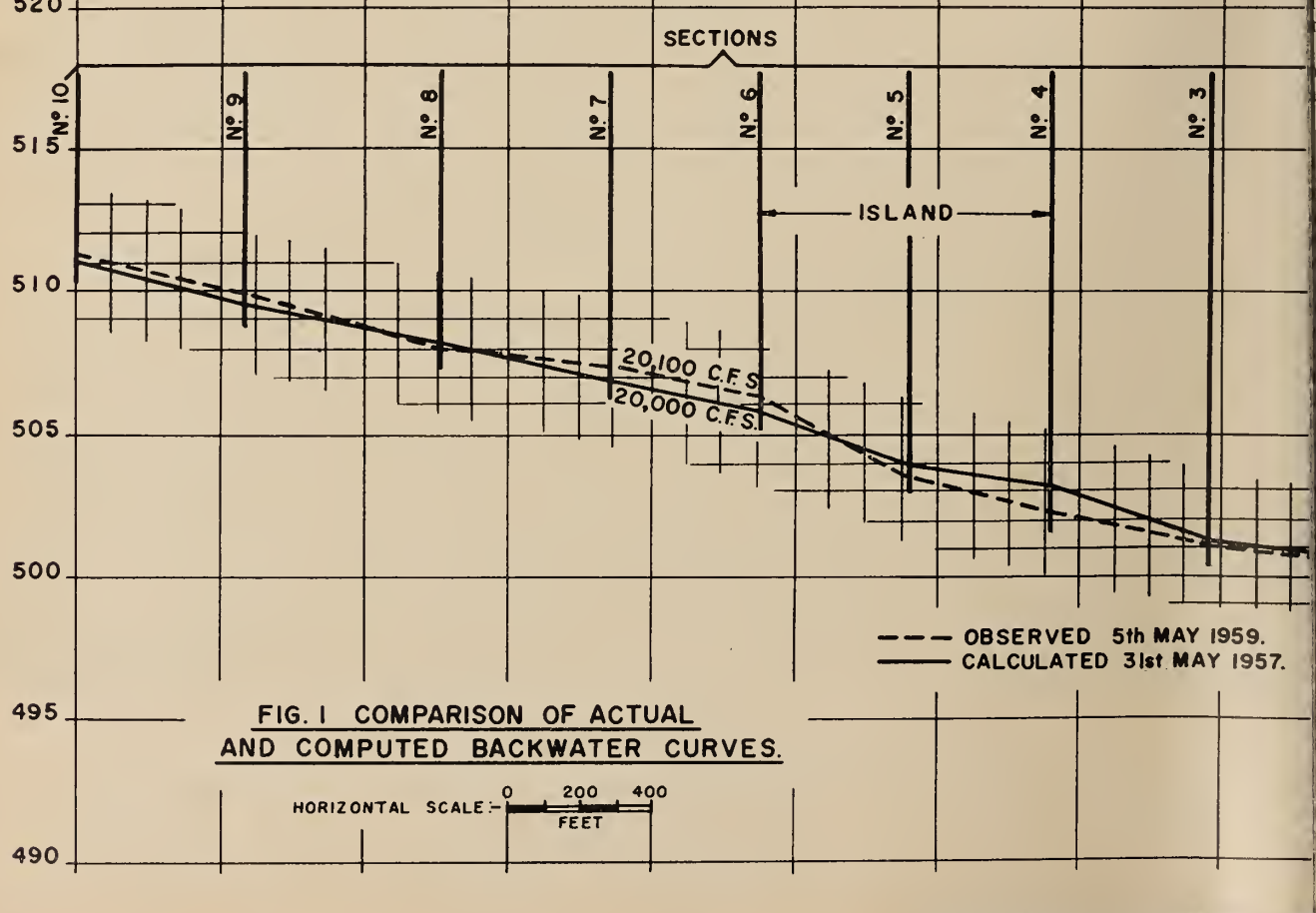


FIG. I COMPARISON OF ACTUAL AND COMPUTED BACKWATER CURVES.

the nature of the material
: used almost immediately

ease in head was 17.6 ft.
5 ft. which had been de-
: excavation was extended
the designed limits. This
: excavated quantities were
than had been provided.
ted that no serious erosion
ed during the spring flood
at the channel appears to
A comparison of water-
during this flood and those
dicted would be interesting.
ig. 1) conducted in May,
vo years after the design
n completed, confirmed the
surface profile for a flow
, thus supporting the as-
045 as a suitable value of
Mr. Smallridge has men-
effective value of "n" for
hannel is 0.041, and it is
a detailed derivation of this
most interesting.

J. A. Randle, M.E.I.C.
H. S. Watson, M.E.I.C.
J. L. Gordon, M.E.I.C.

ile Figure 6

refers to the fact that ex-
stream of Section 2A was
ice no advantage, and hence
rom the excavation schedule.
: the excavated tailrace to be
low river bottom at Section
appreciate knowing how the
made back to river bottom
Section 2A.
scale would help to clarify
Fig. 6, also the plotting of
25,000 c.f.s. river profile
one to compare the theoreti-
with the actual performance

dge states that the most ap-
iction in tailwater level oc-
he excavation of the channel
B and 22. However Fig. 6
rm water surface profile be-
s 22 and 10, steepening be-
A. Hence, there appears to
itradiction between text and
s a few words of explanation
clarify this point.

states that a 50% recovery
ad was assumed. What was the
eddy loss, if any, which was
elerating flow conditions.
udies such as that by J. S.
Panama Canal Zone engineer-
on "Hydraulic Roughness Co-
Large Channels", have indi-
e Manning roughness decreases
ng flow. Was this phenomenon
count in calculations to deter-
ess in the natural channel, or
ecks of the excavated channel?
e assumed "n" of 0.045 (and
sulting "n" of 0.041) is some-
than might be expected for
nk-full condition. The author's
n the possibility of oversize
naining in the channel causing
ghness would be appreciated.
rom Fig. 11 that the actual in-
ead recovery was 1.5 ft. (at
) greater than the theoretical
ould the author care to indicate
h the turbine units were lowered
anufacturer's recommended set-
cipation of such an occurrence.
all units lowered, or only one
ce submergence of the turbines
ase as discharge decreased.

Economic Studies

We assume that, particularly after the commissioning of the Tracy Steam plant, peak capacity without additional energy production will have a value on the Shawinigan System and that the calculation of a unit cost of capacity is a proper basis for justification. However, no comparison with alternative costs is given. We would have liked to see a graph of incremental cost per kw. gained against total gain in capacity at Beaumont due to tailrace excavation, and similar graphs for other alternative sources on the system. There is no indication in the paper that other tailrace excavations were tried to determine optimum benefits. Similarly, the quoted "incremental cost of $42/hp." appears to be the average cost of the total gain of 48,000 kw. Could the author state the cost of the last 1,000 kw. Certain specific queries concerning other costs which may or may not be included also come to mind and clarification would be appreciated:

(a) Was the added cost of powerhouse excavation and substructure concrete required by the lower turbine setting taken into account?

(b) Was the cost of heavier transmission, or alternatively a higher transmission loss, taken into account?

(c) Since the turbine flow has apparently been increased by the root of the head some pondage is likely required, both at Beaumont and at La Tuque. What range of water level is required, and what allowance was made in design and in economic calculations for this?

Discussion by
John C. Godsland, M.E.I.C.
Manager of Projects,
Shawinigan Engineering Co. Ltd.

In retrospect, it is difficult to imagine that the excavation of 2½ miles of the tailrace at Beaumont could have been successfully completed by any other means than that actually employed—a 14 cu. yd. Walking Dragline. Judged by more conventional construction equipment, this mammoth machine with a cab the size of a suburban domestic dwelling and a boom which enabled the 12-ton bucket to be dropped 200 ft. from the operator, appeared to be too unwieldy to tackle anything more than the excavation of a very large and deep hole without any regard to accuracy. In fact, this machine—operated by Shawinigan Engineering Company operators previously employed on 1½ and 3 cu. yd. shovels—completed a dredging and banking job on the St. Maurice River involving the handling of 2½ million yards of gravel, boulders, sand, and silt, some of which was actually loaded into Euclid trucks for disposal "off site".

The secret of the success of this operation was undoubtedly the excellent teamwork of the personnel involved. The team consisted basically of a foreman, a dragline operator, and a bulldozer operator, with a mechanic and oiler in full-time attendance on the dragline. As mentioned in the paper, the machine was assembled about two miles downstream of the powerhouse, so the only excavation done by the machine on its way upstream to the tailrace cofferdam was to provide sufficient material to form an embankment upon which it could travel. Completion of the dredged channel and formation and trimming of the finished embankment was done by the machine on its way downstream, with about half of the new channel width being completed from each side of the river. In this way the fines and silt disturbed during excavation were carried by the river flow away from the newly completed excavation.

Control of depth of excavation was maintained in two ways: firstly, by a marker reset each shift on the hoist line which enabled the operator to "plumb" the depth of excavation below the river profile, and secondly, by our field engineering staff using an "Echo-sounder" set up in a boat by which means complete cross sections of the channel were obtained before the machine moved out of the immediate vicinity. Naturally, the establishment of the output per shift became the number one problem once the operation was under way, and a ratchet type automatic counter was fixed on the machine to record each bucket of excavation deposited on the embankment. By trial and error a capacity per bucket was established from the finished calculated quantities taken each week. The output throughout the entire job averaged 5,345 cu. yd. per working day. Work progressed on the basis of three eight-hour shifts per day, seven days per week, with the machine being stopped for routine maintenance each Saturday for four hours. Greasing and inspection of bucket, bucket teeth, chains, etc., was done at the half-hour meal breaks.

The biggest running maintenance items were repairs to buckets, bucket chains, and teeth, and the replacement of the 2¼-inch diameter drag cables (each of the latter costing $800). In spite of reversing the drag cables as soon as wear became apparent near the bucket, the life of the cables ranged from two days to 21 days. It is only fair to say that the very short life was due almost entirely to dredging operations where boulders were present so that the operator was unknowingly winding-in the cable over the tops of large boulders and rack with subsequent disastrous effects on the underside of the cable.

Much of the excavation was done using 10 cu. yd. heavy duty rock buckets since it was found that these were less inclined to tumble in fast water and produced less wear on the hoist cable due to the favorable location of the centre of gravity. Much of the work was carried out during winter with temperatures down to 30 degrees below zero, and the subsequent coating of ice on ropes, sheaves, chains, and bucket made preventive maintenance and repairs very difficult. The large external mechanism which operated the "walking" action characterising this type of dragline had to be heated constantly during below zero temperatures to prevent cracking of the cast iron cams.

The Cooper-Bessemer eight-cylinder diesel motor in the dragline had a sump oil capacity of 250 gallons and used an average of 17.6 gallons of diesel fuel oil per hour. Controls from the operator's cab were electro-pneumatically operated and reduced operator fatigue to a minimum. During the course of the project, the machine "walked" a distance of 11 miles—rather in the fashion of an elderly duck moving tail first in very heavy mud Notwithstanding the uncomplimentary remarks of visitors viewing this performance for the first time, the "old lady" amply justified the faith placed in her capabilities by those in the company who decided to purchase her for this project.

Discussion by Simon Ince, M.E.I.C.
Hydraulics Laboratory,
National Research Council, Ottawa

Three important points emerge from Mr. Smallridge's account.

1. Relationship between design office and hydraulic laboratory.

Close co-operation and discussion between laboratory and design office, in the early stages of the planning, will outline the limitations under which each group will be

working. Very often the design engineer will be under the impression that all questions can be answered by the model. The laboratory engineer, confronted with difficult and stubborn flow problems, will wonder why the design office has not adopted a simpler layout. This project was a good example of close co-operation. From the beginning, the laboratory personnel were aware that for very practical (economic, etc.) reasons major bend cut-offs could not be undertaken. The design office knew the limitations of the model and that certain problems could be tackled better mathematically.

2. Philosophy of Model Testing.

A distorted river model, as an analog computer, has very definite limitations. For example, it cannot be used to verify accurately the drop in tailwater elevation where the excavations are so large that the hydraulic characteristics are drastically changed along the entire reach under investigations as at Beaumont. In such a case it is not known what artificial roughness to use in the model. Moreover, the roughness satisfying one flow condition (25,000 c.f.s. prototype) will not satisfy a much smaller or much larger flow. Under these circumstances a straightforward calculation, based on a reasonable value of Manning's "n", will give more consistent results.

As stated by Mr. Smallridge, the principal object of the tests was to determine the excavation method which would ensure the greatest lowering of the tailwater from the time the first unit came into operation, without encountering excavation difficulties due to local hydraulic conditions. This was a problem for which the model was invaluable. Once it was verified for the natural and the final excavated conditions, it was used to predict the effects of local changes and evaluate the hydraulic advantages of the various excavation schemes.

It can be generalized that the main value of the model is for rapidly varied flow (acceleration predominant) with irregular boundaries, provided that the distorition is not too great. In gradually varied flow (friction predominant) machine computation is preferable.

For evaluating the operation of the dragline in a current, mathematical analysis was the easiest and most effective approach.

One point in Mr. Smallridge's paper needs clarification. Although a close reproduction of prototype velocity distribution is desirable in the model, it is very difficult and laborious to achieve this at all sections. On the Beaumont model, this was done only at one section to check that, as a first approximation, the velocity distribution in the model was representative of the prototype conditions.

3. Model-Prototype Conformity.

It is gratifying that many of the results of the model tests and mathematical analysis were closely checked by field observations. Shawinigan Engineering Company and Mr. Smallridge are to be complimented for making these measurements and bringing them to our attention. Very often the laboratory engineer does not know to what extent his prognostications have been vindicated and feels left out after the model tests are completed. Comparison between model and prototype results is invaluable in increasing our knowledge and limits of confidence in extrapolating laboratory data to prototype conditions. It is hoped that this will become an established practice.

Author's Reply

The author is grateful to the discussers for their comments which add considerably to the value of the paper. The comments by Mr. Godland and Dr. Ince both emphasize that teamwork and careful planning were the essence of success in this unusual undertaking. Dr. Ince's comments are also valuable in that they point out the advantages of hydraulic models in evaluating construction techniques in addition to solving design problems.

The points raised by Messrs. Randle, Watson and Gordon on the tailrace design are dealt with in order below.

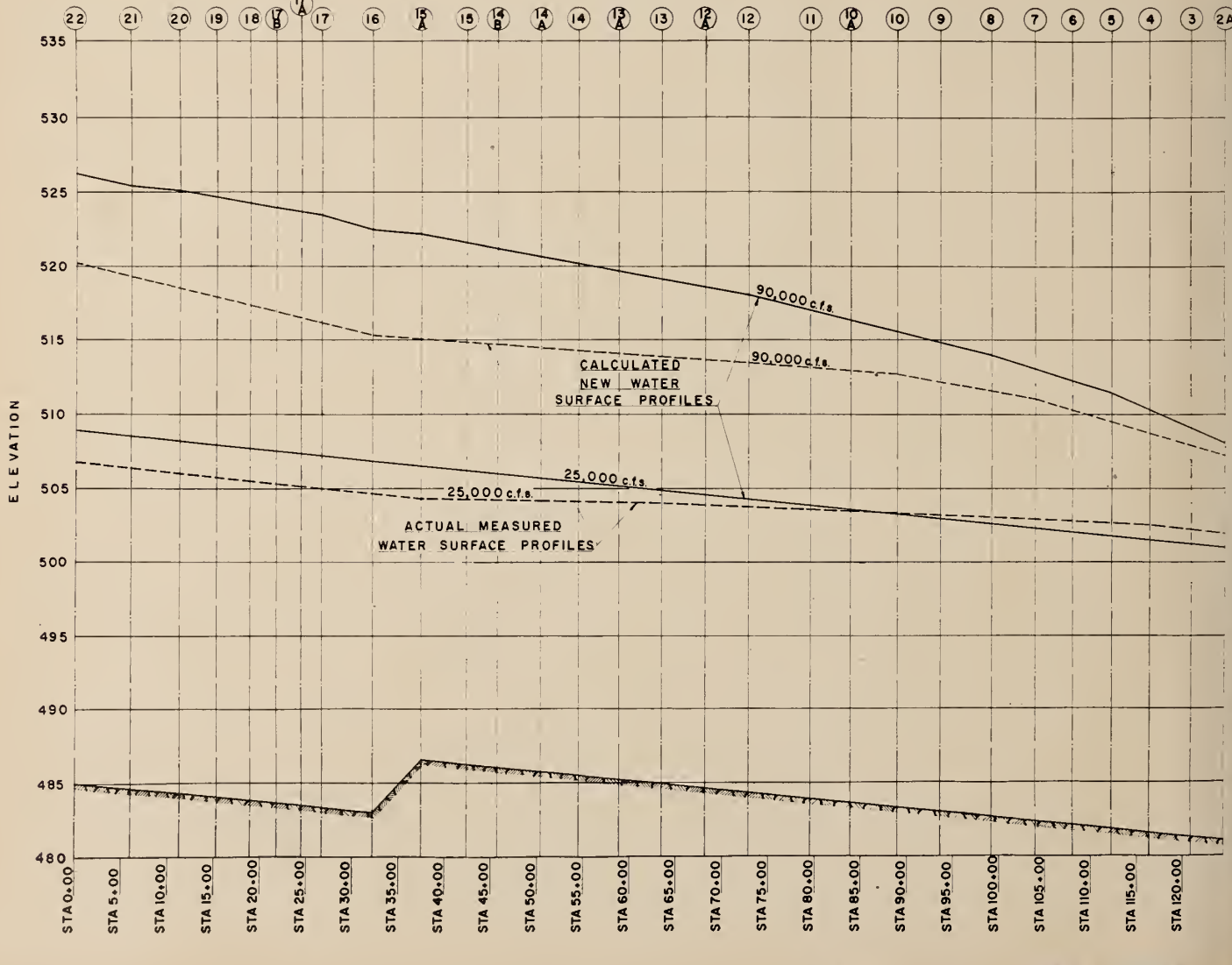
The transition back to the natural riverbed downstream of section 2A consisted of a simple upward slope with an average grade of 1 to 10. This was excavated from the east bank.

Figure 2 shows calculated and measured river profiles for flows of 25,000 c.f.s. and 90,000 c.f.s., the latter measured during the spring flood of 1960. The effect of the additional excavation downstream of section 16 and the bypass at section 5 is clearly indicated by the flatter slope of the water surface between section 16 and section 4.

The statement in the paper "that the most appreciable reduction in tail water level occurred with the excavation of the channel between section 17B and 22" referred to the effect of the initial excavation before the on-power site date of the first unit. While initial excavation at points further downstream might have produced a greater lowering of water level locally, the effect at section 22 was less due to convergence of the backwaters.

In accelerating flow, the velocity hea coefficient used was 100% and all losse

FIGURE II.



ere included in the effective values of the Manning "n". In part, this accounts for ne somewhat high effective "n" value of 041 obtained for the channel. This value as determined from the final profile using he enlarged sections of channel as excavated and averaging the "n" value for a umber of reaches. Calculations to determine the natural roughness of the original iver channel were carried out for flows etween 20,000 and 25,000 c.f.s. and for this imited range, there was no variation in Manning "n" with flow. Checks on channel oughness at 25,000 c.f.s. and 90,000 c.f.s. or the excavated channel also show a contant Manning "n". In view of the size of he dragline bucket compared to the maximum boulder size, it is considered unlikely hat oversize boulders remain in the channel o cause an unduly high channel roughness.

The turbine setting was determined for flow of 4,300 c.f.s. with excavated conditions. The differences between predicted nd actual tail water levels at this flow was pproximately 6 in. which was acceptable to he turbine manufacturer.

No comparison with alternative costs was given in the paper since the overall tailrace excavation was unquestionably economic. The incremental cost of capacity rom excavation in the Beaumont tailrace was considerably below the cost of incremental capacity from any other source on a Shawinigan system. As deduced by the writers, the incremental cost of $42 per hp. is the average cost of the total gain of 48,000 kw. The author has not calculated the cost of the last 1,000 kw. but it is less than the average cost for the total gain in head due to the fixed charges associated with the dragline operation which would be incurred regardless of the quantity of excavation.

Significant channel enlargement beyond that actually carried out, however, would have involved uneconomic rock excavation upstream of section 16 and, as can be seen from the measured profile for 25,000 c.f.s. in Fig. 2, little gain in head was possible from excavation downstream of section 16 due to the flat water surface slope. Also since the dragline was excavated close to the limit of its reach below section 16, further excavation would have required considerable rehandling of material.

The cost per kw. does not include the difference in cost of the powerhouse due to the lower turbine setting or the cost of heavier transmission. Both of these items were considered but neither is significant in this plant since it was necessary to lower the draft tubes in any event to reach bedrock and the transmission line capacity was amply sized for the increased output based on system considerations.

The Beaumont plant operates essentially as a run-of-river plant and the full load flow matches the La Tuque flow reasonably closely. The pondage at La Tuque is ample to take care of any temporary differences in powerhouse flows.

Turning to the general question of heavy-water reactors, we may assume that the technical superiority of heavy water as a moderator for large reactors is evident; but the cost per pound is often considered prohibitive. Here it seems to me that we should recall the saying, "you get what you pay for". Have you not bought the expansive brand, against the advice of your friends who know where they can get "something just as good for half the price"? As time passed you watched these friends having trouble and frustration. Eventually perhaps they began to express an interest in your choice. This is Canada's position with regard to heavy water. Nowadays one encounters regularly in the technical press statements to the effect that the Canadian heavy-water reactor system is receiving serious consideration in some countries in preference to their own systems. A possible price of $17/lb. instead of the present $28/lb. of heavy water would be a further incentive. There is not, of course, a single answer for all situations and the high capital, low fuel cost heavy-water reactors are most promising where the annual charge for capital is low.

To the reactor concepts in other countries mentioned by Mr. Dickinson we might add the CANDU cost estimate made recently for India, the steam generating heavy-water reactor being thoroughly studied by the U.K.A.E.A., and several studies in the U.S.A.

A number of prototype reactors are under construction and these are listed in the Table.

ECONOMICS OF HEAVY WATER REACTORS

J. R. Dickinson,
Civilian Atomic Power Department,
Canadian General Electric Company,
Peterborough, Ont.
The Engineering Journal,
October, 1962, page 41
Discussion by Dr. D. G. Hurst

The author lists three coolant systems for heavy-water reactors that are comparable in net cost per kilowatt-hour. Recently a fourth has been added to the competition. This is boiling light water with 10 to 15% exit quality. Like the fog cooling, the steam will be used directly in the turbine. The simplification and higher efficiency made possible by the direct cycle may more than offset the loss of neutrons to the water. A number of items enter into the balance. The reduced pressure for a given steam temperature (relative to the pressurized heavy-water coolant) permits a thinner pressure tube and therefore fewer neutrons captured. It is too early to give detailed costs.

As regards the estimating of power costs, higher station outputs must be considered. Evidence for this is to be seen in Table 5 where unit costs for a coal-fired plant in Ontario are listed. This table refers to 300 Mw. units in a multiple unit plant, whereas the nuclear plants of Tables 2, 3 and 4 are 200 Mw. nuclear stations of 1000 to 2000 to 750 Mw. should be compared with Mw. output with individual units of 500 corresponding fossil-fuelled stations, e.g., Ontario Hydro's 1800 Mw. Lakeview. Unit capital costs decrease with increasing size and this favors the high capital, low fuel cost nuclear stations.

Author's Reply

Dr. Hurst has provided interesting additional information supplementing that contained in the paper.

AECL's recent interest in a boiling light water coolant stems from the potential for substantial economic advantage to be gained from an increase in plant thermal efficiency. The advantage comes more from a reduction in the dollars kilowatt of capital cost than from a reduction in the mills per kilowatt-hour of fueling cost.

There is no doubt that nuclear power plants will be built in very large unit sizes in the future. In this respect the heavy water cooled CANDU reactor has the advantage of being demonstrated as a feasible design for, say, a 500 Mw. unit. The other types of heavy water reactors have yet to be demonstrated in more modest ratings before such very large unit sizes can be seriously considered.

The list of heavy water power reactors under construction is only a conservative indication of the present world-wide interest in the heavy water concepts. The list omits mention of the boiling heavy water reactor at Halden, Norway, which has been in operation for more than a year. As the NPD plant at Rolphton, Ont., has successfully come into operation we have seen a substantial increase in world wide interest in our Canadian program.

(Continued on page 80)

HEAVY-WATER POWER REACTORS UNDER CONSTRUCTION
(*non-Canadian*)

Country	*Name*	*Type*	*Fuel*	*Cooling*	*Output Mw(e)*	*Date of Criticality*
Czechoslovakia.....	KS-150	Pressure Vessel	Natural Uranium	CO_2	150	1965
France.....	EL-4	Pressure Tube	Natural Uranium	CO_2	84	1964
West Germany.....	MZFR	Pressure Vessel	Natural Uranium	D_2O	50	1965
U.S.A.....	CVTR	Pressure Tube	Slightly enriched uranium	D_2O	17	1962
Sweden.....	Agesta	Pressure Vessel	Natural Uranium	D_2O	10	1962
(design stage).....	R-4	Pressure Vessel	Natural Uranium	D_2O	100	1967

E.I.C. News

R.I. & C.C. MEETINGS HIGHLY SUCCESSFUL

At its meeting of September 7, 1962, Council decided to give a two-year trial to a regional system of organization of Institute activities. The hoped-for result would be an improved two-way flow of information between Branches, Councillors, national officers, and Headquarters. The results to date have far exceeded expectations.

Regional Information and Co-ordination Centre meetings were held October 27 in Regina for Regions I and II; in Port Arthur on December 8 for Region III; in Toronto January 12 for Region IV; in Sherbrooke January 14 for Region VII; in Ottawa on January 18 for Region V; in Vancouver February 9 for Region 1; and in Yorkton February 16 for Region II.

Meetings are planned for Region IX in Moncton on April 26, and for Region X at Corner Brook on April 23.

The R.I. & C.C. for each region consists of the Councillors and Branch Chairmen of the region, the Vice-President responsible for the region, and the First and Second Vice-Chairmen elected from among the Councillors of the region. Provision is made for alternate delegates.

A detailed agenda is prepared through the efforts of the appropriate Vice-President, the General Secretary and other interested parties. E.I.C. Standing Committees are invited to contribute to the discussion by providing information regarding their present and proposed activities.

It is expected that the President will attend R.I. & C.C. meetings when feasible, and the General Secretary or his delegate will attend all meetings.

The basic function of these meetings is the communication, to the maximum possible extent of ideas, suggestions, recommendations, questions and grievances from Branch Executive Committees to Council and of the philosophy, planning and decision of Council and of its Executive Committee.

Shown are delegates to a highly-successful R.I. & C.C. meeting held January 18 in Ottawa. Clockwise, from the bottom: President F. L. Lawton; J. S. Waddington, Brockville, Vice-President Region V; T. C. Willcox, Peterborough Branch Executive Committee; J. S. Watt, Councillor, Ottawa; L. A. Capelle, Councillor, Ottawa; J. L. Miller, Kingston Branch Chairman; B. O. Baker, Ottawa, representing the Publications Committee; F. E. Ayres, Chairman, Ottawa Branch; K. H. Barbard, Chairman, Cornwall Branch; D. B. Ashender, Chairman, Brockville Branch; A. B. Connelly, Past Chairman, Ottawa Branch; D. A. Lamont, Councillor, Peterborough; Garnet T. Page, General Secretary.

COMING EVENTS

American Society of Civil Engineers. Environmental Engineering Conference. Atlanta, Ga. Feb. 25-Mar. 1.

Society of Plastics Engineers. 19th Annual Technical Conference. Los Angeles. Feb. 26-Mar. 1.

American Society of Mechanical Engineers. Aviation and Space, Hydraulic, Gas Turbine Power. Joint Conference. Los Angeles. Mar. 3-7.

American Concrete Institute. 59th Annual Convention. Atlanta, Ga. Mar. 4-7.

Institute of Aerospace Sciences. Flight Propulsion Meeting. Cleveland. Mar. 7-8.

American Institute of Chemical Engineers. Second Petrochemical and Refining Exposition. New Orleans. Mar. 10-13.

Second International Congress on Metallic Corrosion in conjunction with the 19th Annual Conference of the National Association of Corrosion Engineers. New York City. Mar. 11-15.

Instrument Society of America. 13th Spring Iron and Steel Instrumentation Conference. Pittsburg, Pa. Mar. 13-14.

British Nuclear Energy Society. Symposium on the Advanced Gas-Cooled Reactor. London, England. Mar. 14-15.

Chemical Institute of Canada. Protective Coatings Division. Divisional Conference. Toronto, Ont., Mar. 21; Montreal, Mar. 22.

Southern Ontario Regional Conference. Park Plaza Hotel, Toronto. Mar. 23.

American Chemical Society. 144th National Meeting. Los Angeles. Mar. 31-April 5.

American Institute of Industrial Engineers. Southern Ontario Chapter. Seminar "New Product Development". Royal York Hotel. March 29.

Engineering Institute of Canada. 77th Annual Meeting. Chateau Frontenac, Quebec City. May 22-24.

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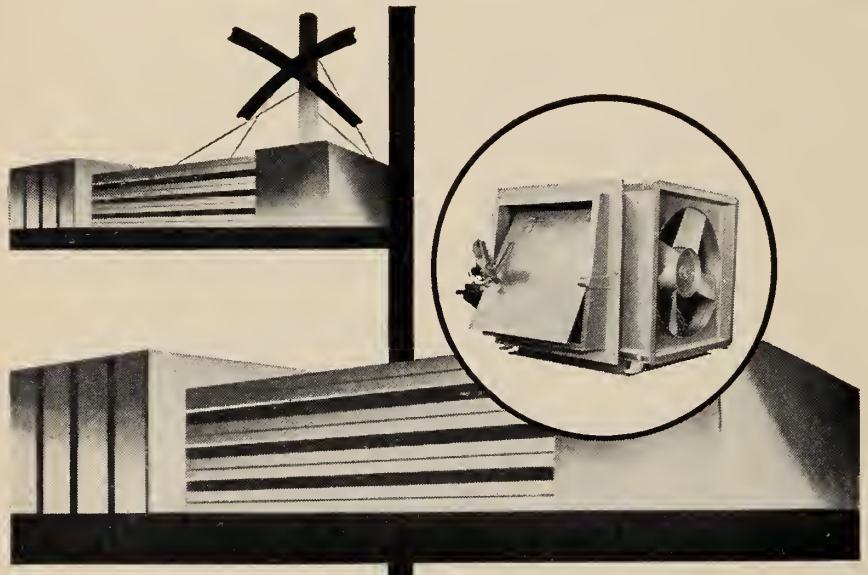

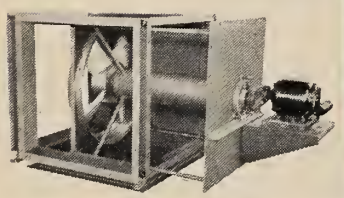

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ABSTRACTS

Transactions of the E.I.C.

EIC-63-BR&STR 5

"Variations of Snow Loads on Roofs"
W. A. Dalgliesh, W. R. Schriever and B. G. W. Peter

Because the snow load is usually the critical load for which roofs in Canada must be designed, the assumed magnitude and distribution of the design snow load have a considerable effect on the safety and the cost of the structure. The treatment of this load in building codes is compared in the paper with the actual snow loads found on buildings with particular attention given to the effect of the wind and the shape of the structure as well as climate variations across Canada. An extensive country-wide survey of actual snow loads on roofs and on the ground being conducted by the Division of Building Research of the National Research Council is described, and future improved approaches to the specification of snow loads are indicated.

EIC-63-CIV 5

"The Mechanism of the So-Called Shear Failure"
G. J. Kani

The practical aspects of the problem in question are (a) when is it necessary to concrete beam to prevent a so-called shear use additional reinforcement in a reinforced failure, (b) where to place this reinforcement, (c) what kind of reinforcement to use. The answers to these questions may be found only by investigating and understanding the internal mechanism of the so-called shear failure.

EIC-63-MECH 2

"Aspects of the Aeroelastic Behaviour of Bluff Cylinders"
G. V. Parkinson

Under certain conditions, elastically supported bluff cylinders will exhibit oscillations of considerable amplitude in a steady transverse wind. In the paper, some existing aerodynamic theories of these oscillations, and available experimental evidence are examined. The theories relate the oscillations to the influence of the separated wake from the cylinders indifferent ways, either as a resonance phenomenon between the elastic system and the wake considered to be organized as a Karman vortex street of regular frequency, as a response of the elastic system to random excitation from a turbulent wake, with no dominant frequency, or by assuming a quasi-steady model, using the stationary flow pattern about the cylinder as a function of attitude to the wind in dynamical equations. Since the amplitudes of oscillation, as well as the tendency to oscillate are of interest, the possibilities of using non-linear dynamical equations in the above theories are considered. In the existing theories of the oscillations, the aerodynamics if purely experimental. The effect of the sectional shape of the cylinder in relation to the separated wake is discussed.

EIC-63-MECH 16

"Absolute Measures of Work Mangement, RCAF Aircraft Maintenance"
A. B. Howell

A common problem in the RCAF and in industry is the defining of standards of work management and performance. Because of the difficulty of fixing absolute standards, judgements are usually based on degrees of conformity with arbitrary definitions accepted as reasonable. Management by exception is based on such definitions. But a standard fixed on comparative or arbitrary grounds contains the uncertainty that while it may be acceptable for the demonstrated circumstances, it may not be an absolute and universal best. If standards are uncertain then judgements based on them are uncertain. Attempts will be made to develop absolute standards of management and performance in two major categories of work in field maintenance of aircraft. These categories of work are common ones in industry.

Division Papers of the E.I.C.

EIC-63-BR&STR 6

"The Structural Design of the Place Ville Marie Project"
J. E. Brett, R. P. Ouellette and P. R. Nicolet

Described are the main features of the structural analysis and design carried out for the Place Ville Marie project in downtown Montreal. Special emphasis is given to the design of the Royal Bank of Canada Building. The architectural features of this building, the cruciform shape and a height in excess of 600 feet, necessitated the use of unusually complex methods of investigation. The paper describes the extensive use made of an IBM 704 computer to solve the complex of problems arising from various combinations of live and dead load, wind and earthquake loads and from stability considerations. Extensive application of the composite method of construction was made possible by the layout of the framing. The main features of the structural systems of the parking floors below street level, the Quadrant Buildings and the Cathcart Building are outlined. The presence of the Canadian National Railways tracks necessitated careful insulation of the various buildings against vibrations.

EIC-63-BR&STR 3

"Materials Handling Suspension Bridges"
T. Lamb and R. N. McManus

The problem of handling petroleum and natural gas products, granular and liquid materials across rivers, gorges and other difficult terrain often requires long span structures for its economic solution. Topography, foundation conditions, scour and ice hazards in rivers, together with other general considerations often indicate the suspension type of structure as the most suitable. While consideration has been given in Canada to suspension bridges for aggregate and earth fill handling, it is thought that in Western Canada the pipeline suspension bridges carrying natural gas, oil and liquid sulphur are the only ones in use at present. These structures vary in clear span from 600 feet across the Bow River near Calgary, to 1,670 feet across the Peace River at Taylor Flats, B.C.

EIC-63-CIV 4

"Drilled, Cast-in-Place Piles and Caissons in Western Canada"
B. B. Torchinsky

This paper deals with developments during the past 10 years in the use of cast-in-place concrete piles and caissons in Western Canada. A description of the soil types in which such foundation units are most readily installed and some aspects of design criteria will be presented. The author will also discuss some of the problems encountered in construction and some special techniques used to cope with these problems.

EIC-63-GEOTECH 3

"The Tilting of a Blast Furnace Foundation"
Nyal E. Wilson and A. H. Atkinson

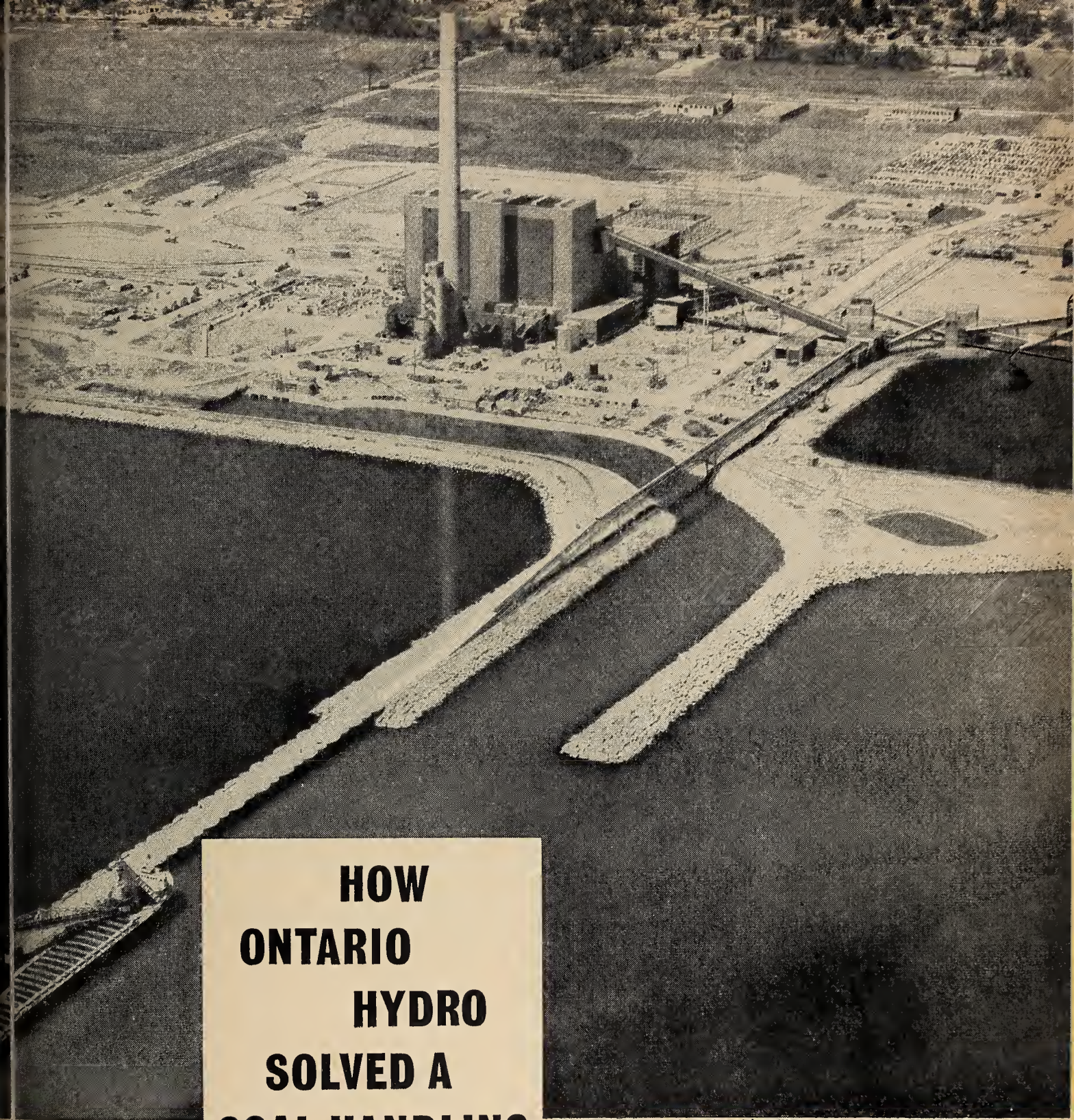
This paper describes the remedial measures taken to stabilize a large blast furnace foundation which started to tilt during construction. The foundation slab, 66 feet in diameter and six feet thick, was supported by 250 twelve-inch closed-end pipe piles; the piles were driven through 70 feet of soft clay and silt to refusal in a 100 foot layer of hard pan. The pile-driving took 10 days and the foundation slab, containing more than 1,000 cubic yards of concrete, was poured two months later. A few days after the foundation slab was poured, the excavation, 24 feet deep and 50 feet long, was made adjacent to the blast furnace foundation. Within two weeks the entire slab, which now weighed 2,500 tons, moved four inches horizontally.

EIC-63-MGMT 3

"Operation of the Belleville Transit System"
S. Sillitoe

Almost without exception, municipal transit systems in Canadian cities of all sizes find themselves in the position of requiring a subsidy or incurring a deficit for a number of reasons, the most significant being the competition of the private automobile. Smaller cities find an additional deterrent to a completely successful operation in poor street patterns and frequency of service required to compete with relatively short walking distances in downtown areas; and in very light patronage for long periods of the day in outlying and recently annexed areas. The Belleville Transit System is no exception. The paper deals with the problems arising from the City taking over the privately-owned bus system and placing it

(Continued on page 84)



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Bird's-eye view of coal-handling system at the Lakeview Thermal-Electric Generating Station, of Ontario Hydro in Toronto Township.

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Personals

S. G. Jackson,
M.E.I.C.

Z. C. Van Schwartz
M.E.I.C.

Spencer G. Jackson, M.E.I.C. (Norwich City Coll. '47) has been appointed General Manager of Warnock Hersey. Since joining the company in 1953, Mr. Jackson has directed major supervision, inspection and testing assignments in all parts of Canada. In his new capacity, he will be located in the company's Montreal office.

Zolly Carleton Van Schwartz, M.E.I.C. (Northwestern '30) has been elected President of Friedell-Vanschwartz & Associates, Inc., Management & Engineering Consultants — Designers, Manufacturers, Denver, Colo. Mr. Van Schwartz is a lecturer, author, and inventor. He is an authority on Fluid Mechanics (Pure Fluid Systems), on matters relative to Heat Transfer and in the Logistics Sciences.

J. E. Nelson
M.E.I.C.

L. L. Goddard,
M.E.I.C.

L. L. Goddard, M.E.I.C. (McGill '44) has been appointed manager of the tractor division of Mine Equipment Co. Ltd. Mr. Goddard who has 14 years' experience in heavy equipment sales, will be in charge of sales in Eastern Canada for Eimco tractors and loaders.

J. E. Nelson, M.E.I.C. (Queen's '46) has been appointed Sales Manager, Mining Products, Industrial Machinery at Dominion Engineering Co. Ltd. Mr. Nelson joined the company in 1953 after several years' experience in the mining industry.

R. G. Simpson, formerly Manager, Consumer Products Market Research and Assistant to the Vice President, Consumer Products has been appointed General Manager, Home Instruments Merchandising Division at RCA Victor Company, Ltd. Mr. Simpson will be responsible for the development, designing, engineering and procurement of all Home Instrument product lines.

D. H. Evers, M.E.I.C. (McGill '49) has been appointed chief engineer of the Alberta branch of Dominion Bridge Company Limited. Mr. Evers, whose headquarters is at Edmonton, has held a number of executive positions with the company including six years as contract engineer for the Calgary plant and sales manager of the Alberta branch for two years.

J. R. Harvey,
M.E.I.C.

W. H. Bunting

J. R. Harvey, M.E.I.C. (Toronto '45) has been appointed Vice President of Babcock-Wilcox and Goldie-McCulloch, Limited, Galt, Ont. Mr. Harvey has been with the company since 1945. He will be responsible for the engineering and service affairs of the company.

William H. Bunting has been appointed Contracts Manager for Taylor Woodrow of Canada Limited. Mr. Bunting joined Taylor Woodrow in 1954 and has been site superintendent on many of the company's projects. He will have headquarters in Toronto.

T. R. Braithwaite has been promoted to shaft superintendent of number two shaft at the potash operation of the International Minerals & Chemical Corporation (Canada) Ltd. near Esterhazy, Sask. Mr. Braithwaite joined IMC in 1961 as a senior project engineer, and was chief engineer prior to his recent appointment. In his new assignment, Mr. Braithwaite will head the group which will work on the planning, designing and sinking of a second shaft at the potash development.

H. M. Davy
M.E.I.C.

M. K. Baillargeon,
M.E.I.C.

Harry M. Davey, M.E.I.C., has been appointed Project Development Manager at Taylor Woodrow of Canada Limited. Mr. Davy will be responsible for various company projects, with special reference to Canadian S.T.W. Developments Limited, formed by Taylor Woodrow, building and civil contractors and the Standard Life Assurance Company, for the development of property.

Maurice K. Baillargeon, M.E.I.C. (McGill '52) has been appointed mechanical superintendent of The Canada Starch Company Limited operation at Cardinal, Ont. Mr. Baillargeon joined Canada Starch in 1956.

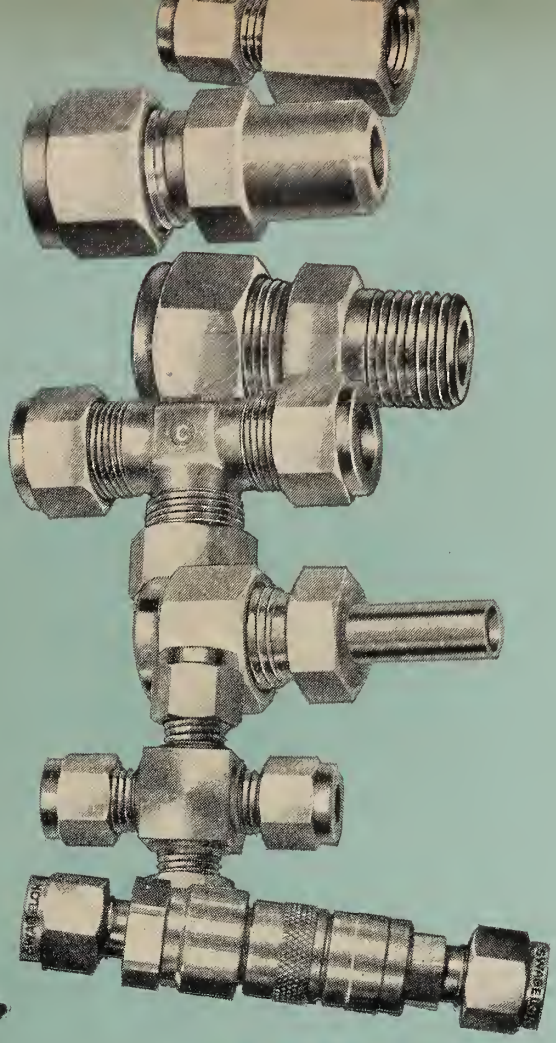
Terrance M. Brennan has been named Branch Manager of the Vancouver office of Jenkins Bros. Limited, Lachine, Que. Mr. Brennan joined the company in 1958 and since that time has been on the sales staff of the Vancouver office.

G. E. W. Winship has been appointed Area Manager for Monarch Construction Limited, an affiliate of Taylor Woodrow of Canada Limited. Mr. Winship has a sound background in architecture and has been connected with the building industry for 20 years.

(Continued on page 62)

G. E. W. Winship

T. M. Brennan



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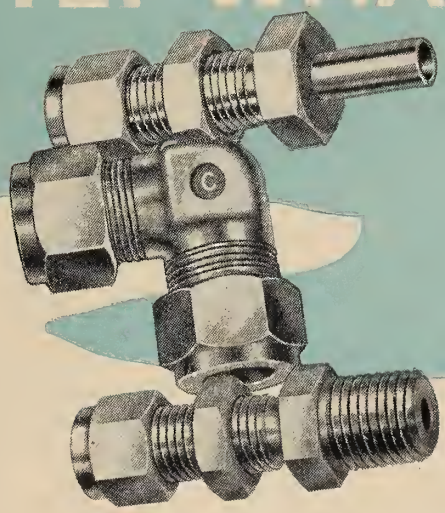

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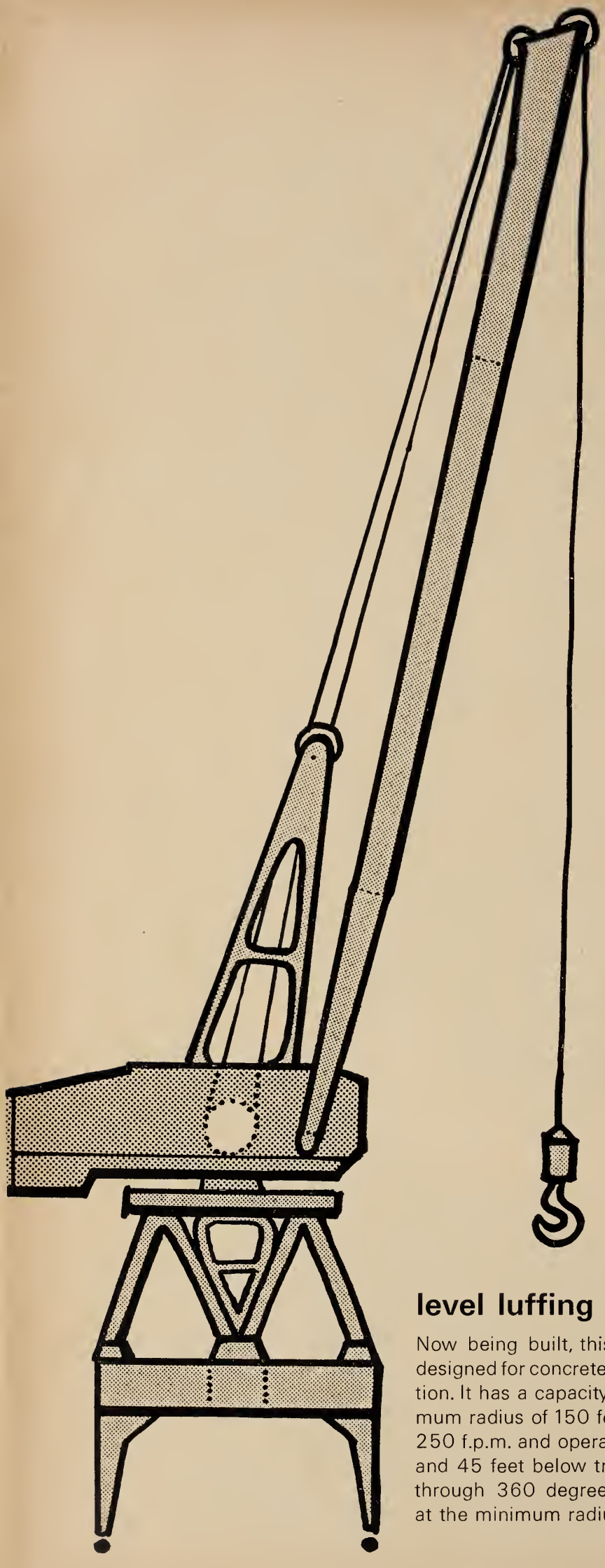

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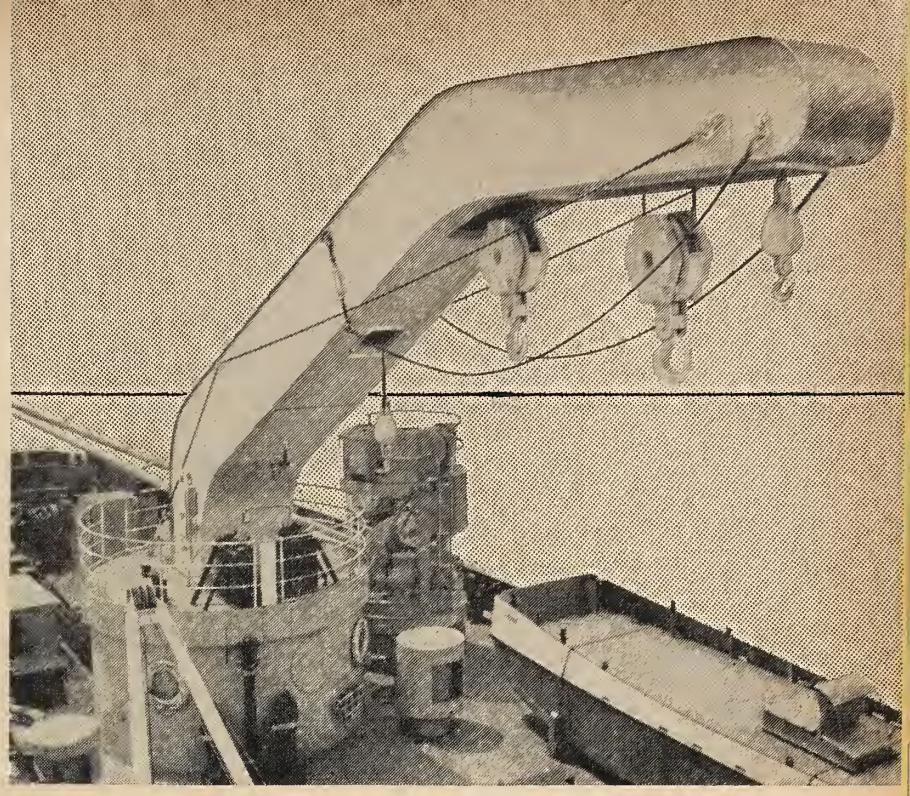
MECHANICAL DIVISION
DOMINION BRIDGE

level luffing crane

Now being built, this crane is specifically designed for concrete work in dam construction. It has a capacity of 11 tons at the maximum radius of 150 feet. The hoist speed is 250 f.p.m. and operates at 200 feet above and 45 feet below track level. It will swing through 360 degrees. Maximum capacity at the minimum radius is 50 tons.

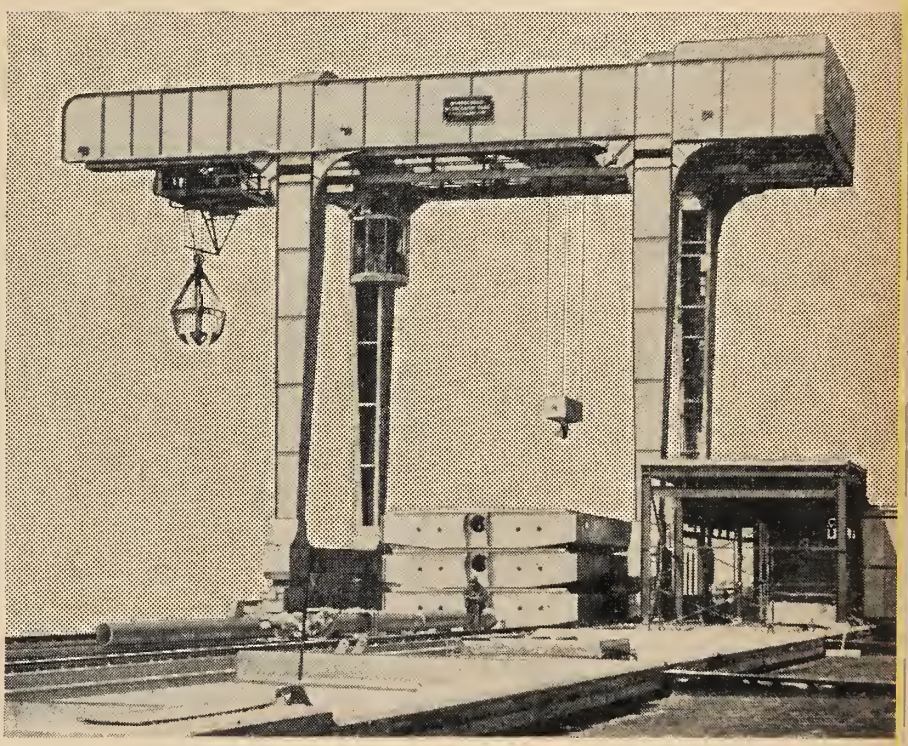


deck crane

This crane is used for handling navigation buoys on an arctic patrol ship. It has two main hoists and one auxiliary hoist all operating on fixed radii. The unit will turn through 360 degrees. Capacity: Two main hoists, 15 tons each; auxiliary hoist, 4 tons.

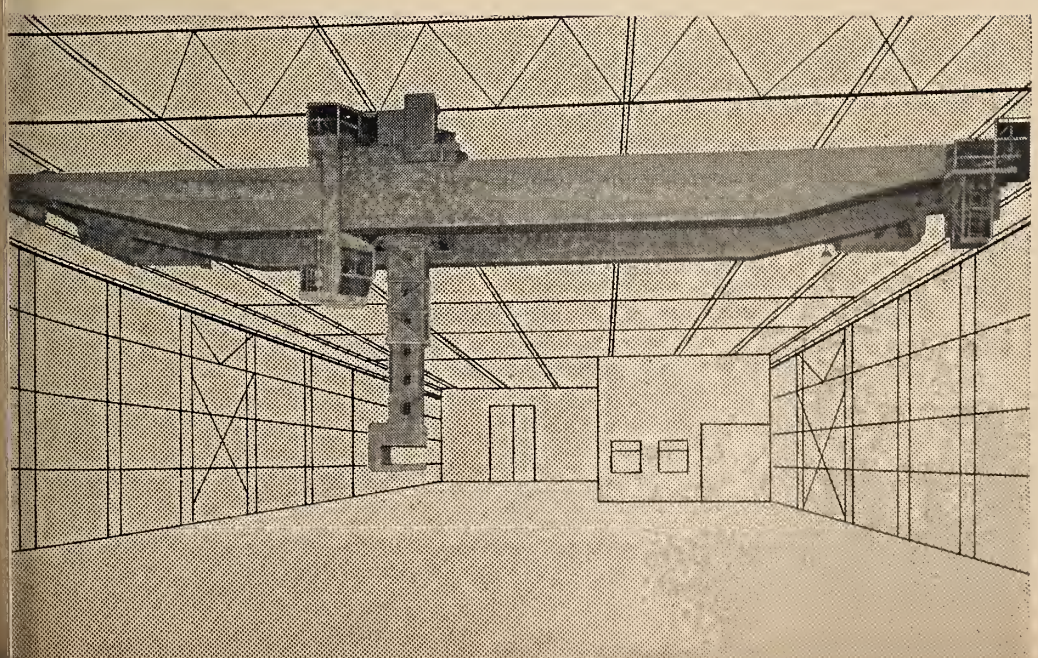
intake gantry

Broadly typical of many power house gantry cranes. This one has hoisting and trolley travel mechanisms located in a machinery house built over the downstream cantilever extension of the portal girders. A trash grapple is also fitted to the upstream side. Capacity: 80 tons. Hoist speed: 8 f.p.m. Trolley travel: 76 f.p.m. Gantry travel: 120 f.p.m.



stacker crane

The stacker crane is becoming increasingly popular for handling piece goods. This one is designed to handle steel billets in free standing stacks with alternate layers at 90 degrees to each other. No load slinging is required. Capacity: 30 tons. Main hoist speed: 0 f.p.m. Trolley travel: 200 f.p.m. Bridge travel: 450 f.p.m.



Canadian Engineering

Sod Turned For Fathers of Confederation Building

Premier Robert Stanfield of Nova Scotia turned the first sod early this month for the Fathers of Confederation Memorial Building.

Canada's first monument to the founders of the nation is being built in Charlottetown where the Fathers met, and where Confederation began in 1864.

Construction of the Memorial Building fulfils the hopes of the Fathers of Confederation Memorial Citizens Foundation. Chairman of the Foundation is Dr. John Bertram Stirling, Hon. M.E.I.C., a past President of the Institute, and its Manager is Hugh Crombie, M.E.I.C.

Promoted by the Foundation and financed by the federal and provincial governments and private sources, the building will include a memorial hall, theatre, library, museum and art gallery. It will be decorated and furnished on the basis of themes drawn from the history, art and traditions of all parts of Canada. The $5½ million project is a national effort, and the building will be a national shrine.

The design resulted from an architectural competition financed by a grant from the Canada Council in which 47 architects from coast to coast participated. The winning entry was that of Affleck, Desbarats, Dimikopoulos, Lebensold and Sise of Montreal.

Premier Stanfield, who turned the first sod, is chairman of the Premier's Conference. The speaker at this ceremony was Premier Jean Lesage of Quebec, immediate past chairman of the Premier's Conference. The Prime Minister is to place the cornerstone later this year.

The turning of the first sod of the Fathers of Confederation Memorial Building, a model of which is shown below, took place early this month. This first monument to the founders of the Canadian nation is being built at Charlottetown and is to be finished in 1964.

New Stamp To Honour Sir Casimir Gzowski

Sir Casimir Stanislaus Gzowski, one of the founders and an early president of the society which grew into the Engineering Instiute of Canada, will be commemorated by a new five-cent stamp to be issued early next month.

The stamp will be issued March 5, the 150th anniversary of the birth of Sir Casimir. It honours the many contributions made to Canada by its various ethnic groups.

Gzowski was born in St. Petersburg, Russia, on March 5, 1813, the eldest son of Stanislaw Gzowski, a Polish nobleman and officer in the Imperial Russian Guard. He studied military engineering in Poland but was exiled to the United States for his part in the Polish uprising in 1830. He came to Canada in 1842 and was employed as a government engineer until 1848, constructing a number of roads in the western part of Upper Canada.

He was naturalized in 1846 and from 1848 until 1853 was employed on construction work for the St. Lawrence and Atlantic Railway. In 1853 he founded the contracting firm of Gzowski and Company. His partners were Alexander Tilloch Galt, Luther Holton and James Macpherson.

This firm built the Grand Trunk Railway line between Toronto and Sarnia. In 1871-73 Gzowski built the International Bridge across the Niagara River at Fort Erie. Other business interest included the Ontario Bank and the Toronto Rolling Mills.

He was one of the early proponents of a learned engineering society, and saw his hopes and plans materialize in 1887 with the founding of the Canadian Society of Civil Engineers, the predecessor of the Engineering Institute of Canada. Gzowski served as President of the Society from 1889 to 1891. He later established the Gzowski Medal which is presented by the Institute each year for the best technical paper on a civil engineering subject.

In 1890, for his service in engineering and education, he became Sir Casimir as a Knight Commander of the Order of St. Michael and St. George. Besides being an aide-de-camp to Queen Victoria, he was an officer in the Canadian engineers.

The commemorative stamp was designed by Philip Weiss of Ottawa. Its size is approximately 1 3/16 inches by 1 inch. The head of Sir Casimir occupies the left side of the stamp, and on the right is a railway locomotive against a background of a factory and a girder. Vertically along the left border are the words "Sir Casimir Stanislaus Gzowski", and beneath his picture are the dates "1813-1963".

Sir Casimir Stanislaus Gzowski

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Branch News

BORDER CITIES
William J. Luciani

President Lawton visited the Branch last Fall. He was taken on a tour of Assumption University's Essex College where he met Dr. F. A. DeMarco and his staff. Mr. Lawton later met with the Branch Executive, Faculty and Student Representatives including the student prize winner. A dinner was held in the faculty dining room. This was followed by an informal meeting of the executive and the local press. Later in the evening, a general meeting took place in the Hiram Walker Lounge. Refreshments were served following the meeting.

BROCKVILLE
A. N. Campbell

D. B. Ashenden, Technical Supervisor, Phillips Electrical Company, was the guest speaker at the Fall meeting of the Branch. In his talk, "New Challenges in Cable Design," Mr. Ashenden outlined the complex cable requirements and the different materials necessary for insulating purposes. He explained the challenges presented to cable designers, and pointed out the advances which have been made in all insulation fields. The advances include the increasing use of chemical polymers. The nuclear and rocket age has also contributed more complex challenges to the cable designer. Mr. Ashenden then gave a general outline of insulation materials covering those used from the earliest days of electrical power transmission to those of the space age.

Roy F. Fortune, Supervising Engineer, Contract Liaison, Canadian General Electric, Peterborough, was the guest speaker at the Branch's November 15 meeting. Mr. Fortune gave an interesting and informative talk on the past, present and future developments of atomic energy for peaceful purposes. After a brief description of various types of reactors, he confined his remarks mainly to the heavy water moderated, natural uranium fueled reactors developed in Canada. The talk covered developments from 1945, when the first reactor ZEEP or Zero Energy Experimental Pile went critical at Chalk River, through NRX, NRU, PTR and the Z-2 reactors. This period also included NPD which went critical at Rolphton in April 1962. The progress to date on CANDU, now under construction at Douglas Point, was also discussed. The reaction and power development of NPD were illustrated by slides. The design, fabrication and construction of this reactor, a joint undertaking of Atomic Energy of Canada Limited, Canadian General Electric and the Hydro Electric Power Commission of Ontario, were shown in a colour sound film. Mr. Fortune discussed future developments and mentioned some of the other coolants which are now under test. He also reviewed the economics of electric power, and stated that firm prices can now be quoted for erection of such power plants anywhere in the world. Larger power plants continue to appear on drawing boards. When utilities are ready to build them, Canadian General Electric will be prepared to quote prices. Power developed from nuclear sources is now competing with power from other sources.

Some 55 members attended this meeting along with guests from the local branch of the Institute of Power Engineers. The annual meeting of the Branch was held at a dinner meeting at the Grenadier Inn on December 11.

CENTRAL B.C.
J. W. Nelson

Peter Tassic of Vernon was elected Councillor during a joint meeting held at the Highlander Hotel in Kamloops.

Other executives elected included: M. G. Elston, Chairman; G. Hirtle, Vice-Chairman; H. M. Trueman, Branch Secretary-Treasurer; A. L. Fairbairn, Association Secretary-Treasurer.

Members of the E.I.C. Committee for 1963 include: R. K. Coates, Revelstoke, R. J. Talbot, Kamloops; and E. Cameron, Penticton. The 1963 Directors of the Association include: W. Mercer, Kamloops; J. Hamilton, Penticton; and D. McKay, Vernon.

During the meeting retiring president Brian Harvey presented M. L. Wade, M.E.I.C., P. Eng., with an Honorary Life Membership in the A.P.E.B.C. Mr. Wade, a well-known consulting engineer in Kamloops, has completed 42 years as a professional engineer. He graduated from McGill in 1920 after which he was employed by Westinghouse, and later by East Kootenay Power Company. He worked as a consulting engineer in Central B.C. since the early 1930's.

Mr. Wade's many friends also presented him with a pen, and Mrs. Wade with flowers.

CORNWALL
Fred R. Warner

The Annual Dance was held by the Branch at the Cornwall Golf and Country Club. Branch Chairman G. B. Stidwell, and Mrs. Stidwell received Branch members and their guests. Past-Chairman John M. Ferguson and Peter Schwarzkopf were responsible for the arrangements for this successful event which 35 couples attended.

ESTEVAN
O. P. Lesiuk

Group Captain Magnasson, of the NORAD Air Force Base at Minot, N.D., was the guest speaker at an early Branch meeting. In his talk, "SAGE, its role in the North America Defence", Group Capt. Magnasson explained how the radar station lines across North America are tied to all defence bases on the continent. He elaborated on the usefulness of the radar lines in peacetime aerial activities. Group Captain Magnasson described the Minot Air Base, its operational activities and capabilities. He described in particular, the role of SAGE, (Semi-Automatic Ground Environment), the automation and control achieved to date in aerial flights, and the great need in the present-day air force for highly skilled and trained electronic personnel. A lively question and answer period followed the talk. R. Egglestor thanked Group Capt. Magnasson on behalf of the members.

A $100 scholarship was awarded to J. Mojoleski, an Estevan Collegiate graduate entering first year engineering at the University. A cheque for $25 was acknowledged from the Engineers' Wives Association in aid of the scholarship fund.

KINGSTON
K. L. Coupland

The Branch was host to engineering undergraduates from Queen's University and the Royal Military College at its annual Students Night. The meeting was held at Ellis Hall where a large number of both senior engineers and undergraduates were in attendance.

The speakers were Dr. D. C. MacPhail of the National Research Council and J. S. Waddington, of Brockville, the regional vice-president for the Institute.

(Continued on page 73)

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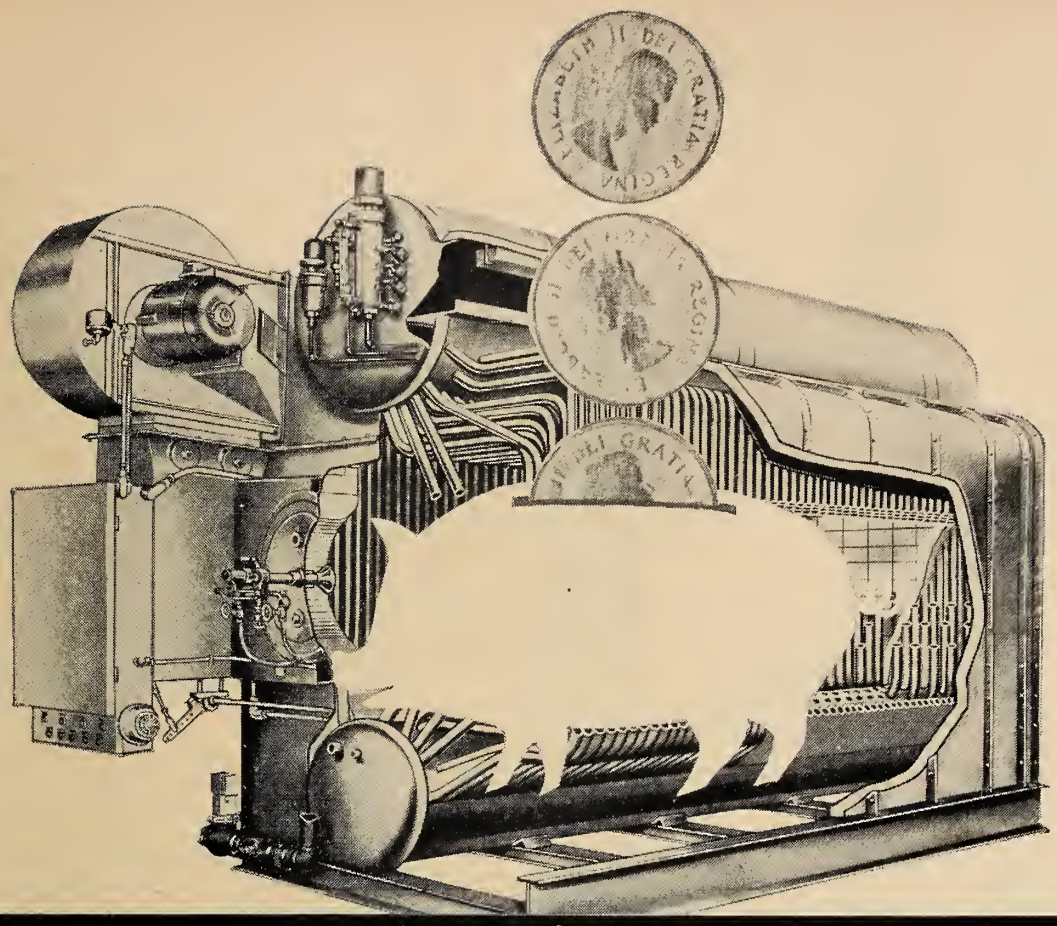

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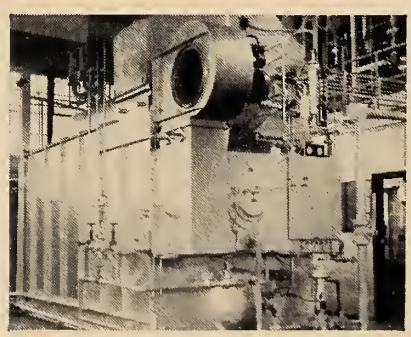

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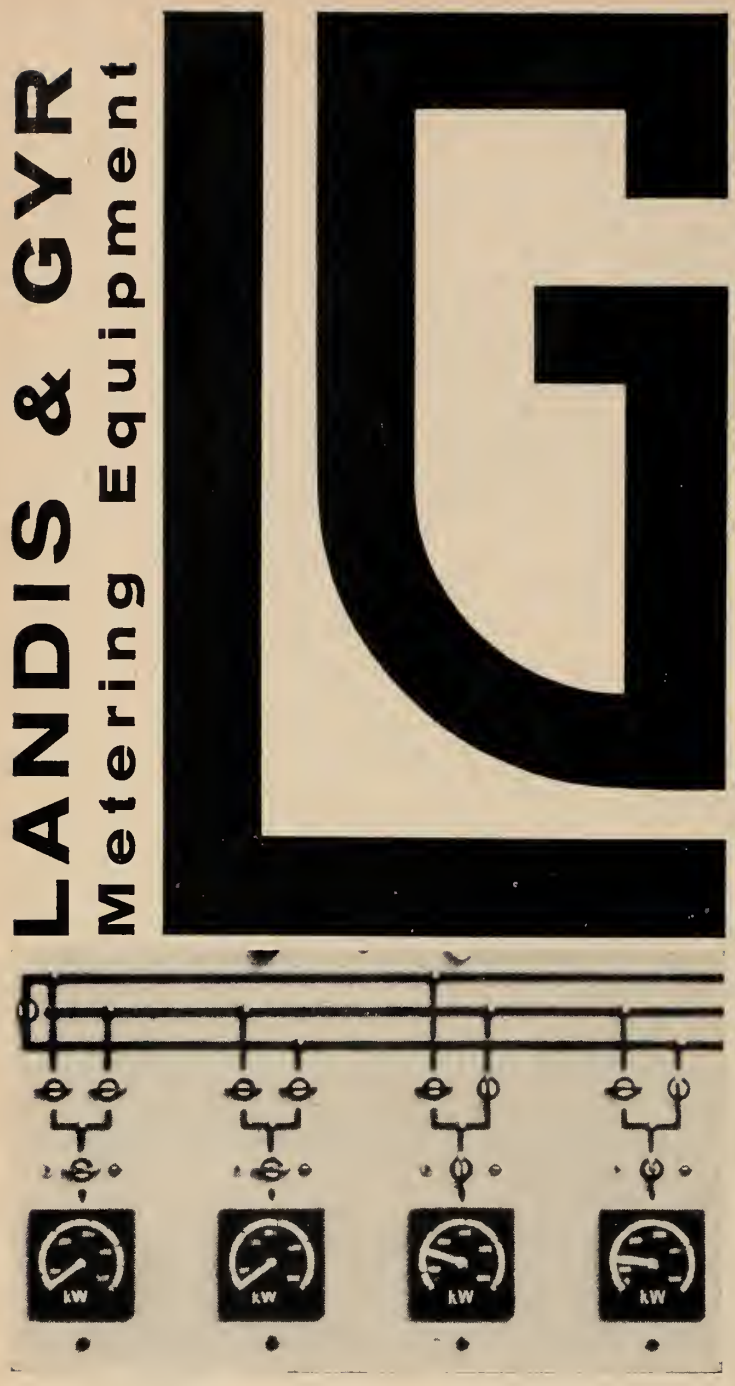

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Engineering Information Service

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COMPUTER PROGRAMMING FUNDAMENTALS, H. D. Leeds & G. M. Weinberg, McGraw-Hill, Toronto, $9.75.

RADIATION HEAT TRANSFER FOR SPACECRAFT AND SOLAR POWER PLANT DESIGN, F. Kreith, International Textbook, Scranton, Pa., $10.

SYNTHETIC LUBRICANTS, Edited by: R. C. Gunderson & A. W. Hart, Reinhold, N.Y., $15.

THE ELECTRICAL POWER BUSINESS, E. Vennard, McGraw-Hill, Toronto, $5.95.

METALLURGICAL PROBLEMS FOR ENGINEERS – THE CONTROL, MANUFACTURE, MANIPULATION & USE OF METALS, J. G. Tweeddale, Iliffe, London, 85s.

VARACTOR APPLICATIONS, P. Penfield, Jr. & R. P. Rafuse, The M.I.T. Press, $15.

A SELECTED BIBLIOGRAPHY ON FLUID MECHANICS, HYDROLOGY & HYDRAULIC ENGINEERING, 1950-1960, compiled by: H. Wellisch, Tahal, Israel, $1.50.

STATIC POWER CONVERTORS–PERFORMANCE AND APPLICATION, R. Wells, Wiley, N.Y., $7.

NUCLEAR REACTOR FUEL ELEMENTS METALLURGY & FABRICATION, Edited by: A. R. Kaufman, Wiley, N.Y., $27.

CONCRETE TECHNOLOGY–VOL. II, D. F. Orchard, Contractor's Record, London, 63s.

THE EFFECT OF VARIOUS STEELMAKING PROCESSES ON THE ENERGY BALANCES OF INTEGRATED IRON AND STEELWORKS. SPECIAL REPORT 71, The Iron and Steel Institute, London, 42s.

DICTIONARY OF BUSINESS & SCIENTIFIC TERMS, compiled by: D. F. Tver, Gulf Publishing Co., Houston, Tex., $7.50.

GRANDI DIGHE ITALIANE–MINISTERO DEL LAVORI PUBBLICI CONSIGLIO SUPERIORE–Servizio Dighe, Roma. Published for the 7th Congress on Large Dams, 1961.

TEMPERATURE–ITS MEASUREMENT AND CONTROL IN SCIENCE & INDUSTRY, VOL. III, PART II, APPLIED METHODS & INSTRUMENTS, Edited by: A. I. Dahl, Reinhold, N.Y., $29.50.

SINGLE SIDEBAND FOR THE RADIO AMATEUR, American Radio Relay League, $2.25.

ARTIFICIAL EARTH SATELLITES, TRANSLATED FROM RUSSIAN, Editor: L. V. Kurnosova, Academy of Sciences of the USSR, $15.

PHYSICAL SCIENCES–SOME RECENT ADVANCES IN FRANCE AND THE UNITED STATES, Edited by: H. P. Kallman, S. A. Korff, & S. G. Roth, New York University Press, $7.50.

DAVIS DAM AND POWER PLANT–TECHNICAL RECORD OF DESIGN AND CONSTRUCTION, United States Government Printing Office, Washington, D.C., $3.25.

(Continued on page 72)

THE VOLUNTARY CONCEPT

I have frequently referred to the voluntary concept in connection with the learned societies in the engineering profession, such as our own. What is this voluntary concept?

One definition of voluntary is an act proceeding from or effected by the will. Another, which is most appropriate, is any work or performance not compelled or imposed by another.

The voluntary concept is exemplified by the great flowering of Greek philosophy and sculpture during the Golden Age of Greece, which led to our great heritage of the dignity of man.

The voluntary concept is exemplified by the great works of literature, arts and music, in all ages and all civilizations. These were achieved through the flowering of individual and voluntary effort, not because of dictation.

The voluntary concept is exemplified by the great scientific discoveries and inventions, either by individuals or individuals in association. These came about through the conception of an idea and the voluntary pursuance of its achievement.

The voluntary concept underlies the great medical discoveries. Voluntary effort was entailed on the part of both the discoverer and the volunteer subjects who were frequently neecessary.

The voluntary concepts underlies the great development of parliamentary government which is one of the Anglo-Saxon gifts to the world.

There are many other examples of the role the voluntary concept has played in the development of our civilization. I do not think I need add to these.

Now every learned society, whether in engineering or in other fields, was founded by individuals who conceived an idea of an organization necessary to meet a particular need of the community. They have flourished to the extent that the successors of the founders, the members in every decade, have contributed to the work of the society, not only as ordinary members but in the active formulation of ideas and pursuance of the ideals set by the founding members. Voluntary work underlies all effective organized activities, at whatever level, be it local, regional or national. Recognition of this fact is the motivation behind those members who accept responsibility of office, at whatever level. They recognize the need of voluntary work and have decided to put their shoulders to the wheel. What about you, Mr. MEMBER?

It is the voluntary concept, not the obligatory one, which leads to the fullest flowering of human effort, in whatever field of endeavour it may be. It is the voluntary concept which leads to the most effective development of the learned society in the engineering field, in its ability to serve the members.

Have you ever stopped to think what the other side of the coin is? Almost invariably active participation in the work of a learned society, particularly in the engineering field, leads to a material development of the individual. His realization of the role of the society grows. His ability to contribute grows. His ability to serve as an individual member reaches its fullest flowering.

F. L. Lawton, President.

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NOON: Lunch

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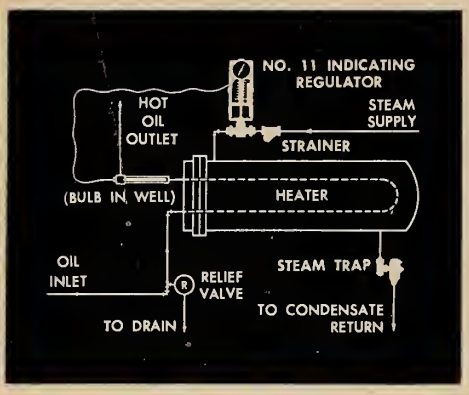
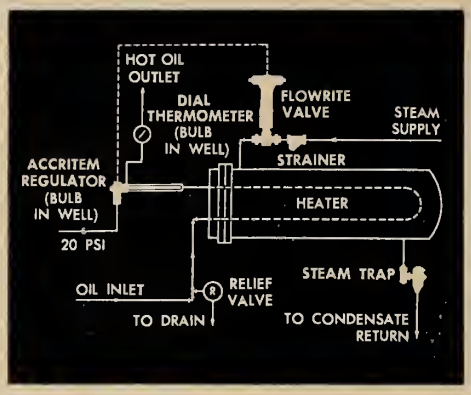


Outside power is not required by this system. The temperature indicating regulator is installed in the steam supply line, with a remote sensing bulb set in the hot oil outlet of the heater. A self-cleaning strainer precedes the regulator, and a properly sized steam trap is used in the condensate return.



Easy temperature selection and a calibrated regulator dial are features of this system. In this case a control valve is used in the steam supply line. Temperature regulator and dial thermometer are installed in the hot oil outlet to give a constant visible check of operating temperature.

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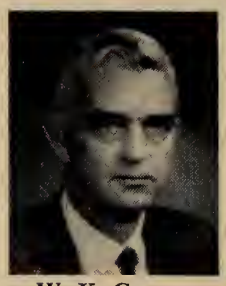
Personals

(Continued from page 50)



W. K. Gwyer
M.E.I.C.

M. J. Watson

W. K. Gwyer, M.E.I.C. (U.B.C. '36) has been appointed General Manager of the West Kootenay Power and Light Company. Mr. Gwyer has been Assistant General Manager since 1959 when he joined the company. During 1962, he was responsible for co-ordinating the emergency measures taken to establish standby power across Kootenay Lake after the bombing of the power span. He has headed the $3,500,000 power transmission expansion project undertaken to serve the increasing power needs of the Okanagan area.

M. J. Watson has been named a director and vice president of Canadian Industries Limited. Mr. Watson joined C-I-L at Nobel and after serving at James Island and Beloeil, transferred to Defence Industries Limited where he was responsible for shell filling operations from 1944 to 1946. He returned to C-I-L after the war and was appointed general manager of the explosives division in 1954.

L. A. Thorssen, M.E.I.C. (Alta. '39) has been elected president of the Expanded shale, clay and Slate Institute. Mr. Thorssen, president of Consolidated Concrete Limited, is the first Canadian to hold an executive position with this Institute which is composed mainly of United States' companies, with only seven Canadian members and a few from Australia, Puerto Rico and Japan.

ERRATA

On page 52 of the December issue of the Engineering Journal, in the Personals section, we stated that D. G. Currie, M.E.I.C., had recently been named Assistant to the President of Bathurst Power and Paper Company.

Identifying Mr. Currie as a member of the Institute was an error entirely on our part. Derek G. Currie is an able administrator, but is not an engineer and has never made any such claim.

We apologize for any confusion or embarrassment our error may have caused.

J. A. MacRae

J. H. Gregson

James A. MacRae has been appointed to the chief administrative post of the Military Products Division, Honeywell Controls Limited. Mr. MacRae brings to his position wide experience in engineering and management gained in his twelve years association with Honeywell. **Joseph H. Gregson** has been named chief engineer, Military Products Division of Honeywell. Mr. Gregson will be responsible for the organization and administration of the division's engineering and research programs.

R. T. O'Keefe, M.E.I.C. (N.S.T.C. '46) has entered into private consulting practice in Montreal specializing in civil, hydraulic and municipal engineering. Mr. O'Keefe, formerly with H. W. Lea, Consulting Engineers, Montreal, is completing a term of office as mayor of Rosemere, P.Q.

Alan Hugh Armstrong of Ottawa and Toronto has been appointed principal executive officer of the Canadian Council on Urban and Regional Research. Mr. Armstrong is Advisor on Community Planning at the Central Mortgage and Housing Corporation.

Arnold J. Groleau, M.E.I.C. (McGill '28) has been appointed chairman of the Trans-Canada Telephone System. Mr. Groleau joined the Bell Telephone Company in 1928. In 1954, he was appointed chairman of Trans-Canada Telephone's engineering committee. After holding successive engineering posts with the telephone company, he was named vice-president and general manager of its Toll Area in 1960. On February 1, 1963 he became vice-president of the Toll Area.

F. Thomson has been named chief engineer at International Minerals & Chemical Corporation (Canada) Limited's potash operation at Esterhazy, Sask. Mr. Thomson has been associated with IMC since 1958. In March, 1960, he became construction engineer. **K. A. McLeod** has been appointed construction supervisor at the project. Mr. McLeod joined IMC in 1962 as maintenance control supervisor. **A. F. Toth** has been named chief design and cost engineer. Mr. Toth joined IMC's engineering department in 1961 as senior design engineer.

K. M. Bartlett has been named manager of the switchgear and control department of Canadian Allis-Chalmers. Mr. Bartlett previously was manager of the company's Halifax district office and brings to his new position many years experience in sales and electrical engineering.

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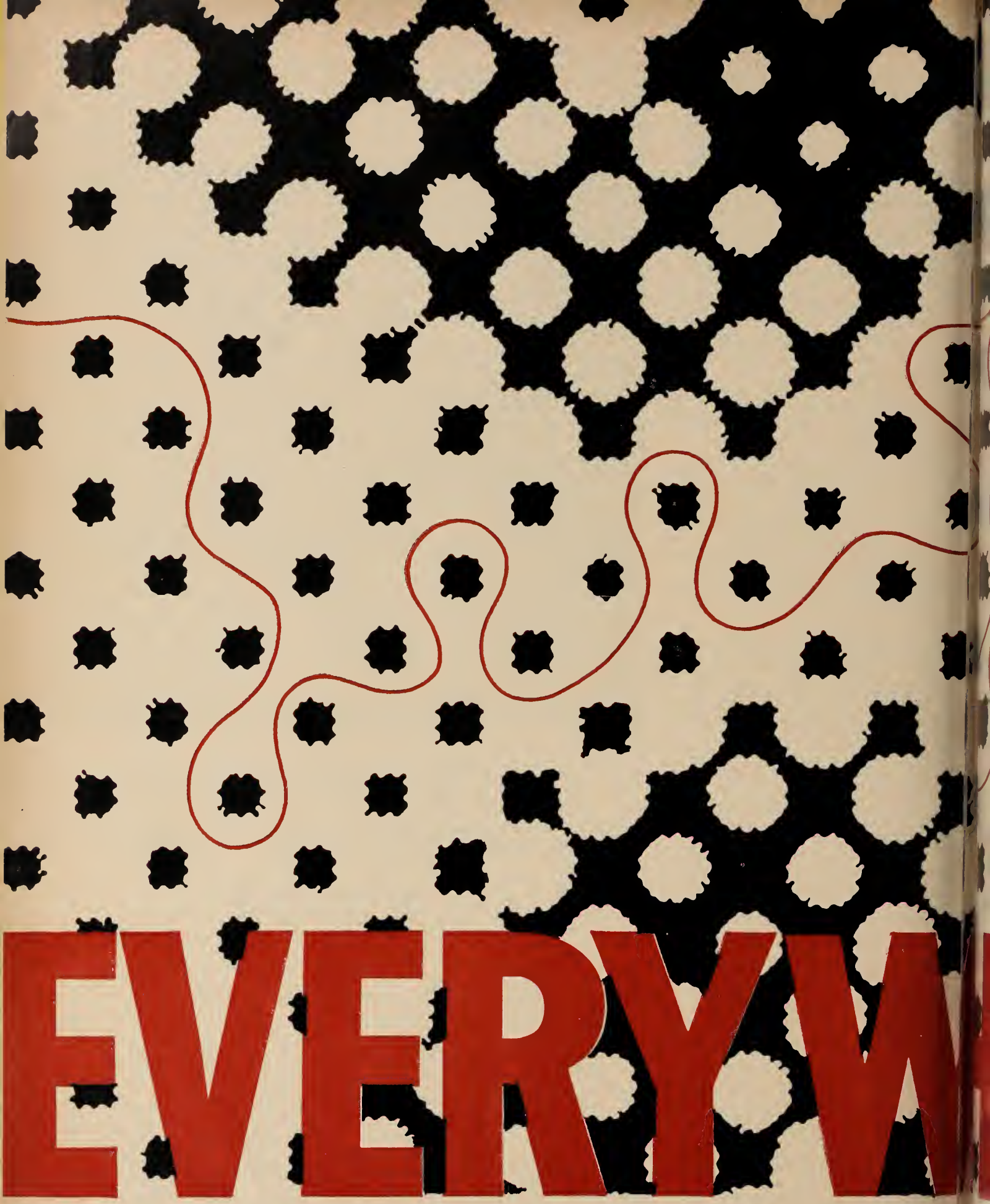

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SITUATIONS WANTED

CIVIL ENGINEER — M.E.I.C., P.Eng., B.Sc.(C.E.) '59, age 27, single. Graduating May '63 Master of Business Administration, University of Western Ontario. Four years heavy construction experience with contractor as project engineer, and superintendent. Roads, Quarry work, airports and paving. Will locate anywhere. File No. 369-C.

CIVIL ENGINEER — A.M.E.I.C., P.Eng., B.Sc., Manitoba '60. Age 24, single. 2½ years post-graduate experience in highway engineering, soils, asphalt, concrete. Carried out numerous special research projects in lab. and field. Additional 5 summers pre-graduate experience surveying, highway construction, inspection, and supervision. Desires position with progressive organization. Preferably Western Canada. File No. 403-C.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., age 38, married. Six years experience in Canada: Two, with manufacturer of heavy industrial equipment, preparing quotations to customers' specifications; two, in plant maintenance for distillery and bottling equipment; two, in air conditioning design. Previous five years with earth-moving equipment, diesel engines, etc. in repair and maintenance shop. Seeks position in maintenance or production, preferably in Montreal. File No. 384-M.

PROMOTION OF FOREIGN OPERATIONS — PROJECT ENGINEER, P.Eng., Mechanical, 5 years experience in thermal power plant projects and coordination, wishes to join or assist organization dealing with general industrial projects, surveys and promotion in foreign countries. Fluent in Spanish and German, understands French. File No. 337-M.

MECHANICAL ENGINEER — M.E.I.C., P.Eng. Sask., age 25, married. B.Sc. University of Saskatchewan 1960. Presently employed in the petroleum refining industry. Desires employment in a position of plant maintenance and design engineer. Preferred location, Western Canada. File No. 419-M.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., age 34. Over 10 years practical experience in air conditioning, heating, ventilation, refrigeration, dust collection. Would like to join small to medium sized Consulting Engineering firm. Location Montreal. File No. 418-M.

MECHANICAL ENGINEER — M.E.I.C., P.Eng. (Ont.). 22 years of varied experience at estimating, designing, draughting and plant design in the metal fabrication and chemical industries; also teaching and coaching in mathematics, sciences and other related engineering subjects at all levels. Now fully employed but desires part-time work in the Toronto area. File No. 417-M.

CIVIL ENGINEER — M.E.I.C., P.Eng. (Que.), B. Eng. (McGill '51), married. 11 years of construction experience with general contractor in all phases of the work. Seeks position in New Brunswick where experience will be an asset. File No. 416-C.

MECHANICAL ENGINEER— A.M.E.I.C., R.M.C., B.Sc. (Queen's '60). Married, age 27. 3 years with R.C.N., administration and training with each branch. Desires position with a company in the East or B.C. Interested in thermal power but will consider any position in the mechanical field. Available June 1st, 1963. File No. 415-M.

CIVIL ENGINEER — B.Sc. (Man. 1961). Studying for M.Sc. (University of Glasgow); subject: hydraulics (broad-crested weirs). Age 25. To be marriel in fall 1963. Available in summer 1963. Experience (6 summers only): surveying; soils, concrete and asphalt testing; industrial design. Speaks some French. Desires experience in hydroelectricity, hydraulic models, flood control, etc. Will locate anywhere. File No. 414-C.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., (McGill '57). Age 32, multilingual and widely travelled with 5 years experience in development and design of construction equipment, desires responsible position with engineering or manufacturing firm in Montreal, Toronto or Vancouver. File No. 413-M.

CIVIL ENGINEER — A.M.E.I.C., B.Sc. 1959. Age 25, married. Three years varied experience with small private electrical utility. Responsible for all engineering associated with design, construction, maintenance and operation of distribution and transmission lines, hydro and thermal generating stations and allied operations. Desires position with unlimited responsibility and potential in similar or associated field. File No. 411-C.

PROFESSIONAL ENGINEER—(B.E. 1959, M.Sc. 1962) desires position in structures, preferably timber or concrete. File No. 103-Agr.

PROFESSIONAL ENGINEER — presently on overseas assignment with the Republic of China in Formosa, on Basin Development with particular reference to groundwater hydrology, will be seeking a further assignment in March-April, 1963. Age 40. Resume of experience will be furnished on request to File No. 410-C.

CIVIL ENGINEER— A.M.E.I.C., Athlone Fellow, B.Sc. (U.N.B. 1960). Diploma of Imperial College 1961. Presently investigating the inelastic behaviour of reinforced concrete for M.Sc. (London). Available February 1963. Age 24, married. Willing to work anywhere in Canada. Desires position that offers experience in design and construction. File No. 273-C.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., B.Eng. (McGill 1960), Diploma Business Administration (U.W.O.) 1961. 20 months experience in Plant Engineering work. Other experience includes supervision of construction and installations of a new plant, cost reduction and cost analysis; also some draughting and design experience. Desires interesting engineering position, such as plant engineering or plant maintenance. Location preferred—Montreal. File No. 267-M.

ELECTRICAL ENGINEER — 1950 graduate. Experienced in manufacturing design of mercury arc rectifiers. General electrical controls, process instrumentation, and mechanical services relative to the aluminum and petrochemical industries. Supervisory experience in plant and project engineering. Located in Montreal; desires to relocate, preferably to Ontario. File No. 5962-E.

ELECTRICAL ENGINEER — B.Sc. 1955. Second quarter of graduating class. Age 30, single. Desires position offering experience in the electrical power field anywhere in Canada. Presently employed by transformer and switchgear manufacturer. File No. 412-E.

SITUATIONS VACANT

CIVIL

JUNIOR ENGINEER required by consultant specializing in Foundation Engineering. Opportunity for training in site and laboratory testing techniques and foundation design. Applicant must be prepared for intermittent supervisory duties at sites throughout Ontario. Participation in a limited research project may be available to applicant depending on qualifications. Reply to File No. 336-V.

MINING OR CIVIL ENGINEER—Graduate of Canadian University, with good personality and knowledge of mine surveying, development, ventilation and safety. To take over as mine engineer of a southern Ontario 1,000-ton-per-day producer. Starting salary $5400. Reply to File No. 352-V.

PROCESS ENGINEERS

Our Monufacturing Engineering Department hos immediote opportunities for experienced processor engineers.

Duties include onolyzing engineering releose doto to develop process sheets, orronging ossembly operations in sequence, developing oll details of the work methods to be followed throughout the process, preporing rough sketches of equipment to provide bosic informotion for tool designers, ond follow-up responsibility for the fobricotion of tools ond equipment for the vorious assembly operotions.

One to five yeors' experience in closely related work (preferobly automotive or allied industries) is necessory.

Full company-poid benefits of life insuronce, pension, medicol and hospitol plans ore provided.

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SITUATIONS VACANT

ELECTRICAL

GRADUATE ELECTRICAL ENGINEER required by consulting firm in the Maritimes. To be employed in design of electrical and electrical-mechanical systems for buildings and light industry. Responsibilities will include construction inspection and co-ordination of design with contractors. Future limited only by the person's own ability. Salary commensurate with experience. Reply to File No. 348-V.

MECHANICAL

MECHANICAL ENGINEER with one or two years experience required by Maritime consulting engineering firm. To engage in the design of heating, air conditioning and electrical equipment for buildings. Promising future for the right man. Salary commensurate with experience. Reply to File No. 347-V.

MINING

METALLURGICAL ENGINEERS — Large progressive Corporation with subsidiary Companies in several provinces in Eastern Canada requires Metallurgical Engineers. Excellent opportunities for advancement. Reply in confidence to: File No. 292-V.

MISCELLANEOUS

ENGINEERS FOR MANAGEMENT—project, design, sales, research, development and control. Graduates of most types and ages required by clients of the Technical Service Council, a non-profit, industry-sponsored placement service. Write 2 Homewood Ave., Toronto 5, Ontario or 1500 Stanley Street, Montreal 25, Que. for an application. There is no charge for work done on your behalf. File No. 6648-V.

TECHNICAL SERVICES ENGINEER required by major oil company with headquarters in Toronto. Applicants should be at least 25 years of age with a degree in engineering or chemistry. Industrial sales experience in petroleum products an asset. Position involves travelling throughout Ontario with headquarters in Toronto. Full range of company benefits; salary commensurate with experience. Please apply giving full personal details and salary requirements to File No. 345-V.

TEACHING

McMASTER UNIVERSITY — Applications are invited for appointments in the Department of Electrical Engineering. Candidates should have an interest in one or more of the following: Network Theory; Non-linear Circuits; Communications; Control Systems; Digital Systems. A Doctorate in Electrical Engineering is required and industrial research or development experience would be an advantage. Duties include teaching at undergraduate and graduate levels, conducting research and supervising graduate students. Salary according to qualifications and experience. Assistant Professor $7020-$8730; Associate Professor $9000-$11,310. Additional stipends for summer research work. Applications and inquiries should be addressed to The Chairman, Department of Electrical Engineering, McMaster University, Hamilton, Ontario.

McGILL UNIVERSITY — The present Chairman of the Department of Chemical Engineering will retire in August 1964. It is proposed to make an appointment of a Professor in August 1963, with a view to assuming the Chairmanship in 1964. Applications are invited from persons who are well qualified, and should be addressed to: Dean D. L. Mordell, Faculty of Engineering, McGill University, Montreal, Que., from whom further information is available.

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DEADLINE — Please note that requests for insertions must be submitted in writing not later than the **15th of the preceding month.** Cancellations: same as above.

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DATE IN CIRCULATION — 20th of month.

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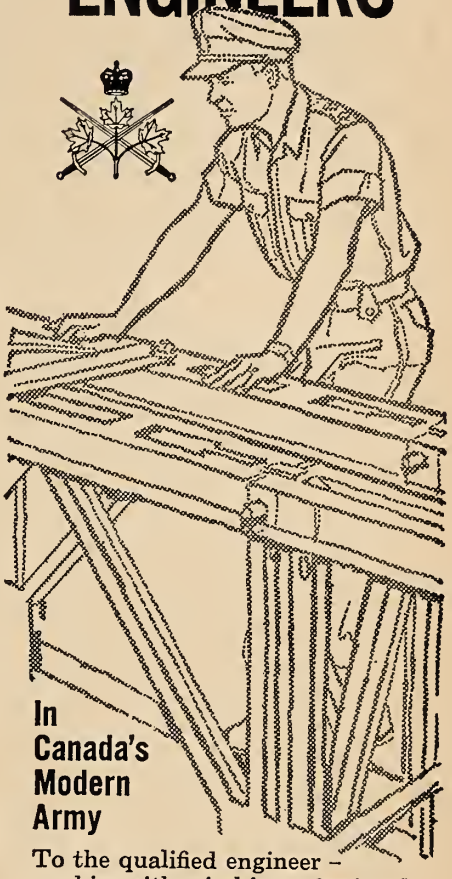

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CIVIL OR MECHANICAL ENGINEERING —With specialization in Fluid Mechanics. Successful applicant expected to take part in developing curriculum and plant for new degree program, with particular responsibility for hydraulics laboratory planning. Master degree minimum requirement; Ph.D. preferred. Rank dependent on qualification. Write Jack Bordan, Chairman, Department of Engineering, Sir George Williams University, Montreal 25, Quebec.

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Also vacancy for Assistant Professor for teaching and research in Applied Mechanics. Advanced degrees required for both posts. Applications with full particulars should be sent to Head, Department of Mechanical Engineering, University of Saskatchewan, Saskatoon, Saskatchewan.

CIVIL OR ELECTRICAL ENGINEER — Graduate degree preferred, to teach in first three years of degree course in engineering. Emphasis would be on teaching, but an interest in research desirable. For details write to: Dean of Engineering, St. Mary's University, Halifax, N.S.

POSITION LIBRE

Les membres de l'Institut sont invités à faire application pour une position responsable sur le personnel le l'Institut Canadien des Ingénieurs. Les candidats doivent être ages de moins de 35 ans préférablement.

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Toutes communications seront considérées confidenciellement.

Personals

(Continued from page 63)

Kenneth C. Tiffany has been elected a director of Massey-Ferguson Limited. Mr. Tiffany joined the company in 1960 as vice president, finance. Previous to this, he had been vice president in charge of finance and a member of the board of directors of Burroughs Corporation, Detroit.

Terence H. Ussher has been appointed Chief Engineer at Garrett Manufacturing Limited. Mr. Ussher, formerly Avionics Project Chief, will hold responsibility for all engineering activity. Mr. Ussher has been associated with Garrett for three years.

R. S. Caulfield has been named general manager, West African Explosives and Chemicals Limited, Liberia, Africa. The company, which is building a plant in Liberia, was recently established by Canadian Industries Limited. Mr. Caulfield joined the technical services staff of C-I-L explosives division in Vancouver in 1951 and has held a number of positions in sales and technical services.

Marcel Delage has been named field representative for the Quebec Province Branch Office of the Master Builders Company Limited. In his new position, Mr. Delage wil be responsible for sales and field service activities in the Montreal area.

Gordon B. Morris has been appointed manager of construction for B.C. Hydro's Peace River Project. Mr. Morris was formerly general manager of Perini Pacific Limited. Mr. Morris has had many years of engineering and construction experience in Canada, the United States and South America.

Dr. Mervin J. Stewart has been appointed to the staff of Associated Engineering Services Ltd., in Vancouver. Dr. Stewart, a specialist in water and waste-water treatment and water and air pollution control, has had a 15-year background in consulting, research, teaching and public health. Recently associated with Engineering-Science Inc., in California, Dr. Stewart was project supervisor for industrial waste surveys and municipal refuse disposal analyses, and was in charge of development projects involving water and biological waste-water treatment processes.

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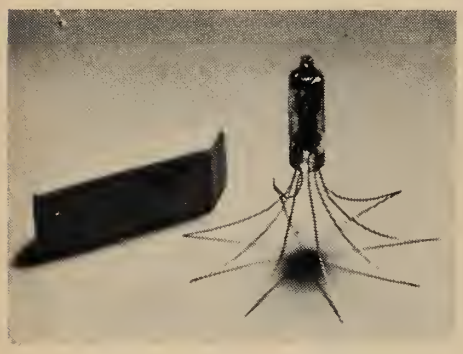
Industrial Briefs



Raytheon's Ck8096 Triode

A QUIET SUBMINIATURE heater-cathode triode, 20 db lower than conventional triodes in microphonic noise output due to reductions of structural resonances within audio frequency range, has been announced by Raytheon Canada Limited, Waterloo, Ont. The high mu CK8096, built to withstand impact shock of 450 Gs, acceleration of 100 Gs, and vibration of 10 Gs over extended periods, has been tested to operate at altitudes of 60,000 feet.

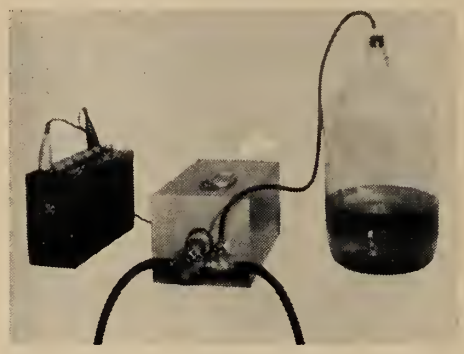
MONTREAL INDUSTRIES STUDY AIR POLLUTION. An association formed and financed by 18 industries in the east end of Montreal Island has established a permanent laboratory where effects of air pollution will be studied.

The Laval Industrial Association was formed two years ago by six oil refineries, three chemical plants, three copper plants, a cement plant, quarry, asphalt plant, reduction plant and a building products plant.

A permanent headquarters and laboratory was opened officially late in 1962 and there the main air sampling equipment will be located. The staff will depend upon data accumulated at 12 testing stations in Montreal's east end. In addition the staff will utilize various technical analysers, installed at member company laboratories, which analyze dust and identify hydrocarbons in the atmosphere.

Chairman of the Association is John Schloen, managing director of Canadian Copper Refineries Limited. Director of surveys is Dr. Louis-Philippe Roy. Past Chairman is John Rowan, M.E.I.C.

A CHEMICAL SOLUTION used to determine levels of atmospheric pollutants is inspected by John Rowan, M.E.I.C., past Chairman of the Laval Industrial Association at the opening of the Association's new permanent laboratories in Ville d'Anjou.



Fixed Time Simplex Sampler, Type FTS

AN AUTOMATIC SAMPLER for sewage and industrial waste has been introduced by the Permutit Company of Canada, Ltd., of Toronto. The samplers are said to provide more accurate and representative samples, and operate with trouble-free reliability. The Simplex Samplers are portable, compact, and require a minimum of maintenance. The samplers are available in five models, which can be supplied with integral refrigeration units.

Developments

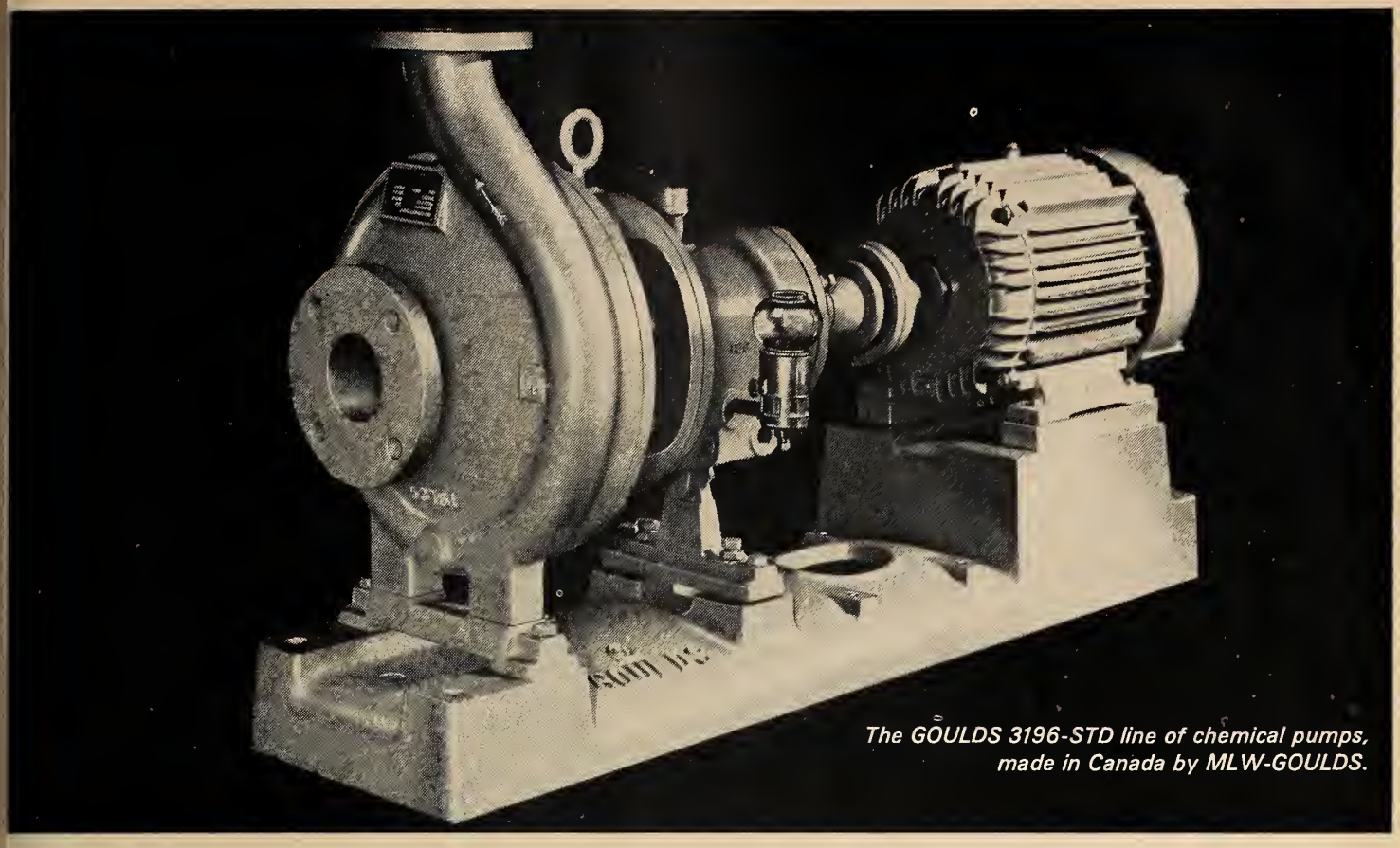
Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.

A NEW BOOKLET on low torque valves for high pressure service at high and low temperatures is available from Velan Engineering Companies, Montreal. This 32-page color publication describes and illustrates the peak performance valves manufactured by the company and gives vital information such as pressure/temperature ratings, test procedures and dimensions.

CRANE CANADA LIMITED has introduced the "Monarch", a new butterfly valve to the Canadian market. The valve is available in five sizes, three, four, six, eight, and 10 inches, in the wafer and two-flange type with molded-in seats. The wafer type is also available with replacable seat. It is rated for 200 p.s.i. at 200 F. The Teflon-Fiberglas bearings are immune to corrosion. A greatly reduced torque increases the life of the valve.

A $750,000 ADDITION to the Montreal plant of The Foxboro Company was officially opened November 29. The new two-storey structure provides for increased machine operations, an extensive sub-assembly area, and the enlargement and streamlining of the final assembly departments. The facilities include enlarged quarters for the Engineering Section which provides stronger backup to the production, application and panel engineering departments. A Quality Assurance Department and Training Centre for customers' instrument technicians are also features.

Foxboro's Expanded Plant



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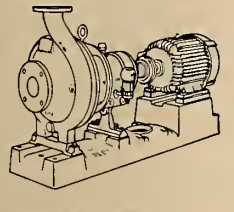

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Engineering Information Service

(Continued from page 60)

1961 TRANSACTIONS—AMERICAN VACUUM SOCIETY —THE 8TH NATIONAL VACUUM SYMPOSIUM, THE SECOND INTERNATIONAL CONGRESS, VOLS. I AND II, Edited by: L. E. Preuss, Permagon Press, London, £15 per set.

STRUCTURAL FOAMS, UNITED STATES NATIONAL ACADEMY OF SCIENCES, National Research Council, $5.

SUMMARIES OF RESEARCH ON THE FISH POWER PROBLEM AND RELATED WORK, FISHERIES AGENCIES OF BRITISH COLUMBIA, Department of Fisheries.

THEORIE ET PRATIQUE DES CIRCUITS DE L'ELECTRONIQUE ET DES AMPLIFICATEURS, J. Quinet, Dunod, Paris, 29 NF.

THE TECTONICS OF THE CANADIAN SHIELD, John S. Stevenson, University of Toronto Press, $6.50.

SYMMETRISCHE KOMPONENTEN IN WECHSELSTROMMASCHINERS, K. Paul Kovacs, Birkhauser Basel, Stuttgart, Fr. 36.

TRAVAUX ET OUTILLAGE A LA PRESSE, B. Wassilieff, Dunod, Paris, 13 NF.

TRAVAIL DES METAUX EN FEUILLES, A. Quescy, Dunod, Paris.

INTRODUCTION TO THERMODYNAMICS OF IRREVERSIBLE PROCESSES, SECOND EDITION, I. Pregogine, Wiley, N.Y., $5.

THE THEORY OF TRANSONIC FLOW, K. G. Guderley, Addison-Wesley, Reading, Mass., $9.

ROCK MECHANICS, H. R. Reynolds, Lockwood, London.

UBER DAS KUHLEN VON BETON, Mandry, Springer, Berlin, DM 28:50.

THE THEORY OF MACHINES, T. Bevan, Longmans, Toronto, $6.

THEORY OF ION FLOW DYNAMICS, D. G. Samaras, Prentice-Hall, N.J., $16.

STOCHASTIC SERVICE SYSTEMS, J. Riordan, Wiley, N.Y., $6.75.

SPECTROCHEMICAL ABSTRACTS, VOL. III, E. H. S. Van Someren & F. Larchman, Hilger & Watts Ltd., London, E 2.2.0.

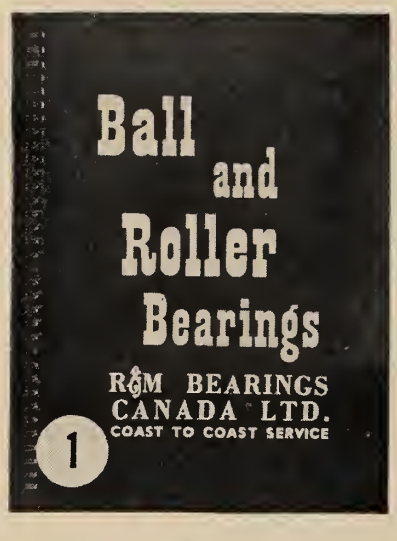
TABLES FOR ULTIMATE STRENGTH DESIGN OF REINFORCED CONCRETE BEAMS, JOISTS, SLABS, J. M. Cunningham, H. W. Keister, A. W. Newett, Jr., J. R. Phillips, CKNP Tables, Jacksonville, Fla., $4.95.

PROPERTIES OF SHAPES, PLATES, BARS AND TUBES, STEEL CONSTRUCTION SERIES, BOOK TWO, 1962, Canadian Institute of Steel Construction, $3.

STRUCTURAL STEEL MATERIAL SPECIFICATIONS, STEEL CONSTRUCTION SERIES BOOK ONE, 1962, Canadian Institute of Steel Construction, $2.

URBAN SURVIVAL & TRAFFIC: THE PROCEEDINGS OF A SYMPOSIUM 1961, Editor, T. E. H. Williams, E. & F. N. Spon Ltd., London, 60s.

USING THE SLIDE RULE IN ELECTRONIC TECHNOLOGY, C. Alvarez, Rider, N.Y., $2.50.



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(Continued from page 56)

Dr. MacPhail's topic was "Where is Engineering Headed?" In this talk, he demonstrated that engineering knowledge has not by any means reached an impasse and is literally only at the beginning of further tremendous developments. Mr. Waddington spoke on the necessity for Canada to have a senior engineering body which would be the learned society for the engineering profession. Although present-day engineering requires large numbers of specialists, the trend appears to be, in many cases, towards a consolidation of knowledge. Eventually, for instance, a structural engineer will enlist the latest electronic techniques in his stress analysis. Mr. Waddington claimed that the specialist may find his field of knowledge swept out from under him if he is caught unawares.

After the formal portion of the meeting, the students and graduates held an informal discussion on engineering careers.

KOOTENAY

I. Waterlow

At the fall meeting of the Branch G. R. McMeekin, Special Assistant, Administration Tadanac, Commonwealth Conference, was the guest speaker. Mr. McMeekin described the Duke of Edinburgh's Commonwealth Conference in general, and the aim, purpose, and operation of the Conference in particular. The section of the Conference with which he was associated visited the city of Peterborough before travelling west to Vancouver for the meeting.

Councillor L. Williams presented a report on Council Meetings, fee increase, and confederation.

PETERBOROUGH

C. L. Willcox

The Branch offers annually a prize and certificate of merit to each of the city high schools for presentation to the student achieving the highest class standing in mathematics and science. The prizes are made known to the students at the beginning of each school term to serve as an incentive to improve the level of scholastic achievement in these subjects. During November commencement exercises, the following presentations were made: Kenneth Lewis of Adam Smith Collegiate Grade 10 Mathematics & Science; Donald Genner of Kenner Collegiate in Grade 11 Mathematics & Science; Terrence O'Donnel of St. Peter's Senior High School in the International Mathematics Contest; Edred Flak of Peterborough Collegiate in Grade 10 Mathematics & Science. Presentations and arrangements for the awards were made by chairman Bill Durant and Executive members John Bright and Tod Willcox.

(Continued on page 76)

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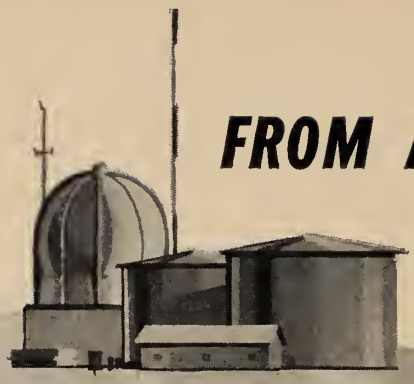

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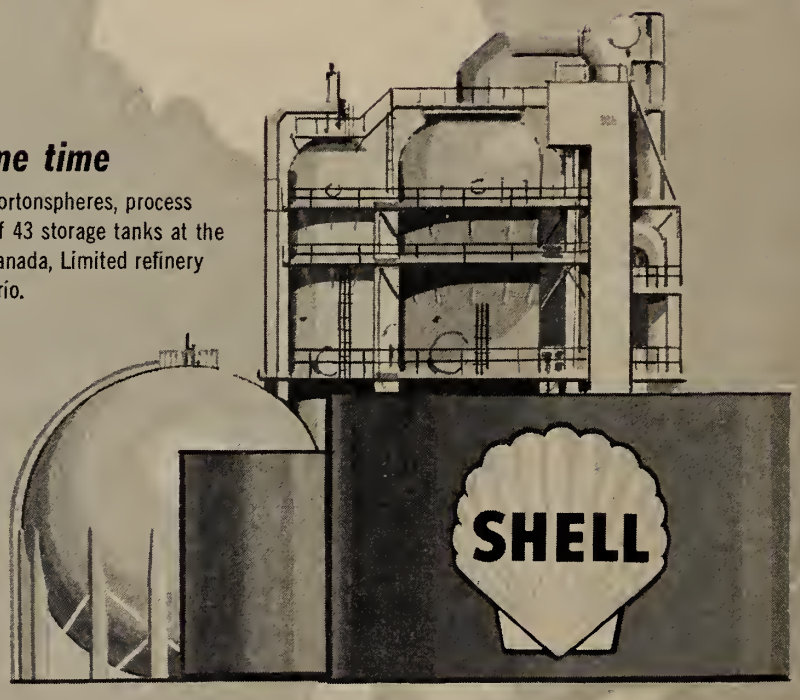

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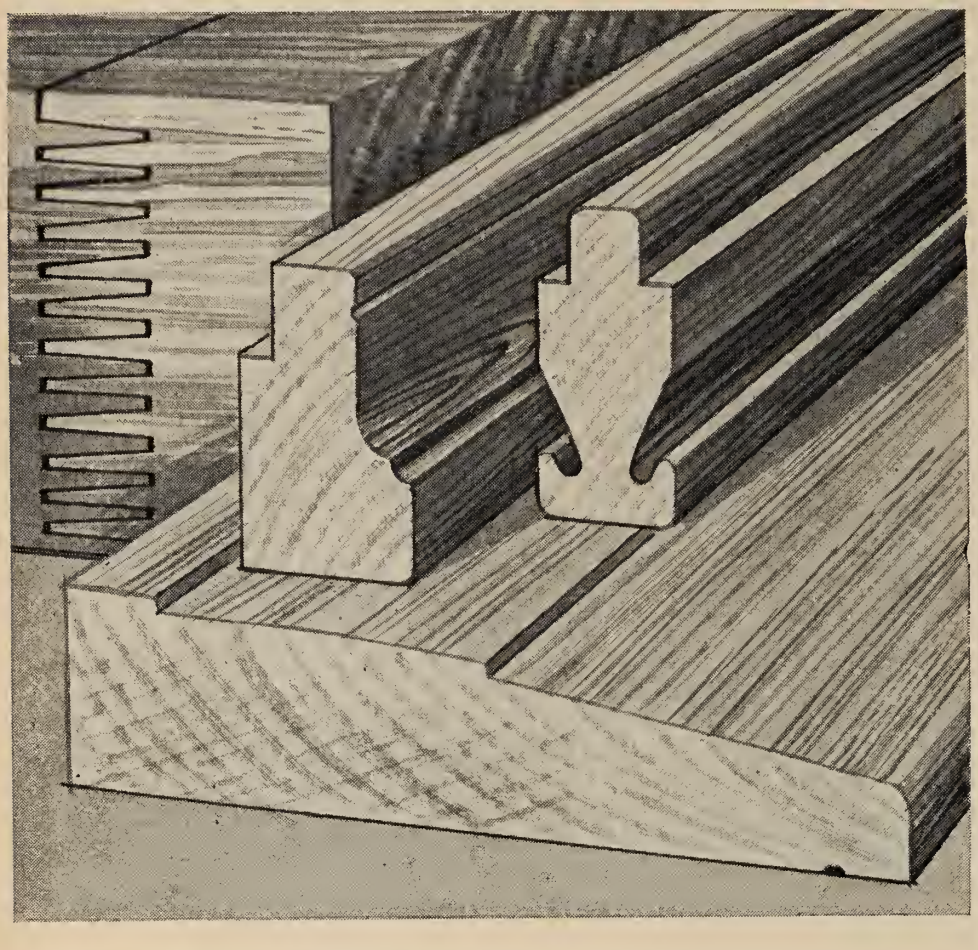
(Continued from page 73)

LETHBRIDGE
R. J. D. Gardner

The November 23 meeting of the Branch took the form of a "Senior Member Night" dinner meeting with 40 members present to honor senior Lethbridge and district engineers. J. M. Campbell, M.E.I.C. retired member of the CPR engineering staff, who has a wide knowledge of the early days of the Branch and its members, acted as master of ceremonies. The featured speaker of the evening introduced by C. S. Clendening, was P. M. Sauder, Hon. M.E.I.C., who played a part in the development of southern Alberta and the city of Lethbridge. He used the biographies of three western Canada pioneers, Col. John S. Dennis, Charles A. Magrath, and J. T. Watson, to develop his talk, "The Early History of Engineering in Southern Alberta". Col. Dennis and his contemporaries had to refute the statements of men such as Captain Palliser who classified that portion of the western plains south of the South Saskatchewan River as "part of the great American desert, not suitable for agriculture". This area is now one of Canada's richest agricultural regions. C. A. Magrath conducted engineering work in the early coal mines and irrigation works of the district, and was instrumental in the incorporation of the town of Lethbridge. He was the town's first mayor. Jack Watson played an important part in modernizing power plants in several south Alberta centres, and was Lethbridge's first city manager. Mr. Sauder paid tribute to all the early engineers and land surveyors of the district for their part in the opening up of the West.

Mr. Sauder was thanked by J. H. Graham, M.E.I.C. local manager of the St. Mary-Milk Rivers development.

Entertainment for the evening was arranged by G. S. Brown. A well-known barber-shop quartet provided several renditions of local favorites, and the traditional Branch sing-song was led by E. A. Lawrence and accompanied by Mrs. G. Brown.



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LAKEHEAD
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J. Cook, M.E.I.C., Chief Engineer at the Barnett, McQueen Company in Port Arthur, and J. Coughlin, M.E.I.C., Chief Field Engineer, C. D. Howe Company, were the guest speakers at the November 1 meeting of the Branch. They provided a commentary on the film, "Disaster and Triumph" which dealt with the collapse, in the fall of 1960, and the rebuilding of the grain annex in Port Arthur owned by the United Grain Growers of Canada.

Revised by-laws were presented and discussed by the members.

LONDON
E. T. Skelton

Fall activities of the Branch include a joint meeting with the local A.P.E.O.; the President's visit, November 7; and a joint meeting with the Woodstock Branch, in Woodstock, November 27 which included a tour of Schell Industries Limited's pre-stressed concrete plant. The annual Feather party was held December 12.

This year the Branch is sponsoring a Professional Development Course at the University of Western Ontario. The course consists of 10 two-hour lectures on Political Science. There are 50 members registered in the course.

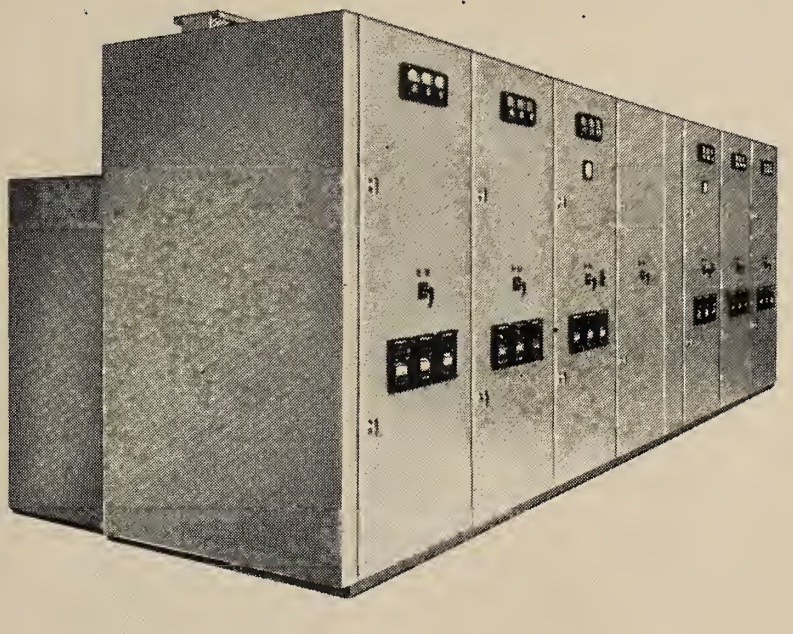
LOYOLA
Origene Roy

The General Secretary of the Institute was the guest speaker at the Branch's first meeting held in mid-October. In his address, Mr. Page outlined the history of the Institute, and emphasized the facilities and benefits available to members. New members of the Branch were initiated by Mr. Page.

The executive for the 1962-63 season include: Dick Stoddart, Chairman; Glenn Morrison, Vice-Chairman; and Origene Roy, Secretary Treasurer.

metalclad air circuit breakers

for Alberta hospital



This metalclad switchboard was made in Canada by Pioneer Electric for the Royal Alexandra Hospital, Edmonton, Alta. A 7-panel unit, it contains Pioneer Series DST, 15 KV 500 MVA air circuit breakers, and is part of an extensive range of equipment supplied to Sunley Electric Limited. Consulting engineers were Allsopp, Simpson and Morgan. ■ Pioneer DST air circuit breakers are available in all standard 5 KV and 15 KV ratings with solenoid or stored energy mechanisms. Simple design and efficient positive action assures dependable protection and serviceability. Advanced insulating and molding techniques include: Polestiglas® molded-on bus insulation; Pioneer epoxy molded current transformers; Pioneer epoxy molded primary disconnect shrouds; Pioneer epoxy molded potential transformers. ■ The DST series offers a full range of voltage and interrupting capacities to meet your system requirement. All components are coordinated and engineered for the application. If you would like further details, call or write us today. Pioneer Electric Limited; Vancouver, Red Deer, Regina, Brandon, Winnipeg, Toronto and Lachine.

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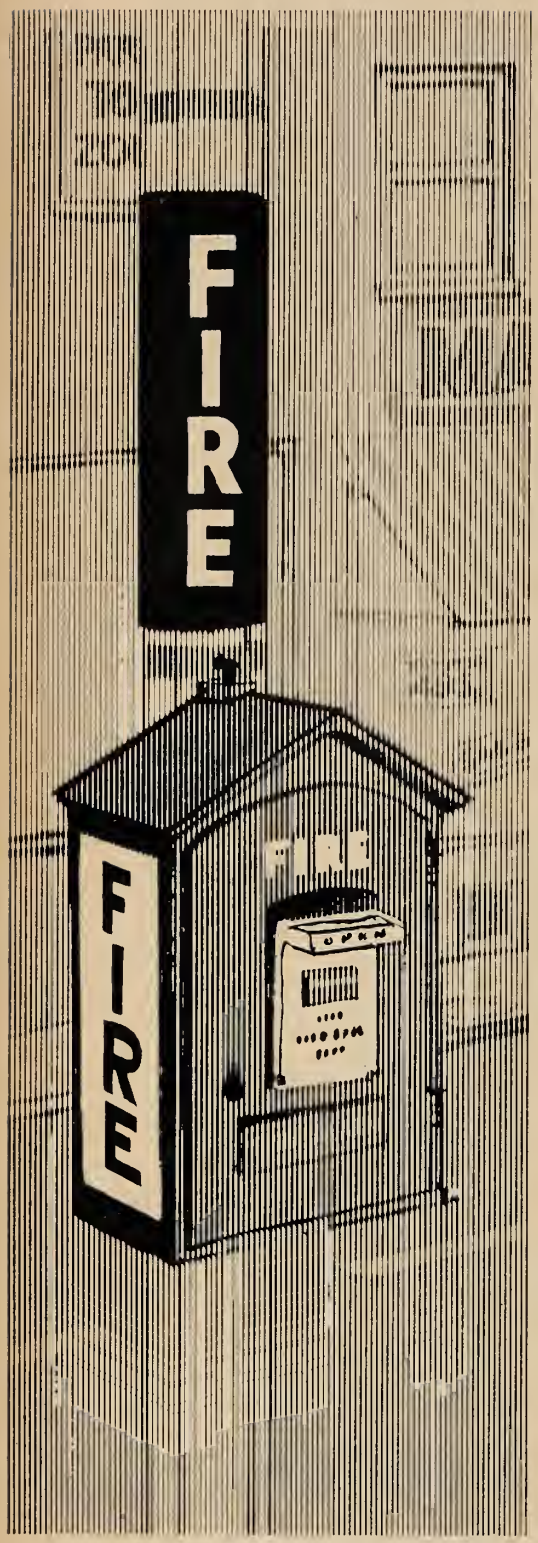

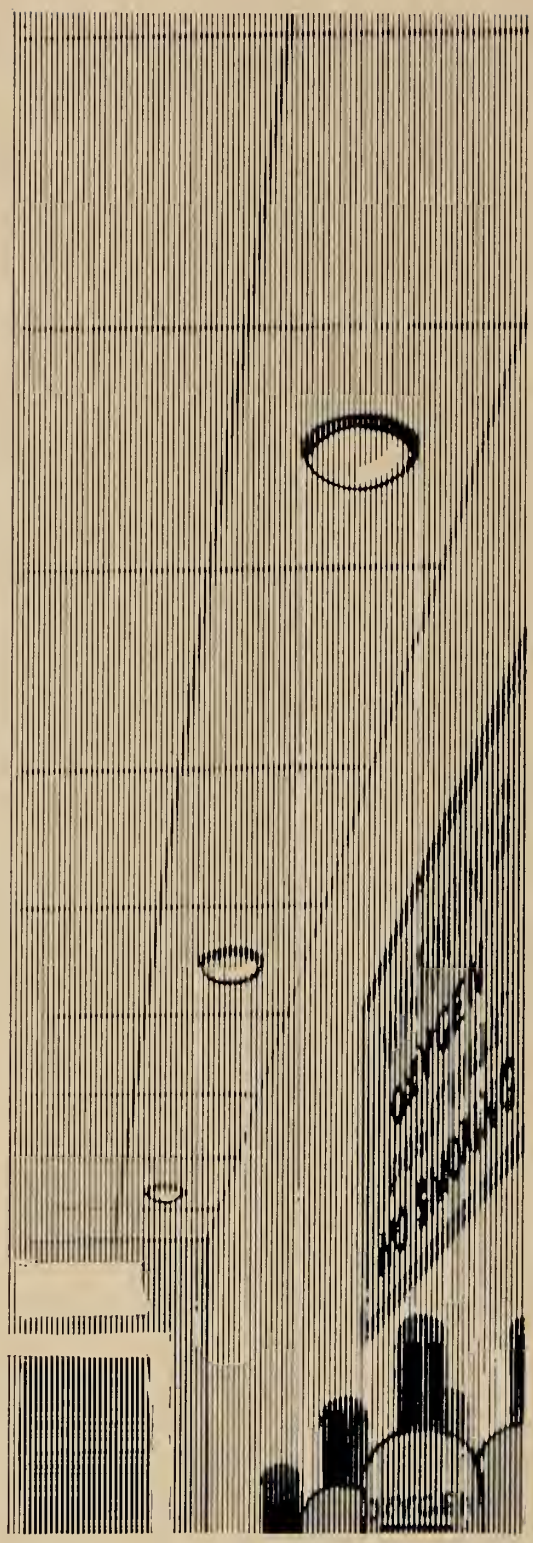

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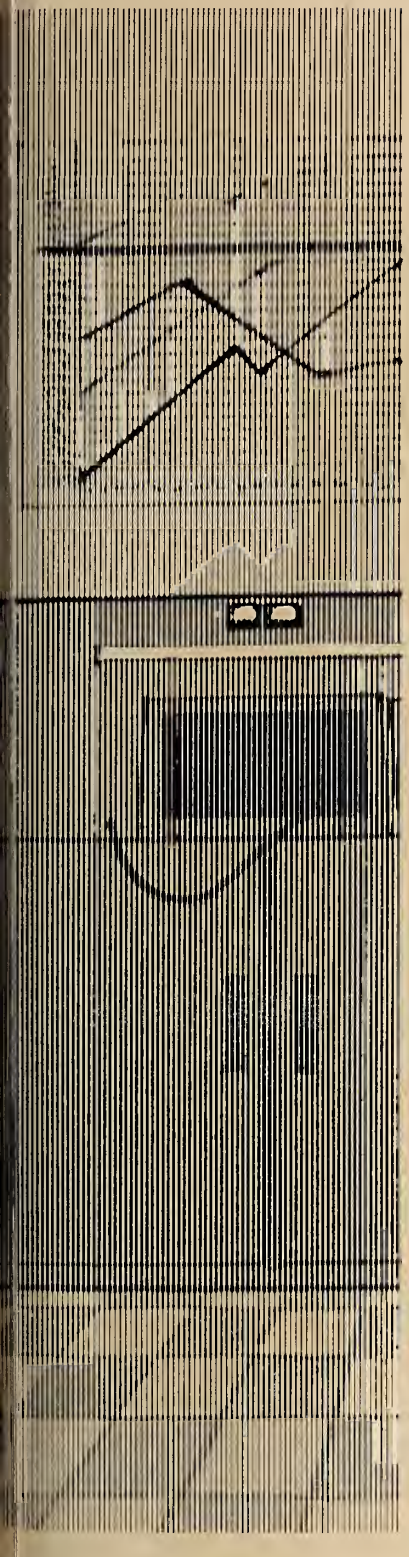

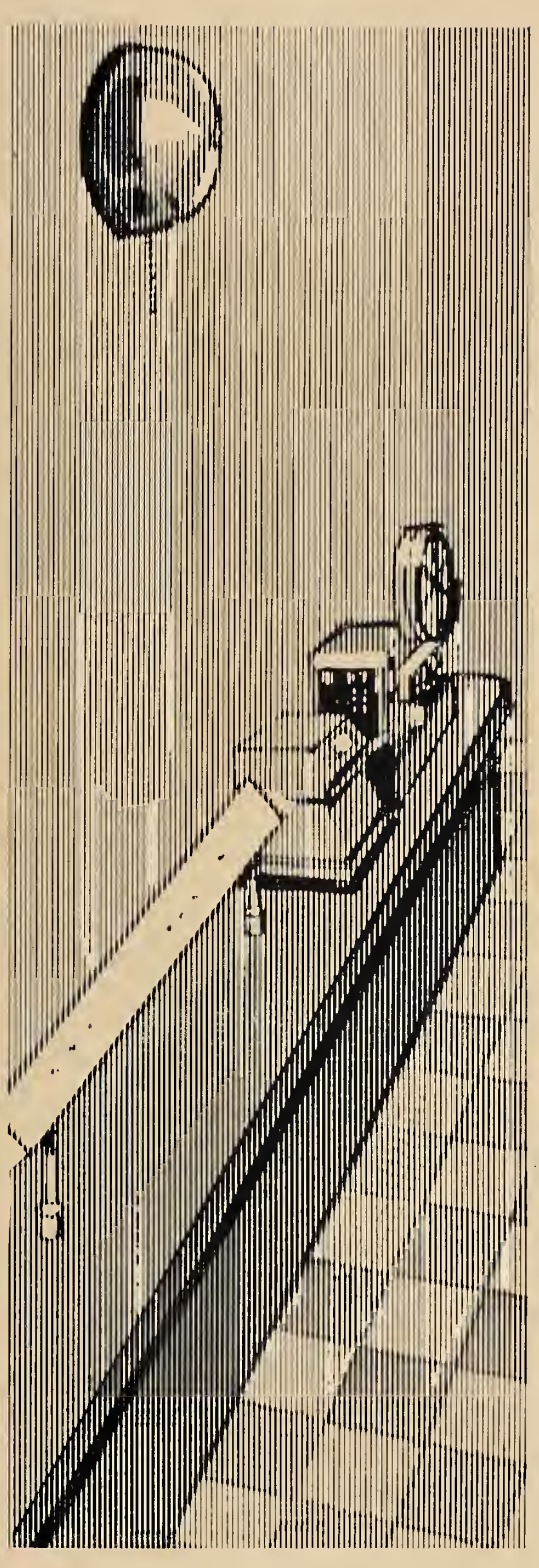

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Discussion

(Continued from page 43)

PROGRESS IN POWER DISTRIBUTION

R. E. Jones,
Contributing Editor,
Electrical News and Engineering

The Engineering Journal,
October, 1962, page 55

Discussion by
Archie Benjamin, M.E.I.C.
Distribution Engineer,
Quebec Hydro-Electric Commission

Mr. Jones not only presents a concise history of power distribution in general, and its various components, but also brings us up to date with the trends of modern practice. This paper can well be used by distribution engineers as a reference to acquaint new engineers with a suitable background of the subject, which can be useful in planning new concepts. A knowledge of the evolution of distribution practice is often necessary to understand why we do certain things.

I am intrigued by the author's reference to "transmission" as a branch of "distribution". As a distribution man myself, I will go along with this, but I am sure that some transmission engineers may not agree. It seems that some feel that the higher voltages involved in transmission often sets this "branch" apart, and the problems involved cannot be mixed with those of distribution. However, the author justifiably includes transmission (both overhead and underground) in his paper on power distribution. With primary voltages increasing over the years, it is often difficult to define the voltage limits of distribution and transmission.

I feel that Mr. Jones' reference to the use of higher utilization voltages is an over simplification of the problem, and that the subject is still a controversial one in both Canada and the United States, with the hope that some agreement will be reached in the near future. This has been under study in Canada by a joint CEA — AMEU — CEMA committee and I would refer you to the conclusions reached at the May 7, 1962, meeting of this Committee regarding the choice of higher utilization voltages. These are not entirely in line with those indicated in the paper. I understand that these conclusions will be widely publicized in the industry.

In the section on underground distribution, Mr. Jones refers to the European practice of direct-burial of cables and the use of conduits in North America. It should be noted that some utilities on this side are using direct-burial for some high voltage lines in urban areas and also for distribution in residential developments; although the downtown areas in most large cities are provided with conduit systems for flexibility.

I am particularly interested in Mr. Jones' forecast for the year 1986. It appears that he looks for a streamlining of the overhead distribution system, using wood poles at the rear of the buildings with crossarms and other attachments, and the possible use of aerial cables.

Although this would improve the appearance of the overhead system and still maintain an efficient installation, it is doubtful if this would satisfy the increasing demand for complete underground by town planners and other interested parties. It is well known that poles in the rear are also often found objectionable from an aesthetic point of view. It may be that an overhead system as forecast by Mr. Jones will be used in many cases, while underground will be used to an extent, depending on a particular area's requirements. In any event, because of the higher cost of underground, there will have to be a compromise between appearance and economic efficiency.

The present great interest in aesthetics of distribution in Canada is indicated by a Symposium on the subject (sponsored by the Canadian Electrical Association) held in Ottawa on May 2, 1962, with papers presented by representatives of the following bodies: Canadian Electrical Association, Association of Municipal Electrical Utilities (of Ontario), Royal Architectural Institute of Canada, Telephone Association of Canada, and the Town-Planning Institute of Canada. Other organizations represented, and who participated in the discussion, were: Canadian Association of Real Estate Boards, Central Mortgage and Housing Corporation, Community Planning Association of Canada, and National House Builders Association.

Discussion by
E. A. Stanger,
Vice-President, Planning,
Southern Canada Power, Co. Ltd.

With regard to distribution transformer taps, the new C.S.A. specification C2-1959 calls for one above and two below rated voltage. We have found this changs from

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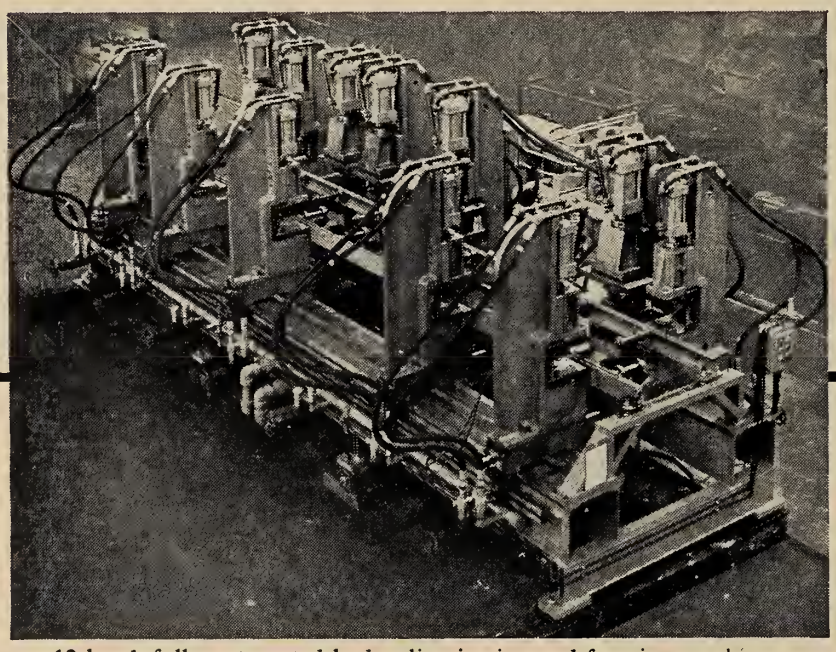

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the old standard to be very useful, particularly on long feeders where the bus voltage is maintained at a higher voltage than nameplate rating.

Automatic oil reclosers have done a good deal to improve continuity of service, particularly with co-ordinated protection on the feeder and its tapoffs underground distribution seems to be showing a trend for subdividers to pay for the differential in cost recouping by adding its share to the selling price of each lot.

Voltage regulators and capacitors make a good team for controlling feeder regulation. I agree with Mr. Jones that pole-mounted regulators are only a temporary measure until a proper remedy can be worked out and applied.

We find that outdoor metering, particularly for seasonal customers, saves time and customer annoyance.

Mr. Jones mentions in his look into the future an encapsulated transformer on the premises of heavy consumers. There is a development of this type under field test in the United States of a plug-in unit combining metering and transformer fed by underground co-axial cable fused preferably at the pole.

Quadruplex conductors make a very neat secondary system and can be used on long span construction reducing the number of poles per mile of secondary.

Discussion by
P. A. Duchastel, M.E.I.C.

The paper contains historical information of great value and will become an authoritative document to the student of electric distribution in Canada, as well as in other countries. It is possible that some of the views given as to the reason for certain past practices will be questioned by some of the elders in our industry.

Under the chapter "Prognostication" time only will tell if the author has hit the target. There is one omission which I feel should have been covered and that is the matter of feeder loading. There was a time when 1500 kw. was considered a top value, this has now climbed with higher voltages to somewhere between 6,000 to 10,000 kw. With the advent of 25/14.4 kv distribution will this reach 15,000 kilowatts?

Other aspects that bear further discussion include continuity of service, rate of growth of underground distribution as compared to overhead, and finally aesthetics in overhead construction. In this respect will spacer type cable be used exclusively?

I wish to thank Mr. Jones for his very worthwhile contribution, which adds to a fruitful career in the field of electric distribution.

Discussion by
G. H. de Witt, M.E.I.C.
Chief Engineer,
Commercial and Distribution Department,
The Shawinigan Water & Power Company, Montreal

Mr. Jones mentioned the use of reclosers and their ability to clear transient faults. I should like to carry this one step further and mention some aspects of co-ordinated protection. Manufacturers, through their research and development programs, have made available high-speed, low-cost breakers and reclosers. These, if used in conjunction with other protective devices, such as fuses and sectionalizers, will result in a co-ordinated scheme and reduce customer outages to a minimum. The combination of protective devices in a co-ordinated scheme will depend on the feeder capacities and types of loads served. What may be ideal for one feeder will be unsatisfactory for another at the same voltage. The ultimate scheme can only be arrived at by a thorough understanding of the customers and area served. As distribution feeder loads increase, with increases in primary voltage, this problem of co-ordinated protection becomes even more important, and distribution engineers are now conscious that this is a field where more system improvements may yet be effected.

Secondly, Mr. Jones mentioned the use of aerial cable with primary circuits to improve appearance and reduce tree problems, with the comment that the trend would be towards the "spacer" aerial cable. Aerial cable, either pre-assembled or spun on the job, has not been met with any great amount of enthusiasm in Canada. The main disadvantages have been cost, difficulty in locating faults, and time to repair faulted cable. The "spacer" type aerial cable has eliminated or reduced these disadvantages and will no doubt be accepted for 3-phase primary circuits where aerial cable is desired. It is noted that recent E.E.I. papers report an increase in the use of this type of aerial circuit in the United States.

(Continued on page 82)

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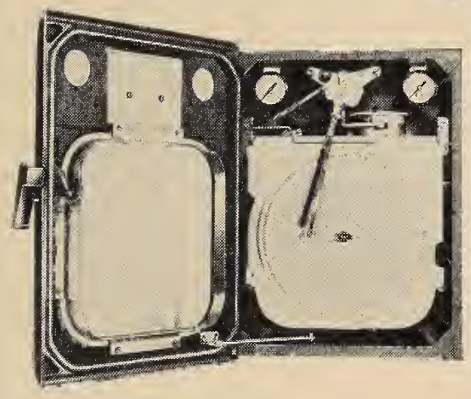

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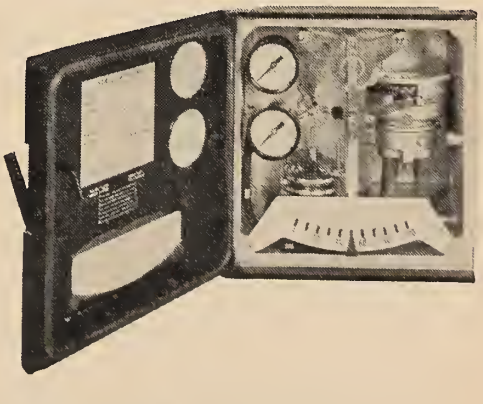

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Discussion

(Continued from page 81)

It is my feeling that this trend will spread to Canada in the near future, as pole attachments, spacers, and working problems are improved or solved.

Author's Reply

In reply to Mr. Benjamin's comments regarding buried cables it should be noted that while the pull-in system is the general practice there are some directly buried systems on this continent but it is largely in the residential areas as noted in the paper.

The forecast for pole lines is not "with crossarms" but "with few crossarms". It is realized that a streamlined overhead system will not satisfy all but it will reduce the demand for the more costly underground.

Mr. Duchastel would like the future loading of feeders included in the forecasts. This is a subject worthy of a paper by itself.

The load limitations on feeders at the lower primary voltages was largely due to losses and heating. With the higher voltages the losses are greatly reduced and heating is no problem but consideration is given to service security — how many customers will be out of service in the event of a circuit failure?

Spacer cable may not be the ultimate answer to pole-top simplification but it is the best proposal made available so far where there is more than one wire to the circuit.

Mr. Stanger points out the value of taps on distribution transformers but that applies to only a small proportion of the transformers on a system. As pointed out in the paper it is not economical to install taps on all transformers for the sake of the few that may require them when alternative methods are available.

Mr. deWitt has a good point in highlighting the necessity of proper co-ordination of protective equipment. It is a fallacy to expect satisfactory operation when reclosers of various makes and fuses are mixed up on a line without a proper consideration of the loads and their nature and the time-current characteristics of the protective devices. Properly installed reclosers on a rural line can save many hours of costly travel, particularly when the work must be done at premium rates.

The use of aerial cable has been held back due largely to the comparatively high cost. Faults can be readily located with the rural condenser discharge method. However with the spacer type cable the fault problem is pretty well eliminated. We still have the cost but many new methods are costly when first introduced. The cost of a spacer cable installation is inherent in the basic design. There are enough spacers to prelude the conductors swinging together but we insulate the entire length of conductor instead of using the cheapest of all insulations — air. The only place at which the insulation may be required is at the spacer — perhaps three per cent of the length of conductor. The saving would be great if bare conductor were used with sufficient insulation in the spacer itself where it is actually needed. In fact a spacer of porcelain is now on the market but it may not have the necessary creepage distance.

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ABSTRACTS

Division Papers

(Continued from page 48)

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E. W. Whitman, S. A. Reipas and R. M. Hardy

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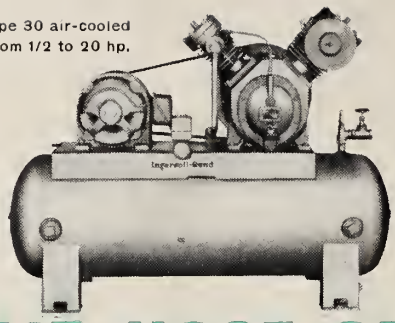

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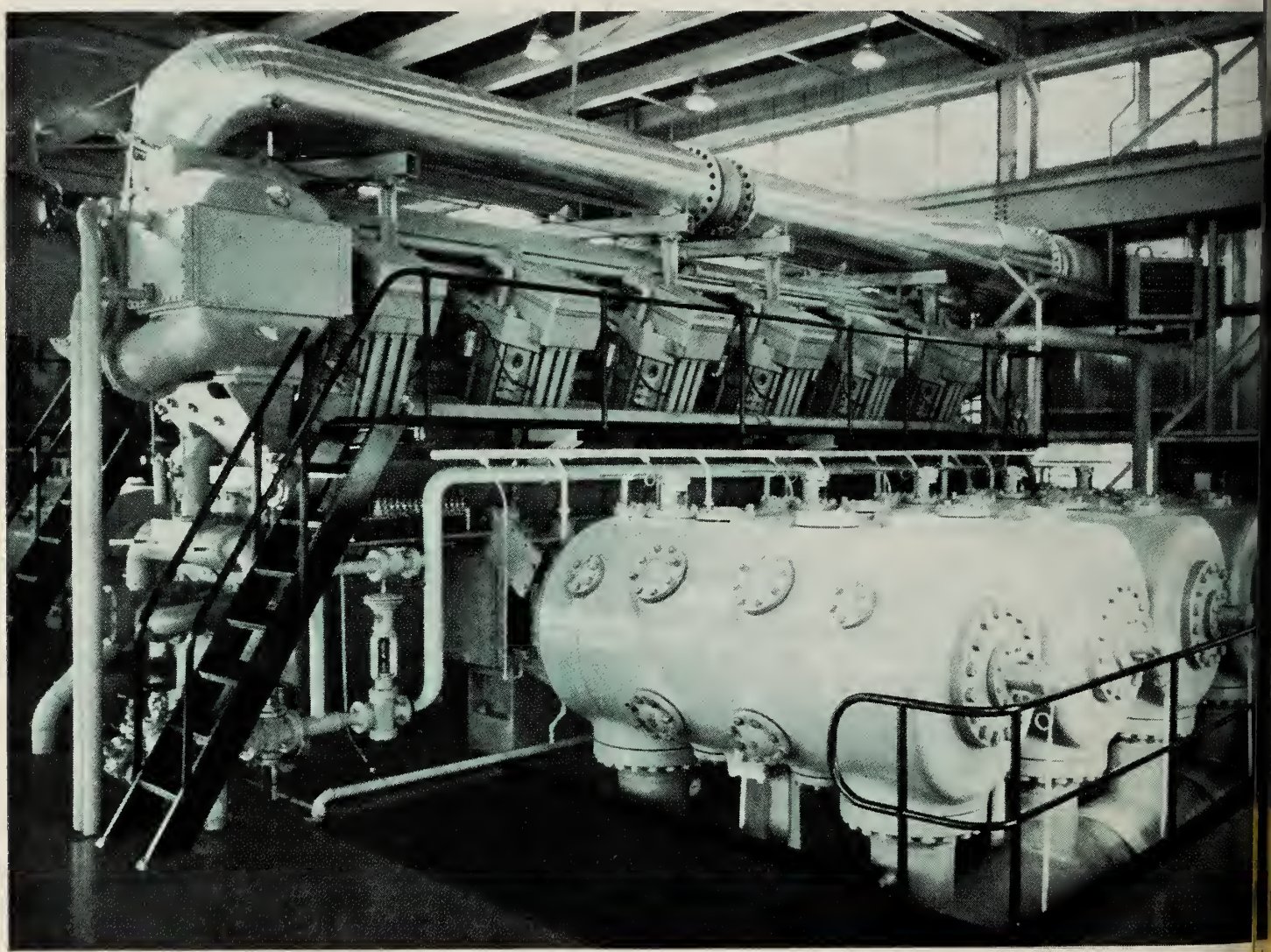

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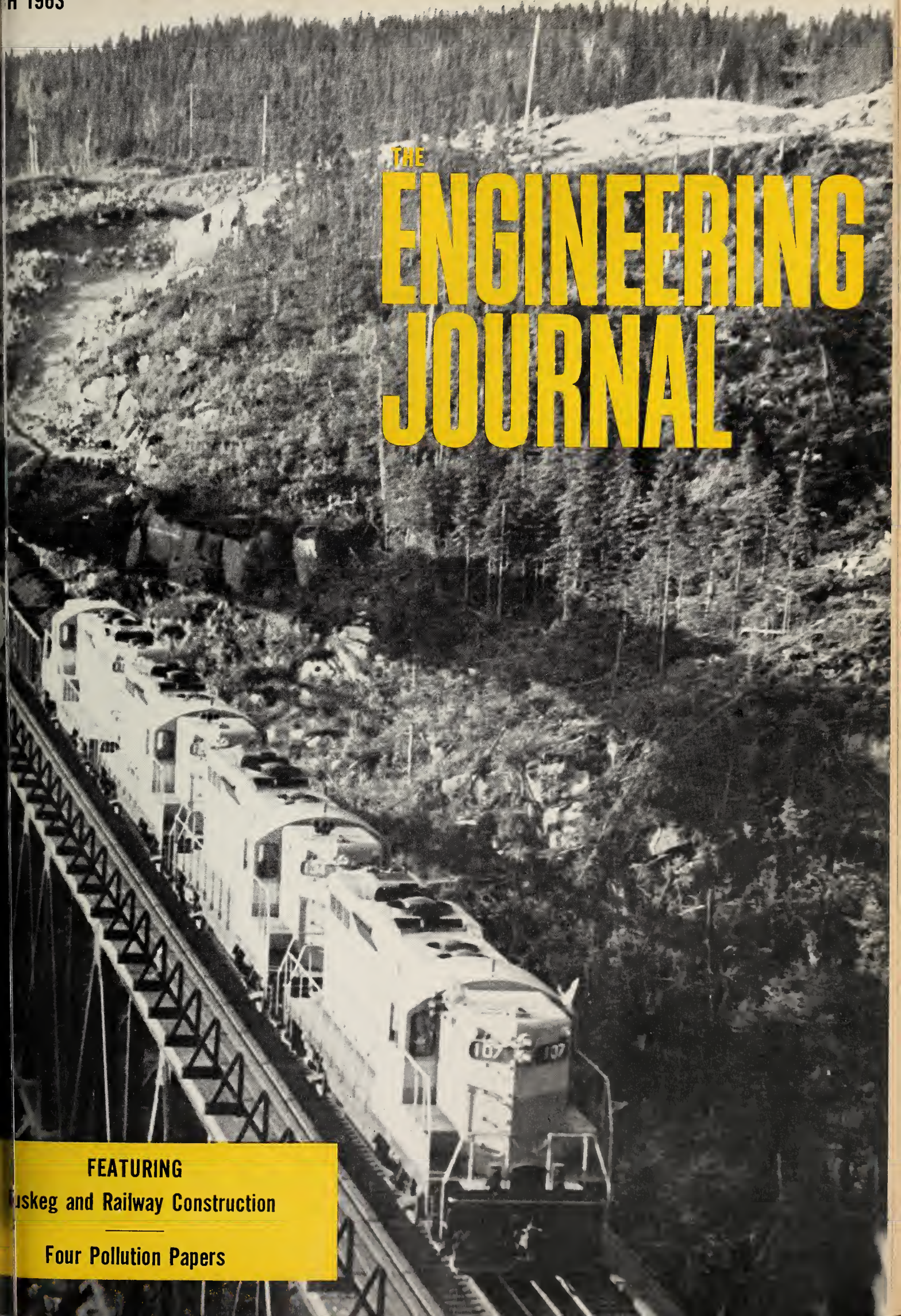

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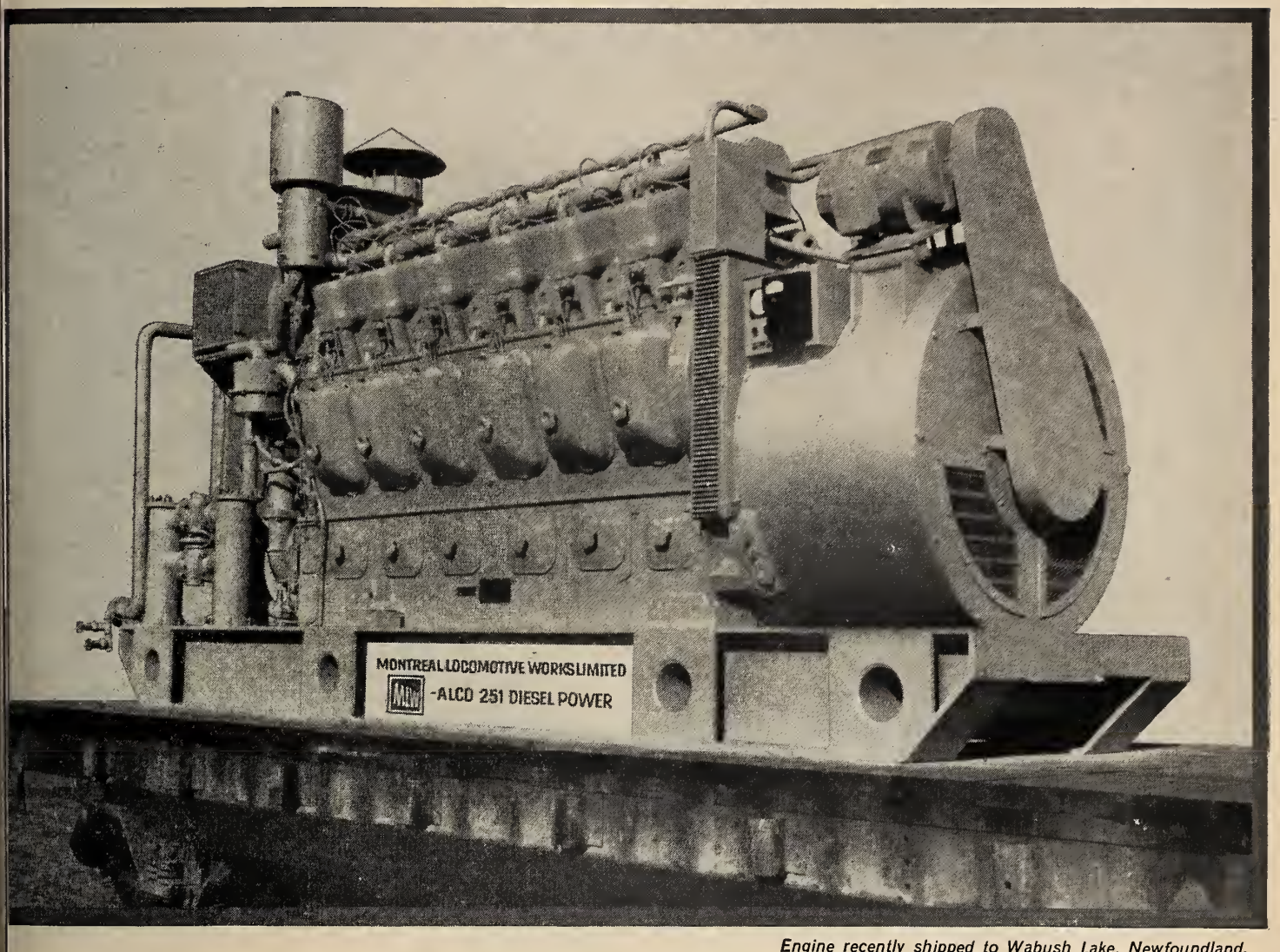

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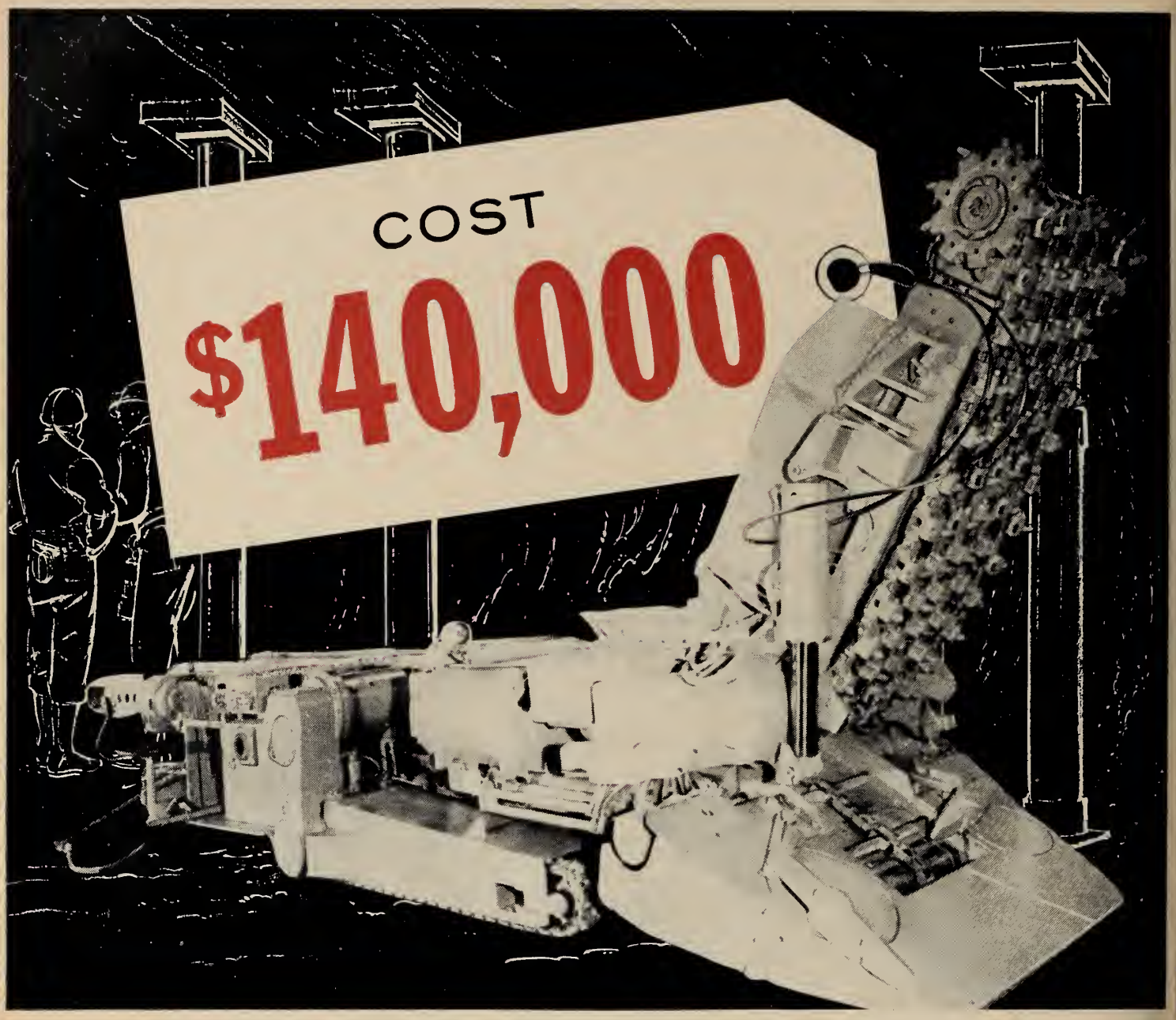

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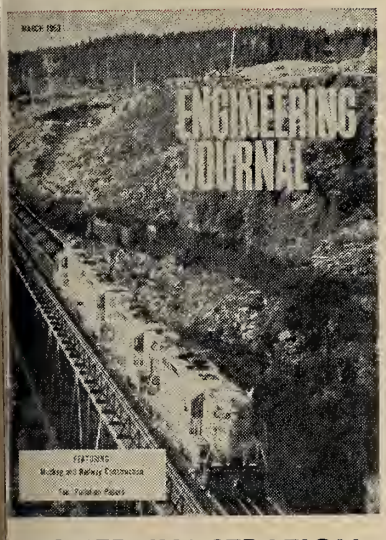

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The success of a tough engineering job is shown on this month's cover. The lead paper deals with Muskeg and the Quebec North Shore and Labrador Railway. Shown is a train heavily loaded with iron ore on its way to Sept-Iles.

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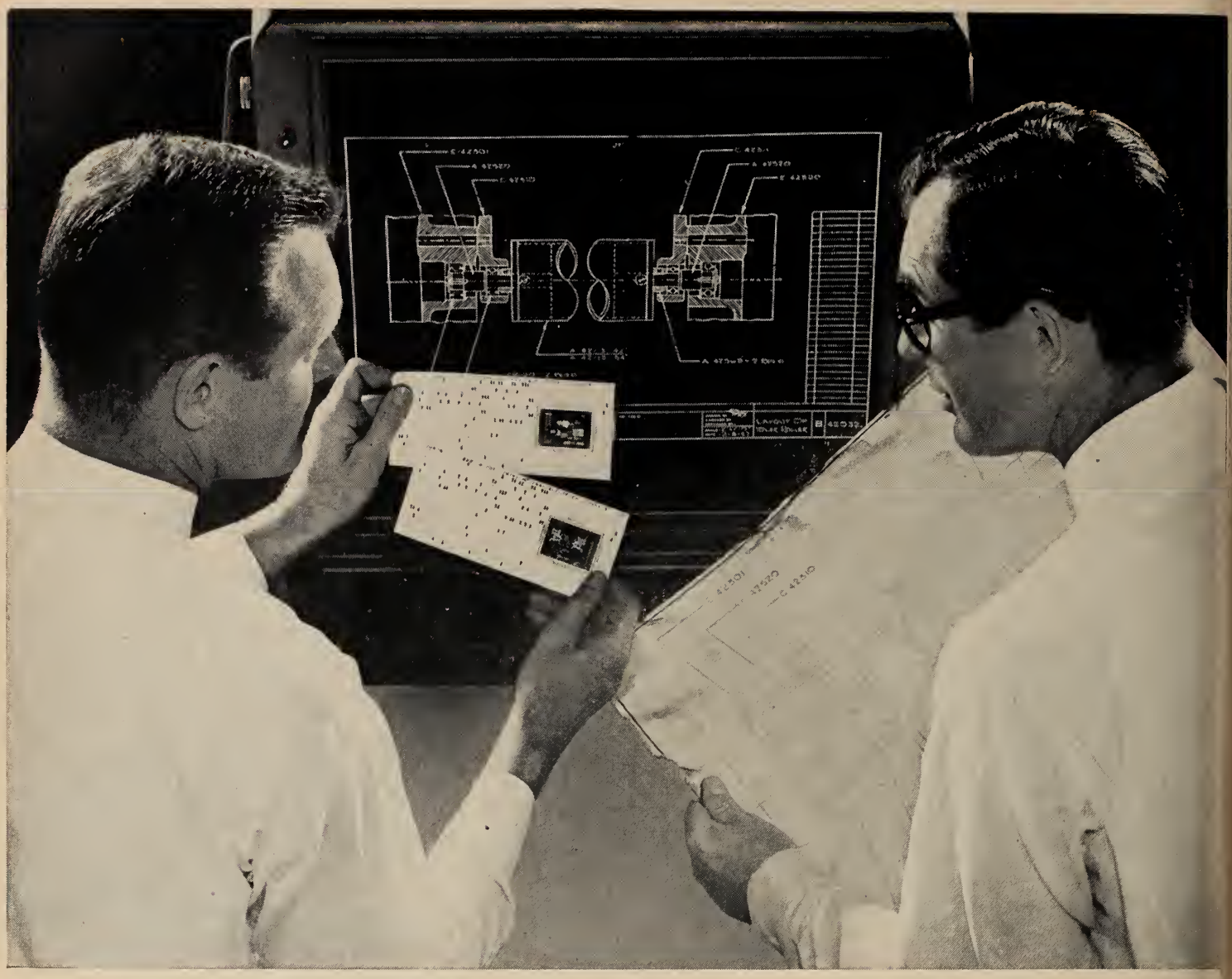

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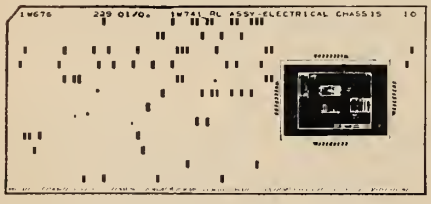

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IN THIS ISSUE

The Quebec North Shore and Labrador Railway, a subsidiary of the Iron Ore Company of Canada, links Schefferville and Sept Iles, Que. In operation since 1954, this was the first railroad to serve the interior of the Labrador-Ungava peninsula. Because of its unnavigable rivers and streams, the rugged terrain which extends inland from the Gulf of St. Lawrence for about 100 miles presented a natural barrier to the interior plateau. Another obstacle occurred on the plateau itself in the form of extensive areas of muskeg. In his paper, **Muskeg and the North Shore and Labrador Railway, B. M. Monaghan,** Chief Engineer with the railway, describes the nature of the terrain crossed by the railway, and includes an account of the construction procedures adopted.

"No form of human activity is possible without air and water," Dr. Lucien Piche said in opening a panel discussion on industrial plant pollution. "I do not expect that anyone will question such a statement nor that it would prove very stimulating in opening a planned discussion. This is, of course, because we have grown in a context of inexhaustible water supply and unfailing atmosphere."

Dr. Piche, who is Vice-Rector of University of Montreal, made his remarks on November 23, 1961, at a discussion sponsored jointly by the E.I.C. and C.I.C. Montreal Chemical Engineering Program Committee.

The Meeting Chairman was Dr. E. Nenniger, Jr., Chairman, Chemical Engineering Program Committee, E.I.C., Montreal. Dr. Piche was Moderator.

A feature in this issue of the Engineering Journal is the series of four papers presented then. The four panelists, and thus our four authors, were:

Dr. Norman E. Cooke, Principal Chemical Engineer, C.I.L., who spoke on **Industry's Viewpoint on Industrial Waste; Douglas Jones,** Executive Secretary, Technical Section, Canadian Pulp and Paper Association, whose remarks concerned **A Pollution Policy; Dr. L. P. Roy,** Survey Director, Laval Industrial Association, who described **Results of a Co-Operative Approach to a Water Survey; and A. L. Van Luven, M.E.I.C.,** who spoke on **Governments' Role in Pollution Control.**

"It is a clear advantage to any society to have a fairly high proportion of imaginative minds who can grasp the overwhelming burdens of top administrative posts", says **John G. Dickinson, M.E.I.C.,** in his paper, **Productivity & Economic Growth.** "It is also a clear advantage to any society to have and use learned societies as a springboard and sounding board on questions of national policy and approach". Mr. Dickinson, Systems Development Manager with Northern Electric Company, was executive director of the National Productivity Council for more than a year. He joined Northern Electric in 1946 after having received a B.Sc. degree in Electrical Engineering from the University of Manitoba. He also obtained a degree from Harvard's School of Business Administration.

The Design and Construction of The Shawinigan Water and Power Company's 345 KV Transmission Line Using Guyed and Rigid Structures, by V. F. Crowley, Manager, Transmission Division, The Shawinigan Engineering Company and **S. T. Rudkin, M.E.I.C.,** Senior Design Engineer with the same company, described the background and the terrain traversed by the line, and reviews the studies leading to the decision to use a combination of guyed and rigid structures. A discussion of the mechanical and electrical design features of this line which reaches from Ile Maligne to Quebec City, and a description of construction methods employed are also given. The authors also provide a summary of the advantages of the guyed portal over the rigid type transmission line tower.

Discussions

Research and Development Objectives, by **A. B. Hunt,** Vice-President—Research and Development, Northern Electric Company Limited is discussed in this issue by the following: **W. S. Kendall,** Director of Marketing and Product Planning, Computing Devices of Canada Limited; **J. L. Orr,** Defence Research Board, Ottawa; and **Arthur C. Stewart.**

T. D. Northwood's paper, **Rail Vehicle Noise,** is discussed in this issue by **A. T. Edwards** and **Ian J. Billington.**

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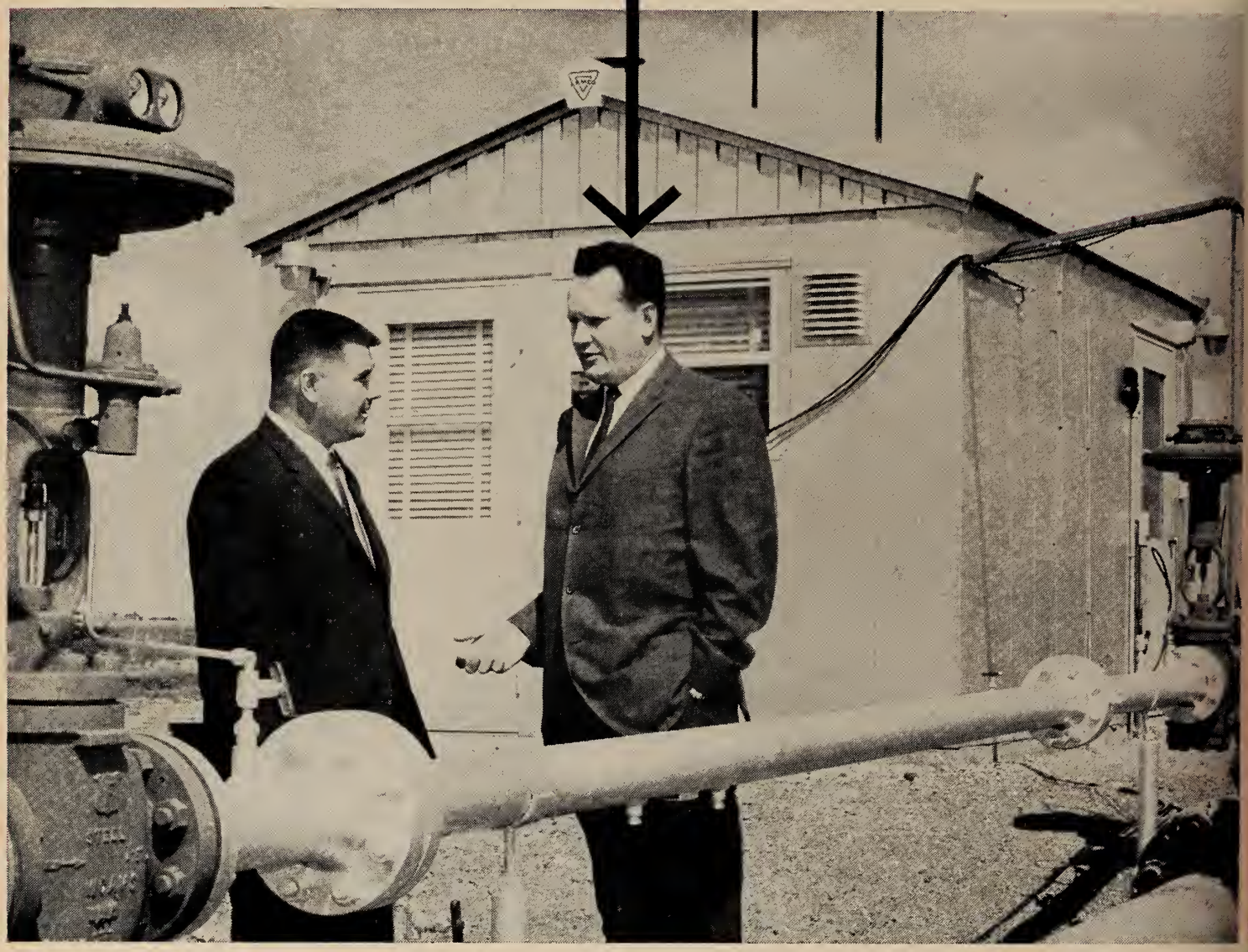

A gas terminal building is examined by J.Tkachuk of the Saskatchewan Power Corporation and Armco's Jack E. Moore at Regina, Saskatchewan.

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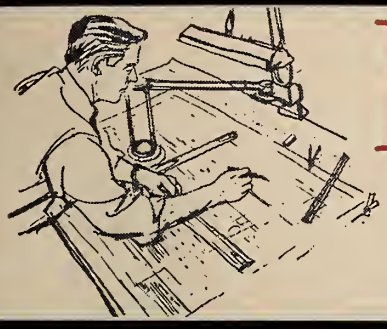

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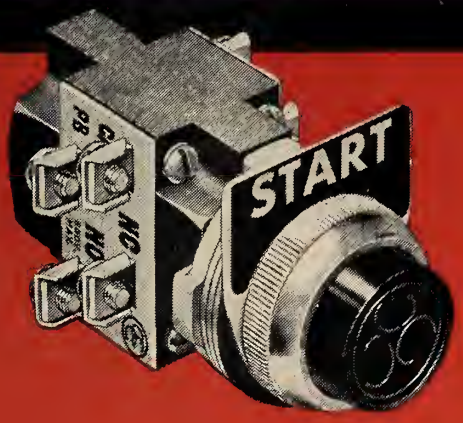

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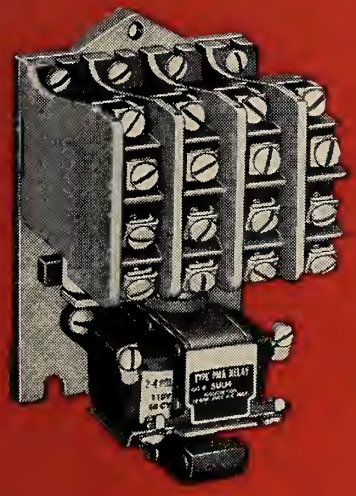

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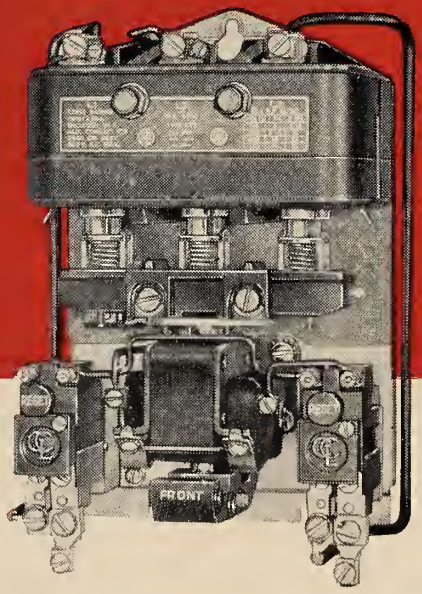

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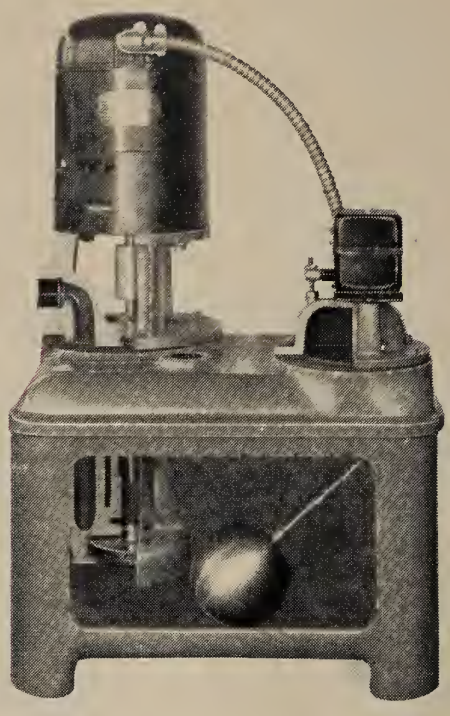

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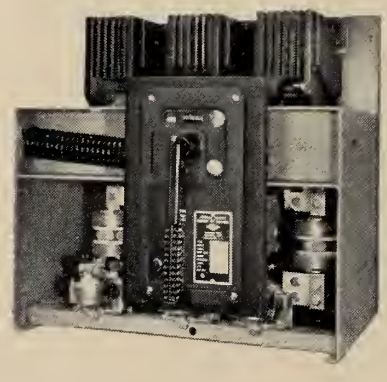

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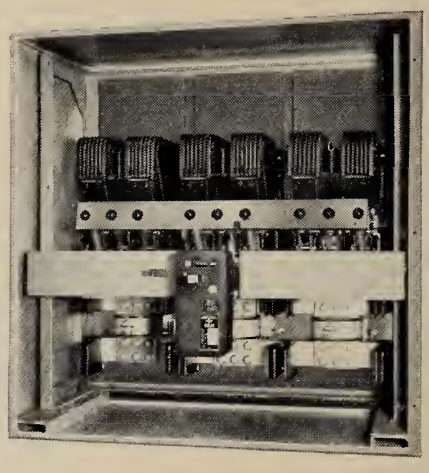

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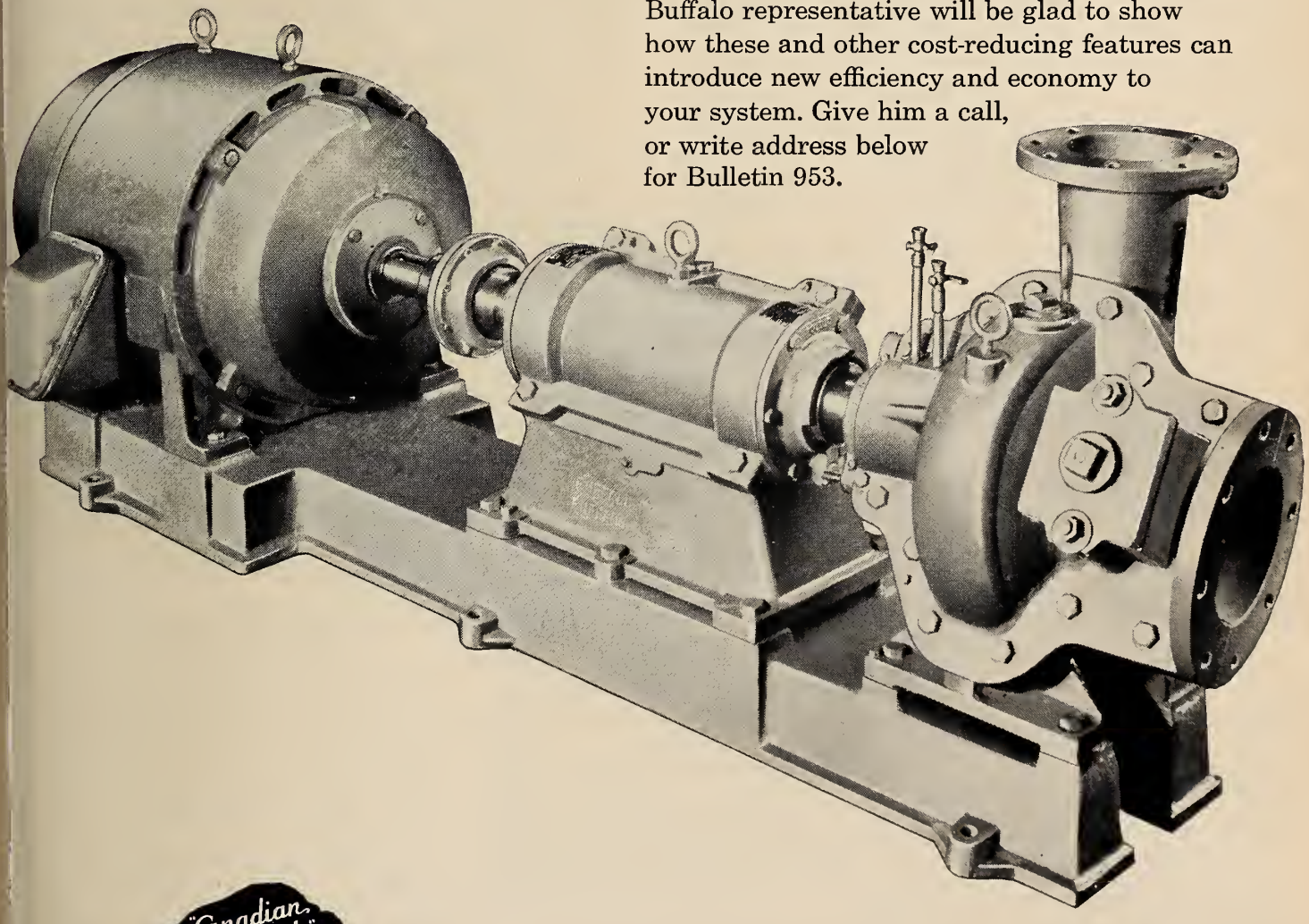

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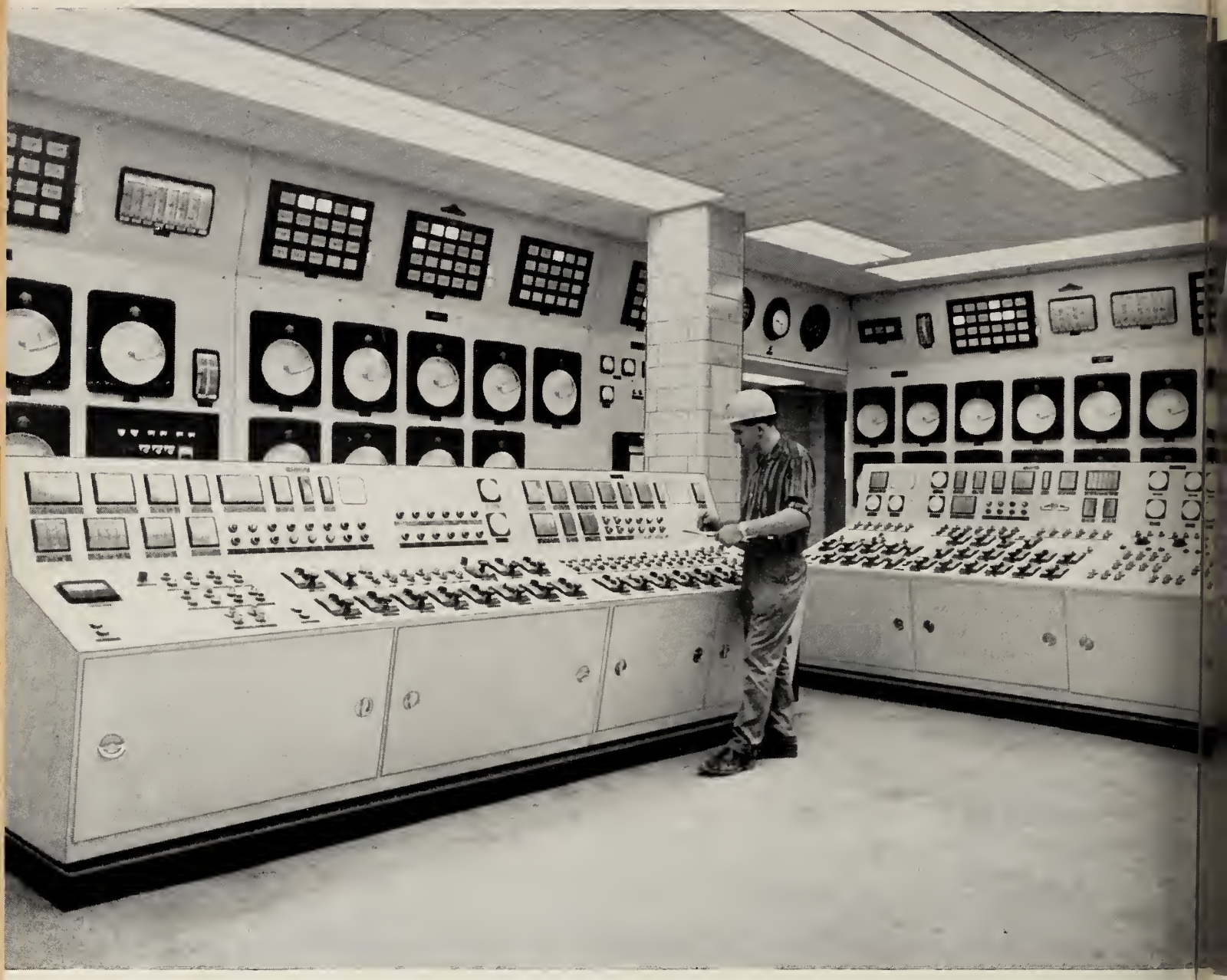

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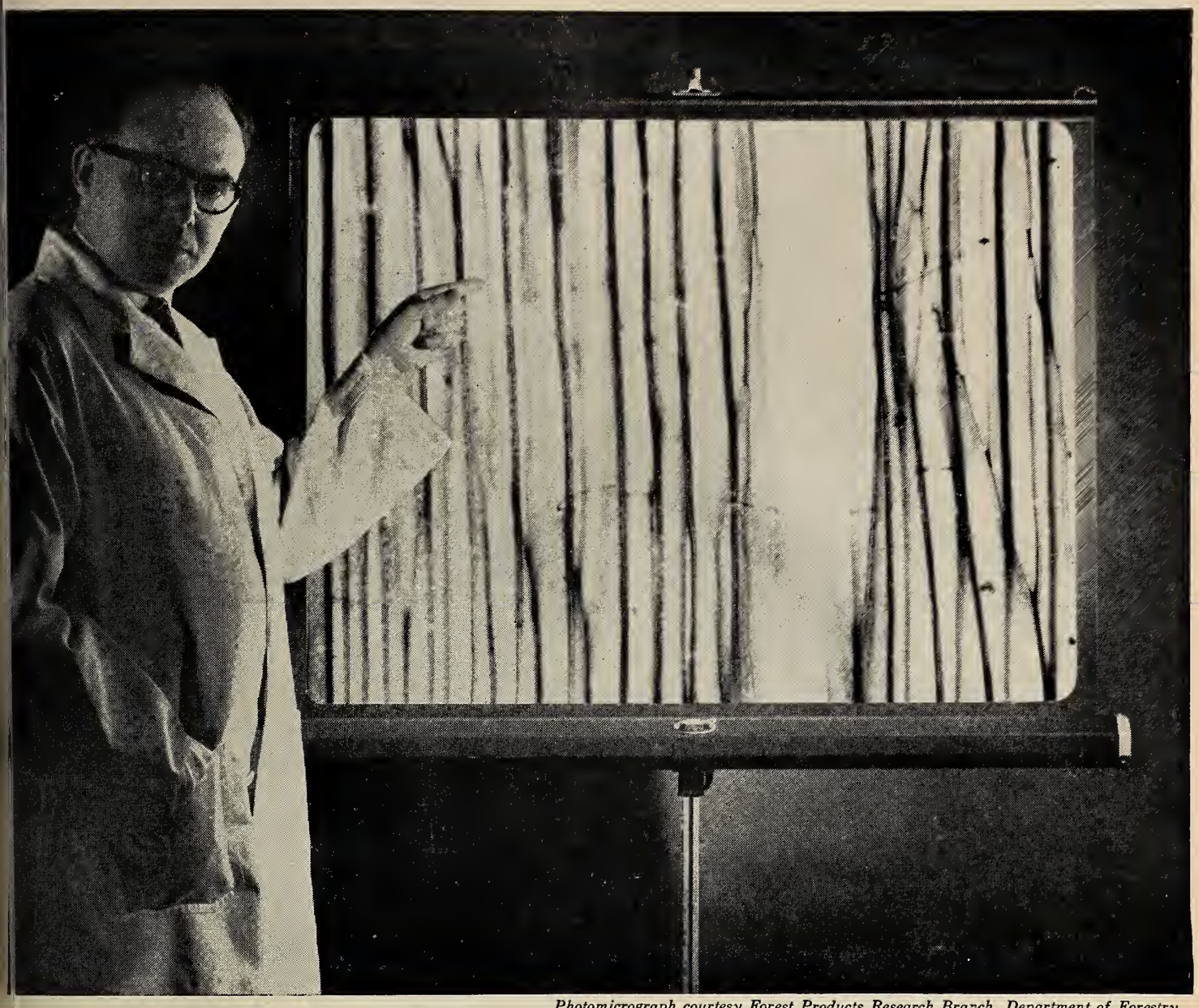

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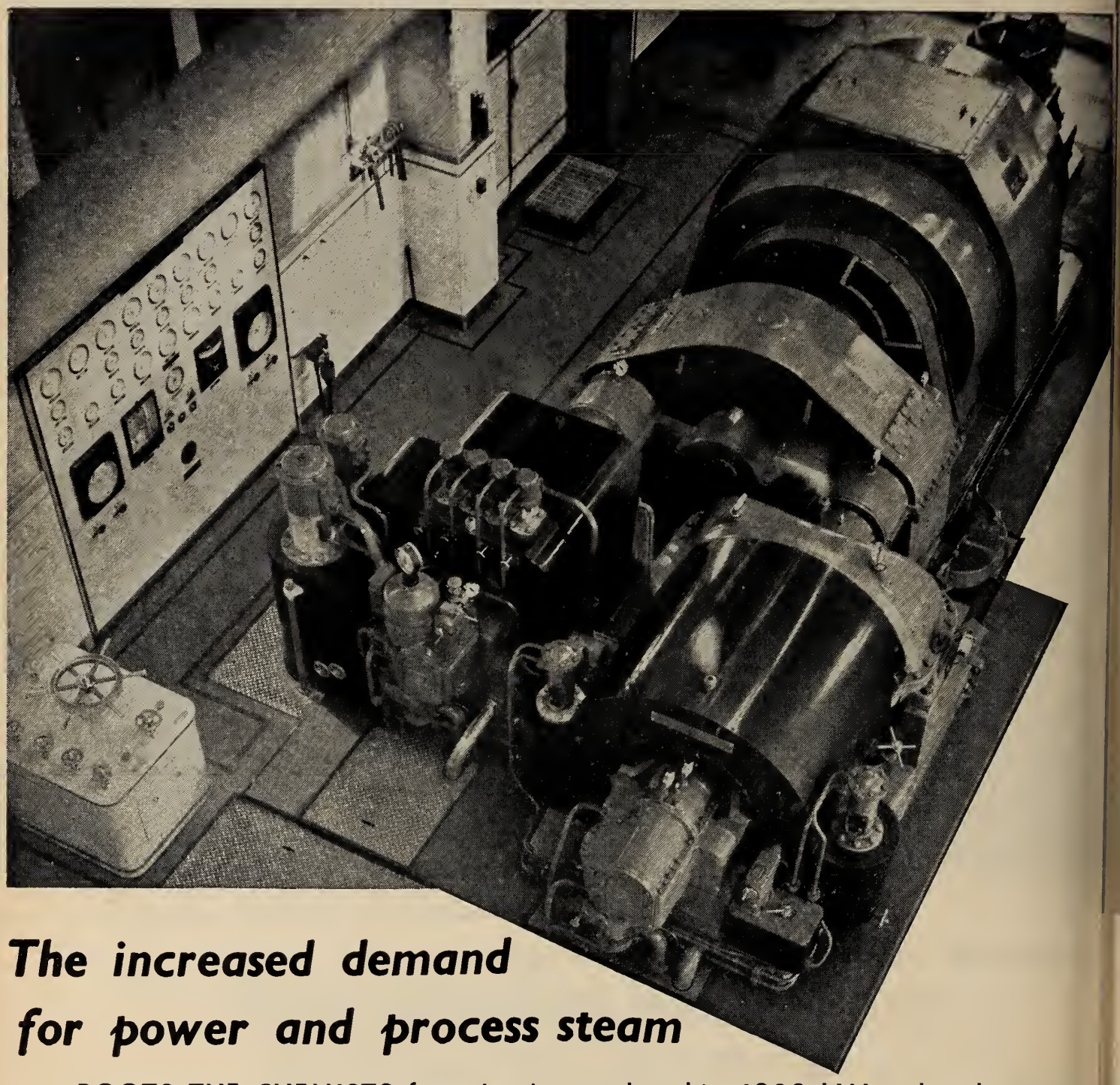

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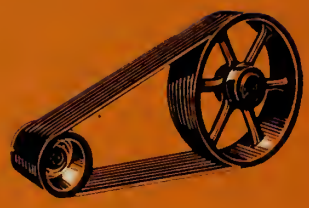

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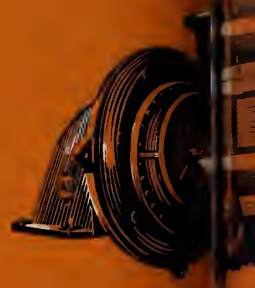
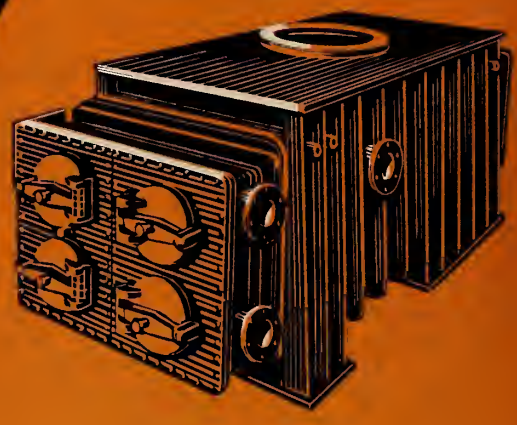


Centrifugal blow

Hydraulic Turbines

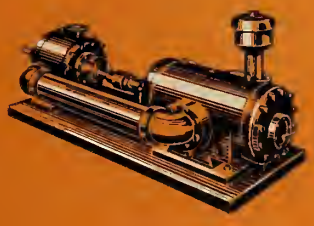


Condensers

High voltage co

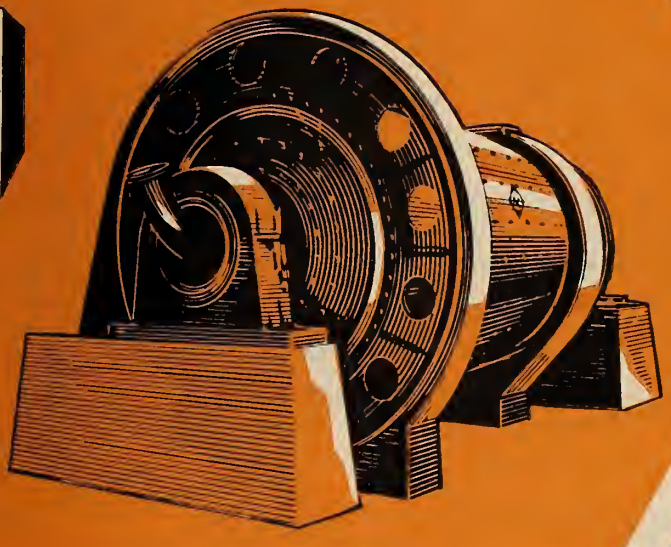
Crushers

Low voltage control



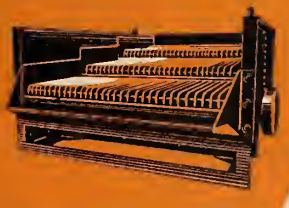
Rotary compressors

itchgear



Grinding Mills

ves



Screens

Rotary Kilns

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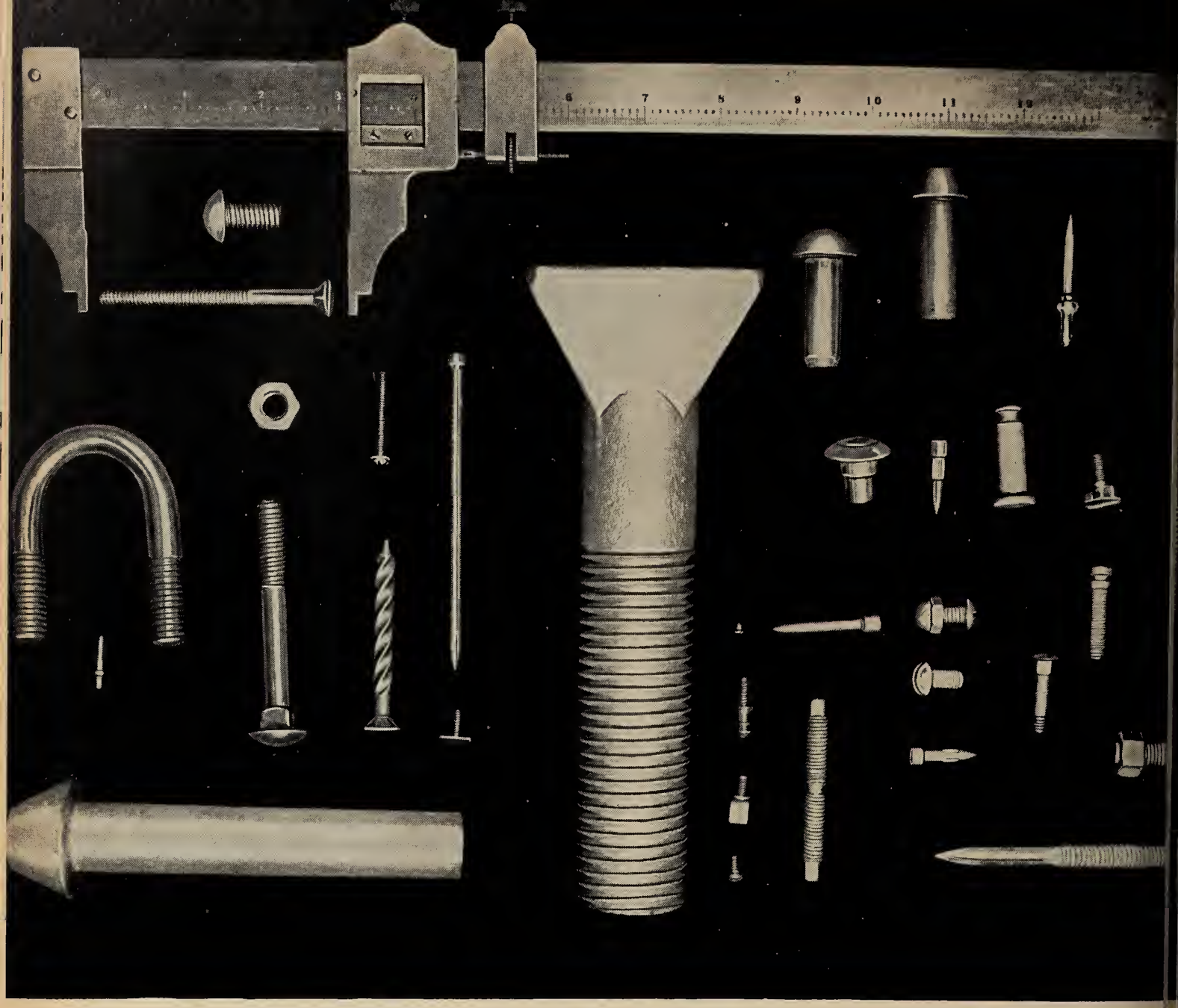

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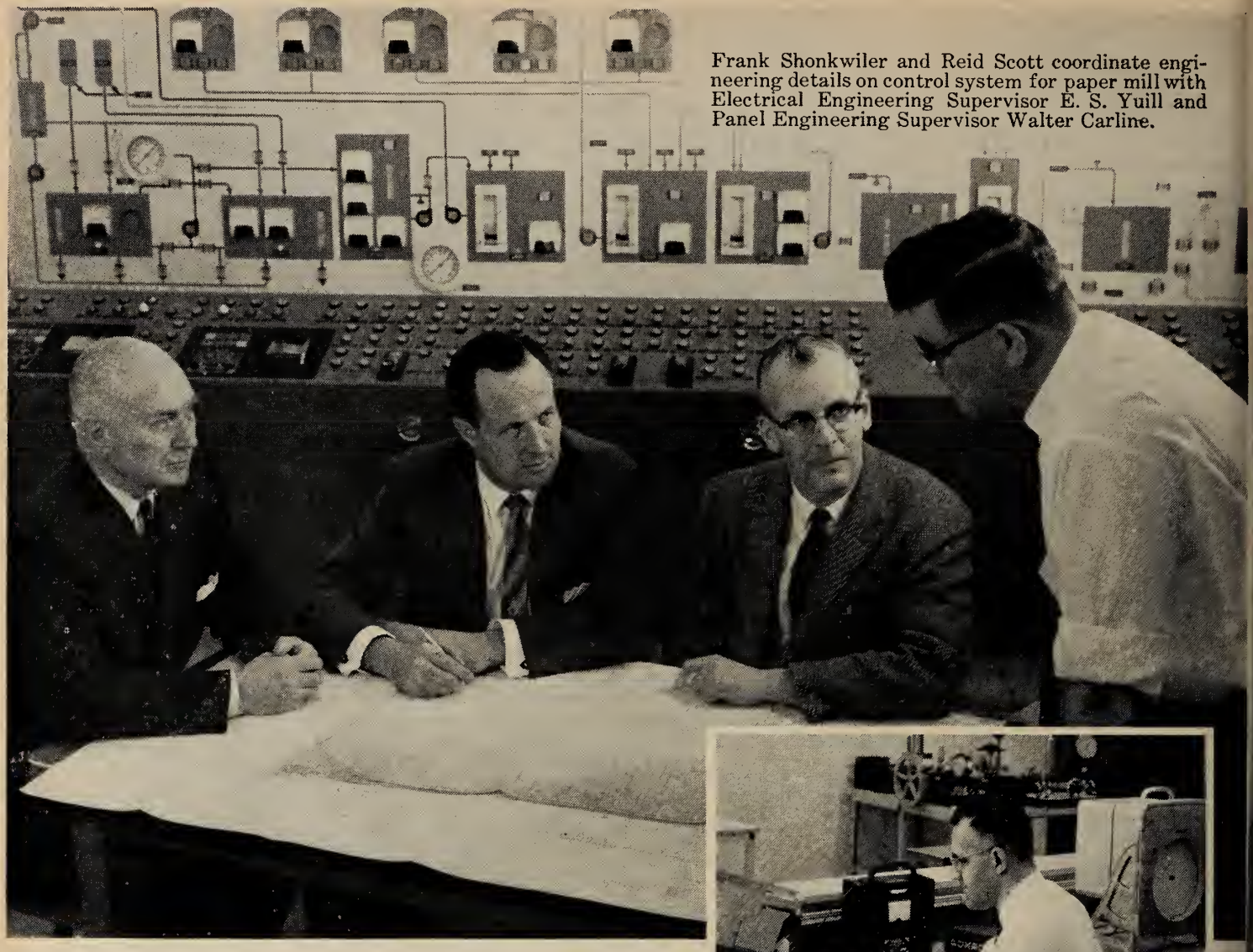

Frank Shonkwiler and Reid Scott coordinate engineering details on control system for paper mill with Electrical Engineering Supervisor E. S. Yuill and Panel Engineering Supervisor Walter Carline.

Quality Control Supervisor Tom Waterston checks performance of new Foxboro instrument at Standards Laboratory. Pressure-test equipment in background is used in continuous Quality Assurance Program.

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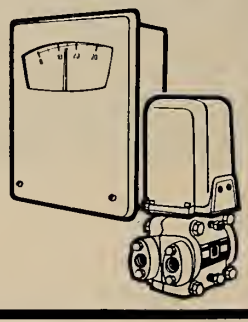

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Taum Sauk pumped storage power project has first USS "T-1" Steel penstock in United States

Bifurcated section of USS "T-1" Steel penstock for the Taum Sauk project of Union Electric Company, St. Louis. Capacity: 350,000 KW.

Consulting Engineers: Sverdrup & Parcel and Associates, Inc. Fabrication and installation by Nooter Corp. General Contractor: Fruin-Colnon Const. Co. & Utah Const. & Mining Co. Total USS "T-1" Steels used: approximately 2300 tons.

Engineers blasted off the top of 1500-foot-high Profitt Mountain in the Missouri Ozarks and dug a tunnel-penstock 7,179 feet long through solid granite to build this unique power project. Where pressures were highest, in the lower sections of the penstock, they lined the tunnel with two extra-strong steels, USS "T-1" and "T-1" type A brands.

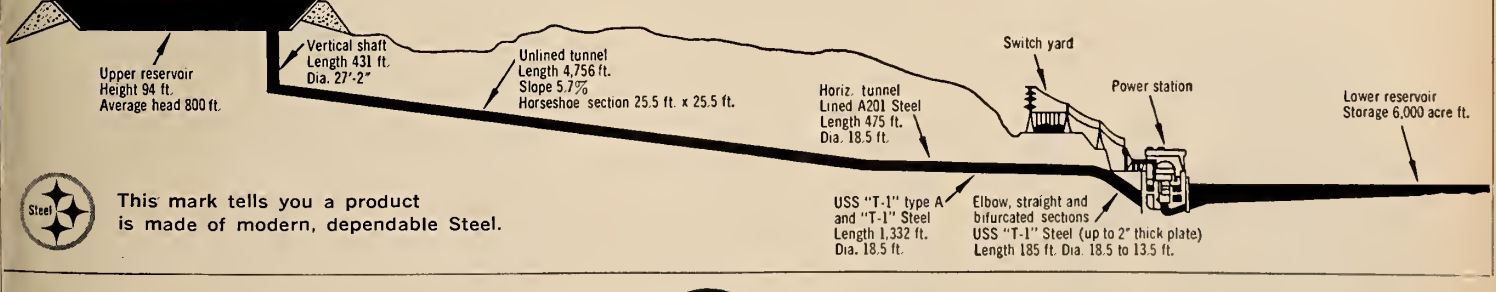
You can't beat these tough, weldable steels for high-pressure penstocks and spiral cases. They are more than three times as strong as structural carbon steel . . . so you can obtain large reductions in plate thickness and weight. Welding costs are thus less. Freight handling costs are lower and no stress-relieving is necessary.

In the middle section of this penstock, with ample rock cover, USS "T-1" type A Steel was used at a working stress of 50,000 psi compared to 24,000 psi for ASTM A201 carbon steel. In the lower section, with little or no rock cover, working stresses of USS "T-1" Steel were reduced to 28,750 psi, which meets the ASME Code Case 1204-10. Spaces between steel lining and rock tunnel were filled with concrete and pressure-grouted to eliminate voids and aid further in resisting high pressures.

Where the penstock connects to the two turbines, operating pressures are highest with a maximum head of 863 feet. Here, an elbow, a straight section and a bifurcated section were built with USS "T-1" Steel using the allowable working stress of 28,750 psi.

Other penstocks and scroll cases built of USS "T-1" Steel have been installed in Canada, Switzerland, and India where weight savings of 40 to 50% have been realized. Savings in freight and welding costs were also substantial.

Write for our booklet on the use of USS "T-1" Steels in penstocks and spiral cases. United States Steel Export Company, Royal Bank Building, Toronto, Ontario. USS and "T-1" are registered trademarks.



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1 (above) **2**

1 SPORTS ARENA AT VILLE LASALLE, Que.
Architects: Rioux & Morin
Consulting Engineers: Gagnon and Associates
General Contractors: Desaulnier Construction Ltd.
Lift Slab Contractor: Lift Slab of Eastern Canada Ltd.

2 SCHOOL AT TABER, Alberta, featuring concrete hyperbolic shell roof
Architect: N. Fooks
Design Engineer: J. R. Milne
General Contractor: Chronik Construction
Gunite Sub-Contractor: Canada Gunite Co. Ltd.

3 CHRIST THE KING CHURCH, Moncton, N.B.
Architects: LeBlanc, Gaudet & Associates, Moncton
Project Architect: Jacques Roy
Consulting Engineers: Adjeleian and Associates Ltd., Ottawa
General Contractor: Modern Construction Limited

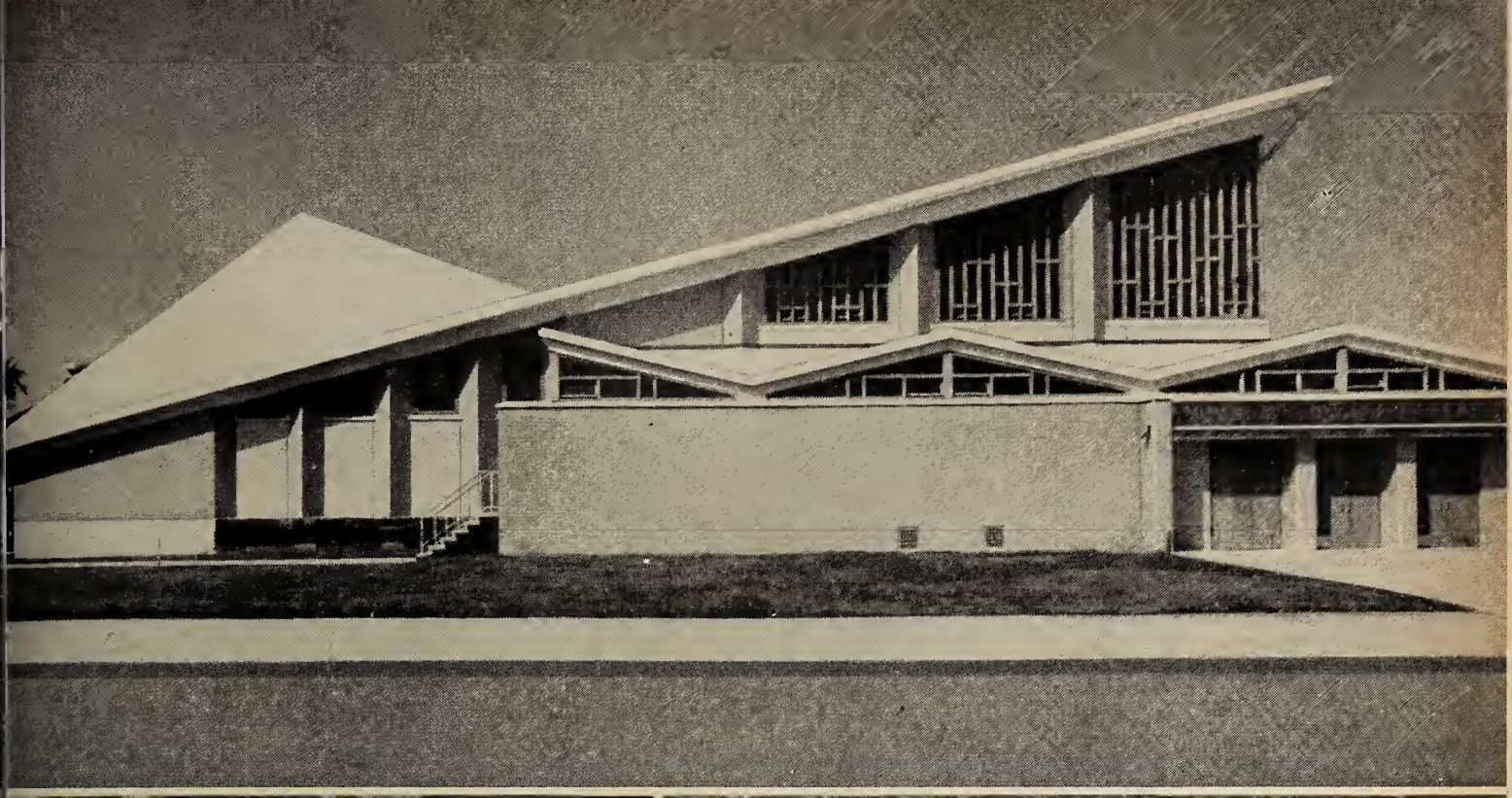
4 STE. GERMAINE-COUSIN CHURCH, Pointe aux Trembles, Montreal, Que.
Architect: Gérard Notebaert
Consulting Engineers: Lalonde & Valois
General Contractor: Paul Desormeaux Ltée.

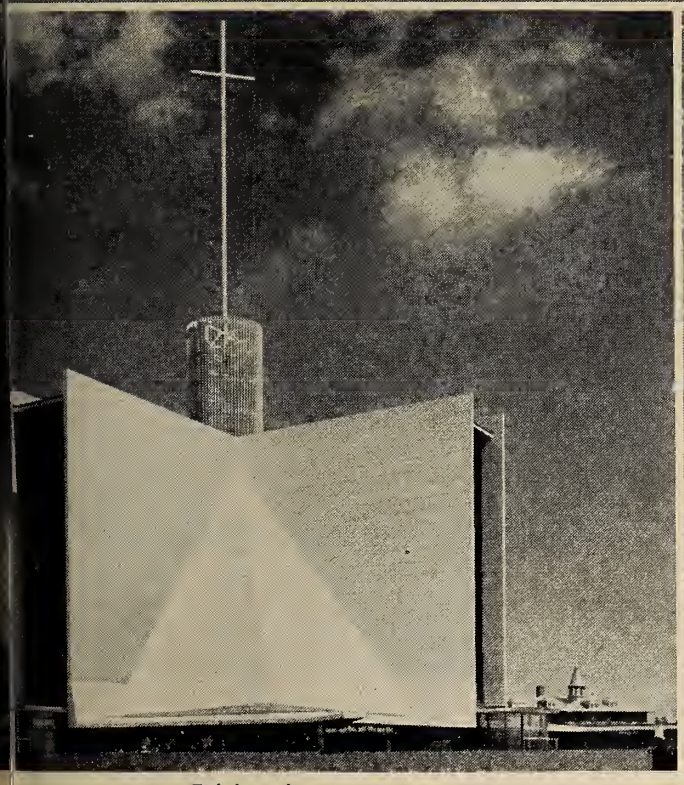
5 ST. HILDA'S ANGLICAN CHURCH, Toronto
Architect: Philip C. Johnson, London, Ont.
Consulting Engineer: Raimond Miniats
General Contractor: Fassel Construction Co. Ltd.

6 UNIVERSITY OF SASKATCHEWAN new Arts Building, Saskatoon
Architect: Shore & Moffat, Toronto
General Contractor: W. C. Wells Construction Co. Ltd.
General Contractor: (For tall part of the building):
Bird Construction Co. Ltd.
Sub-Contractor for Precast Concrete: Precast Concrete Ltd., Edmonton

3

CANADA CEMENT





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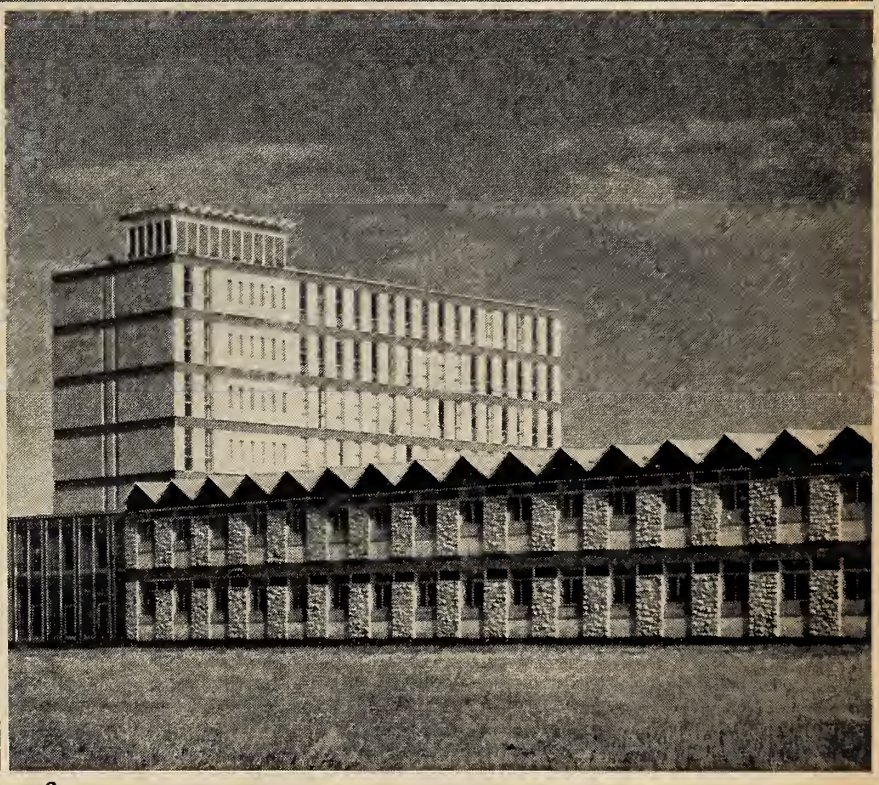

6

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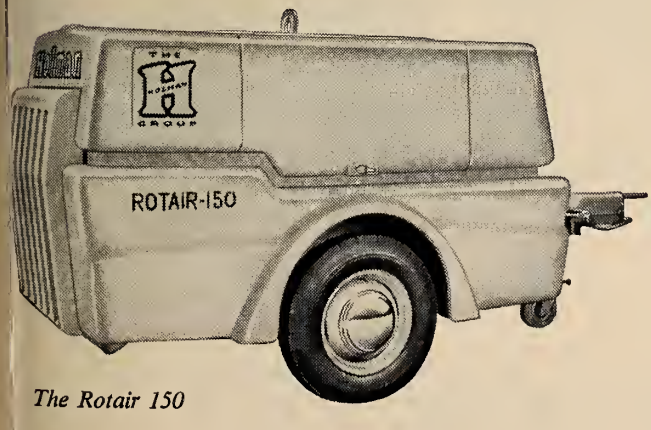
When a HOLMAN Rotair rotary-screw air compressor was tested for a full year, the washer above was the only replacement part needed—just one washer—total replacement and spare parts cost for the machine tested was exactly 85¢!

Buy a Rotair! Put it to work for a full twelve months every year and don't worry about replacements. The reason you need so few spare parts is because so few of the Rotair's parts move at all—just six of them. There's practically nothing in a Rotair that *can* go wrong!

Rotairs deliver pulse free compressed air in outputs from 150 cfm up to 600 cfm. There's a HOLMAN Rotair to suit you exactly. Write for data to



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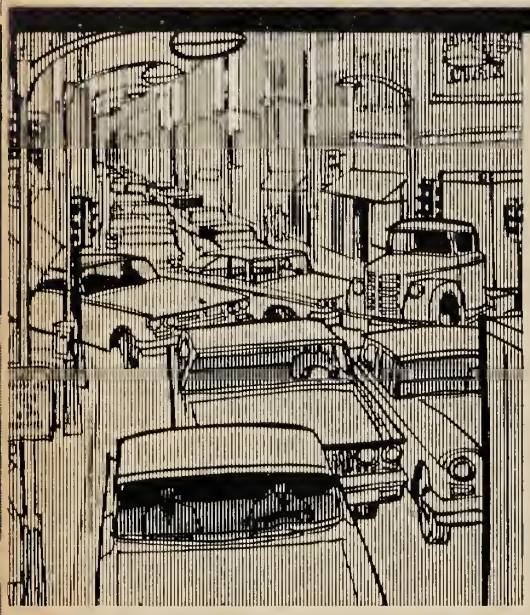
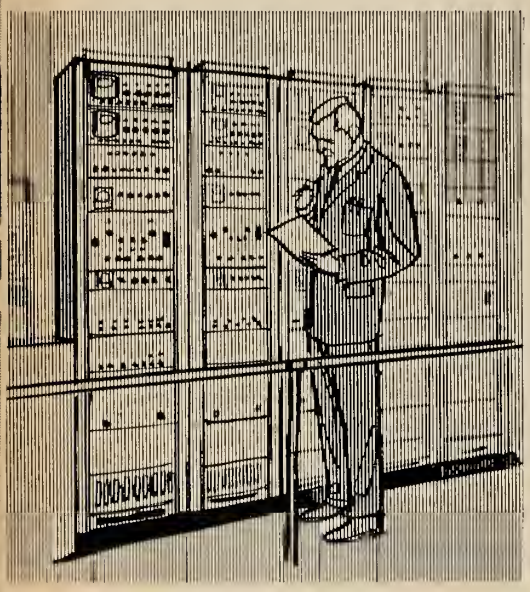
Takes 10 minutes to read this ad.



Traffic jam. Irate citizens. Chokes the growth of enterprising business and keeps new "business blood" from locating in your city. Perhaps you're unaware there is an electronic traffic expediting system which can move up to twice as much traffic (sometimes more) as your present "control" system now permits.

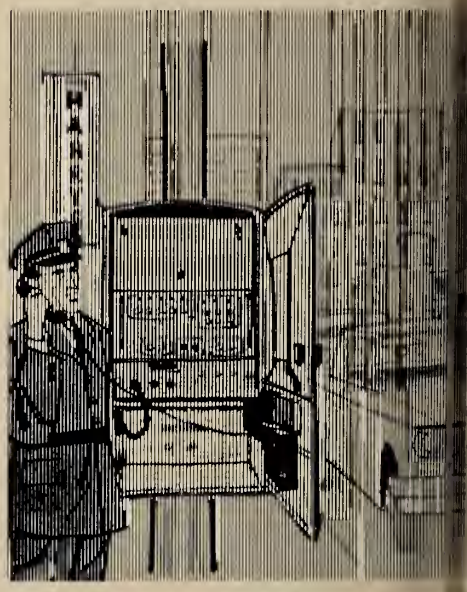
Important: Unlike pre-set "synchronized" light controls (which only move traffic under ideal conditions along a single artery, often jamming it on access streets.) Northern's "PR" system moves vehicles throughout the complete traffic "grid", evenly distributing traffic throughout the system.

Example: A rainy day (could be a pa a holiday, a voting day, etc.) plays h with ordinary control systems. Bu "PR" system continually measures fic density at key points throughou area . . . and automatically adjusts t control devices at every intersectio create optimum movement at all t



The master calculator. It correlates all the "Intelligence" collected in the continuous survey. The "brain" now automatically and simultaneously does the work a thousand traffic policemen could never do.

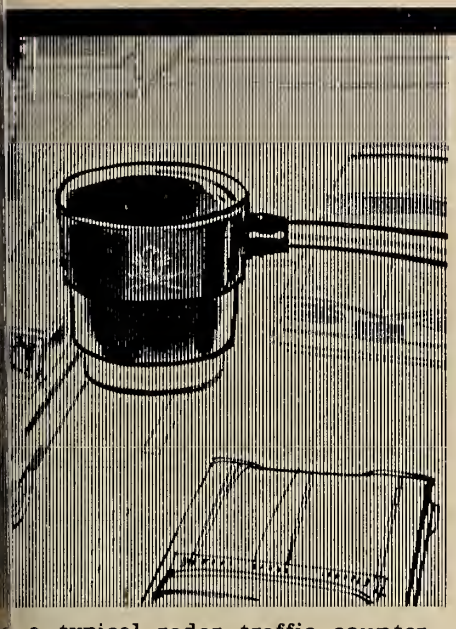
Lights at every connected intersection in the entire network respond to the master command. Thus, at any given time, traffic movement conditions are at their peak. It's exactly as if each and every intersection sees each and every other intersection and reacts accordingly.



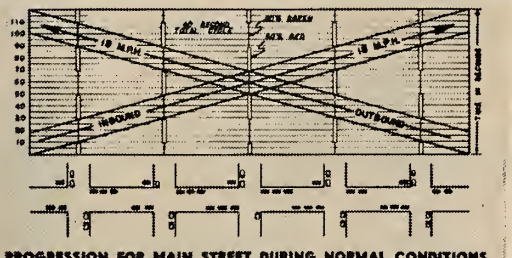
In the event of emergency the syst not tied up. Local control units at va intersections take over and keep t moving until the master contr restored.

If yours could be a happier city if tr fi moved faster, and safer, find out more a u "PR" from your nearest Northern o ce

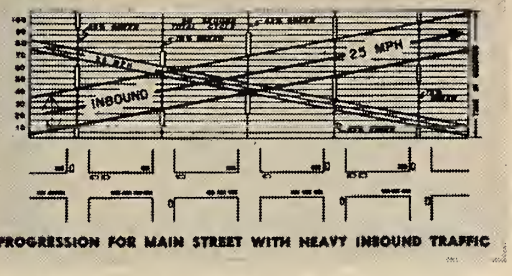
Shows how computer traffic control saves twice this time every day for every driver



a typical radar traffic counter continually measures traffic flow. ng with your traffic engineers, you your city's new "PR" system by ing (and rotating) a few of these ghout your traffic territory to ob- tal sampling data.

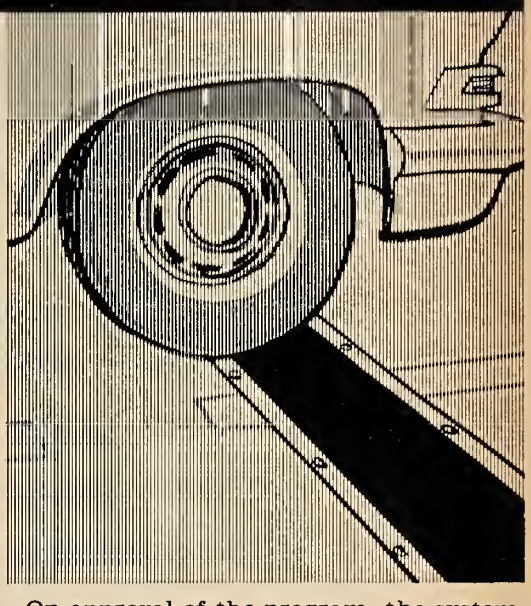


PROGRESSION FOR MAIN STREET DURING NORMAL CONDITIONS

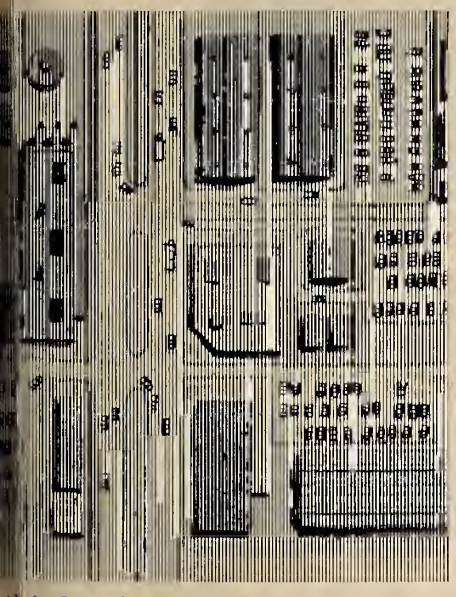


PROGRESSION FOR MAIN STREET WITH HEAVY INBOUND TRAFFIC

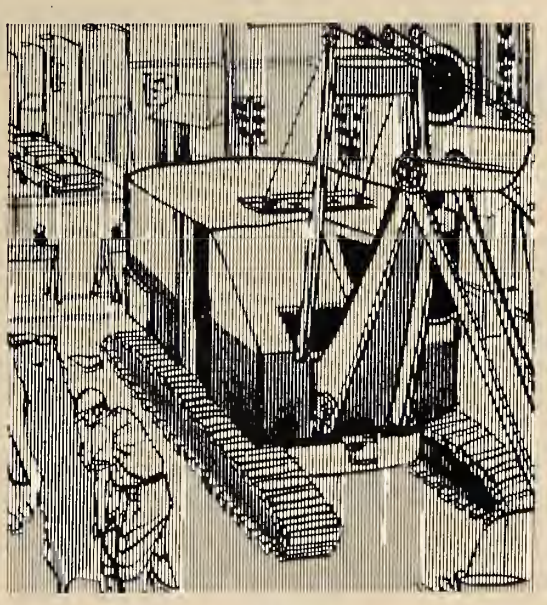
This information is then plotted on "time-space" charts which divulge the optimum traffic "intelligence" for every spot in the traffic picture. This "intelligence" enables you to complete the traffic survey, make final, accurate recommendations and estimates.



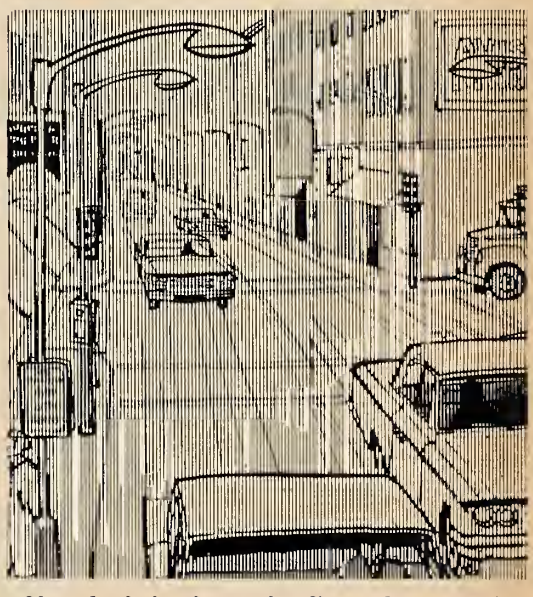
On approval of the program, the system is made operational. Traffic counters (some like this treadle or magnetic type, others like the earlier-shown, overhead radar type) are now installed at recommended locations. These samplers relay a running count of overall traffic to . . .



industrial fringes of large cities, the main thoroughfares of smal- es "single-artery" traffic expedi- often the only problem. The "PR" is as useful and economical for urpose as for clearing traffic h an entire crosstown network.



The "PR" system has the effect of adding new lanes to existing roads, can often work better than multi-millions invested in new thoroughfares. Another advantage: installation of a "PR" system does not create antagonizing traffic disruptions.



Now look back to the first photograph. Hard to believe this is the same intersection at rush hour after "PR" had been installed. Actually, in cities such as Calgary, Edmonton and Vancouver, "PR" now moves as much as 50 - 100% more traffic on some routes in a given time span during peak periods.

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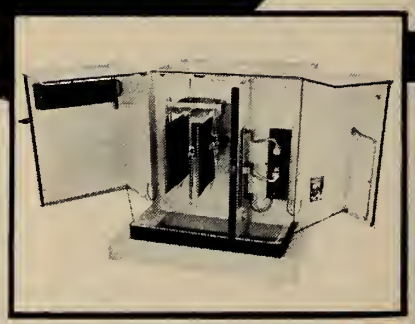
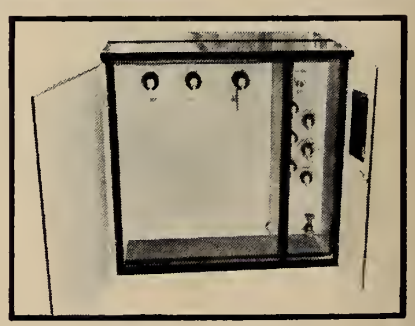


minEEsub pad mounted units are now available for single phase residential distribution up to 150 kva, 25 kv, 125 kv b.i.l.



maxEEsub pad-mounted units provide three phase distribution for apartments and light industries up to 600 kva, 15 kv, 95 kv b.i.l.

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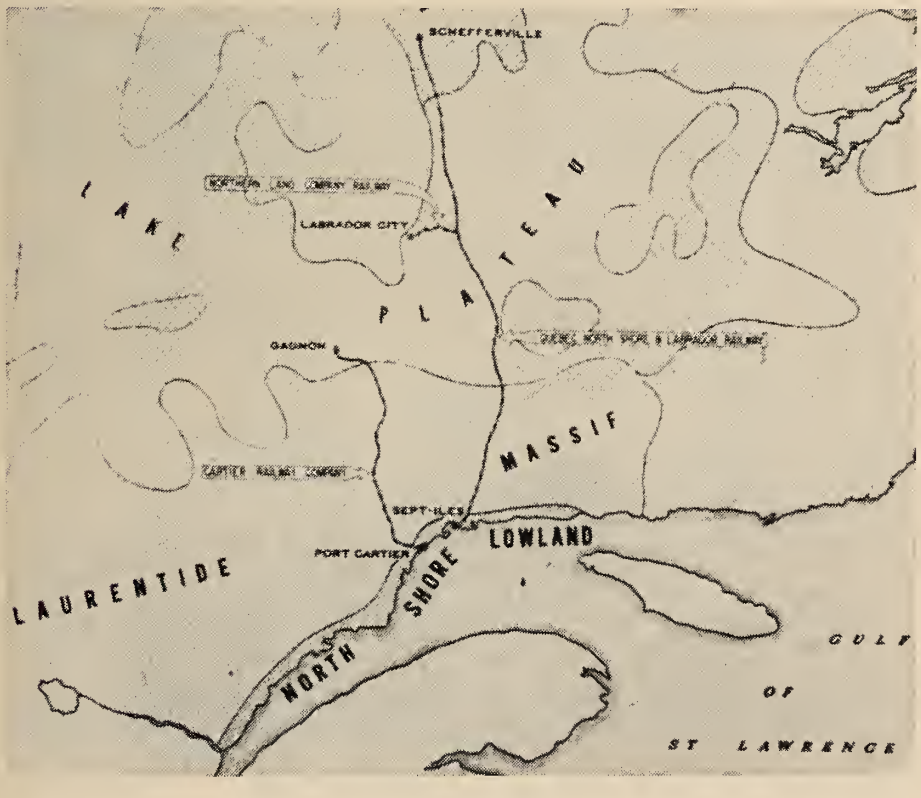
EIC — 63 — GEOTECH 4

MUSKEG and the Quebec North Shore and Labrador Railway

B. M. Monaghan

Chief Engineer, Quebec North Shore and Labrador Railway Company, Sept-Iles, Que.



THE QUEBEC NORTH SHORE and Labrador Railway, a subsidiary of the Iron Ore Company of Canada, links the mining town of Schefferville with Sept-Iles, a seaport on the north shore of the Gulf of St. Lawrence. It was built at a cost of $325,000 per mile, is 360 miles in length, has been in operation since 1954, and was the first railroad — indeed, the first surface transportation route of any description — to serve the interior of the Labrador-Ungava peninsula.

Lack of interest in the exploration and development of Labrador-Ungava can be attributed to a number of factors, most of them related to the rigorous climate of the region and to the problem of access. Because of its unnavigable rivers and streams, the rugged terrain which extends inland from the Gulf of St. Lawrence for almost 100 miles presents a natural barrier to the interior plateau. Another obstacle occurs on the plateau itself in the form of extensive areas of muskeg.

When reconnaissance surveys for the Q.N.S. & L. Railway began in

This paper was presented in May, 1962, at the Eighth Muskeg Research Conference in Saskatoon, Saskatchewan, sponsored by the Associate Committee on Soil and Snow Mechanics of the National Research Council.

1945, it was generally believed that muskeg would be responsible for serious and persistent difficulties in connection with railroad location, construction, and maintenance. This paper describes the nature of the organic terrain crossed by the Railway, and includes a brief account of the construction procedures adopted.

THE CLIMATE OF THE REGION

Labrador-Ungava has a number of climatic features which distinguish it from other sections of the country. Some of these features are noteworthy in view of their influence on muskeg development and their effect on construction operations.

Sept-Iles, the southern terminus of the Q.N.S. & L. Railway, has a mean annual temperature of 34 degrees Fahrenheit, almost identical with that of Saskatoon. However, the maritime climate of the north shore of the Gulf of St. Lawrence causes mid-winter temperatures at Sept-Iles to be five to ten degrees warmer than those at Saskatoon, while midsummer temperatures tend to be about five degrees cooler. The annual snowfall at Sept-Iles is approximately 170 inches, and the annual total precipitation is 42 inches — more than three times that at Saskatoon.

At Schefferville, the northern terminus, the climate is sub-arctic and the area is one of sporadic permafrost. Here, the mean annual temperature of 23 degrees Fahrenheit is comparable with that of Fort Simpson, 150 miles west of Great Slave Lake in the North West Territories. Again, however, there are important differences between temperature extremes at the two localities; the range from mid-winter low to midsummer high temperatures being much less marked in the case of Schefferville. The annual snowfall and annual rainfall totals at Schefferville are 130 inches and 14 inches respectively. The corresponding figures for Fort Simpson are 55 inches and 7 inches.

Climatic conditions at Schefferville are typical of those which prevail over most of the muskeg area traversed by the Railway. Thus, this region is characterized by long severe winters with heavy snowfall — the mean annual maximum depth of snow cover on the ground is 60 inches — and cool summers with persistent light rain.

DESCRIPTION OF THE TERRAIN

The concept of muskeg as "organic terrain" rather than a troublesome type of waterlogged organic matter—or "muck"—is a useful one since it involves a consideration of the physiographic features of the areas in which muskeg occurs, and the subsurface materials upon which the organic cover develops.[1] These are important considerations to those concerned with problems of access, construction, and drainage in muskeg areas.

Fig. 1

The Q.N.S. & L. Railway crosses three of the major physiographic subdivisions of Labrador-Ungava:[2] The Labrador Trough, The Lake Plateau, and the Laurentide Massif. To these might be added a fourth—the narrow North Shore Lowland. With the exception of the Laurentide Massif—which poses its own problems of access—muskeg is one of the important features of each of these areas (Fig. 1.)

The Labrador Trough, or Labrador Geosyncline, is the "iron belt" of the peninsula; the new mining communities at Schefferville, Gagnon, and Labrador City are all situated in this area of Precambrian sedimentary and volcanic rocks. As a geologic unit it extends in a south-westerly direction from the west side of Ungava Bay for a distance of more than 400 miles and has a maximum width of about 50 miles. Physiographically, the term "Labrador Trough" is used to describe the ridge and valley type of upland which is characteristic of most of the Labrador Geosyncline north of Schefferville. The more resistant formations form the ridges, while valleys have developed in the weaker slates and shales.

The route of the Q.N.S. & L. Railway follows the valleys of this physiographic subdivision for about 30 miles through an area with a mean elevation of 1800 ft. and local relief in the order of a few hundreds of feet. Ridges are generally bare of tree cover, and valleys are occupied by many elongated lakes, ponds, and expanses of muskeg. Here, as over much of the Labrador peninsula, an established drainage pattern has been deranged by a mantle of glacial drift. Its clayey texture distinguishes the drift in this area from the sandy and silty soil formations in many other parts of the region.

The Lake Plateau occupies a large drift-covered area in the south-central section of the peninsula. The salient feature of the area is the one from which it derives its name — the profusion of lakes, ponds, and string-bogs. The extent to which bodies of open water dominate the landscape is particularly impressive when the ground surface is viewed from the air or examined in airphotos. Another important feature, also conspicuous in airphotos, is the large number of eskers oriented in a roughly north-south direction.

The presence of eskers and scattered outwash deposits, and the oc-

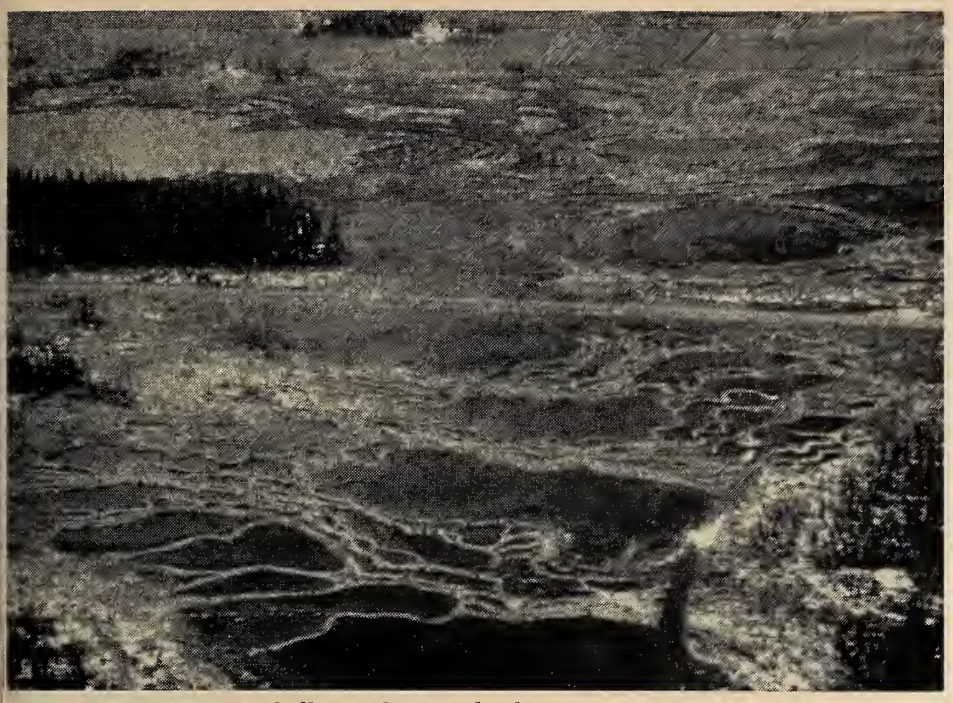


Fig. 2 Shallow railway embankment across string bog.

currence of glacial drifts in drumlins (or drumlin-like landforms) does much to mitigate the problems of access presented by great expanses of open water and muskeg. Generally the drift is silty textured and excessively wet; in some locations, particularly in the vicinity of larger lakes, it may be overlain by a deposit of silt which rarely exceeds one or two feet in depth.

The Railway crosses this physiographic unit for a distance of 250 miles, about half of which is predominantly bog. Most of the organic terrain occurs to the north of Milepost 150 where the route crosses the low divide (elevation 2066) separating the headwaters of south-flowing rivers from those of the upper Hamilton River.

The Laurentide Massif is an area of rugged hills situated between the Lake Plateau and the Gulf of St. Lawrence. Summits approach an average elevation of 2500 ft. and, apart from the major river valleys, local relief is in the order of 500 ft. The larger streams occupy deep gorges in the northern part of the section and deep glacial troughs in the south. In its ascent to the Lake Plateau the Railway follows the valleys of the Moisie River and several of its tributary streams. The nature of the terrain precludes the development of important areas of muskeg.

The North Shore Lowland is a narrow coastal strip which extends inland to the steep south-facing Laurentide Escarpment. Except where river terraces form northward extensions, the width of this physiographic subdivision rarely exceeds five or six miles.

The north shore of the Gulf of St. Lawrence is an emerging coastline. In the vicinity of Sept-Iles, marine and estuarine sediments deposited during the period of submergence overlie a rocky foreland of low hills, and the coastal plain rises in a series of beach ridges to an elevation of about 400 ft. Scattered areas of muskeg occur in the depressions between adjacent ridges. The Railway crosses the coastal plain 12 miles before entering the valley of the Moisie River.

MUSKEG FEATURES

Although aerial survey and airphoto interpretation techniques have done much to simplify and improve the quality of route location work, reconnaissance and location parties must still devote a considerable amount of time to on-foot surveys of the terrain. This was even more necessary in 1945-46 than it is today. Consequently, the early civil engineering workers in Labrador-Ungava soon became familiar with muskeg in the field and, locally, the term came to be applied more or less exclusively to areas of open or lightly timbered bog which could be crossed only with the greatest difficulty — or not at all — except during the winter months.

The depth and area of bog formations were matters of primary interest to those engaged in reconnaissance and preliminary surveys. Since the airplane, or floatplane, generally provided the means of access, there were ample opportunities to view the terrain from the air. This circumstance led to the increasing use of airphotos and to efforts to relate conditions on the ground to the patterns revealed from the air. Three important types of bog were recognized; (a) string

Fig. 3 Raised dragline ditching in string bog.

bogs — readily identified from the air or in airphotos by the striped appearance of areas in which they predominate; (b) marshes, in which expanses of grassy vegetation surround pools of open water; and (c) raised bogs, a feature of the North Shore Lowland. The information accumulated on the depth and composition of these formations, although fragmentary, was of value during final location and construction phases of the railway project. In recent years, the results of detailed studies have been published,[3] and helpful information on the identification and classification of string bogs is now available.[4]

String bogs excited much interest during the initial surveys for the Railway; the original cause for concern being the extent to which they hampered movement on the Lake Plateau. Figures 2 and 3 are, respectively, air and ground views of bogs of this type.

The amount of water associated with string bog areas may be large or small, and local descriptions are likely to vary accordingly. In some situations an observer on the ground might be confronted by a "lake crossed by many narrow bands of waterlogged vegetation"; elsewhere, a "series of parallel ridges separating elongated pools of water" would be a more appropriate description. Occasionally, where grassy vegetation or sedges encroach upon the pools. open water is absent altogether. The "strings" themselves are stable ridges of peat which support a growth of sphagnum moss and low shrubs. Stunted trees are a feature of some bogs.

Efforts were made to determine the more important features of string bogs when it became apparent that construction across them could not be avoided without resort to lengthy diversions or a tortuous alignment. In many instances it was found that the depth to a firm stratum, measured from water level, did not exceed about four feet. Since this was considered to be a tolerable depth of organic material, alignment changes were made only when soundings indicated an appreciably greater depth. Practical importance was also attached to the observation that string bogs occur on gentle—often imperceptible—slopes rather than in topographical depressions. The variation in water levels suggested that drainage measures might meet with some success.

Marshes cover an area comparable with that occupied by string bogs. As used here, the term refers to the variety of basin bog which develops as vegetation encroaches on the shores of a lake. On the Lake Plateau and in the Labrador Trough, marshes are characterized by a cover of sedges surrounding scattered pools of open water; the surface mat is frequently underlain by water or semi-fluid organic material, and the depth to a firm stratum is commonly in the order of 15 ft. The term "Sedge Meadow" has been used to describe bogs of this type in the vicinity of Schefferville.[3] In the North Shore Lowland area the vegetative cover may include such woody members as alder and the Labrador Tea Plant. From the standpoint of access, marshes are particularly treacherous. During location of the Q.N.S. & L. Railway they were regarded as a more serious obstacle than string bogs and were avoided whenever possible.

Raised Bogs are a feature of the North Shore Lowland where they have developed on relatively flat marine terraces. Figure 4 is an aerial view which shows part of a typical bog in the vicinity of Sept-Iles; it is roughly circular in shape and a little over a mile in diameter. The plotted elevations indicate a drop of approximately 10 ft. between the centre of the bog and its margin. Precipitation provides the only source of water while a single small stream serves as the only permanent drainage outlet. Sedges and low, woody, shrubs are the predominant forms of vegetative cover.

Noteworthy features of raised bogs include: the variety of materials upon which they develop — sands, silty clays and even rock outcrops; the peculiar drainage characteristics, which are occasionally responsible for the flooding of adjacent areas; and the deep accumulation of peat which generally underlies the surface.

RAILWAY LOCATION, CONSTRUCTION & MAINTENANCE

Because of the large tonnages involved and the long haul from mine to loading dock, the single track railroads serving the interior of the

Fig. 4 Raised bog in the vicinity of Sept-Iles.

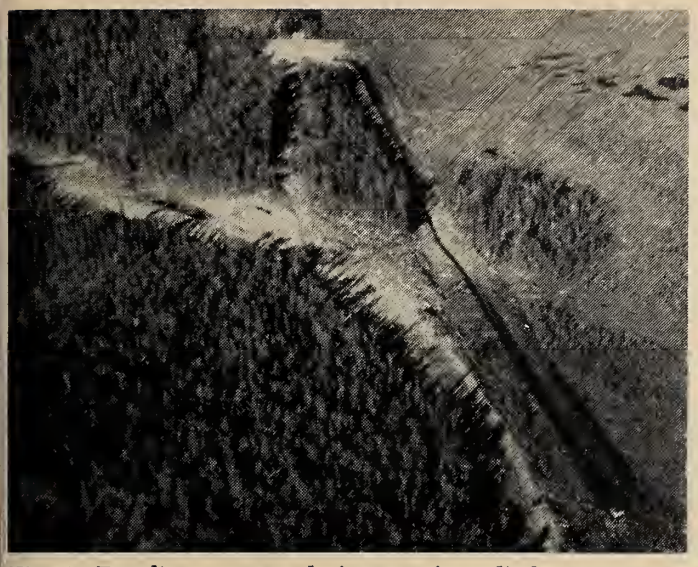


Fig. 5 Dragline—excavated intercepting ditch at perimeter of raised bog.

Fig. 6 Dragline ditching and casting suitable material onto centreline to form trafficable road.

Labrador - Ungava peninsula must operate long, heavy trains. In the case of the Q.N.S. & L. Railway which hauls up to 13 million tons of ore annually in an operating season of approximately 200 days, nine loaded trains and as many empty trains may occupy the track at one time. It is evident, therefore, that mining railroads in this region must be constructed and maintained to high standards — they are in no way comparable to the secondary highways designed to serve small communities in some remote areas.

Location. Field surveys covered a otal distance of more than 1500 niles. They were complicated by the grade and curvature requirements dictated by such economic considera- ions as optimum train lengths, veights, and speeds. Subsurface stud- es were confined to bridge sites, and errain conditions were evaluated on he basis of information derived from irphotos or from the soundings and bservations of survey parties. Since t was recognized that construction cross the Lake Plateau would neces- itate a departure from the traditional nethod of balancing cut and fill quantities, efforts were made to locate vithin short haul distances of sources f suitable borrow material. Efforts vere also made to avoid encounters vith muskeg, particularly those of the narsh variety, but wide detours were eld to minimum.

During the years 1945 and 1946, eld work was restricted to the sum- ner months. Later, it was undertaken n a year-round basis using dog teams nd ski-equipped airplanes during the vinter months; floatplanes and canoes n the summer. Helicopters, which vere used to great advantage during ne construction phase of the opera- on, have been employed on more ecent reconnaissance and location studies, and are now considered to be indispensable for this type of work.

Construction. In this region, construction of a railroad is likely to be the major item involved in bringing a mining property into production. It is of particular importance, therefore, that the task be completed in the shortest possible time, and serious consideration may be given to methods which would otherwise be regarded as extravagant. For example, it may be judged expedient — as it was in the case of the Q.N.S. & L. Railway — to move tractors by air, or to fly 190,000 bags of cement a distance of 300 miles rather than move them overland. As might be expected under these circumstances, the approach to the problem of construction across muskeg areas was a straightforward one.

On the Lake Plateau construction operations were deferred until the winter of 1952-53. By this time a railhead had been established at Milepost 108, an airstrip was in operation at Milepost 134 and others were under construction, and a large force of personnel and equipment became available as the heavy earthwork was completed south of Milepost 100. During the winter months the greater part of this force, which included 56 shovels and 180 tractors, was concentrated in the most inaccessible bog areas. By June, 1953, the railhead had been advanced to Milepost 153 and grading operations were completed to Milepost 224.

During the following summer many construction difficulties were averted by close attention to every possible drainage improvement. Offtake ditches were often effective, and in a few instances all surface water was drained from string bogs or shallow lakes and ponds. Drainage ditches were blasted using ditching dynamite or excavated by means of light draglines supported on timber mats (Fig. 3 and Fig. 5). Airphotos were of value in determining the most suitable location for many of the longer offtake ditches.

The most satisfactory construction procedure in string bog areas involved the use of draglines working in pairs on opposite sides of the roadbed. These machines — often preceded by ditching parties using dynamite — were used to excavate longitudinal drainage ditches to the full depth of the organic cover. Organic matter and silt was wasted along the edges of the right-of-way, and the underlying granular material was cast onto the centreline of the roadbed to form a trafficable road (Fig. 6). Haulage units working from suitable borrow areas were then used to complete the subgrade. Settlement caused by heavy construction traffic and consolidation of the underlying peat usually necessitated minor amounts of additional fill; this was placed during final grading operations immediately prior to the laying of track.

The few encounters with deep muskeg occurred mainly in the Labrador Trough area where their depth occasionally amounted to more than 15 ft. Embankments were constructed by end-dumping, and the toe-shooting method of fill settlement was used in some cases.

To varying degrees, all construction operations were complicated by problems of access and transportation. Muskeg received the major portion of the blame for these difficulties, but a number of other factors were also involved. Because of the heavy snowfall and the late date to which snow cover persists, much of the available granular material was placed in a saturated condition. This difficulty

was aggravated by the cool, wet, summer weather which made it almost impossible to achieve adequate compaction. Thus, even when the completed (or partially completed) railway subgrade was used as a haul road, construction traffic was frequently in distress. This condition occurred in both cut and embankment sections and was particularly troublesome wherever silty textured soils were involved.

The thawing of ground ice after the insulating cover had been removed was another cause of distress to traffic during the summer months. Scattered islands of permafrost in the northern part of the route sometimes made it necessary to drill and blast frozen ground to depths of at least six feet. More commonly, shallow ground ice was found at sites where conditions were favorable to unusually deep frost penetration. The removal, or compaction, of snow and organic cover during winter haul operations was the most obvious cause, and muskeg sections in which a shallow depth of peat was underlain by silt were the areas generally affected.

The difficulties associated with muskeg led to the adoption of a variety of schemes to minimize road traffic. Over much of the Lake Plateau it was possible to take advantage of the larger lakes; some construction camps were serviced almost entirely by floatplanes or amphibious airplanes; 40-foot boats with an eight-ton capacity served the purpose of trucks in transporting fuel and supplies; and personnel were sometimes transported to work sites by means of boats and canoes. Under these circumstances, helicopters were invaluable for inspection and expediting.

Maintenance. Sections of the Railway constructed over organic terrain required fairly extensive maintenance during the first one or two years of operation; drainage, differential settlement, and frost damage were the principal features.

No important drainage problems were involved, but there was a need to complete work which would have been costly and time-consuming if undertaken during the construction period. In contrast to highway and airfield pavements, the track structure of a railroad is not seriously affected by differential settlement. Train fill methods were used to provide additional coarse-textured fill on which to raise track levels, and also to widen embankments in order that they might accommodate deep subballast and ballast sections.

Frost damage was responsible for heaved track which required attention until June or July, and for soft subgrade conditions that persisted throughout the wet summer months. It was, and continues to be, the most serious maintenance problem in muskeg areas. The frost-susceptible soils responsible for the difficulty are always associated with a surface cover of peat. Since this insulating material reduces the depth of frost penetration, the sections of the Railway most severely damaged by frost during the first years of operation were those in which the organic cover was shallow (or was removed altogether), and where embankment heights were low. Ground temperature measurements made toward the close of the construction stage provided useful information on the depth of frost penetration under various conditions; they were of value in determining the extent to which embankment heights should be increased. Track lifting operations have produced a marked decrease in the incidence of frost damage with the result that the problem is now confined to shallow cuts and to sections where frost-susceptible soils were incorporated in the subgrade. Muskeg areas are entirely free of the slope stability, drainage, and icing problems which account for much of the roadbed maintenance activity in other sections of the route.

During the early life of a new railroad, an increasingly high proportion of all maintenance of way activity involves the requirements of the track structure and ballast section. Heavy loads and the intensity of traffic cause this proportion to be unusually high in the case of the Q.N.S. & L. Railway. From the standpoint of rail wear and track maintenance, sections located in muskeg areas are considered to be relatively trouble-free — a feature attributed to level grades and the absence of sharp curves.

CONCLUSIONS

Interest in Labrador-Ungava has been stimulated to a remarkable degree by the success of this undertaking. Recent achievements in the field of railroad and highway construction include: a 200-mile access road and railroad to serve the iron ore development of the Quebec Cartier Mining Company; an additional 70 miles of main line railroad linking other mining areas and dock facilities with the Q.N.S. & L. Railway; extension of the Provincial highway system by 175 miles to serve the growing communities along the north shore of the Gulf of St. Lawrence; and a 105-mile all-weather access road between the Q.N.S. & L. Railway and the site of major hydro-electric scheme on the Hamilton River. The mining industry provides the basis for the economic life of the region, and the Labrador Trough will probably continue to be the primary producing area. Future developments may eventually create a need for highway access to the new mining communities; they will almost certainly necessitate the extension of existing railways or the construction of new ones. Secondary activities such as the development of sources of hydro-electric power and the exploitation of forest resources will continue to require the construction of transmission lines and access routes. It seems inevitable, therefore, that difficulties caused by muskeg — often compounded by the presence of permafrost — will continue to beset the civil engineer involved with construction in this region.

The Radforth Classification System, which appeared as a "Suggested classification" during the closing stages of construction of the Q.N.S. & L. Railway, is likely to be of great practical value in future location studies. It is to be hoped that the results of the current program of research into the engineering properties of muskeg will be equally useful to the engineer in the field.

ACKNOWLEDGEMENTS

The author is grateful to Dr. N. W. Radforth for the invitation to present this paper, and to Mr. R. W. Pryer for assistance in its preparation. Special acknowledgement is due to Professor K. B. Woods and Dr. R. F. Leggett. During his long association with the Railway as a soils consultant, Professor Woods has been responsible for many of the techniques used to overcome construction and maintenance difficulties. His contributions are highly valued. Dr. Leggett has long been interested in construction problems in Labrador-Ungava, and the members of his staff at the Division of Building Research have provided much useful advice and assistance. The paper is presented with the permission of Mr. W. D. Durrell, Executive Vice-President of Hollinger-Hanna Limited.

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The four following papers were first presented orally during a panel discussion on "Industrial Plant Pollution Control" sponsored jointly by the E.I.C. and C.I.C. Montreal Chemical Engineering Program Committee on November 23, 1961.

Setting the tone of the discussion were the opening remarks of the Moderator, Dr. Lucien Piche, Vice-Rector of the University of Montreal:

"No form of human activity is possible without air and water. I do not expect that anyone will question such a statement nor that it will prove very stimulating in opening a planned discussion. This is, of course, because we have grown in a context of inexhaustible water supply and unfailing atmosphere.

"However, this context is rapidly changing: our industries multiply in number, variety and complexity and we are becoming more and more crowded in our growing cities. There now is an increasing awareness that the legendary greatness of our rivers is more folklore than reality and that "breathing space" is indeed a concrete fact. We now are reminded, for instance, in the crowded morning elevator, by a friendly office neighbor who innocently blows a puff of strong tobacco smoke in one's face, that the era of biological survival of the fittest is no less a reality than in medieval civilization.

"This awareness becomes particularly acute when we are concerned with the function that the atmosphere and our rivers must serve in disposing of the various wastes of our growing urban and industrial activities.

"We are invited (during the panel discussion) to look into some aspects of water pollution. While we have a panel of knowledgeable gentlemen who can speak with authority of the responsibilities of industry we do not, of course, propose to make any definite decision; it has been the intention of your executive that an airing through discussion of some of the aspects of the problem of pollution of water by industry might promote what I would call a 'rapprochement des idees' . . ."

EIC—63—CHEM 3

A POLLUTION POLICY

Douglas Jones
Executive Secretary, Technical Section
Canadian Pulp and Paper Association

THE phrase "water pollution" now is being presented more and more to the public by many who are not fully aware of its real meaning. It is used indiscriminately and has become as popular as the word "fallout". But before the expression "water pollution" can be discussed adequately, it must first be defined.

Definition

Chemically pure water does not occur in nature. Our lakes, streams and rivers contain many chemicals in solution. Some of these, although only trace elements, are essential to life. Some are harmless, indeed useful in small quantities but may be harmful in larger concentrations. Very few are harmless irrespective of concentration. The situation is further complicated because the number of chemicals which may be harmful depend on the use to which the water is put. For example, a content of calcium carbonate harmful in boiler feed water would not harm fish or humans.

It follows, therefore, that any definition of the term "water pollution" must take into account the use to which the water is normally put. Probably the widest practical definition of "water pollution" is an artificial change brought about in a natural water which adversely affects its beneficial use.

Having defined "water pollution" in general, the next problem is to measure it. It should be clear that no general standards can be used in a measurement of water pollution. In addition to the use of the water some of the variables which will be encountered would include differences which the same material in the water has on different natural waters. For example, heavy metals are more toxic in soft water than in hard water. Other variables include temperature differences, flow fluctuations, other sources of pollution upstream and

downstream, and the nature of the source of pollution. Obviously, therefore, the measurement of pollution must be related to local circumstances, and any attempt to provide standards to be applied broadly without reference to local conditions is unrealistic both technically and economically.

At present, the most beneficial uses of natural waters are as a source of drinking water, for swimming and general human recreation, as a habitat for fish, as industrial water supply, for agricultural use and as a means of disposal of some reasonable amounts of wastes from industrial activity.

The use to which water is put has a very important bearing on the measurement of pollution. One of the common methods of measuring organic pollution is by the biochemical oxygen demand test (B.O.D.). This measures the amount of oxygen used in an experimental five-day period of oxidation of the organic matter present in the water. The B.O.D. of a water sample can be measured whether the organic material originates from, for example, a chemical pulp mill or a domestic sewer. Two water samples may have identical B.O.D.'s but be completely different in their suitability as a source of drinking water. First, the water containing domestic sewage may contain harmful bacteria. To swim in, or drink unchlorinated water carrying domestic sewage is dangerous even though the B.O.D. is within acceptable limits. With a pulp mill effluent, there is no risk of infection by harmful bacteria, and in assessing the effect of B.O.D. from a pulp mill, only its effect on the oxygen balance in the receiving stream need be considered.

The psychological aspects of pollution also need consideration. Imagine the difference in the feelings of anyone who finds a wood chip in a glass of water compared with finding a piece of human excreta.

The question of oxygen balance is a complex but important consideration. Natural water always contains organic matter. Also always present are micro-organisms that break down the organic matter, thus putting the material back into circulation for reuse by life forms. This leads ideally to a state of equilibrium. When more organic matter is added to natural water, the micro-organisms multiply and attack it in an effort to restore the state of equilibrium. In the process, oxygen is used. The oxygen is replaced by re-aeration through the surface, by turbulence and by photosynthesis of plants. The rate of this activity is also affected by temperature. In any water system the rate of micro-organism activity and the available oxygen supply depend on temperature, turbulence, and many other factors. Provided the amount of organic material added and the rate of micro-organism activity is not such as to exhaust the available oxygen supply, no irreparable harm will be caused. Therefore, the amount of B.O.D. which can safely be added to any water-course depends among other things on the use to which the water is to be put, the temperature, the flow and the stream-bed characteristics, the oxygen content above the addition, the fluctuations in both loading and flow, and the nature and extent of other polluting materials.

I have tried to demonstrate that it is not a practical course to lay down broad standards for B.O.D. or for other measurements which would be applied to widely different circumstances. Each river or lake, each location on a river and lake has its own special considerations which must be taken into account if a realistic picture is to be obtained and a realistic solution found to its pollution problem.

What Is Industry Doing About Pollution?

The Canadian Pulp and Paper Association and its member companies for many years have been actively promoting the reduction of mill effluents, thereby reducing pollution load. As Executive Secretary of the Technical Section of the Association I have co-ordinated these activities which have been a major item of study by the Chemical Engineering Committee of the Technical Section for some 20 years or more. We have formed six regional effluent improvement committees in Quebec and Ontario. These committees represent all the pulp and paper mills in six specific watersheds.

To give you an example of the activities involved in these regional industrial effluent improvement committees I will cite the terms of reference of one of them formed in Ontario in 1957.

1. To co-operate with the Ontario Water Resources Commission and with each other in carrying out investigations and planning for the improvement of water utilization and of industrial waste conditions in the area.

2. To present facts and statistics that will inform the public on pulp and paper manufacturing problems as they affect water pollution loads.

3. To keep informed on technical developments in the field and arrange attendance at technical meetings where such matters are discussed.

4. To consider recommendations to senior management on what steps should be taken to improve conditions at individual mills."

In a report prepared in 1960 we compiled the following interesting facts from 15 companies which operate 40 mills in Manitoba, Ontario, Quebec and New Brunswick. They collectively represented nearly 50% of the total production of our industry.

In 1959, eight of these companies spent a total of $62,250 in carrying out biological surveys of the rivers or streams on which their mills are situated. In addition to this the 15 companies spent $421,240 in 1959 on items in their research budgets which have a direct bearing on stream improvement.

From 1949 to 1959 these same companies spent a total of $22,646,-991 in closing the mills' white water systems and in installing high-yield pulping equipment which materially reduced the pollution load of the effluents. As examples of this material reduction in pollution, two mills, at which high-yield pulping equipment had been installed during the previous few years at a capital cost of $3,450,-000 report a reduction of 35,000 tons per annum in the total solids sewered. Another group of four mills reported a reduction of 43,000 tons per year total solids sewered during the previous three years.

Of the same 40 mills, only four still allow bark refuse to enter the rivers on which they are situated. Two mills installed bark pressing and burning equipment in the 18 months prior to the taking of this survey. Cost of the installation was $850,000. Nineteen mills which installed bark pressing and burning equipment during the 10 years prior to this survey spent $5,382,000 on this operation. While recent technical improvements have made bark burning economically self supporting, the savings affected by replacement of coal provide approximately 40% of the normal depreciation allowance, without anything being left over to provide for return on the investment.

It is obvious that some of the steps taken during the past 20 or more years which have reduced, in many cases, the pollution load by the mills have been motivated by economic considerations. With steadily increasing wood costs it is imperative that less and less wood substance should be allowed to go to sewers. Therefore, for many years much research endeavour has been aimed at improving operating techniques and utilizing new and improved equipment which will reduce the amount of wood fibre and other suspended solids in mill effluents. This has been accomplished,

in part, by closing mill white water systems by the use of savealls; by the use of flotation cells in fine paper mills; by the almost complete elimination of the sewering of groundwood pulp tailings or rejects; and by the virtual discontinuance of sewering bark from the mill barking plants.

In November 1961, at Toronto a meeting of representatives of Ontario pulp and paper mills was held with officials of the Ontario Water Commission at which time reports were presented outlining some of the major accomplishments made during the previous 10 years. Also present at this meeting as guests were the Honourable Paul Earle, Dr. Gustave Prevost and Mr. A. L. Van Luven from Quebec Province.

I will not attempt here to review all the reports of the two-day meeting. However it is important to stress that the pulp and paper industry does recognize its responsibilities in the matter of effluent and stream improvement.

In a paper which I presented at the Toronto meeting I said in part:

"I am sure you will agree when you have heard the three reports which are to follow that the pulp and paper industry has not lagged behind in its endeavours to implement action effectively to reduce its losses in mill effluents. I can assure you that it will continue its studies and research and that eventually, based on sound biological and engineering principles it will do everything that is economically possible to achieve the recommended objectives of the Ontario Water Resources Commission . . ."

"We should be expected to play our part in effluent improvement but must, in return, ask that we can do this only in an environment that bases the results on sound biological principles taking full advantage of the fact that waterways must and should be used to assimilate some reasonable amounts of waste materials."

I would like to refer to one of the specific reports presented at the Toronto meeting. This statement, presented on behalf of five mills of the same type operating in Ontario, reported in part:

"A review of various mill reports indicated that since 1950 a total of $11,501,500 has been expended by the five mills. This total . . . shows that $945,500 was spent exclusively for the abatement of stream pollution (direct expenditure), and $10,556,000 was spent for system installations, mainly for reasons of economic return, but where stream improvement is secondary (indirect expenditure) . . ."

"The per cent reduction in total load of the mill effluent streams, due to improved chemical recovery, ranged from 5% to 40% for one chemical and from 17% to 70% for another. The mill showing a 70% reduction in pollution load of one chemical reported a concurrent production increase of 143%. . ."

"One mill emphasized a 54% reduction in B.O.D. of the total mill effluent sampled at the mill, between 1952 and 1960 . . ."

"The reduction in fibre loss was difficult to evaluate. However, one mill, where an integrated operation exists, did report a reduction in fibre loss of 48%, with an accompanying increase of pulp production of 64%. Another mill reported a reduction in suspended solids of 44%, with an increase in pulp production of 12%."

Where Do We Go From Here?

I am certain that the various provincial regulatory agencies will receive co-operation from industry in general, but submit that there is a need for the co-ordination of objectives by all concerned.

The International Joint Commission, created after the signing of the U.S.-Canadian Boundary Waters Treaty of 1909, recognized the importance of preserving the asset of our boundary waters. All our waterways, be they boundary waters, interprovincial waters or provincial waters should be considered as a usable resource and the various agencies concerned should recognize the concept of multiple use for our waterways. The International Joint Commission at the outset created specific objectives for water quality in the boundary waters. These were intended to restore and maintain these waters in a condition which would permit them to serve the many purposes expected of them. The provincial agencies would do well to study the objectives of the International Joint Commission and to set similar objectives for determining the quality of the treated wastes and of the receiving water bodies.

With municipalities, industry and individuals carrying out their respective responsibilities in a co-ordinated manner across the country we can expect to produce an end result which will be satisfactory to all concerned.

This cannot be accomplished overnight, however. Much research and the expenditure of considerable sums of money will have to be made before we are all satisfied. It is easy to suggest that by-products should be developed which would utilize large proportions of the waste material which now have no economic value. However, the cost of such research can be enormous and so can the cost of changing processes or installing special equipment without economic return. The latter can cost many millions of dollars and few, if any, businesses can afford this expenditure of capital unless it is spread over a number of years, or unless special tax incentives are offered by the governments concerned.

EIC-63-CHEM 4

Government's Role in Pollution Control

A. L. Van Luven
Technical Adviser Quebec Water Purification Board

WHEN we consider Government's role we must, of course, also deal with Industry's role to a certain extent because there must be a four-way partnership if we expect to make substantial progress in the water resources field.

I would like to stipulate that my entire outlook on these pollution questions is founded on the important fact that it is virtually impossible to attempt to deal successfully with any aspect of pollution without considering at least several other of the many inter-related aspects of the water resource field.

Continuing with this partnership theme, in my view, there must be a working co-operative partnership between the dominion, provincial, and municipal governments and with industry as the fourth partner. The partnership in this water resource field must be effective and permit a well co-ordinated program that is designed to achieve results in respect to research (development of objectives

and standards, methods, etc.) and action on a broad front. Incidentally if the partnership achieves good results in the municipal sewage field industry may be more disposed to co-operate.

It seems to be generally accepted by many engineers, scientists and industrialists in Canada that the role of these partners should be as follows:

DOMINION GOVERNMENT

This government should conduct extensive research programs, make known the general magnitude of the problems, lay down the general plan of attack, set up board policies, provide minimum pollution-control standards, enact enabling legislation that might be complemented by Provincial statutes and provide assistance in financing.

It is quite likely that there should be a National agency for co-ordinating all resource ideas, especially research, from coast to coast. There is certainly a widely recognized need for research in this field and, undoubtedly, co-ordination of research activities would greater reduce duplication of effort and produce far better results.

There seems to be a great deal of merit in the idea of having a national advisory council and a declared national water policy. Many engineers and administrators in the field have declared themselves to be in favour of having more uniformity in the regulations that are adopted by each of the provinces.

Federal activity will be increasingly more essential to meet the rapidly-approaching, serious and complex problems of the Great Lakes Basin where two provinces and eight states are intimately involved.

PROVINCIAL GOVERNMENTS

It seems to me that the provincial governments should set up resource programs and policies with good supporting legislation in such manner as to support a joint Federal-Provincial advisory and investigatory committee. The provincial governments should enact legislation that would complement the basic Federal statute after basic country-wide pollution-control measures are evaluated.

There is little doubt, at any level, that the provincial authority should be the controlling body. In this regard, there are few engineers in this field who do not greatly admire and seek to copy the policies and methods of the Ontario Water Resources Commission. Let me remind you that this body is concerned with all aspects of water resources. The O.W.R.C. can force action, finance, construct, acquire, operate and maintain both water and sewage plants. It can control and regulate the collection, production, treatment, storage, transmission, distribution and use of water. It can conduct research programs and prepare statistics for its purposes.

There is no doubt in my mind that we are creating unnecessary problems when we consider pollution-control only. In this work, we must concern ourselves with all the many interrelated aspects of this field. These include water supply problem such as ground water protection and storage, reclamation and re-use of water, surface water impoundments, oxygen-balance in streams, reservoir and water-shed management (including forestry operations). There are also a great variety of water Water Rights Laws and other legal problems with which engineers must be intimately concerned if we hope to do this job properly. All of these aspects, of course, are in addition to the many facets of the pollution problem, which includes toxicity, detergents, suspended solids and their effects on photosynthesis and benthic organisms, radioactivity, excess nutrients, pathogenic bacteria viruses and parasites, sludge handling and the industrial waste picture.

MUNICIPAL GOVERNMENTS

It seems clear that municipal governments should set up their own by-laws in regard to sewage and other matters that affect resources, having their own by-laws comply with the objectives and standards that are provided by the senior governments.

Municipal governments should be responsible for policing these by-laws under the supervision of the provincial governments. However, it must be understood, for example, that it is sheer nonsense for a provincial government to approve the construction of a sewage treatment plant and then allow the municipality to operate it so haphazardly that the plant deteriorates and has very low efficiency.

Every municipality must be fully aware of its responsibility to down-stream users and of its need to co-operate with surrounding municipalities in the economical solution of their mutual problems of water supply and waste disposal. Municipalities have a definite responsibility to control their areas by such measures as: realistic town planning and zoning; industrial development programming; responsible attitude toward industry.

INDUSTRIAL

The importance of the industrial partner is almost pre-eminent, particularly if this country hopes to compete successfully with the rapidly expanding and increasingly more productive economies in the so-called under-developed parts of this world. Partnership and cooperation with industry must be emphasized.

Industry, for its part, must be fully aware of its responsibility to treat, or pay for the treatment of its effluents (solids, liquid and gas) and to meet reasonable, equitable standards and/or objectives.

Industry must state its requirements for a reasonable future period, of all natural resources, especially water, having regard for both quality and quantity. Conservation concepts must be actively pursued by all industrial organizations. Incidentally, it must be clearly understood that conservation is the informed, conscientious management of resources; it is development as well as protection; it is use as well as saving. A conservationist is not a hoarder but a person who makes judicious choices concerning resources.

In my opinion, there is a great deal to be said for governmental support of research as an aid in solving some difficult industrial pollution-control problems, especially for marginal and small industries.

There is aso a great deal of merit in forming governmental-industrial action committees that would, for example, discuss objectives and standards for streams and effluents, region by region, watershed by watershed before the governmental control agency declares their policies and sets up these objectives and/or standards. This has been emphasized by Dr. E. J. Cleary of ORSANCO, when he described the work being done in the Ohio valley. There State-Industry conferences and Action Committees are used extensively to develop regulations which relate to industrial wastes. Co-operation has been emphasized over, and over again.

Specifically we mean:

a) Co-operatoin between industry and municipality.

There should be joint treatment wherever satisfactory agreements can be arranged and providing the volume and other technical aspects are suitable. It is understood that the paper industry, for example, may someday evolve an economical closed system which would preclude joint treatment.

b) Industry with Industry.

This means that even competitors must work together to solve waste

problems that may offer nothing but trouble and expense for each.

c) Municipality within its own area.

It is fundamentally wrong for a school commission or one part of an organized community to be building a sewer system that bears absolutely no relationship with the remainder of the municipality perhaps even in the future.

d) Municipality with municipality. Here I wish to emphasize the tremendous importance of having combined schemes. Wherever possible, municipalities should join with their nearby neighbours to build combined sewer systems and large sewage treatment plants.

Small plants are subject to shock loading both organically and hydraulically and thus severely limit the potential for industrial growth in any given area.

A great deal has been said about stream and effluent standards which some prefer to call objectives. Stream and effluent standards should always be used together. Stream standards pertain to the receiving stream; they permit a flexible adjustment of waste discharges and the optimum use of the natural purification capacity. However the proper stream standards for a given stream, are difficult to determine, owing to the many influencing factors.

Effluent standards are easy to apply; they specify the amounts of each deterimental material, that may be discharged from any sewage outfall into a stream. Frequently, effluent standards are based on draught flows and, therefore, they are unnecessarily rigid and expensive for all other conditions of flow.

All standards must account for the great variability in any given receiving stream, in order to keep the riparian communities and water-side enterprises co-operating with the water authority. We must utilize our streams to the greatest possible extent, in harmony, of course, with the value of each stream to the present and future generations of our society.

Dr. C. J. Velz, one of the foremost authorities in this field has emphasized, many times, that regulations are unrealistic when they ignore the waste-assimilation capacity of streams and that this policy will surely lead to serious violations. Using a case history in the Atlantic and Gulf coast area Velz showed that it is possible to increase the industrial potential in any area by 10 to 50 times by regulating the release of water in accordance with the variation in waste assimilation capacity of a stream. Velz emphasizes the concept of the Multiple-Use Policy and the pooling of interests among all water users in any given basin—these, of course, being based on long range planning and statesmanship.

AVOID NON-COMPETITIVE SITUATIONS FOR INDUSTRY

To realize the importance of this concept from the industrialist's point of view, it is only necessary for one to have had first hand experience with an organization that operates in more than one of our provinces, competing on both domestic and foreign markets. Then this important fact is driven home.

We, in the water resource field, will do well to remember this point if we expect to make headway in solving our problems.

Quite apart from the competition viewpoint, it should be simple for us to grasp the concept that, under free enterprise, industries must obey the rules of economics. This may well mean, of course, that over the years, we can gradually achieve results which presently may be unrealistic. In fact, our technology will definitely improve, although this improvement will certainly be required.

CONTROLS

We were asked what controls there should be. Controls will vary with the location and the circumstances. It is, therefore, difficult to be specific about this. It seems to me that the best thing to do is discuss certain aspects of controls in a general way.

There are three significant aspects regarding the control of pollution: recognition; establishing control; maintaining control.

Recognizing the problem, involves, primarily, a definition of pollution, and this varies widely.

For example, some define pollution as "the contamination or rendering unclean or impure, the waters of the State or making the same injurious to public health, harmful for commercial uses or deleterious to fish, bird, animal or plant life".

As another example, others define it as "anything which brings about a reduction in the diversity of aquatic life and eventually destroys the balance of life in a stream".

Recognizing the problem also entails both general and exact knowledge of the existing conditions. We must establish both qualitatively and quantitatively, data regarding oxygen balance; fish, animal and plant life; hydrology of the water over a reasonable period; certain other chemical, physical, biological and bacteriological data as required; description and analysis of the regional characteristics.

It is interesting to note that Dr. E. J. Cleary of ORSANCO has emphasized the importance of being armed with facts which he calls "vital data". He says that the vital data needs of the water pollution-control administrator are his inventory on the status of control installations. He must have a list of the sources and the amounts of waste discharges, a catalogue of the water uses and data on quality and quantity aspects of streams. Cleary emphasized that an aggressive, professionally competent program on pollution control is not possible without compilation and use of these vital data. Cleary has much more to say on the importance of surveys but I have said enough to make my point.

Control is established by: public education and this is a long term process; co-operation at all levels; industry — municipality action committees; establishing realistic objectives for stream and effluents; assisting communities to establish sound, practical and reasonable by-laws; co-ordination of all aspects of water resource development and protection. Control is maintained by: co-operation; good inspection with realistic sampling; periodic resurveys of the river or lake; setting up engineering parameters (correlated with hydrological data) that will continuously assess the total pollution and the actual state of the water resource, in question; demonstrating to everyone, in a practical way, that a realistic approach is being taken.

Appendix

Possible Parameters for Continuous Assessment: (1) Stream discharge; (2) Five-day B.O.D. (3) Immediate B.O.D. (4) Ultimate B.O.D. (5) Dissolved oxygen (6) Temperature (7) pH (8) Suspended solids-volatile and fixed (9) Stability test for all effluents using methylene blue (10) Careful record of all the hydrological changes to which all tests can be related. These data are subject to statistical analysis over the long term. (11) Biological indicators — these must be developed for each case.

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Results of a Co-Operative Approach to a Water Survey

L. P. Roy
Survey Director—Laval Industrial Association

IN A BULLETIN issued in September 1961 by the Royal Bank of Canada and entitled "Water Pollution", it is reported that in general, for the last 25 years, industry has been more active than municipalities to assume its responsibilities with respect to water conservation. As a representative of a group of industries, I would like to be more specific and report to you the results of a few years of a cooperative effort by these industries to reduce the water pollution to a low level in a rather complex industrialized area.

About two years ago, a group of 17 industries located in the municipalities of Montreal East, Pointe-aux-Trembles and Ville d'Anjou, have formed, on a voluntary basis, the Laval Industrial Association.

The successful experience gained by an organization known as the St. Clair Research Committee in Sarnia, has convinced our industries that a similar approach offers a promising solution to the air and water pollution problems. For instance, The Association has the advantage of being able to use the laboratory facilities of the participating companies so that a more elaborate research program can be carried out than would have been possible for individual industries. It is understood, however, that these industries continue to carry out their own research or pollution control programs. Once a month, technical representatives of the industries meet to study the results and to discuss various aspects of the survey. These activities have a definite beneficial effect on the members who become more aware of the pollution threat. This effect has been observed in their enthusiastic collaboration in providing the Association with valuable information about the various plant operations which can present a pollution problem or in noticing the Association before a plant shutdown or shortly after an emergency situation.

TABLE 1

Year	*B.O.D. p.p.m.*	*O_2 dissolved % saturation*
1957.....	2.0	90
1958.....	2.1	91
1960.....	1.7	95
1961.....	2.4	92

The objectives of the Association are first, to assess the effects of air and water-borne industrial effluents in the immediate neighborhood of the industrial area, secondly to follow the trend of contamination as a function of time, that is, to measure the pollution in order to form a basis against which subsequent levels could be compared, and thirdly to suggest remedial action whenever enough information has been gathered.

Figure I

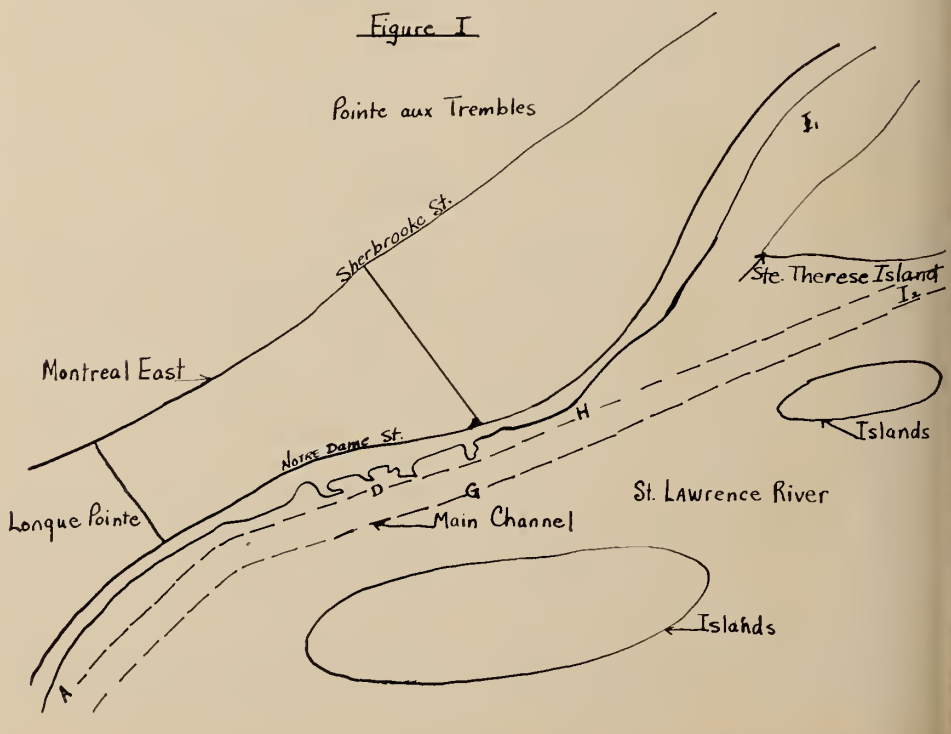

TABLE 2

Phenols p. p. b.

Year	A	D	G	H	I_1	I_2	Average
1957.....	22	88	67	61	44	20	50
1958.....	8	27	40	43	42	18	30
1960.....	6	11	17	15	4	3	10
1961.....	3	33	22	1	7	5	12
Average....	10	40	37	30	24	12	25

As a first step to the primary objective, the Association carried out in 1960 and 1961 a water survey in the St. Lawrence River between Longue Pointe and Ste Therese Island in an effort to determine the level of the water contamination in that highly industrialized segment of the River. The location of the sampling stations are shown in Fig. 1. Stations A and I_2 were chosen as representing the situation of the waters entering and leaving the industrial area respectively. The determinations, carried out according to the Standard Methods for Water Analysis of the American Public Association were as follows:

a) Dissolved oxygen (% of saturation); b) Biochemical oxygen demand (B.O.D.). Weight of O_2 used for the stabilization of reducing wastes through aerobic biochemical action of bacteria; c) oil film on surface of water; d) phenols; e) coliform bacteria.

A similar survey, in the same area, was carried out in 1957 and 1958, by Professor Lucien Piché, under the auspices of the Montreal East Refineries' Steering Committee for Air and Water Pollution. As their results were made available to us, a comparison of the results is thus possible to see if some improvement has been achieved from 1957 to 1960.

RESULTS

Dissolved Oxygen and B.O.D.

The results of percent of dissolved oxygen and of B.O.D. for the years 1957, 1958, 1960 and 1961 given in Table I show minor disturbances in oxygen balance. There is some indication that the amount of dissolved oxygen is somewhat higher in 1960 and 1961 than in 1957 and 1958. Furthermore the low B.O.D. value in 1960 indicates a definite improvement over the situation in 1957 and 1958. The high B.O.D. in 1961 could be partly explained by the presence of an increased load of domestic and industrial wastes. For instance the number of coliform bacteria, which is an indication of the presence of untreated municipal sewage, has more than doubled in 1961 as compared to 1960.

As the two previous determinations are not specific to industrial wastes, no definite conclusion can be drawn about them.

Phenols

The results of the phenol concentrations at the various test stations are summarized in Table 2. The values recorded at stations D, G and H are obviously an indication of the presence of phenol compounds of industrial nature. It is interesting to note that the average concentration (12 p.p.b.) at outlet I_2, is nearly identical to the concentration (10 p.p.b.) at inlet A. This situation indicates that the quality of the water is rapidly restored to its initial level. But the most interesting aspect of these results, is the steady decrease of phenol concentrations since 1957. For instance, the average level which was 50 p.p.b. in 1957 had decreased to 12 p.p.b. in 1961. The improvement is even more noticeable, if we consider the appreciable industrial growth that has been observed during that period. This situation is mainly the fruit of careful control operation and good housekeeping of the industries sponsoring this survey.

Oil Film

The determination of oil as surface film, was carried out by the method developed by Professor Piche in 1958. Oil, on the surface of water, is entrained with water by capillary action into a filter paper. Subsequent solvent extraction and distillation give the oil absorbed in the paper. The results are expressed in milligrams per square meter and are shown in Table 3. As the method used in our surveys is different from the method used in the surveys of the Refineries' Committee, a comparison of the results is not possible. However, the results of the 1957 and 1958 surveys are presented to show the presence of a constant and significant background level at station A, while the average value in 1958 is about 35 percent lower than in 1957. The results of the 1960 and 1961 surveys present a similar although less noticable pattern. The residual background of 55 mgms/m² contributes appreciably to the individual values at the downstream station so that the actual values are substantially lower than indicated. It is also interesting to point out that the average value in 1961 is about 10 percent lower than in 1960. The difference is more significant if we consider the increase in vessel traffic, which is an important source of oil contamination.

Coliform Bacteria

The results of the coliform bacteria will not be reported here, as they are an index of the presence of untreated domestic sewage only.

CONCLUSION

The steady decrease of industrial water pollution observed over the period covered in the present report, is an indication of the determination of our industries to reduce the pollution to minimum levels. The cooperative approach is we believe greatly responsible for the encouraging results of our surveys, because individual industries are aware that a survey is carried out and they work without the fear that one industry might nullify their effort by a careless operation. Obviously, in some cases, more efficient control devices are needed. Once these devices have been developed, and their efficiency demonstrated, there is no doubt, from the past experience, that our industries will not hesitate to have them installed.

TABLE 3

Oil films p. p. m.

Year	A	D	G	H	I_1	I_2	Average
1957.....	1.6			3.0	2.1	1.9	2.2
1958.....	1.6			1.7	1.5	1.1	1.5
				mgms/sq. meter			
1960.....	59	80	82	68	71	73	72
1961.....	50	.68	82	77	70	49	66
Average....	55	74	82	73	71	61	69

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Industry's Viewpoint on Industrial Water

Norman E. Cooke

IT IS WELL recognized that it is not only economically impossible but also unnecessary to remove all wastes from streams and rivers. Streams and rivers have a certain natural capacity for assimilating wastes without seriously affecting their quality and the rational approach to pollution control, therefore, it is to permit the limited use of receiving waters for transporting wastes, regulating this use so that the streams and rivers are still suitable for whatever other purposes are deemed desirable.

The degree of treatment needed for adequate control is a complex problem depending on many factors which must be defined for each local situation. It cannot be resolved by an overall legislative decree or by the adoption of arbitrary or restrictive standards, but depends rather upon co-operative action between industry and control agencies.

Three aspects of the problem will be developed in this paper. They are: industry's view on the nature of provincial control agencies; industry's policy on water pollution control; recent industrial activity in water pollution control.

Industry's view on the nature of provincial control agencies

Some time ago, the Quebec Division of the Canadian Manufacturers' Association formed a committee to make recommendations to the Quebec Provincial Government on the subject of legislation for water pollution control. Since this committee was composed of individuals representing various industries and since the brief was approved by the Quebec Division of the CMA, it can be considered to be a valid industrial viewpoint on the subject of legislation for water pollution control. Certain recommendations contained in that brief are worthwhile considering here.

The committee recognized that there is need for a central body to evolve, develop and implement a well-defined co-ordinated program based on proper research and all available knowledge and experience. They felt that care should be taken to ensure the representative character of such an agency, so that the thinking and advice of all those directly concerned might be brought to bear on the deliberations and the formulation of policies.

The committee, therefore, recommended that an autonomous board or commission be appointed composed of representatives from: a) public health services; b) game and fisheries; c) agriculture; d) recreation; e) private and public electric power production; f) forestry, including pulp and paper production; g) processing industries; h) manufacturing industries; i) municipal affairs.

The committee also recommended that:

"The major activities of the Board should be to ensure the maintenance of public water supplies in a safe condition for consumption and other uses, including the proper treatment of waste before it is discharged into lakes, streams and rivers. The Board should also make arrangements to facilitate the financing of modern water and sewage works".

The committee was concerned with the type of rules and regulations which might be issued by such a Board and recommended as follows:

"While the Board should be given power to issue rules and regulations for the carrying out of its duties, it should see to it that they are so drafted as to give them a high degree of flexibility to cope with particular situations. With this in mind, serious account should be taken of the following considerations:

a) In principle, the Board should not issue a set of regulations governing the discharge of sewage or industrial effluent designed to cover all eventualities. Rather, each source of sewage or industrial waste should be considered in relation to local conditions, e.g., the volume of diluting water and other sources of pollution in the locality.

b) Certain general objectives should be set forth as a guiding aim, but the Board should have the power to relax or tighten such objectives with due regard to local circumstances. In this connection, the International Joint Commission on the Pollution of Boundary Waters, following a comprehensive study, advanced a series of objectives for water quality control which have stood the test of time. With minor modifications, similar protective rules are being followed as a guide in other jurisdictions and it is recommended that they be adopted for use in the Province of Quebec.

c) After due study, and taking into account all factors such as the total discharges and the total flow of the river or stream and any other pertinent condition or circumstance, the Board should make a specific set of rules governing the discharge of waste water flowing from a given municipality or industrial plant or any other condition or circumstance coming under their jurisdiction. In issuing such regulations, the Board should also set a limit of time by which the municipality or industrial establishment concerned would be required to comply. In this connection, careful consideration should be given to providing a delay that would be just and reasonable in the light of the conditions imposed by the regulations and other pertinent circumstances."

Industry's Policy on Water Pollution Control

In considering water pollution control from an industrial viewpoint, one of the most important factors is the policy which had been adopted by the industrial concerns with regard to this problem. Through the good offices of G. C. Bernard, the Manager of the Ontario Division of the Canadian Manufacturer's Association, a number of the larger companies were asked to supply a statement in 100 words or less outlining their policy with respect to water pollution control. Statements of policy were received from 16 companies which represented a good cross-section of the chemical, oil refining, pulp and

paper, food processing and metal industries.

Space doesn't permit including of all these statements of policy and, therefore, the important points have been summarized. All these 16 companies stated that it was their policy to provide and maintain adequate pollution control measures for all their plants and to co-operate fully with the regulatory agency concerned. Most of the companies stated that they were fully in accord with the Objectives of the International Joint Commission or the Ontario Water Resources Commission. A number of the companies stated or implied that pollution control is considered by them to be an integral part of the process, i.e., the apparatus used for pollution control is considered to be just as essential as the main reactors or distillation columns.

From the foregoing, it appears safe to conclude that responsible industry is willing to co-operate to the utmost with the regulatory authorities, the companies realize their responsibility in respect to the problem and they have a real desire to improve water quality.

Recent Industrial Activity in Respect to Water Pollution Control

No matter how well intentioned industry may be in respect to water pollution control, it is what they have done about the problem which really counts. If space permitted it would be instructive to review the recent activity in this field. Since space is limited however, only a few typical examples will be mentioned.

Last year, Campbell Soup Company Limited opened a new soup canning plant at Portage la Prairie, Man. They worked closely with the Province of Manitoba and the consulting engineers for the City to ensure that there would be no contamination in the Assiniboine River. Lagooning installations were made to handle the total sewage load for the entire City. Special arrangements were made in the water piping design of the plant to divert warm cooling water to the lagoon rather than to storm drains, to reduce the period of ice cover and the thickness of the ice on the lagoon.

Canadian Industries Limited has been carrying out a large scale biological survey in the waters of Lake Ontario since 1956 to monitor the cumulative effect on the Lake of waste water coming from two large chemicals plants. This survey once detected incipient pollution which was corrected before any damage was done. The results are reported in Sewage and Industrial Waste 31 1383-94 (1959).

Cyanamid of Canada Limited completed a new 60 million cu. ft. primary sludge settling basin late this year. This additional facility brings the total settling basin area to 160 million cu. ft. Also, a secondary refermentation system was installed in the new antibiotic plant to eliminate any discharge of an objectionable deoxygenating waste.

One of the steel companies recently completed the engineering design work on a new phenol extracting plant to treat the effluent from the coke ovens. Construction on this installation was completed in 1961 at a cost of $600,000.

In total, the 16 companies are carrying out seventeen surveys or like studies; are having engineering designs prepared for thirteen installations; have recently completed 24 different installations to combat water pollution; are conducting at least seven research programs on the subject; and are sponsoring at least seven educational programs for dissemination of knowledge about pollution control.

Summary and Conclusions

Industry would like to have the regulatory agencies to be autonomous groups representative of important groups which use water.

Industry would like to have the rules and regulations issued by a regulatory agency drafted with a high degree of flexibility to cope with particular situations.

Industry's policy on water pollution control is in accord with realistic objectives such as those proposed by the International Joint Commission and adopted by the Provinces of Manitoba and Ontario and is anxious to co-operate with the authorities to achieve this result.

The record shows that, in recent year, industry has devoted considerable time, money and effort in installing suitable apparatus for water pollution control and that industrial effluents are indeed rapidly approaching such objectives. Industry will continue to follow this course of action.

PLAN TO ATTEND

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PRODUCTIVITY & ECONOMIC GROWTH

John G. Dickinson, M.E.I.C.
Systems Development Manager
Northern Electric Company Limited, Montreal

BEING the hand-maidens of the tools of potential good or ill, the scientist and engineer have a key role to play in economic and human progress. We are in an age quite unlike any that has gone before. It is an age that has seen the flights at Kitty Hawk and orbits from Cape Canaveral; the serenity of 19th century politics and the upheaval of 20th century ideology; all within the span of one lifetime. We are living in a world of accelerated change where a premium is placed on far-sightedness, adaptiveness and brains. Although not possessing a corner on brilliance, the scientist and the engineer, given the necessary stature, are especially equipped by training and inclination to have sufficiently imaginative minds to cope with the growing complexities of modern civilization, if there is to be one.

It is a clear advantage to any society to have a fairly high proportion of imaginative minds which can grasp the overwhelming burdens of top administrative posts. It is also a clear advantage to any society to have and use learned societies as a springboard and sounding board on questions of national policy and approach. According to C.P. Snow the Soviet is ahead of us here where something like 35% to 40% of top executives or high-ranking diplomats are scientifically-trained men, and where much regard is given to opinions of the Soviet Academy of Science which is composed of something like 250 full Academicians and 150 corresponding members ranging from economists to creative writers.

It takes little explaining to see the tremendous challenges that lay before us in coping with an ideological threat on one hand and intense competitive environment on the other. Ever-increasing rates of productivity and economic strength nurtured in a society of free men co-operatively disposed and internationally inclined is the only sure way of meeting this challenge. Here we must turn to science and the ever-increasing role it is being called on to play in this drama of human existence.

Particular emphasis on the single word productivity in this drama may sound trite but it is surprising how all-embracing the use of the term can be. Even a brief examination of articles one the subject will produce a number of definitions. Here are a few:

"Productivity is an attitude of mind; it is a mentality of progress, of constant improvement of that which exists: it is the certainty of being able to do better today than yesterday; it is the will to improve on the present situation—the adaptation of the economic and social life to changing conditions; it is the continual effort to apply new techniques and new methods: it is faith in human progress." (European Productivity Agency)

"Productivity or output per head is raised by increasing the skill of manpower and management and by applying improved techniques through the right kind of investment." (Lord Hayworth Report. U.K.)

"Productivity may be defined as the ratio of output to any or all of the inputs employed in production." (John W. Kendrick, University of Washington)

"The standard of living of every one depends primarily on the productive efficiency of its industries and services, on the effective use of the country's human and material resources." (National Productivity Council, Canada)

The term productivity first found its way into economic literature about a century ago in the form of "the marginal productivity theory of value". Thus, according to this theory, the wages paid for labor will equal the value—productivity of labor at the margin and similarly for the other factors of production: not an easily measured or understood term.

The industrial engineering approach to the productivity concept began with Taylor through time and motion study about the turn of the century. Workers generally characterized the resulting increase in efficiency as speed-up. Here emphasis was on the role of direct labor time in relation to the quantity of output in a given operation.

For convenience and convenience only, it has become customary to measure productivity variations in terms of output per man-shift, man-hour or, in some cases, per worker. In fact most reference to productivity, unless qualified, can be taken as dealing with output per worker just as reference to the efficiency of a motor car is, for the sake of simplicity, measured in terms of mileage per gallon of gasoline. The large shift in recent years from direct to indirect labor in production processes has necessitated the inclusion of both types of labor in the measure where data permits.

With the introduction of full employment policies, primary emphasis turned to productivity in economic growth. Since productivity is a primary factor in determining the rate of growth, there developed the so-called global concept, that is the relationship between the nation's total output of goods and services to the total labor time expended in its production. Technology, of course, is a key factor in the relationship.

Although technological productivity has always been viewed by the workers as a natural threat to job security and redundancy, the fact is that the reverse is true as evidenced by the much higher rate of growth among industries with higher levels of technology and the higher rates of pay and increased purchasing power that these industries afford. In fact even in the case of automobiles, in spite of the several-fold increase in productivity, the number of man-hours per vehicles remains the same as in the 1920s while production rates and employee incomes have multiplied several times. Indeed, as pointed out by the U.S. telephone companies to the automation sub-committee of the joint economic committee in July, 1960, without automation telephone service which now is about 96% dial-operated and employs more than two-and-a-half times the number employed in 1920 when it was manually operated, would long ago have been priced out of reach of a large portion of the present subscribers. It is also a fact that without technological progress it would not now be possible to get

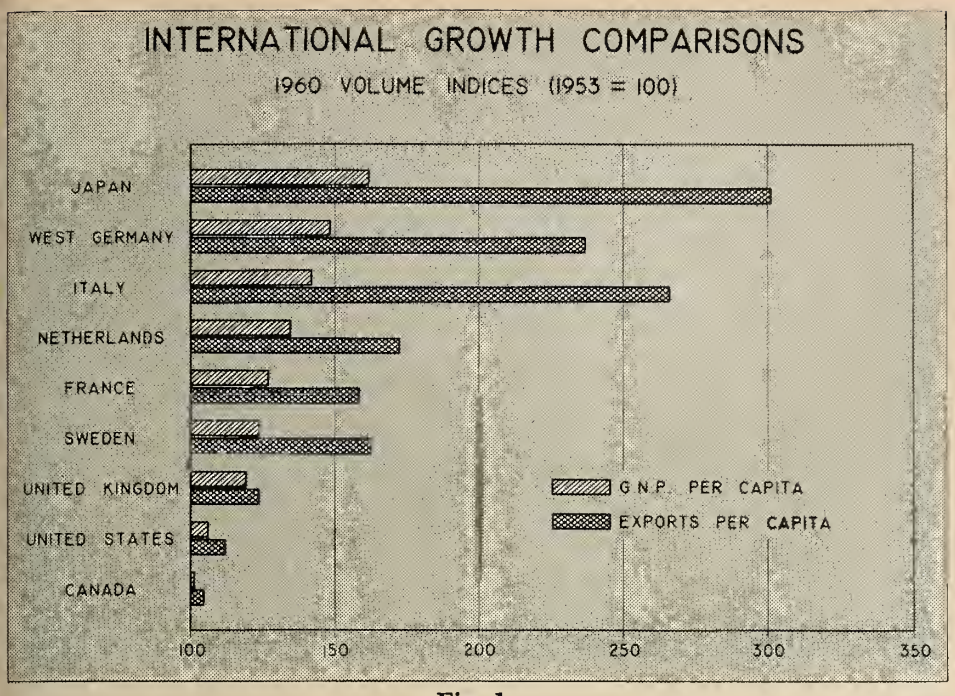


Fig. 1.

enough qualified people to provide the volume and scope of products and services which the public, industry and government need and have today.

Much emphasis is placed on capital in productivity improvement. Capital is indeed necessary for economic progress but equally important is the productive use of it. Although massive capital investment programs, for example, can put many unemployed to work on worthwhile projects, they cannot of themselves solve the structural type of under-utilization of labor and plant from which Canada has been suffering. In fact Aukrust, a Norwegian statistician reporting in the February, 1959, issue of the European Productivity Review, found that the greater part of the increase in productivity observed in Norway during the past 60 years, where unusually accurate statistics of national accounts have been kept, must be explained in terms of technical, organizational and educational improvement and not as a consequence of additional capital investment as such. In other words, capital is needed but waste will result if productive uses for it has not been developed beforehand.

In the broader sense then, productivity is the underlying force in economic progress. In this context it means not merely advances in the development and application of new techniques and machinery but embraces improvements in all fields. Every step forward by management, for instance, in the adaptation of new materials, redesigning of products, production control, improved distribution methods, expansion of market, etc., is as important to better yields as mechanization or automation alone. Every step forward in improved management-labor relations through better understanding of problems in relocation of displaced workers, in training and retraining, in job benefits, etc., could yield results as important as more efficient methods by themselves. Every step forward, for instance in developing clearer national goals through closer co-operation among management, labor and government in determining objectives, and better public understanding of a unified approach, are as important to higher levels of national output as advancement of new techniques only.

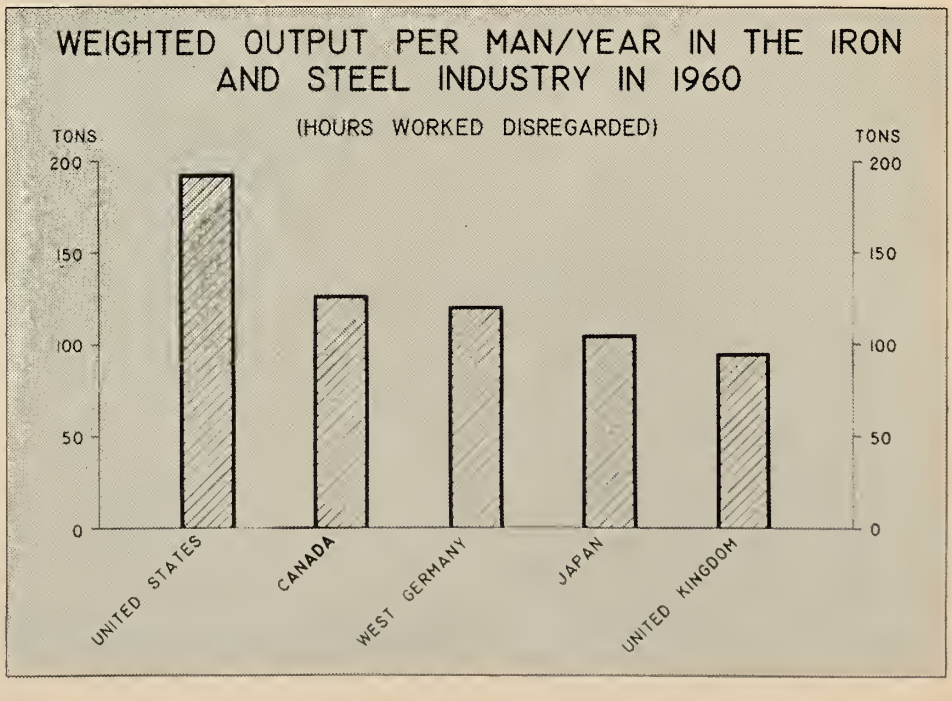
The stress put on this broader attitude to productivity is especially evident overseas. Productivity and economic development councils are perhaps an outward manifestation of this point of view. At last count there were 58 countries with such bodies ranging from very elaborate programs such as France and Japan at $4 million per annum to others of more modest proportions. Although they may differ in organization, their goal is the same—a more competitive growing economy. The results of these concerted efforts, tied in as they are with highly selective growth policies, might well give cause for very serious reflection. In fact it was as a result of such developments overseas that the National Productivity Council of Canada was born by act of Parliament in December, 1960.

Although it may be a familiar story, perhaps a brief review of comparative economic growth and productivity rates among western countries would be of interest. As can be noted from Fig. 1 on the comparative increases since 1953 in per capital GNP and exports, Japan and the Common Market countries have outdistanced other industrialized countries of the western world by a very considerable margin. Although the differences in rates of growth have since narrowed, the pattern remains.

The oft-cited explanation for the higher rates of growth in Europe and Japan since 1953 is the relatively low base from which the economies of these countries sprang. Perhaps overlooked in this explanation is the gain which it represents in relative level of capacity and competitive edge. For example, the amount of new plant and facilities being installed in proportion to the number of workers in such countries as Germany now is about the same as in North America. The volume indices of gross domestic fixed capital formation in 1960 relative to 1953 was 193 for Germany, 181 for Italy, 160 for France, 161 for the Netherlands and 117 for Canada and the U.S.A.

In the past, the lower level of

Fig. 2.



personal incomes, together with the fragmentation of European markets, retarded the general development of mass markets and economies of scale such as have prevailed in North America. Although without mass markets of its own, Canada has benefitted from the U.S.A. mass market technology as it was integrated with its Canadian branch plant operations. Now, however, the market of the Six represents almost 200 million persons, or about the same as that of the North American continent. The United Kingdom adds another 52 million. The opportunities for specialization and economies of scale are, of course, obvious and every activity is aimed to that end.

One example of what is happening might be illustrated by Fig. 2 which shows weighted output per man-year in the iron and steel industry in 1960 for the U.S.A., Canada, West Germany, Japan and the United Kingdom. The weighting was by way of giving effect to the different man-hour component for each product or, in other words, an adjustment for a different product mix. The figures were based on a report by a special committee of O.E.E.C., now O.E.C.D., on the European iron and steel community. Clearly the advantage that North America may have had once is fast disappearing. Rising productivity in other countries, coupled with lower levels of resource cost such as in labor rates or economies of scale is of course a prime reason for increased emphasis on higher productivity levels here.

Figure 3 on comparative unit production costs in selected areas of manufacturing is taken from some charts recently published by the National Industrial Conference Board on "Canada in a Changing World". As is evident from the chart, Canada's relative position is not entirely attractive. In fact, as pointed out by the N.I.C.B., "although Canada is increasingly a manufacturing country, it is relatively a high-cost producer, still heavily reliant on imports of finished products."

The full significance of the situation is not entirely apparent unless we also relate it to certain sociological factors such as the demand for higher levels of employment as well. The employment record in recent years and the future projections of employment requirements as contained in the Royal Commission report on Canadian economic future clearly shows the structural nature of our employment problem.

The point here is that it is upon increased processing of manufactured products and the associated expansion of trade and services that much of this growth depends. Our problem is to provide for this higher-than-average level of anticipated growth in the drastically altered international competitive environment with which we now are faced. The challenge is to do so while at the same time retain the degree of independence and personal well-being to which we have grown accustomed.

Can we do it? I think we can but first we must have a clearer understanding of what is required and a greater degree of desire and unanimity in doing it. Let us turn more specifically to some of these problems with particular emphasis on the role of the scientist and the engineer.

Research and development of course are particularly vital to economic progress. Research has been characterized by Sumner Slighter as the industry of discovery. The product is knowledge. Investment in this industry is investment in the future. The provision of adequate resources to nurture and strengthen our research activities has tremendous implications for our industrial productivity and military security. In relation to GNP Canada invests about one-third the proportion allocated to research and development by the U.S.A. and the U.K. Since it is estimated by Prof. H. Striner of Johns Hopkins University that, over time, $1 in a sound research and development program results in about a $25 increase in product value added, it behoves us to pay particular attention to any deficiencies that exist in this area. And when we think of research we should not limit it to the physical sciences only but to social sciences and economics as well because concurrent advances in all fields are necessary to balanced growth.

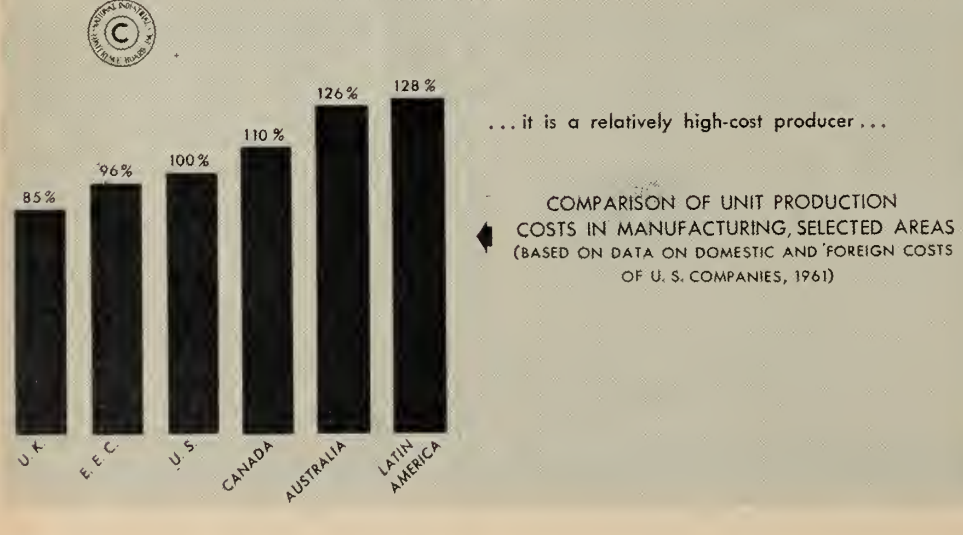
The relatively lesser amount of resources allocated to research and development in Canada is perhaps linked with the failure to achieve increased specialization and rationalization of effort. In all Canada there are only some 195 manufacturing firms with more than 1,000 employees. And since one scientist represents an average annual expenditure of about $25,000, it is little wonder that 150 establishments out of some 36,000 in Canada in 1959 accounted for at least 80% of all industrial research. In fact only 500 establishments reported any effort at all.

This points up the pressing problem which exists in smaller countries where there are relatively few large firms and where, therefore, there is correspondingly less demand for scientists and less research being done. Reasons behind this situation are, of course, related mainly to the cost of doing research. In discussing this problem at a scientific congress meeting in Australia Lord Nelson of Stafford concluded that companies must have a turnover of at least £5-1/5 million per year to engage in any serious research. In practice, most research laboratories have a staff of at least 50. This requires annual gross sales of at least $25 million.

In the conference held by the National Science Foundation on research and development and its impact on the economy, a major problem considered was how to extend the benefits of research to small firms unable to bear the financial burden of a continuing research and development program. This problem also has been given attention by the Organization for European Economic Co-operation, now the O.E.C.D., and is manifested in a report to the Organization by Dana Wilgress. In this report he said he considered one of the main problems to be "to make these medium and small-sized firms research minded." The Canadian engineer and scientist has a key role to play here.

Education and training also are linked closely with research and development as a vital factor in technological progress and increased growth. It is a sad fact that in Canada 70% of the children leave school be-

Fig. 3.



fore completing their secondary education. It is no mere coincidence that 43% of the employed have only primary school or less, and that 75% to 80% of the unemployed fall into this group. In addition to the problem of higher education for new entrants, there is the problem of how to reclaim adult workers or unemployed who had left school too early.

Here there is the need for constant short-term retraining within industry in changing from one set of production methods to another or from changing from one job to another—an ever-increasing problem in an era of rapid technological change. There is a need for craft training which will develop the familiarity with materials and the working of them, and the facility with many kinds of tools and equipment, and the broad understanding of the end product.

There is the expanding requirement for technicians and technologists in many areas. Not only is there a need for the engineering assistant who puts the design of the engineer in tangible form for construction and production, but there is need for the systems man who may work with the engineer in such fields as production planning and control, work study, quality control, and more recently, computer technology and systems engineering.

Although facilities for training of technicians have been considerably expanded by means of some $225 million in federal vocation training assistance in the past two to three years. Facilities for the technologist whose training falls somewhere between the technician and the engineer remain inadequate. It is worth noting that the proper ratio of technologists to engineers is considered by the International Science Foundation to be about 4 to 1, whereas in Canada it tends to be the reverse. The fact that a preponderence of our graduates in applied science find employment as technicians rather than designers is evidence, perhaps, of a serious shortcoming in itself.

As pointed out in the Department of Labour report to the special Senate committee report on manpower and employment, at the root of most of the deficiency in educational programs in Canada are two basic factors. One is the lack of more serious interest and concern, and the other is lack of a more adequate and complete concept of what is required. Surely here is a clear opportunity for every community and profession to study its particular problem and needs, with emphasis on raising all levels of education to suit the balanced requirements of an advanced society.

On the question of secondary manufacturing and employment, the report of the Senate committee on manpower and employment had this to say:

"In the domestic economy our main concern must be focussed upon the secondary manufacturing and capital investment industries. It is particularly vital to achieve renewed expansion in both these fields. The malaise in secondary manufacturing points strongly to the need for new and positive approaches. The solution is not to be found in restrictive and cost-raising measures of self-sufficiency. The temporary spurt which such measures provide would quickly subside and leave a heritage of rigidity and inefficiency. What is needed are measures which would stimulate expansion along efficient and dynamic lines which hold promise for future growth and adaptability in the highly competitive and rapidly changing world.

". . . Our secondary manufacturing industries must be encouraged to keep abreast of the most advanced, to engage in a rapid rate of innovation and development, to seek areas of advantageous specialization and to achieve adequate scales of output so that they can compete effectively both at home and abroad. This is the surest way of maintaining a high standard of living, of obtaining a satisfactory rate of growth and of holding a tenable position among the industrial giants around us".

At the Tenth Wallberg Lecture, Dr. O. M. Solandt phrased the industrial development problem very well.

"The experience of the past five years has made it clear that the primary and service industries of Canada cannot supply full employment for all," Dr. Solandt said. "We must have strong and growing secondary industries in order to employ our expanded work force."

"The Canadian domestic market is limited by the size of our population. If we are to find jobs for an expanding labor force, we must seek export markets for our manufactured goods. Canadian labor is among the most highly paid in the world and we are all anxious to see this continue. Therefore, if Canadian products are to compete effectively in world markets, they must do so either because they are of such high quality or novelty that they will sell in spite of high prices, or they must be of good quality and sold at competitive prices because of the high productivity of Canadian labor.

"It follows that if Canadian secondary industry is to grow rapidly and absorb our unemployed, it must both supply novel and superior products that will command world markets even at relatively high prices, and also perforce production methods which will permit industry to produce other quality products at low prices. All of these things depend very directly on aggressive and competent industrial research."

This is a very direct challenge to Canadian science and engineering.

But how is all of this achieved? There is, of course, no quick answer, no magic wand short of hard work. One thing is certain, however, and that is it won't be effective unless there is a common goal and a strong sense of achievement. It seems an irony of history that in the past it has taken a war or a similar calamity to bring it out.

The point here is that the really important factors making for economic growth are not physical but human—the education, enterprise and effort of the people. Governments can encourage or discourage these attributes but not create them. Large though the sums be that we have spent on higher education, the demand for creative minds has nevertheless risen faster than the supply, especially in the fields of science, technology and engineering. There are still too many men who have had inadequate or no secondary schooling, whose industrial experience has only been as operatives and who find it difficult to adjust to technological change. There is the need for increased social relations and better understanding between management and labor and the role of government in fostering growth. An organizational network to accommodate such relations is quite foreign to the North American scene. There is also the growing need for science to take a fuller role in the affairs of state.

Nevertheless the attitude in Canada is much healthier than it has been for some time. The importance of productivity and economic development for balanced growth now is being recognized at all levels. Private enterprise is much more cognizant of its broader social and economic responsibility to society as a whole. Labor is more prepared to play its full part on the team. In spite of the many differences that characterize the vigor of a free society, every section of the community seems to be placing less emphasis on doctrinaire solutions and placing more emphasis on co-operation and getting on with the job. Although there are many unsolved problems, the economy is moving forward significantly. Our job, individually and collectively is to keep it so.

EIC-63 — CIV 11

The Design and Construction of a 345 KV Transmission Line for the Shawinigan Water and Power Company Using Guyed and Rigid Structures

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Line Location and General Description of Terrain

Fig. 1 is a route map showing the location of the line and of the five material distribution yards used during the line construction.

The southern section of the line between Quebec City and the south boundary of the Laurentide Provincial Park, a distance of approximately 25 miles, consists of some farm land and an appreciable percentage of heavily wooded and rugged terrain. The middle section, some 86 miles in length, is within the Provincial Park. The terrain, mainly rugged and heavily wooded, reaches a maximum elevation of approximately 3250 ft. above sea level. The northern section between the north boundary of the Park and the Isle Maligne Terminal Station, approximately 24 miles in length, is primarily rolling farm land with the exception of a heavily wooded section in rough terrain immediately north of the Park. The route has some very minor areas of muskeg but, generally speaking, the terrain is suitable for the installation of grillage and rock type tower footings.

FIG. 1 - ROUTE MAP

Studies Leading to Choice of Tower Types

The guyed structure, portal or V type, consists essentially of three basic parts—masts (two), crossarm (one),

and guys (four). The V structure, as its name implies, rests on a single footing with the four guys attached to four separate anchorages. The portal structure rests on two separate footings with the four guys normally attached in pairs to two anchorages. Masts are pin connected to the crossarm and rockered on the footings, generally using locating pins, thus making the structure highly flexible. As a result, all torsion forces resulting from longitudinal loads, which require a complex bracing system in the rigid tower, are transferred in the guyed tower through the crossarm into the masts and guys as direct axial loads.

As the major portion of the projected line would be on crown land within the Provincial Park, this section furnished an excellent opportunity to introduce this type of design, provided it could be proved economically superior and mechanically equal to rigid type construction.

A preliminary study was made to compare the relative costs per mile of a 345 kv. line using six different basic types of structures (Fig. 2), namely, (a) conventional rigid delta type, (b) rigid portal type, (c) wood pole H-frame, (d) narrow base "semi-flexible" type, (e) guyed V type, and (f) guyed portal type. The comparative costs obtained from this preliminary study indicated a possible worthwhile saving to be obtained by the use of the guyed portal type tower.

The use of aluminum as a material for tower fabrication was being actively promoted and it was decided to include it in the more detailed comparative cost studies to be carried out.

A loading specification for a suspension type tower was prepared and designs solicited from leading Canadian and European transmission tower fabricators for

i) A conventional rigid delta type tower

ii) Guyed portal type tower

iii) Guyed V type tower.

A total of five manufacturers submitted designs and unit prices for the rigid type tower, using a combination of standard structural steel and high strength steel. Four manufacturers submitted designs for the guyed portal type tower in steel, and one in aluminum (with steel bolts and steel grillage anchors). The design weights for the guyed V type tower were almost identical to those for the guyed portal type.

A comparison was made of "installed costs of the rigid versus guyed portal and guyed V towers. The graph in Figure 3 shows the comparison of "installed" structure costs, based on increase in height of extensions. The installed cost differential between the portal and V guyed structures is due to the lower excavation cost for four versus five footings plus anchors. In the case of rock footings and anchors for the guyed structures, there is very little cost differential between the portal and V type.

Due to the magnitude of the cross line conductor and overhead ground wire loads imposed by large angles, it was decided to limit the use of guyed structures to suspension type towers having a line angle not exceeding 5°.

The final decision for the proposed line was to install rigid type structures exclusively in the upper and lower sections outside the Laurentide Provincial Park and to use guyed portal type suspension structures (for line angles up to 5°) combined with rigid type strain structures (for line angles up to 45° and very long tangent spans) for the 86-mile section within the Park.

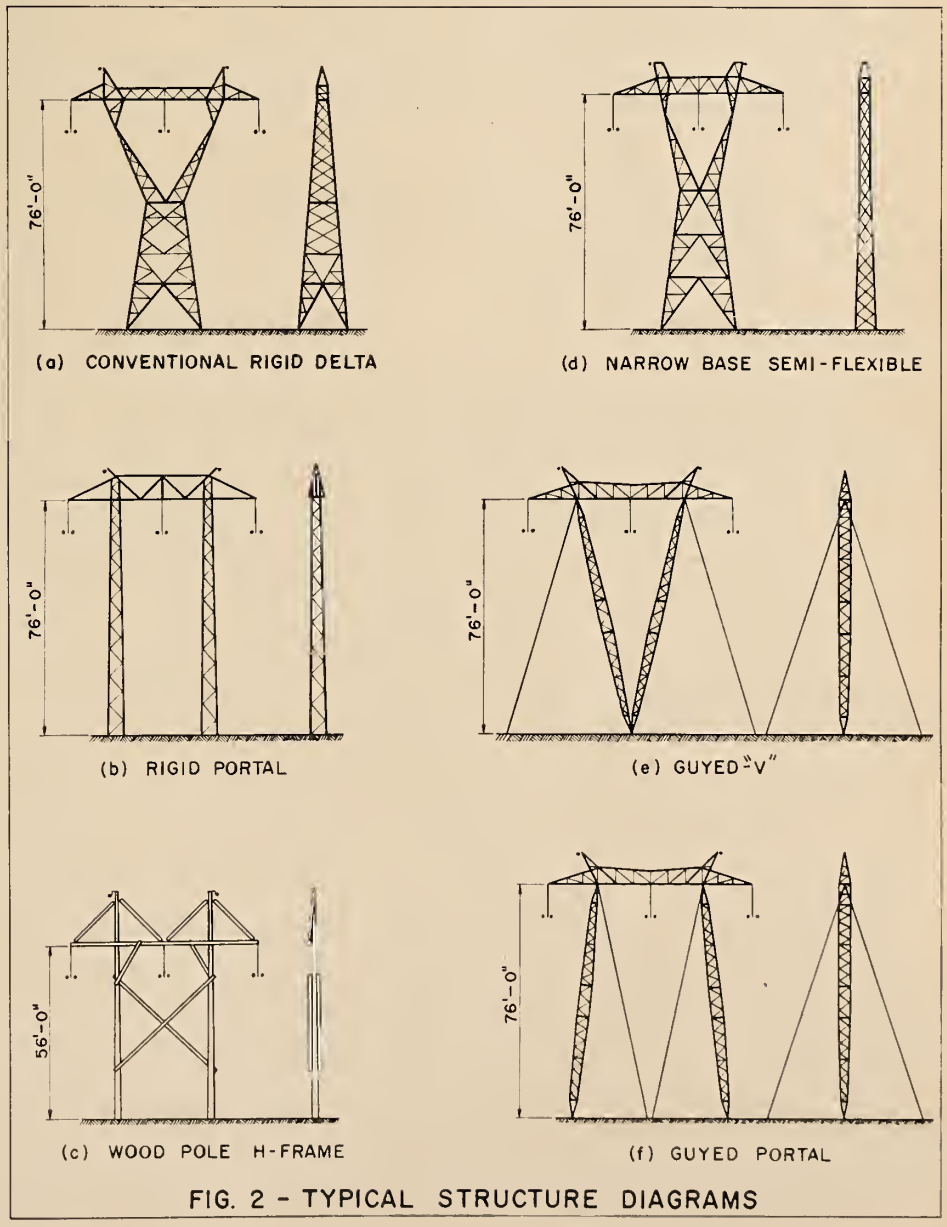


FIG. 2 - TYPICAL STRUCTURE DIAGRAMS

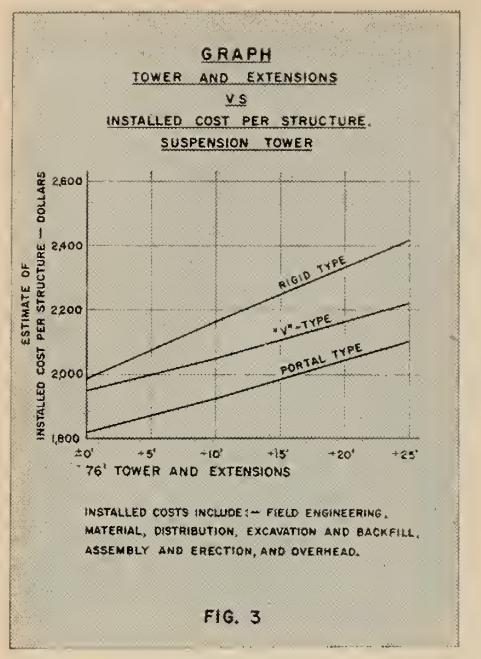


FIG. 3

Mechanical and Electrical Design Features

Conductor Design and Loading

As the area through which the transmission line passes is basically a heavy loading one, a design criteria of 8 p.s.f. horizontal wind on conductors and overhead ground wires carrying ½ in. radial ice at 0° F together with wind on the structure of 13.5 p.s.f. on twice the projected area of one face was used. Under this loading, a maximum conductor tension of approximately 38% of ultimate tensile strength was decided upon, with unloaded initial tension at 0° F to be less than 33% uts and unloaded final tension at 0° F to be less than 25% uts. The final conductor choice was 795 mem acsr 54/7 "Condor".

Tower Design and Loadings

Six types of towers, four rigid and two guyed portal, are used on the line with design loadings as shown in the following table:

All tower types are designed with individual leg or mast extensions in 5 ft. increments to give a height range to the bottom of the crossarm from 66 to 101 ft.

One production unit of each structure type was fully tested by the manufacturer under all design and overload combinations, applied according to the design specification.

Overhead Ground Wires and Buried Counterpoise

The two overhead ground wires extending the full length of the line are 7/16 in. diameter grade 160 galvanized steel, and provide a cone of conductor coverage of 30°. In addition, two buried counterpoise wires, #5 AS&W galvanized steel, were ploughed in to a depth of 24 in., one on each side of the transmission line centreline and approximately 10 ft. outside of the outer phase conductors. These counterpoise wires are connected to the legs of each tower and cross-connected to the counterpoise of the existing double circuit line where the lines parallel on common right-of-way.

Conductor Clearances, Phase Spacing, etc.

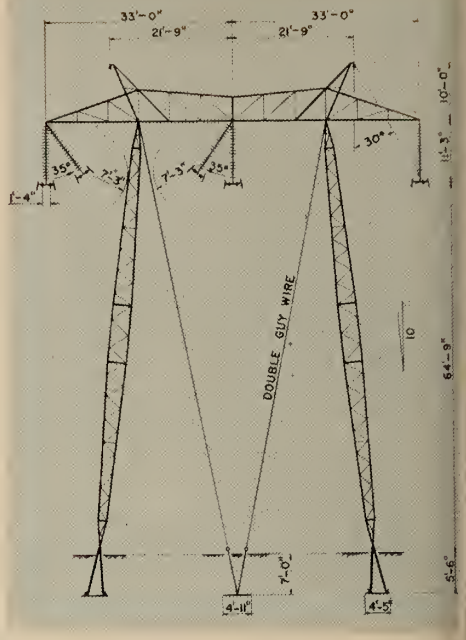
Phase spacing, ground wire coverage, conductor and insulator swings and clearances are shown diagrammatically in Fig. 4.

Insulation and Hardware

The suspension and strain insulator assembly arrangements are shown in Figure 5.

One torsional type damper per conductor per span is installed on all spans under 1400 ft. in length, and two per conductor per span on spans exceeding 1400 ft. On the more open

Fig. 4.



sections of the line, two dampers per conductor per span are used irrespective of span length. With this amount of conductor damping, it was not felt necessary to install armour rods at the suspension clamps.

The spacer choice was a single bolt open spring type. The first spacer on each phase of every span is located 50 ft. from each tower, with the remainder of the span equally divided to give a minimum spacing of 225 ft. and maximum spacing of 300 ft.

Radio Interference and Corona Losses

As a purely precautionary measure, control rings are installed at all suspension and dead end points for a distance of five miles out of Quebec City and three miles out of Isle Maligne. These might be considered the more populated areas of the line. In addition, control rings are installed at all counterweight locations and provision has been made for future installation at all suspension and dead end points if found necessary.

Portal Tower Guys and Guy Hardware

The four guys for each portal suspension tower consist of looped seven-strand grade 180 galvanized steel cables, 9/16 in. in diameter having an ultimate breaking strength as a double guy of approximately 65,000 lb. The four guys for the light angle tower are ⅝ in. diameter, having an ultimate breaking strength as a double guy of approximately 84,000 lb. Each guy is looped over a 5 in. diameter steel sheave

Tower Type	*Code*	*Quantity*	*Line Angle (degrees)*	*Weight Span (feet)*	*Maximum Tangent Span (feet)*	*Weight of Standard Tower and Grillage* (pounds)*	*Height of Standard Tower to Crossarm (feet)*
Rigid Suspension	A	118	0— 2	1500	1300	9,168	76
Portal Suspension	N	259	0— 2	1500	1300	8,825	76
Rigid Light Angle	B	44	0— 5	2000	1800	11,267	76
Portal Light Angle	P	87	0— 5	2000	1800	10,354	76
Rigid Semi-Anchor	C	60	0—20	2400	2000	17,104	65
Rigid Anchor	D	31	0—45	3000	2500	31,788	65

*Including guys and fittings for tower types N and P. Guys and guy fittings for the standard height N tower weigh 725 pounds and for the P tower, 910 pounds.

attached to the tower crossarm, and the bottom end of the guy is attached to a threaded U-bolt 3 ft. long by means of a specially designed anchor block. The bottom end of the U-bolt is connected to the eye of an anchor rod which is in turn connected to the guy grillage anchor in the case of earth grillages or grouted into solid rock in the case of rock anchorages. The threaded U-bolt provides the means of adjustment of the guy length and also allows for a degree of pre-tensioning of the guys. The two ends of each looped guy are brought together and joined by means of a pre-formed guy splice. Each guy is given four twists before connecting to its U-bolt to reduce the likelihood of guy vibration.

Tower Footings and Anchorages

The four types of rigid towers were all designed with grillage type footings consisting of channels and bearing angles bolted to the stub angles which in turn are bolted above ground level to the tower legs (Fig. 6).

In the case of muskeg footings for the rigid towers, combination bearing and uplift timber pads were designed and bolted to the steel grillages for the suspension type towers where all four footings could be subject to compression or uplift, depending on wind direction. For heavy angle structures in swampy ground, special bearing or uplift pads were designed to suit the individual case. Footing depth varied from 7 ft. for the suspension tower to 11 ft. 6 in. for the anchor tower.

The footings and anchorages for the guyed portal towers were of both the rock and grillage type (Fig. 6).

Line Construction

Footing Installation

At the peak of the footing installation program, the work was carried out on a production line basis. The first footing installation crew, using a back-digger, excavated in earth or removable boulders, if possible to final footing depth. If solid rock was encountered, this crew moved on to the next tower location and a drilling and blasting crew took over to carry the excavation to the required depth. A setting crew installed the four separate grillages to the required tolerances, vertically and horizontally, with the correct stub angle slope, then backfilled each footing.

In muskeg areas, temporary and sometimes permanent wood sheeting was required, depending upon the depth of good bearing soil. As all four footings of the rigid type tower required bearing footings, the installation of timber pads in low bearing soil was a costly and time-consuming procedure. In shattered rock, also, the levelling and setting of rigid tower type footings proved very labourious and time consuming.

Footings for the 599 towers in the line—253 rigid and 346 guyed, of which 224 were of grillage type and 122 rock anchor type—were installed between April and December of 1961.

Tower Erection

In the case of the rigid towers, as much sub-assembly as possible was carried out on the ground. With the guyed structures, complete ground sub-assembly, including bolt punching, was possible for each of the two masts and for the complete crossarm. The erection crew, separate from the sub-assembly crew, consisted for both tower types of a foreman, Bombardier driver, and 10 men.

In the case of the rigid structures, five of the men were climbers as against only three for the guyed structures. A 112 ft. aluminum gin pole, in five sections and easily transported by a Bombardier, was used to erect both tower types.

Conductor and Ground Wire Stringing and Sagging

The two 7/16 in. diameter, seven-strand, grade 160 galvanized steel overhead ground wires were supplied on reels holding approximately 15,000 ft. lengths. The two wires were pulled out together by means of a tractor and carried on stringing blocks suspended from the ground wire peaks in the conventional manner. Sagging was done by transit to previously prepared sag tables.

Conductor was ordered in reels of approximately 11,500 ft. and distribution, as far as possible, was in sets of six equally matched reels. Normally, all six conductors were pulled out in one operation by means of a tractor, with care being taken to match the stress histories of the two conductors forming a phase bundle to ensure equal sags. Timber lagging was used for surface protection where necessary. Sagging was done by transit to sagging tables, with fine adjustment accomplished by means of the turnbuckles on each conductor at the strain towers. Following the sagging and clamping-in operations, vibration dampers and corona rings were added where called for. Spacers were installed from carriages riding on the bundled conductors.

Buried Counterpoise

The two No. 5 AS&W gauge galvanized steel counterpoise wires were

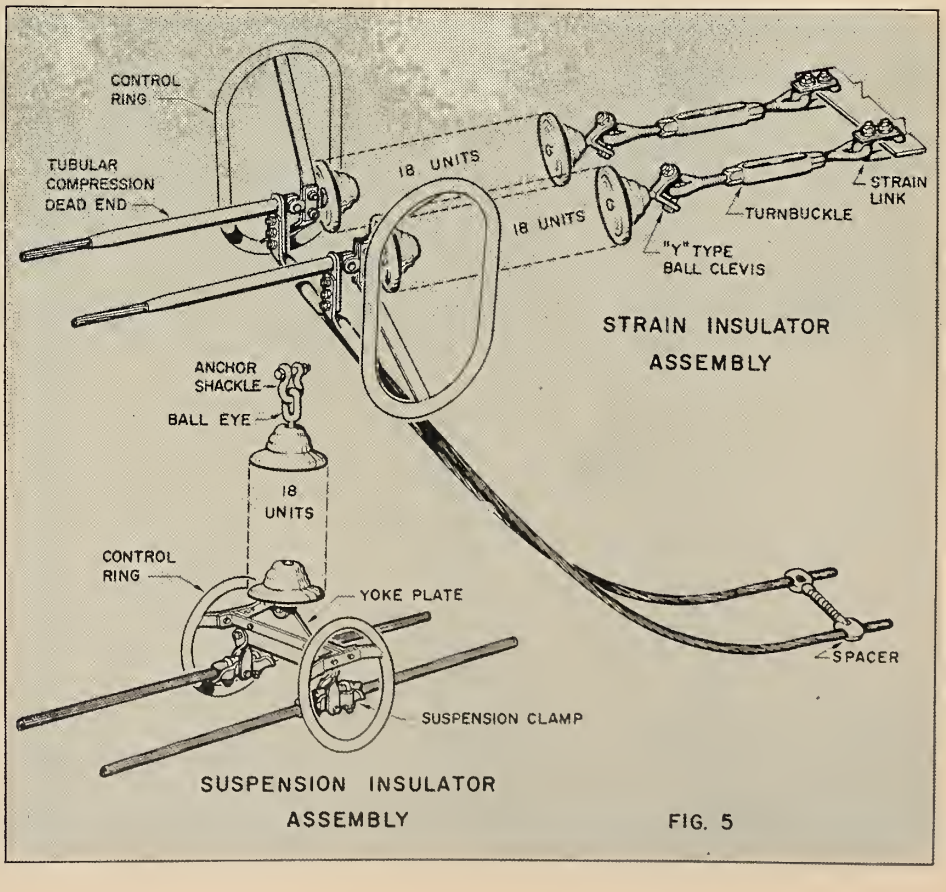


FIG. 5

installed by means of a tractor with a direct wire feeding hydraulically operated plow blade. An average of approximately two miles of counterpoise per day was installed with this machine, though of course this varied greatly with the terrain involved.

Advantages of Guyed Portal Over Rigid Type Transmission Line Tower

Based on the experience gained during the construction of this 135 miles of 345 kv. line, and on technical and operational data accumulated from years of operation of guyed type structures in Finland, the following are some of the advantages that may be attributed to the guyed tower design.

The installation of footings is much simpler and faster. In the case of the rigid type structure, footings must be installed to very close tolerances both vertically and horizontally to avoid introducing initial stresses into the tower. Grillages must be placed on carefully levelled undisturbed earth. For the guyed structure, the setting tolerances of mast foundation and guy anchors are much greater, and in the case of the guy grillages, there is no necessity to install on levelled undisturbed earth. Under normal conditions, footings for two rigid towers versus three to four guyed towers were installed per working day.

The excavation quantities for the two mast footings and two guy anchorages for the guyed structure are approximately 12% less on this line than for the four grillage footings of the comparable rigid tower.

The guyed tower can be subassembled on the ground in three main sections, two masts and crossarm, and erected accordingly. Bolt tightening and punching can be done on the ground. On level or gently rolling terrain, the guyed structure could be completely ground assembled and erected as a unit by means of a falling A-frame and winch. The rigid tower normally must be sub-assembled in smaller sections and erected by means of a gin pole. Bolt tightening and punching must be done after erection In the case of this particular line, the same gin pole and mechanical equipment were used for both structure types but, in the case of the guyed tower, only three climbers were required, and for the rigid tower, five climbers, including a spare climber in each case. On flat terrain, the guyed tower crew could be reduced by at least two men. Under normal conditions a single crew erected two rigid structures per day versus three guyed structures with a maximum in a single working day of four.

The weight of the guyed structure including guys and foundations is approximately 6% less on the average for this line than its rigid counterpart designed for the same loading conditions. However, the weight advantage in favor of the guyed structure increases with tower height due to the heavier extensions of the rigid tower.

The individual extensions for the guyed structure, which form the centre portions of the masts, are simpler than the leg extensions for the rigid structure. In addition, the problem of determining in advance the extension requirements is much more difficult for the rigid tower with four legs instead of two.

The portal mast can be set on rock which would be unsuitable for a rock type footing for a rigid tower, and at a much lower cost due to the simpler type installation required.

Due to its inherent flexibility, it is felt that the guyed structure is less susceptible to damage either from the effects of a broken conductor or from aeolian vibration, and in the case of the latter phenomenon, the guyed structure could possibly have an appreciable damping effect.

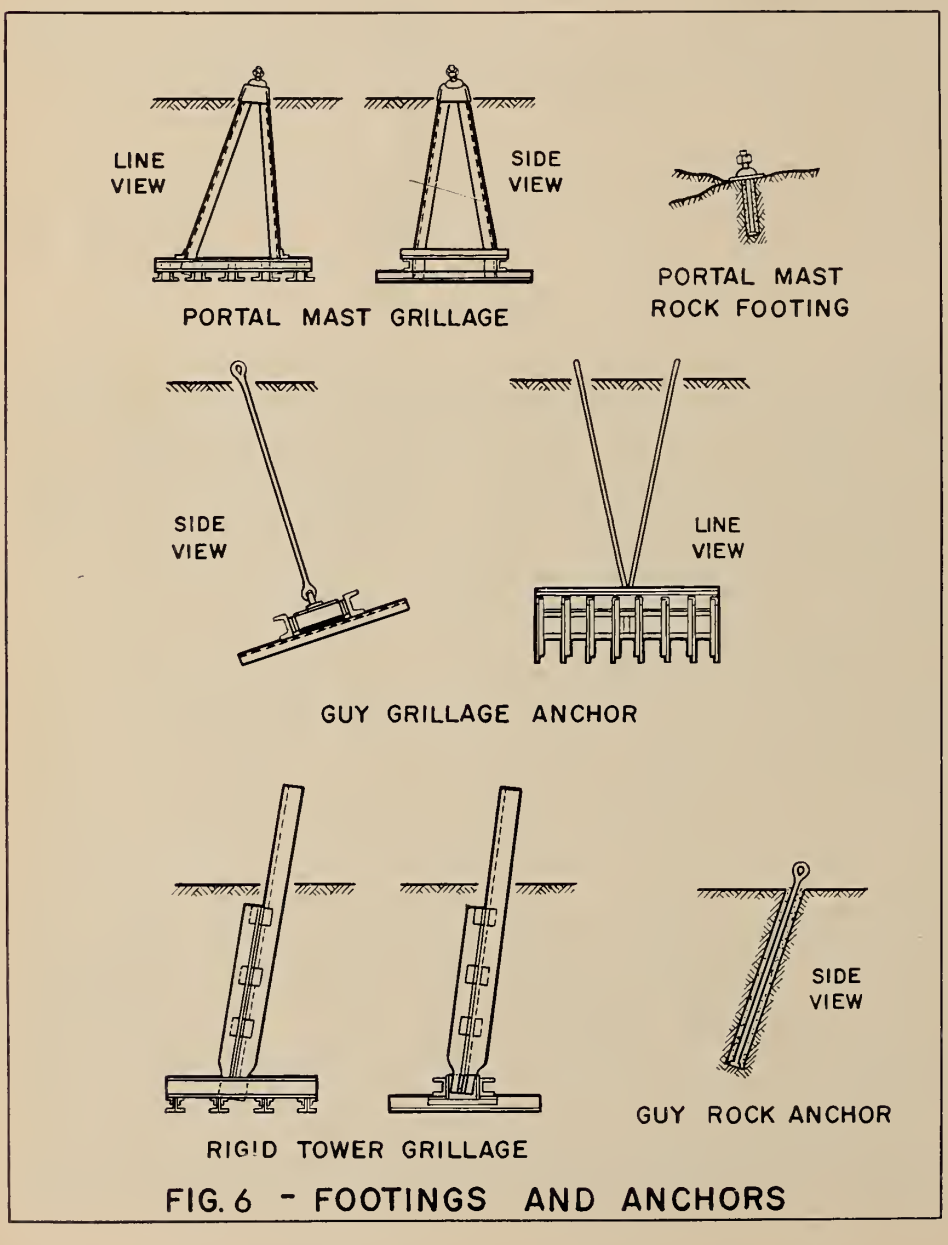


FIG. 6 - FOOTINGS AND ANCHORS

CONCLUSION

From the experience gained on this transmission line, we feel that guyed structures will play an ever increasing part in high voltage transmission line construction.

Acknowledgements

The design, construction, and management of this project were carried out by The Shawinigan Engineering Company Limited, Montreal. The authors wish to express their appreciation to the Field and Construction Divisions of the Company, and to Mr. J. M. Sharpe, Executive Assistant, Production and Power Operations, The Shawinigan Water and Power Company.

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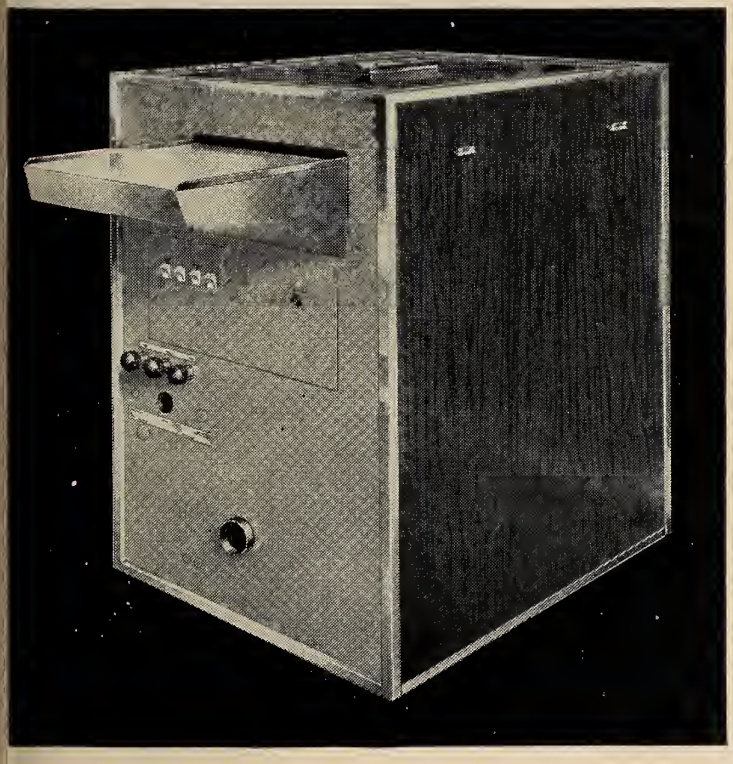

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Discussion

RESEARCH AND DEVELOPMENT OBJECTIVES

A. B. Hunt
Vice-President—Research and Development, Northern Electric Company, Limited

The Engineering Journal, November, 1962, page 53

Discussion by W. S. Kendall
Director of Marketing and Product Planning Computing Devices of Canada Limited

I am not discussing this paper as a scientist or as an engineer but as a Marketing Manager and because of that I am somewhat more interested in the products of research than in the research function itself. What appeals to me most is a product which I can sell in large volume in domestic or export markets and at a profit to our Company. That is the end result I like to see from research activities—a well loaded production facility. For that reason I can heartily endorse the philosophy which runs through the entire paper of directing research towards the objectives of the corporation. I agree that to do so corporate goals must be spelled out so that everyone in the company has proper direction and a sense or purpose. It is satisfaction of corporate growth and profit goals which provides the means of sustaining further research. One of the more important reasons why there has been so little research in some industries in Canada is the dismayingly low level of profits being reported. The electronics industry for 1960 reported a profit of just 1.52% after taxes on the sales dollar. The Canadian Manufacturers Association figures for the same year were 4.4% (I believe this figure was increased very slightly for 1961). It is from this inadequate profit base that further research must be supported. If we want to increase research in Canada it must be done by a combination of industry initiative and positive support and encouragement from the Government.

Another point which just stood out for me in your paper was the emphasis you placed on directing research to the needs of the marketplace. In highly technical industries there is often an unfortunate tendency for the research fraternity to fall in love with a particular technical approach or product and then wonder why on earth the marketing people don't go out and sell it. This is the reverse approach to that of the market-oriented management which accepts the philosophy that we don't build a product and then find a market for it—we find the market first and then shape the product to meet market needs.

In companies having high technical capability there is often a tendency to regard the marketing people as just salesmen. In fact, I have heard them described as an uneasy adjunct to an engineering organization. I would like to make a plea for more recognition of the professional status of the well-trained marketing man. In his paper, Mr. Hunt referred to the planning group in his organization which must provide the answers to market needs and provide the information for intelligent management decision making. This is the market research portion of the Marketing Department, which also includes the program planning, contracts negotiation function, etc.

Mr. Hunt referred to the shortened time span between the product concept and delivery to the customer, and the increasing toughness of the competition. In technical fields this situation is posing some very real problems for the market planner and for management. Not only do we have to second-guess the competition but we often have to make a product decision for a requirement some years ahead and one for which no specification has yet been written. This, again, highlights the need for the highest degree of cooperation between the marketing man and the scientific staff. It should be a partnership aimed at meeting market needs and in so doing contributing to company growth and profits.

My next comment concerns Mr. Hunt's statement that research in Canadian industry is starting to pick up. This is certainly most welcome. Recent Government incentives have been proposed by Mr. Fleming in his budget speech of April 10, 1962, and one of the most interesting to me is the 150% tax allowance on research costs for work done in excess of that accomplished in the base year. This is a major step forward but I am not clear on the definition the Tax Department would use in defining research. I know there are many definitions but in our company we would like to regard research as being everything which takes place from the original technical concept to the point where we have a proven product prototype and complete information ready to turn over to the Manufacturing Department. If the Government objective is as I understand it, to improve the capability of the Canadian company to get out and bid for business, not only in domestic markets but in export markets, and to do this by the encouragement of research, then I would expect the tax Department to take the broadest possible interpretation of this legislation. Only in this way would industry receive maximum benefit, and only in this way could we expect a large increase in Canadian research facilities and expenditures.

Discussion by J. L. Orr
Defence Research Board, Ottawa

I agree so thoroughly with the underlying philosophy of Mr. Hunt's paper that I find it difficult to criticize in any important particular. Therefore, I can only reinforce some of his most important points based on several years' experience with industrial research in the defence field.

(1) Technically speaking we are in a "Dynamic" situation where the only constant is change. No industrial organization can survive with static technology. For example, one electronics manufacturer states that 80% of current sales are based on products which did not exist 10 years ago. The burning question is no longer whether to engage in research and development, but rather how much and where to direct one's effort.

(2) Industry must be primarily concerned with "Applied Research" and the application of new science and technology to problems of economic consequence. Industrial research requires more justification than merely satisfying the scientist's curiosity—in other words it must be "problem oriented". In a country such as Canada where we are making the transition from a primary to a secondary economy, top priority must be given to "Applied Research" and such research should be conducted mainly by industry where the results can be exploited rapidly and effectively. This aspect has been seriously neglected in the past, and it is only within the past year that the federal government has taken steps to alleviate the imbalance between basic and applied research by raising the general level of government support for research in industry.

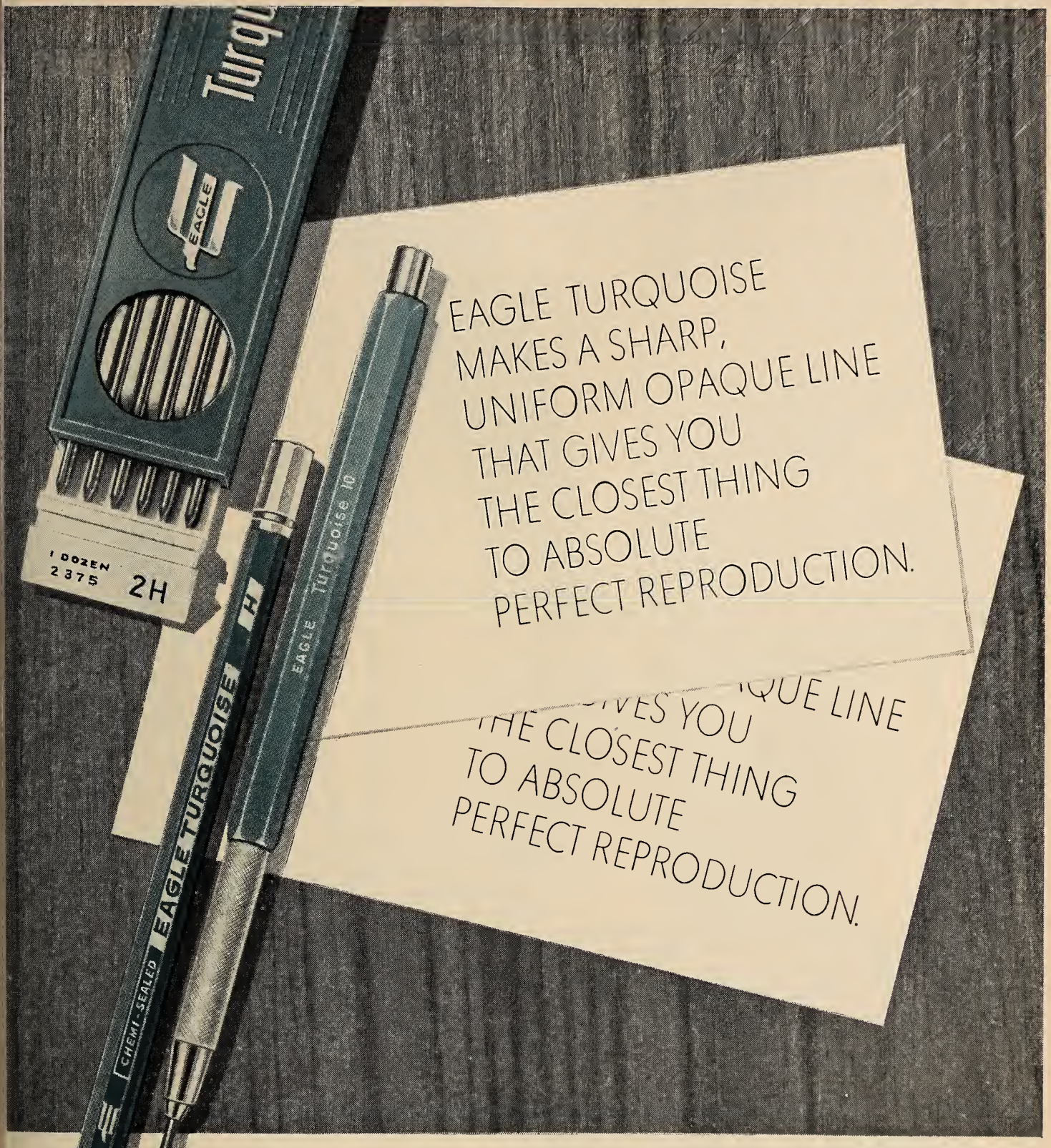
(3) As regards the place of research in an industrial organization, I strongly endorse Mr. Hunt's views that the research group must have direct lines of communication to top management in view of the profound effects which its work will have on the future of the firm. Conversely, the efforts of the research group must be directed in support of the company's objectives and conform to its long-term development plans.

Moreover, I believe that for maximum effectiveness the research group should be divorced from the distraction of day-to-day operation, I am not advocating an "Ivory Tower" approach however, and it should be clear from the foregoing that the research team must keep in touch with reality and concern itself essentially with the scientific aspects of the problems facing the firm.

(4) Mr. Hunt has suggested that there are good opportunities for original product design by Canadian industry to meet special Canadian conditions. I should like to expand upon this theme and the need for a concerted effort to establish technological superiority as a prerequisite for competing in world markets. In establishing its research program Canadian industry must be highly selective and should be prepared to deploy a sufficient weight of effort to ensure that it can attain technological superiority and produce timely results. The keynote must be specialization, and the results must be converted into better "mouse traps" expeditiously and promoted on an international basis.

(Continued on page 62)

Discussed in this issue is A. B. Hunt's paper entitled "RESEARCH AND DEVELOPMENT OBJECTIVES".
Following the above is a discussion on T. D. Northwood's paper entitled "RAIL VEHICLE NOISE".



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In selecting specific areas of endeavour, these should preferably be based on some particular Canadian resource, requirement, or capability and otherwise be compatible with the Canadian environment and economy. Canada is still a relatively underdeveloped nation in the geographical sense, and two major problems of our economy are transportation and communication. We have the scientific resources and industrial capacity to make substantial advances if our efforts were channeled in this direction. Such a capability would obviously find application to many of the newly-emerging nations in Africa, Asia and South America where a vast potential market exists.

Canada has long been a major exporter of primary products, but many of these are "wasting assets". We cannot be content to remain "hewers of wood and choppers of water" much longer and hence we must substantially increase the Canadian labour content of our exports. The most obvious starting point is in the further processing of our raw materials leading to the supply of finished materials and ultimately extending into the fabrication of finished products.

Another so-called "handicap" which we should exploit is the relatively small scale of our industrial activities which gives us distinct advantages in flexibility and the ability to cater to specialized requirements and markets.

(5) Perhaps the most serious limitation in building up Canada's technological resources is the continuing loss of our best qualified scientists and engineers due primarily to lack of opportunity to usefully employ their talents at home. Recent statistics indicate that approximately 30% of the entire graduating class in science and engineering still emigrate each year, mainly to U.S. industry. In concluding, therefore I would contend that it is in our best interests to export Canadian brains in the form of industrial products, rather than "on the hoof".

Discussion by Arthur C. Stewart

I would like to associate myself with the sentiments so ably expressed by Mr. Orr: Mr. Hunt has analysed the need for research and development groups to establish specific objectives in their work and he has shown how essential it is for these objectives to be closely related to overall company policy. His outline of ways and means to achieve this relationship should prove helpful to many companies presently trying to enlarge their interest and activity in the research and development field, and particularly to those who are trying to initiate work at the research level in order to support their product development.

Throughout research and development work there exists a possibility of conflict between the policies and the objectives of the company on one hand and the need to maintain incentives for good scientific work on the other. In this discussion I would like to mention one or two of these problems whose resolution by the scientific manager is essential to the realization of his research and development objectives and which in themselves lead to a continuing objective.

One of these problems arises as a consequence of scientific training; in general, scientists working in the "pure" disciplines, as they first come to industry are unprepared, by virtue of their training, to be industrial laboratory employees; rather is the contrary the case, in that the majority have come to place an overriding importance on scientific achievement and the methods of work needed to reach this end. These lend the man an innate professional character and spirit which are independent of commercial goals and the objectives of outside groups generally and those of the company in particular; it may be observed that this independence of spirit is liable to be more deeply rooted the greater the proven technical competence of the individual.

Thus, to establish a successful industrial research and development group one must consider the human relations problem and enable the young scientist to accept a modification of his own idealized goals and the direction by others of his creativity towards the needs of the company rather than to the demands of his earlier conception of himself as a more or less dedicated research worker. This process of adaptation can cause strain on the individual and one of the aims of the industrial research and development group will be to ensure an environment in which this strain will be rapidly eased and the scientist quickly brought to the point where his skills are effectively and willingly used in pursuit of the company's objectives.

One key in realizing this initial objective may lie in the scientist's desire for recognition which, apart from professional advancement, increased monetary reward, etc. must include an opportunity for him to obtain judgement of his work by his peers and thereby to seek their esteem and respect. To achieve the latter the scientist will wish to carry on the highest quality of scientific work of which he believes himself capable; thus, when industry employs highly competent individuals they are likely to develop pressures within the group due to their endeavouring to carry their work beyond the scope of the objectives set by the company. This situation arises from a genuine need inherent in the individual, and one of the things which the scientific manager must achieve is satisfaction of this need if the scientist is to devote his creative efforts whole-heartedly on behalf of the company.

A further conflict of objectives can arise as a result of the scientist's desire for recognition; Mr. Hunt has made the point that industrial research and development exists in order to help companies make a profit; this is axiomatic, but if recognition and advancement are tied too closely to the profit motive the scientist may lose the confidence that is the reward of creativity. In the small company particularly, the same individuals must carry out both the research work and the later development of the company's products; if it is felt their efforts will be appreciated in proportion to their contribution to profits, then in their work they will concentrate on aspects aimed at immediate profitability of the product. This will be achieved at the expense of the more scientific, and in the long term more rewarding, interests which are more tenuously connected with profit.

Thus it may be inferred that in addition to having to coordinate and meld research and development with manufacturing, marketing and the whole spectrum of company activity, the scientific manager must have a real understanding of the expectations of different kinds of scientists if he is to be successful in building the kind of research and development team which will enable him to reach the company's objectives: this can form in itself an ever-present objective in carrying on industrial research and development.

RAIL VEHICLE NOISE

T. D. Northwood

Head, Building Physics Section, Division of Building Research, National Research Council, Ottawa

The Engineering Journal, January, 1963 page 30

Discussion by A. T. Edwards, Hydro-Electric Power Commission of Ontario

Discussion by Ian J. Billington, Dilworth, Secord, Meagher and Associates, Toronto

It has been my pleasure to have been associated with Dr. Northwood on a number of co-operative studies during the past few years. Among these is included the development of a rail supporting system for suppressing ground-transmitted noise and thus I much appreciate this opportunity of discussing his paper on railroad noise.

I very much like Dr. Northwood's concept of optimum noise. In these times when there is a growing awareness, by the general public, of noise, we are apt to believe that the lowest possible noise level for any environment is the ideal objective. Recently I had the experience of an office noise problem where the ambient level is actually so low that it is possible to hear a pin drop, say 50 ft. away. This has resulted from two factors. The first is that the building is air-conditioned and thus is impervious to outside noise and the second is that the ventilating equipment is exceptionally quiet. Actually in this office there would be very much less disturbance from other workers sharing the same space if the ambient level had been 10 decibels higher but it has been difficult to get the rather unusual idea of raising the noise level accepted. Dr. Northwood's criterion of an ambient level in which it is possible to converse easily at 3 or 4 ft. but not be understood at greater distances seems very logical and should be quite satisfactory for rapid transit cars. In this connection, for the benefit of those who are not conversant with acoustical terminology, I would suggest that perhaps it would be worth-while, if there is time for Dr. Northwood to quickly define for you such terms as, decibel, loudness, NC and NCA. I wonder also whether NC 65 is not somewhat too high as I have found it difficult to converse in noise levels with a speech interference level of 60-65 decibels.

I have little further comment to make on the noise within the rail car other than to remark on the rather surprising effectiveness of the treatment of the tunnel walls. Is this result predictable? Would Dr. Northwood also comment on the desirability or otherwise of acoustically treating the internal surfaces of the car and of providing vibration damping on the outer shell of the car to reduce the effects of structurally-borne vibration and induced vibration generated by aerodynamic effects resulting from the movement of the train through the air.

I would like to discuss in more detail the problem of ground-transmitted vibration. The noise that is generated in buildings close to subways may travel by both the air-borne and ground-borne paths. In general the air-borne noise does not appear to be a problem with exception of the rail

(Continued on page 98)

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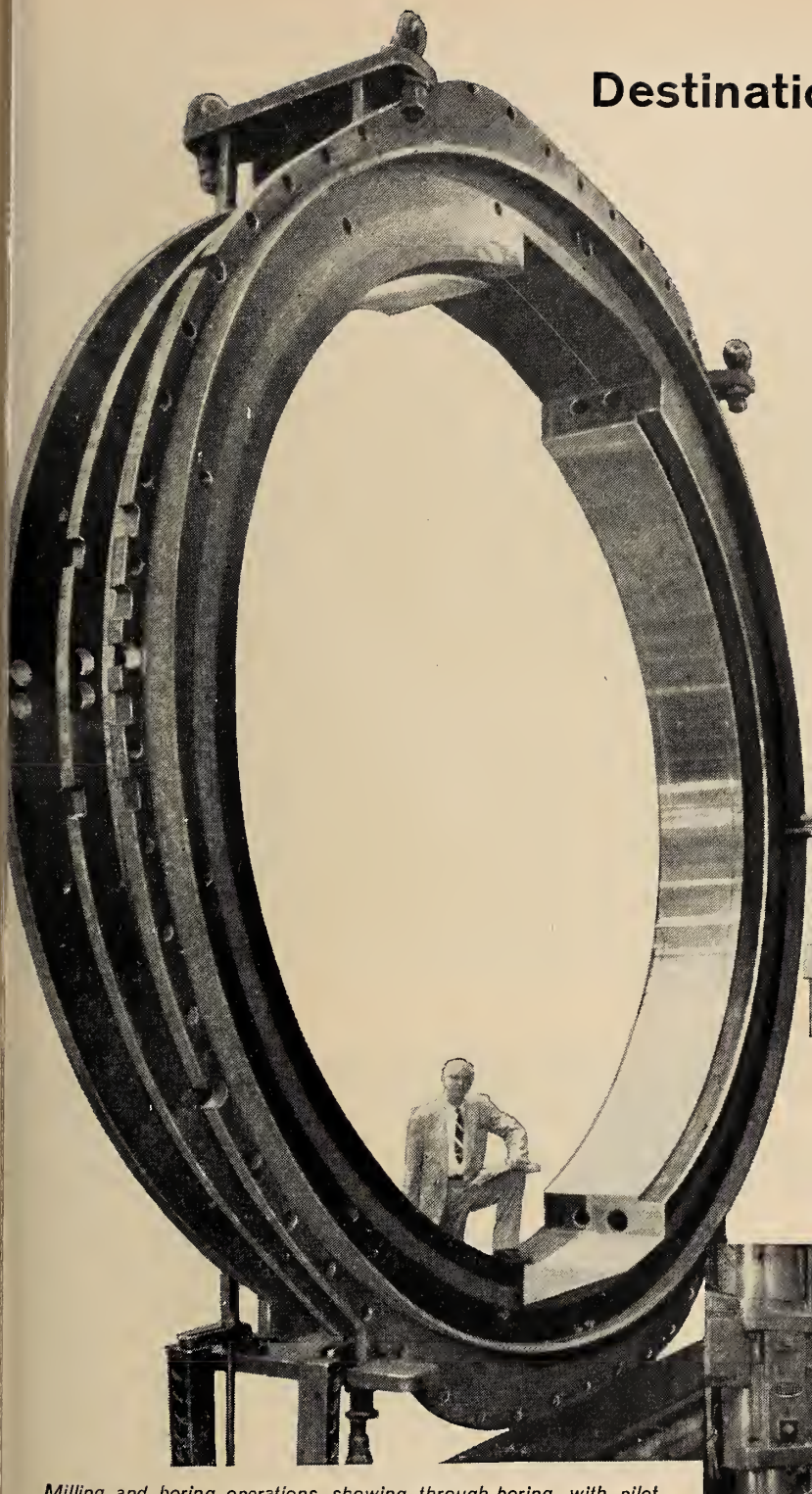

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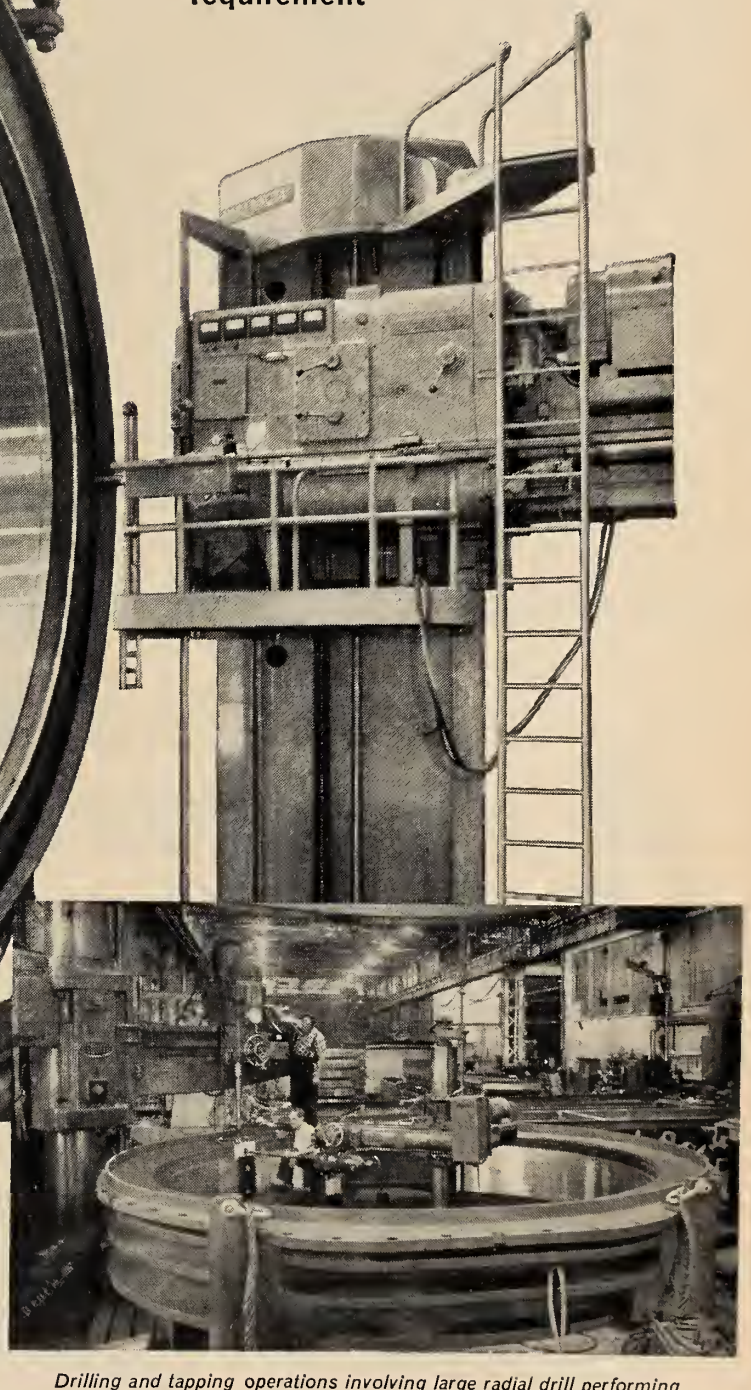

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Ballard Named NRC President

Dr. Bristow Guy Ballard, HON. M.E.I.C., immediate past-President of the E.I.C., has been appointed President of the National Research Council of Canada.

Dr. Ballard, Vice-President (Scientific) of the NRC since 1954, served as Acting President since the death last August of Dr. E. W. R. Steacie, HON. M.E.I.C.

Dr. Léo Marion, Senior Director of the NRC, and Director, Division of Pure Chemistry, was appointed Vice-President (Scientific), succeeding Dr. Ballard.

The new President of the NRC was born in 1902 at Fort Stewart, Ont. He attended Queen's University after which he followed a Westinghouse graduate course in electrical engineering. In 1924-25 he joined the staff of the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa.

In 1930 he was appointed to NRC's Division of Physics, and during the next 10 years built up the electrical engineering section of that Division.

For his wartime efforts, which included the development of mine sweepers and other means of protecting ships against enemy magnetic mines, Dr. Ballard was made an Officer of the Order of the British Empire (O.B.E.).

In 1946 he was named Assistant Director of the Division of Physics and Electrical Engineering, and two years later, when a full Division of Radio and Electrical Engineering was established, Dr. Ballard was appointed Director.

He was awarded the Ross Medal of the Engineering Institute of Canada in 1949 for his paper, "Recent Canadian Radar", and in 1953 he received the Coronation Medal.

Dr. Ballard is an Honorary Member of the E.I.C., and is its immediate past President. He is President of the Canadian Standards Association, and a Fellow of the Institute of Radio Engineers and of the American Institute of Electrical Engineers, of which he is a former Vice-President.

He holds honorary D.Sc. degrees from Queen's University and from Assumption University at Windsor.

Dr. Marion, a native of Ottawa, received his B.Sc. (Honours, 1926), and M.Sc. (1927) from Queen's University and his Ph.D degree from McGill in 1929. The same year he began his career with the National Research Council of Canada, continuing in the field of organic chemistry, principally alkaloids on which he did post-doctorate work at University of Vienna in 1934-35.

He became head of the organic chemistry section of the Division of Chemistry in 1943, Dierctor of the Division of Pure Chemistry in 1952, and Senior Director of the NRC in 1960.

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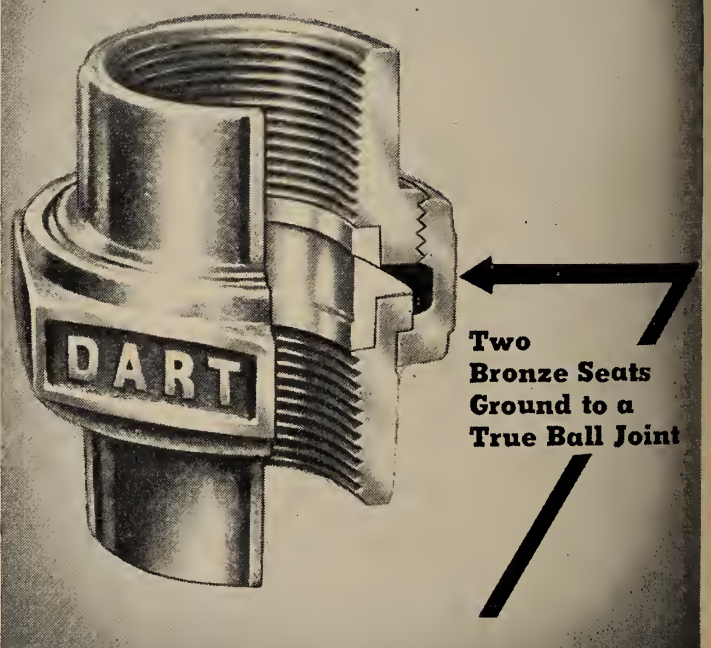

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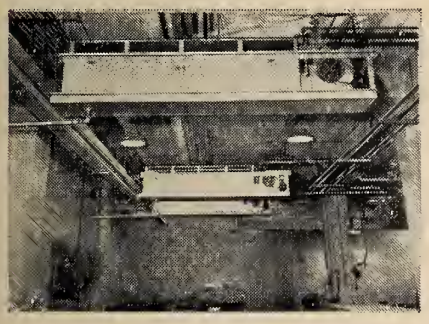

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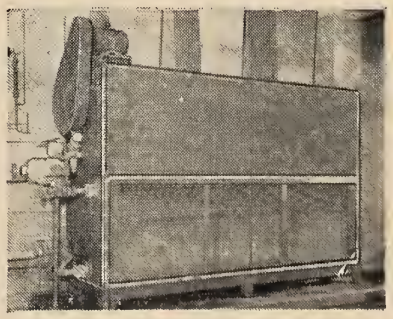

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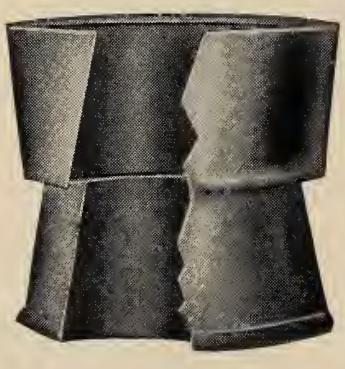

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AUTHORS AND PROSPECTIVE AUTHORS

For the benefit of engineers wishing to submit papers to the Engineering Institute of Canada, a comprehensive Guide For Authors has been prepared and is available free from EIC Headquarters.

ABSTRACTS

Transactions of the E.I.C.

EIC-63-CIV 7
"Proposed Design for a Shell-Type Dam"
Paul F. Csagoly

The author feels himself justified to say without presenting further evidence, that both magnitude and distribution of the water load of a dam can be easily determined. One might even note that the water load is more reliable in nature than are those dead and live loads imposed on frames and bridges. It is true, on the other hand, that for any structural problem—a most suitable and particular solution can be chosen, provided that the loading pattern is known and simple. The designer will automatically use parabolic cables for a long suspension bridge, fixed-base frames for a power house, and prestressed ring for a dome. So, one may raise the question; can or can not a special structure (structure in its true sense and not a great mass of earth or concrete) for the purpose of supporting a large body of water be found? The author feels that the answer is yes.

EIC-63-MECH 17
"Very High Pressure Hydraulic Control Systems"
P. N. Nikiforuk

This paper is divided into three parts. The first part is introductory. It describes the nature and the status of high-pressure hydraulic control systems. It also includes a comparison of the merits of electrical, pneumatic and hydraulic control systems in order that the specific advantages and disadvantages of the latter can be clearly understood. The second part discusses the design and analysis of these systems. It starts with a description of these load characteristics which influence system design and continues with a description of the more common types of components available. It is then shown how this data can be used to realize a physical system. The third and last part is devoted to practical considerations and typical applications. Included in this part is a brief description of the high-pressure hydraulic installation located in the Mechanical Engineering Department of the University of Saskatchewan.

EIC-63-MECH 18
"The Electrical Power System for a High Energy Nuclear Accelerator"
E. de Haas

A large nuclear accelerator uses electrical power equipment which belongs to the heaviest and most complicated in its class. The magnet power supply of the Princeton-Pennsylvania machine consists of a 130 ton choke, an 85,000 kva capacitor bank, and a five piece motor generator set, output controlled to one part in 10,000. When fully built up, the project will require between 40 to 50 megawatts of electrical power.

Division Papers of the E.I.C.

EIC-63-BR & STR 7
"The Construction of Place Ville Marie"
T. M. Phelan

This paper describes the general construction features of the Place Ville Marie Project. It outlines some of the preplanning of various temporary facilities carried out before commencing construction operations, as well as the most successful technique developed on the project for blasting and removing more than 125,000 cu. yd. of rock in downtown Montreal. The tie-back shoring method, which was also developed on this project is described, as are numerous other construction innovations and procedures involving many trades found to be effective in constructing a large high-rise structure.

EIC-63-BR & STR 8
"Place Ville Marie—Structural Steelwork"
C. J. Pimenoff and J. Daccord

This paper deals with the fabrication and erection of structural steel for the Place Ville Marie Development consisting of the Royal Bank of Canada Cruciform Building soaring over 600 ft. above Dorchester Boulevard, the street level plaza and the Cathcart Building. Nearly 60,000 tons of steel were fabricated and erected by the "Dominion Bridge-Dominion Structural Steel" Joint Venture. Due to some unusual design features of the structural steel frame, special problems were encountered both in the shop and in the field. This paper describes the design of the more important connections, the fabricating techniques used in making some of the heaviest steel building components ever built in Canada and the solution of some special problems in erection.

EIC-63-CIV 6
"Design and Construction of the Brazeau Dam"
J. K. C. Mulherin

The Brazeau Storage Dam on the Brazeau River, in Alberta, is 210 feet high and contains 4,000,000 cubic yards of earth fill. It is the first major unit of the $40 million Brazeau Storage and Power Development to be completed, and besides providing storage to be released during the low flow period of the North Saskatchewan River, it raises the Brazeau River to an elevation at which it can be pumped into a high level canal 12 miles long leading to the headworks of the Big Bend Power Plant where 400 feet of head will be utilized to develop an ultimate 800,000 horsepower.

This paper describes the design of the unwatering conduits, to cope with velocities in excess of 60 feet per second, and the design of the earth fill in view of the varying qualities of earth fill material available. Also described are the tests and experiments carried out in the field to obtain smooth surfaces and joints in the conduits, to control earth fill placement, and to obtain satisfactory foundations for the structures.

EIC-63-CIV 8
"An Engineer Looks at Shelters"
A. T. Jeffrey

This paper discusses some of the more important problems in the nuclear field as they would apply to shelter survival. A number of engineering studies have been done for major industries in Canada with respect to the problem of survival and possible plant damage in a nuclear war. These have been done on an engineering basis assuming strikes on certain strategic targets and plotting from known measured data the resulting conditions as they would occur. The thinking required in these studies has made it very apparent that fallout is unquestionably the major problem and that also protection against it almost as much a problem of education as one of shelters. This paper gives one a basis to assess realistically the value of shelters for the population as a whole.

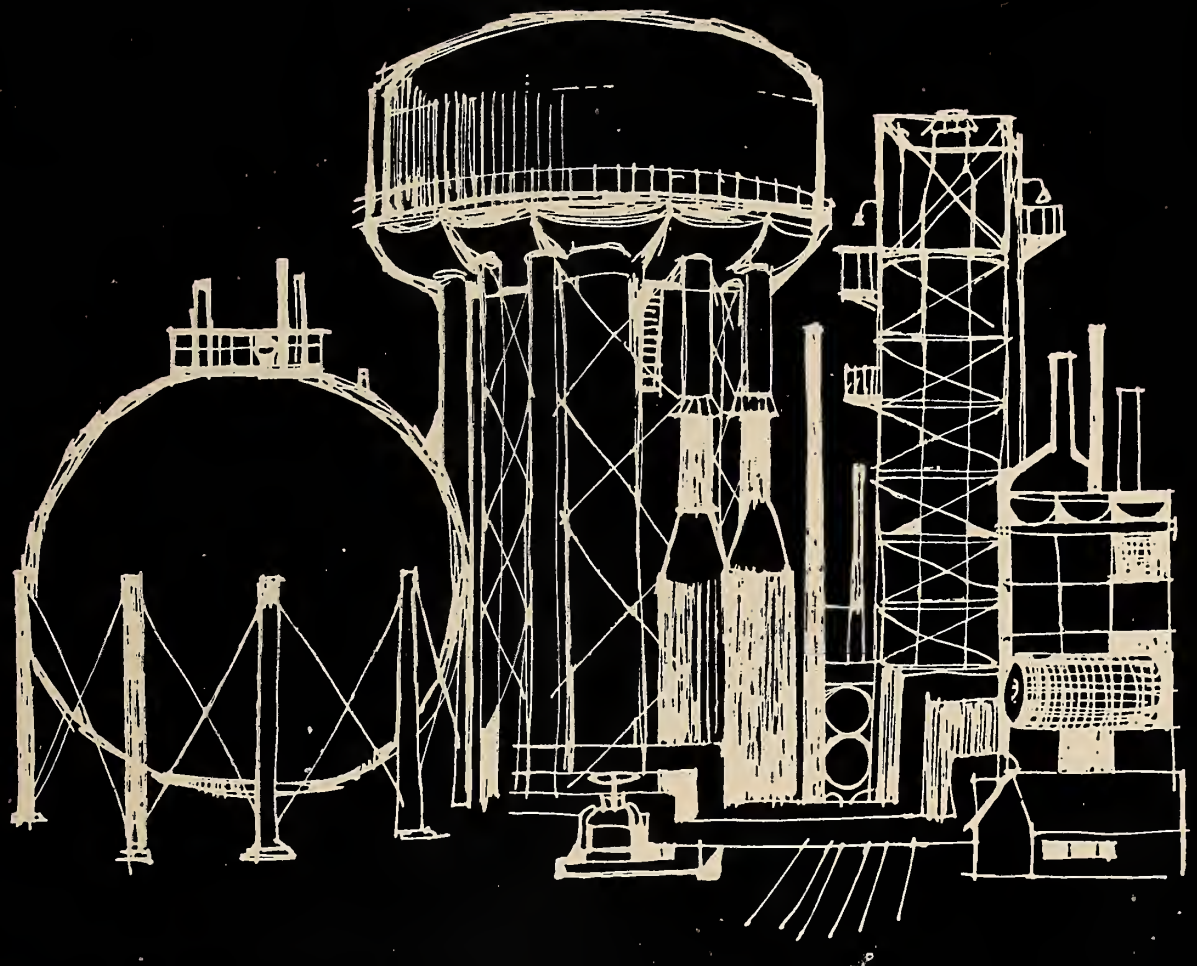
EIC-63-CE&A 4
"Oscillations Sous-Harmoniques dans un Asservissement par Plus-ou-Moins"
J. C. Gille et J. G. Paquet

On établit des conditions nécessaires pour l'existence d'oscillations sous-harmoniques d'ordre n dans un asservissement par plus-ou-moins dont la partie linéaire est d'ordre quelconque et dont l'organe non linéaire peut comporter une hystérésis, le seuil étant négligeable. On exprime ces conditions per des constructions graphiques simples. Dans les asservissements réguliers, les sous-harmoniques n'appraissent pratiquement qu'en présence d'hystérésis; on donne un exemple de système par plus-ou-moins capable d'engendrer des sous-harmoniques même en l'absence d'hystérésis.

EIC-63-HYDEL 3
"Sir Adam Beck No. 2 Storage Reservoir Observation of Performance"
E. M. Taylor

Since August 1957, a pumped storage reservoir has been in operation as a significant feature of the Sir Adam Beck No. 2 Development at Niagara Falls. Because of the unusual drawdown conditions, the nature and extent of the dyke structure and the variation in foundation conditions, extensive observation programs have been carried out. The fluctuations of pore pressures in the dyke core and foundations have been measured, seepage occurrences and flows have been recorded and precise surveys have been made to determine the extent of lateral and vertical displacement of the dyke structure. Valuable experience was gained in the examination and determination of the cause of a local failure through the clay core and in effecting its repair.

(Continued on page 79)



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Branch News

HALIFAX
D. Rudolph

The Annual Meeting of the Branch was held December 6 at the Flamingo Restaurant. The meeting was attended by 53 members. A certificate of Life Membership in the Institute was presented to Professor Spencer Ball by Councillor Herb Marshall. After the various committee chairman gave their reports, W. J. Phillips reported that the following were elected as executive for the year: J. B. Ternan, Chairman; Frank O'Neill, Vice-Chairman; W. L. Griffin, John Jay, and Larry Murphy were elected representatives for the Halifax area and Jim Archibald, and Jim Morrow as representatives for the surrounding area.

Professor Spencer Ball is shown receiving a Life Membership Certificate from Councillor Herb Marshall.

BELLEVILLE
J. E. Tomlinson

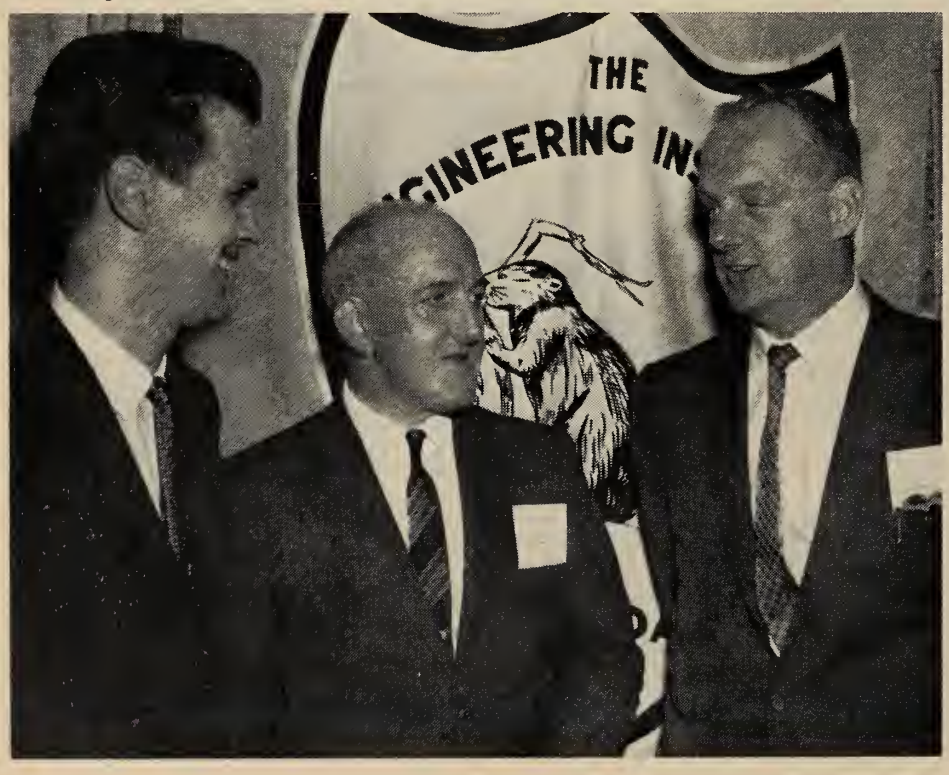
On Deeember 10, members of the Branch and their guests heard a talk given by C. J. Summers, Manager of Eastern Operations of North America Inspection Services. Mr. Summers, introduced by Carl Whittemore, spoke on non-destructive testing of materials. Mr. Summers has had considerable experience in this field. He stated that there are several basic methods for non-destructive testing. The first and most generally used system is the X-ray examination of materials. This very sensitive method gives good results which are easily interpreted. The main disadvantage is that the equipment is large and fragile which makes transport quite difficult. The use of gamma-ray radiation from iridium and cobalt isotopes is also employed in testing. This method gives excellent results with odd shaped castings, and better contrast than those achieved with X-ray examination. There is less scatter on the film. The main deterrent, though, is that it is necessary to store the isotope in a lead and tungsten container beeause of the possible danger to the health of the operators. This system can be used for materials from one-half to two-and-one-half inches thick. Magnetie particle inspection is used for determining surface defects in ferrous materials and in magnetic materials. In this system, ferrous powder is applied to the material being tested, and a D.C. current is applied by a pair of probes. The ferrous powder shows the magnetic lines of force between probes, and reveals the shape of the defect. This system is not very widely used since the interpretation of defects is very difficult. The most versatile system for non-destruetive testing is by the use of ultra-sonics. Ultra-sonic testing has been developed in the past ten years, and is used extensively throughout Europe. In this system, a high frequency pulse of 5 to 20 mcs is projected into the material being tested, and is reflected back from any area within the material which may contain a defeet such as a crack or a porous hole. The reflected signal is amplified and fed to an oscilliscope for easy viewing. Materials up to 20 feet thick can be examined by this method. It requires a very experienced operator to analyse the readings. The main disadvantage of this method is that there are no permanent records kept of test results.

Following Mr. Summer's talk, demonstrations of the various testing methods were presented. Al Drysdale thanked Mr. Summers for his most informative talk.

David H. Scholes, of the Bell Telephone Company was the Branch's guest speaker at the January 14 meeting. Mr. Scholes, in his talk, "New Arts Teehniques", described an eleetronic central office as envisaged the Bell. This office, based on an experimental installation which was in operation for approximately two years in Illinois, must aceommodate both incoming and outgoing cells and eonnect them to the telephone network. Scanners, central control, program storage, temporary instruction storage and master control are required from the business office. For transmission of telephone conversations, a pulse code modulation system is used which will accommodate up to 24 conversations simultaneously on one pair of conductors. By this means, each conversational signal is sampled 8000 times per second, coded, stocked and transmitted. At the receiving end, these signals are used to regenerate a wave equivalent to the original sample wave. To assist the caller with the lengthy number which will be necessary for dialing calls in the future, it is proposed to program or pre-record the most

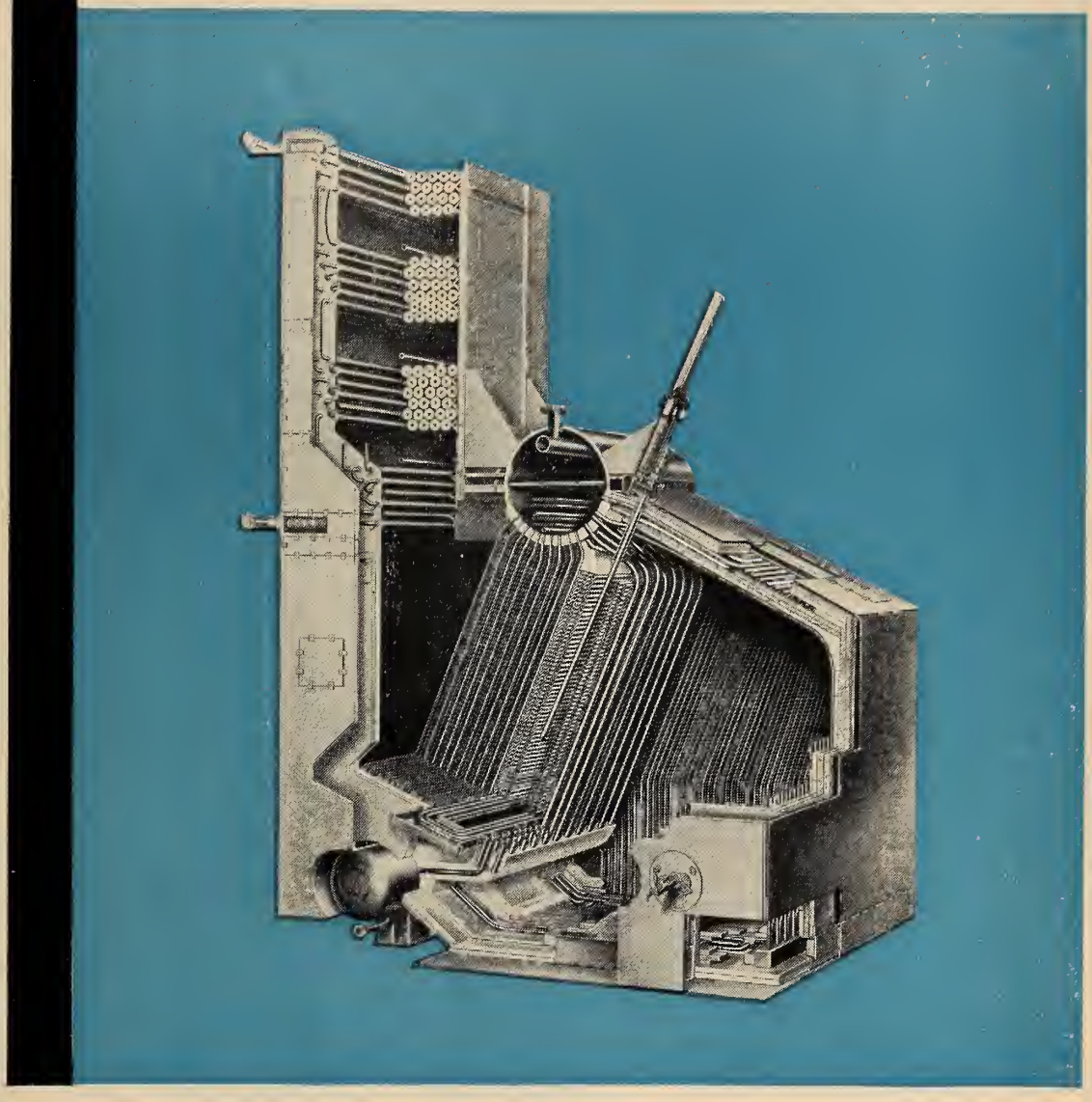
(Continued on page 86)

Left to Right: Don Waller Chairman; Jim Ternan, Chairman; Frank O'Neill, Vice-Chairman.



There's a bonus in this boiler design!

Cutaway of "D" type marine boiler, a design that has helped Foster Wheeler achieve its position as one of the world's leading suppliers of marine steam generators.



A Foster Wheeler type "D" boiler does not require baffling beyond the superheater so that adjacent tubing is not needed for superheater support.

The design gives a bonus of accessibility to the superheater . . . and an efficient work area for inspection and maintenance, *not only between superheater tubes but also beyond the superheater tubes* on the down stream side. Further, there is freedom of access between tube banks in cooler zones.

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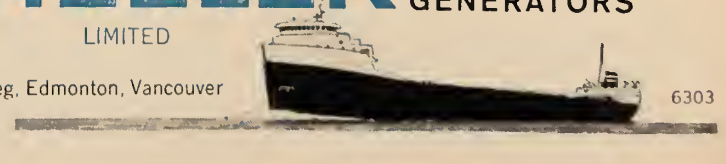

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Personals

D. H. Sharp, M.E.I.C.

R. W. Stedman, M.E.I.C.

J. W. Howe, M.E.I.C.

W. C. Byers

T. A. Hughes, M.E.I.C.

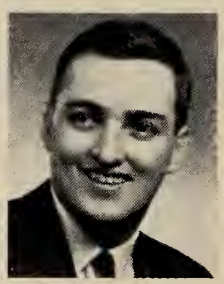
G. S. Halter, M.E.I.C.

Six executive appointments have been announced by the C. D. Howe Company Limited. **D. H. Sharp,** M.E.I.C. has been appointed vice-president and general manager. Mr. Sharp has been with the company since 1951 and previous to his recent appointment, was assistant manager of the Montreal office. **R. W. Stedman,** M.E.I.C. (Toronto '47) has been appointed vice-president and manager of the Montreal office. With the company since 1947 and previously chief mechanical engineer, Mr. Stedman has been in charge of mechanical design on many of the company's major projects. **J. W. Howe,** M.E.I.C. (McGill '48) has been appointed vice-president and manager of development branch. Mr. Howe has been with the company since 1948. His experience includes design and investigation of various grain handling and shipping projects. **W. C. Byers,** has been named manager of the Port Arthur office. Mr. Byers, formerly assistant manager, joined the company in 1939 with experience as a field engineer on various public and private projects. **T. A. Hughes,** M.E.I.C. (Cardiff '42) has been appointed assistant manager of the Montreal office. Mr. Hughes, with the company since 1953, was chief construction engineer. He has had field and design experience on a wide range of projects for both consulting and contracting firms. **G. S. Halter,** M.E.I.C. (Manitoba '46) has been named assistant manager at the Port Arthur office. Mr. Halter joined the company in 1946. His experience includes feasibility studies, design and construction supervision. He is secretary of the permanent Committee on Grain Elevator Dust Problems.

D. L. Spanjer, M.E.I.C. has become the Chief Engineer with Canadian Car, Division of the Hawker Siddeley Canada Ltd., Fort William, Ont.

T. A. Somerville, M.E.I.C. (McGill '48) has been elected president of the Canadian Construction Association for 1963. Mr. Somerville, President of E.G.M. Cape & Co. (Ontario) Ltd., is also a director and Vice-President of the E.G. M. Cape & Co. Ltd., Montreal, the parent firm, and is a director of E.G.M. Cape International Ltd. Mr. Somerville joined the company in 1948 as a field engineer and was promoted rapidly to his present office in the organization. Mr. Somerville succeeds H. R. Montgomery, M.E.I.C. (McGill '29) of Pentagon Construction Co. Ltd., Montreal.

G. R. Connor, M.E.I.C.



Ross G. Dobbin, M.E.I.C.

G. R. Connor, M.E.I.C. (Toronto '28), Assistant Vice-President of Alchem, has been transferred to Nalco Limited, London, England. Nalco Limited is the English subsidiary of Nalco Chemical Co., Chicago, Alchem's U.S. affiliate. Mr. Connor's wide experience in the field of specialized chemical engineering will be of major assistance in the extension of the company's activity in the United Kingdom.

Ross G. Dobbin has been appointed manager of the Calgary office of Wade In Canada Plumbing Specialties Limited. Mr. Dobbin has wide experience in the trade gained through years of association with major suppliers of heating and air conditioning equipment and with Adamson & Dobbin, mechanical contractors in Peterborough, Ont.

John E. Maybin, M.E.I.C. (Alta. '48) has been appointed vice-president, engineering and gas supply for Canadian Western Natural Gas Company Limited and Northwestern Utilities, Limited. Mr. Maybin, formerly manager of engineering, has held a number of positions since he joined the companies in 1949.

James A. Scott has been appointed vice-president administration for Canadian Western Natural Gas Company Limited and Northwestern Utilities Limited. Mr. Scott joined the companies in 1961.

Murray E. Stewart, M.E.I.C. (Alta. '47) has been appointed vice-president of Canadian Western Natural Gas Company Limited and Northwestern Utilities Limited. Mr. Stewart will continue as general manager of Northwestern Utilities, the position he has held since 1956. As vice-president for both companies, he will be responsible for economic planning and rate administration.

J. G. Stewart, of Air Reduction Canada Limited has been appointed a Technical Sales Representative for the Ontario region. Mr. Stewart is a tool and die specialist. His extensive experience includes active welding and supervisory responsibilities in all phases of the rebuilding and repair of metalworking tools and dies. Mr. Stewart is located at the company's Toronto office.

A. S. Mitchell, M.E.I.C. (McGill '38) has been elected Mayor of Lennoxville, Que. Mr. Mitchell is completing a successful term as E.I.C. Councillor for the Eastern Townships Branch, and has served the Branch as Treasurer. He has taken an active part in municipal affairs for many years and was an Alderman in Lennoxville before being elected Mayor. Mr. Mitchell is Works Manager for Union Screen Plate Company.

(Continued on page 100)

OUR BRANCHES — WHAT IS THEIR ROLE?

As I think all of you know, EIC membership is served, on a local or regional basis, through the medium of some 60 Branches. What is a Branch? What is its role?

I think the simplest and the most straightforward answer is that the Branch is merely a miniature EIC. It is a fundamental organizational unit of the Institute, whereby the members in the Branch territory can conduct all their activities and carry out meetings for the presentation and discussion of papers and any other purpose within the terms of their Branch by-laws, consistent with the by-laws of the Institute.

The Branches are the Institute, and, I believe, it can be said that the Institute is the Branches.

This can only be so if each Branch is operated as to make it the most vital reflection of the objectives of the Institute. These will bear repeating. They are:

a. To develop and maintain high standards in the engineering profession
b. To facilitate the acquirement and the interchange of professional knowledge among its members
e. To advance the professional, the social and the economic welfare of its members
d. To enhance the usefulness of the profession to the public
e. To collaborate with universities and other educational institutions in the advancement of engineering education
f. To promote intercourse between engineers and members of allied professions
g. To co-operate with other technical societies for the advancement of mutual interests
h. To encourage original research and the study, development and conservation of the resources of Canada

These are the objects of the Branches because they are the objectives of the Institute. How well the Branch functions to accomplish these objectives will depend on the alterness of the Branch executive to the many possibilities open to it and to the Branch members to achieve the objectives through the medium of meetings, the presentation and discussion of technical papers and the interchange of professional knowledge among its members.

I have drawn attention to the alertness of Branch executives to their possibilities. However, Branch executives can only achieve results consistent with the objectives if the best men available in the Branch membership are elected to office and if, once elected, they accept the responsibilities devolving on them.

Success in achievement of Institute activities through the work of the Branches does not depend entirely on Branch executives. It depends in great measure on you, the members, through your participation in all Branch activities. You should attend Branch meetings and participate in discussions. You should play your role in committee activities and not turn them down because a little extra effort is demanded from you. Remember that serving on a Branch commitee is likely to lead to the greater responsibility of the Branch executive, perhaps the Branch chairmanship, and ultimately Council. It is a responsibility devolving on you, Mr. Member, to contribute what you can to the welfare of your profession through keen participation in the work of the Institute.

You have this opportunity in your Branch activites. Why not participate?

F. L. Lawton, President.

ANNOUNCING

REGION I AND II (Western Canada) ENGINEERING INSTITUTE OF CANADA

TECHNICAL DEVELOPMENT PROGRAM

Dates: September 5, 6, 7 1963
(Sessions 9:00 a.m.—12:00 noon, 1:30 p.m. 4:30 p.m.)

Location: College of Engineering, University of Saskatchewan, Saskatoon.

Cost to Participants (estimated):
Registration Fee — $25.00
Room and Meals — $5.50 per day
(In University Residence)

Form: A number of "up-dating" courses for graduate engineers. Courses put on will depend on demand and will be selected from the following:

- Engineering Implications of Digital Computers
- Instrumentation—Principles of Measurements
- Irrigation for Engineers
- Design of Automatic Control Systems
- Reservoir Engineering
- Profitability Analysis and Production Economics
- Petroleum Production Engineering
- Structural Steel-Analysis and Design
- Reinforced and Prestressed Concrete Beams and Shells
- Symmetrical Components
- Semiconductors
- Aspects of Soil Mechanics

For more information: Write for information sheet and questionnaire to:

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In applications where a large number of buildings spread over several acres have to be supplied with heating, cooling and process steam the high temperature water boiler installation has very definite advantages.

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Boiler Products Division **DOMINION BRIDGE**

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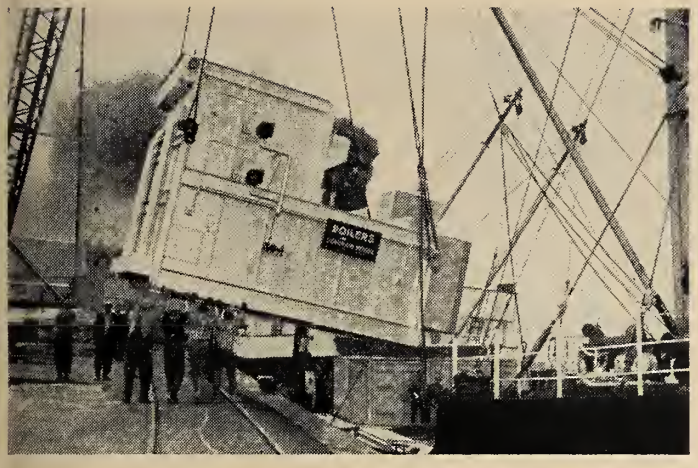
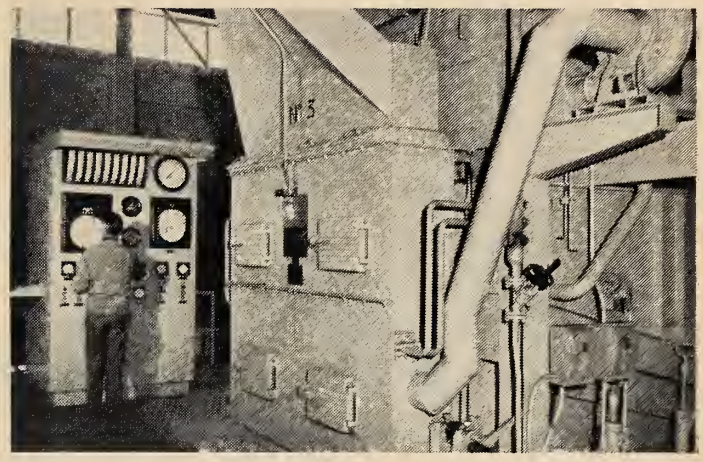


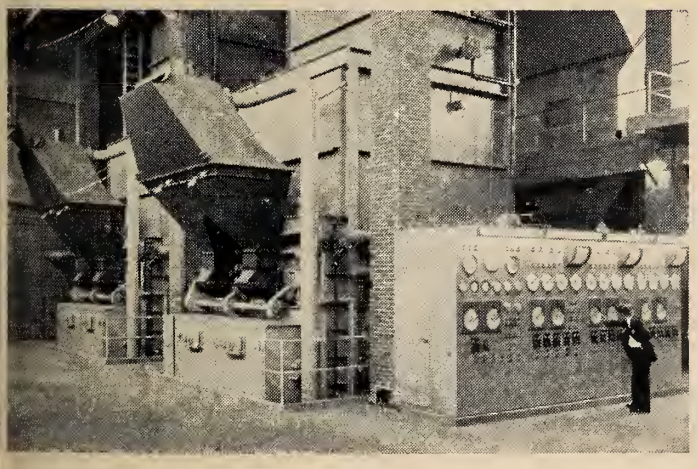
IRON ORE COMPANY OF CANADA

Capacity: 30,000,000 BTU/HR. *Design pressure:* 400 psig. *Inlet temperature:* 250°F. *Outlet temperature:* 380°F. *Fuel:* Oil. *Number of boilers:* 2. *Location:* Carol Lake in Western Labrador. *Engineers & contractors:* Bechtel & Company. *Application:* Supplies heating and hot water requirements for ten buildings spread over several acres.



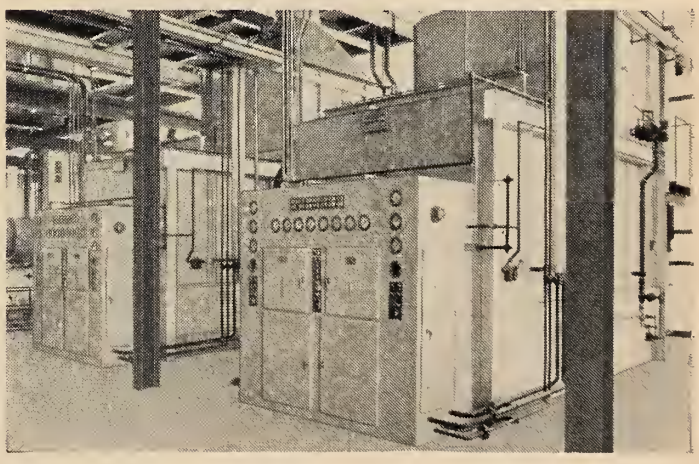
CENTRAL EXPERIMENTAL FARM

Capacity: 30,000,000 BTU/HR. *Design pressure:* 300 psig. *Inlet temperature:* 225°F. *Outlet temperature:* 366°F. *Fuel:* Bituminous coal or oil. *Number of boilers:* 3. *Location:* Ottawa, Ontario. *Consultants:* Wiggs, Walford, Frost & Lindsay. *Application:* Space heating, domestic hot water and steam for air conditioning, autoclaves, sterilizers, pressure cookers, laboratory outlets, etc.



DEPARTMENT OF PUBLIC WORKS

Capacity: 40,000,000 BTU/HR. *Design pressure:* 300 psig. *Inlet temperature:* 220°F. *Outlet temperature:* 350°F. *Fuel:* Bituminous coal. *Number of boilers:* 3. *Location:* Ottawa, Ontario. *Consultants:* J. Klassen & Associates. *Application:* Central heating for ten large office buildings spread over several acres.



MALTON INTERNATIONAL AIRPORT

Capacity: 27,500,000 BTU/HR. *Design pressure:* 300 psig. *Inlet temperature:* 220°F. *Outlet temperature:* 320°F. *Fuel:* Oil or gas. *Number of boilers:* 2. *Location:* Malton, Ontario. *Consultants:* John B. Parker & Associates. *Application:* Central heating for all buildings in the terminal complex.

Canadian Engineering

Army Engineers Publish History

The "History of the Corps of Royal Canadian Engineers, Volume One," a story of Canadian engineers reaching back to the "ancien regime" of New France, has been published recently.

The book mainly recounts events about the work of officers and men of the engineers from 1749, when the first known artificer company was formed, to 1939. A second volume dealing with World War II is nearing completion. Co-authors of the history are Col. A. J. Kerry (retired) and Maj. W. A. McDill, a staff officer in the Office of the Chief Engineer at Army Headquarters. Cartography is by Cpl. P. Heinrichs, formerly with the Army Survey Establishment, R.C.E., in Ottawa.

The historians mention engineering work done in the early 1600's by the Militia in Quebec and by the settlers in Newfoundland years before the first regular troops were dispatched to these areas. The militia companies that built the pioneer defences of Halifax in 1749 are recorded. Attention also is drawn to the Upper Canada Provincial artificers and the Lower Canada Voyageurs during the War of 1812.

Officially the Corps celebrates its 60th birthday this year. The book points out, however, that it must be considered much older.

Outlined in the foreword of the book is the task of the military engineer: "to apply engineering science to the emergencies of modern warfare in order to protect and assist the troops, to ameliorate the conditions under which men serve and to facilitate locomotion and communications".

Volume One is available from the Military Engineers Association of Canada through the office of the Chief Engineer for the Canadian Army, Ottawa. The cost is $5.

Letter to the Editor

The Role of Canadian Engineers in the World Fair

Dear Sir:

Since Montreal has been chosen as the site for the World Fair in 1967, we, the Canadian engineers have a duty to co-operate and participate in making it a success. I believe Mr. Yvan Hardy of Hydro-Quebec has already presented a motion to the Annual Meeting of the Montreal Branch of the Engineering Institute of Canada for the creation of a Special Committee and possible holding of an Engineering conference of International scope in Montreal.

Since engineers have played an important part in every aspect of the Canadian development, it is only logical that they should assist, through the E.I.C., to project the image of Canada at the World Fair. Exhibits in the fields of mining, hydro, civil works, atomic energy installations, to mention only a few, could be organised and co-ordinated through the E.I.C. Also, visits could be arranged for the benefit of the foreign visitors to the impressive array of projects completed or in hand (e.g. the Manicouagan development, the St. Lawrence Seaway, the Dominion Engineering Works, the Aluminum plants at Arvida and the Iron ore projects in Northern Quebec), the hydraulic laboratories at LaSalle and the engineering universities like McGill and Laval. Time, money and effort spent in this direction could result in greater awareness abroad of the capability of Canadian Engineering and in due course, pay dividends in the form of increased demand for Canadian goods and consulting services.

Members of the E.I.C. throughout Canada and particularly the members from Greater Montreal with knowledge of foreign languages and customs would, I am sure, take keen interest in volunteering their services and help in these matters.

Yours very truly,
T. R. ANAND, M.E.I.C.

COMING EVENTS

Institute of Radio Engineers. National Convention. New York. March 24-28.

American Institute of Electrical Engineers, American Society of Mechanical Engineers. 25th American Power Conference. Chicago. March 26-28.

American Chemical Society. 144th National Meeting. Los Angeles. March 31-April 5.

Canadian Institute of Mining and Metallurgy. 65th Annual General Meeting. Edmonton. April 1-3.

American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. 46th National Open Hearth Steel Conference and Blast Furnace, Coke Oven, and Raw Materials Conference. Buffalo. April 1-3.

American Chemical Society. Division of Petroleum Chemistry. Los Angeles. April 1-5.

American Society of Tool and Manufacturing Engineers. Annual Meeting. Chicago. April 1-5.

American Society of Mechanical Engineers, Society for Advanced Management. Management Engineering Conference. New York. April 4-6.

Society of Automotive Engineers, American Society of Naval Engineers. Aero-Nautical Meeting, Production Forum and Aerospace Support Conference. Washington, D.C. April 8-11.

American Institute of Electrical Engineers. Biennial Electrical Heating Conference. Pittsburgh. April 9-10.

Institute of Radio Engineers, American Institute of Electrical Engineers, Institute of the Aerospace Sciences. Fourth Symposium on Engineering Aspects of Magnetohydrodynamics. Los Angeles. April 10-11.

Electrochemical Society, Inc. Spring Meeting. Pittsburgh. April 14-18.

European Federation of Chemical Engineering. DECHEMA Annual Meeting. April 25-26. Frankfurt (Main).

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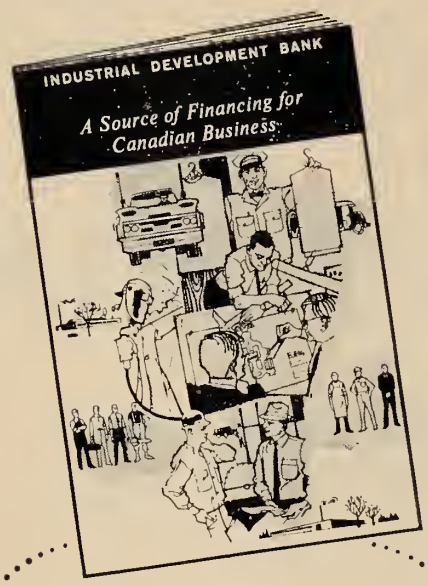

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Engineering Information Service

The following books have recently been received.

AMERICA'S FORGOTTEN LABOR ORGANIZATION, A. B. Shostak, Industrial Relations Section, Department of Economics, Princeton University, N.J., $12.

DIRECTORY OF DIRECTORS, Financial Post, Toronto, $15.

THE ELECTRONICS OF LABORATORY AND PROCESS INSTRUMENTS, V. S. Griffiths & W. H. Lee, Clarke, Irwin, Toronto, $12.

RIVER POLLUTION: Two; CAUSES AND EFFECTS, Dr. L. Klein, Butterworth's, Toronto, $17.

INDUSTRIAL WATER RESOURCES IN CANADA—WATER SURVEY REPORT NO. 13—THE LOWER ST. LAWRENCE RIVER DRAINAGE BASIN IN CANADA, J. F. J. Thomas, Canada Department of Mines and Technical Surveys, $2.

DIESEL ENGINE PRINCIPLES AND PRACTICE, Edited by: C. C. Pounder, British Book Service, Toronto, $21.75.

PROCEEDINGS OF THE 14th BRITISH ELECTRICAL POWER CONVENTION, 1962—The British Electrical Power Convention.

SPECIFICATIONS FOR UNIFIED SCREW THREADS, PARTS 1, AND 2, British Standards Limited, London.

LABORATORY PLANNING, J. F. Munce, Butterworth's, Toronto, $17.

NATIONAL DIRECTORY OF THE CANADIAN PULP AND PAPER INDUSTRIES, National Business Publications Ltd., Gardenvale, Que., $7.

EVIDENCE AND PROCEDURES FOR BOUNDARY LOCATION, C. M. Brown & W. H. Eldridge, Wiley, N.Y., $9.75.

LAGER UND SCHMIERUNG, K. Milowiz, Springer-Verlag, Berlin, $18.

ELEMENTARY SAMPLING FOR ENGINEERS, The ENO Foundation for Highway Traffic Control, Conn.

THEORY OF GROUND WATER MOVEMENT, P. Ya. Polubarinova-kochina, Translated from the Russian by J. M. R. de Wiest, Saunders, Toronto, $12.

VIBRATION ANALYSIS AND DESIGN OF FOUNDATIONS FOR MACHINES AND TURBINES, A. Major, Collet's, London, £ 5.5.0.

WORLD POWER CONFERENCE, SURVEY OF ENERGY RESOURCES, 1962, The Central Office of the World Power Conference, London, £ 1.1.0.

PROVINCE OF NOVA SCOTIA—REPORT OF THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES, FOR THE YEAR ENDING DECEMBER 31, 1961, Queen's Printer, Halifax.

UNITES DE MESURE- TABLES DE COEFFICIENTS DE CONVERSION, Gauthier-Villars, Paris, 40 NF.

NON-FERROUS METALS-STATISTICS-TREND, 1961-1962, Organization for Economic Co-operation and Development, Paris, $1.50.

METAL COLOURING, D. Fishlock, Draper, London, $12.75.

Engineering Information Service

INFLUENCE DU TYPE D'AMORTISSEUR DES MACHINES SYNCHRONES SUR LEUR COEFFICIENT D'AMORTISSEMENT ET LEURS REACTANCES TRANSITOIRES ET SUBTRANSITOIRES, M. Achab, Juris-Verlag, Zurich.

SPECIFICATIONS FOR RING SPANNERS, British Standards Institute, London, 5/.

ELEMENTS DE CALCUL DES PROBABILITIES, J. Bass, Masson, Paris, NF 34

RADIO-TELEVISION ELECTRONICS DICTIONARY, National Radio Institute Teaching Staff, Rider, N.Y., $3.50.

METALLURGY IN NUCLEAR POWER TECHNOLOGY, J. C. Wright, Illiffe, London, 32s.

AUTOMATIC CONTROLS HANDBOOK, G. A. T. Burdett, Advisory Editor, Newnes, London, 90/.

TRANSACTIONS OF THE MADRID SECTIONAL MEETING, 1960 OF THE WORLD POWER CONFERENCE.

THE STRUCTURAL USE OF ALUMINUM IN BUILDINGS, Canadian Standards Association.

PRINCIPLES OF TRANSISTOR CIRCUITS, S. W. Amos, Rider, N.Y., $4.25.

MECHANIQUE PHYSIQUE ET EXPERIMENTALE, TOME I, STATIQUE ET RESISTANCE DES MATERIAUX, A. Foch, Masson, Paris, 55 NF.

METALLURGIE STRUCTURALE, A. de Sy et J. Vidts, Dunod, Paris.

LA MESURE DES TEMPERATURES AU LABORATOIRE ET DANS L'INDUSTRIE, M. Terry, Dunod, Paris.

MECHANICS OF MATERIALS, SECOND EDITION, F. E. Miller & H. A. Doeringsfeld, International Textbooks, Scranton, Pa.

NETWORK ANALYSIS AND SYNTHESIS, F. F. Kuo, Wiley, N.Y., $9.25.

(Continued on page 80)

ABSTRACTS - Division Papers

(Continued from page 68)

EIC-63-HYDEL 4

"Operating Experiences in a Hydro-Electric Plant Feeding a Semi-Isolated System"
M. G. Green

The Bowater Power Company Limited is located on the west coast of Newfoundland. It is uniquely isolated geographically, technically and economically. This, in addition to the normal problems of hydro-plant operation, has developed many interesting experiences over the past 37 years since the original plant was commissioned. Some features of this system and some of the operating experiences are brought out in an effort to show the larger and more sophisticated systems something of the problems involved. Also, it is hoped that these comments will give some insight on expected conditions for those who will continue to build semi-isolated systems in the development of Canada's northlands.

EIC-63-MECH 19

"Steam and Gas Turbines"
E. R. Signer

The first industrial gas turbine to be installed in Canada was commissioned in 1952. Between then and the end of 1961 more than 700,000 hp. was installed or on order. The author discusses the reasons behind this fact; major applications in Canada; and the future of gas turbines.

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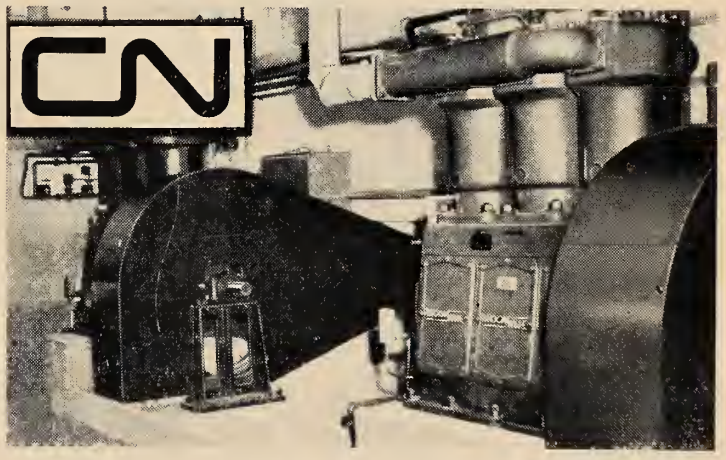

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(Continued from page 79)

GREAT LAKES BASIN, H. J. Pincus, American Association for the Advancement of Science, Washington, D.C., $7.50.

GRAPHICS WITH AN INTRODUCTION TO CONCEPTUAL DESIGN, A. S. Levens, Wiley, N.Y., $9.50.

GAS FILM LUBRICATION, W. A. Gross, Wiley, N.Y., $14.

INERTIAL GUIDANCE ENGINEERING, M. Fernandez & G. R. Macomber, Prentice-Hall, N.J., $14.75.

DICTIONNAIRE INTERNATIONAL DE FONDERIE, Dunod, Paris, 80 NF.

EXPLOITATION DES MINES, TOME 3, V. Vidal, Dunod, Paris, 84 NF.

METHODES OBJECTIVES D'INTERPRETATION DES MESURES, G. Yvon, Dunod, Paris, 16 NF.

LINEAR ACTIVE NETWORK THEORY, L. de Pian, Prentice-Hall, N.J., $16.

FRAGEN ZUR THEORIE DER NETZWERKE MIT VERANDERLICHEN PARAMETERN, W. A. Taft, Verlagsgesellschaft, DM 16.

RF INTERFERENCE CONTROL HANDBOOK, B. Kemp, Sams, Indianapolis, Ind., $6.95.

MATERIALS SCIENCE AND TECHNOLOGY FOR ADVANCED APPLICATION, Edited by: D. R. Mash, Prentice-Hall, N.J., $12.

THE BRITISH CANADIAN TRADE REGISTER OF BRITISH INDUSTRIAL PRODUCTS FOR CANADA, 1962-1963, Iliffe, London, 15s.

ANALYSIS OF STATICALLY INDETERMINATE FRAMEWORKS, T. M. Charlton, Longmans, Toronto, $6.

SIMPLIFIED CALCULATION METHODS OF SHELL STRUCTURES, Editors—A. Paduart & R. Dutron, Wiley, N.Y., $15.

THE ROBERTSON GUIDE TO WORLD SCREW THREAD SERIES SYMBOLS, P. C. Harron, Robertson, London, 20/

ELECTRIC MACHINE ANALYSIS USING MATRICES, W. J. Gibbs, Pitman, London, 17/6.

HEAT TRANSFER MEASUREMENT IN THE ENTRANCE REGION, Dr. P. Zanoni, Verlag-Leeman, Zurich, SFR 8.

ULTIMATE LOAD ANALYSIS OF REINFORCED AND PRESTRESSED CONCRETE STRUCTURES, L. L. Jones, Chatta & Windus, London, 45s.

WATER SUPPLY AND MAIN DRAINAGE, S. J. Asher, Lockwood, London, 12/6.

VIBRATION ANALYSIS AND DESIGN OF FOUNDATIONS FOR MACHINES AND TURBINES, A. Major, Collets, London.

WELL SPACING IN THE ANETH RESERVOIR, F. W. Cole, University of Oklahoma Press, $6.95.

WATER SUPPLY ENGINEERING, SIXTH EDITION, H. E. Babbitt, McGraw-Hill, Toronto, $12.50.

SINGLE-SIDEBAND COMMUNICATIONS HANDBOOK, H. D. Hooton, Sams, N.Y., $6.95.

MECHANIQUE APPLIQUE, R. Ouziaux, Dunod, Paris, 16 NF.

SILICONES—AN INTRODUCTION TO THEIR CHEMISTRY AND APPLICATION, G. G. Freeman, Iliffe, London, 27s6d.

SCIENTIFIC METHOD: OPTIMIZING APPLIED RESEARCH DECISIONS, R. L. Ackoff, Wiley, N.Y., $10.25.

BIBLIOGRAPHY ON SOIL MECHANICS, VOL. III, H. Petermann & H. Kohn, Kirschbaum Verlag Bad Godesberg.

RESERVOIR ENGINEERING MANUAL, F. W. Cole, Gulf, Houston, $11.50.

PURER METALS, Institute of Metallurgists, Iliffe, London, 35s.

PROPERTIES OF REACTOR MATERIALS AND THE EFFECTS OF RADIATION DAMAGE, Editor, D. J. Littler, Butterworths, London, $25.25.

PROGRESS IN INDUSTRIAL GAS CHROMATOGRAPHY, VOL. I, Edited by: H. A. Szymanski, Plenum Press, N.Y., $8.50.

SIX LANGUAGE DICTIONARY OF AUTOMATION, ELECTRONICS AND SCIENTIFIC INSTRUMENTS, A. F. Dorian, Illife, London, $21.25.

SPANNBETON FUR DIE PRAXIS, F. Leonhardt, Ernest, Berlin, DM 76.

OPERATIONAL METHODS FOR LINEAR SYSTEMS, W. Kaplan, Addison-Wesley, Reading, Mass., $10.75.

NON-LINEAR & PARAMETRIC PHENOMENA IN RADIO ENGINEERING, A. A. Kharkevich, Rider, N.Y., $6.50.

PIPELINE CORROSION AND CATHODIC PROTECTION, M. E. Parker, Gulf, Houston, $6.50.

PHOTOELECTRIC CONTROL, H. Pollack, Rider, N.Y., $3.50.

PERMANENT MAGNETS AND MAGNETISM, Edited by: D. Hadfield, Iliffe, London, 105s.

PHYSICS FOR STUDENTS OF SCIENCE AND ENGINEERING, PART II, SECOND EDITION, D. Halliday & R. Resnick, Wiley, N.Y.

LE PLANNING DE LA PRODUCTION ET LE CONTROLE DES STOCKS, J. F. Magee, Dunod, Paris, 54 NF.

PHYSIKALISCHE GRUNDLAGEN DER ELEKTROAKUSTIK, W. Reichardt, Teubner Verlag, Leipzig.

PHYSIQUE APPLIQUE AUX INDUSTRIES DU VIDE ET DE L'ELECTRONIQUE, G. A. Boutry, Masson, Paris, 55 NF.

PRODUCTIVITY IN THE IRON AND STEEL INDUSTRY, The Iron and Steel Institute, London, 30s.

PREMIERES APPLICATIONS DE STATISTIQUE COMMERCIALE, H. Pin, Dunod, Paris, 38 NF.

PRACTICAL GEOMETRY, BOOK 2, P. F. Harrop, MacMillan, N.Y.

PROCEEDINGS OF THE AMERICAN POWER CONFERENCE, 24th ANNUAL MEETING, VOL. XXIV, 1962, Illinois Institute of Technology, Chicago, $10.

FOURIER ANALYSIS ON GROUPS, W. Rudkin, Wiley, N.Y., $9.50.

LES MECHANISMES HYDRAULIQUES, SECOND EDITION, Dunod, Paris, 44 NF.

MECHANICS OF FLUIDS, I. Shames, McGraw-Hill, N.Y., $8.95.

(Continued on page 103)

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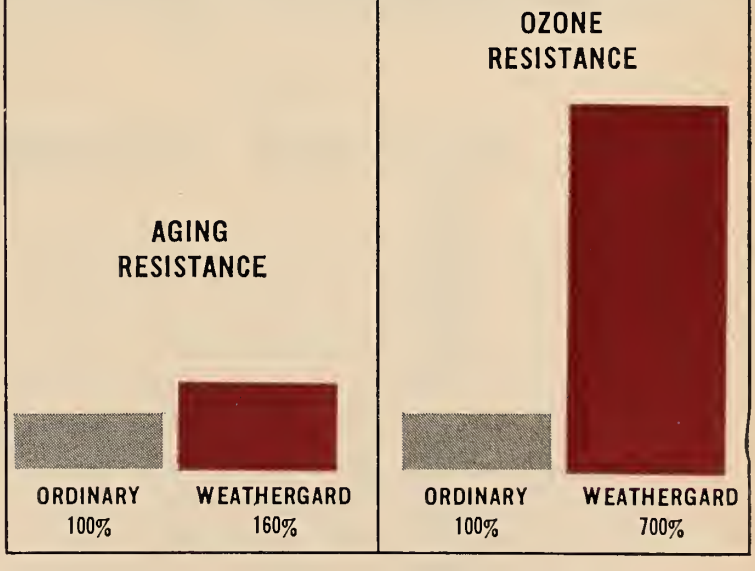

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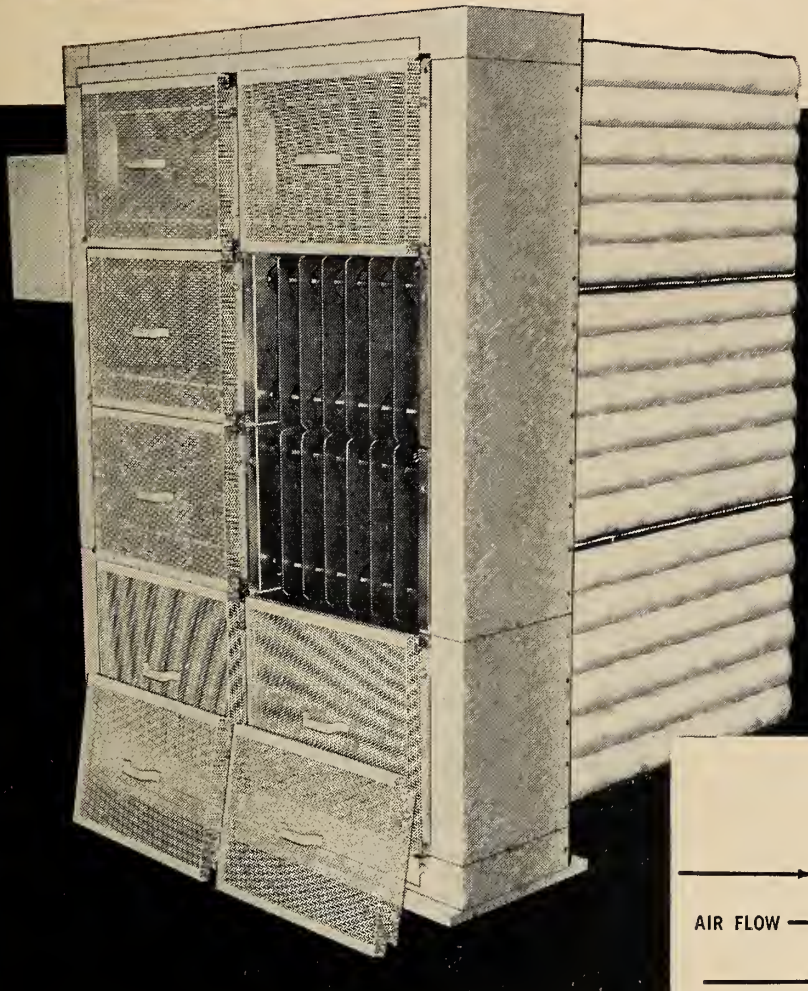

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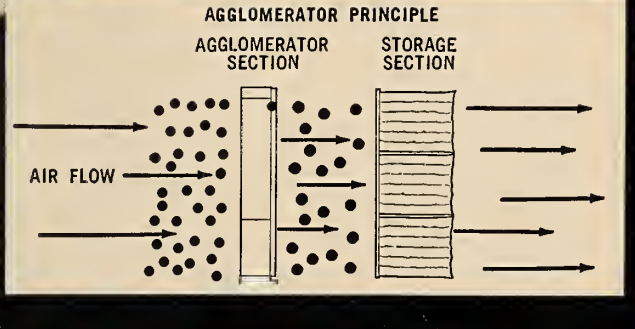

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(Continued from page 70)

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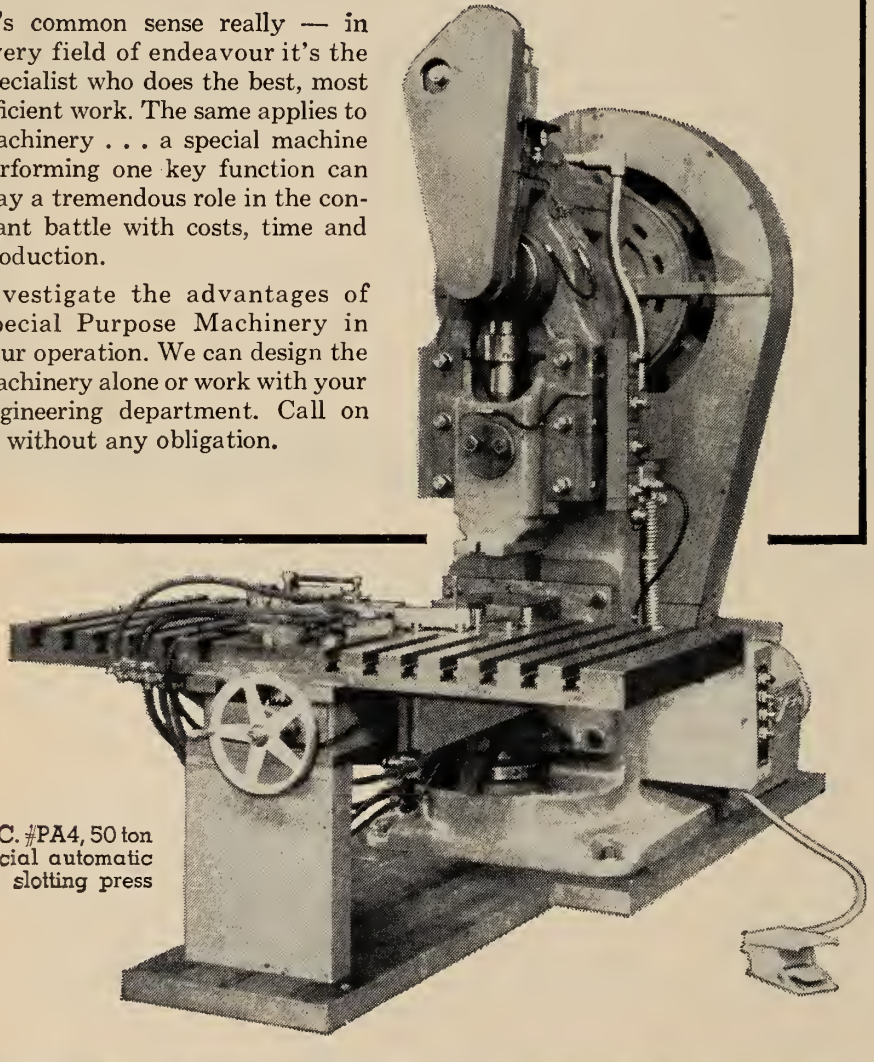

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The Grenadier Inn was the scene for the Branch's Annual General Meeting December 13. After a dinner, reports were presented by the various committee chairman. J. S. Waddington, Vice President of Zone B, presented a Life Membership in the Institute to A. S. Fraser of Canada Starch Company. The Branch officers elected for 1963 are: D. B. Ashenden, Phillip's Electrical, Chairman; W. E. Currie, DuPont of Canada, Vice Chairman; P. D. Stata, Secretary-Treasurer. Executive Members include: M. J. Baillargeon, Canada Starch Company; F. W. Barnhouse, Phillip's Electrical; R. A. Ward, Selkirk Metal Products; W. L. McCrea, Parke-Davis; J. E. C. White, Automotive Electric. Auditors are F. F. Walsh and R. M. Powell.

Ontario's Minister of Transport, J. A. C. Auld, was the guest speaker. He spoke on highway safety, and discussed the program for driver training in Ontario's secondary schools. His talk was illustrated with films.

CAPE BRETON

Lloyd Boutilier

The December 5 meeting of the Branch took the form of a Past-Chairmens' Night. This event was held in recognition of the Institute's 75th Anniversary. Each Past-Chairman was presented with an Institute key chain as a memento of the evening. Past Chairmen honored were: R. R. Moffat, M. R. Campbell, M. R. Chappell, I. W. Buckley, J. A. Macleod, M. F. Cossitt, C. N. Murray, J. R. Wallace, G. W. Ross, W. A. MacDonald, J. V. Palmer, H. M. Aspinall and R. A. Bradley. Major C. M. Smyth, C. M. Anson, H. A. Marshall and William Dodson, all past-chairman, were unable to attend the meeting.

Gordon Naish, a former secretary of the Branch, presented films on ancient Roman architecture and engineering achievements which are still in existence today in the south of France. Slides were shown of aqueducts, amphitheatres and temples which were constructed thousands of years ago without the aid of equipment such as is available today.

CENTRAL B.C.

J. W. Nelson

A joint meeting of the Branch and the local A.P.E.B.C. was held at the National Hotel in Vernon on January 25. M. G. Elston was chairman of the meeting which 32 engineers and affiliates attended. Ed Stiles, former Chief Engineer for Consolidated Mining and Smelting Company gave a very interesting talk on the growth of Cominco from 1917 to 1953. In 1917, the main mine for the company was the Sullivan Mine, a rich ore body which contained lead, zinc, iron and silver. No economical processes existed at that time for the separating of these different components. Cominco owned at the time a 50-ton electrolytic refinery, a zinc plant, a copper smelter and the West Kootenay Power and Light Company. During the 36 years Mr. Stiles

was with the company, it went through wide expansion. A few of the accomplishments were: discovery of a new process to separate lead, zinc, iron, silver and their components; construction of a large concentrator at Trail; construction of the C.P.R. railway along Kootenay Lake; development of fertilizer as a by-product, and the construction of a large fertilizer plant; construction of a large machine shop and casting shop; construction of dams, power houses, and electrical transmission lines to provide the additional power required. During the period between 1917 and 1953, Cominco extended its activities to many countries. Mr. Stiles described his personal experiences with the company in his travels through Canada, the United States, Europe and Australia. Gordon Hirtle thanked Mr. Stiles.

CORNER BROOK

Robert G. Scott

Members of the Branch were conducted on a tour of the Atlantic Gypsum Company Limited's plant during a November meeting. Prior to the tour, Max Prorinsh, Manager of Operations, explained by the use of a flow chart, the production processes at the plant. Of particular interest was the special method developed for the handling of the rather fragile gypsum wallboard which is produced here. An informal discussion followed the tour. Coffee and sandwiches, prepared by members' wives, ended an interesting meeting.

On December 4, Spencer G. Jackson, Manager of Warnock Hersey Co. Ltd., Montreal, spoke to the Branch on "Non-destructive Testing of Metals". In his talk, he outlined various methods of testing, such as radiography, magnetic particle and penetrants, and discussed advantages and disadvantages of each. His talk dealt also with the questions of when testing is necessary, and how much is required. The interpretation of test results was also covered. A lively question and answer period followed the talk. Coffee and sandwiches were served.

EDMONTON

R. J. Allman

The Branch held a panel discussion in November on the topic "Fallout Protection—How Necessary?" The panel, composed of four engineers and two architects, discussed various aspects of fallout protection as it affected individual citizens and city populations. All panel members had recently attended an Emergency Measures Organization course at Arnprior, Ont.

The first speaker, an engineer, described the expected results of a five-megaton nuclear bomb explosion and the resultant fallout effects. The second panel member, an architect, estimated that the chances of survival would be 10,000 % greater with a concrete fallout shelter as protection. He discussed the course of action that individuals should take regarding fallout shelters, such as using house basements as protection. The protection of the individual from fallout radiation injury was discussed by an engineer, the third speaker. He stated that an individual should wear clothing to protect the skin from exposure, and should not drink water which has been exposed to fallout. An architect was the fourth speaker. He discussed municipal plans for protection of the public against dangers from a nuclear explosion. He stated that it was essential that all vital services be maintained and that the public shelters should be provided in downtown areas. The fifth and final speaker was an engineer who discussed in detail the movement of people that would occur before, during and after a nuclear attack. A very interesting question-and-answer period followed during which the panel members discussed many of the problems in greater detail, answering specific questions about each of their topics. Various suggestions came from the floor regarding possible steps that might be implemented during a nuclear attack. One member suggested that large evacuation drills be held in the city to test the readiness and to discover weaknesses. The problem of the responsibility

(Continued on page 88)

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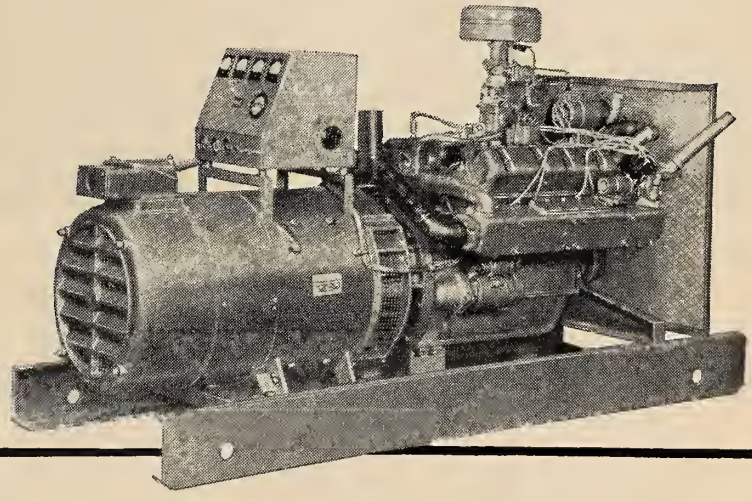

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CANADIAN

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(Continued from page 87)

of individuals during attack was discussed at some length, and a number of the members felt that this problem would remain largely unsolved until an actual attack occurred.

On December 7, J. Thomas, Assistant General Manager at the B.A. Oil Refinery, Edmonton, was the guest speaker at the Branch's meeting. His talk, "Petroleum Processing", dealt with the various units and operations at the refinery. He discussed each unit in detail with the aid of an illustrated flow chart.

KINGSTON

K. L. Coupland

The Branch held a panel discussion entitled, "Management Training for Engineers", on December 12, at the Officers' Mess of the Royal Military College. Members of the panel were: Dean H. G. Conn, Panel Moderator; F. G. Carson, DuPont of Canada; R. M. Beatty, Canadian Industries Limited; Major K. L. Coupland, The RCEME School; and A. W. Balson, Aluminum Company of Canada. Each presented a brief description of his company's philosophy and the procedure followed in the development of engineering personnel. Following this, discussions were carried out between the panel and members.

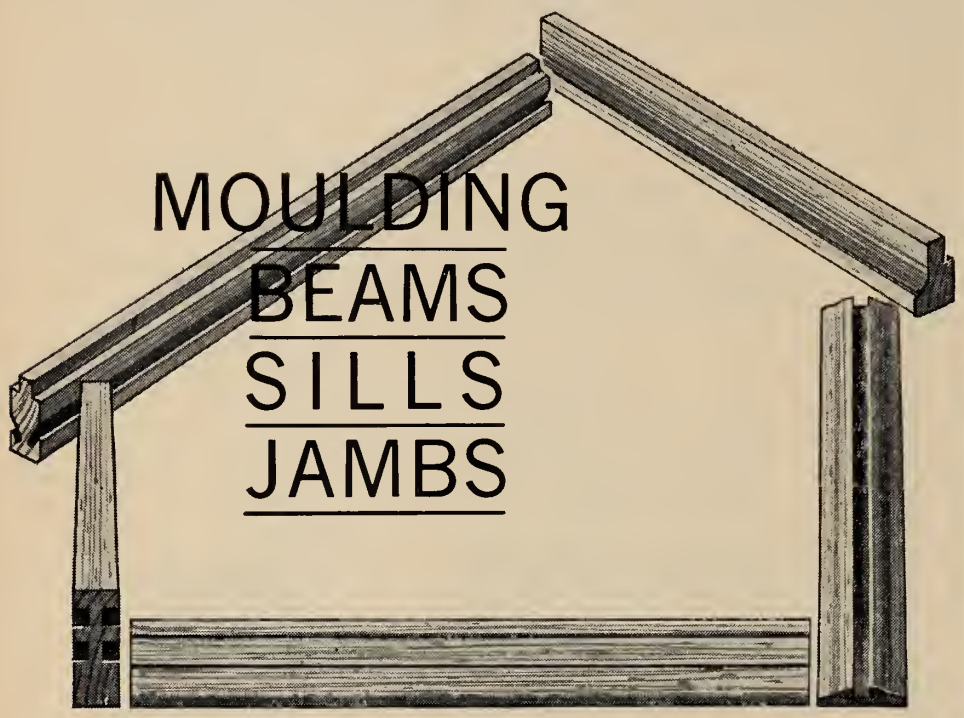
It was agreed generally that if engineers were to become proficient managers, most of them would benefit from a planned career program in which they would be employed in positions giving them varied and graded experience as they progressed from junior to senior positions. Courses in managerial development and regular on-the-job coaching would also be of great value. Apparently, two paths exist for engineers. They may take the technical path which confines itself strictly to engineering, or, they may choose the non-technical path on which the engineer gradually moves into managerial positions which are increasingly separated from pure enginering. The tendency is to encourage engineers towards pure engineering by offering him increased status and salary.

"Nuclear power today is truly within the field of Engineering", D. Chase, of the Canadian General Electric Company, Limited, Peterborough, told the Branch members at their January 9 meeting. "We now are able to apply technology with the proper regard to economic aspects." Mr. Chase was the commissioning engineer for the 20 megawatt Nuclear Power Demonstration located at Rolphton, 12 miles up-stream from the Chalk River Research Center of Atomic Energy of Canada Limited. A.E.C.L., Ontario Hydro and C.C.E. co-operated in the building of the station. No major problems were encountered in the application of the fundamental concepts, and the project progressed from "first critical" to full power in only 11 weeks. It was put into full-scale operation during the summer of 1962, with its output being fed into Ontario Hydro Power System. This plant is the prototype of much larger plants such as the 200 megawatt Douglas Point Nuclear Power Station.

KITCHENER

W. N. Meikle

A. J. Baehmeier, Head of the Gas Dynamics Division, National Research Council, was the guest speaker at the Branch's December 5 meeting held jointly with the local chapter of the A.P.E.O. at the Officers' Mess, Knollwood Park. Mr. Baehmeier dealt particularly with the application of gas turbines for mobile power. He stated that, at the present time, the world's installed capacity for this use is approximately eight million horsepower with a total of 30 million horsepower for all purposes. He then discussed the advantages and disadvantages in the efficiency and maintainance of gas turbines as compared to diesel electric for rail locomotion. Gas turbines were described as being particularly efficient when operating at full load. For this reason, it tended to limit their use to situations where the units could be tailor-made for the job. However, by the use of heat exchangers, 75% of the exhaust gas energy could be recovered so that their efficiency at partial loads approached that of the diesel. It was pointed out that efficiency and reliability



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of operations was a particularly serious problem with Canadian railways because of weather conditions and the fact that Canada has a density of only 500 people per square mile of road as compared to the United States and the U.S.S.R. with between 5000 to 10,000 persons per mile. Slides were shown and a description of the various designs being tried out by several automobile manufacturers. It was indicated that there are still many problems to be solved before the gas turbines could be in general use by the public in automobiles. In the discussion which followed, the free piston engine was described as having distinct possibilities of being a competitor for particular applications due to its relatively high efficiency. Prior to Mr. Bachmeier's talk, a movie was shown of the collapse of the suspension bridge over the Tacoma Narrows in Washington state in the early forties. From this film, bridge designers have been able to gain considerable knowledge as to bridge construction. The bridge has been called "the engineers' most successful failure".

LONDON
W. L. Thompson

A Professional Development Course consisting of nine lectures on "Canadian Politics and Foreign Policy", was held by the Branch from October to December, 1962. This program was arranged by Professor J. E. K. Foreman, M.E.I.C., of the Department of Engineering Science at the University of Western Ontario. A series of lectures were given by six professors from the faculty of Political Science. These lectures, which were attended by an enrollment of 45, were presented at the Alexander C. Spencer Faculty of Engineering Building.

President Lawton visited the Branch November 7 and met with Branch Executive who accompanied him to the University where he addressed the Student Branch. A dinner meeting which 35 attended, was held that evening in the Hotel London.

On December 11, the Branch held a very successful "Feather Party" at the Reserve Militia Mess, Wolseley Barracks.

MONCTON
V. C. Blackett

On November 19 the Branch held a dinner meeting in the Brunswick Hotel, at which the guest speaker, Donald Buck, Redevelopment Officer for the City of Saint John, spoke on "Urban Renewal in Saint John". Mr. Buck, who was educated in England and studied at the College of Estate Management and at the London School of Economics, is a professional valuer with extensive experience in land development. He served with Central Mortgage and Housing Corporation in Ottawa, Winnipeg, Regina and other cities across Canada on a number of assignments until March 1961 when he went to Saint John to take charge of the Redevelopment Program for that city. This meeting concluded the Branch's activities for 1962.

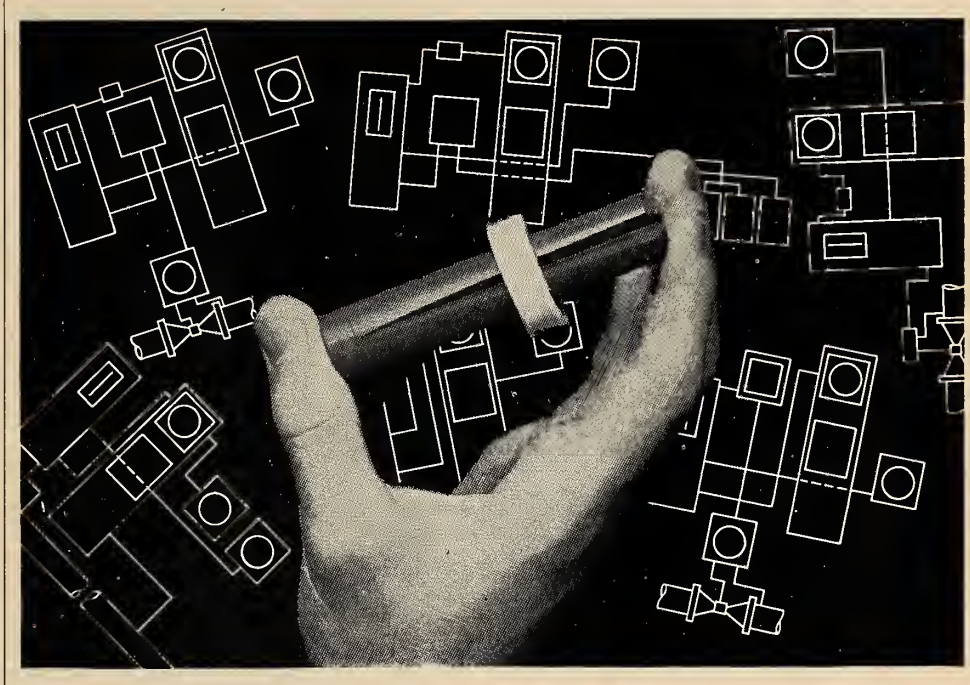
PETERBOROUGH
John M. Hubicki

The 1963 Branch executive met for the first time January 10. The executive consists of: Chairman, C. L. Willcox; Secretary-Treasurer, C. R. Phillips; Technical Meetings, R. H. Rehder; Membership, D. T. Bath; Publicity and Commercial Relations, J. M. Hubicki; General, Fred Ness; Past Chairman, N. C. Durant; Councillor, D. A. Lamont; Historian, B. Ottewell.

PORT CREDIT
J. Reid Clark

A very successful Annual Meeting was held by the Branch on January 16. Members of the Oakville Branch joined Port Credit members at this dinner meeting. Retiring Chairman, T. H. Rosborough presented a report in which he reviewed Branch activities of 1962. Mr. Rosborough then introduced the following executive for 1963: A. E. Cook, Chairman; J. R. Challis, Vice Chairman; G. B. Nelson, Secretary-Treasurer; D. S. Moyer, Branch Councillor; A. G. Hamilton and J. R. Clark, Branch representatives. Mr. Rosborough paid special tribute to the contribution made by Harry D. Smith who retired from the

(Continued on page 93)



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SITUATIONS WANTED

STRUCTURAL ENGINEER — M.E.I.C., P.Eng., B.Sc. 1948. Seeks position in Western Canada. Experienced in the design of buildings, municipal plant and bridges with a sound knowledge of foundations, reinforced concrete, steel and glulam. Presently employed by firm of Architects in Prairie Provinces. File No. 101-C.

REGISTERED ENGINEER — M.E.I.C., B.E. 1959, M.Sc. 1962, A.S.A.E. Desires position in design, development, teaching and/or research, preferably in timber structures. Location open. File No. 103-Agr.

CIVIL ENGINEER — M.E.I.C., B.Eng., P.Eng.(Que.). Age 41, married. Completely bilingual. 12 years commercial heavy industrial and marine design and construction experience as project manager and resident engineer. Present location central Canada but will relocate anywhere. Desires responsible and challenging position with consulting engineering firm or general contractor. Complete resume upon request. File No. 112-C.

SENIOR MECHANICAL ENGINEER/-ADMINISTRATOR — M.E.I.C., P.Eng. Age 40. Wide experience maintenance, quality control, production, etc. Seeks interesting position with definite opening to executive level in small/medium expanding organization. Location Ontario or West. File No. 170-M.

STAFF ENGINEER — M.E.I.C. 10 years experience in project development, planning, design and field supervision. Seeks technical-administrative position with consulting, industrial or contracting group. Functions could include new business, investigations, technical and economic analyses, feasibility reports, project planning and programming. Experienced in Latin American development projects. File No. 171-C.

MECHANICAL ENGINEER — M.E.I.C., P.Eng.(Ont.). Age 38, married, 2 children. Seeks position with challenge and opportunity. Diversified experience in petrochemical plants and manufacturing engineering. Supervisory and administrative experience in project coordination, inspection, design and specifications. Both practical and theoretical knowledge of plant equipment, plant maintenance, codes and materials for construction. Will locate anywhere. File No. 317-M.

CIVIL ENGINEER — M.E.I.C., P.Eng. Age 40, married. 11 years field and office experience on construction and maintenance public roads, water control projects, plus 6 years senior administrative experience abroad. Desires responsible permanent position where employer requires application of experience in contract documentation and administration together with interest in legal procedures, technical writing, personnel supervisory duties. Presently located Toronto; will relocate anywhere. File No. 320-C.

ENGINEERING BUSINESS ABROAD — Mechanical Engineer with overseas experience wishes to work for firms or consultants on surveys, promotion and coordination of general industrial projects and equipment sales abroad. Fluent in English, German and Spanish, understands French. File No. 337-M.

IMPORT/EXPORT SALES — Electrical/-Mechanical Engineer, M.E.I.C., A.M.I.E.E. Married, aged 38. Wide experience technical sales, U.K. Eastern and Western Canada. Presently District Sales Manager with proven sales record. Requires responsible executive position offering greater scope and advancement, preferably in import-export sales Canada, U.S. or Europe. Resume on request. File No. 404-E.

PROFESSIONAL ENGINEER — M.E.I.C., P.Eng.(Ont.), B. Eng. (Civil) N.S.T.C. 1953. Age 34. Ten years diversified experience in project and plant engineering in the Chemical and Pulp and Paper industries. Experience includes design, maintenance, supervision, administration and production. Presently employed as Senior Project Engineer in a paper mill. Seeks responsible position in Engineering, Administration, or Production in Industry, Consulting or Government. File No. 425-C.

ENGINEERING PHYSICIST — A.M.E.I.C., (Alberta '60), Athlone Fellow, now completing Research for Ph.D. in Mechanics at the University of Cambridge, England. Desires position in Mechanical, Structural or Aeronautical Engineering. Available September 1963. Locate anywhere. File No. 426-Ph.

CIVIL ENGINEER — Pilot. B.Sc. 1960 University of Alberta. Age 25, single. Relatively no experience in Engineering field. 3 years since graduation spent in Naval Aviation flying conventional airplanes and helicopters. Desires position in established Canadian firm. Prefers to work in the north, however will consider working anywhere. Available September 1963. File No. 427-C.

CIVIL ENGINEER — A.M.E.I.C., P.Eng. (Que.), B.Sc. Eng. 1959. Experience in heavy construction, planning and cost estimating with some experience in design. Desires responsible position in municipality or manufacturing in Maritime Provinces. File No. 428-C.

CIVIL ENGINEER — A.M.E.I.C., B.A.Sc. University of British Columbia. Married, age 30. Studying for M.B.A. degree, desires summer position. 10 years experience in construction as superintendent and estimator. Available April 22, 1963. Resume and references on request. File No. 429-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. 10 years experience in materials testing field and concrete production. Familiar with quality control, production and company-customer relations. File No. 430-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. Age 42. Extensive experience of construction and contract management in hydro and thermal power projects and industrial plants. Seeks progressive position. File No. 431-C.

ELECTRICAL ENGINEER — M.E.I.C., A.M.I.E.E., M.Eng. (McGill '51). Age 39, married. 2 years experience in electrical design with consulting firm in Canada. 8 years experience in design, construction and operation with large British petroleum company in Borneo. Well versed in fault analysis and protective relaying. Seeks employment with industry, consulting firm or government. Location open. File No. 432-E.

CIVIL ENGINEER — A.M.E.I.C., N.S.T.C. 1959. Age 26, single. 3 years experience in industrial construction as general superintendent and project engineer. Desires employment in construction industry of industrial plants or buildings or management of precast concrete plant. Presently located in Maritimes. Will consider any location. File No. 433-C.

CIVIL AND MINING ENGINEER — M.E.-I.C., A.R.S.M., B.Sc., A.M.I.C.E., P.Eng. Age 44. Wide range of experience in hydro-electric and thermal-electric work; mine and mill development; docks and harbours; structural design; handling and storing of petroleum products. Will locate anywhere. File No. 434-C.

BUSINESS ENGINEER — M.E.I.C., P.Eng., B.Eng. Mech. (McGill), M.B.A. (U.W.O.). Age 34, married, bilingual. Over 8 years experience in design and project engineering in all branches. Experienced in C.P.M. and management presentations. Desires challenging position offering scope and chances for advancement in management level. Willing to travel or relocate to U.S. or overseas if necessary. File No. 435-M.

CIVIL ENGINEER — A.M.E.I.C., P.Eng. (Que., Nfld.), B.Eng. (McGill '59). Age 27, single. Nine years undergraduate and graduate experience in materials aspect of construction including subsoil investigation, and design, testing, field supervision and quality control of asphalt pavements and concrete mixes. Considerable experience in highway design, layout and construction. Desires position with technical, construction, municipal or consulting engineering firm in similar field. File No. 6385-C.

SITUATIONS WANTED

MECHANICAL ENGINEER — M.E.I.C., P.Eng., age 38, married. Six years experience in Canada: Two, with manufacturer of heavy industrial equipment, preparing quotations to customers' specifications; two, in plant maintenance for distillery and bottling equipment; two, in air conditioning design. Previous five years with earth-moving equipment, diesel engines, etc. in repair and maintenance shop. Seeks position in maintenance or production, preferably in Montreal. File No. 384-M.

ELECTRICAL ENGINEER, P.Eng., M.E.-I.C., B.Sc.E.E., University of New Brunswick '35. Age 48. 4 years experience electrical construction, maintenance in Gold Mines. 23 years Naval experience in electrical engineering, training electrical personnel, ship construction and repair, production, administration and technical supervision of ship electrical design and control group. Ex-Electrical Officer retiring and available August '63. Seeks employment in Ottawa or vicinity. File No. 395-E.

SITUATIONS VACANT

CIVIL

SOILS/FOUNDATION ENGINEER required by consulting engineering firm expanding its specialized services in Civil Engineering fields. Applicant must be experienced in soils investigation and advanced design of structural foundations for buildings and bridges. Present workload includes civil engineering works such as high embankment fills and deep cuts, dams and roads. Must be capable of specifying and supervising laboratory test programs including triaxial tests with porewater pressure measurement. Opportunity for senior engineer interested in entering consulting field as an associate. Reply in confidence to File No. 335-V.

ELECTRICAL

GRADUATE ELECTRICAL ENGINEER for Consulting Firm. Experience 4 to 6 years related to the following scope of work: Design of electromechanical instrumentation, servo systems, automatic relay and solid state sequence control systems, mathematical analysis, some field supervision and testing with complex mechanical projects. Location Toronto. Please send complete resume of qualifications to File No. 368-V.

PROJECT ENGINEER. Graduate Electrical Engineer or equivalent with strong electrical control background, capable of carrying out his duties with minimum supervision. His responsibility will cover all technical problems arising from one of our industrial projects, including the commissioning of the electrical plant. To the right applicant we offer excellent salary plus living allowance and hospitalization plan. Interested applicants should submit a complete resume of their experience, stating salary expected and when available. File No. 377-V.

ELECTRICAL ENGINEER. Recent graduate (or up to two to three years experience), who is interested in a career in Latin America, is required for a Canadian Electric and Power Company located in Bolivia. Duties would involve operation, maintenance and construction of distribution, transmission and hydro-electric production facilities. There are good opportunities for eventual advancement to senior administrative level. Reply to File No. 376-V.

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PROJECT ENGINEER. One of our paper mills requires a graduate engineer, mechanical preferred, with 2 to 6 years experience in industry. Responsibilities will include design as well as coordination of engineering projects involving existing and new pulp and paper manufacturing equipment. Experience in solving material handling problems an asset. Resumes are invited in confidence: Recruitment Services Manager. Dominion Tar & Chemical Company Limited, 2100 Sun Life Building, Montreal 2, Quebec.

MISCELLANEOUS

PROCESS EQUIPMENT DEVELOPMENT ENGINEER. To improve and extend present product line in evaporators, crystallizers, spray dryers and flash dryers, pulp washers and filters; adapt equipment to new process requirements; and develop new process, process equipment, and process systems. Will determine needs and controlling parameters in operations to be performed, devise feasible attacks on process problems, design and participate in pilot-operation experiments, and pursue development projects to conclusion. Position requires B.Sc. or equivalent thereof, with some graduate study in mechanical, chemical or mining engineering or engineering physics, five or more years experience in process equipment research and development, including a majority of the following: Elementary stress and structural analysis; Mechanical design of equipment and follow through to application; Fluid flow and heat transfer—basic theory, equipment and application; Shop methods and fabrication. The man we seek has creative curiosity, a speculative inclination, a sound technical background, and persistence. He will welcome challenge in applied physical chemistry and an opportunity for independent work. Excellent salary, liberal relocation provisions, benefits and educational aid with pioneer process equipment manufacturer. Send resume including present salary, in confidence, to: Swenson Evaporator Co. Division, Whiting Corporation (Canada) Ltd., P.O. Box 217, Welland, Ontario. Attention: Mr. E. H. Storey.

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SITUATIONS VACANT

MISCELLANEOUS

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SALES ENGINEER — Leading electrical manufacturer requires a registered professional engineer with 2 to 3 years experience in sales to the electric utilities or with experience in electric power measurement. Starting salary commensurate with qualifications. Established sales territory in Ontario. Reply to Manager, Industrial Relations, Sangamo Company Limited, 215 Laird Drive, Toronto 17, Ontario.

SALES ENGINEER — wanted for selling automatic control equipment and associated products to the marine and industrial fields. Marine background desirable; bilingual preferred; salary, commission and car allowance; location Montreal. Reply to File No. 378-V.

MECHANICAL OR CHEMICAL ENGINEER, for design and sales work with a Canadian company in Toronto, manufacturing stainless steel pressure vessels, reactors and heat exchangers. Age under 35. Previous experience in Process industries desirable. Reply to File No. 379-V.

METALLURGICAL

METALLURGICAL ENGINEERS — Large progressive Corporation with subsidiary Companies in several provinces in Eastern Canada requires Metallurgical Engineers. Excellent opportunities for advancement. Reply in confidence to: File No. 292-V.

TEACHING

McGILL UNIVERSITY — The present Chairman of the Department of Chemical Engineering will retire in August 1964. It is proposed to make an appointment of a Professor in August 1963, with a view to assuming the Chairmanship in 1964. Applications are invited from persons who are well qualified, and should be addressed to: Dean D. L. Mordell, Faculty of Engineering, McGill University, Montreal, Que., from whom further information is available.

UNIVERSITY OF WINDSOR has the following academic vacancies available from September, 1963: Three Assistant or Associate Professors for teaching in undergraduate, graduate courses and research in Soil Mechanics, Foundation Engineering and Transportation Engineering; in Advanced Hydraulics and Hydrology; in Engineering Mechanics, Graphic statics and Mechanics of Materials. Prefer men with a Ph.D. degree or working toward it. Salary open, dependent upon education and experience. Apply to Dr. H. P. Herbich, Head of Civil Engineering Department, Assumption University of Windsor, Windsor, Ontario.

CIVIL OR MECHANICAL ENGINEERING —With specialization in Fluid Mechanics. Successful applicant expected to take part in developing curriculum and plant for new degree program, with particular responsibility for hydraulics laboratory planning. Master degree minimum requirement; Ph.D. preferred. Rank dependent on qualification. Write Jack Bordan, Chairman, Department of Engineering, Sir George Williams University, Montreal 25, Quebec.

McGILL UNIVERSITY, Montreal. A permanent teaching and research appointment is available in the Department of Civil Engineering and Applied Mechanics for a candidate with interests in traffic and transportation engineering. Teaching load will be moderate and the Civil Engineering Laboratories will be available for research. The candidate will also have opportunity of cooperative work with the Centre for Systems Research and the Computing Centre. Required qualifications are Ph.D. or equivalent research experience. Initial appointment as Assistant Professor, September 1963. Enquiries to Professor J. O. McCutcheon, Chairman, Department of Civil Engineering and Applied Mechanics.

McGILL UNIVERSITY, Montreal. A permanent teaching and research appointment is available in the Department of Civil Engineering and Applied Mechanics for a man with interests in the broad field of engineering hydrology. Required qualifications are Ph.D. or equivalent research experience. Extensive Soils and Fluids Laboratories are available for independent research. Teaching load is moderate. Initial appointment as Assistant Professor. Enquiries to Professor J. O. McCutcheon, Chairman, Department of Civil Engineering and Applied Mechanics.

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NOTICE TO ADVERTISERS

DEADLINE — Please note that requests for insertions must be submitted in writing not later than the **15th of the preceding month.** Cancellations: same as above.

SITUATIONS VACANT — Classified rate: $6 per column-half-inch per insertion. Display rates: Per insertion — 1/12 page — $100; 1/8 page — $120; 1/6 page — $195; 1/4 page — $215; 1/3 page — $285; 1/2 page — $345.

DATE IN CIRCULATION — 20th of month.

SITUATIONS WANTED — Accepted free of charge from Members of The Engineering Institute of Canada only.

(Continued from page 89)

position of Branch Secretary-Treasurer. An informal discussion was held during which members were able to present suggestions for future meetings. A film of a football game and one which dealt with bridge construction were shown.

QUEEN'S UNIVERSITY
Harold Briggs

Recent activities of the Branch included a talk by Dr. D. C. MacPhail, Director of the Division of Mechanical Engineering, National Research Council, Ottawa, and a talk given by J. S. Waddington, Regional Vice-President. Dr. Robert Leggett, Director of Building Research, National Research Council, presented a talk on his recent trip to Czechoslovakia. He described engineering as it is practised in that country today. Technical and scientific films for all Queen's engineers are presented weekly. Recent films include: "Atomic Energy in Canada"; "NPD — Nuclear Power Demonstration"; "Futures in Steel"; and "The Mechanical Man".

UNIVERSITY OF SHERBROOKE
Claude Desrosiers

The October 15 meeting of the Branch was held for the purpose of establishing the program for the third Science Week held at the University November 19-23. The aims of the Week were: to make the engineering profession better known to the public; to establish better relations between engineers and scientists; to create meetings between engineers and other students; to show scientists the importance of the engineers' role in society; to realize the effect of scientific progress on our way of life. The ultimate aim is to establish, under the control of the Institute, a national Science Week throughout Canadian universities.

During the week interviews were held on the local radio and television stations. President Lawton visited the University November 22, and toured laboratories where experiments were being conducted. The Science Week was very successful and was given coverage in Sherbrooke's French and English daily newspapers.

UNIVERSITY OF WATERLOO
W. N. Meikle

One of the series of noon hour talks by prominent engineers was given February 6 when H. B. White, Power Transmission Engineer, Aluminum Company of Canada, spoke on "The Revolution in Transmission Line Design". In his talk, Mr. White pointed out that in the past 15 years, transmission towers have undergone a change from great free-standing structures requiring vast amounts of on-site labor, to light guyed structures capable of being assembled in a yard and transported.

UNIVERSITY OF WESTERN ONTARIO
David J. Fader

On November 27, N. E. Field, Assistant Area Engineer, Canadian National Railways, London, gave a lecture on "Railway Signalling". After describing some historical methods of signalling, Mr. Field explained the basic principles of modern signal circuits. His talk was illustrated with models of block signal and crossing protection circuits constructed of prototype relays, and model railroad equipment. A lively discussion period followed.

On January 15, A. F. Walden of the Proctor and Gamble Company gave a talk to the Branch and the Student Branch of the Chemical Institute of Canada. Mr. Walden spoke about the problems involved in the esterification of fats and oils into a suitable product for use in the making of margarine.

At the afternoon meeting of the Branch on January 29, technical films were shown and the 1963 executive was elected. William Dukelow is Chairman, J. Dexter Lindsay, Vice-Chairman and Gerald Mowbray is Secretary.

VANCOUVER
L. B. Davies

On January 29 the Branch with the local A.P.E. branch, held a meeting at which L. B. Lucas, M.E.I.C., of the Canada Department of Fisheries, Vancouver, was guest speaker. Mr. Lucas attended the symposium on cavitation and hydraulic machinery sponsored by the International Association for Hydraulic Research held in Sendai, Japan, from September 2-8, 1962. At the symposium, he presented a paper entitled, "Fish Mortality and Turbine Characteristics". At this meeting, using color slides taken during his trip, Mr. Lucas presented a very entertaining and informative talk entitled, "New Japan". In this talk, he described Japan's heavy industry and industrial research which he observed at several large manufacturing companies and laboratories. He discussed too, the fishing installations which he saw in visits to the northern part of Japan. The people, architecture and scenery of Japan were also covered in Mr. Lucas' talk.

VANCOUVER ISLAND
J. Devlin

The first 1963 joint technical meeting of the Branch with the A.P.E.B.C. was held January 16. The members heard a very interesting and informative talk on "Minerals and Metals of B.C." by Dr. Hartley Sargeant, Chief, Mineralogical Branch, Department of Mines and Petroleum Resources for Brtish Columbia. Dr. Sargeant traced the upward trend in value of the produced mineral wealth of B.C. from early times when gold was the predominant factor, to the present day where the greatly increased number of individual minerals has brought the annual production value to impressive levels.

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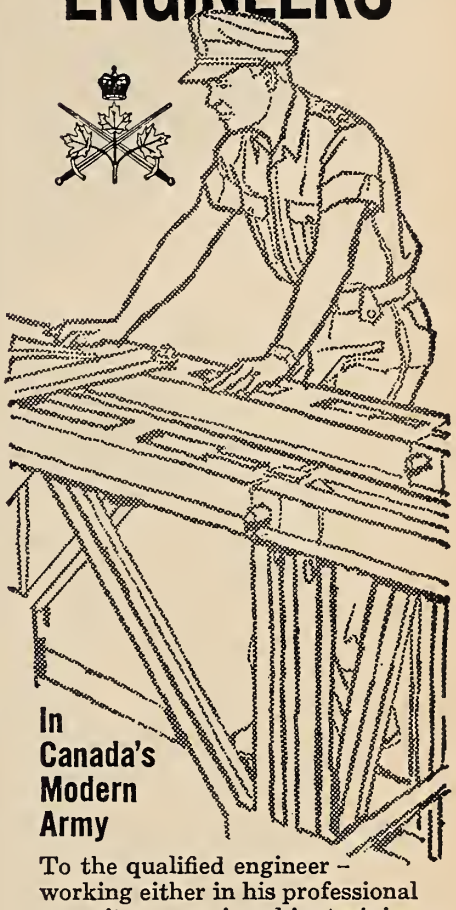

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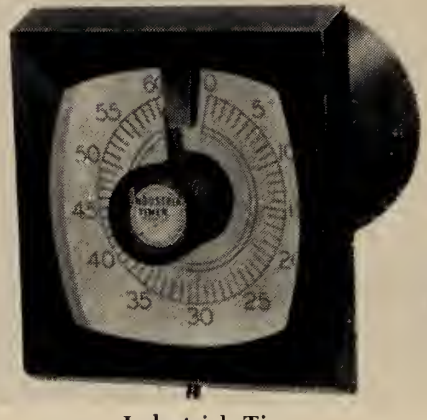
Engineering Briefs

THE MINEMASTER, a downhole drilling rig for heavy-duty underground use, has been introduced by Canadian Ingersoll-Rand Co. Limited. The downhole drill, by travelling down with the bit, delivers full striking impact at any depth without power loss. The drilling rig, designed and built exclusively for mining, is small enough to load on a 2½ x 3½ x 10 ft. skip, and weighs only 3800 lb. The tower, of heavy-section welded steel construction, is hydraulically adjusted for drilling in any position from vertical to horizontal and tilts up to 15 degrees on either side. All controls are conveniently centrallized for easy operation. Foot pedal control for hydraulic pump requires simultaneous foot and throttle operation. The Minemaster is recommended for drilling 4¾, 5, 6 and 6½ in. holes to 200 ft. in depth and 25 ft. or more horizontally.

The Minemaster

SPEC AND MASTERS Wire and Cable Pulling lubricants, manufactured by the G. F. Thompson Company Limited and distributed by Northern Electric Co. Ltd., are both CSA approved and can be applied to all present-day cable sheaths or coverings, ducts and conduit materials. SPEC is the standard grade formula for use on materials such as fibrous (asbestos, cotton, rayon), Neoprene, Hypalon, P.V.C. (polyvinyl chloride) aluminum, lead copper and zinc-coated steel. MASTERS is the heavy duty grading with the added feature that it can be applied to wire and cable being pulled in temperatures of 15 degrees F.

A HALF INCH PHOTOCONDUCTIVE CELL which responds to considerably lower light levels than previous units, has been announced by Canadian General Electric. At a low light level of two foot-candles illumination, the cell resistance is 1000 ohms, a level which previously required 25 foot-candles illumination. The new cell's maximum current-earrying capacity is 20 milliamperes. Peak spectral response is 6100 angstroms. The new unit, an end-illuminated cadmium sulfide cell, Type B46, is hermetically sealed against deterioration by moisture.

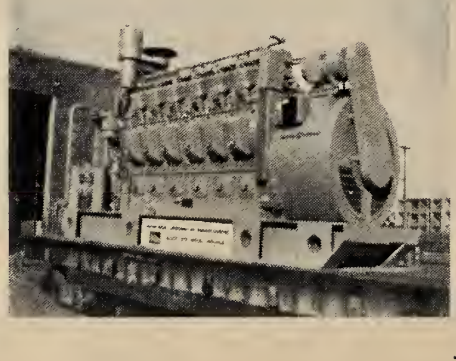


Industrial Timer

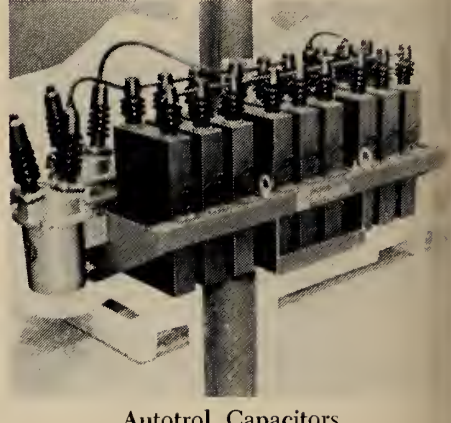
SPERRY GYROSCOPE Ottawa Limited has introduced a glass face time delay timer in a new housing for commercial and industrial use. This synchronous motor driven Series GTD timer with instant automatic reset is available in 12 standard models giving time intervals of from 1/20 sec. to 3 hours. Time cycles of from 1/60 sec. to over 60 hours are also available. The timers feature simplified mounting. This series lends itself to timing applications where load rating is 15 amps, and instant reset, high repeat accuracy, and a wide range of adjustment and appearance are impor-

MONTREAL LOCOMOTIVE works MLW-ALCO Model 251 Diesel Engine which ranges from approximately 500 KW for the 50 cycle type to 1750 KW for the 60 cycle engine, can be operated anywhere on land or sea. Weight of the sets available vary from 2250 lb. for the Vee-6 model, to approximately 42,000 lb. for the Vee-16. The 251 engine can be skid mounted. One of the features of this diesel engine is the flange mounting of the alternator which eliminates the danger of misalignment when the set is being transported to the site, or when being located.

MLW-ALCO Model 251 Diesel Engine



THE REDESIGNED ALPHA "design 12", a centrifugal industrial exhaust fan with radial blades, is available from Alpha Products Division of Joy Manufacturing Company (Canada) Ltd., Galt, Ont. The fan, for dust removal, materials conveying, fume exhaust and long shaving exhaust applications, is available in three versions. The 12K has a material handling wheel design for dust or chips. The 12M rim-type wheel design is for relatively clean air, and the 12W wool wheel was designed for stringy materials. The fans are available in mild steel or stainless steel from 7 in. to 104 in. wheel diameters.

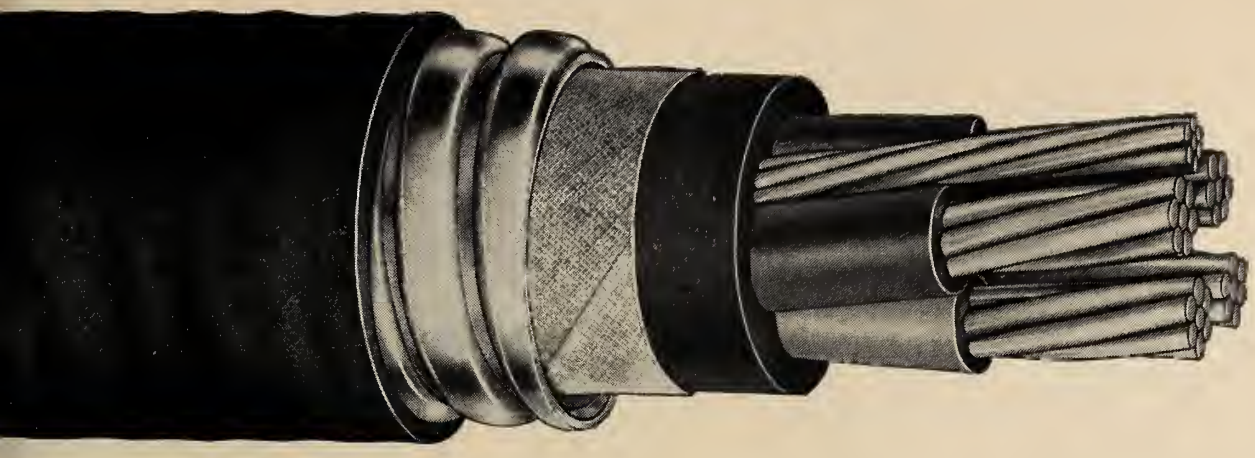


Autotrol Capacitors

AUTOTROL CAPACITORS, a factory-assembled package designed for pole mounting contains a sturdy structural aluminum frame which supports the required number of outdoor weather-proof capacitor units, three single phase electrically-operated oil switches, and a junction box containing a terminal block to terminate the three switch control leads as well as incoming power and control circuits. This unit, introduced by Canadian Westinghouse, is available in ratings up to 1200 KVAR, 2400 to 13,800 volts, 3 phase, 60 cycles.

Developments

Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.



TECK is for the TOUGH jobs in industrial power distribution

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MPACITY

or use up to 5 kv, Teck cables meet SA requirements for RW60 and 75; or for RW75 and R90. Can be erated at up to 90C in dry locations, C in wet locations.

Above 5 kv the insulation meets CEA specification S-19-81 for ozone-sistant butyl insulation. Can be erated at up to 85C.

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ll conductors are stranded coated pper, with conductor identification either surface colouring or col-red tapes.

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ter jackets in either Neoprene or C withstand severe corrosive con-ions. Both compounds are specially rtified by CSA for this purpose.

The standard inner jacket is Nor-ene, a substance immune to high centrations of ozone. It is flame, isture and impact resistant. Since rprene is not a thermoplastic, idental exposure to high temper-ures below its ignition point will t cause it to flow or melt.

An optional Butyl inner jacket is ilable for use where maximum at and moisture resistance are sired.

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Flexible interlocked armour is normally provided in either aluminum or galvanized steel. Copper interlocked armour can be provided when requested for special applications.

SPLICING & TERMINATING

A full range of terminating and splicing fittings is available from Northern Electric. For splicing and terminating practices on the jacketed core of Teck Cable, refer to Northern Electric Engineering Instruction No. 2001—"Splicing and Termination of Norzone-Norprene Cables".

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Northern Electric makes available a full range of prefabricated cable troughs and supporting rack elements, in materials, finishes, sizes and accessories to meet various needs.

full information, please refer to your nearest rthern Electric Office and request Bulletin G17-A.

3-5

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Discussion

(Continued from page 62)

squeal, already referred to by Dr. Northwood. The ground-borne noise, however, can be significant and troublesome. We have measured in a few buildings adjacent to the Yonge Street subway an increase in noise level of 20 decibels when a train passes, and this is a justifiable cause for complaint by the residents. Dr. Northwood has pointed out that this source of noise is dependent on the maintenance of the rolling-stock. Our observations indicate this is associated with the mechanical braking system used on the present TTC cars and is due to irregularities in the wheel surfaces. This is produced in two ways:— occasionally, in the open-cut section in wet conditions, the mechanical brakes can lock a wheel and thus cause it to slide along the rail. This can generate flats, ½ in. to 3 in. in length, across the periphery of the wheel. A more frequent cause of irregularity is due to non-uniform pressure of the brake shoe against the tread of the wheel. The non-uniformity of the pressure arises from the holes in the composition lining which facilitate the riveting of it to the shoe. Along the line of the rivet holes excessive temperatures develop which cause the surface of the wheel tread to melt. The molten metal is carried off and deposited on other parts of the wheel. The deposited metal often builds up in the form of a ridge of the order ⅛ in. high.

Recently we have measured, in the Yonge Street subway, a 20-decibel improvement in the transmitted noise as compared to that generated by the rolling stock a year ago. This apparently is a reflection of improved maintenance and of the fact that the TTC now has six trains fitted with regenerative braking which should greatly reduce the possibility of producing out of roundness of wheels.

The ground transmitted noise can be substantially reduced by mounting the rails on elastic members. The following table shows the performance of various types of rail pads which have been evaluated in controlled tests on the Yonge Street subway.

Type of Pad	Reduction in Transmitted Noise, decibels
Steel	0 (reference)
Lead-Asbestos pad	1
Neoprene Pads	
½ in. 68 Durometer (tightly clamped)	14
½ in. 68 Durometer (unclamped)	17
½ in. 45 Durometer (tightly clamped)	21
½ in. 45 Durometer (unclamped)	24
1 in. 45 Durometer (unclamped)	24

This result shows that the lead-asbestos, as would be predicted, is virtually useless in reducing ground-transmitted vibration. Neoprene pads are very effective although it did appear, with the condition of the rolling stock a year ago, that it would be impractical to get sufficient reduction by the use of neoprene pads.

Finally, I would like to draw on our experience with an analogous problem to make a more general comment regarding ground-borne vibration. Our organization has been concerned with the transmission of vibrations from substation power transformers through the ground to adjacent buildings. Early attempts to solve the problem followed the usual simple procedure of choosing mounting elements whose stiffness, in combination with the transformer mass, would indicate a suitable resonance frequency well below the disturbing frequency. Design charts for this purpose are available from any manufacturer of vibration-isolating devices or materials. But the elastic properties of the mountings so chosen were very like those of the underlying soil, and the mountings therefore made no significant change.

The point to be noted here is the necessity of considering the whole transmission path. To be effective a vibration-isolating pad or mounting must introduce a substantial discontinuity between the disturbing body and the adjacent structure or medium. If the adjacent material is soil, or even concrete or rock, the use of relatively stiff materials such as layers of cork, lead or asbestos board may not be very helpful.

At the outset I should like to compliment Dr. Northwood on his most interesting and informative paper. To the laymen, the field of acoustics and even its special vocabulary are apt to be confusing; a situation which stems largely from the difficulty of measuring and describing noise phenomena in a meaningful manner. Dr. Northwood has managed to cover a rather complex acoustic problem in a clearly understandable manner while employing a minimum of acoustic terminology. In this respect I was intrigued by his criteria for the desirable noise level in a subway car.

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Discussion

For the benefit of those who may not be familiar with the "noise criterion" curves shown in several of Dr. Northwood's figures, the following comments may be of interest. These curves are based on the degree to which a background noise will interfere with speech communication. The "NC" numbers attached to these curves represent the average sound level in that portion of the frequency spectrum which is most important from the point of view of speech intelligibility. For background noise approximating any particular NC curve it is possible to specify quite precisely how the ease of voice communication will vary with distance. It is also possible to use these curves as criteria for noise control in rooms and enclosures of various kinds. For example the NC-55 curve is considered to be the maximum permissible level for secretarial offices with typing. The sleeping areas of a dwelling should have a level below NC-25.

As a matter of interest I have compared some of Dr. Northwood's graphs with measurements which we have taken under various conditions. Some readings which we obtained of the ambient noise level on a street in downtown Montreal, but without moving vehicles near the microphone, correspond almost exactly with the NC-55 curve mentioned above. Another set of readings, taken in an enclosed railway station in the absence of moving trains, compared more closely with Dr. Northwood's curve for a modern railway coach and would correspond approximately to NC-45. The U.S. Air Force "Handbook of Acoustic Noise Control" also presents some data relevant to the present discussion — sound levels for a moving subway train at 50 ft. distance from the microphone. This is found to lie close to the NC-75 curve. It would be of interest to know how this compares with the TTC Yonge St. line.

The application of absorption treatment to the walls of the subway tunnel is a novel concept. I should like to know the source of the experimental data presented on this method. There are economic aspects to this problem — whether to treat the tunnel or the cars to obtain a specified noise reduction inside the train. I would also be interested to know whether treatment of the tunnel has any beneficial effects with respect to noise transmission to adjacent buildings. It appears that there is considerable room for further study in this area.

I suspect that many readers may wish to pursue this subject in greater depth. In this connection I should like to ask Dr. Northwood if he could suggest any references which might be a suitable starting point for further study.

Author's Reply

I thank Mr. A. T. Edwards and Dr. J. Billington for their illuminating discussions, which help to fill in a few areas where my paper was unduly brief. Perhaps the major omission was documentation; I append a list of references that elaborate on the various topics sketched in the paper. Reference 2, in particular, is a thorough review of the whole subject. The experimental data on subway noise are extracted from our studies on the Toronto system.

Both discussors have amplified usefully my discussion of the Noise Criteria (NC) Curves; these are discussed in further detail in Reference 1. Perhaps it might be added that although the NC curves are used in many applications they were developed specifically for office communication problems. The oppressively quiet office described by Mr. Edwards probably corresponds to about NC-30; a noise spectrum corresponding to NC-40 or 45 would provide some protection from other people's noise without interfering with normal short-range conversation. Regarding Mr. Edwards' doubt as to the suitability of NC-65 for subway trains, I would emphasize that this was proposed as an upper limit for the highly fluctuating sound characteristic of subway service. Communication, albeit in a raised voice, is still possible at 3 ft., but I agree that NC-65 would be too high for sustained noise.

Both discussors express surprise at the use of the absorption treatment in the tunnel and query the alternative of treating the interiors of the cars themselves. Other things being equal, the latter course would obviously be cheaper, since all the treatment would be concentrated near the noisy locations. Things are not equal, however. The tunnel may be regarded as a peripheral duct (around the train), with absorption treatment applied at the right-angle bends near the source. Absorption treatment in this ideal position may be expected to yield an attenuation of 10 to 15 db immediately opposite the wheels, and somewhat more in the space between wheels. To achieve an equivalent effect simply by treatment inside the car would require a thirty-fold increase in interior absorption, which is impossible.

The measures mentioned by Mr. Edwards for improving the sound insulation of the car body are useful and important. In a noise problem of this severity it is necessary to take all reasonable control measures to achieve an adequate over-all reduction. Aerodynamic noise, about which he inquires, is of negligible importance, compared to rail noise.

The tunnel absorption treatment is not relevant to the problem of noise transmission to adjacent buildings since air-borne sound is disposed of by the intervening layers of concrete and soil. Ground- or structure-borne vibration is the major source of trouble beyond the confines of the subway system. I cannot usefully add to Mr. Edwards' comments in this regard, which I commend to Dr. Billington.

REFERENCES

1. **Criteria for office quieting based on questionnaire rating studies,** L. L. Beranek, J. Acoust. Soc. Am. 28, 833 (1956).

2. Noise in rail transportation, W. A. Jack, Chapter 32 of **Handbook of Noise Control,** Ed. Cyril M. Harris, McGraw-Hill, 1957.

3. **Noise control in Toronto's new subway,** W. A. Paterson and T. D. Northwood, **Noise Control 2(5),** 28 (September 1956).

4. **Silencing London's tubes,** John S. Trevor, Bull. Int. Railway Congress Assoc., p. 475, May 1939.

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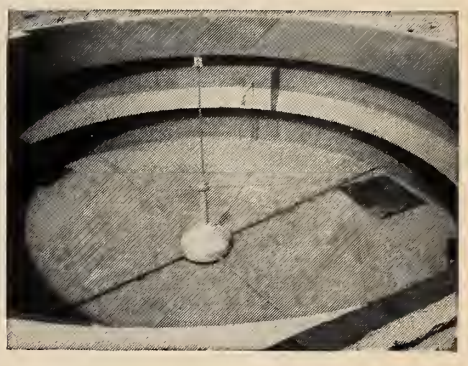

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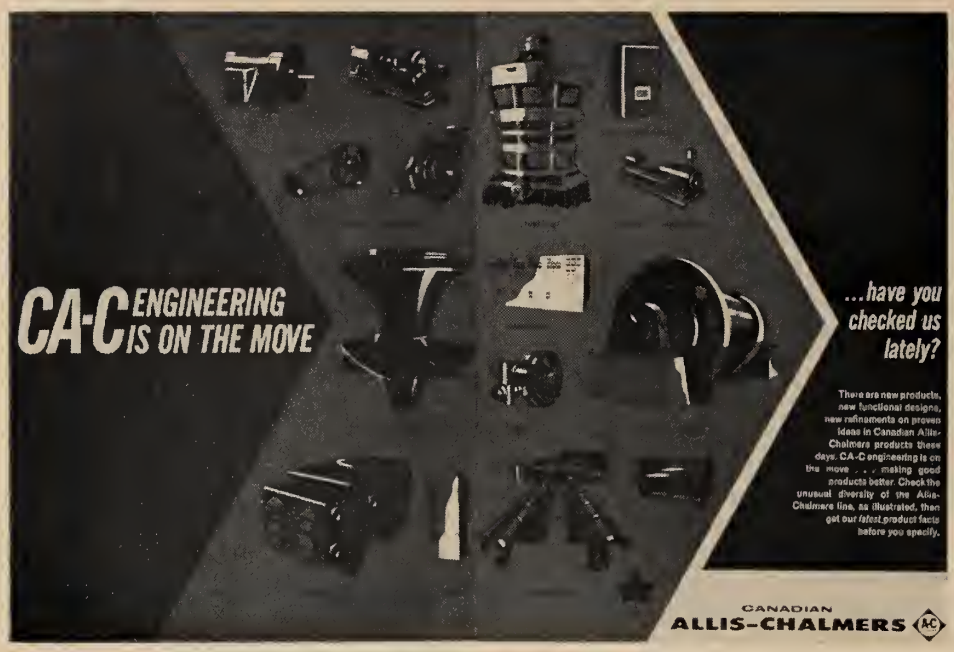

A striking black-and-orange double-page spread showing the reader that "CA-C ENGINEERING IS ON THE MOVE" was the winner of the monthly award for the best advertisement in the December, 1962 issue of the Engineering Journal.

A broad orange wedge-shaped panel between two panels of black shows ". . . new products, new functional designs, new refinements on proven ideas in Canadian Allis-Chalmers products these days . . ."

Advertising Manager for Canadian Allis-Chalmers is A. C. Hincks. The ad was placed by the Montreal office of the Industrial Advertising Agency Limited, George Temple, Account Executive.

Each month a different panel of 50 Journal readers from across Canada selects the award-winning advertisement of their choice from the viewpoints of ACCURACY — INFORMATION — ATTRACTION.

Personals

(Continued from page 72)

E. L. Rogers, M.E.I.C.

R. M. Wood, M.E.I.C.

Edward Lee Rogers, M.E.I.C. (Alberta '53) has been appointed Supervisor of Quality Control at the Toronto plant of Bourns (Canada) Ltd. For the past nine years, Mr. Rogers worked in the Quality Control Department of Canadian Westinghouse Company Ltd. in Hamilton where he rose to the position of Senior Quality Assurance Engineer, Airborne Equipment. In his new position, he will be responsible for the administration and supervision of all quality control and reliability procedures affecting parts procurement and receiving, manufacturing and final product inspection.

R. M. Wood, M.E.I.C. (Queen's '53), former Sales Engineer with Babcock-Wilcox and Goldie-McCulloch Limited, has been appointed Manager of the Central Branch and will be located at the company's Toronto office.

Albert M. Martin has been appointed a director of the Bowater Corporation of North America Ltd., Montreal. Mr. Martin is president of Bowater's Newfoundland Pulp and Paper Mills Ltd., Corner Brook, and of Bowater's Mersey Paper Company Ltd., Liverpool, N.S.

Allan T. Sherrett, M.E.I.C. (Manitoba '49) has been appointed manager of the Port Arthur office of the consulting engineering firm of Gibb, Underwood & McLellan. Mr. Sherrett has been employed as Senior Engineer by Underwood, McLellan & Associates, in charge of coordination and design of National Defence projects. Mr. Sherrett will be responsible for the engineering for projects such as Port Arthur's new civic arena, and a new trunk sewer currently being designed by the company.

Claude Donaldson, M.E.I.C. (Ecole Poly '56) has been named director of technical services for the town of Fabreville, Que. Mr. Donaldson has been employed by the consulting firm of Desjardins & Sauriol of Chomedy, Que.

A. B. Danard

L. B. King

A. B. Danard, formerly Manager of the Central Branch of Babcock-Wilcox and Goldie-McCulloch Limited, has been appointed Sales Manager Special Products and has moved from Toronto to the company's head office in Galt.

L. B. King has been appointed President and a director of Caterpillar of Canada Ltd., Toronto. Mr. King has been the Employee Relations manager of Caterpillar's Peoria, Ill. plant since 1957. Mr. King joined the company in 1941.

John W. Wallace, M.E.I.C.

F. G. Murphy, M.E.I.C.

John W. Wallaee, M.E.I.C. (McGill '49) has been appointed Vice-President and General Manager of George F. Pettinos (Canada) Limited, Hamilton and Montreal. Formerly Superintendent of Foundries at Canadian Westinghouse Company Limited, Mr. Wallace brings with him a solid background in foundry operations.

F. G. Murphy, M.E.I.C. (Toronto '40) has been appointed General Works Manager at Union Carbide Canada Limited, Linde Gas Division. Mr. Murphy will be responsible for all production and distribution of all Linde gas, electric and distributor products.

D. A. Larmour, M.E.I.C. (Sask. '45) has been appointed Deputy Minister of the Department of Public Works of Saskatchewan. Mr. Larmour was formerly chief engineer of the Department of Highways & Transport. He joined the Department of Highways as resident engineer in 1945 and since has served as assistant construction engineer, supervising engineer, and since 1954 as chief engineer.

Robert L. Hicks, M.E.I.C. (Toronto '45) has been named President of the Ontario Association of Professional Engineers for 1963. Mr. Hicks, who was first vice-president during 1962, is assistant to the engineer of distribution planning and design at Toronto Hydro-Electric System.

(Continued on page 102)

10
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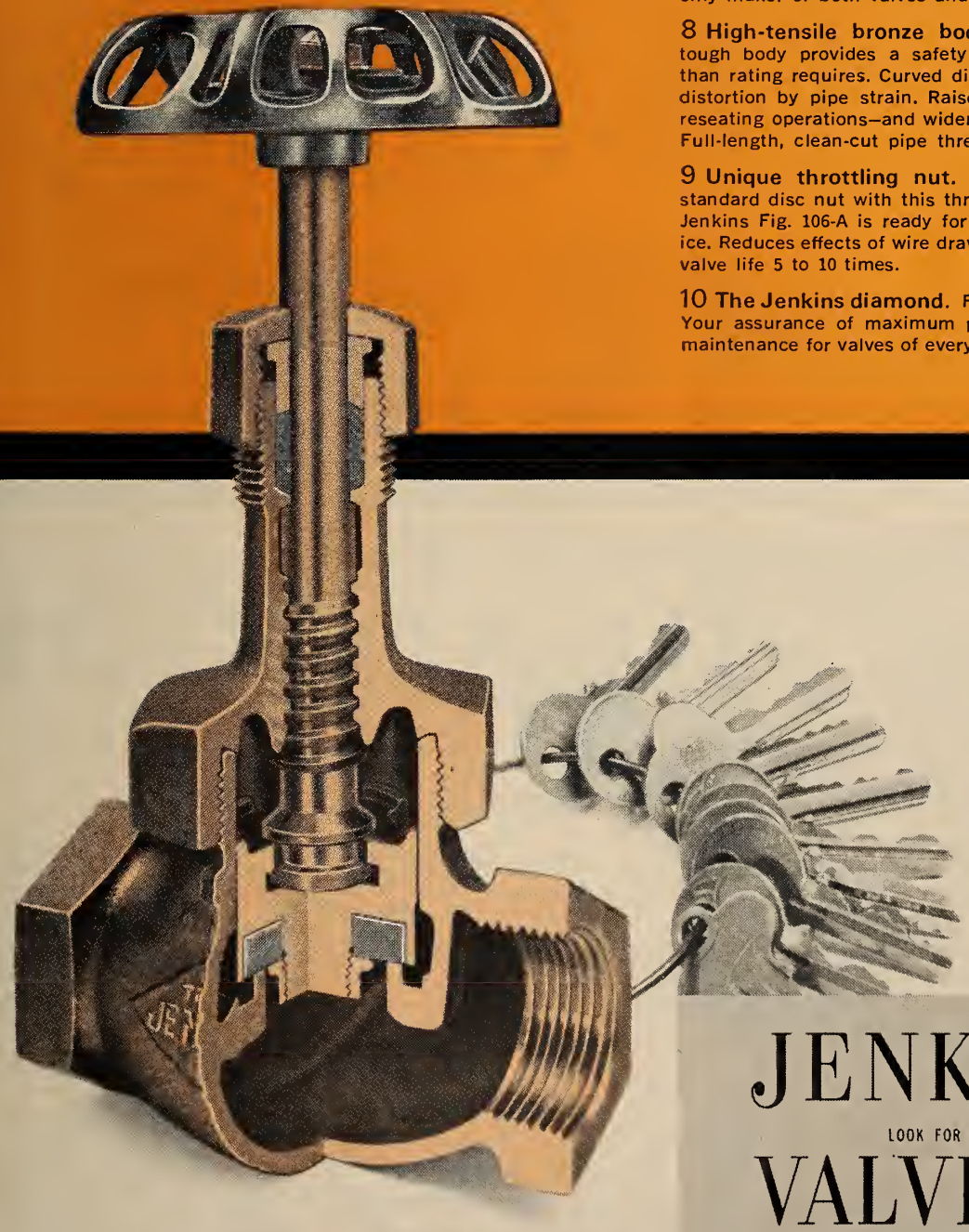

1 Easy-to-handle wheel. Tough malleable iron. Unmatched design for cool, sure grip.

2 Silicon bronze spindle. Heavier, more deeply cut threads engage bonnet securely. Crowned head reduces friction on disc holder. Costs more to produce, but reduces wear, preserves packing, and is easier to operate.

3 Sturdy packing nut and gland. See the heavy, deep bronze hex. Bronze gland compresses packing toward spindle.

4 Deep Packing Box. More packing space means less repacking. Depth equals 1½ times spindle diameter. An asbestos, lubricated and graphited packing is used.

5 One-piece bonnet. Screw-over design with big hex surfaces. Easy to remove. Notice how the bevel joint between bonnet and body serves as internal brace against crushing effect of bonnet assembly. Unique design resists distortion and springing.

6 Slip-on, Stay-on disc holder. A Jenkins original! Correct protective depth prevents flaking or cracking of disc.

7 Disc easily renewable... without removing valve from line. Regularly supplied with 119A disc. Other compositions available for various services...and made by Jenkins, the only maker of both valves and discs.

8 High-tensile bronze body. Wall thickness of this tough body provides a safety factor many times higher than rating requires. Curved diaphragm protects seat from distortion by pipe strain. Raised seat is higher—for more reseating operations—and wider, to avoid cutting into disc. Full-length, clean-cut pipe threads.

9 Unique throttling nut. Simply replace standard disc nut with this throttling nut, and Jenkins Fig. 106-A is ready for throttling service. Reduces effects of wire drawing, increasing valve life 5 to 10 times.

10 The Jenkins diamond. Famous symbol of quality. Your assurance of maximum performance with minimum maintenance for valves of every type and for every purpose.

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Personals

(Continued from page 100)

G. W. Downie, M.E.I.C.

H. Fellhauer

G. W. Downie, M.E.I.C. (Alberta '46) has been appointed Assistant Superintendent of the Warfield Department, Chemicals and Fertilizers Division of The Consolidated Mining and Smelting Company. Mr. Downie joined the company in 1946 and since then has held a number of supervisory posts in maintenance and production operations. Since 1960 he has been Superintendent of the Ammonia Plants.

H. Fellhauer has joined the company of Ingledow, Kidd & Associates Limited in Vancouver as Senior Hydroelectric Design Engineer. Mr. Fellhauer has had design responsibility for many of the hydroelectric developments in British Columbia, including Mission Dam of the Bridge River Development, the Cheakamus project, the Seton project and the Clowhom development. Recently he has supervised design work on the Portage Mountain Dam of the Peace River Development.

Paul E. Carrier, M.E.I.C. (Ecole Poly. '49) has been appointed a sales representative of The Borden Chemical Company (Canada) Ltd. Mr. Carrier will be responsible for sales of the company's complete building products line in Greater Montreal.

S. Frost, M.E.I.C.

Stewart Frost, M.E.I.C. (McGill '50) has been appointed regional engineer, Canadian Institute of Steel Construction for provinces of Alberta, Saskatchewan and Manitoba. Before joining CISC, Mr. Frost served with Adjaleian & Associates, Consulting Engineers, Ottawa, specializing in the structural design of buildings. Prior to that, he worked for six years with the National Research Council of Canada on the development of the National Building Code of Canada.

C. H. Rosier, M.E.I.C. (N.S.T.C. '39) has been named Vice-President (Research and Development Board Products) at Abitibi Power & Paper Company, Limited. Mr. Rosier joined Abitibi in 1959 as Vice-President and General Manager, Abitibi Corporation, Alpena, Mich. In 1961, he became Vice-President (Board Products) of the parent company in his new appointment, he will also be responsible for Abitibi's research and development program.

Raymond V. Beck, M.E.I.C. (N.S.T.C. '46) has been appointed port engineer for Halifax. Mr. Beck, assistant port engineer since 1952, has been with the National Harbours Board in Halifax since 1946.

B. M. Brown has been appointed general factory manager of Massey-Ferguson Limited's North American tractor assembly plant in Detroit. Mr. Brown was formerly assistant comptroller responsible for all factory accounting functions in Massey-Ferguson's United States and Canadian plants.

Fraser H. Fargey, M.E.I.C. (Manitoba '34) has been named manager of the Eastern District of DeLaval Turbine Canada Ltd. Mr. Fargey, who will be located at the new offices in Montreal, has had more than 20 years' experience in the Canadian industrial field.

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MODERNE SYSTEM THEORIE, G. Wunseh, Geest & Portig, Leipzig, DM 25:50.

MODERN PETROLEUM TECHNOLOGY, THIRD EDITION, The Institute of Petroleum London, 2.10 G.

LINEAR ELECTRIC CIRCUITS, Z. Hennyey, Addison-Wesley, Reading, Mass., $14.

LABORATORY ORGANIZATION AND ADMINISTRATION, K. Guy, St. Martin's Press, N.Y., $12.

LEGAL ASPECTS OF ENGINEERING, R. C. Vaughn, Prentice-Hall, N.J., $10.60.

MAGNETO-GAS DYNAMICS AND PLASMA-DYNAMICS, Shih-I-Pai, Prentice-Hall, N.J., $14.

MAGNETISM AND MAGNETIC MATERIALS, Proceedings of the 7th Conferenee, Editor, J. A. Osborn, Plenum, N.Y., $14.

LOUIS SULLIVAN: PROPHET OF MODERN ARCHITECTURE, H. Morrison, W. W. Norton, N.Y., $2.50.

MATHEMATIQUES ET STATISTIQUES POUR LES ECONOMISTES, TOME I, METHODES ELEMENTAIRES, Dunod, Paris, 58 NF.

MATHEMATICS FOR THE PHYSICAL SCIENCES, H. S. Wilf, Wiley, N.Y., $7.95.

MATHEMATICS AND INDUSTRY, J. Crank, Oxford University Press, Toronto, $2.25.

MARINE STEAM ENGINES & TURBINES, SECOND EDITION, Newnes, London, 50s.

INSTRUMENTATION FOR ENGINEERING MEASUREMENT, R. H. Cerni & L. E. Foster, Wiley, N.Y., $12.50.

INDUSTRIEOFEN UND OLFEUERUNGEN FEUERFESTE BAUSTOFFE, Vulkan-Verlag.

AN INTRODUCTION TO DIMENSIONAL METHOD, E. W. Jupp, Cleaver-Hume Press, London.

INTRODUCTION TO DESIGN, M. Asimow, Prentice-Hall, N.J., $3.95.

HOW TO SOLVE PROBLEMS IN ELECTRICITY AND ELECTRONICS, H. Jacobowitz, Rider, N.Y., $3.50.

INDUSTRIEOFENBAU, J. H. Buinklaus, Vulkan-Verlag-Essen, DM 60.

HYDRAULISCHE PRESSEN UND DRUCKFLUSSIG-KEILSANLAGEN, E. Muller, Springer-Verlag, Berlin, KEISANLAGEN, E. Muller, Springer-Verlag, Berlin, DM 48.

HOW TO READ SCHEMATIC DIAGRAMS, D. E. Herrington, Sams, N.Y., $1.50.

HEATING AND HUMIDIFYING LOAD ANALYSIS, F. W. Hutchison, The Ronald Press, N.Y., $12.50.

HALBLEITERBAUELEMENTE – I, W. Guggenbuhl, M. J. O. Strutt & W. Wunderlin, Birkenhauser-Verlag, Stuttgart.

GUIDE POUR LA PRATIQUE DU CONTROLE DE GESTION, F. Jonio, G. Plaindoux & R. Lelui, Dunod, Paris, 22 NF.

A GUIDE TO IBM 1401 PROGRAMMING, D. D. McCraehen, Wiley, N.Y., $5.75.

ETUDE DE LA LUBRICATION ET CALCUL DES PALIERS – DEUIXIEME EDITION, L. Leloup, Dunod, Paris, 40 NF.

POMPES VENTILATEURS COMPRESSEURS CENTRIFUGES ET AVIAUX, A. de Kovats & G. Desmur, Dunod, Paris, 78 NF.

SPECIFICATIONS FOR VALVE FITTINGS FOR COMPRESSED GAS CYLINDERS – PART I – VALVES WITH TAPER STEMS, British Standards Institute, 12/6.

REFRACTORIES FOR OXYGEN STEELMAKING – SPECIAL REPORT 74, The Iron and Steel Institute, London, 70s.

(Continued on page 107)

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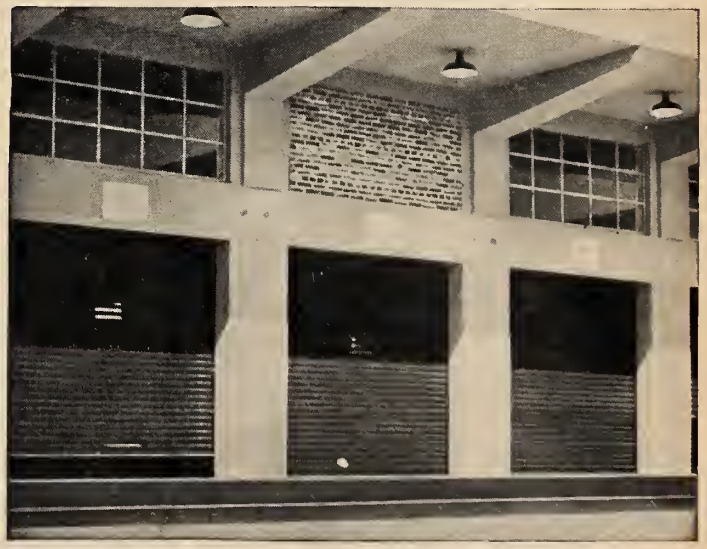

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LECTRIC CIRCUIT ANALOGIES FOR ELASTIC STRUCTURES, R. H. MacNeil, Wiley, N.Y., $11.50.

ULLETIN, POLYTECHNIC INSTITUTE OF JASSY, Jassy, Roumania.

COMMISSION D'ENQUETE DU BARRAGE DE MALPASSET, RAPPORT DEFINITIF—TOMES I-IV, Ministere de L'Agrieulture.

HIGH STRENGH STEELS, SPECIAL REPORT 76, The Iron and Steel Institute, London, 65s.

PRESSURE TREATED TIMBER PILES, Canadian Institute of Timber Construetion, $4.50.

MECHANICS FOR ENGINEERS—STATICS AND DYNAMICS, 2nd EDITION, McGraw-Hill, Toronto, $13.20.

PRESTRESSED CONCRETE DESIGNERS HANDBOOK, P. W. Abeles & F. H. Turner, Concrete Publications Ltd., London, $7.

DIE DYNAMIK EINDIMENSIONALES BODENKORPER IM NICHTLINEAREN, NICHTELASTISCHEN BERLICH, W. Heierli, Buchdruckerei, Zurich.

STATIONARE UND INSTATIONARE STROMANGEN IN DEN LEITUNGEN VON EISENBAHN-DRUCKLUFTBREMSEN, H. Loosli, Leeman, Zurich.

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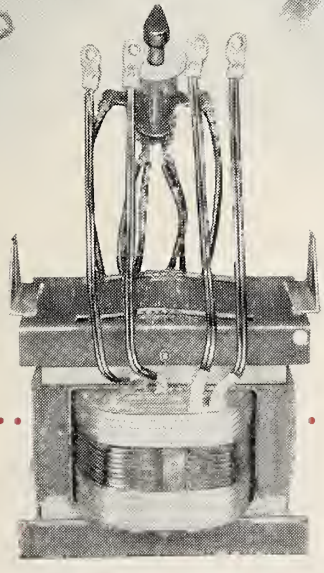

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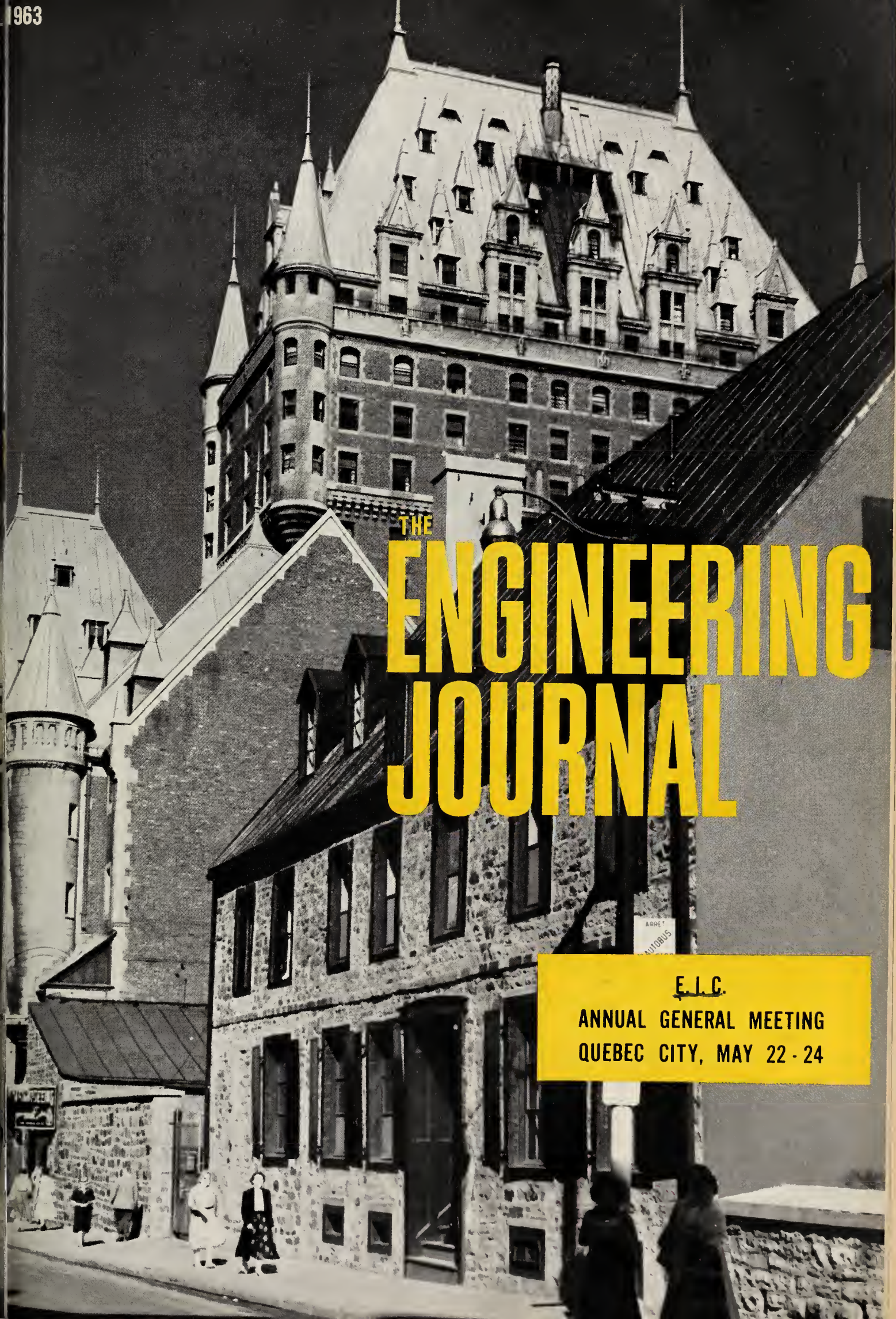
1963



THE ENGINEERING JOURNAL

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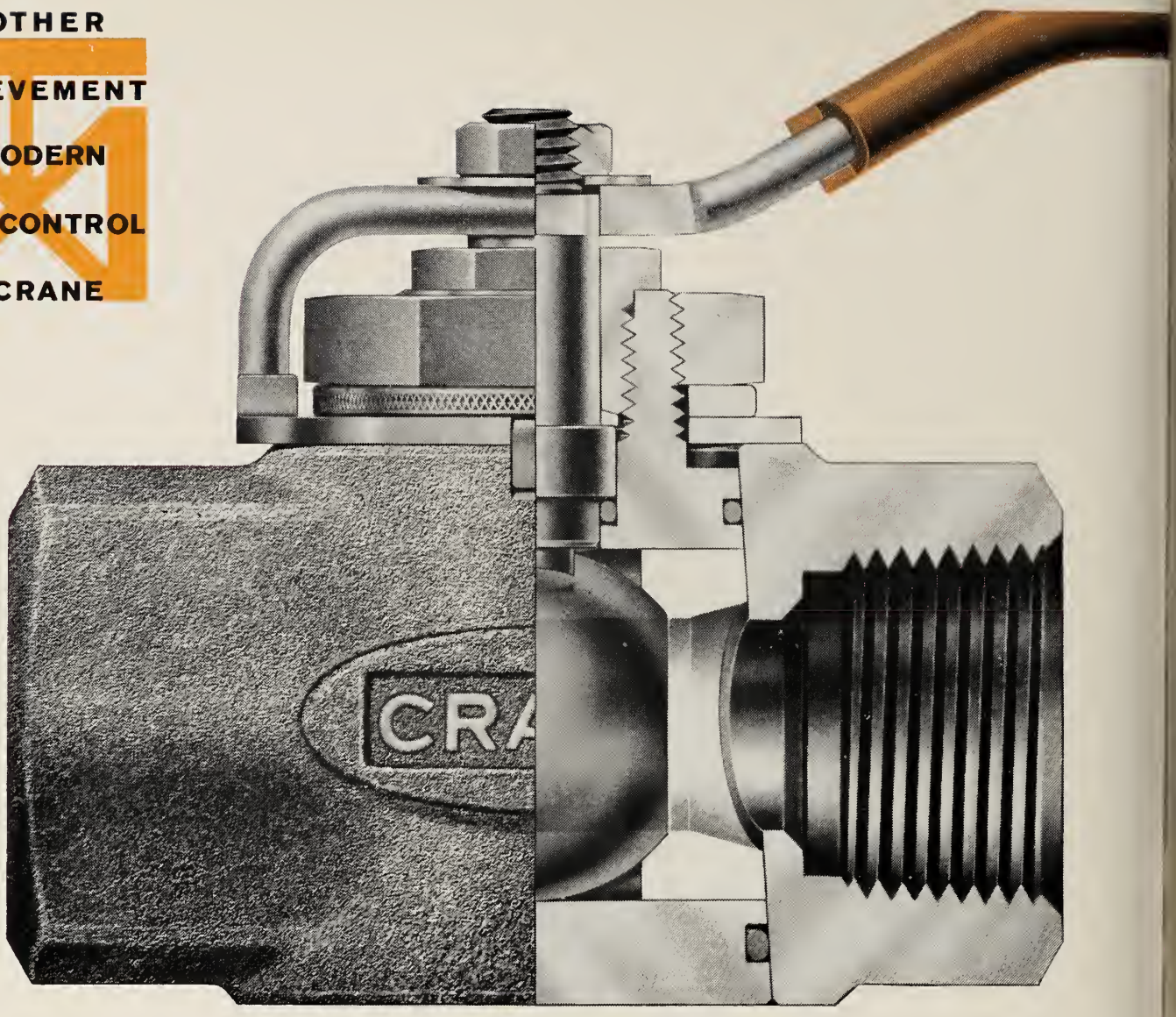
ANNUAL GENERAL MEETING
QUEBEC CITY, MAY 22 - 24

ANOTHER
ACHIEVEMENT
IN MODERN
FLOW CONTROL
BY CRANE



this ball beats all!

CRANE BALL VALVES are engineered for superior flow control and minimum-maintenance operation. The secret of this valve's all-around outstanding performance is its beautifully simple, Crane-designed tapered cartridge containing all the working parts. While the valve body remains in line, acting as a pipe connection, the entire cartridge may be removed from the bottom, quickly and easily, for fast exchange or simple, low-cost maintenance.

Precision pre-loaded Teflon* seats assure bottle-tight closing in either direction with a quick, easy quarter turn of the bright, Crane orange insulated handle. The self-aligning, precision machined ball is polished and chrome-plated to reduce friction and wear on the self-cleaning seats. All steel parts are plated for corrosion resistance. Crane Ball Valves handle fluid, gas and air services from vacuum to 800 psi and temperatures from –40 to 400F. Available now from your Crane Distributor for prompt delivery—sizes from ¼" to 2", screwed ends, in bronze, carbon steel, and Type 316 Stainless.

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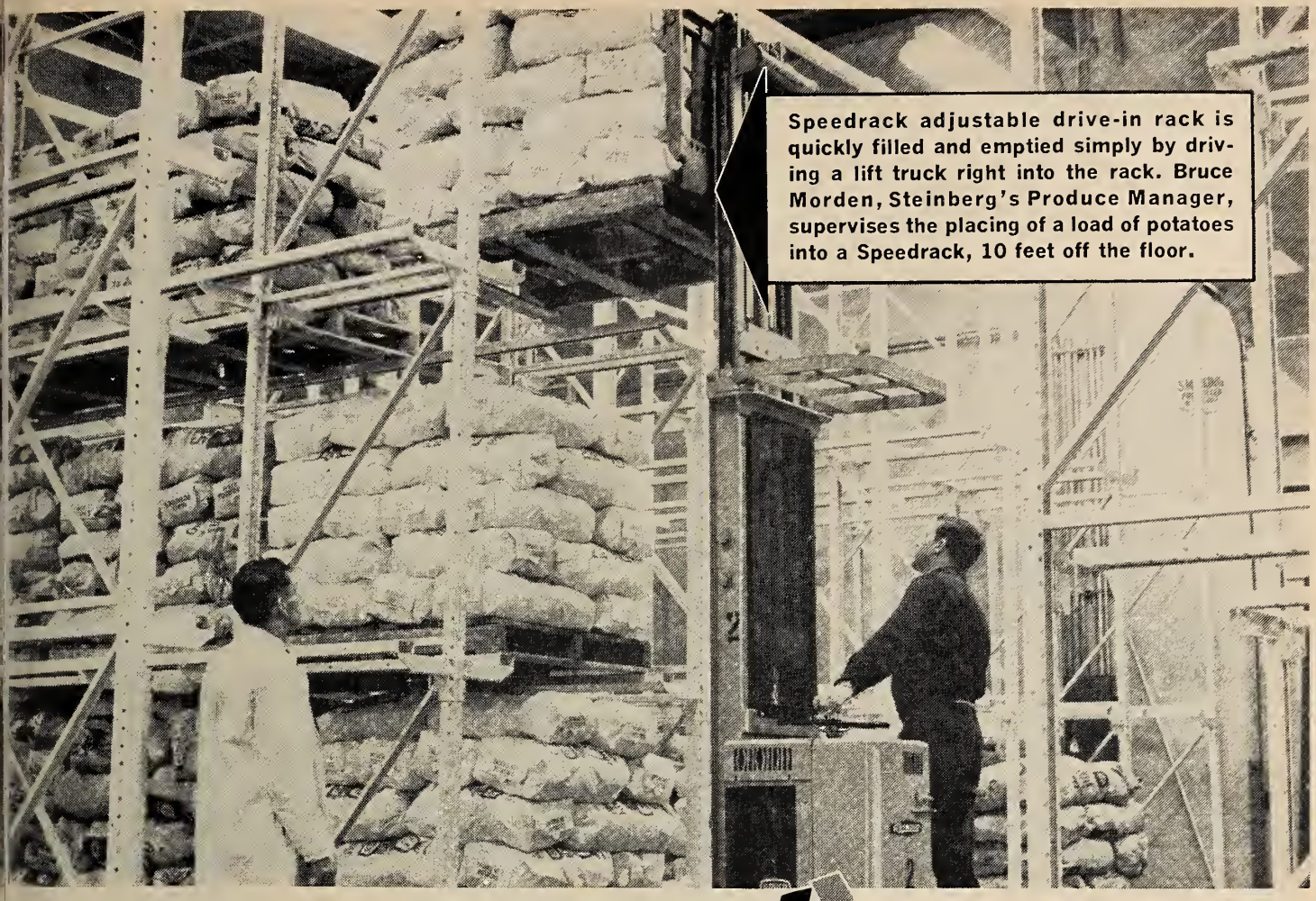

Speedrack adjustable drive-in rack is quickly filled and emptied simply by driving a lift truck right into the rack. Bruce Morden, Steinberg's Produce Manager, supervises the placing of a load of potatoes into a Speedrack, 10 feet off the floor.

IOW G. N. JOHNSTON HELPED STEINBERGS OLVE MAJOR PROBLEMS IN MATERIALS HANDLING

ree problems confronted Steinberg's (Ontario) Limited when planning their new rehouse near Toronto:

RST: the 220,000 square feet building is one of the largest food warehouses in nada. **SECOND:** Steinberg's knew they would stock more than 4,000 different food ms. **THIRD:** these items would turn over at least 20 times per year.

einberg's called on G. N. Johnston Equipment Co. Ltd. and with them designed a aterials Handling system unique in the food-handling business. Selecting Raymond rrow Aisle electric Lift Trucks with speeds of up to 6 m.p.h. solved the area and ed problem. Raymond Straddle-type trucks and Raymond "Walkies" are used in ck placing, loading and off-loading and by stock selectors. Compared to similar its of their type they handle an unusually large volume, thus solving the problem the large number of items and fast turn-over. To further facilitate rapid turn-over, th standard and drive-in types of Speedrack are used to enable Steinberg's to stack ods higher—with greater speed. A Baker electric lift fork is used to facilitate day- nd operation in Steinberg's frozen food warehouse. Jack Sawyer, Grocery Manager, ims it has been practically trouble-free during its many years of operation.

N. Johnston Equipment Co. Ltd., can help you in the same way we helped einberg's (Ontario) Limited. Phone or write us today!

"WHEN THEY TELL US THEY CAN DO SOMETHING, THEY DO IT!" *says Gordon Metcalf, P. Eng., Director of Distribution, Steinberg's (Ontario) Limited, about G. N. Johnston Equipment Co. Ltd.*

Mr. Metcalf heads a materials handling department that has earned a continent-wide reputation for efficiency. The use of G. N. Johnston equipment has helped him to develop a materials handling system that enables Steinberg's (Ontario) to do all warehousing during a normal working day—an unusual feat in food warehousing.

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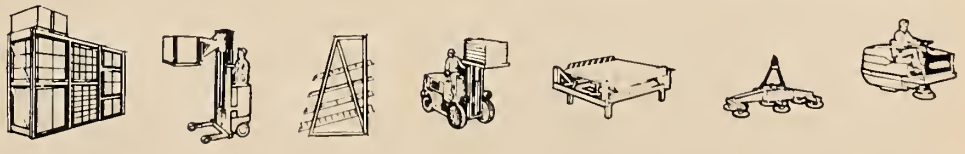

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April 1963 - Vol. 46, No. 4

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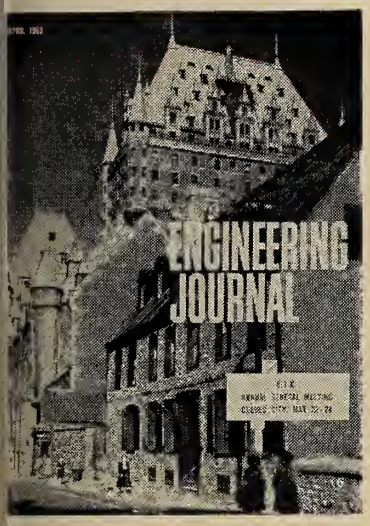

COVER ILLUSTRATION

ıe 77th Annual Meeting of the En- ıneering Institute of Canada will be ıld in Quebec City, at the Chateau ontenac. This gracious hotel is pic- red from a quaint, Lower Town reet. (Photo courtesy Canadian ıcific Railway)

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CCAB MEMBERSHIP

Indexed in The Engineering Index, Applied Science and Technology Index

FRANKI FACTS

TYPE OF STRUCTURE:
Iron Ore Dock

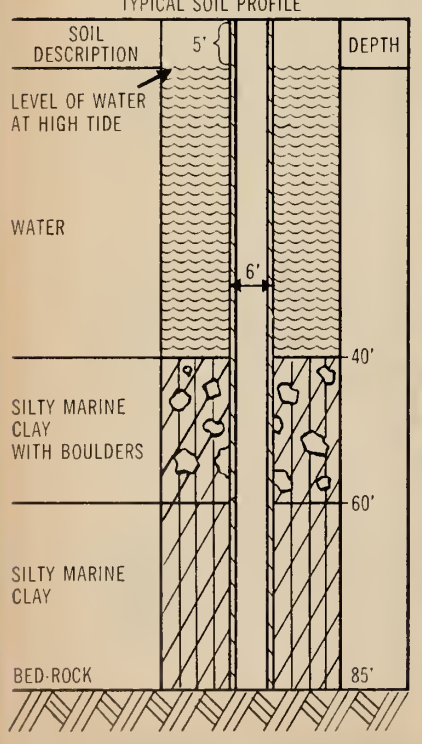
LOCATION:
Pointe Noire, Seven Islands, Quebec

ENGINEERS:
Akers, Ellis, Stephenson & Quinn
Ville LaSalle, Montreal, Que.
New York, N.Y.

GENERAL CONTRACTORS:
McNamara Quebec Limited

NUMBER OF UNITS:
186 Steel Caissons

AVERAGE DEPTH OF CAISSONS:
85' 0"



FRANKI PUSHES OPEN-END CAISSONS TO ROCK

Problem

The whorf for looding iron ore at Pointe Noire, Seven Islonds had to extend 400' i the river, with bed-rock to be found ot on overoge depth of 85'. This wos overlain by 45-foot loyer of silty morine cloy above which the water depth varied between 33' ond 4 offected by a heavy tide.

The foundotion design colled for 6' O.D. steel coissons with ¾" wall thickness, four eoch row, with reinforced concrete moin cross beoms ond longitudinol precost beoms su porting the deck.

One hundred ond eighty-six open-end coissons were to be sunk to bed-rock by mec of driving, loading or jocking, but jetting wos prohibited in order to ovoid structurol collap of this silty morine clay.

Rigid tolerances were imposed, namely, of only 6 inches out of position ond 1% of plumb.

Solution

The chorocteristics of the silty morine clay showed thot friction during sinking of t open-end coissons could be overcome by simultaneous driving ond pushing.

Franki wos selected becouse the company's special method of driving ond pushi simultoneously offered oll guorontees thot these operotions required. Fronki's engineeri staff perfected o method by which both operotions could be corried out by a lorge Frai rig with o 75-foot stiff leod fixed on to a 1000-ton borge. Modificotions were mode to t rig so that it could pick up coissons up to 130 feet long (ot the shore or from the launchi borges), erect them ond sink them by driving, while constont pull wos applied to the caisso by meons of odditionol hoists.

Actual performonce wos much better thon onticipoted with o record of eight units driv in one single 16-hour shift.

All coissons were occepted, os they were found to be within toleronce, both as position ond plumb. This, in spite of a number of boulders encountered in the first 20 fe of clay below the water, which hod to be pushed oside, and in spite of strong head wir which often hod to be overcome.

Sound onolysis of the problem, fine equipment, competent staff, plus a little imaginati brought about a successful solution, ond Fronki appreciotes the technicol co-operation receiv from the general contractors.

FRANKI
OF CANADA LIMITED
Head Office: 187 GRAHAM BLVD., MONTREAL 16, P.Q.
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Literature - This series of job highlights, as well as other descriptive literature, will be sent to you upon request to Franki of Canada Ltd., 187 Graham Blvd., Montreal 16, P.Q.

IN THIS ISSUE

Canada's geographical position affords a unique opportunity for scientific rocket sounding of the upper atmosphere. The Associate Committee for Space Research of the National Research Council of Canada sponsors a program to exploit this opportunity. These rocket experiments are applied to the extension of knowledge in fields of science where work has been carried on at NRC for many years. They support research in the universities both by grants and by co-operative efforts. They provide test facilities, new developments, and a source of information for industry. Because rocket sounding programs are an excellent school for more advanced space work, they are the basis for an expanding industrial technology in the new space age. **W. L. Haney, M.E.I.C.**, Head, Space Electronics Section, Radio and Electrical Engineering Division, National Research Council, in his paper, **Space Research and the National Research Council of Canada,** describes the scientific and engineering background of the program.

The Canadian National Railways owns 94,200 freight cars. Their replacement value is about $1 billion. Like every other railway in the world, the CN has been seriously concerned about the utilization of its fleet. Some time ago, the Vice-President, Transportation and Maintenance, directed that an intensive effort should be made to improve freight car distribution. To further this work, a study team was set up representing both the car service office of the transportation department and operational research.

Freight car distribution has attracted considerable theoretical attention. A wide variety of technique including the use of allocation models, inventory models and queuing models have been applied to the problem of calculating requirements for cars. In their paper, **An Experiment in Operational Research, J. W. Johnson, M.E.I.C., C. J. Hudson and G. A. Cooper,** describe some experimental work on some of the broader aspects of car control. These include the responsibility and authority of the various levels of the organization, data collection, and planning procedures as well as the actual calculation of how many empty cars should be removed from one place to another.

Discussions

Discussed in this issue is **Aspects of the Background of the Columbia River Projects in Canada** by **R. C. McMordie, M.E.I.C.**, which appeared in the October 1962 issue of the Engineering Journal. Contributing to this long and highly significant discussion are: **General A. G. L. McNaughton, Hon. M.E.I.C.; A. F. Paget, M.E.I.C.; P. R. Purcell, M.E.I.C.; A. W. F. McQueen, M.E.I.C.; F. J. Bartholomew; J. F. Glennie, M.E.I.C.; and J. F. Muir, M.E.I.C.**

PLAN TO ATTEND

77th Annual Meeting

of the

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MAY 22-24

1963

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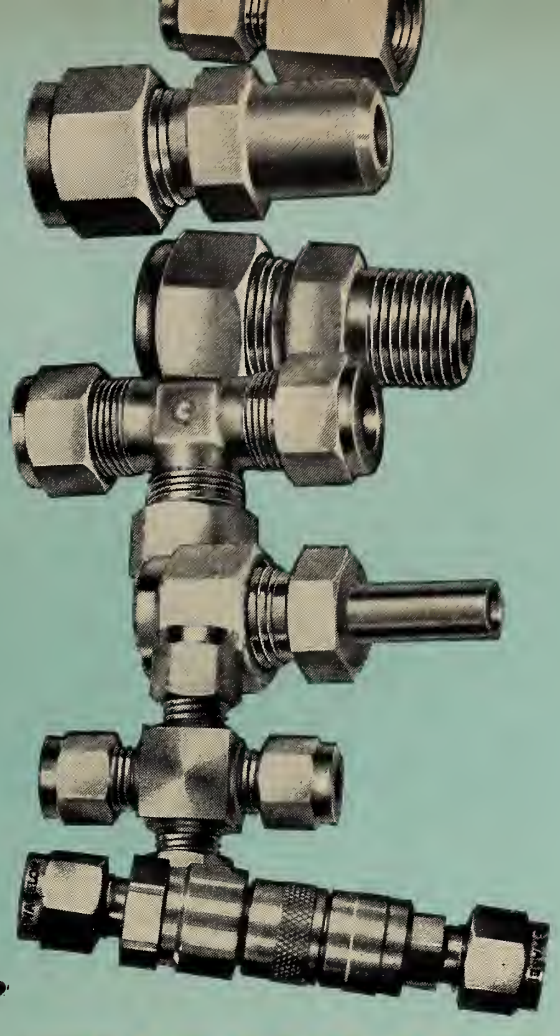

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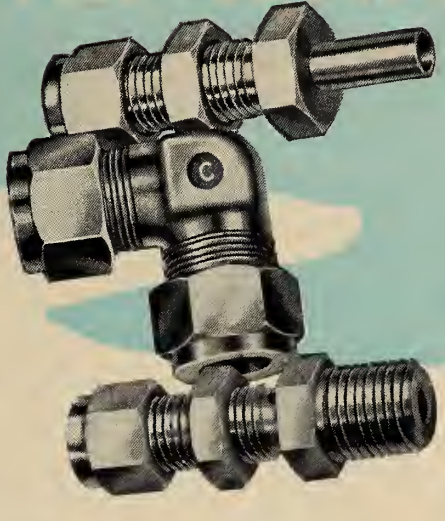

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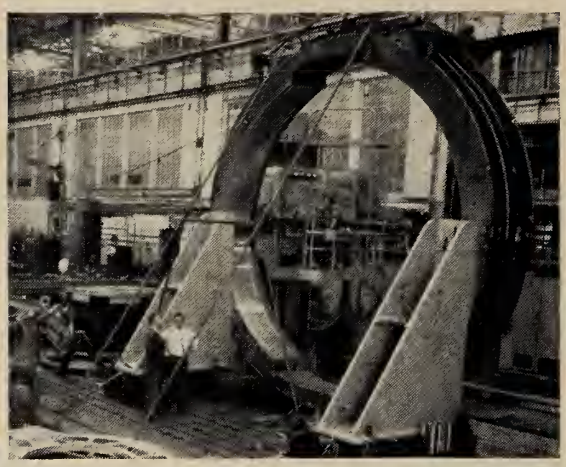

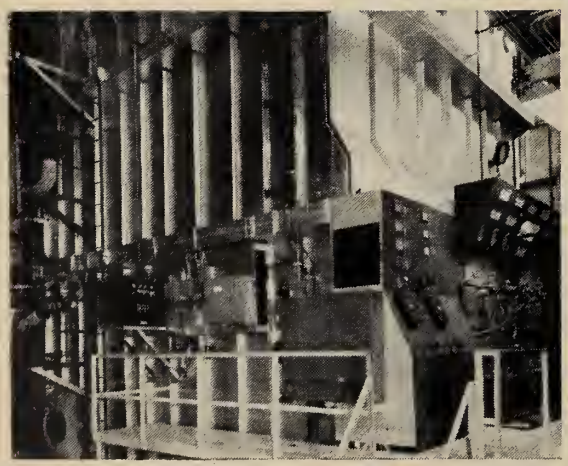

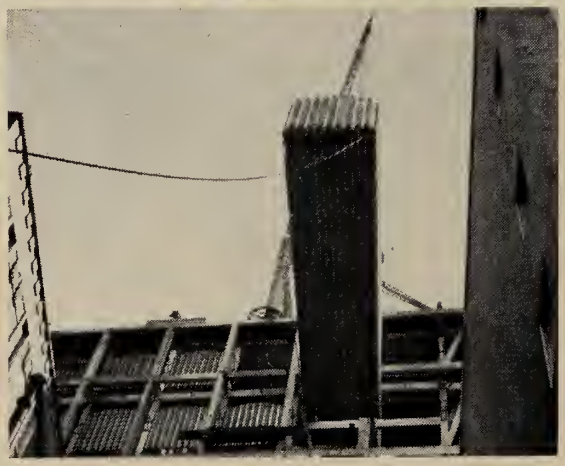

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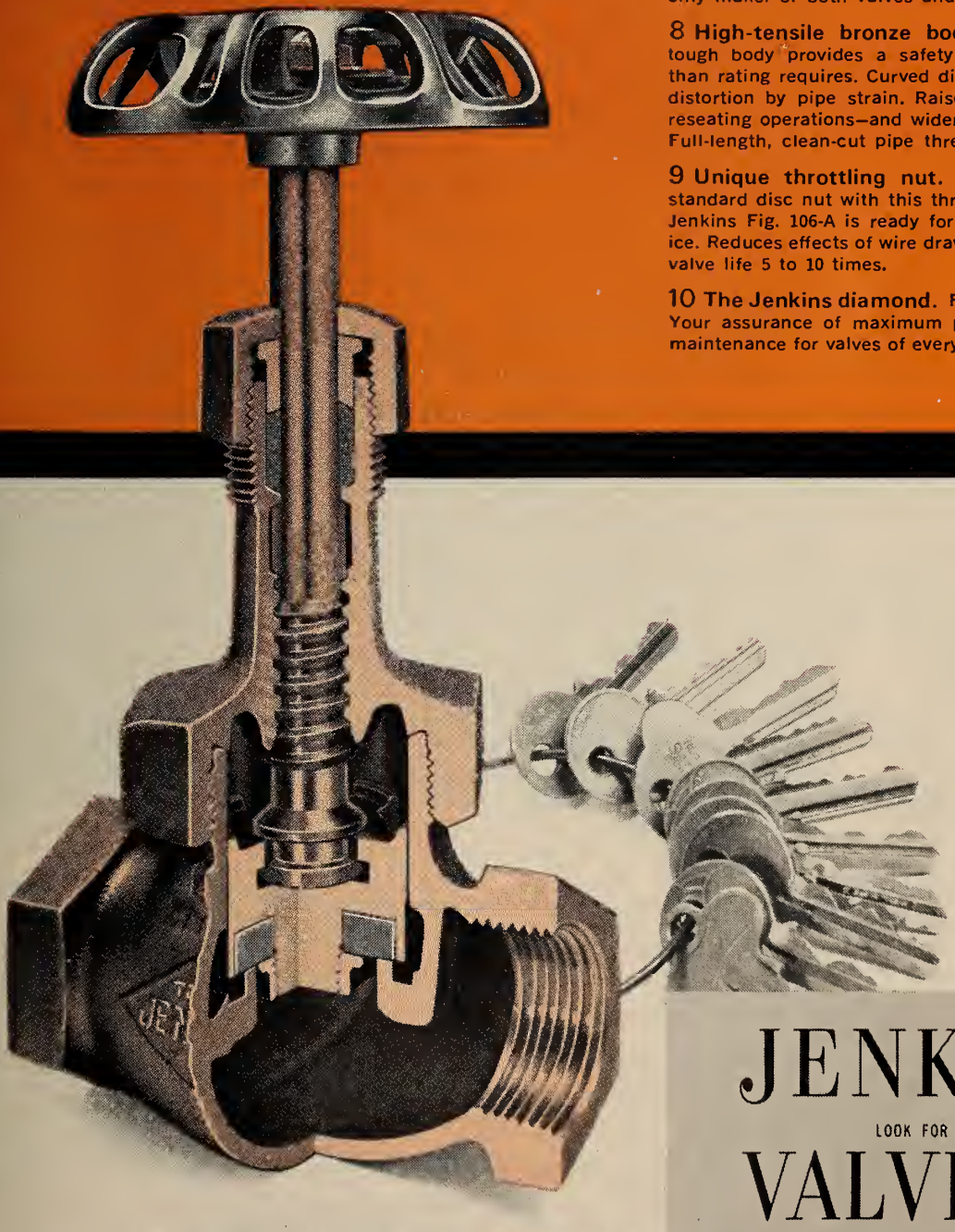
1. Sluice gates for Hydro-Quebec electr power development at Carillon, on t Ottawa River
2. End shields for CANDU nuclear pow project, Douglas Point, Ontario
3. 100,000 lbs. per hr. steam generator McGill University, Montreal
4. 32,500 gal. stainless steel ferment tanks for Molson Breweries Ltd. in Montreal.

10
keys to outstanding value with JENKINS bronze valves

Jenkins Fig. 106-A Bronze Globe Valves typify the exceptional craftsmanship, performance and value received by every specifier and buyer of Jenkins valves, ever since Nathaniel Jenkins introduced the first renewable composition disc nearly a century ago. Designed for 150 lbs. Steam and 300 lbs. OWG, these precision-engineered valves are also available flanged (Fig. 107-A) or angle screwed (Fig. 108-A). For informative, descriptive folder, write: Jenkins Bros. Limited, Lachine, Que.



1 Easy-to-handle wheel. Tough malleable iron. Unmatched design for cool, sure grip.

2 Silicon bronze spindle. Heavier, more deeply cut threads engage bonnet securely. Crowned head reduces friction on disc holder. Costs more to produce, but reduces wear, preserves packing, and is easier to operate.

3 Sturdy packing nut and gland. See the heavy, deep bronze hex. Bronze gland compresses packing toward spindle.

4 Deep Packing Box. More packing space means less repacking. Depth equals 1½ times spindle diameter. An asbestos, lubricated and graphited packing is used.

5 One-piece bonnet. Screw-over design with big hex surfaces. Easy to remove. Notice how the bevel joint between bonnet and body serves as internal brace against crushing effect of bonnet assembly. Unique design resists distortion and springing.

6 Slip-on, Stay-on disc holder. A Jenkins original! Correct protective depth prevents flaking or cracking of disc.

7 Disc easily renewable... without removing valve from line. Regularly supplied with 119A disc. Other compositions available for various services...and made by Jenkins, the only maker of both valves and discs.

8 High-tensile bronze body. Wall thickness of this tough body provides a safety factor many times higher than rating requires. Curved diaphragm protects seat from distortion by pipe strain. Raised seat is higher—for more reseating operations—and wider, to avoid cutting into disc. Full-length, clean-cut pipe threads.

9 Unique throttling nut. Simply replace standard disc nut with this throttling nut, and Jenkins Fig. 106-A is ready for throttling service. Reduces effects of wire drawing, increasing valve life 5 to 10 times.

10 The Jenkins diamond. Famous symbol of quality. Your assurance of maximum performance with minimum maintenance for valves of every type and for every purpose.

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VALVES

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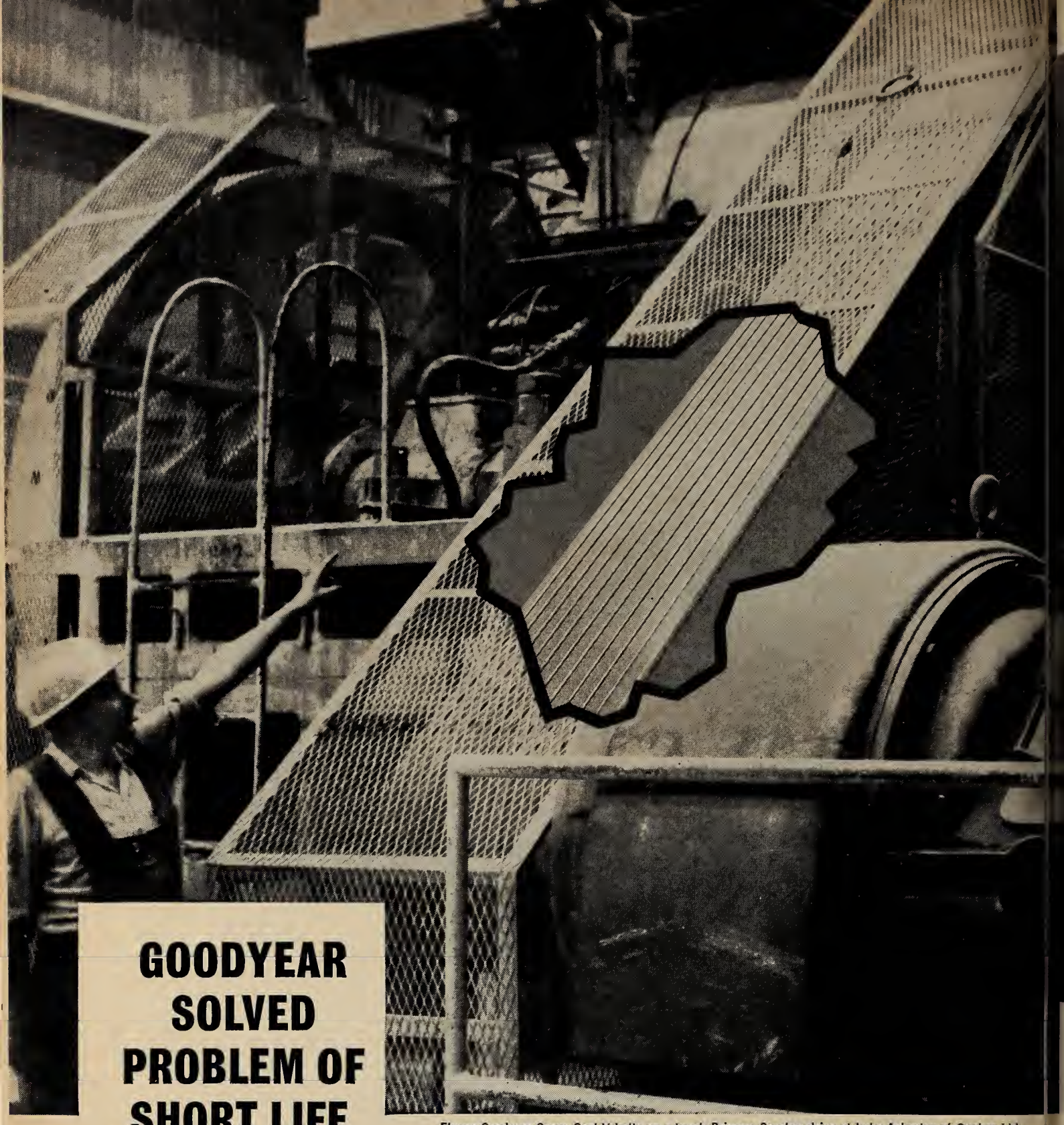

GOODYEAR SOLVED PROBLEM OF SHORT LIFE OF V-BELTS

Eleven Goodyear Green Seal V-belts on a tough Primary Crusher drive at Lake Asbestos of Quebec Ltd.

At Lake Asbestos, the problem of extremely short, V-belt service life was both critical and costly. Goodyear Technical Service was consulted. Plant engineering personnel tested Goodyear Green Seal V-belts on torturous, belt-killing Fiberizer drives. The results proved that dimensionally stable Green Seal V-belts with tough, sinewy 3-T Cords far outlasted ordinary V-belts. Today, most of the V-belt drives at Lake Asbestos are equipped with Green Seal V-belts by Goodyear. □ So once again, Goodyear Technical Service has proved that "the right answer" boils down to the right job analysis . . . the right recommendation . . . and the right industrial rubber product. Make sure you get all three . . . call your nearest Goodyear Branch or Head Sales Office, Bowmanville, Ontario.

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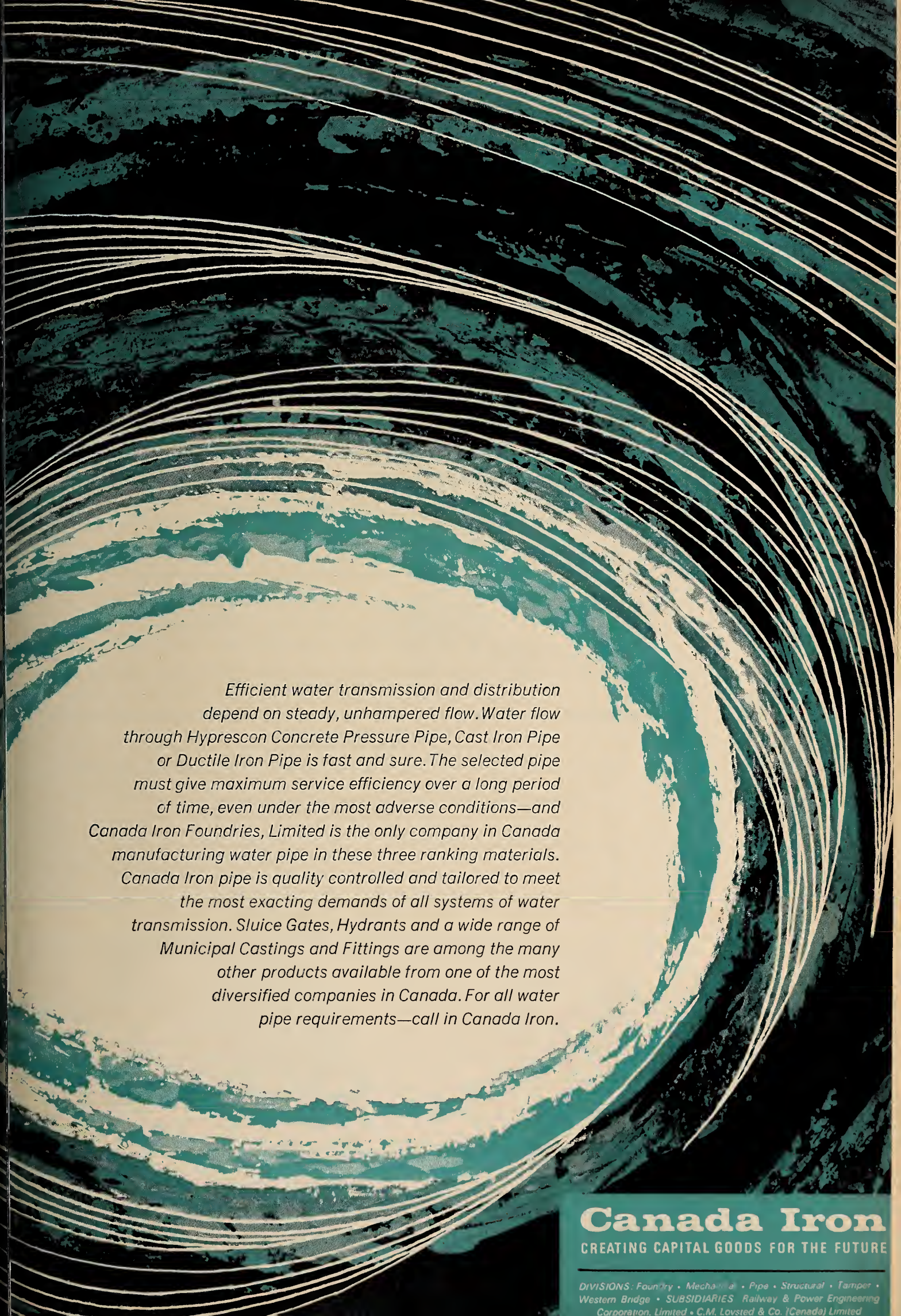
Speed Reducers

FLOW



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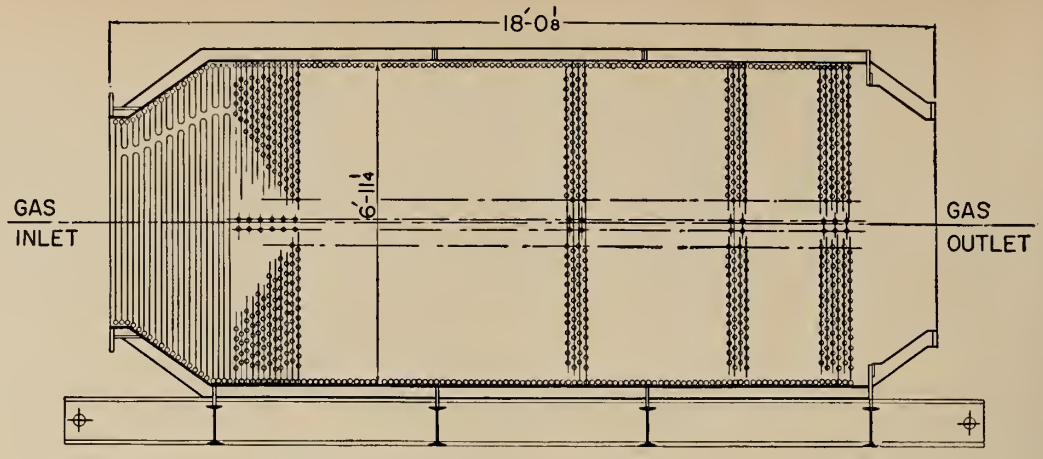


Appl'cation: Initially for research work to:

a) cool exhaust gas from aircraft jet engine, and

b) raise steam for coach heating by utilizing locomotive gas turbine exhaust.

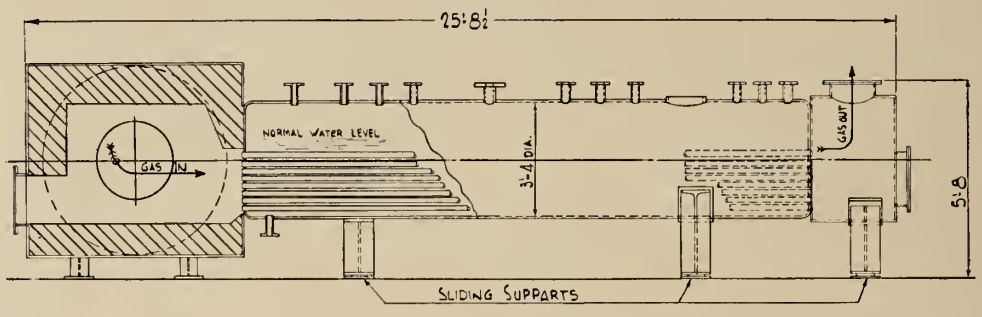
Specification condition A.

Gas in 3150°F
Gas out 104°F
Cooling water run through the waste.

Specification condition B.

Gas in 800°F
Gas out 395°F
Steam generated 16,500 pph.

The boiler heating surface is 6,000 sq. ft. and the design pressure 250 psig.

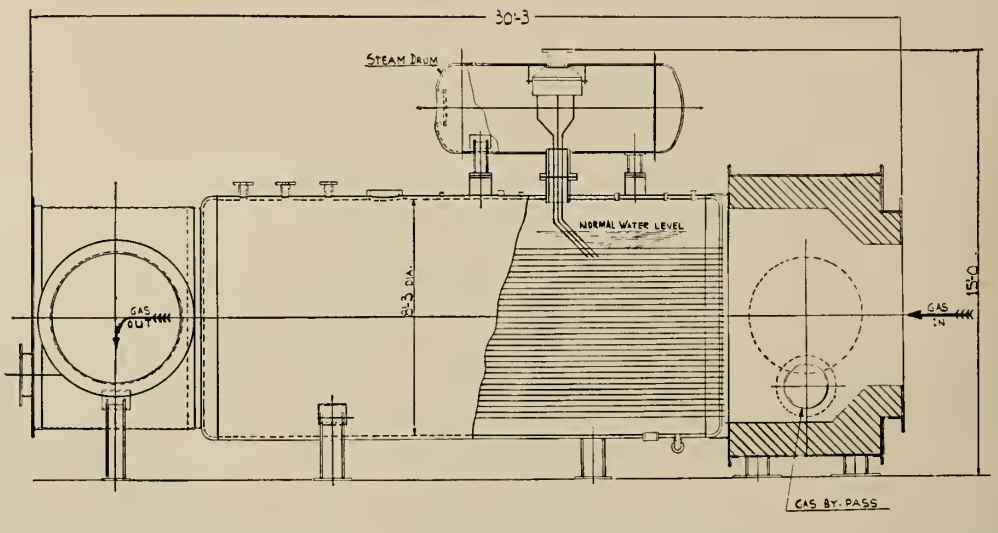


Application: Reduce temperature of discharging SO_2 in the production of sulphuric acid.

Specification

Gas in 2000°F
Gas out 780°F
Steam generated 53,000 pph. max.
Heating surface (fireside) 6,800 sq. ft.

Recovered heat warms building and operates air movers through turbines.



Application: Reduce temperature of discharging SO_2 in the production of sulphuric acid.

Specification

Gas in 2000°F
Gas out 711°F
Steam generated 6,260 pph.
Heating surface (fireside) 630 sq. ft.

Recovered heat warms building and operates water evaporator unit.

waste heat recovery boilers

The three diagrams facing this page are representative of types of waste heat recovery boilers produced by Dominion Bridge for use in Canada and abroad.

The engineering group of the Boiler Products Division has extensive and diversified experience in producing designs to meet a wide variety of applications and particularly where corrosive gases are involved. If you have unusual or specialized heat recovery problems, this group can undertake a design development program to fulfil your requirements.

As a separate unit within the Dominion Bridge Company, the Boiler Products Division produces:

- Standard firetube boilers from 15 to 500 h.p.
- Watertube boilers from 9,000 to 150,000 pph.
- High temperature water boilers
- Custom boilers

Thermal plant equipment:

- D.B.-John Thompson boilers with capacities from 150,000 pph. upwards.
- Ash handling plants
- Feed water heaters
- Surface steam condensers

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BOILER PRODUCTS DIVISION
DOMINION BRIDGE

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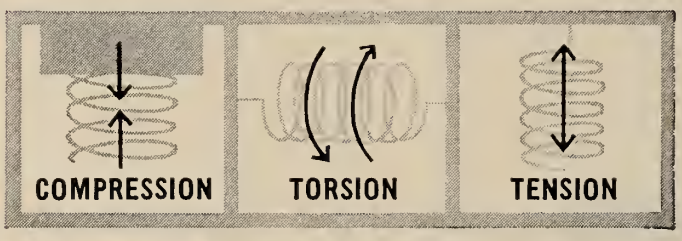
We will coil hot wound springs to your specifications in bar diameters from $\frac{3}{8}''$ to $1\frac{7}{8}''$ — inside spring diameters from $\frac{3}{4}''$ to $10''$ — in free lengths up to $30''$ — all to ASTM standards or closer tolerances if required.

You can specify bar size, shape and alloy needs — or discuss your requirements with our engineers.

Springs Shot Peened for longer life.



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cable is the work-horse of the power cable field. Its extensive background of long trouble-free service makes it one of the most dependable power cables presently available. It is relatively low in cost, has high ampacity and is suitable for all types of feeder and distribution work. As examples of its versatility, it can be used underground directly buried, in ducts, in tunnels or in submarine crossings. It can also be installed above grade on poles or on racks and trays. For complete details please write for Bulletin P6-A.

The Northern Electric Company's long experience and modern engineering, laboratory and manufacturing facilities ensure a quality PILC power cable that is second to none.

"Second to none" is a specific term–and a challenge. We meet it by exceeding the minimal standards of engineering bodies...by maintaining five of the best-equipped cable laboratories devoted to research and development. We demand the best from our raw-material suppliers...from our processes and our people. We are proud that our manufacturing tolerances are increasingly narrow–that our process controls detect–and correct–unwanted deviations before they could be hidden by subsequent operations.

Our laboratories, our resources and experience are at your disposal. If you are concerned with the design or installation of cable, it will pay you to consult Northern Electric.

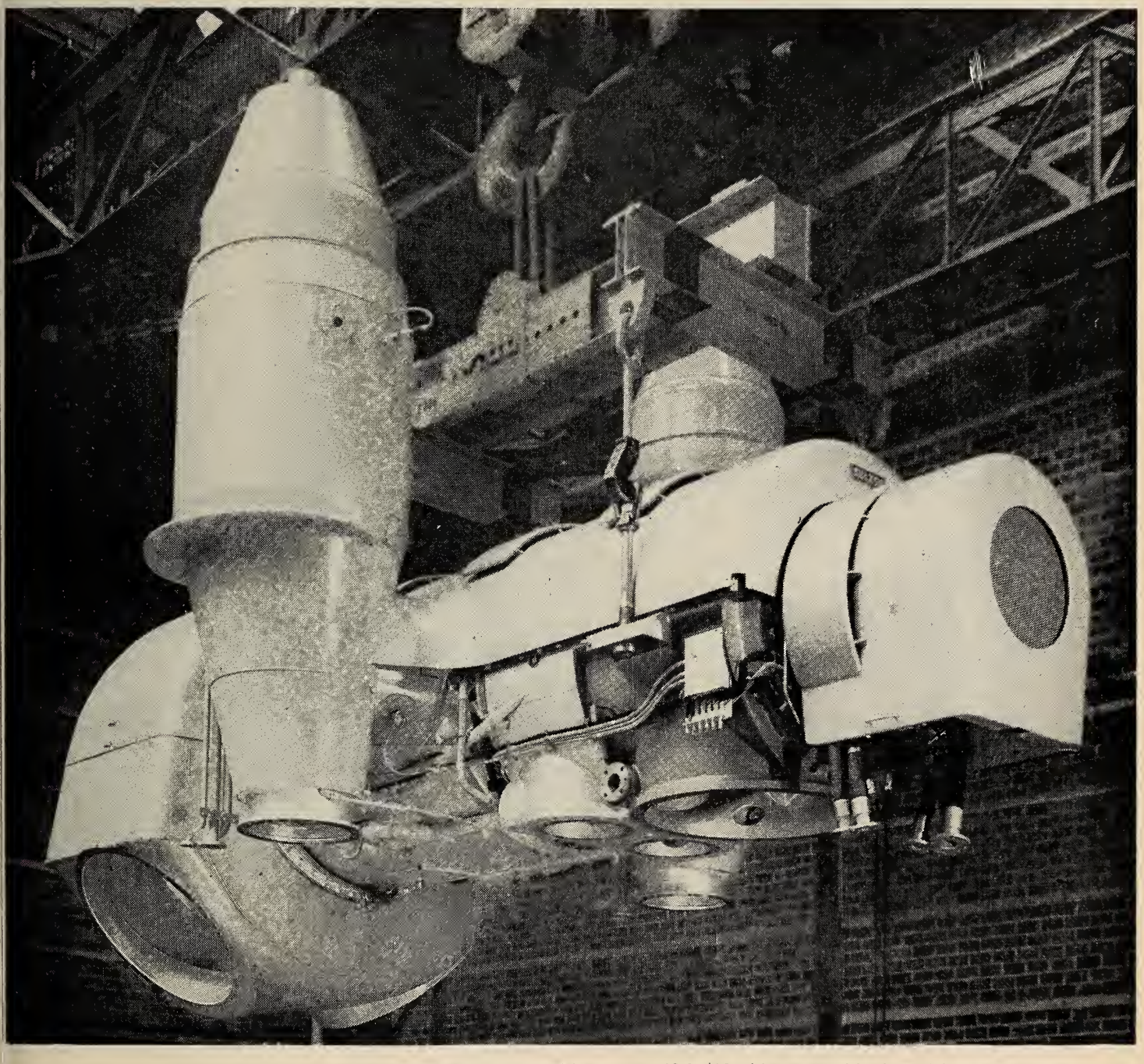
Northern Electric
COMPANY LIMITED

The Swiss engineering company of world-wide repute

SULZER

Gas Turbines for Pipelines

Sulzer 3,000-kW Gas Turbine ▪ Standard split-shaft version



3,000-kW Gas Turbine Type NS 63/45; this power block and its steel frame form a single, compact unit.
Ask for further details of this robust, easy-to-transport set!

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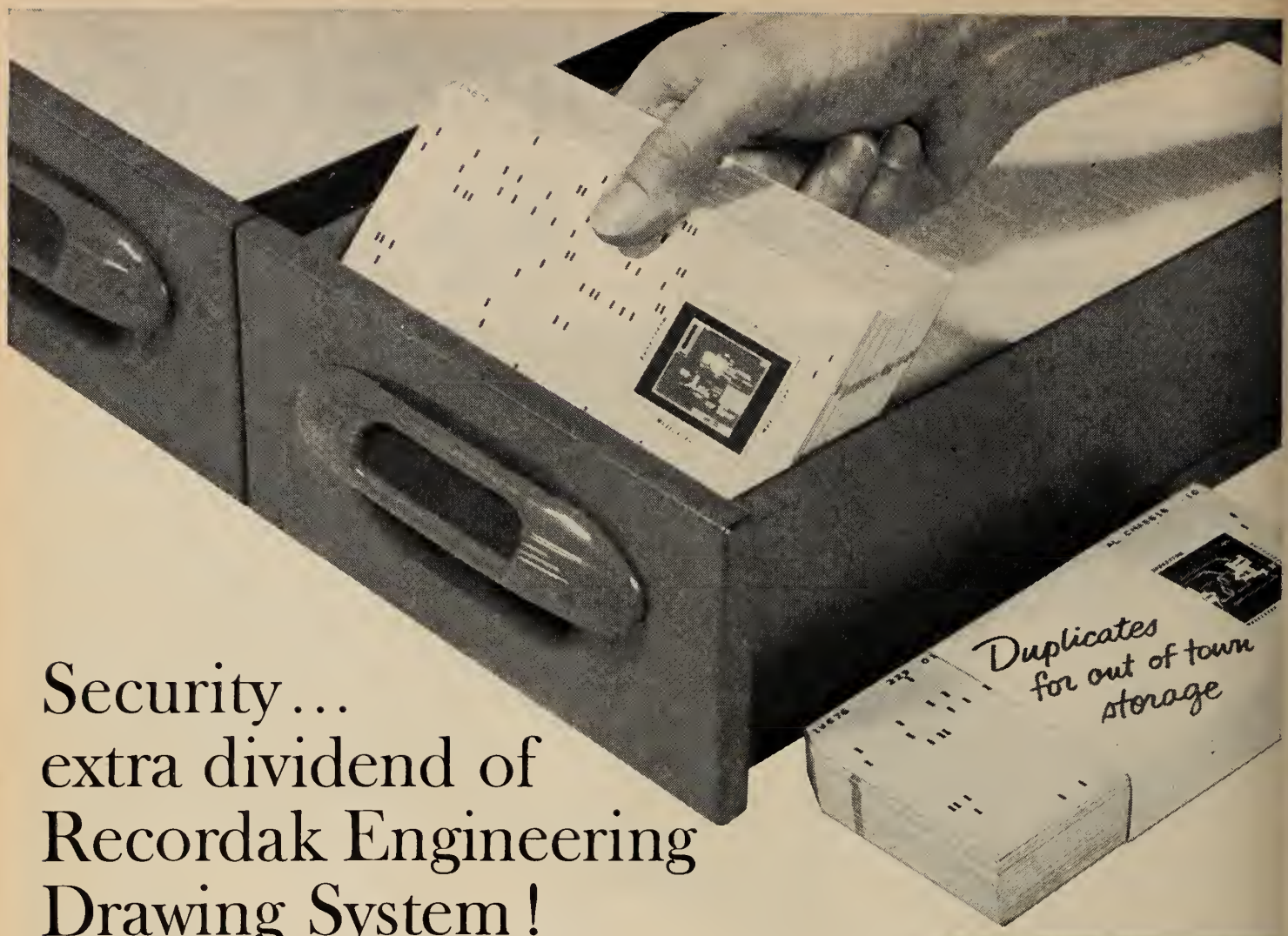

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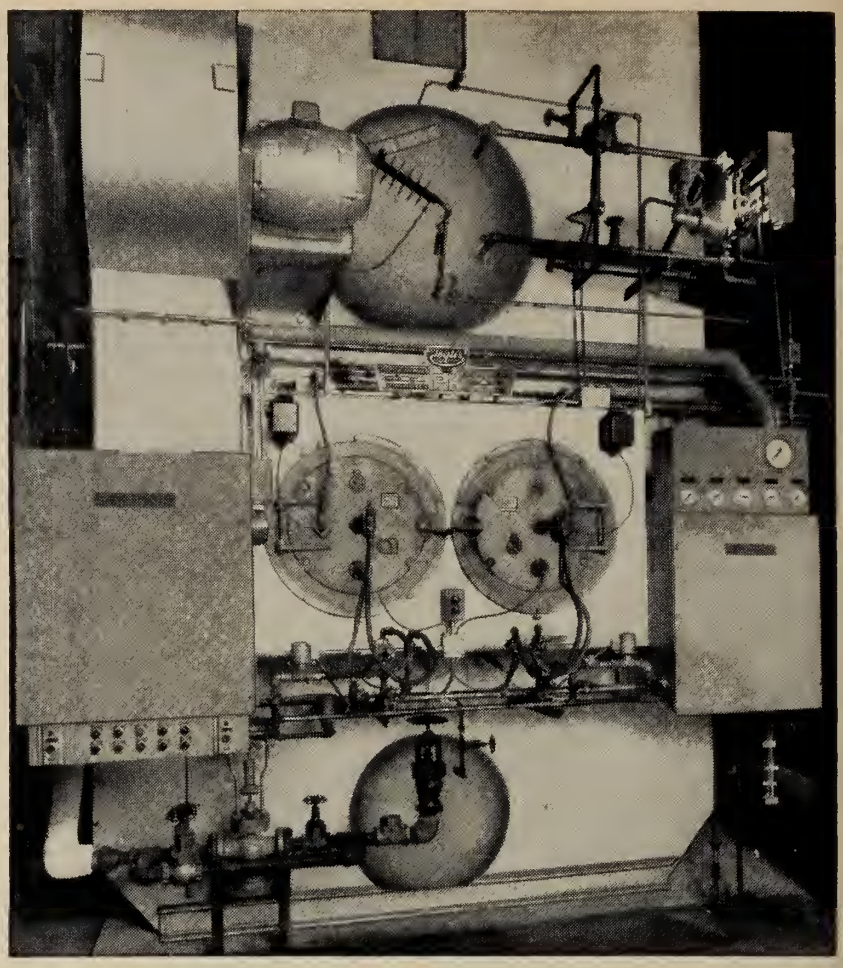
ANOTHER INGLIS COMPACT HIGH EFFICIENCY PACKAGED WATER TUBE STEAM GENERATOR



Inglis "PK" Pressurized Package Water Tube Steam Generator 45,000 lbs/hr. at 125 psig. oil-fired at Carling Breweries (Quebec) Limited in Montreal

UNIQUE DESIGN

The completely water cooled tangent tube furnace is centrally located between two symmetrical banks of closely spaced convection tubes, enclosed by an outer row of tangent tubes. This in turn is covered by a seal-welded inner casing to which insulation and bolted outer casing are applied.

ADVANTAGES

The tangent tube furnace surrounded by closely spaced convection tubes which are enclosed by outer walls of tangent tubes ensures **reduced radiation losses, greater heat absorption and lower exit temperatures.**

- Sealed inner casing adjacent to outer tube wall ensures that the **combustion gases will not condense and corrode the outer casing.**
- Shorter rapid-steaming riser tubes discharging into bottom of drum reduce turbulence and ensure **better steam quality.**
- Symmetrical banks of tubes connecting top and lower drums mean **greater thermal and structural strength.**
- Top smoke outlet **eliminates hot stack in the aisle.**
- Where oil and/or gas is the fuel, in sizes ranging from **5,000 to 100,000 pph. up to 600 psig.,** the John Inglis "PK" Watertube Package is **more economical in both initial and operating costs.**

As specialists in this field, Inglis engineers welcome all enquiries on steam generation.

Inglis

STEAM GENERATORS

JOHN INGLIS CO. LIMITED

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137 manufacturers will show mechanical components. **105** will demonstrate electrical and electronic components. **90** will exhibit hydraulic and pneumatic components. **51** metals. **74** non-metallic materials. **60** shapes and forms. **67** fasteners and adhesives. **29** finishes and coatings. **96** power transmission equipment and **63** exhibitors will demonstrate engineering equipment and services.

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and concurrent ASME conference

Trane Announces:

Greater application
lower costs in induction

All-new UniTrane line features 16 basic models, saves up to 25% valuable floor space.

Here's induction air conditioning that keeps pace with the beauty and efficiency of today's newest buildings, enhances the traditional decor of existing buildings. It's the all-new Induction UniTrane that offers significant advances in air conditioning . . .

NEW COMPLETE LINE MEANS AIR CONDITIONING MATCHED TO YOUR REQUIREMENTS!

Exclusive selection flexibility with this broad new UniTrane line eliminates costly oversizing, provides operating cost savings, quieter operation. Enables selection of the proper size unit to meet your specific design requirements. Permits use of minimum primary air supply, smaller ducts, fans and motors.

Induction UniTrane line includes 16 models: standard capacity vertical, horizontal and low vertical, each with a choice of two coil sizes . . . new high capacity vertical and horizontal models . . . all with or without cabinets.

All models, factory assembled, are available in 20, 2 36, 48 and 60-inch coil lengths; any of eight different nozz arrangements.

NEW, THINNER DESIGN SAVES RENTABLE FLOOR SPACE!

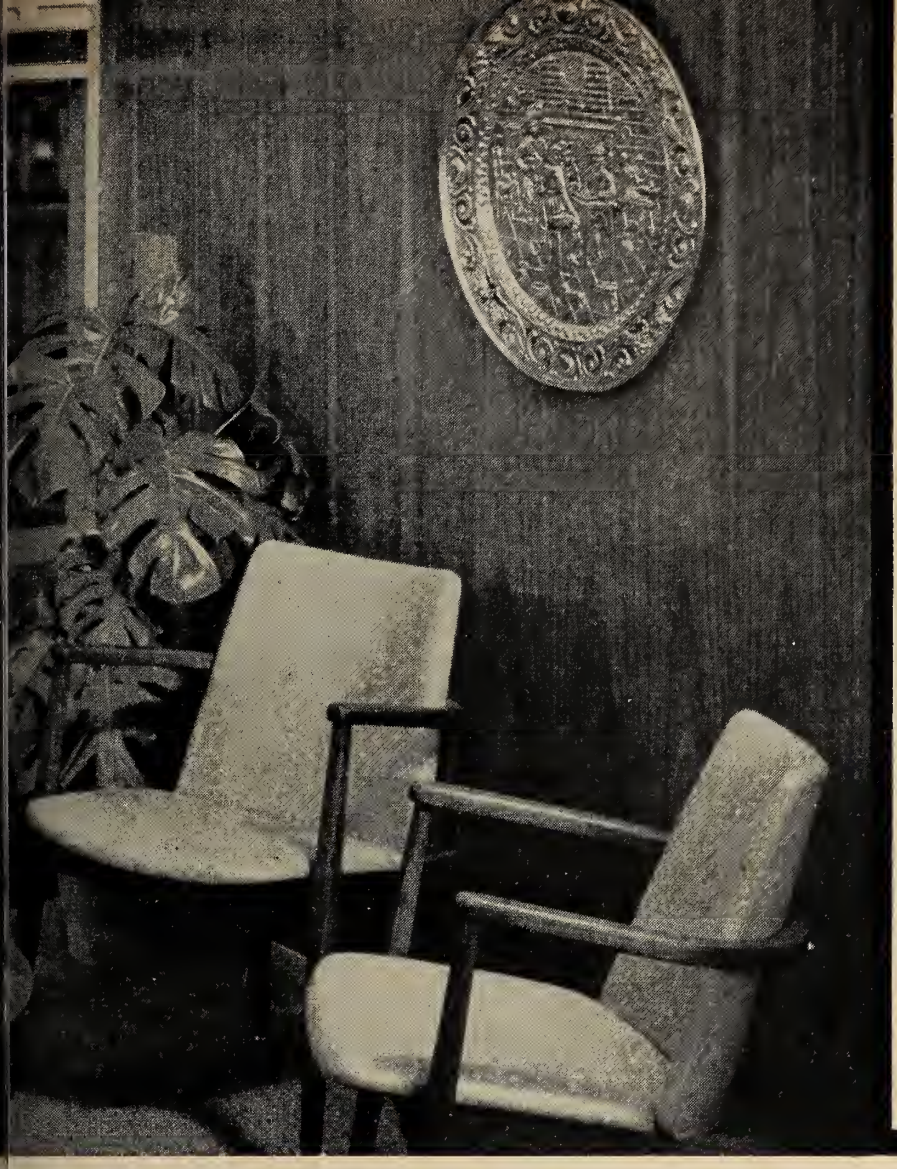
UniTrane is now up to 25% thinner than comparable cor petitive units. The vertical cabinet model is only 6⅝" thi Also more compact in length and height.

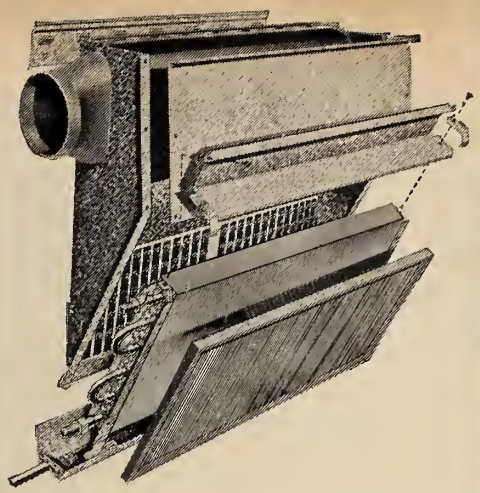
Some typical dimensions: Vertical cabinet and verti concealed units are 20 inches high, require only 4-inch t space. Low vertical cabinet is 9 inches deep, 12 inches hig

NEW STYLING COMPLEMENTS THE BEAUTY OF ANY BUILDING!

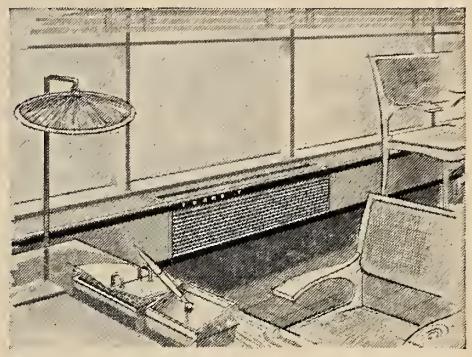
Cabinet front on the standard vertical unit slopes slight outward to create a smart, subtle convex appearanc Design is smooth and clean! Secondary air is drawn throu *concealed* openings in toe space. And *no* front inlet gri is required.

Separate and adjustable *metal* outlet grilles are recess in cabinet top, permit tenant's choice of multiple air di charge patterns. Access doors to individual controls a recessed in unit top, blend with matching grille desig





Exploded view of standard vertical concealed unit.



Shorter and thinner, new low-vertical Induction UniTrane is attractive, practical for buildings featuring curtain-wall construction, for other installations where height requirements are critical.

ew **Induction UniTrane** combined with wall-to-wall enclosure create a custom-built look that complements any interior.

selectivity and air conditioning

ternal primary air balancing damper adjustment is easily cessible but is provided with tamperproof feature.

Combining greater application selectivity with TRANE'S ditionally rugged construction, new Induction UniTrane sures you of efficient, quiet operating air conditioning m the start. If you would like more complete details d specifications, contact your nearby TRANE sales office. write TRANE, Toronto 14, Ontario.

CHECK THESE SPECIAL TRANE FEATURES!

- Whisper quiet! Engineered for quiet operation. (And with TRANE'S greater selection flexibility you are able to design for even quieter performance.)
- Automatic air flow regulator—an exclusive TRANE option—assures optimum system balance; maintains constant air delivery within 5%, regardless of supply pressure variations.
- New compact filters are available in cleanable or disposable types; both offer full air filtration for low maintenance and efficiency equal to conventional one-inch filters.

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FOR ANY AIR CONDITION

Manufacturing engineers of air conditioning, heating, ventilating and heat transfer equipment

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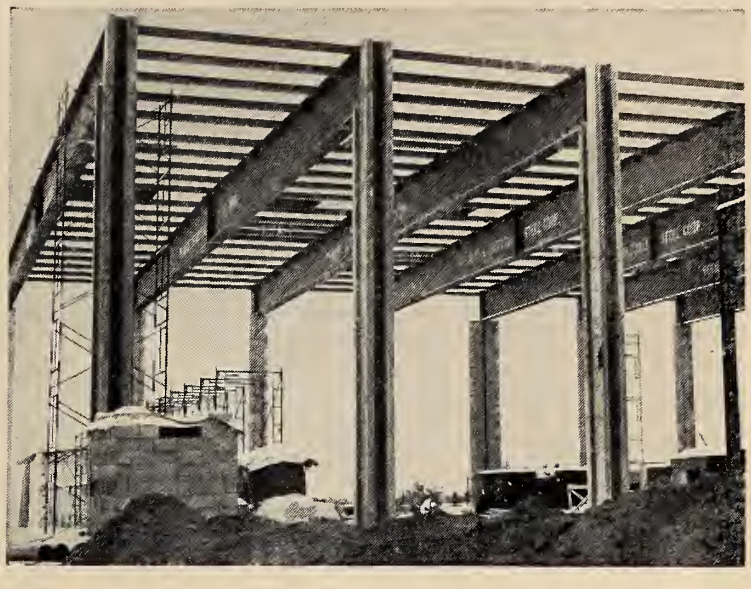

design save $37,000

Structural steel, on the basis of firm competitive bids, won out over laminated wood arches and prestressed concrete beams, and saved $37,000 in the construction of a $3 million field house and gymnasium for the University of Vermont. Another important factor: the speed with which steel can be erected in severe winter weather.

The T-shaped structure is being built on the campus in Burlington. Housed in the cross of the T are a hockey rink, baseball diamond, and running track. Other facilities include a swimming pool and courts for basketball, handball, and squash.

$7,000 saved on field house

This arch-roofed building is 486 feet long, 153 feet wide, and 51 feet, 6 inches high at the center of the roof arch. Here, the final alternate in steel—based on a composite of A7 and A36 for higher strength and lower weight—proved $7,000 cheaper than the design using laminated wood trusses.

Twenty-eight arches weld-fabricated

Each of the 28 arches, 198 ft, 2½ in. long and weighing 24,423 pounds, was weld-fabricated in four sections. Flanges of the arches are curved to conform to the roof line radius. Overall depth is 27 inches. The web plates are 26 inches deep by ⅜ inches thick, and flange plates are 15⅝ inches wide by ⅝ inches thick. Designed snow loading varies from 40 down to 10 pounds per square foot, depending on location in the slope.

A roof of 4-inch tongue and groove planks is laid on 4 x 10-inch nailers attached to the arches in the fabricating shop. Built-up roofing material covers the planking.

Erection of the arches was begun January 23 and completed March 16. Two truck-mounted cranes handled the job. Each arch was shipped to the site in four sections, assembled on the ground into two halves and pin connected to the foundations. Then the two halves were raised together, and pinned at the top. High-strength bolts were used in all field connections.

$30,000 saved on gymnasium

For the gymnasium, in the center part of the leg of the T, the alternate in steel proved $30,000 cheaper than using concrete roof beams. The building is 234 feet, 4 inches long and 122 feet, 10 inches wide.

There are 12 welded plate girders in the gymnasium roof construction. They measure 122 feet, 2⅜ inches long and vary in depth from 4 feet, 8½ inches to 5 feet, 6½ inches. They have half-inch web plates and 18 x 1-inch flange plates. Each weighs 29,825 pounds.

The A7 steel girders are designed for a combined dead and live loading of 60 pounds per square foot.

Architect on the project is Freeman-French-Freeman of Burlington. Structural engineer is Severud, Elstad, & Krueger of New York. General contractor is Franchi Construction Co. of Newton, Mass. Bethlehem Steel Company supplied 686 tons of steel to the steel fabricator and erector: Vermont Structural Steel Corp., Burlington.

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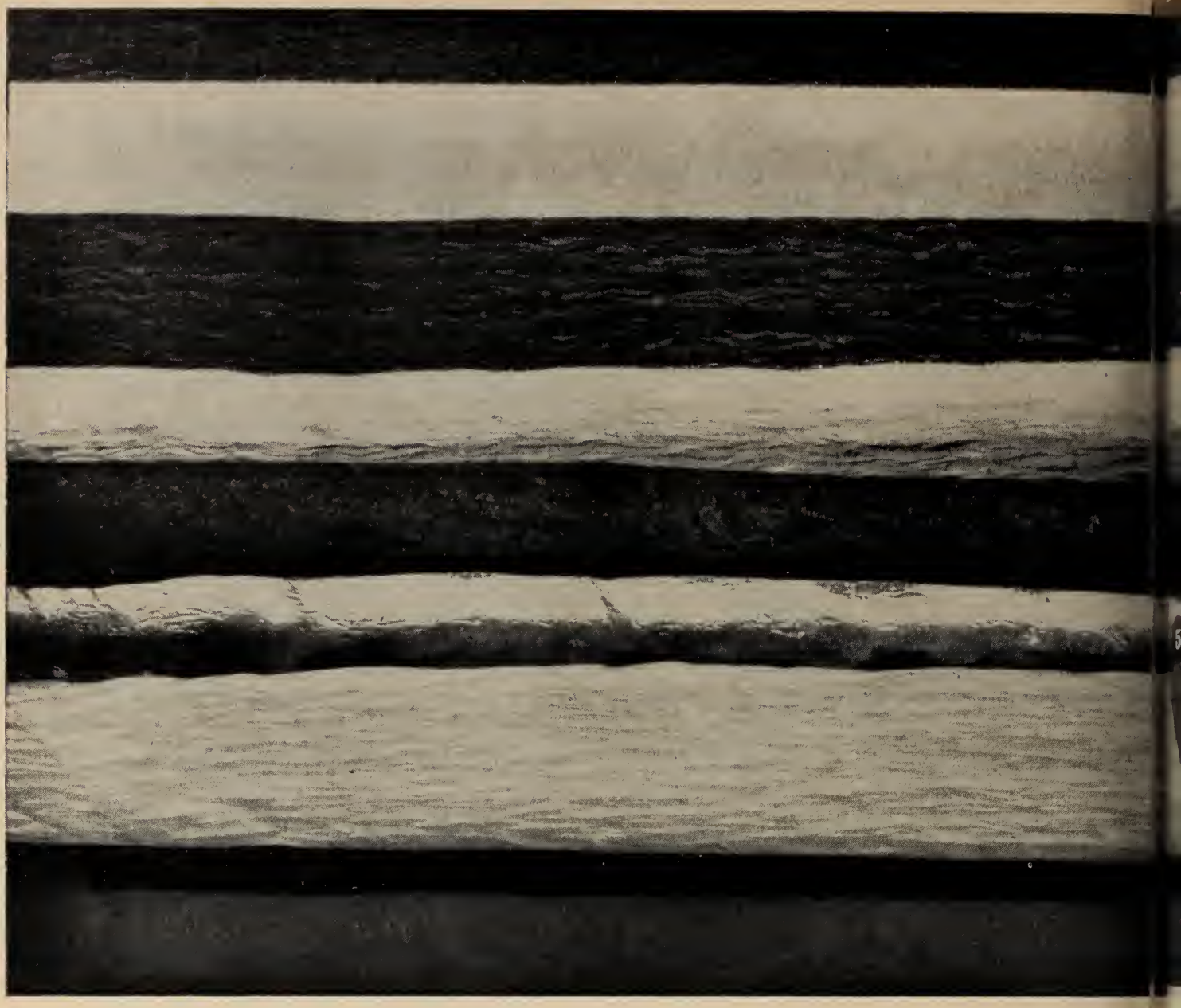

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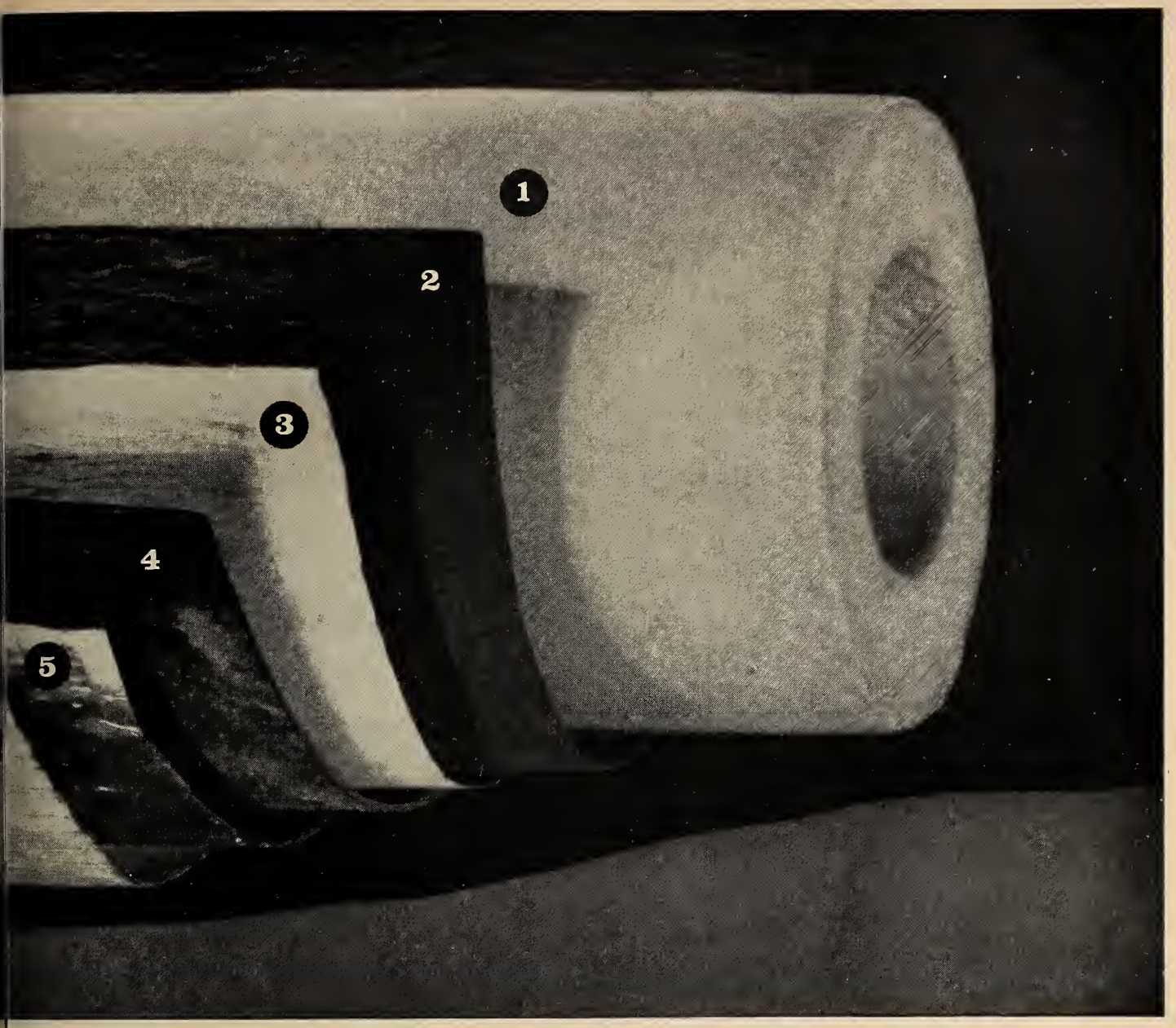

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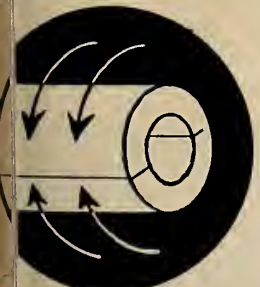

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3	DUAL TEMPERATURE (White)	Three-ply with 45-lb. white bleached kraft; 0.001" aluminum foil; and 45-lb. black asphalt-impregnated kraft. Vapor transmission rate less than .02 perms.	Used for piping below 50 F. (to minus 120 F.) and where piping temperatures vary from hot to cold.
4	WEATHER RESISTANT	Two weights of asphalt-saturated felt available — 45-lb., 55-lb.	For pipe insulation 1" thick and over.
5	FLAME BAR	Flame retardant kraft paper laminated to aluminum foil by a flame-retardant adhesive. Vapor transmission rate less than .02 perms. Aluminum surface is exposed.	Where codes or other requirements call for a fire resistant jacket.
6	GENERAL PURPOSE	45-lb. white bleached kraft laminated to 0.0007" thick aluminum foil. Vapor transmission rate less than .05 perms. Available for ½" thickness only in all pipe sizes.	Used for cold water and hot water service lines. Can be used instead of canvas on hot water and steam lines. (Not recommended for piping operating below 50 F.)

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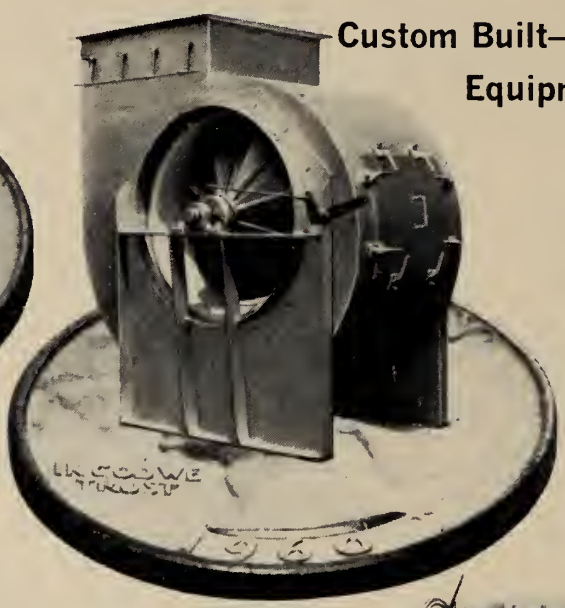

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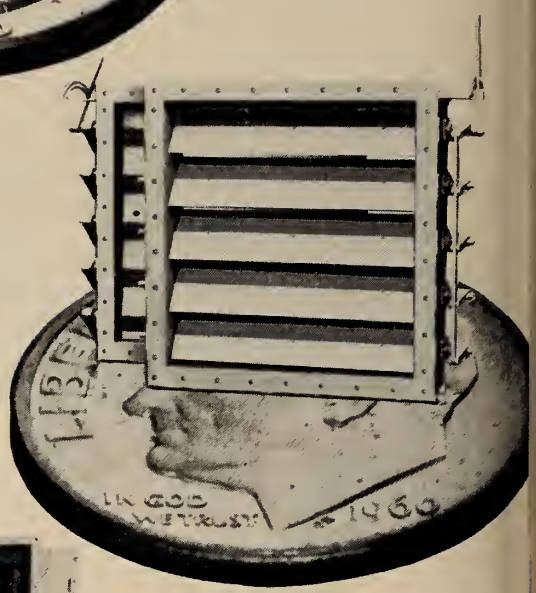

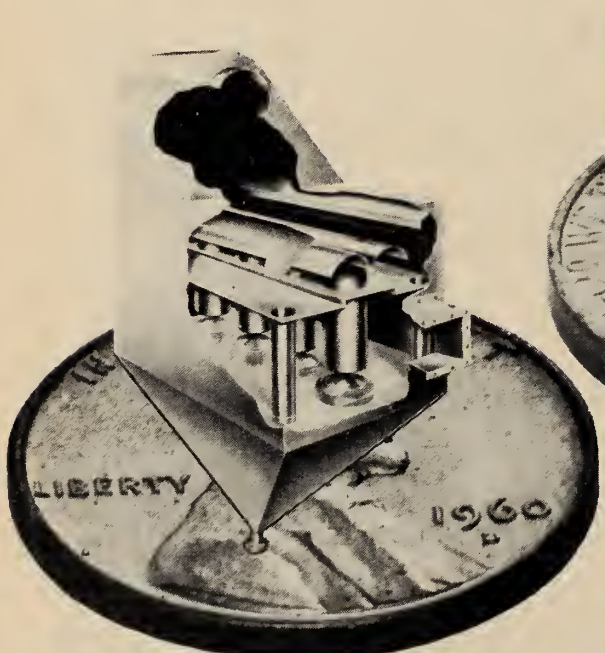

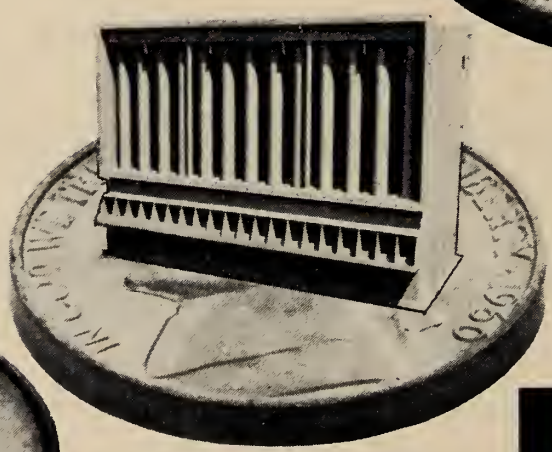

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AN EXPERIMENT IN OPERATIONAL PLANNING

J. W. Johnson, M.E.I.C. C. J. Hudson G. A. Cooper

Operational Research Branch, Research and Development Department, Canadian National Railways

THE CANADIAN NATIONAL RAILWAYS owns 94,200 freight cars. Their replacement value is about $1 billion. Like every other railway in the world, the CN has been seriously concerned about the utilization of its fleet. About 18 months ago the Vice-President, Transportation and Maintenance, directed that an intensive effort should be made to improve freight car distribution. To further this work, a study team was set up representing both the car service office of the transportation department and operational research.

Freight car distribution has attracted considerable theoretical attention. A wide variety of techniques including the use of allocation models, inventory models and queuing models have been applied to the problem of calculating requirements for cars. This paper describes some experimental work on some of the broader aspects of car control. These include the responsibility and authority of the various levels of the organization, data collection, and planning procedures, as well as the actual calculation of how many empty cars should be moved from one place to another. The first figure shows CNR lines in Eastern Canada. System headquarters is at Montreal. The Atlantic Region, where the study was conducted, consists of the lines east of Diamond and Riviere du Loup. The headquarters of Atlantic Region is at Moncton, N.B.

THE PROBLEM

There are a number of large seasonal freight movements which require empty cars to be transferred from one region to another. These include the grain movement from Western Canada, paper loadings in Quebec and Ontario, and potato loadings in the Maritime Provinces. The particular problem selected for detailed study was the supply of refrigerator cars to the Atlantic Region. Each year about 15,000 refrigerator carloads move to the Atlantic Region — largely with export traffic through Saint John and Halifax. About 13,000 carloads of refrigerator traffic leave the region, mainly from the potato growing areas in northwestern New Brunswick and Prince Edward Island. An additional 5,000 carloads annually move from one point to another within the region. All this traffic is much heavier in the winter. Refrigerator cars are, of course, heated in the winter, not cooled, so the name is a bit of a misnomer.

During the year, a net of 2,000 empty cars are returned to Central Canada. However, for short periods between October and May the traffic pattern is reversed. This reversal is due to peaks in potato loadings. At these times empty cars are brought to the region from as far away as Chicago or even St. Louis. During these peaks private refrigerator cars must be rented at a cost of 4.35 cents a mile.

The car supply situation was most critical on Prince Edward Island, as shown in Fig. 2. The graph is for the 1960-61 season, and the number of cars are shown up the side of the chart. The lower line shows the daily loadings averaged over the week. The top line shows the total cars on the Island. The middle line are "active" cars —this includes cars on trains, being cleaned, being loaded, or otherwise usefully engaged. In practice, active cars are calculated by substracting the empty cars sitting in the yard from the total cars.

The figure indicates that the usual situation was a short critical shortage followed by a prolonged period of oversupply.

In the past the movement of empty cars to the Atlantic Region for potato loadings was initiated by a car order from the car distributor at Charlottetown. When he foresaw a shortage, he would call the Area car distributor, who started the available cars toward the Island. The area car distributor would call regional headquarters, who would relay the message to system headquarters. System headquarters then arranged the supply of cars from other regions.

This procedure is designed to handle the supply of a small number of special types of cars, and the organization handles this type of request quite well. For various reasons, however, this decentralized control of cars

Figure 1. Route of Refrigerator Cars in Eastern Canada

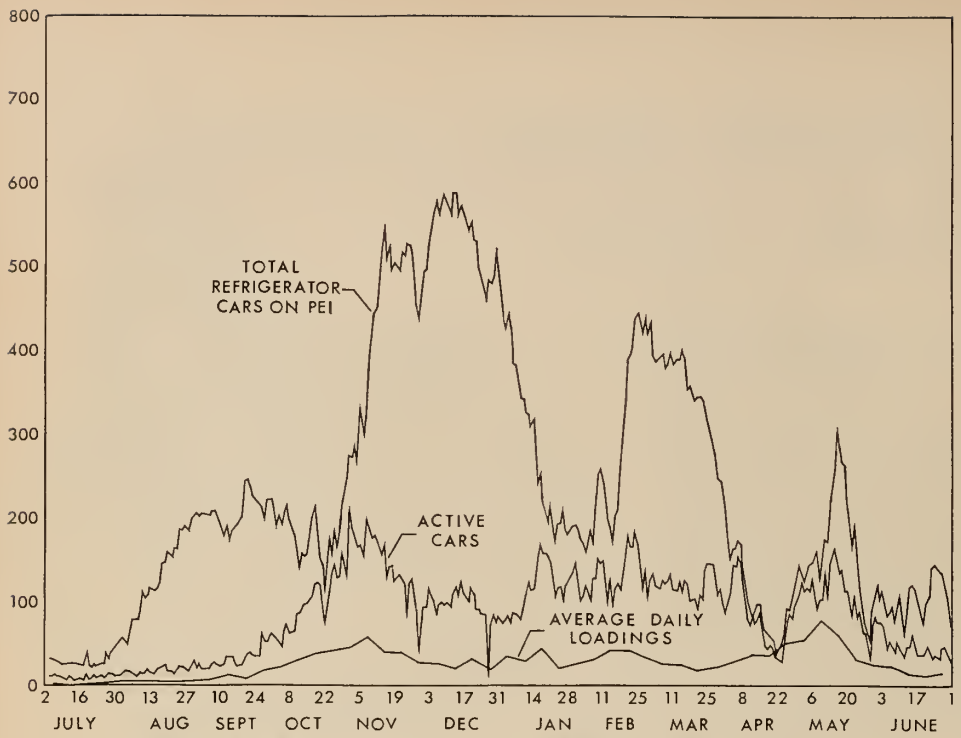


Figure 2. Refrigerator Car Situation on Prince Edward Island 1960-1961

does not work too well in the case of major seasonal movements.

The shortages and surpluses of refrigerator cars occurred mainly on Prince Edward Island, and at first it appeared that the problem might be the estimation of P.E.I. car requirements. However, the problem was quite a bit deeper than this. The reason that shortages did not occur in New Brunswick, for example, was that empty cars were pulled off trains as required. Similarly, if Halifax started to run short, the local car distributor would simply stop releasing empty cars. Both types of action, of course, aggravated the supply problem to P.E.I. considerably.

STRUCTURE AND FUNCTION OF THE CONTROL CENTRE

It was therefore concluded that any proposed system would have to consider refrigerator car requirements for the region as a whole.[1] The logical place to anticipate these requirements was at the Regional headquarters. An experimental car distribution control centre was therefore established in Moncton with the initial responsibility of planning refrigerator car movements in the Atlantic Region.

To carry out the Regional planning responsibility and to have effective control over the car supply situation, a need was recognized for

(a) Procedures for collecting, summarizing and communicating relevant information.

(b) The effective forecasting of car loadings and unloadings.

(c) Targets and control limits on the car supply situation.

(d) The display of information for control purposes.

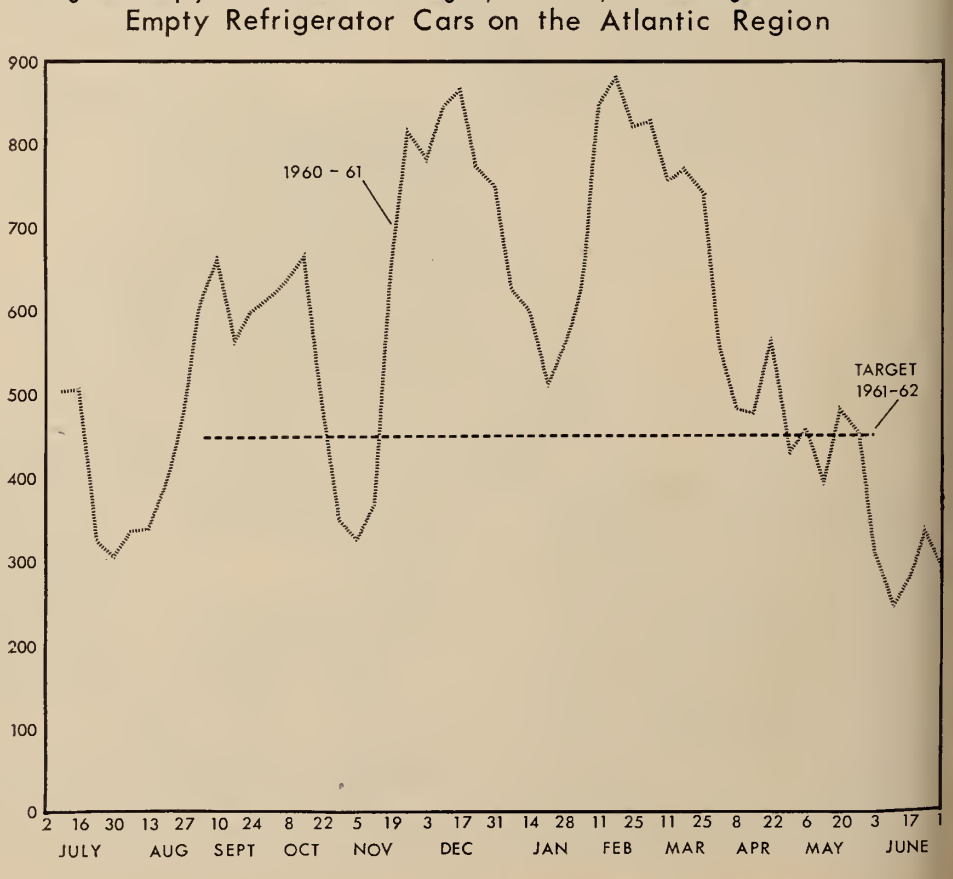
Almost any experimental system will work well with half a dozen analysts and three or four vice-presidents critically reviewing the results. The control centre takes advantage of this effect by building a permanent "spotlight". The control centre is a focus of attention and interpretation and highlighting of what is going on is faciiltated by displaying important information on wall charts. Their value has been summed up by R. H. Tivy, General Superintendent, Transportation, Atlantic Region, as follows:

"In past years I would not enquire about our reefer situation more often than once a week because it would take car service about five minutes to calculate just where we were that day, without giving any idea as to where we had been or where we were going. Now, in just 30 seconds, the whole picture is crystal clear and I can afford 30 seconds every day just to keep up to date. So, too, can the Operations Manager of the Maritime Area and others. You certainly feel now that you're flying less by the seat of your pants and operating in a controlled situation. With a clear picture in mind of what is going on it is much easier to take intelligent action than in the past."[2]

Figure 3. Alternative approaches to Data

Detailed Information on all moves	Summary Information Interchange Loadings Empty Cars
Very Expensive Very Slow	Uses Existing Data Very Fast

Figure 4. Empty Cars on the Atlantic Region, 1960-1961, and the Target for 1961-1962



The main aim of the control centre was to get the right number of empty cars on the region. Any imbalances on the region could easily be adjusted within a day or two by the traditional car control methods. This aim simplifies the data problems considerably, as shown in Fig. 3.

Figure 3 illustrates two alternative approaches to data. In each case the circle represents the regional boundary, and the arrows represent movement information reported for control purposes. The approach to information on the left is to report every move on the region, and also interchange and loading data. This is sufficient data for all possible car distribution problems, but tends to be too expensive and too slow.

Having defined the problem to be to get enough cars on the region, much less information will do. The basic requirement is for regional interchange data, an estimate of the internal traffic as a whole, the total number of empty cars on the region and certain special information on the timing of requirements. This information was already reported through existing channels, and well within the time requirements necessary for control.

OPERATION OF THE CONTROL CENTRE

The three stages in the operation of the control centre were the analysis of historical data, the calculation of car requirements and controlling the timing of movements. The historical analysis was done by the study team. We then worked with the Atlantic Region's Supervisor of Motive Power and Car Service in interpreting the results and helped calculate the first car order. After that, the operation of the control centre was handled by Atlantic Region personnel.

CALCULATION OF CAR REQUIREMENTS

The first step in calculating the car order was to set a target for empty cars on the entire region. In the previous year, 1960-61, empty cars varied between 286 and 904, with the weekly average, shown in Fig. 4, varying over a slightly narrower range. When the weekly average empty cars fell below 350, a shortage occurred somewhere. Therefore this level was set as a minimum. A target of 450 cars was then set to allow a protection margin for variability. The governing factor on the protection was the variability in the supply of empty cars, not the variability in car loadings. Since it was hoped to reduce the variability in car supply, the protection was set largely on the basis of judgment.

The next problem was to convert the target into a car order. To accomplish this, the number of cars which should have been moved to the Atlantic Region in the previous season to keep the number of empty cars constant at the target level was calculated. Figure 4 shows the interchange of loaded cars to and from the Atlantic Region during the 1960-61 season. The peaks in October, January and May can be seen clearly.

It takes about two weeks for a car received in interchange to move to the unloading point, be unloaded, cleaned, moved to the loading point and then moved off the region. Therefore the net number of cars available, which we have called the net "phased" movement, was calculated. This was the loads to the region two weeks previously less loads from the region this week.

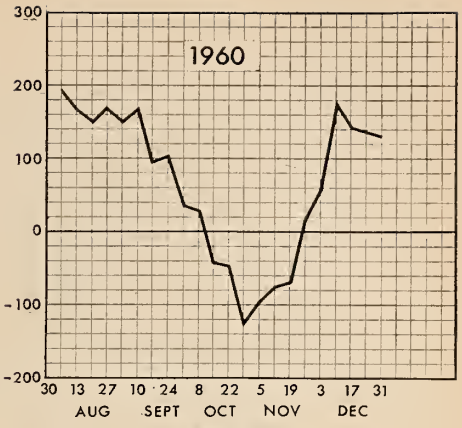


Figure 6
Net Interchange of Loaded Refrigerator Cars Phased Two Weeks. (To Minus From)

A graph of this is shown in Fig. 6. The total number of cars required was found by adding the ordinates for the six weeks in the fall of 1960 when the net movement was outbound.

The previous year's requirements were then used as the forecast for the current season. The rest of the calculation is shown on Table 1. Added to the phased interchange of loadings is an allowance for a forecasted increased internal traffic during the period of interest. This was estimated to be 150 cars per month at two trips per car per month or 75 cars. To the total, an arbitrary 15% safety factor was allowed, making a total of 615 cars.

Figure 5. Interchange of Loaded Refrigerator Cars To and From the Atlantic Region, 1960-1961

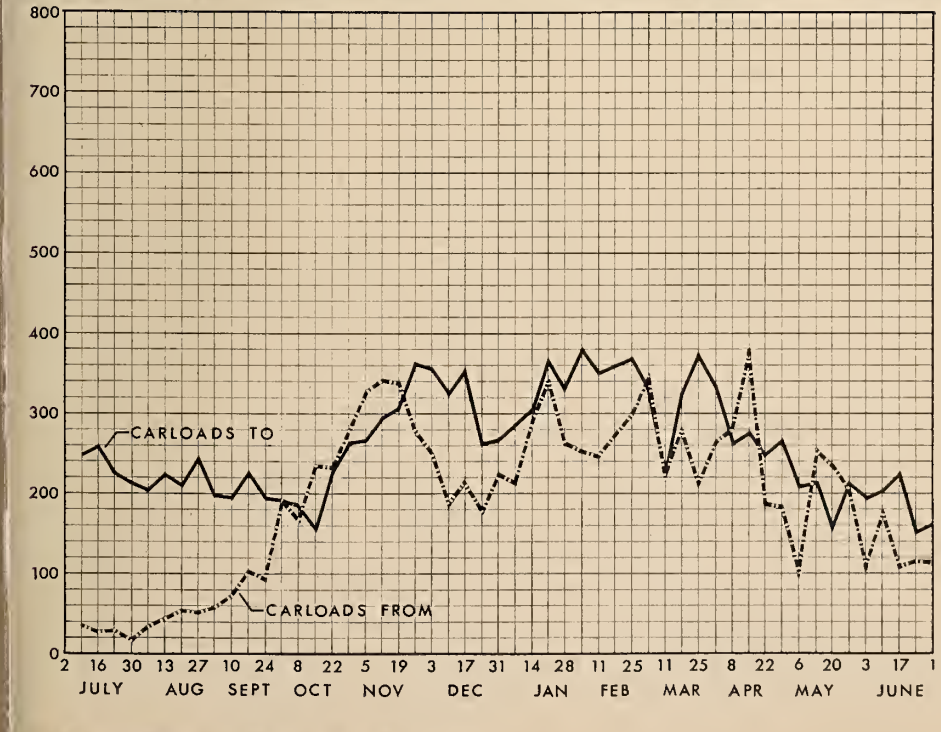


TABLE 1

Forecast of Atlantic Region Refrigerator Car Requirements October 8—December 1, 1961

1. Desired inventory of empty cars		450
2. Initial inventory, October 5, 1961		450
3. Net difference in inventory		0
4. Expected outbound less inbound loads (phased) October 8—December 1		460
5. Extra intra-regional loads	= 150/month	
Carloads per month per car	= 2	
Extra cars for internal traffic	= (150/2)	75
6. Expected requirements		535
7. Safety factor	(15%)	80
8. Total requirements		615
9. Car order	85/week	

In practice the procedure has been to re-estimate regional requirements weekly for the succeeding six weeks.

CONTROLLING THE CAR SUPPLY SITUATION

The timing of requirements is fairly accurately determined by the situation on Prince Edward Island, because the biggest seasonal surges originate there. Because of the traffic pattern, shortages or surpluses are bound to appear on P.E.I. first. Therefore, in addition to the charts showing the over-all regional situation special charts are maintained which warn when to modify or cancel car orders. The timing problem is shown in Fig. 7, which shows normalized loadings on P.E.I. during the previous four years. It is clear from the diagram that the November and January peaks are quite predictable timewise, but the spring peak can occur almost any time.

The P.E.I. control chart is shown next, in Fig. 8. Typical total cars, active cars and average daily loadings in previous years were drawn for reference. Control limits were then drawn. The upper control limit was set arbitrarily at about 300 cars. The lower limit was set at about five days' supply plus 50 cars.

The loadings in the early fall of 1961 were lower than in the previous year, but at the time it was difficult to tell if the season was just late or if fewer cars would be required. The situation chart for P.E.I. on November 20, 1961 is illustrated in Fig. 9. The "active" car line had just started to break downwards, and changes in active cars had been found to give about three days' advance notice of changes in the loading trend. The number of empty refrigerator cars on P.E.I. was high and the number of empty cars on the region (Fig. 10) was climbing. Therefore the Atlantic Region controller cancelled the car order without waiting for someone to inform him of an oversupply situation. This decision illustrates that the control of inter-regional movements requires judgment, initiative and the ability to grasp the over-all situation.

RESULTS

Figure 10 shows the main results. The heavy solid line shows the number of empty cars on the region this year. The peak number of empty cars on the entire region was reduced by about 300 cars. The number of empty cars straddles the target, and on the low side the number is close to, but still above, the minimum of 350 cars. Except for two weeks in the spring of 1962 when the strait between P.E.I. and the mainland was filled with ice, there was no shortage of cars.

Not only has the amplitude of the savings in car supply in Fig. 10 been reduced by half, but the wave length has been reduce by half also. Each wave is caused by a problem or decision faced by the car controller, so the number of his problems has doubled. In the past many of these problems did not arise because the normal situation was a large surplus.

It was concluded that the information and advice available was used to good advantage by the Atlantic Region's transportation department. Action was taken without waiting for shortages or surpluses to occur in the areas. The result was both better equipment utilization and better service to customers.

Figure 7. Weekly Loadings on Prince Edward Island Normalized to 1957

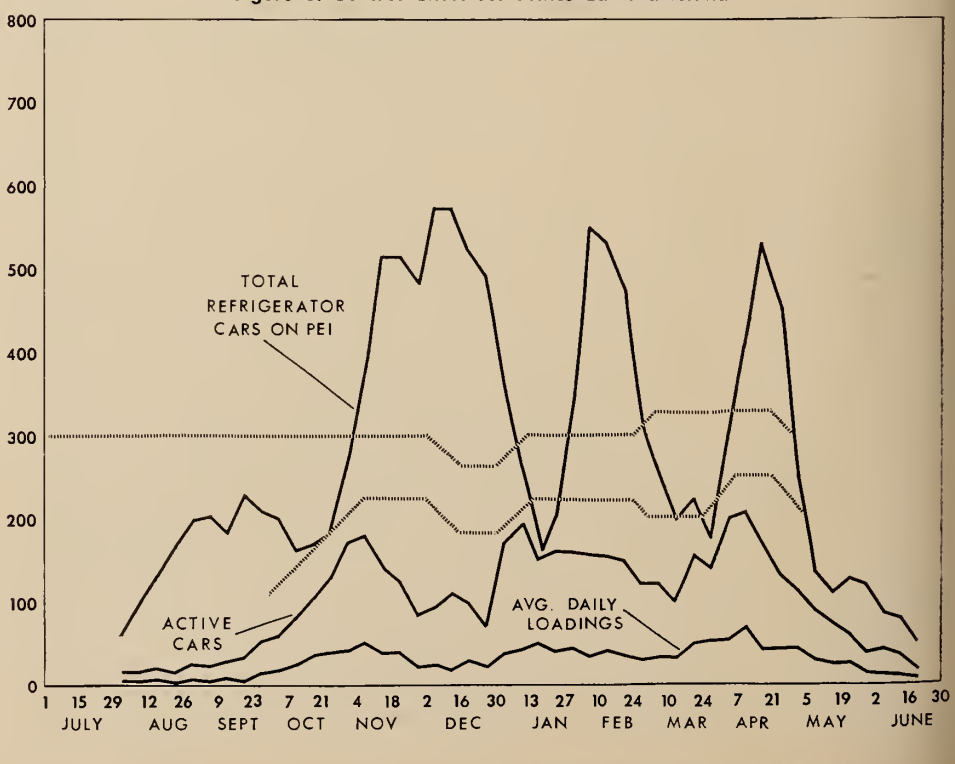
DISCUSSION

The nature of the changes in the various aspects of structure and function are discussed in the following sections.

(a) **RESPONSIBILITY**—The most important improvement was that the responsibility for controlling refrigerator car utilization was clearly defined and was delegated to a specific individual.

(b) **AUTHORITY**—The authority of the Transportation Department was

Figure 8. Control Chart for Prince Edward Island



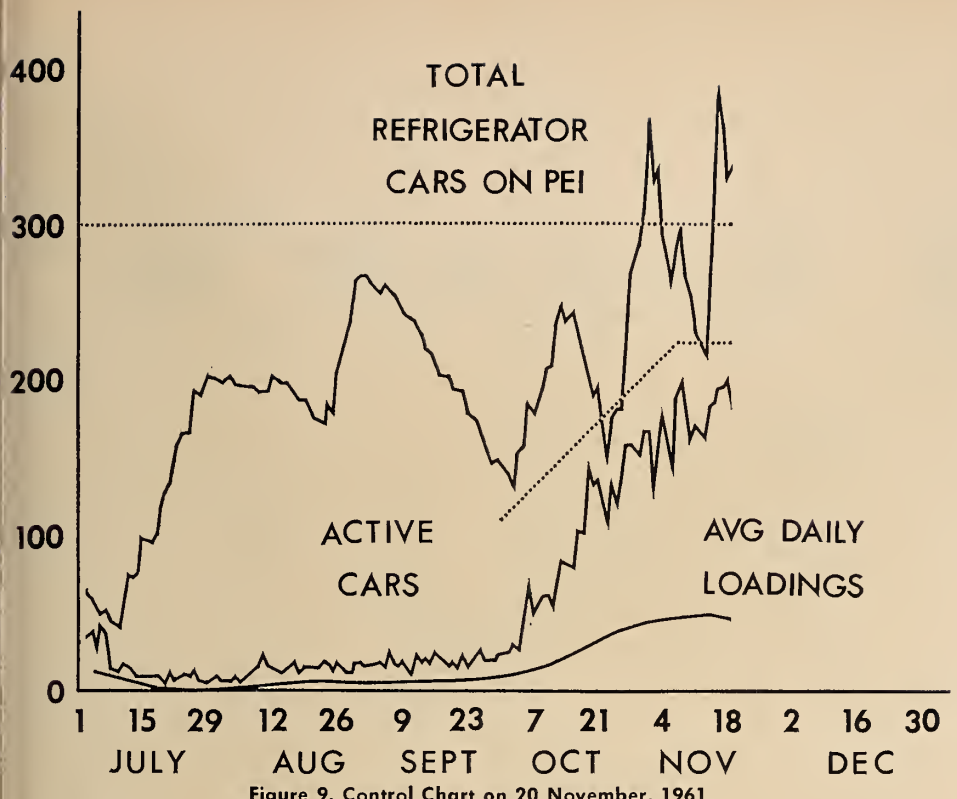


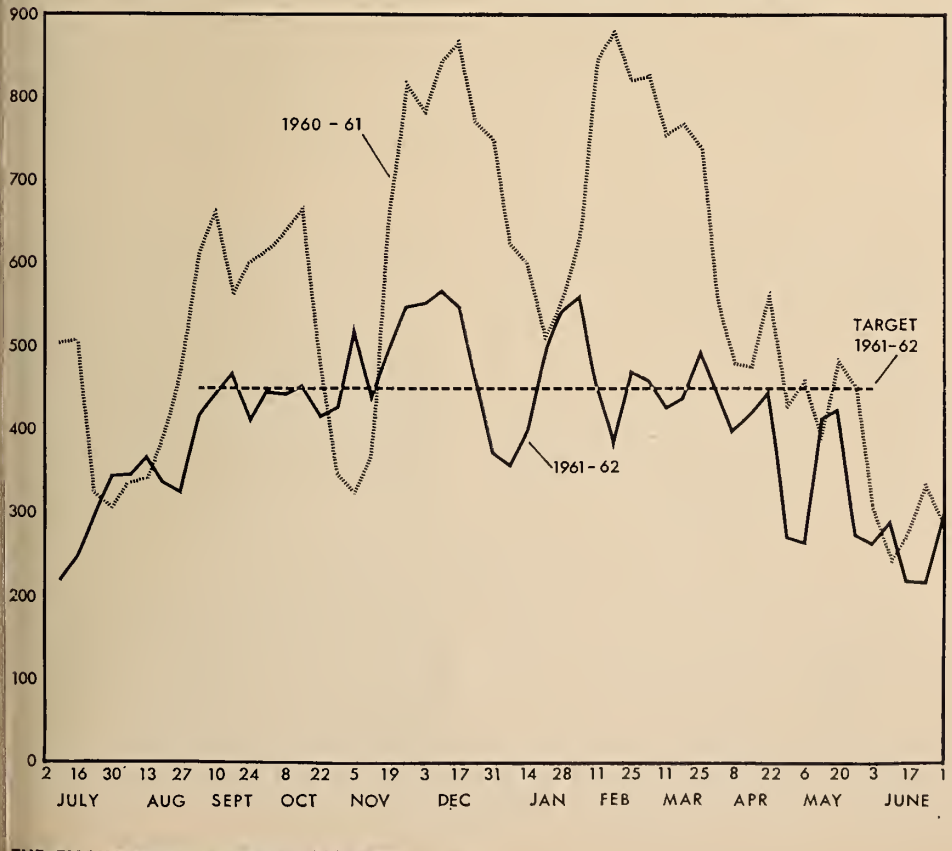
Figure 9. Control Chart on 20 November, 1961

not changed. However, the control centre helped the General Superintendent, Transportation, in the effective use of his authority.

(c) **DATA**—The data were all obtained from the existing manual reporting system, and proved both adequate and timely for their purpose. Although improvements in data are desirable, these are not a critical factor for improved car utilization.

(d) **PROCEDURES**—Planning and control were logical extensions of existing car distribution procedures, using simple arithmetic methods. The important practices were the use of targets, control limits, and quantitative forecasting of car requirements.

Figure 10. Empty Cars on the Atlantic Region, 1961-1962



(e) **HISTORICAL ANALYSIS**—About one man year was invested in the historical evaluation of the traffic pattern of loadings and unloadings.

(f) **DISPLAY OF INFORMATION**—Although the information displayed was available in report form, charts were more effective. In particular, they assisted car service officers in recognizing trends and anticipating car requirements.

The results indicate some avenues which can lead to significant improvements in equipment utilization. However, the various aspects of the control system could only be compared qualitatively. The quantitative evaluation of the structure of a system is a profitable area for intensive research.

SUMMARY

A test of procedures for planning and controlling major inter-regional movements of freight cars has been described. The test was confined to one region and one type of car, but the procedures were designed to meet the general problem of controlling inter-regional movements and were not a tailor-made approach to a special situation. The planning and control procedures were logical extensions of existing car service practices.

Important developments were the use of targets, control limits, and quantitative forecasting of car requirements based on a thorough analysis of historical performance. The most important improvement was the clarification of the regional headquarters' responsibility to anticipate the requirements and surpluses for the region as a whole and the development of methods to allow this responsibility to be discharged more effectively. The main result of the study was that the peak number of empty refrigerator cars on the Atlantic Region was reduced by 300 cars compared with the previous year, while service to customers was noticeably improved. In the first eight months of operation, which covers the traffic season, the saving in empty car days was 48,000 or 32%.

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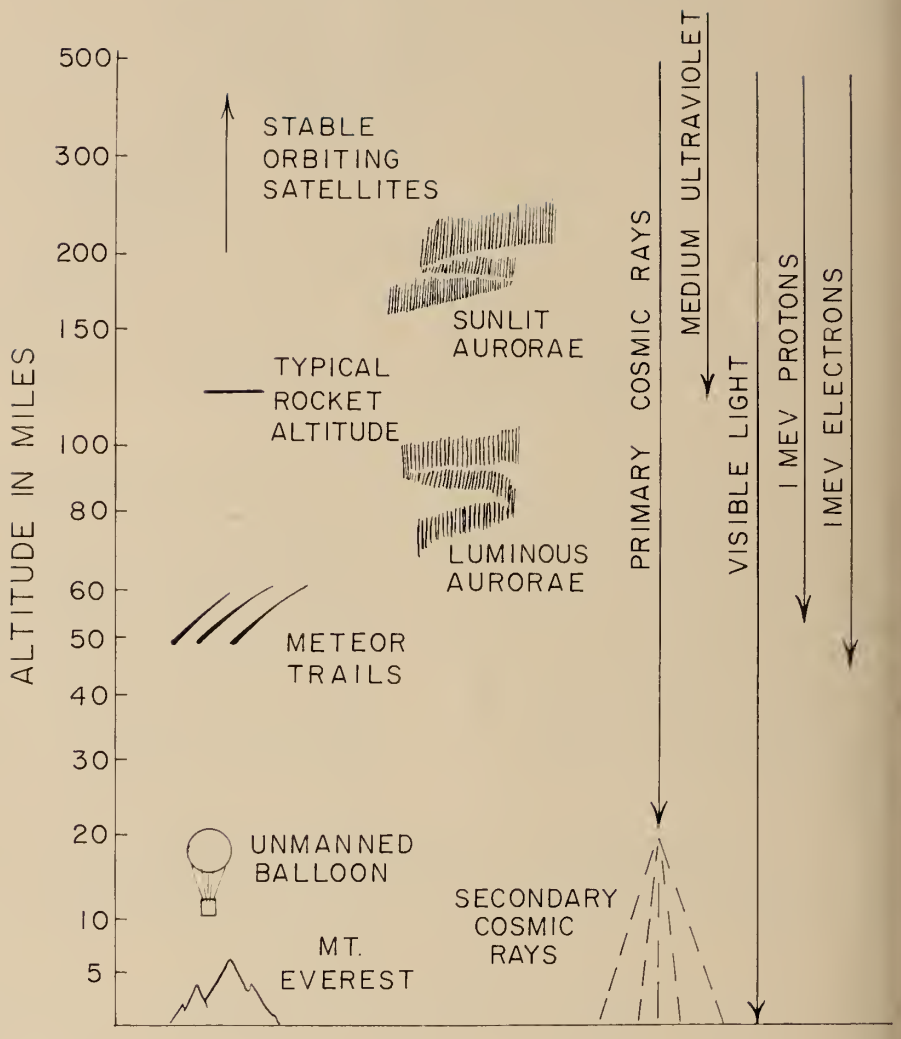


THE term "space research" today tends to mean the exploration of space by vehicles carrying instruments, or more often, men. It sometimes has a more restricted meaning — the engineering of the vehicles themselves. There is a much wider meaning however — the study of that part of the universe which lies outside the surface of the earth, by any means at man's disposal. The oldest of the sciences, astronomy, is also the earliest space research. The older methods of astronomy were the "purest" of pure research, as only observation and hypothesis were possible. The tests of hypothesis by controlled experiment could not be carried out, and so any attempt at applied science or engineering was bound to fail. Considering the difficulties, the present understanding of astronomical phenomena is remarkable.

Studies of the nearer regions of space have been similarly restricted. Until recently they have been pure sciences in the same sense as astronomy — that is, it has not been possible to create a deliberate disturbance, in order to observe the effect. One of the most interesting regions, and perhaps the most important to man, lies between the sun and the earth. In this region there is a discernible boundary between outer space and our atmosphere. It is at this boundary, and in the adjacent

TABLE I

ROCKET CHARACTERISTICS

	BLACK BRANT II	BLACK BRANT III
Diameter	17.2″	10″
Length	27.5′	18′
Weight	2817 lbs.	675 lbs.
Altitude	120 miles	120 miles
Typical Payload	150 lbs.	40 lbs.

Note: These rockets are designed and manufactured under a cooperative development program between the Defence Research Board (CARDE), Department of Defence Production, and Bristol Aero-Jet Limited, Winnipeg.

volume that many of the spectacular natural events can be seen: for example, the aurora and "falling stars" or meteors. It is here that the earth's magnetic field reacts with the ionosphere with important effect upon radio communications. Because of the geographic position of the earth's magnetic field, with respect to Canada, Canadian scientists have long been interested in its effect upon this boundary region. The term "upper atmosphere" is frequently used to describe the boundary region.

INTEREST at the National Research Council in upper atmospheric work arose as a result of World War II radio science and engineering. The principles of radar and its wartime employment arose out of the study of the ionosphere by the use of radio pulses, in the early 1930's. These ionospheric studies, which set out to be a "pure science", soon became of practical engineering importance for the prediction of radio communication conditions. The techniques and knowledge of radar gained during the war by Canadian engineers and scientists has been put to use for the observation and study of meteors and auroral phenomena.

This interest in the upper atmosphere is shared by groups of physicists in the universities for much the same reasons. It is natural then that when means of making direct measurements in the upper atmosphere became available that these scientists should wish to use them.

Another line of pure science which leads to much the same need for direct measurement is the study of energetic particles, cosmic radiation, which as the name implies arises from extra-terrestrial sources. This work at NRC has been carried out by a group of physicists, again in part, because the earth's magnetic field plays a part in the distribution of the radiation. In the polar areas, within the auroral belt, the distribution and strength of this radiation is of interest and importance. The data on particles of low energy is of interest to scientists. Direct measurement above the atmosphere is necessary since this relatively weak radiation does not penetrate into our atmosphere. The Alouette Satellite contains an experiment designed by this group.

FIG. 1. Polar Map of Features of Significant Canadian Interest. Auroral Maximum is Maximum Frequency of Visual Observation.

The chemical composition and physical state of the upper atmosphere can be determined more easily by direct measurement. Temperature, pressure, wind condition and tidal movements can be measured and confirmed. These physical quantities have practical importance. To some degree the surface weather is dependent upon their variations. The effects of the sun's energy at various wavelengths upon the earth are closely connected with the composition and physical state of the upper atmosphere. The filtering of damaging radiation is a function of the chemistry and physics of the upper atmosphere. Physical damage by meteors is largely prevented by the physical properties of the upper atmosphere. Certain physical and chemical reactions take place in the boundary regions which do not occur at all in the laboratory. Some of these reactions have practical importance in industry and agriculture, particularly those associated with the various forms of atomic oxygen and nitrogen.

Another subject, initially of purely scientific interest, is the study of radio emission from the sun. During the war years, it was observed that the sun was a source of radio noise. As a result of wartime radar experience, NRC began a series of observation on the generation of radio noise by the sun in 1947. These measurements are made at a frequency of 2800 megacycles. This series of observations, one of the longest in the world, has now become much more important because of the increased interest in solar activity, and its potential effects on manned space exploration. As disturbances, such as aurora and magnetic storms, in the upper atmosphere are known to be associated with solar activity, it can be seen that a good deal of effort at NRC deals with the upper atmosphere and associated phenomena, and has done so for a number of years.

With this long established interest in view, it is easy to see why NRC has an interest in rocket experiments since both direct measurements, and to a lesser extent experiments in which deliberate disturbances may be introduced are now possible. Rockets

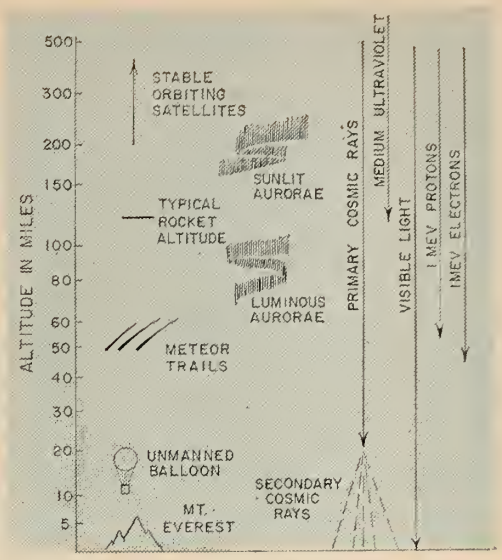


FIG. 2. Altitudes of Some Features of Interest in Upper Atmosphere Research.

are also capable of making measurements at altitudes above those reached by balloons, and less than those at which a satellite can be maintained. These altitudes lie between 100,000 ft. and 600,000 ft. As compared to satellites, it is simple to obtain vertical distribution of quantities in the above altitudes, often in association with the passage of a satellite. Similarly, synoptic observations from many points on the earth's surface are possible. With some difficulty direct measurements may be made of specific events in time, or in direction: for example, during a solar disturbance or directly into an auroral display. It is also possible to make measurements using very wide frequency bandwidths over a short period of time. Such a measurement may require a large power source, which is difficult to provide in a satellite. These advantages, taken with the relatively low cost of rockets, as compared to satellites, make the rocket attractive to scientists engaged in upper atmospheric research of most kinds.

THE National Research Council has a mechanism for exploring a new field of research, or new ways of doing research. This method has been used by the National Research Council since it was founded in 1917. It consists of the formation of what is known as an Associate Committee. An Associate Committee is composed of engineers and scientists with special technical knowledge in a particular field. The practical experience of industry is often obtained from representatives of the various companies engaged in the same or related fields.

Co-ordination of effort, and the exploitation of the best methods of tackling a scientific problem are sought. The best place or places in which to carry out research are deter-

mined, and the most promising areas of research are outlined. Financial grants may be obtained from the National Research Council, or from other sources, to promote research in the field of interest. Such grants may be placed in the hands of researchers in the universities, or in industry, for the purchase of special equipment.

Another function which such Associate Committees frequently provide is representation of the Canadian scientific viewpoint to various international groups. Two such groups have a direct interest in space research. The first is the International Council of Scientific Unions, which was responsible for sponsoring and for the success of the International Geophysical Year. The late Dr. E. W. R. Steacie, Hon. M.E.I.C., was the President of the I.C.S.U. at the time of his death, as well as, of course, President of the National Research Council. The I.C.S.U., in 1958, established a Committee on Space Research known as COSPAR, which is intended to coordinate and foster scientific space research on an international scale, following the general pattern of the I.G.Y.

The second group, which is political, but non-military, is the United Nations Committee on the Peaceful Uses of Outer Space. This Group is intended to foster international cooperation in scientific research, to exploit the peaceful uses of space research, and to study the international and legal problems which are likely to arise from space research. These international bodies which are non-military require the national representation to be from a National Academy, or its equivalent. The National Research Council meets this requirement.

When it became apparent that space research was to be of long term future interest to scientists in Canada, an Associate Committee on Space Research was established under the Chairmanship of Dr. D. C. Rose, M.E.I.C. Dr. Rose is a scientist of international repute, in the field of cosmic ray research, and with considerable experience in the organization of international scientific effort, having been responsible for the coordination and representation of Canadian science in the International Geophysical Year. The other members of the Committee are drawn from the Universities, the Defence Research Board, and other parts of NRC. At an early meeting it was decided that the most useful results would come from rocket exploration of the upper atmosphere, for reasons which were outlined in the introduction.

THE most useful place to carry out rocket experiments is at Churchill, Man., which was established as a rocket range in 1955-56, in preparation for the International Geophysical Year. This range, under the direct command of the Canadian Army, has been operated as a rocket research facility originally by the U.S. Army, but now by the U.S.A.F., first as part of the I.G.Y., and later as a continuation of that program beyond the original time limits. Its advantages are: First and foremost it is in a region of maximum auroral activity. It is close to the magnetic pole, and is relatively easily reached at any time of the year. It has both the Hudson Bay, and a large unpopulated area into which the rockets can fall.

Fortunately, the Canadian Armament Research and Development Establishment of the Defence Research Board had developed a rocket, then known as "Snow Goose", and now known as Black Brant I. This rocket was essentially a test vehicle for a rocket motor, which CARDE had developed in the course of their work on propellants. The design of BB I and its successors, BB II and IIA, is ideally suited to scientific rocket sounding having payload capacities up to 150 lb. and altitudes of a hundred miles or more. The significant differences in these rockets are in the burning time of the motor. Rocket motors with longer burning times are desirable since they reach peak velocities at higher altitudes, and therefore have lower aerodynamic and thermodynamic losses. The major problem in rocket design is to achieve the maximum velocity with efficiency, and at the same time retain aerodynamic stability. This requires minimum weight structures, careful control of centre of gravity, and centre of pressure, as well as precise aerodynamic design of the fin stabilizers. The margin between a successful rocket and a poor one is slight. In addition, some of the thermal and aerodynamic problems do not yield to analytic treatment and the final proof of a successful design must be achieved by flight testing. Many of the problems of aircraft design are present in rockets without an opportunity to carry out extensive flight tests, since a rocket is likely to be in flight for less than 10 minutes, and, in fact, the critical period—the flight in dense atmosphere—is usually less than a minute. Velocities of the order of 5000 f.p.s. are not unusual.

ASSUMING that the vehicle problems are solved, there remains the problem of obtaining the results of the measurements. There are, in general, three methods of obtaining these results. The first is by converting the measured quantity to an electrical signal and transmitting it to the ground. This is radio telemetry. The second is by recording the measured quantity on film or tape, followed by recovery of the data after impact. The third is by direct observation. For example, the injection or "seeding" of certain gases, into the upper atmosphere, permits the observation of chemical reactions which result in the emission of light, and so allow the determination of some of the constituents and properties of the upper atmosphere.

The program of scientific rocket sounding at NRC will use radio telemetry for most experiments in the early firings at least, although we have assisted in the ground observations of some of the seeding experiments. The telemetry system used operates in the VHF region between 215 and 260 mc, which starts just above TV Channel 13. The transmitted power is less than five watts, usually about one watt. The prime power sources are usually nickel cadmium storage batteries, as the energy-to-weight ratio is better than for other methods, if all the conversions to electrical energy, as well as voltage transformations are considered. In addition, the variation in output is small, which is important if precise measurements are required. The requirement for many measurements taken simultaneously require a system which allows simultaneous transmission of the measurements. This can be done by using a number of frequencies. This system, known as FM/FM, is the one we use. The radio link to the ground uses frequency modulation, and the measured quantities are converted to frequency analogues in a number of channels between 5 kc/s and 100 kc/s, in which a change in the quantity is represented by a change in frequency. This changing frequency is used to modulate the main radio link, itself a frequency modulation system, hence FM/FM. Several slowly changing quantities may be sampled in successive intervals of time, leading to a series of pulses, each having some amplitude representing the magnitude of a quantity. Such a system is known as "pulse amplitude modulation". We use this system in combination with the FM/FM system to telemeter such quantities as temperature, pressure, and other slowly changing variables. Often these are rocket vehicle performance figures. When received on the ground, these quantities are recorded on magnetic tape, from which they may

be subsequently transferred to chart paper, for further analysis.

It is possible to transmit nine continuously changing measurements, and another 25 slowly varying quantities with this system. An overall accuracy of about 1% is possible and changes taking place in a millisecond may be transmitted. A large amount of equipment on the ground is required to receive, demodulate, record and analyze the signals. In our own case the dimensions of the ground station equipment are 6 ft. high, 10 ft. wide by 2 ft. deep. The power required to run this equipment is five kilowatts.

THE planning and management engineering aspects of a program of this kind are unusual for a scientific program. The rocket itself requires three kinds of engineering: the motor system, the aerodynamic system and the electronic system. These parts are often designed and manufactured in widely separated places. In most instances the engineering required cannot be found in standard textbooks. Liaison with the scientists from universities throughout Canada requires the ability on the part of the engineers responsible to learn and appreciate rapidly a variety of advanced scientific ideas and principles. As the firing must be carried out at a distant place, at a reasonably firm date in the future, it can be seen that a great deal of organization and planning are required. As several experiments may be carried out in one rocket, and since several rockets may be in preparation at any given time, it is clear that careful co-ordination is required.

The detailed engineering of the payload requires planning to achieve the maximum economy of weight, space, cost, power, information rate, and reliability. The environmental conditions in a normal rocket flight are not severe. Vibration is about the same as for an automobile, and certainly less than for a freight car. Shock is about the same as occurs in a fall of a few inches onto a hard floor. Linear acceleration is about 50g, but since it is in the direction of flight, it does not present serious problems since its effects can be readily anticipated. Unpressurized payloads, however, must be capable of operating in vacuum. This usually causes problems in heat dissipation, and electrical breakdown. Special techniques for reducing friction are often needed as the coefficient of friction may become large under these conditions.

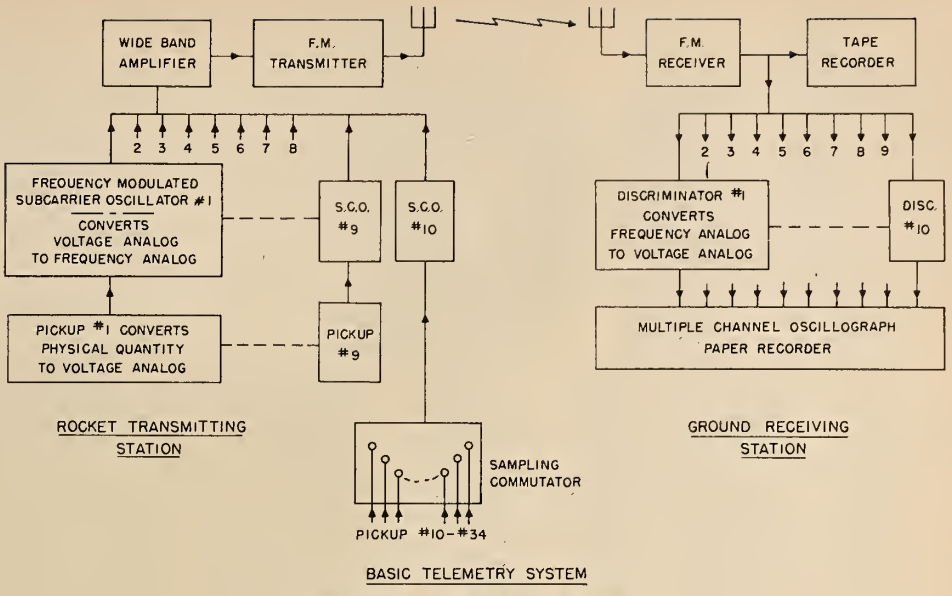


FIG. 4. Basic Telemetry System.

Great care in design and fabrication is necessary for reliability, since a single component failure can ruin a rocket experiment. Long life is not necessary, as in a satellite. While the normal conditions are not severe, a vehicle malfunction can produce accelerations, and temperatures which may be large indeed. The instrumentation which measures rocket performance should continue to operate after the onset of a disturbance since evidence may be obtained of the nature and cause of the failure. This may be used to prevent future malfunctions.

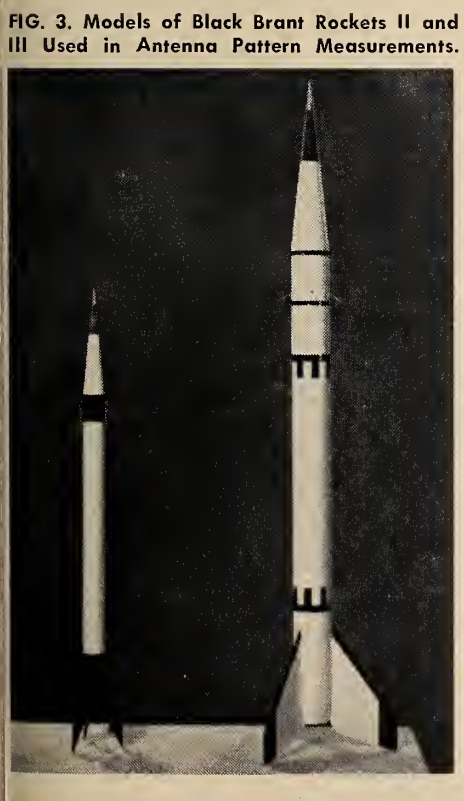
To achieve this desirable reliability, careful environmental testing is required. A further problem is the prevention of mutual interference between a variety of precision electronic equipment tightly packaged into a small space.

ON the engineering side, there is in addition to the participation in the sounding program a considerable amount of development work carried out at NRC. This takes place mainly in the engineering divisions. In the National Aeronautical Establishment, the use of aerodynamic theory, and of the supersonic and hypersonic wind tunnels in vehicle design is obvious. This division is actively engaged in model testing of a new rocket design. This new rocket is one of a series sponsored by a commercial company, Bristol Aero-Industries Limited of Winnipeg, the Defence Research Board, and the Department of Defence Production. It must be emphasized that these rockets are for scientific sounding, and represent an opportunity to exploit our technological skill by increasing export sales.

The Mechanical Engineering Division has an interest in and are carrying out studies in the problems of ignition of propellants. One of the most interesting developments from this Division is the self-erecting antenna, which is used on the Alouette Satellite. This antenna uses a predistorted tape, stored on a drum, which forms a spiral wound pipe when unwound from the reel. The original invention was made following the war and was used for military purposes. It is now manufactured by DeHavilland and is being widely used in space research, and for other uses.

In the Radio and Electrical Engineering Division, we have been engaged in the development of antennas for use on rockets; in particular, one which will withstand temperatures which can approach 1500°F. In addition, we have developed a transistorized transmitter, employing a novel circuit for which a patent application has been made, and which can provide an output power of one watt, up to 300 mc/s. This and other components are being produced under

FIG. 3. Models of Black Brant Rockets II and III Used in Antenna Pattern Measurements.



an agreement between Bristol Aero-Jet Limited and Canadian Patents and Development.

Another item of importance in Space Research, which has been developed in the Radio and Electrical Engineering Division, is the Inverted Magnetron Ultrahigh Vacuum Gauge. This gauge allows the measurement of vacuum pressures lower by two or three orders of magnitude. This new gauge removes many of the problems associated with both measurements of gas pressure in outer space and also permits the measurement of ultrahigh vacuum in space simulation chambers. This device now is being manufactured under a licensing agreement.

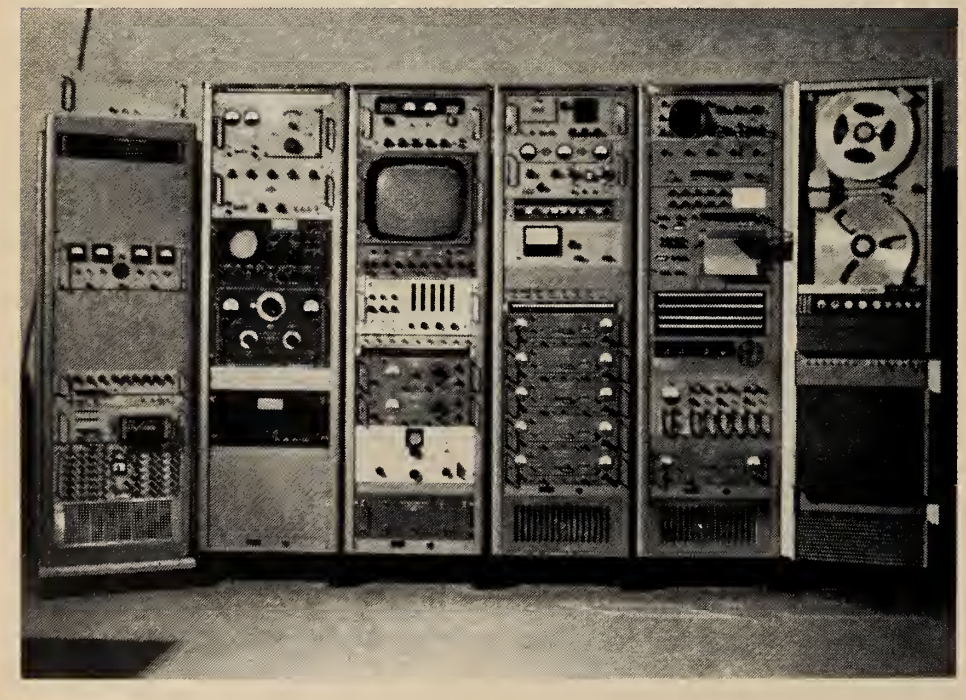
In addition to this work, the Division has been responsible for the supervision and operation of a satellite tracking station in Newfoundland, under an agreement between the Governments of Canada and the United States. This station is part of the NASA network of tracking stations, but is operated under contract to NRC by a commercial company.

ONE may ask why we engage in space research at all. There is no simple, single answer. To be sure, national prestige, both internally and externally, is enhanced by the more spectacular space achievements. These are incidental, however, to the main aims of science and engineering. The aim of science is to understand our environment and to predict its behaviour. The aim of engineering is to control our environment by the application of science. Within a nation, science and engineering should have three aims. The first is to study nature to enhance our knowledge. "Science for science's sake", if you wish. The second is to provide for the scientific education of future generations. The third is for the development of the national economy and well being. These three are interdependent, and equally important. Sir Francis Bacon, 350 years ago, recognized these three roles. In his "New Atlantis" he proposes what amounts to a research centre—"Salomon's House". He has a staff of nine divided, as he says "We have three that try experiments such as themselves think good. These we call pioneers. We have three that bend themselves, looking into the experiments of their fellows and cast about how to draw out of them things of use and practice for man's life and knowledge. These we call benefactors. Lastly we have three that raise the former discoveries by experiments into greater observations, axioms and aphorisms. These we call interpreters." Even though he is wrong about the numbers, it is difficult to improve upon his description of the relationship of science, engineering and education.

It is clear that the direct application of space research in the fields of communication, meteorology, navigation and mapping will have a significant effect on the control of man's environment. The knowledge to be gained of the upper atmosphere will be equally useful. To obtain the benefits for our national economy, we must have the trained scientists and engineers with "know why" and "know how", so necessary to our industrial technology, so that we may benefit from the advantages of space research. We are surprisingly well on the way now. There is a company in Canada developing rockets, and about to manufacture solid propellants in a new propellant filling plant. Another company is designing and developing the radio portions of a communications satellite. Still another has financed and built a research facility for testing the effects of re-entry. The use of a 16-inch Naval gun to launch a sounding vehicle by the McGill High Altitude Research Program (HARP) is ingenious, imaginative, and promises advantages over rockets in some applications. The government has a direct interest in the financial, legal, and international aspects of satellite communication. The Meteorological Branch of the Department of Transport is using the data from the TIROS weather satellite, particularly the data about ice conditions in Labrador and the Gulf of St. Lawrence. The Defence Research Board's "Alouette" satellite, as well as being a magnificent engineering achievement, will certainly add to our knowledge of the ionosphere; in fact it has already done so.

The problem is not whether or why we should support space research, but how we can best do so, bearing in mind the other fields of technology which must be supported and advanced.

FIG. 5. Ground Telemetry Receiving Station.



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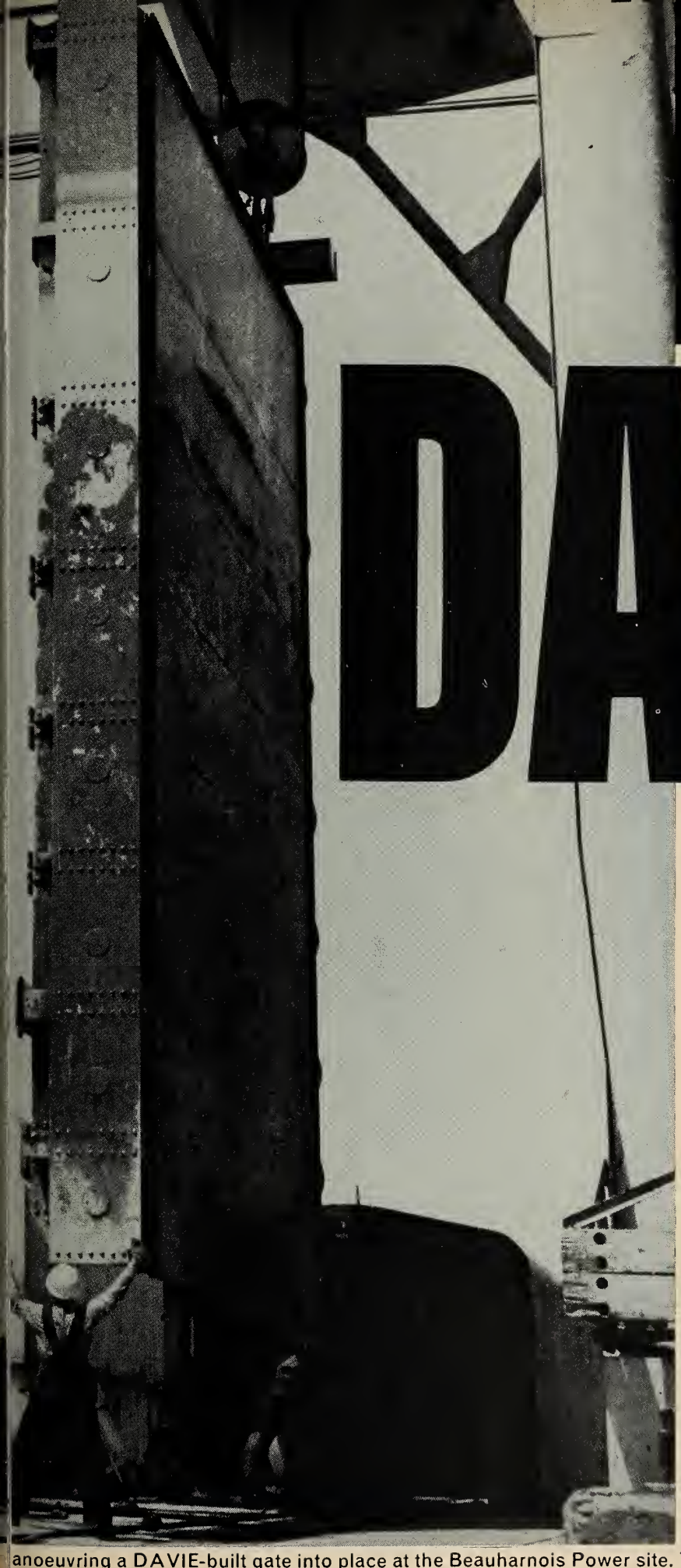

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Discussion

ASPECTS OF THE BACKGROUND OF COLUMBIA RIVER PROJECTS IN CANADA

R. C. McMordie, M.E.I.C.

British Columbia Hydro and Power Authority

The Engineering Journal, October, 1962, page 47

This paper first was presented on June 13, 1962, at the 76th Annual Meeting of the E.I.C. The discussion which follows was also prepared for presentation at that time.

Discussion by

General A. G. L. McNaughton, HON. M.E.I.C.

In view of the limited space available for discussion of Mr. McMordie's paper on the Columbia River Project, I propose to confine my observations to a few of the more general considerations which are at issue and to avoid detail so far as possible. We have the assurance, given to the House of Commons by several Ministers of the Crown that ample time will be provided for the presentation of this detail in another form.

The plans presented by Mr. McMordie are, of course, an expression in terms of the proposed treaty of January 17, 1961, and so if my own remarks are indicative of difference with that document, please do not take this as criticism of Mr. McMordie and his associates who have had to work within the framework of that proposal to the best of their very considerable ability.

The Columbia Treaty was ratified by the United States Senate in March, 1961, after a brief non-contentious session during the course of which it received strong expressions of approval. Appreciation was recorded for the efforts of the U.S. negotiators in securing very large, important and long-lasting benefits for their country.

The treaty has not yet been submitted for ratification to the Canadian Parliament, and meanwhile anxiety has come to be felt throughout the country as to whether, considering the issues at stake, the treaty proposals represent an equitable solution in which Canada will receive due returns for the very large resources she must commit in head and flow and upstream storage and their development; and whether or not the recompense for the services of regulation which are to be provided in the interest of flood control and the production of firm and other power downstream in the U.S. are adequate to justify participation by Canada in this co-operative venture.

I share these anxieties so what I will have to say at this time derives in large measure from the major aspects in which the Treaty in its present form is defective.

This in my view is the fact in at least two important respects. The first relates to the physical plans of development and the second relates to control of storage.

The first basic principle to be agreed by the ICREB following the IJC Reference of March 1944 provided that:

"the boundary is to be ignored in setting up the physical elements of the best plan for the comprehensive development of the Columbia Basin and parts thereof". This principle was initiated by the U.S. members and I regret to report that the support of the U.S. agencies ceased when it became apparent that their favorite project, Libby—involving flooding into Canada —would fail to qualify.

Libby, for which the treaty provides an option exercisable by the U.S., is a very expensive project partly because of the inundation and necessary replacement of important main road and rail facilities which link the Pacific Northwest with the central portion of the U.S. Libby is also deficient in merit because, even with its downstream satellite and existing plants in Canada, only partial use can be made of the potential head available above the confluence of the Kootenay and Columbia at Castlegar.

To make Libby financially tolerable to the U.S., Canada is to pay for the flowage of this trans-boundary project where its reservoir extends 42 miles into Canada. Canada is to receive no recompense for flood control downstream which could have been provided more efficiently by the use of Canadian water in an alternative which was available to Canada, and which would also provide greater at site power in Canada.

Other adjustments also have been made in the treaty which provide the U.S. with increased share of the power benefits.

Another project which would be very useful to the U.S. is of no intrinsic value to Canada. This is High Arrow.

The 7.1 MAF reservoir capacity of High Arrow is to be operated for power to re-regulate flows from Mica to match U.S. requirements after MICA has been machined and is being regulated specifically for at site power in Canada. Under these circumstances, it is a little odd to call for the construction of High Arrow to be completed before MICA itself, and long before the machines are to be installed at Mica. With 11.7 MAF and no machines, Mica can well provide the regulation required for downstream benefits in the U.S., and similarly for flood control to prevent damage at existing levels of development in the lower Columbia. High Arrow, on the other hand is only considered to add 3.8 MAF for Flood Control because the remaining 3.3 MAF has been classed as channel storage, the effect of which is available in nature in the U.S.

To my mind, the most serious effect of this project is that it will flood out some 2000 persons in the Arrow Lake region whose future condition is made precarious because the high level selected for the reservoir eliminates not only their homes and communities, but also most of the usable land and there is nowhere left for them to go in the vicinity. This is well brought out in the evidence presented to the B.C. Water Comptroller on the Application for a conditional licence. Every community concerned without exception is against the proposal.

As regards the costs of High Arrow, I note that Mr. McMordie mentions $66.4 million as being the cost estimated by the ICREB and he uses this figure in his subsequent calculations of benefits. This was an early estimate before the surveys were completed and the quantities determined. Also at that time interest was figured at 3%, the basic rate agreed to be used by both sections for all projects. The rate for Canada is now 5½%.

The cost for High Arrow used by the negotiators was $71.8 million and the latest figure, that of the Montreal Engineering is still higher at $88.7 million. The Sir Alexander Gibb figure is about the same when allowance is included for engineering and interest during construction.

Moreover the "conditional licence" issued by the Water Comptroller under date of April 16, 1962 indicates that additional and perhaps large costs will be inforced on B.C.P.C. by reason of the need for log handling and other traffic facilities at Castlegar; for fish and wild life; and for clearing to comply with more stringent specifications now demanded by the public.

A further point is the fact that the government of B.C. reserved the $64 million payment for Flood Control for other purposes: so it is questionable whether Mr. McMordie is entitled to use this as a credit to High Arrow financing.

High Arrow is a key project in the proposal evolved from the Treaty and it is not required in the alternative. It is therefore a matter of great importance in making a decision to know what the additional costs would be and what would remain in the way of net benefits if any, even without taking proper account of the misery which the construction will cause to a large, well established, group of our people.

In the foregoing I have indicated the objections from a Canadian point of view to Libby and High Arrow. May I say that the force of these objections was understood and appreciated by my U.S. colleagues in the IJC and by the chief of U.S. Army Engineers who was the chairman of the U.S. section of the I.C.R.E.B. Even after the matter passed from the Commission to the negotiators, until mid June, 1960, the record shows there was acceptance by the U.S. of the basic proposals I had made namely that the development of the Kootenay in the U.S.A. including Libby and Falls and of High Arrow in Canada would have been dropped and the much more advantageous proposal for Door-Bull River-Luxor adopted together with the early machining of Mica.

This arrangement represents a reduction in the total investment for both countries of more than $250 million and an increase of 450 MW of firm Energy net at load centres.

I am prepared to support these figures with a detail analysis based on the latest information on costs etc., drawn from the various reports.

May I say that these arrangements which include the use of Mica Duncan and K Lake storages permit the provision of all Primary Flood control which has been requested by the U.S. for the intercept of flood flows in Canada on the Kootenay and Columbia.

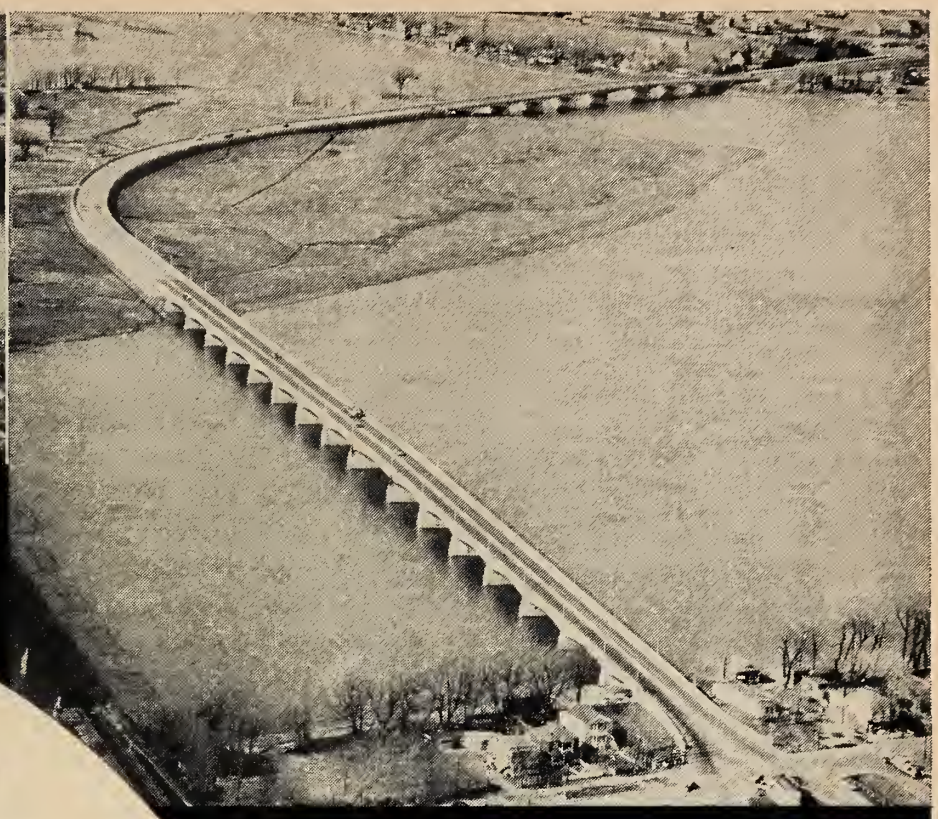
The diversion at Canal Plate raises the storage supply at Mica by 40% thereby permitting that storage to be operated effectively in the 20 year agreed period up to the full capacity of 11.7 MAF.

Now I come to my other grave difficulty with the Treaty and that is the arrangements which place control over the operation of the reservoirs in the hands of the U.S.

In this paper, because of limited space, I will defer my remarks on operation for Flood Control.

The Treaty calls for operating plans "designed to achieve optimum power generation in the United States of America" until power generating facilities are installed in Canada. There is not the least objection to this as no harm would be done thereby to any Canadian interest.

PIE IX STREET BRIDGE, MONTREAL, P. QUE.



BOUT-DE-L'ILE BRIDGES, REPENTIGNY, P. QUE.

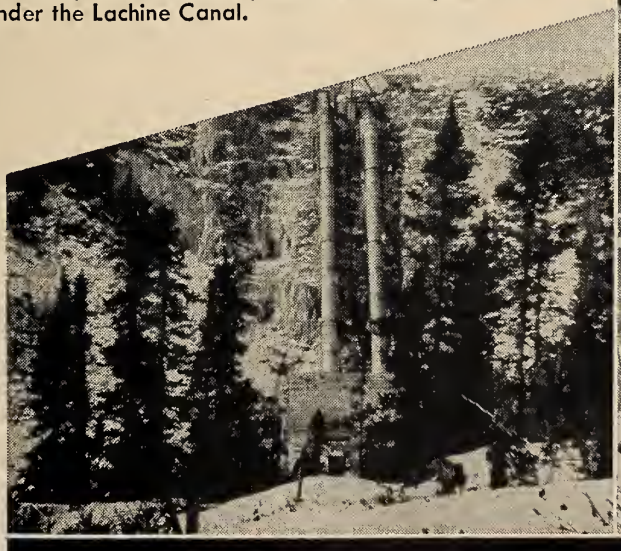
Dufresne Engineering Company Limited

(GENERAL CONTRACTORS)

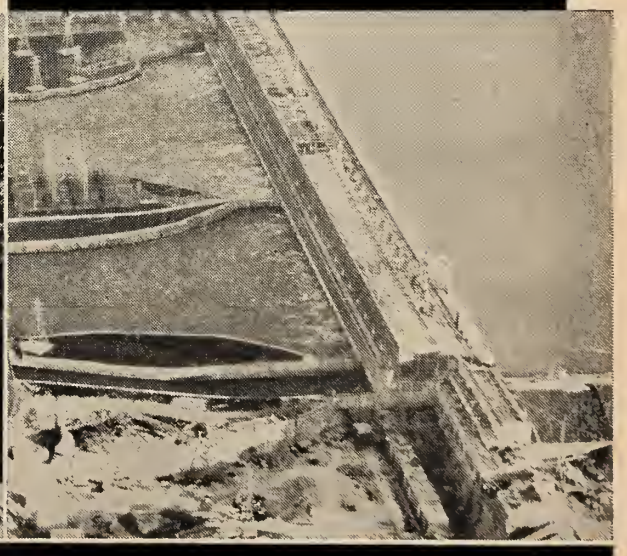
The Company was established in 1922 and its larger contracts have included bridges, dams, hydro-electric developments, wharves, viaducts and tunnels. Among the bridges are those at Bout-de-l'Ile, Pie IX Street, Viau Street, Ile Perreault, Ste. Rose, St. Eustache, Bordeaux, the sub-structure of Jacques Cartier and Mercier, all in the Montreal area, Chambly, Three Rivers, Gaspe and Valleyfield.

Dams and hydro-electric developments include those at Passe Dangereuse on the Peribonka River, Rapid No. 7 at Abitibi, Lake Metis, Lake Morin, Power Houses Numbers 2 and 3 which develop 1,700,000 K.W. at Beauharnois, the first and second stage power houses which develop 1,500,000 K.W. at Bersimis, and Twin Falls Development, Labrador, 240,000 H.P. Other major contracts include the Windmill Point Wharf, Sorel Wharves, and the Wellington Street Tunnel under the Lachine Canal.

JACQUES CARTIER BRIDGE, MONTREAL, P. QUE.



HYDRO-ELECTRIC POWER DEVELOPMENT, TWIN FALLS, LABRADOR, NEWFOUNDLAND.



HYDRO-ELECTRIC POWER DEVELOPMENT, BEAUHARNOIS, P. QUE.

1832 PIE IX BLVD. LA. 1-2154 MONTREAL 4, QUE.

Then, after atsite power is developed down stream in Canada, probably first at Mica, the Operating plans are to be changed "to achieve optimum power generation at-site in Canada and down stream in Canada and the United States of America . . ."

The words "optimum power generation" in the above criteria do not imply that the releases are restricted to any specific kind of benefits, whether shareable or not. The term is general and so as the U.S. need shifts from operation for Firm Power to operation for Thermal replacement or Peaking the regulation ordered by the U.S. may alter accordingly quite regardless of the fact that the requirement in Canada may still be Firm Power. Apart from this the timings of the flows from Canadian storage required by the U.S. may be out of phase with Canadian needs.

Just how serious this may be to Canada in a later phase is well brought out in the statement by the Chairman B.C.P.C. at Hearings on the High Arrow licence when he said in effect that Mica with flow regulated to U.S. requirements would produce only 100 or 200 MW of Firm Power for the Canadian Load by freeing the regulation from U.S. requirements by Re-regulating the flows at High Arrow then the MICA Production could increase to 1000 MW of Firm Power, as he said "a more than five fold" increase.

I cannot support these specific figures because I do not know the period which the Chairman B.C.P.C. had in mind and in consequence the "level of development" which would exist, or whether his Mica is the Full Scale Edition or the cut down version described by Mr. McMordie.

But, I do say with all emphasis that the effect of regulation which it is open to the U.S. to impose in their own interest could be ruinous to Canada. I say also that such an order if given by the U.S. Entity must be obeyed by Canada or Canada will be liable for damages under the provisions of Art. XVIII. In these circumstances there would be no purpose in an appeal to the IJC or the other Tribunal mentioned in Art. XVI for the reason that where a breach of the Treaty is involved it is on the terms of the Treaty itself that judgment would need to be given. Here equity is not a consideration at all.

In the light of the foregoing I do not disagree with the drastic damaging effect foreseen by the BCPC but I do disagree in the Remedy.

It is my view that the Treaty should be revised to provide a Criteria for regulation which will be specific to Firm Power or other shareable benefits to production as was the intention in the IJC Principles. This should include provision that when the Firm Power requirement in the U.S. diminishes and Peaking becomes important, so that a mutually acceptable adjustment and continued equal sharing of the actual benefits as required by Art. V(I), with Appendix A suitably modified, will result.

In all the long experience of the IJC no one country has ever been vested with control over the regulation of the flows of waters of Common interest. It is important to both countries that this practice should be made the responsibility of a Board which is instructed to proceed by agreement or failing this to report their differences to the IJC for action as prescribed by the Boundary Waters Treaty of 1909. I think that this is vital to the maintenance of good relations in this most sensitive field of Water use.

This method and procedure is now in full force and effect on the St. Lawrence and giving visible results in a regimen of great difficulty. It should be instituted on the Columbia also.

Discussion by

A. F. Paget, M.E.I.C.
Deputy Minister,
Water Resources Service
Department of Lands, Forests and Water Resources
Province of British Columbia

Mr. McMordie has described the characteristics of the Columbia River system and the existing hydro power development on it in both Canada and the United States, and has reviewed generally the nature of the studies which preceded the negotiation of the Columbia River Treaty and the provisions and expected benefits of the Treaty. He has touched briefly on some of the considerations with which the negotiators were confronted in the negotiation of the Treaty which gave rise to some of the provisions of the Treaty which have since become the subject of controversy. It appears that additional emphasis on some of these considerations might be of assistance in reaching an understanding of the form which was finally taken by the Treaty.

The first point to which attention is drawn is the statement on Page 48 (Engineering Journal, October, 1962) that "The United States Corps of Engineers recommended a total of 32 m.a.f. for these purposes". The Corps specified that this storage should be dispersed over the Columbia River and its main tributaries and especially that the Kootenay River be controlled to provide flood protection in the general vicinity of Bonners Ferry, Idaho. This requirement would place some limitations on the latitude that could be taken in negotiations with respect to the volume of water that could be stored on the main stem of the Columbia River.

The second point that deserves close attention is dealt with on Page 49 under the heading "International Joint Commission Report on Engineering Studies", and concerns the instruction to the Commission to consider the river as a whole and as if no international boundary existed. This instruction led to the evolution of a Report which was subject to severe limitations, as are noted by its authors. These limitations go far beyond the qualifying notations of the Commission's Report, for because of the "no boundary" concept, responsible political bodies were not required to go along with the planning developed in the report and in fact did not greatly disturb themselves as to how any plan could be effected until the Report was completed and accepted. Great credit must be given to the task forces of the International Joint Commission for assembling the basic data needed and establishing feasibility for the international development of the Columbia River. Equal credit should be given the several task forces that reconstituted the International Boundary through the discussions that led to the I.J.C. Principles and later to the proposed Treaty itself without destroying the fundamental concepts of the original report. It is largely from the "no boundary" concept that some individuals have picked up parts of the Report to demonstrate the unreasonableness of the Treaty that was finally negotiated. It might comfort our engineers to know that the same type of exercises have been going forward in the United States to demonstrate the imprudence of their negotiators.

The third point to be emphasized is the difficulty the negotiators must have faced of deciding the order of development of projects, which in the I.J.C. Report was solved by considering all feasible projects to be completed and in operation simultaneously. Such a solution in an ultimate river development might be quite satisfactory, but for the purposes of negotiation each project required to be examined for its worth in meeting the load growth of both countries and the timing of the completion of a project then became a very important consideration. Then as each project was considered and agreed upon and allocated its share of benefits, it becomes obvious that some of the projects dealt with by the Report could not be constructed in the foreseeable future as the residual benefits were not great enough to make these projects economic.

Generally, the matters previously outlined probably created the greatest difficulty for the negotiators charged with the final responsibility of arranging a Treaty for the international development of the Columbia River. The principles negotiated by the I.J.C. were most useful in creating a basic framework for the Treaty task force but some arbitrary decisions contained in the I.J.C. Principles, such as the decision to share the flood control benefits equally, would appear to leave a very limited field for bargaining in some important respects. (It is interesting to note that the final draft Treaty conformed very closely with the enunciated and agreed Principles).

One final point which cannot be too strongly emphasized concerns the right of the Provinces of Canada to control the use of their own water resources. Jurisdiction in this respect is assigned to the Provinces by the B.N.A. Act, and consequently the Province of British Columbia has always rightfully reserved to itself the final decision as to whether any project or sequence of projects could be accepted. In addition, the Province has maintained the further reservation that Columbia projects would have to be treated administratively in the same manner as any other proposals for water development in British Columbia.

In dealing with the hypothetical questions on Page 53, the author has been logical and conclusive. Agreement can be expressed with the concepts and arrangement of the paper which will no doubt serve a very useful purpose in introducing the Columbia River development to further technical discussion.

Discussion by

P. R. Purcell, M.E.I.C.
Chief Engineer,
British Columbia Energy Board

This timely evaluation of the Columbia River Treaty is of special interest since the author is an engineer of the agency responsible for constructing and operating the Canadian hydro-electric storage reservoirs required by the Treaty. Mr. McMordie has provided an objective assessment of the projects to be constructed and the benefits to be derived by Canada under the terms of the Treaty.

A brief account is given of the history of the Columbia River project from March, 1944, up to the signing of the Treaty on January 17, 1961. It may be of interest to note that the limitation adopted by the International Columbia River Engineering Board "to consider the river as a whole and as if no international boundary existed" did not derive from the terms of reference to the International Joint Commission but was adopted in order that preliminary engineering plans of co-operative development of the Columbia Basin could be prepared. It was implicit in the Board's report of March, 1959, that modifications to any of the three alternative plans prepared would likely be required when economic and political considerations were taken into account. The array of projects at present proposed in Canada and the United States results from painstaking resolution of economic and

political factors in both countries. As the author points out, "the Treaty, from its nature, is the outcome of controversy and must reflect compromise by the diverse interests concerned in its preparation."

One of the many interesting aspects covered in the paper is the estimate of Canada's share of the downstream power benefits, expressed in megawatts of dependable capacity and megawatt years of energy. It is sometimes assumed incorrectly that the estimated entitlements to capacity and energy will determine the annual load factor at which Canada's share of energy must be received. However, provision is made in the Treaty for the two countries to arrange for suitable adjustments in load factor. This may be effected from time to time by compensating adjustments in capacity and energy entitlements calculated to maintain their combined economic value.

In setting out the estimated capacity and energy benefits for the years 1970, 1985 and 2010, the paper points out that "the rate at which the decline in downstream power benefits will occur will depend on the many factors influencing the feasibility and economy of both hydro and thermal generation and on the rate of load growth." The figures presented in the table are based on an estimated load growth which included an assumed market in British Columbia for the Canadian share of the downstream power benefits. Separate estimates by the same engineers based on an estimated load growth which included only the United States market indicated that the estimated rate of decline in downstream benefit entitlement would be significantly reduced if Canada's share of capacity and entitlement were used in the United States. Between 1970 and 1985, the estimated decline for capacity and energy entitlements, respectively, was about 15% and 48%, with all Canada's downstream power benefits used in Canada. With all the downstream power benefits used in the United States, the corresponding estimated decline was about 3% and 37%.

Careful perusal of the paper supports Mr. McMordie's conclusion that "There is no doubt that implementation of the Treaty will be greatly beneficial to both Canada and the United States."

Discussion by

A. W. F. McQueen, M.E.I.C.

In this paper, the author has presented the various provisions of the Columbia River Treaty with clarity and completeness. This is the first time that such a treatment has come to the writer's attention, despite the fact that well over a year has elapsed since formal signature. As everybody knows, much has been said and written about the Treaty during that period and, undoubtedly, much discussion will continue until ratification has taken place, and probably for many years thereafter. However, as a result of the presentation of this paper, it will now be possible for such future discussion to take place at a reasonably informed level.

The language of the Treaty is beautifully clear and precise. Its preamble states the intentions and ends towards which the Treaty was drawn; the body of the Treaty sets forth certain general considerations and makes some definite stipulations. Very properly, it leaves the detailed translation of its provisions into actual operating practices to those public bodies who are intimately concerned therewith. Those who participated in the drafting of the Treaty should be highly complimented for such a well-written and well-conceived document.

Much has been said about the cost of the power resulting to Canada from implementation of the Treaty. Such cost should take into account not only the downstream benefits and at-site generation, but also the effect of Mica storage as a regulator for plants downstream in Canada. Some serious studies of such costs have been made. They involve assumptions as to sequence of construction, timing, location of points of delivery, etc. However, despite these various assumptions and the necessary speculations about the future which were required for these studies, the results indicate that development of the Columbia River, in accordance with the Treaty, will make available, at a very low price indeed, large blocks of power to southern British Columbia and, perhaps, to neighbouring territory.

The Treaty requires Canada to provide a large volume of storage at three sites on the Columbia River. Operation of two of these storages must start within five years of the ratification date and the third within nine years of the ratification date. Largely by reason of (a) the four-year time interval between these two dates which permits storage at the Arrow Lakes—Duncan Lake combination to be given a 'next-added', and thereby more favourable position in calculating downstream benefits, and (b) the considerable difference in construction costs as between this storage combination and that at Mica Creek, it is possible to make calculations purpoting to show that the cost of downstream benefit energy is much less for Arrow Lakes and Duncan Lake storage than for Mica Creek storage.

However, as the author points out, such calculations and any statements based thereon are quite unrealistic. The Treaty stands or falls as a whole and cannot be divided into parts. Moreover, it is the total Canadian storage to which the Treaty gives 'next-added' position to the United States base storage system, and not any part thereof. Hence, it is the total cost of the the three Canadian storage dams and the total Canadian entitlement to downstream benefits which must be used in any calculation of the cost of attributable energy.

The engineering profession is greatly indebted to the author for his able, factual presentation of a difficult and controversial subject, but one which at the same time is of considerable importance to British Columbia and to the nation at large.

Discussion by

F. J. Bartholomew

Mr. McMordie's paper is a useful and timely presentation and comprises, it is believed, the first official, or at least semi-official, explanation of British Columbia's views of the Treaty between the United States and Canada governing the development of the Columbia River. The thanks of us all are due to Mr. McMordie for this contribution to the subject.

Unfortunately, the explanations of the Treaty given by Mr. McMordie do not in any way remove the serious objections to it which have arisen in the minds of many who have given it comprehensive and serious study. This statement is not to be taken as a criticism of Mr. McMordie's treatment of the subject: he was presented with a fait accompli and has, without question, developed the most favourable interpretation which could be adduced.

Mr. McMordie states that the principles set forth in the report by the I.J.C. were adopted as a basis and guide to the deliberations of the negotiators. This was certainly expected to be the case but a careful reading of the I.J.C. Report side by side with the Treaty clearly shows that the power principles defined were largely abandoned —to Canada's great disadvantage.

Just one or two of the serious Treaty failures will be instanced.

Power principle No. 3 states that interconnection and co-ordination of the systems in the two countries should be provided.

This is of vital importance to Canada. The U.S. system will have turned to thermal development and hydro power will be used for peaking and thermal displacement by the time major Canadian power development has taken place. The Treaty calls for system operation to be based on optimum conditions for the two systems jointly. However, the U.S. system will then be some 10 times larger than the Canadian system so that Canadian operation (i.e. water release) will essentially have to be based on the U.S. system needs which will not achieve optimum Canadian use.

The need for a defined co-ordination agreement protecting Canada from power loss is obvious and the principles which are to guide it need to be clearly stated if Canadian interests are to be preserved. The broad permissive clause in the Treaty refering to co-ordination is useless or worse.

Power principle 3 states that the storage credit position of the upstream storage thus established should be preserved throughout the period of the agreement. The Treaty fails to do this in any conclusive manner and it is at the best only inferred.

Power principle No. 4 proposes adjusting the upstream country's entitlement as between capacity and energy to amounts of equivalent total value which conform more nearly to the requirements of the upstream country's load. This is not done. The Treaty contains a permissive clause allowing this but such adjustment is by the grace of the down-stream country only.

Kootenay River incremental power to arise from Libby storage is referred to by Mr. McMordie but there is no assurance under the Treaty that water releases at Libby will necessarily provide firm power at all times at the Canadian plants between Kootenay Lake and the Columbia River.

Mr. McMordie makes an economic comparison between Mica and Arrow giving Arrow first credits. In that Mica is the key development for Canadian power generation and Arrow serves only to provide downstream benefits in the United States, Mica should be analyzed first of all as a project of its own and the analysis should show the potential flood benefit storage which is ignored by the Treaty, as well as its value for downstream power production and Arrow should be considered as adding such additional potential as it may after full credit has been given to Mica, regardless that Arrow may be completed at an earlier date.

The U.S. Army Engineers Report shows that Mica is creditable with 4,000,000 acre feet of flood benefit storage towards limiting flood flow at the Dallas to 800,000 CFS and that it creates a further similar 1,000,000 acre feet of effective storage on the Arrow Lakes without the construction of any dam at Robson. The annual value of this, to be shared, would be $6,850,000 /y and over 1,000,000 KW of firm downstream power is created (Jack Stevens Report 1955). This without the Kootenay diversion water. The residual benefits attributable to Arrow after this procedure make its construction as compared with the Bull River-Luxor diversion entirely uneconomic.

It is pointed out in the I.J.C. Report in the discussion of Power principle No. 1 that the requirements for storage operation in the interest of power and flood control are such that little, if any, loss of ability to maximize power benefits is required to accommodate flood control.

While Mica will require a longer period to build than Arrow, nevertheless, much storage will become available well before the Mica Dam will have been completed and the additional earlier earning capacity of Arrow will in no way compensate the major serious losses to Canada resulting from the deviation from Project IXa.

The Treaty credits Libby with 1,350,000 acre feet of first added storage which should have been credited to Canadian storage. Canada pays the cost of the Libby reservoir in Canada without the assurance of firm power benefit nor share in on site or downstream benefits.

It must not be forgotten that downstream power benefits to Canada are only estimates and diminution of these occurs at an indeterminate rate entirely controlled by U.S. conditions.

Perhaps the most difficult matter which B.C. faces is the disposal of Columbia River power. If the U.S. would make a firm contract to buy a specific block of Canadian downstream power at, say, 5 mils/KWH for the term of the Treaty without diminution then B.C. or Canada can afford to engage in the Columbia River development without on site generation. The Peace River development now under way cannot be ignored. Its delivery of power into B.C. systems seriously postpones the possible use of Columbia River power to such a date that planning this far ahead is quite unreasonable. If an equitable Treaty were available, power costs in B.C. from this river would be far below those which will arise from Peace River power and then, apart from other reasons, it would be highly economic to shelve Peace River for 10 or 15 years or more.

Discussion by

J. F. Glennie, M.E.I.C.

The Columbia River Treaty covers the very complex subject of the development of the headwaters of the Columbia River and its tributary the Kootenay River. The conclusion of a treaty on a problem that has so many aspects and facets is bound to give rise to much controversy and wide differences of opinion as to whether Canada or the United States has got the best of the deal.

If and when the Treaty is ratified by all concerned, one of the signal achievements will be the fact of its existence—without it, the full and best development of the water resources of the Columbia River would be impossible. It must be admitted, then, that some sort of treaty is better than none at all. The second and almost equally valuable success of the Treaty is the agreement to share the downstream benefits equally between Canada and the United States. This is undoubtedly a big step forward towards an equitable settlement of the cost of development between the two countries, but it is suggested that it does not go far enough in this case.

In simple terms, the engineering works required to produce the additional power comprise the storage dams and the generating units through which the stored water will pass, and the cost of producing the power is made up of the cost of the two separate parts of the engineering works—storage dams and generating units. By the terms of the first part of the Treaty Canada has to pay for the storage dams in Canada and the United States has to pay (if it has not done so already) for the generating units in the United States, and the transmission of the Canadian share of the power to Canada. The question is whether these two payments are equal. There is little doubt about the cost of storage; that can be estimated in the usual way, but the cost of the generating units, practically all of which are already installed in the United States, would be very difficult to extract from the costs of the structures with which they were included. An estimate might be attempted from known overall unit rates for generating units per kilowatt, but, in general terms, the cost of generating is usually a fraction of the cost of the dams, perhaps one-half, varying from one-third to two-thirds. Only in extreme cases of small dams, such as at the Owen Falls in Uganda at the outlet from Lake Victoria, does the cost of the generating units equal the cost of the dam.

We may deduce therefore that although the benefits in increased power are being shared equally between the United States and Canada, the cost of producing that power will be borne more by Canada than the United States. This is clearly inequitable, or, in plainer English, unfair. The inequality is emphasized by considering other benefits that the United States will get and for which no payment is made, such as half as much again in "firmed up" power, improvement to navigation, and other water uses resulting from better river regulation. Furthermore the benefits to Canada will decrease with the passage of time.

The only benefits enjoyed almost exclusively by the United States will be security against damaging floods; and it is only right that the United States should pay for this, as provided for in the Treaty. We must accept that the amount to be paid has been assessed as realistically as possible in a field where accurate assessment is difficult.

In his address to the House of Commons, the Prime Minister of Canada said: "By avoiding complicated cost sharing and by making the arrangement as self-enforcing as possible we have ensured that there will be no unnecessary intrusion into each other's affairs." It is suggested that injection of capital in the form of a grant from the United States would be a very welcome "intrusion".

The clauses of the Treaty that deal with the development of the Kootenay are based on a rather different principle. It should be noted that although the Canadian storage is to be operated at first for optimum power production in the United States, and later for the same in both Canada and the United States, the United States storage will only be operated to suit Canada if the required variation is not to the disadvantage of the United States. This is just another instance from the Treaty in which the United States has gained.

On the other hand, as the Treaty stands, Canada is little concerned with the high cost of the Libby project, and will benefit from some increase of power at small cost from the existing Kootenay River plants, though not as much as would be possible with better cooperation from the United States.

The principle of sharing costs as well as benefits is not a new one, and it is hard to understand why it was not adopted in the Columbia River Treaty. In the 1959/60 agreement on the division of the Nile waters between the United Arab Republic, (Egypt), and the Republic of the Sudan, it is clearly laid down that recipients of benefits from water conservation projects must pay for part of the cost of the projects in proportion to the benefits received. Furthermore, either party can buy a share of the benefits of a project at any time, or increase its share of the benefits, by the necessary financial adjustment.

The same principle is incorporated in the famous agreement, effected largely with the assistance of the World Bank, between India and Pakistan over the separation of the water of the River Indua and its tributaries and the cost of the required engineering works.

It is also unfortunate that the principles adopted by the International Columbia River Engineering Board were not followed throughout the negotiations and were not embodied in the Treaty. I refer to the statement that "The various plans studied and set forth herein are based principally on engineering and economic consideration; they take no cognizance of the international boundary." If they had been, the Treaty would have been a much more equitable one and a much more significant example of cooperation between one of the biggest countries in the world and its youthful neighbour.

Furthermore, it is unlikely that the particular engineering plan incorporated in the Treaty would have been adopted. This plan which includes the Libby Dam, Arrow Lakes storage, may be called the United States plan, because it gives the greatest increase in power in the United States and the least in Canada, as opposed to the Dorr Diversion plan which might with similar justification be called the Canadian plan because it reverses the proportions of power in the two countries.

If the estimates of the costs given by the I.C.R.E. Board are relatively correct, and if the costs of development were to be shared equally, then it is more probable that the Dorr Diversion plan would have been chosen because it is the cheapest of the three, and there is no significant difference between the three projects in the total power generated.

On the other hand, it may be argued that when the time factor is taken into account, and the relative needs for additional power in Canada and the United States, then the Treaty has certain advantages, particularly in view of the many alternatives for development presently available in British Columbia. It would provide a large increase in very cheap power in the United States, and a Canadian share of reasonably priced power which might be disposed of in the United States if Canada were not ready or able to use it.

The Treaty does not exclude the Dorr Diversion plan for ever; it specifically makes provision for diversions of flow from the Kootenay River in increasing quantities, 20, 60, and 80 years after ratification, but it is suggested that, as possession is nine-tenths of the law, it would be very difficult, in spite of the clauses in the Treaty, for Canada to deprive the United States of the flows in the Kootenay to which it will have established a prescriptive right by the construction of the Libby Dam. After enjoying all the flows for 20 years, and a major share of them for 60 years, there would be no doubt about the right of established usage, which is recognized in other international river agreements.

An interesting aspect of both this Treaty and of the Boundary Water Treaty of 1909 is that neither of them recognize the principle just mentioned, and it is suggested that even though diversion of the headwaters is written into the 1909 agreement it is a matter of doubt whether Canada could in practice have done so without considering the effect downstream. Similarly it is suggested that although diversions of the flows of the Kootenay are written into the present Treaty, difficulties will arise if and when Canada should desire to do so. It appears therefore that Canada has not only waived her rights to diversions outside the Columbia basin, but also made it difficult to effect diversion from one part of the Columbia basin to another.

Much has been said about the undesirable flooding of agricultural land from the proposed storage in the Arrow Lakes, and from the Libby Dam in Canada but it must be recognized that the alternative Dorr Diversion plan will incur flooding in the Upper Kootenay Valley and Upper Columbia Valley near Lake Windermere and Athalmer. Which involves the least hardship is not a simple matter of economics; the engineering advantage of storage in the Arrow Lakes would be considerable, but so would be the social upheaval.

(Continued on page 132)

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PROGRAM

Monday, May 20th

Annual Meeting of Council	7:00 p.m.

Tuesday, May 21st

Committee on Technical Operations	9:00 a.m.
Deans' Committee	9:00 a.m.
Committee on Branch Operations	9:00 a.m.
Registration Opens	10:30 a.m
Joint Luncheon: Branch Officers, Committee Members, all conference delegates. Ladies Welcome	12:30 p.m.
Continuation of all meetings	2:00 p.m.
Press Conference	4:30 p.m.
Open House—Informal Reception Muriel	8:30 p.m.

Wednesday, May 22nd

Authors' Breakfast	7:45 a.m.
Registration Continues	8:30 a.m.
Annual General Meeting	9:00 a.m.
Reception—Muriel	12:00 noon
Opening Luncheon	12:30 p.m.
Student Conference	2:00 p.m.
Association of Consulting Engineers—Board of Directors Meeting	2:30 p.m.
Technical Sessions	2:30-5:30 p.m.
Reception—Muriel	6:30 p.m.
Informal Dinner	7:00 p.m.
Film Presentation—New Defence Communications Centre	9:45 p.m.

Thursday, May 23rd

Authors' Breakfast	7:45 a.m.
National Committee on Professional Development	9:00 a.m.
New Council Meeting	9:00 a.m.
Technical Sessions	9:00-12:00 noon
Association of Consulting Engineers —Annual General Meeting	9:30 a.m.
Reception—Muriel	12:00 noon
Awards Luncheon	12:30 p.m.
Student Conference—2nd Session	2:30 p.m.
Committee on Membership	2:30 p.m.
Association of Consulting Engineers —Annual General Meeting Continued	2:30 p.m.
Professional Development Group—Continued	2:30 p.m.
Technical Sessions	2:30-5:30 p.m.
Association of Consulting Engineers —Annual Dinner	6:30 p.m.
Evening Entertainment—Muriel	9:00 p.m.

Friday, May 24th

Authors' Breakfast	7:45 a.m.
Technical Sessions	9:00-12:00 noon
Life Members Luncheon Meeting	12:00 noon
No organized luncheon	Noon
Student Conference—Final Session	2:00 p.m.
Technical Sessions	2:00-5:00 p.m.
Reception—Muriel	6:30 p.m.
Annual Banquet	7:30 p.m.
Annual Dance—Muriel	10:00 p.m.

Saturday, May 25th

Field Trips—Manicouagan, Quebec Cartier, or others.

TECHNICAL PAPERS

Bridge & Structural

"Sheppard Avenue CPR Subway—Agincourt, Prestressed Concrete Railway Bridge". EIC 63—BR & STR—9.
A. M. LOUNT, M.E.I.C.

"Analysis of Plywood Gusset Connections with Steel Nails". EIC 63—BR & STR—10.
PROF. F. H. THEAKSTON, M.E.I.C. AND
J. E. TURNBULL

"The Rational Design of Beam to Column Connections". EIC 63—BR & STR—11.
PROF. A. N. SHERBOURNE

"Ponts en Béton Précontraint dans la Province de Québec". EIC 63—BR & STR—12.
R. MARTINEAU, M.E.I.C.

"Diagnosis of Distress and Failure in Structures". EIC 63—BR & STR—13.
JACOB FELD, PH.D.

"Quelques notes concernant les Cables, les Arcs et les Réseaux d'Arcs". EIC 63—BR & STR—14.
M. NORMANDIN, M.E.I.C.

Chemical Symposium on Air Pollution Control

"Design of Air Pollution Control Facilities and Air Monitoring Systems in Alberta". EIC 63—CHEM—7.
H. L. HOGGE, M.E.I.C.

"The Control of Atmospheric Pollution from Sulphur Compounds in Stack Gases". EIC 63—CHEM—8.
DR. M. KATZ, M.E.I.C.

"L'emploi du chlorure mercurique comme correctif d'un facteur d'erreur dans le dosage de l'hydrogène sulfuré par la méthode Hemeon". EIC 63—CHEM—9.
J. P. PARE, M.SC.

"L'Industrie face au Problème du Controle de la Pollution de l'Air". EIC 63—CHEM—10.
L. P. ROY, PH.D.

Civil

"A Comparison of Actual with Predicted Wave Heights and Periods for the North Shore of Lakes Ontario and Erie". EIC 63—CIV—12.
DR. A. BREBNER AND BENI P. SANGAL

"Wind Loading on a Slim Cylindrical Structure". EIC 63—CIV—13.
PROF. F. H. THEAKSTON, M.E.I.C. AND
PROF. H. K. MALINOWSKI

"Etudes sur differents generes de Glissieres de Securité". EIC 63—CIV—14.
G. G. HENAULT, M.E.I.C.

"The Analysis of Structures by Aid of Models". EIC 63—CIV—15.
DR. J. SCHWAIGHOFER

"The Design and Construction of the Brady Street Underpass (Sudbury, Ontario)". EIC 63—CIV—16.
PROF. L. D. MACDOUGALL AND
J. L. MITCHELL, M.E.I.C.

"Earthquake and Wind Loads in Building Design". EIC 63—CIV—17.
DR. S. CHERRY, M.E.I.C., DR. H. WARD AND
W. A. DALGLIESH, A.M.E.I.C.

"Le Quai Brise-Lames de Baie Comeau". EIC 63—CIV—18.
GAETAN J. COTE, M.E.I.C., AND
GUY R. SIMARD, M.E.I.C.

"Water-Reducing Admixtures for Concrete—Applications and Specifications". EIC 63—CIV—19.
T. G. CLENDENNING AND M. T. LOUGHBOROUGH

"Development of Athabaska Tar Sands". EIC 63—CIV—20.
PROF. R. W. ANSLEY, M.E.I.C.

Communications, Electronics and Automation

"The Environment of Space—Its Simulation and Testing of the Canadian 'Topside Sounder' Satellite". EIC 63 CE & A—5.
F. D. WARD

"The Canadian Topside Sounder Satellite Engineering Performance". EIC 63 CE & A—6.
R. K. BROWN

"Problèmes de Genie Que Posent les Aerostats aux Grandes Altitudes". EIC 63 CE & A—7.
J. BARIL, A. K. LAFLAMME AND R. A. LEFEBVRE

"The Development of a Reliable Miniature Beacon for Radar Tracking of Research Rockets and Balloons". EIC 63 CE & A—8.
W. F. SLAGHT AND H. W. MOREWOOD, M.E.I.C.

The Future of Automation in Canada". EIC 63 CE & A—9.
E. W. LEAVER

"Analogue Computer Control of a Nuclear Reactor". EIC 63 CE & A—10.
R. G. deBUDA

"Feedback Control in Living Prototypes—A New Vista in Control Engineering". EIC 63 CE & A—11.
DR. J. A. TANNER

PANEL: "Function of Electronic Research in Government, Industry and the University".

Moderator: DR. B. G. BALLARD, M.E.I.C.
Panelists: DR. R. W. JACKSON, DR. F. S. EADIE, J. L. ORR, PROF. L. BOULET, M.E.I.C., PROF. G. L. D'OMBRAIN

Engineering Education

"The Danger of Specialization". EIC 63—EDUC—2.
PROF. G. FORD, M.E.I.C.

"The Computer & the University". EIC 63—EDUC—3.
DR. A. D. BOOTH

"Time and Load Factor in Engineering Education". EIC 63—EDUC—4.
PROF. O. CELINSKI

"Continuing Objectives in Chemical Engineering Education". EIC 63—EDUC—5.
DR. D. S. SCOTT, A.M.E.I.C.

"Civil Engineering Education in the University". EIC 63—EDUC—6.
DR. A. M. NEVILLE

"Programme d'études pour un ingenieur électricien". EIC 63—EDUC—7.
PROF. L. BOULET, M.E.I.C.

PANEL: "Selected Topics in Engineering Education".

Chairman: PROF. J. HOOGSTRATEN
Panelists: DR. L. P. BONNEAU, M.E.I.C., DEAN H. GAUDEFROY, M.E.I.C., DEAN H. G. CONN, M.E.I.C.

Electrical

"Aircraft Electrical Power Systems". EIC 63—ELEC—3.
J. GAWLEY

"Installation of In-Span Transpositions in 345 KV Transmission Lines". EIC 63—ELEC—4.
R. M. HARVEY, M.E.I.C.

"NPD Fueling Machines". EIC 63—ELEC—5.
W. M. BROWN

"Non-Icing Conductor". EIC 63—ELEC—6.
DR. A. S. TIMASCHEFF, M.E.I.C.

"A Modern DC Supply System for an Electro-Chemical Zinc Refinery". EIC 63—ELEC—7.
A. LUDBROOK

Geotechnical

"Composite Design of Underground Steel Structures". EIC 63—GEOTECH—5.
DR. G. G. MEYERHOF, M.E.I.C. AND
C. L. FISHER, M.E.I.C.

"The Engineering Geology of the Bersimis No. 2 Site". EIC 63—GEOTECH—6.
DR. D. H. MACDONALD, M.E.I.C. AND G. WILSON

"Till Cofferdams Dumped in Water". EIC 63—GEOTECH—7.
J. I. ADAMS AND D. J. BAZETT, M.E.I.C.

"Soil Sampling in Permafrost Areas". EIC 63—GEOTECH—8.
G. H. JOHNSTON, M.E.I.C.

"The Use of Probability Charts to Predict Ice Thickness". EIC 63—GEOTECH—9.
G. P. WILLIAMS, M.E.I.C.

"Soils and Foundations Aspects of the Rainy Lake Causeway". EIC 63—GEOTECH—10.
A. RUTKA, M.E.I.C., P. F. ANDERSEN AND
M. A. J. MATICH, M.E.I.C.

Hydro-Electric

"Considérations générales sur le dimensionnement des cheminées d'équilibre". EIC 63—HYDEL—2.
DR. BERNARD MICHEL, M.E.I.C.

"Some Foundation Considerations at the Grand Rapids Hydro-Electric Project". EIC 63—HYDEL—5.
J. R. RETTIE, M.E.I.C. AND
F. W. PATTERSON, M.E.I.C.

"Sluice Gate Rating Curves by Model Testing". EIC 63—HYDEL—6.
R. J. SILVER, A.M.E.I.C.

"Analyse et solution du problème d'étanchéitè du barrage amont de Manicouagan 5". EIC 63—HYDEL—7.

G. TURENNE AND C. A. DAGENAIS, M.E.I.C.
"L'Usine de Classification des Agregats Fins—Manicouagan 5". EIC 63—HYDEL—8.
P. AMYOT, M.E.I.C. AND M. J. SEGUIN, M.E.I.C.

"L'évolution de la température de l'eau en hiver dans les réservoirs hydroélectriques et dans les rivières aménagées". EIC 63—HYDEL—9.
ANDRE R. GAGNON, A.M.E.I.C.

"Hydrological Simulation of a River Basin—An Aid in Flood Control Planning". EIC 63—HYDEL—10.
I. W. MCCAIG, M.E.I.C., F. H. JONKER AND
J. M. GARDINER

Management

"Critical Path Scheduling of Construction Projects". EIC 63—MGMT—7.
J. LLOYD CUTCLIFFE

"Life Estimation and Depreciation of Physical Assets and its Use in Industrial Economics and Finance". EIC 63—MGMT—8.

L. I. SZABO, M.E.I.C.
"Under a Bushel". EIC 63—MGMT—9.
G. R. MCMEEKIN, M.E.I.C.

SYMPOSIUM: "Computers—A Modern Aid to Management".

Chairman: W. L. HUTCHISON, M.E.I.C.
Panelists: PROF. J. N. P. HUME, DR. J. KATES, M.E.I.C., P. B. WILSON, W. D. E. ANDERSON

Mechanical

"The Punching of Sheet Metal with Rubber". EIC 63—MECH—21.
P. B. HERTZ, A.M.E.I.C. AND PROF. S. GARBER

"Engineering of Aluminum Pipelines". EIC 63—MECH—22.
J. F. WHITING

"Dragline Simulation of an Analogue Computer". EIC 63—MECH—23.
PROF. P. N. NIKIFORUK, M.E.I.C. AND
D. W. OCHITWA, A.M.E.I.C.

"Determination of the Pattern of Isotherms in a Metal Cutting Tool Using InfraRed Photography". EIC 63—MECH—24.
R. SALMON, M.E.I.C., PROF. W. B. RICE, M.E.I.C. AND
PROF. P. S. CHANDRASEKARAN

"Some Observations on Energy Methods Applied to Problems of Flexure of Beams and Plates". EIC 63—MECH—25.
PROF. J. B. HADDOW AND D. G. BELLOW

Mining and Metallurgical

"Potential Value of Coal-in-oil Fuels in Canada". EIC 63—MIN & MET—2.
G. A. Vissac, M.E.I.C. and Dr. R. P. Charbonnier, M.E.I.C.

"Physical Properties of Kingston Limestone Deleterious in Concrete". EIC 63—MIN & MET—3.
Prof. A. V. Corlett, M.E.I.C.

"Stockage Sauterrain due gaz naturel dans le Sud de l'Ontario et du Québec". EIC 63—MIN & MET—4.
Dr. R. P. Charbonnier, M.E.I.C.

Research

"The Crisis in Industrial Research in Canada ". EIC 63—RES—3.
Prof. F. Noakes, M.E.I.C. and
Dean D. M. Myers, M.E.I.C.

"Simple Reading Machines for the Blind". EIC 63—RES—4.
Dr. M. P. Beddoes

"Magnetohydrodynamic Power Generation—Its Principles and Problems". EIC 63—RES—5.
Prof. W. Craig Moffatt, M.E.I.C.

"The National Research Council—Industrial Research Assistance Program". EIC 63—RES—6.
R. E. McBurney, M.E.I.C.

Thermal Power

"Layout and Building Design Features of the Douglas Point Nuclear Power Project". EIC 63—THERM—1.
E. C. Smith, M.E.I.C.

"Design and Operation of Coal Handling Facilities at the Wabamun Steam Plant". EIC 63—THERM—2.
Z. Kolisnyk, M.E.I.C.

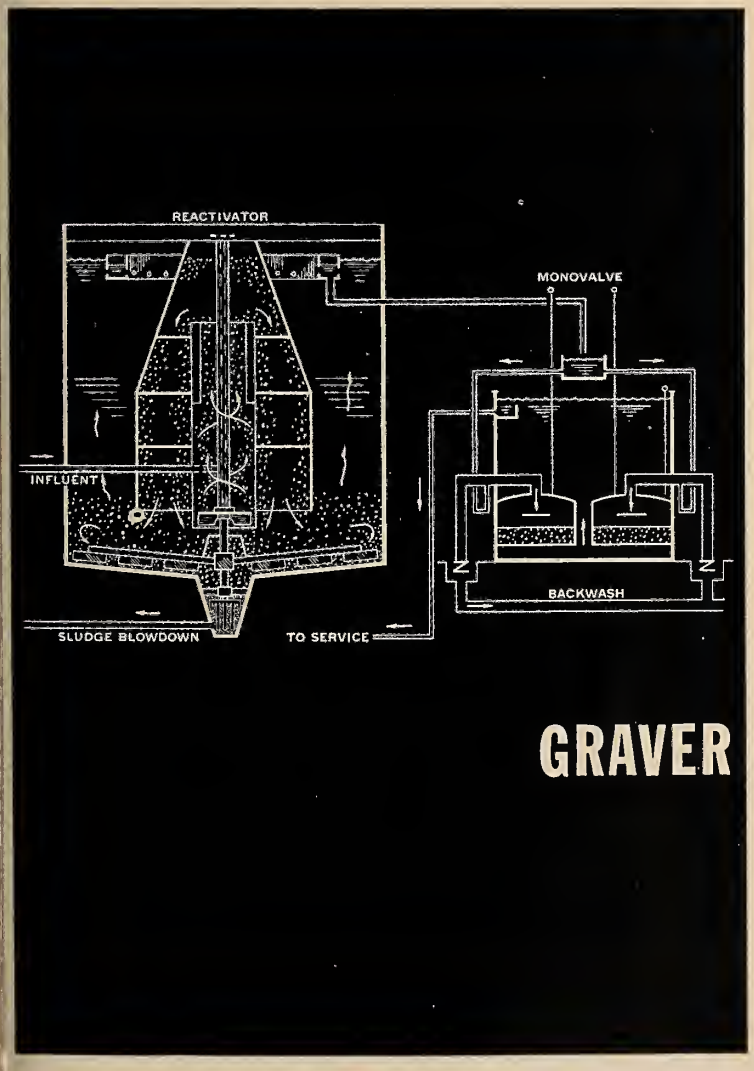
"Some Aspects of Commissioning and Early Operation of 200 Mw Reheat Units at R. L. Hearn GS and 300 Mw Reheat Units at Lakeview GS". EIC 63—THERM—3.
E. D. Holdup
W. Goodbrand

Welding

"Welding in Cold Weather". EIC 63—WELD—1.
Dr. K. Winterton

"Methods to Establish Procedures for Welding Low Alloy Steels". EIC 63—WELD—2.
B. J. Bradstreet

"Welding at Chalk River: EIC 63—WELD—3.
Part I—A Progress Report".
H. D. Tiffin
Part II — Sealing Nuclear Fuel Cans.
M. B. Watson



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ABSTRACTS

AGM63-BR&STR-A

Sheppard Avenue CPR Subway—Agincourt Prestressed Concrete Railway Bridge

A. M. Lount, M.E.I.C.

This structure is the first use of prestressed concrete to support a Railway in Canada, and is the first continuous prestressed concrete rail supporting structure in North America.

The structure consists of a cast-in-place hollow box slab at a skew of 21° (69° from square). This skew created the conditions where this solution obviously required consideration. Cost comparisons were made with other, more standard solutions. Tender prices confirmed the estimate.

The circumstances surrounding the structure are discussed. The choice of framing arrangement was dictated by the high skew. The "influence line" method of calculation used to determine secondary moments in continuous prestressed structures is outlined. This method, developed over a number of years and projects greatly simplifies the determination of secondary stresses. The position of the cables can be adjusted easily without requiring elaborate recomputations, since the effect of unit prestress acting at unit eccentricity over 1/10 of each span has been previously determined.

Selection of anchorage systems and special considera-itons because of railway conditions are discussed.

Early construction experience and photographs of the structure under construction through March and April 1963 will be incorporated.

Construction details are discussed, such as web dimensions, density of standard reinforcement, drainage of boxes and details of stirrups with relation to placement of cables. Also discussed briefly will be the use of an electronic computer to derive the influence fields for external loads, particularly as these affect the "triangular" slabs at the end of the structure where intersection of members could not be otherwise readily predicted.

Viaduc du C.P.R. à l'Avenue Sheppard-Agincourt Pont ferroviaire en béton précontraint

A. M. Lount, M.E.I.C.

Cette structure représente le premier usage de béton précontraint dans le support d'une voie ferrée au Canada; c'est également la première structure continue en béton précontraint supportant des rails en Amérique du Nord.

La structure consiste en une travée creuse coulée en place obliquant a 21° (69° de l'équerre). Cette obliquité créait une situation ou l'étude d'une telle solution devenait nécessaire. On a comparé le coût avec d'autres solutions plus courantes. Les prix des soumissions confirmèrent les estimations.

L'auteur discute des facteurs pouvant influencer la structure. Le choix de l'agencement des composantes est dicté par cette obliquité élevée. L'ouvrage décrit la méthode de calcul dite des "lignes d'influence" utilisée pour déterminer les moments secondaires dans les structures continues en béton précontraint. Cette méthode développée au cours de nombreuses années et pour de nombreux projets, simplifie grandement la détermination des efforts secondaires. La position des cables peut être aisément ajustée sans avoir a refaire des calculs compliqués, puisque l'effet de l'unité de précontrainte agissant sur l'unité d'excentricité sur 1/10 de chaque portée a été déterminé à l'avance.

L'ouvrage traite du choix des systèmes d'ancrage et des considérations spéciales selon l'état du chemin de fer. L'auteur y traite aussi de l'expérience du début des travaux et accompagne son texte de photographies de la structure en voie d'érection durant les mois de mars et avril 1963.

Les particularités de la construction sont discutées, telles que les dimensions de l'âme, densité d'armature courante, drainage des vides et détails des étriers dans leur relation avec l'emplacement des cables. Il discute également de l'emploi d'un calculateur électronique pour déterminer les champs d'influence des charges extérieures, particulièrement en ce qui touche la travée triangulaire a l'extrémité de la structure où l'intersection des membres ne pouvait pas être facilement prédite autrement.

AGM63-BR & STR-B

Analysis of Plywood Gusset Connections with Steel Nails

F. H. Theakston, M.E.I.C.
Prof. Dept. Science, Ont. Agricultural College, Guelph, Ont.
J. E. Turnbull
Prof. Dept. Science, Ont. Agricultural College, Guelph, Ont.

A study of the effects of variations in nail diameter, and nail bending strength on three-member lumber joints with nominal two-inch centre members and one-half inch plywood side members.

"Prediction equations" are shown to express, mathematically, the combined effects of diameter of nails and the bending strengths on the joints. Bend Values and Effective Nail Diameter" are determined through interesting methods of laboratory experimentation.

Graphs are illustrated showing load-slip curves for various nails of varying gage and hardness.

This is a piece of work which will find application in large and small structures and should be of interest to all structural engineers.

AGM 63-BR & STR-B

Analyse d'assemblage de Gousset en Contre-Plaqué avec Clous d'acier

F. H. Theakston, M.E.I.C.
Prof. Genie Civil, Ont. Agricultural College, Guelph, Ont.
J. E. Turnbull
Prof. Genie Civil, Ont. Agricultural College, Guelph, Ont.

Etude des effets des variations dans le diamètre des clous, et de la résistance à la flexion des clous sur joints en bois de trois pièces, avec pièces nominales au centre de deux pouces et pièces extéieures en contre-plaqué de un demi-pouce.

On donne "des équations de prédiction" qui experiment mathématiquement l'effet eombiné du diamètre des clous et de la résistance à la flexion des joints. La valeur à la flexion et le diamètre efficace des clous sont déterminés à l'aide de méthodes intéressantes établies par expérience de laboratoire.

Des graphiques illustrent des courbes de charges se déplaçant suivant l'emploi de différents clous de jauge et de dureté différentes.

C'est un ouvrage qui trouvera son application dans les structures grandes et petites et saura intéresser tous les ingénieurs en structures.

AGM 63-BR & STR-C

The Rational Design of Beam to Column Connections

A. N. Sherbourne
Prof. Dept. Civil Engineering, University of Waterloo, Waterloo, Ont.

The paper discusses the problem of the beam to column connection and critically reviews recommendations affecting the plastic design of bolted and welded connections. The essential requirements are stipulated for determining the adequacy of connections in plastic design and it is pointed out that practical factors play a significant part in the final selection of connection types. It is clear that simple rules for design can be formulated by observing the behaviour of component parts of the connection up to the ultimate load of the assembly. Using such an approach

it is possible to achieve the optimum proportions of (a) the welds and bolts (b) the column size as governed by the strength and stability of the web plate.

The discussion embraces the behaviour of one-way, two-way and four-way connections and attempts to define the limitations and assumptions behind current researches in this field. Suggestions are also made as to possible future researches into the dynamic behaviour of connections under slow cyclic loads.

AGM 63-BR & STR-C

Calcul d'assemblage entre Colonne et Poutre

A. N. Sherbourne
Prof. Genie Civil, Université de Waterloo, Waterloo, Ont.

L'exposé traite du problème d'assemblage entre colonne et poutre, et analyse de façon critique les recommandations touchant l'étude plastique des assemblages boulonnés et soudés. L'auteur énonce les exigences essentielles, pour déterminer l'efficacité des assemblages dans les études plastiques, et attire l'attention sur l'importance que peuvent jouer des coefficients pratiques dans le choix final des genres d'assemblage. Il est évident que des règles simples de calcul peuvent être formulées en observant le comportement des pièces composantes de la connection jusqu'à la charge ultime de l'assemblage. En s'attaquant à la question de la sorte, il devient possible d'atteindre les proportions optimum. A) de soudures et de boulons, B) de la dimension de la colonne influencée par la résistance et la stabilité de l'âme de celle-ci.

La discussion couvre le comportement d'assemblage à une deux et quatre directions et s'efforce de définir les restrictions et les suppositions derrière les recherches courantes dans ce domaine. L'auteur formule aussi certaines suggestions en vue de recherches futures possibles dans le comportement dynamique des assemblages sous des charges cycliques lentes.

AGM 63-BR & STR-D

Ponts en Beton Precontraint dans la Province de Quebec

René Martineau, M.E.I.C., *Ing.P.,*
ingénieur-conseil du bureau Bourgeois & Martineau
à Montréal

L'auteur décrit d'abord d'une façon très générale, le développement du béton précontraint dans la Province de Québec, en mentionnant certaines raisons qui ont motivé l'usage de ce matérieu dans les débuts.

Puis, l'on décrit plusieurs ponts réalisés depuis 1957, en les groupant suivant les genres de tabliers soit: ponts à poutres simples, ponts cantilever et ponts continus.

L'auteur examine ensuite quelques aspects du béton précontraint, en rapport avec les codes de construction existants. Ces aspects sont: a) dalles des ponts à poutres préfabriquées, b) distribution des moments, c) appareils d'appui, d) flèches, e) facteurs d'impact, f) injections.

En conclusion, l'auteur souligne que cette technique n'en est à ses débuts, que la préfabrication est un bon moyen d'exécution mais que la standardisation trop poussée pourrait, à l'heure actuelle, restreindre l'imagination créatrice des constructeurs de ponts. L'auteur souligne également la nécessité d'élargir le code actuel conçu uniquement pour les ponts en acier.

AGM 63-BR & STR-D

Prestressed Concrete Bridges in the Province of Quebec

Rene Martineau, P.Eng., Consulting Engineer,
Bourgeois & Martineau,
Montreal

The author describes first, in a very general way, the development of prestressed concrete in the Province of Quebec, mentioning several reasons which justified the use of this material in the beginning.

Then follows a description of several bridges constructed since 1937, grouping them according to types of superstructures: simple beam bridges, cantilever beam bridges and continuous beam bridges.

Next some aspects of prestressed concrete are considered, in accordance with the existing construction codes. These aspects are, (a) floor slabs of bridges with prefabricated beams, (b) distribution of moments, (c) supporting structures, (d) deflection, (e) impact factors, (f) grout injection.

In conclusion, the author emphasizes that this technique is only in its beginning, that prefabrication is a satisfactory method for carrying out work, but that standardization pushed too far could, at the present time, restrict the creative imagination of bridge builders. He emphasizes equally the necessity of enlarging the present code which was designed solely for steel bridges.

AGM 63-BR & STR-E

Diagnosis of Distress and Failure in Structures

Jacob Feld,
Consulting Engineer

Design of structures and of erection procedures must provide sufficient (1) resistance against gravity, (2) minimum strength of the materials during the life of the structure, and (3) provision against distress resulting from incompatibility of connected dis-similar materials. Any omission in any required sufficiency will result in a failure of the design. It may be a collapse during erection or after completion; it more often shows as a cracked or distorted structure with high maintenance cost and rapid economical depreciation.

Practice of engineering is based on the application of proven scientific principles, but even more on the accumulation of successful experience teaching one what to do. Equally valuable, but often disregarded because it is not readily available, is the record of unsuccessful experience. The paper outlines how such record can become a most important safeguard in reducing and hopefully eliminating failure in design and construction operations.

A few failures stem from malpractice, lack of knowledge of how to do the job. More result from careless application of available knowledge. The recent use of more complicated statistically indeterminate designs, where stress dependence on deformation conditions is not properly evaluated, is one reason for the greater number of structural failures. The present trend to use new materials, whose time dependent dimensional changes are not completely known, result in distress evident only after occupancy of the structure.

These difficulties are found in structures where the basic material is timber, steel or concrete. Only a complete knowledge of the materials used can prevent the failures. Public advice and warning of unsuccessful designs can prevent repetition by others of the same mistakes. It is a professional duty to provide such warnings; it is a breach of professional obligation to bury a report of an unsuccessful performance.

Examples of several incidents investigated by the speaker to show typical cases under various categories of failure and distress are given in some detail. Complete record of such information should be collected and made available to the engineering profession, both as a public service and as a safeguard against being involved in criminal and civil action.

AGM 63-BR & STR-E

Diagnosis of Distress and Failure in Structures

Jacob Feld,
Ingénieur-Conseil

Les calculs des structures et les procédés d'érection doivent inclure (1) suffisamment de résistance contre la pesanteur (2) une résistance minimum des matériaux durant la vie de la structure et (3) des prévisions contre la faiblesse du joint résultant de l'incompatibilité de l'assemblage de matériaux dissemblables. Toute omission suffisamment importante conduira à l'insuccès du projet. Ce sera un effrondrement durant l'érection ou après; le plus souvent elle se traduit par une structure fissurée ou tordue avec coût d'entretien élevé et dépréciation économique rapide.

La pratique de l'art de l'ingénieur est basée sur l'application de principes scientifiques éprouvés, mais surtout sur l'accumulation d'expériences réussies, lui enseignant comment faire. La compilation des expériences infructueuses

est également valable mais souvent ignorée parce que difficile d'accès. L'ouvrage indique comment une telle compilation peut devenir une protection des plus importantes en réduisant et en espérant éliminer l'échec dans l'étude du projet et dans la construction.

Quelques insuccès proviennent de mauvaises méthodes, du manque de savoir faire. Plus encore, ils proviennent de l'application irréfléchie de connaissances disponibles. L'usage récent d'études statiquement indéterminées et plus compliques, où les efforts résultant des conditions de déformation ne sont pas évalués avec soin, est responsable du nombre croissant d'affaisements de structures. La tendance présente d'employer de nouveaux matériaux dont les changements de dimensions avec le temps ne sont pas entièrement connus, conduisent à une faiblesse apparaissant seulement après l'occupation de la structure.

Ces difficultés se rencontrent dans les structures où les matériaux de base sont de bois, d'acier ou de béton. Seule une connaissance parfaite du matériau utilisé peut prévenir l'échec. Des avertissements publics et la publication des études infructueuses peuvent prévenir la répétition par d'autres, des mêmes erreurs. C'est un devoir professional de fournir de tels conseils. C'est un manquement à l'étique professionnelle que de cacher un rapport sur une exécution infructueuse.

Le conférencier donne des exemples détaillés de plusieurs enquêtes qui'il a faites en indiquant des cas typiques de diverses catégories d'insuccès et de faiblesse. Une compilation complète de telles informations devrait être faite et mise à la portée de la profession d'ingénieur, dans l'intérêt du public autant que pour éviter à ses membres des poursuites criminelles et civiles.

AGM 63-BR & STR-G

Of Cables, Arches and Grids
Michel Normandin, M.E.I.C.,
Vice-Dean & Director of Studies,
Faculty of Studies,
University of Sherbrooke

From a few elementary principles of the theory of structures, the author establishes a system to determine the shape of a grid of arches for which the bending moment will be zero everywhere under a specified loading. The limiting process gives a partial differential equation.

The bending moment diagram produced by a unit load applied at a specific point of the grid is determined with the use of a modified form of the deflection formula.

This work is preliminary and should be verified in the laboratory.

AGM 63-BR & STR-G

Quelques Notes Concernant les Cables, les Arcs et les Réseaux d'arcs
Michel Normandin, M.E.L.C.
Vice-Supérieur & Directeur des Etudes,
Faculté des Etudes,
Université de Sherbrooke

A l'aide de la théorie élémentaire des poutres, des câbles et des arcs, l'auteur établit un système permettant de déterminer la forme d'un réseau d'arcs absolument quelconque dans lequel les moments sont identiquement nuls pour un chargement déterminé. A la limite, ce système donne une équation aux dérivées partielles de type membrane.

A partir d'une modification de la formule de déformation d'un arc quelconque, l'auteur détermine le diagramme des moments produits dans le réseau par une charge unitaire placée en un point quelconque du réseau.

Ce travail constitue la première partie d'une étude portant sur les voiles minces quelconques et la théorie mise de l'avant vaudrait d'être vérifiée par une série d'essais en laboratoire.

Chemical Symposium
"Recent Developments in Air Pollution"
Panelists
AGM 63-CHEM-A
H. L. Hogge,
Provincial Sanitary Engineers,
Dept. of Public Health,
Gov't of the Province of Alberta
"Design of Air Pollution Control Facilities and Air Monitoring Systems in Alberta"

AGM 63-CHEM-B
Dr. M. Katz,
Director, Environmental Assessment,
Occupational Health Division,
Dept. of National Health and Welfare,
Ottawa
"The Control of Atmospheric Pollution from Sulphur Compounds in Stack Gases"

AGM 63-CHEM-C
J. P. Pare,
Chief Chemist,
Division of Industrial Hygiene,
Ministry of Health,
Montreal
"L'emploi du chlorure mercurique comment correctif d'un facteur d'erreur dans le dosage de l'Hydrogène sulfuré par la méthode Hemeon"

AGM 63-CHEM-D
Dr Louis Philippe Roy,
Survey Director,
Laval Industrial Association,
Ville d'Anjou, Que.
"L'Industrie Face au Problème du Control de la Pollution de l'Air"

Recent Developments in Air Pollution

During the past few years there has been increased emphasis on methods of testing for Air Pollutants, and investigations to determine the magnitude of pollutants, as well as developments to control the emissions of various substances which can contain irritants or have noxious odours. Work is being carried out by Government bodies, universities and industry.

The following panel papers will be presented with the thought that they should prove of interest to Engineers and various public bodies throughout the country, because of the increasing interest and work on this subject.

Recents Developpements au Sujet de la Pollution de L'Air

Ces dernières années, des méthodes pour contrôler les matières qui polluent l'air et des investigations pour en déterminer le pouvoir se sont accrues de même que des dévoloppements pour contrôler les émissions de substances variées qui contiennent des irritants ou qui dégagent des odeurs nocives.

Le travail à ce sujet a été fait par certains secteurs du Gouvernement, par les Universités et les Industries.

Les travaux suivants seront présentés avec l'idée qu'ils pourront intéresser les Ingénieurs et les différents corps publics à travers le pays à cause de l'intérêt que la pollution de l'air suscité et des travaux qui ont été faits à ce sujet.

AGM 63-CIV-A

A Comparison of Actual with Predicted Wave-heights and Periods for the North Shore of Lakes Ontario and Erie
Dr. Arthur Brebner,
Chairman, Department of Civil Engineering,
Queen's University Kingston, Ontario
Beni P. Sangal,
Graduate Student, Queen's University
Kingston, Ontario

Wave records for three locations on the North Shore of Lakes Ontario and Erie are compared with the wave-heights and periods obtained by various predictive methods, using the actual measured shore wind and fetch along that wind. The SMB and PNJ methods are found, in general, to overpredict the values of wave-height on these Lakes

according to the wave-height measuring device used, whereas the Darbyshire method gives reasonable agreement. The SMB or PNJ methods give good values for period.

AGM 63-CIV-A

Hauteur et durée prévues et réelles des vagues sur la rive nord des lacs Ontario et Erié

Dr Arthur Brebner
Président, Département du génie Civil,
Université Queen's Kingston, Ontario

Beni P. Sangal,
Etudiant diplômé de l'Université Queen's
Kingston, Ontario

La hauteur et la durée des vagues enregistrées à trois endroits sur la rive nord des lacs Ontario et Erié sont ici comparées à celles obtenues par différentes méthodes qui permettent de prédire cette hauteur et cette durée en se servant de la vitesse des vents effectivement mesurée sur la rive ainsi que leur direction par rapport à celle-ci. En général, les méthodes "SMB" et "PNJ" tendent à exagérer la hauteur des vagues obtenues sur ces lacs à l'aide d'appareils servant à les mesurer, tandis que la méthode "Darbyshire" concorde raisonnablement. Les méthodes SMB ou PNJ donnent de bons résultats quant à la durée.

AGM 63-CIV-B

Wind Loading on a Slim Cylindrical Structure

H. K. Malinowski
Prof. Dept. of Engineering Science
Ont. Agricultural College, Guelph, Ont.

F. H. Theakston, M.E.I.C.
Prof. Dept. of Engineering Science
Ont. Agricultural College, Guelph, Ont.

AGM 63-CIV-C

Highway Guide Rails

G. G. Henault, M.E.I.C.
Manager, Highway Dept.,
Warnock Hersey Co. Ltd.

Highway safety depends directly on such factors as vehicle speed, traffic density and vehicle loading. In the face of a growing number of accidents, the question arose whether the guide rails on the elevated section of the Metropolitan Boulevard in Montreal were providing the necessary protection. The Minister of Highways of Quebec initiated a study on this question and, in August 1962, eight (8) different types of guide rails were tested under simulated service conditions.

This paper deals with the selection of the test method and the choice of other important test conditions: the technique for launching the test vehicle, the launching speed and the speed and angle of impact, etc. A film will be shown of tests in progress, and the use of this film in interpreting the results of the tests will be described. Finally, conclusions drawn from thirteen (13) tests of eight (8) different kinds of guide rails, of steel, aluminum and concrete, will be discussed.

AGM 63-CIV-C

Glissières de sécurité

G. G. Henault, M.E.I.C.
Gérant du Département des Routes,
Warnock Hersey Co. Ltee

La sécurité routière s'impose en proportion directe des augmentations de vitesse des voitures, de la densité de la circulation et des charges déplacées. Devant le nombre croissant d'accidents, on s'est posé la question suivante: "Les glissières de sécurité de la voie élevée du boulevard Métropolitain de Montréal offrent-elles actuellement la sécurité requise?". Le Ministère de la Voirie de la province de Québec, chargé maintenant de l'entretien, a confié cette étude à un laboratoire indépendant. En août 1962, huit (8) différents types de glissières furent essayés dans des conditions se rapprochant le plus de la réalité.

La causerie explique le choix de la méthode utilisée lors des essais et le pourquoi de certaines constantes: méthode de lancement, vitesse de lancement, vitesse de frappe et angle d'impact. Un film servira d'illustration de ce qui s'est passé sur le terrain, puis on indique comment il a servi plus tard dans les calculs. L'auteur conclut en donnant les résultats des treize (13) essais sur les huit (8) différents genres de glissières en acier, en aluminium et en béton.

AGM 63-CIV-E

The Analysis of Civil Engineering Structures by Aid of Models

J. Schwaighofer
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Toronto, Ont.

The experimental approach in the field of analysis of structures serves two potential areas: One basic task is to confirm or reject the validity of newly advanced theories and in particular to define their limitations. The second field of activity is to investigate the stress, deformation, and failure characteristics of a particular, possibly a unique structure solely because theoretical means are not available to achieve this end. Model studies may be divided into two groups: studies in which homogeneous and isotropic model materials are used which follow Hooke's law within the testing range, and model studies which consider the linear and the non-linear elastic as well as the plastic behaviour of the structure and employ therefore identical materials for prototype and model. In particular in studies of the second group model analysis is not a mere counterpart of theoretical methods, but goes far beyond the theoretical approach in fully incorporating the physical characteristics of the structure. In this paper a broad survey is given of the modern methods employed in the study of structures by models. Considerable emphasis is placed on illustrations of important structures which were designed on the basis of model studies.

AGM 63-CIV-E

L'Analyse de structures de génie civil à l'aide de modèles

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La méthode expérimentale dans le champ de l'analyse des structures peut servir dans deux domaines: Dans l'un, la tâche de base est de confirmer ou infirmer la validité de nouvelles théories mises de l'avant et en particulier définir leurs bornes. Dans l'autre domaine, la méthode sert à examiner les caractéristiques d'effort, de déformation et de rupture d'une structure particulière, peut-être unique en son genre, seulement parce qu'il n'existe pas de moyens théoriques pour arriver aux mêmes fins. Les études sur modèles peuvent être divisées en deux groupes: Les études où l'on fait usage de matériaux homogènes et isotropes répondant à la loi de Hooke en deçà des limites d'essais et d'études sur modèles: ceux-ci tiennent compte du comportement élastique linéaire et non-linéaire tout autant que plastique de la structure et on emploie par conséquent des matériaux identiques pour le prototype et le modèle. Particulièrement dans le cas d'études sur modèles du second groupe, l'analyse n'est pas une simple contrepartie des méthodes théoriques, mais dépasse de beaucoup l'approche théorique en incorporant les caractéristiques physiques de la structure. Cet ouvrage donne une vue générale des méthodes modernes employées pour l'étude de structures sur modèles. L'auteur accorde de beaucoup importance à l'illustration de structures importantes conçues en partant d'études sur modèles.

AGM 63-CIV-F

The Design and Construction of the Brady Street Underpass (Sudbury, Ontario)

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J. L. Mitchell
P.Eng. M. M. Dillon & Co. Ltd., Consulting Engineers, London, Ont.

Serious vehicular-rail traffic conflictions at a level crossing adjacent to the Canadian Pacific Railway station in Sudbury indicated an ever-growing need for a separation. Negotiations and design began in 1956, with construction completed in 1961.

Site conditions were such that the use of trestle work to detour rail traffic was not acceptable to the C.P.R. It was, therefore, necessary that four tracks be left in their original location while the subway structure was constructed beneath them. In addition, the C.P.R. added the requirement that Trans-Canada eastbound and westbound tracks could not be broken for more than four hours at a time.

The above conditions, combined with a high water table and deep clays over the bedrock at the underpass site, were met in the design and construction methods. Deck components were prefabricated in sections and placed under the tracks, following which the substructure was completed with rail traffic running above.

AGM 63-CIV-F

La Conception et la Construction d'un Passage inférieur à la rue Brady (Sudbury, Ontario)

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J. L. Mitchell
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Des problèmes sérieux de traffic route-rail au passage à niveau adjacent à la gare du chemin de fer Pacifique Canadien à Sudbury, rendait de plus en plus pressant l'étagement des voies. Les négociations et la conception du project furent amorcées en 1956 et la construction achevée en 1961.

Les conditions locales étaient telles que l'emploi d'une structure sur chevalets pour détourner le trafic n'était pas acceptable pour le Pacifique Canadien. Il fut donc nécessaire de laisser les quatre voies dans leur position actuelle et d'ériger la structure du passage inférieur en même temps. En plus, le P.C. stipula que le trafic transcontinental dans les deux directions ne serait pas interrompu plus de quatre heures à la fois.

Pour répondre aux exigences mentionnées ci-haut, en tenant compte de la présence d'une nappe phréatique près de la surface et d'une grande épaisseur d'argile avant d'atteindre le roc à l'endroit de la construction, on eut recours à des méthodes de conception et de construction appropriées. Le tablier fut préfabriqué en sections et placé sous les voies, après quoi l'infrastructure fut achevée sans gêner le trafic ferroviaire au-dessus.

AGM 63-CIV-G

Un Commentaire sur les Charges dues aux Secousses Sismiques et au Vent à Prévoir dans les Projets de Construction

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Dr. H. Ward,
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L'ouvrage traite du comportement des structures durant les tremblements de terre et l'attention se concentre sur les principaux facteurs qui influent sur les réactions dynamiques de la structure.

Les auteurs examinent les exigences du Code sismique de divers pays à la lumière de la théorie pertinente et les dispositions du Code national de la construction du Canada (1960) ainsi que de celles du nouveau Code de construction uniforme des E.U.A. (1961) et du Code de l'U.S.S.R. (1957) sont appliquées à deux édifices existants.

Ces études comparatives font voir que les règlements sismiques incorporés dans le Code national de la construction ne sont pas indûment conservateurs, mais les auteurs notent que les caractéristiques essentielles de la théoric dynamique se retrouvent avec plus de réalisme dans certains des autres codes examinés.

Finalement, en utilisant pour critérium les procédures de séisme en plus du Code national de la construction, les auteurs cherchent à évaluer l'importance relative de l'effect du vent et des secousses sismiques sur les édifices ordinaires à multiples étages.

AGM 63-CIV-G

A Commentary on Earthquake and Wind Loads in Building Design

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Dr. H. Ward,
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W. A. Dalgliesh, A.M.E.I.C.,
Research Officer, Building Structures Section, Division of Building Research, National Research Council, Ottawa, Ont.

The behaviour of structures during earthquakes is reviewed and attention is focused on the principal factors influencing dynamic structural response. Seismic code requirements of various countries are then examined in the light of the relevant theory and the provisions of the National Building Code of Canada (1960), together with those of the new Uniform Building Code of the U.S.A. (1961) and the Code of the U.S.S.R. (1957), are applied to two existing buildings. While these comparative studies suggest that the seismic regulations of the National Building Code are not unduly conservative, it is noted that the essential features of dynamic theory are more realistically reflected in some of the other codes examined. Finally, using the design procedures of the National Building Code as a criterion, an attempt is made to evaluate the relative importance of wind and earthquake loading for common types of multi-storied buildings.

AGM 63-CIV-H

Perforated Breakwater—Wharf at Baie Comeau

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Engineer, Cartier, Côté, Piotte, Boulva, Werminlinger & Assoc. Ville LaSalle, Que.

A perforated breakwater-wharf has recently been constructed at Baie Comeau.

Credit for evolving the novel idea goes to engineers of the National Research Council Hydrodynamics Section. Basically, the perforated structure performs two distinct functions:

1) It reduced the height of the standing wave, by dissipating some of the energy of the oncoming wave through friction and turbulence.
2) It counteracts the familiar undertow which tends to erode the foundations at the toe of vertical wall breakwaters.

The thousand-foot-long breakwater wharf is made up of nine reinforced concrete caisson units.

To-date, the structure is performing as had been predicted from theory and from model studies.

AGM 63-CIV-H

Le Quai Brise-Lames de Baie Comeau

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Le port de Baie Comeau vient d'être doté d'une structure à paroi trouée qui sert à la fois de brise-lames et de quai.

Cette structure est la réalisation pratique d'un concept développé par les ingénieurs de la Section Hydrodynamique du Conseil National des Recherches. Essentiellement, la paroi trouée remplit deux fonctions distinctes:

1) Elle diminue la hauteur du clapotis en dissipant une partie de l'énergie de la lame.
2) Elle neutralise les courants de fond responsables des affouillements souvent observés à la base des bris-lames à paroi verticale.

La nouvelle structure est formée de neuf caissons de béton s'étendant sur une longueur de 1000 pieds.

Les observations faites justqu'ici confirment les prédictions qu'avaient permises la théorie et les études sur modèles.

AGM 63-CIV-J

Water-Reducing Admixtures for Concrete Applications and Specifications

T. G. Clendenning,
M. T. Loughborough

Water-reducing admixtures are finding increasing use in concrete construction and a few large agencies, including Ontario Hydro, have adopted them for mass concrete. By their part in reducing cement content, water reducers have contributed to greater freedom from cracks in Ontario Hydro's dams. No major problem has arisen in their use, although false setting has been aggravated in certain instances.

Although not usually preventing the loss of slump with time that results from high concrete temperatures, retarding water reducers do extend the period during which concrete will respond to vibration. In this way they have been beneficial in the prevention of cold joints. Excessive retardation can result in greater plastic shrinkage and cause difficulties due to higher form pressures.

Specifications for water-reducing admixtures and for dispensers for concrete admixtures were developed by Ontario Hydro in 1961 in the absence of a national specification. Until such time as a national specification is produced both the admixture specification and the dispenser specification, which are suited to any central mixing plant operation, should prove of value to other large scale producers of concrete such as ready-mix suppliers.

Benefits derived either directly or indirectly from the specification have included greatly improved admixture dispensers and very favourable prices on water-reducing admixtures which, since their adoption in 1956, have made possible cement savings amounting to approximately ⅓ of a million sacks.

AGM 63-CIV-J

Additifs réducteurs d'eau pour Béton, leurs emplois et devis techniques

T. G. Clendenning,
M. T. Loughborough

Les additifs réducteurs d'eau sont employés de plus en plus dans les constructions en béton et quelques organismes importants, y compris l'Hydro-Ontario, les ont adoptés pour le béton de masse. En aidant à diminuer le teneur en ciment, les réducteurs d'eau ont contributé à une plus grande absence de fissures dans les barrages de l'Hydro-Ontario. Aucun problème d'importance majeure n'est survenu du fait de leur emploi, bien que dans certains cas, on ait constaté plus de prise fictive.

Bien qu'ils n'empêchent généralement pas la perte d'affaissement causée avec le temps par les hautes températures du béton, les agents réducteurs d'eau et retardateurs de prise prolongent la période durant laquelle le béton peut être vibré. De cette façon, ils servent à prévenir les joints froids. Un retard excessif peut causer un retrait plastique plus considérable et causer des difficultés attribuables à des pressions trop élevées sur les coffrages.

Les devis techniques pour les additifs réducteurs d'eau et les dispensateurs d'additifs pour béton furent rédigés par l'Hydro-Ontario en 1961, vu l'absence d'un devis technique national. Jusqu'à ce qu'un tel devis technique national soit publié, l'un et l'autre des devis techniques pour les additifs et les dispensateurs, qui sont appropriés à n'importe quelle installation de malaxage, devraient s'avérer avantageux pour les grands producteurs de béton, tels que les fournisseurs de béton pré-malaxé.

Parmi les bénéfices provenant directement ou indirectement des devis techniques, il faut inclure une forte amélioration des dispensateurs d'additifs et des prix très avantageux pour des additifs réducteurs d'eau qui, depuis leur introduction en 1956, ont permis d'épargner approximativement ⅓ d'un million de sacs.

AGM 63-CE & A-A

The Environment of Space. Its Simulation for Test Purposes

F. D. Ward,
Canadian Armament Research and Development Establishment

The requirements for extreme reliability of equipment used in space missions is discussed from the point of view of cost and effort. Environments associated with space vehicles are described together with a description of methods of simulation and testing and equipment used. Results of actual tests are described and finally examples of design remedies found to be necessary as a result of environmental testing are discussed.

AGM 63-CE & A-A

Le Milieu Spatial, Sa Reconstitution pour Fins d'Essais

F. D. Ward,
Canadian Armament Research and Development Establishment

Les exigences du fonctionnement sur l'équipement employé dans les missions spatiales sont ici discutées aux points de vue tant du coût que des efforts. Les milieux associés aux vehicules spatiaux sont décrits, de même que les méthodes de reconstitution et d'essai ainsi que l'équipement employé. Suivant une description des essais eux-mêmes et une discussion portant sur les exemples des correctifs jugés nécessaires à la suite des essais sur le milieu spatial.

AGM 63-CE & A-B

Problemes de Genie que Poscitles Aerostats Aux Grandes Altitudes

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L'introduction contient une brève description des recherches entreprises sur la haute atmosphère et les véhicules utilisés: l'avion, la fusée, et la combinaison nacelle-aérostat. Une nacelle typique est ensuite décrite et les problèmes que posent sa fabrication: température, pression, radiation solaire

etc. . . sont ensuite discutées. Une description de la procédure de lancement termine la conférence.

AGM 63-CE & A-B

Enginering Problems Posed in the Design of High Altitude Vehicles

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A brief description of the upper atmosphere research program at CARDE is presented, followed by a discussion of the vehicles used to carry out this program: the aircraft, the rocket and the balloon-gondola. A typical gondola is described and the engineering problems encountered in its design and fabrication are studied and proper solutions presented. The paper concludes with a description of the launching and flight procedure and of the tracking and recovery operations.

AGM 63-CE & A-C

The Development of a Reliable Miniaturized Beacon for Radar Tracking of Research Rockets and Balloons

W. Slaght and
H. Morewood,
Canadian Armament Research and Development Establishment

This paper describes the development of a miniature microwave beacon or transponder which is used to aid radar tracking of high altitude research vehicles. An analysis is made of the various features stressed during the development phase. It is shown how the prime concern for reliability led to such simplifications in circuitry and construction that even laboratory-produced units would be competitive with the existing, mass-produced radar beacons.

The problems involved in the operation of radar beacons under extreme environmental conditions are related to high altitude balloons and rockets and the solutions thereof are discussed.

A summary is made that exemplifies the versatility of the MK7 beacon and shows its application to related fields.

AGM 63-CE & A-D

The Canadian Topside Sounder Satellite Engineering Performance

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The Topside Sounder Satellite has been described in general in several reports and others are in preparation giving details of the mechanical, thermal and electrical design. This paper will not attempt to repeat the spacecraft description in detail but will contain a summary of the main design features and design objectives to enable us to consider and evaluate the spacecraft performance.

The spacecraft contained a primary experiment, the ionospheric sounder and three secondary experiments—the energetic particle detectors, a very low frequency receiver and a cosmic noise experiment. To meet the objectives of these experiments, three distinct designs were required—electrical, thermal, and mechanical. These will be summarized in the paper.

The overall performance of the satellite can only be described as very good. At this writing (4½ months after launch) all components are functioning normally, no subsystems have failed and there is no indication of any circuit component failure. The paper will report the performance of the scientific experiments and the telemetry, command and power supply subsystems. The mechanical performance during lift-off and injection and the thermal performance in space will be described.

AGM 63-CE & A-D

Rendement Technique du Satellite Canadien Topside Sounder

R. K. Brown
Defence Research Telecommunications Establishment, Ottawa, Ont.

Pleusieurs rapports ont déjà expliqué en détails le satellite Topside Sounder. D'autres rapports sont actuellement en préparation donnant des détails concernant sa conception du point de vue mécanique, thermique et électrique. Le présent ouvrage ne veut pas décrire à nouveau ce vaisseau de l'espace mais bien plutôt donner un sommaire de ses principales caractéristiques et de ses objectifs techniques, afin de nous permettre de considérer et d'évaluer le rendement du vaisseau spatial.

Le vaisseau comprend un appareil primaire, l'ionosphéric sonore et trois appareils secondaires, les détecteurs de porteurs électrisés, un appareil récepteur à très basse fréquence et un appareil sonore cosmique. Pour que ces appareils répondent à leurs fins, on a dû prévoir trois systèmes distincts, soit un système électrique, un système thermique et un système mécanique. La communication en donne le sommaire.

Le rendement global du satellite est excellent. Aujourd'hui, (4½ mois après son lancement) tous les organes fonctionnent normalement, aucun des systèmes secondaires n'a subi de panne et rien ne laisse prévoir une panne de circuit. L'auteur donne un compte-rendu du rendement des appareils techniques et du télémètre, de même que des systèmes secondaires de commande et d'alimentation électrique. Il décrit le rendement mécanique lors du lancement et de la mise en orbite et le rendement thermique dans l'espace.

AGM 63-CE & A-E

Panel Discussion on the Function of Electronic Research in Government, Industry and the University, with Dr. B. G. Ballard, M.E.I.C. as Moderator

Dr. B. G. Ballard, M.E.I.C.,
as Moderator

The following men are expected to take part in this Panel discussion, the aim of which will be to examine the relationship of Electronic Research in the various groups of the Canadian economy:—

Professor L. Boulet, M.E.I.C.
Faculty of Science, Laval University, Quebec, P.Q.

Dr. G. L. d'Ombrain
Prof. Dept. Elect. Engineering, McGill University, Montreal, Que.

Dr. F. S. Eadie
Manager, Physical Science Research, Northern Electric Research Lab., Ottawa, Ont.

Dr. R. W. Jackson
Director, Semi-Conductor Laboratory, R.C.A. Victor Research Lab., Montreal, Que.

Mr. J. L. Orr
Director, Industrial Research, Defence Research Board, Ottawa, Ont.

It is expected that the following questions will be explored: Why should industry, the universities, and the government undertake research, either pure or applied?

Is electronic research necessary to put Canada in a better competitive position?

Will increased research stimulate engineering registration, or reduce the export of scientists and engineers?

Would increased communication betwen universities, industry and government be desirable?

Should there be more emphasis on graduate study?

Doubtless other related topics will also come under discussion.

AGM 63-CE & A-F

The Future of Automation in Canada

E. W. Leaver,
President,
Electronic Associates Ltd.,
Willowdale, Ont.

AGM 63-CE & A-G

Analog Computer Control of a Nuclear Reactor

R. G. de Buda,
Electronic Equipment and Tube Department,
Canadian General Electric Company Limited,
Toronto, Ontario

The 20,000 KW nuclear reactor NPD-2 is controlled by a special purpose analog computer which permits continuous operation of the reactor at the highest safe power level.

The computer consists of three identical computer channels. Each channel receives independent measurements from the reactor, compares them with the desired levels of power and steam pressure and then actuates valves which control the heavy water level, and through this the reactivity and the output power of the nuclear reactor.

Three identical channels are used to safeguard against failure in one of them. Some problems of three channel redundance are discussed.

AGM 63-CE & A-G

Commande de la Calculatrice Analogique d'un Réacteur Nucléaire

Monsieur R. G. de Buda,
Division des tubes et de l'appareillage électronique,
Canadian General Electric Company Limited,
Toronto, Ontario

Le réacteur nucléaire NPD-2 de 20 000 kW est commandé par une calculatrice analogique qui permet le fonctionnement continu du réacteur au niveau d'énergie le plus élevé offrant le maximum de sécurité.

La calculatrice comporte trois ondes de liaison identiques. Chaque onde de liaison perçoit du réacteur, des mesures indépendantes, les compare aux niveaux d'énergie voulus et au manomètre. Elle actionne ensuite les tubes qui commandent le niveau d'eau lourde, et par là, la radioactivité et la production d'énergie du réacteur ou pile nucléaire.

Trois ondes de liaison identiques préviennent les pannes qui pourraient survenir à l'une ou l'autre. On étudie certains problèmes concernant l'excédent des trois ondes de liaison.

AGM 63-CE & A-H

Feedback Control in Living Prototypes
A New Vista in Control Engineering

Dr. J. A. Tanner,
Instrument & Control Systems Laboratory,
National Research Council,
Ottawa

Living systems embody many different forms of feedback control from the autonomic functioning of single cells to the coordination of the life functions in highly complex multi-cellular animals and plants. From the many living control processes, it is possible to gain clues and inspirations that could lead to man-made machines of greatly increased capabilities. The self-adaptive capability of living systems is of topical interest to control engineers, particularly in regard to the living embodiment of analogue models and performance criteria. Three modes of self-adaptive control are discussed in relation to specific examples of their living counterparts. Perhaps the ultimate example of a multivariable self-adaptive control system is the human operator, who is endowed with planning and "decision-making" abilities. These abilities are discussed in relation to the optimisation of man-machine relationships. Biologieal transducers and the transmission of information are also discussed.

AGM 63-CE & A-H

Feedback Control in Living Prototypes
A New Vista in Control Engineering

Dr. J. A. Tanner,
Instrument & Control Systems Laboratory,
National Research Council,
Ottawa

Les êtres vivants incorporent maintes forms différentes de contrôle réactif depuis le fonctionnement autonome de cellules individuelles jusqu'à la coordination des fonctions de la vie dans les animaux et les plantes à réseau multicellulaire très compliqué. En étudiant les modes de contrôle de nombreaux êtres vivants, il est possible d'obtenir des renseignements et des inspirations qui pourraient conduire à la création de machines fabriquées de main d'homme et aux possibilités grandement accrues. La puissance auto-adaptive des êtres vivants est fort intéressante pour les ingénieurs en appareillage de commande, surtout en ce qui a trait à l'application à des modèles analogues et aux critères de performance. Il est question ici de trois modes de contrôle auto-adaptif par comparaison avec des exemples spécifiques chez leurs contre-types vivants. Peut-être l'exemple parfait d'un système de contrôle auto-adaptif multivariable se trouve-t-il chez l'opérateur humain qui a les facultés de prévoir et de prendre des décisions. Ces facultés sont discutées en fonction du rendement optimum de la relation homme-maehine. Il y est aussi discuté des transducteurs et de la transmission de renseignements.

AGM 63-EDUC-A

"The Danger of Specialization"

George Ford, M.E.I.C.,
Head, Department of Mechanical Engineering,
University of Alberta

Many changes are taking place in modern engineering curricula not only in course content but in depth of treatment as well. Material which a few short years ago was considered only at the graduate level is already basic to an undergraduate program. Emphasis is being placed on scientific principles and more sophisticated attacks on engineering problems. Great care must be exercised in the selection of courses in an engineering program so as to provide a base from which the orderly process of education may continue after the engineer leaves the university. Such a program can only be constituted by emphasizing the basic engineering science courses at the expense of courses which give specific knowledge in a narrow field. The retention of these specialized courses can only lead to early obsolescence.

Since the specialized courses are to be removed from the curriculum, industry itself must accept the responsibility for providing most of the professional training of the engineer.

AGM 63-EDUC-A

"Les Dangers de la Spécialisation"

Monsieur George Ford, M.E.I.C.,
chef du département de génic mécaniquc,
Université d'Alberta

Le curriculum actuel des écoles de génie s'est non seulement élargi, il s'est aussi approfondi. Les matières qui, il y a seulement quelques années, n'étaient enseignées qu'aux finissants, sont actuellement au programme des classes inférieures. On insiste surtout sur les principes de la science et plus encore sur unc discussion plus poussée des problèmes de génie. Les cours faisant partie du programme de génie doivent être choisis avec soin afin d'assurer une base solide permettant à l'ingénieur diplômé de poursuivre son éducation selon un procédé normal. Un tel programme ne peut être établi qu'en insistant sur les cours scientifiques de base aux dépens des cours spécialisés dans des domaines spécifiques restreints. Retenir ces cours spécialisés nc peut conduire qu'à une atrophie prématurée.

Puisque les cours spécialisés doivent être supprimés du programme, l'industrie devra accepter la responsabilité d'assurer la plus grande partie de la formation professionnelle spécifique de l'ingénieur.

AGM 63-EDUC-B

The Computer & the University

Dr. A. D. Booth
Head Dept., Electrical Engineering,
University Saskatchewan, Saskatoon, Sask.

AGM 63-EDUC-C

Time and Load Factor in Engineering Education

Olgierd Celinski
Prof. Dept., Electrical Engineering,
University of Ottawa, Ottawa, Ont.

The value of the present day distribution of student's work load at the Universities is questioned, and a different method of load distribution in time is discussed.

The proposed scheme divides the academie year into eight short periods in which students alternately study the theoretical and laboratory subjects. The most important feature of the system is the "singleness of purpose" of student's work within any given period. This implies high concentration over a five week theoretical study period culminating in the examinations and then a three week relaxation period of laboratory work.

The scheme offers great flexibility and seems to have merits from the point of view of the student, the teacher and the University.

AGM 63-EDUC-D

Dynamic Objectives in Chemical Engineering Education

D. S. Scott (Dr) A.M.E.I.C.,
Dept. of Chemical Engineering,
University of B.C.,
Vancouver

AGM 63-EDUC-E

Civil Engineering Education in the University

A. M. Neville,
Professor of Civil Engineering,
University of Saskatchewan

A critique of university courses is presented as, in view of the tremendous changes in the field of engineering and technology during the last decade or two, a new, rather deeper and more fundamental approach in engineering courses is needed.

Suggestions on pruning of existing courses are made, and in order to make the student think a study of one or two subjects in considerable depth is recommended. Special reference is made to the teaching and use of mathematics.

The paper finally discusses the proposition that unimaginative courses lead to reduce enrolment in civil engineering, and only a change to more exacting and exciting courses in the universities will produce civil engineers of a high calibre.

AGM 63-EDUC-F

La Formation des Ingénieurs Modernes

L. Boulet, M.E.I.C.

De leur fondation jusqu'en 1950, les universités ou les écoles d'ingénieurs ont formé des ingénieurs de plus en plus spécialisés que l'on pourrait nommer ingénieurs des composantes.

Dans la période 1950-1960, l'introduction des moyens du calcul moderne a permis à l'ingénieur de s'attaquer à des problèmes qui font appel à toutes les disciplines du génie. Depuis quelques années, on réalise de plus en plus la présence de l'humain dans les problèmes de génie.

On réalise qu'il existe trois types d'ingénieurs:

L'ingénieur des composantes

L'ingénieur des systèmes

L'ingénieur économiste.

On doit donner la chance à l'étudiant de s'adapter à chacune de ces possibilités.

On doit former des ingénieurs bons en tout mais bons à rien de spécifique? Ces jeunes gradués pourraient s'adapter facilement à toutes les techniques et à tous les bouleversements que nous vivons maintenant.

Un enseignement de base axé sur la culture générale et humaniste devra développer les qualités de pensée et philosophiques des individus.

En résumé, pour employer un mot de Rimbaud: "Nous allons vers l'esprit".

AGM 63-EDUC-G

"Selected Topics in Engineering Education"

Chairman: J. Hoogstraten (Prof)
Vice-President,
University of Manitoba

(panel members not yet confirmed)

AGM 63-ELEC-A

Aircraft Electrical Power Systems

J. Gawley,
Canadair Ltd.

INTRODUCTION

This will include a brief historical survey both general and with reference to Canadair.

GENERAL

This will include a discussion of the reasons for selection of a given system for any aircraft. A review of how the type of aircraft influences the system selection and a discussion of the major design factors will follow. Three examples of Canadair aircraft will be cited. These descriptions will then be expanded to the extent shown below, with greatest emphasis being placed on Aircraft (c).

Aircraft (a) Long Range Military Patrol Aircraft.
Electrical System: 4-40 KVA Constant Frequency A.C. Generator.
4—200 amp 28 V D.C. Regulated Transformer-Rectifier Units.

Fairly complete description of the system. Implications of the system e.g. Need for development program, Canadair Test Laboratory etc. Review of operation in service.

Aircraft (b) Medium Range Specialized Transport
Electrical System: 2—40/60 KVA Variable Frequency A.C. Generators
2—3.5 KVA Constant Frequency A.C. Generators
2—100 amp 28 V D.C. Unregulated Transformer-Rectifier Units.

Description of the electrical system and discussion of reasons for changing from the type of system used in Aircraft (a). Discussion of areas requiring particular design attention.

Aireraft (c) Military Trainer Aircraft
Electrical System: 1—300 amp 28 V D.C. Starter Generator
1—750 VA Static Inverter
1—750 VA Rotary Inverter

A description of the system in more detail than for (a) or (b) will be given. This will include a review of the various conflicting requirements and of the reasons for compromising in one direction or another. The effect on the electrical system of changes in other apparently unrelated systems will be discussed.

AGM 63-ELEC-A

Systèmes Electriques Pour Avions

J. Gawley,
Canadair Ltd.

INTRODUCTION

L'auteur donne un aperçu historique des installations en général et des installations de Canadair en particulier.

GENERAL

Il traite des raisons qui ont conduits au choix d'un système électrique pour chacun des avions considérés. Il montre l'influence du type d'avion sur le choix d'un système électrique et discute des problèmes les plus importants rencontrés durant l'élaboration du système. Trois types d'avions Canadair sont mentionnés. En décrivant ces types d'avions, l'auteur détaille les appareils suivants, tout en s'attardant à l'avion du type C.

A—Avions militaires à grand rayon d'action
Système électrique: 4 Générateurs C.A. de 40 kva de puissance à fréquence régularisée.

4 Transformateurs—Redresseurs assurant un voltage régularisé de 28 v à 200 amp. c.c.

Description à peu près complète du système. Implications du système, i.e.: Le besoin d'un programme d'accroissement, le laboratoire d'essais de Canadair, etc. Résumé de la mise en service.

3-Avions de transport à rayon d'action moyen
Système électrique: 2 Générateurs C.A. de 40/60 kva à fréquence variable.
2 Générateurs C.A. de 3.5 kva à fréquence régularisée.
2 Transformateurs—redresseurs de 100 amp. c.c. assurant un voltage non régularisé de 28 v.

L'auteur décrit le système électrique et traite des raisons qui ont nécessité l'adoption d'un autre système électrique que celui des avions du type A. Il traite aussi les points qui ont requis une attention particulière lors de l'élaboration du projet.

C—Avions pour apprentissage militaire
Système électrique: 1 Générateur de démarrage de 300 amp. c.c., 28 v.
1 Convertisseur statique 750 V.A.
1 Convertisseur rotative 750 V.A.

La description de ce système est plus détaillée que celles données pour les avions du type A et B. L'auteur résume les difficultés rencontrées pour satisfaire à des exigences variées et contradictoires et les raisons des compromis adoptés. Il montre comment certains changements apportés à d'autres systèmes et qui semblent n'avoir aucun rapport avec le système électrique, peuvent néanmoins influer sur ce dernier.

AGM 63-ELEC-C

Installation of in-span transpositions in 345 KV transmission lines

R. M. Harvey, M.E.I.C.
Aluminum Company of Canada, Shipshaw, P.Q.

The installation of in-span transpositions in transmission lines is not new in itself. However, installing the transpositions with full tension on the conductors is a unique project.

The lines which were transposed consist of two, single circuit, 345 KV transmission lines strung with two 850 MCM ACSR conductors per phase carried on waist type towers in a horizontal configuration.

Operating experience after one and one-half years indicated that the unbalances present in the untransposed lines produced adverse effects on adjacent communication circuits and caused false relay operations. This led to the decision that transpositions be installed. In-span transpositions are made by inserting double-length insulator strings in each conductor using a special yoke assembly, and transferring each electrical phase to its new position by means of jumpers looped below the line. Three transpositions were installed per line to obtain a complete rotation and were located at the one-sixth, one-half and five-sixth points. This placed one set of transpositions at dead-end towers and the other two at suspension towers.

The conductor tension had to be maintained at all times during the installation to avoid undue strain on adjacent towers. The procedure in all cases consisted of taking up the tension in the conductors for a length of 200 feet from the tower as described later, to create a slack section and then cutting a piece out of each conductor to allow the installation of the insulators and hardware.

At the dead-end towers, come-alongs were installed on each conductor of one phase at a distance of 200 feet from the tower. These were connected together by means of a special yoke plate to a steel wire rope which was fastened to the tower through a six-ton puller. By means of the puller the tension of the two conductors was taken up, creating a slack section 200 feet long. The conductors were then cut at a distance of 50 feet from the tower and the two ends dropped to the ground where insulators and hardware were installed. A length of approximately 17 feet was cut out of the conductors to allow for the insulators and hardware.

At suspension towers the outside phases were done by dropping the conductor to the ground, installing come-alongs at two points 200 feet apart on each conductor and taking up the tension with the six-ton pullers. The cutting and installing of the insulators and hardware was again done in the slack section. The center phase in this case was more difficult since the conductors pass through the tower and cannot be lowered to the ground. The end closest to the tower is only 50 feet long and therefore cannot reach the ground for installation of dead-ends. Therefore a special platform was built and suspended from the crossarm. The conductor was then looped back onto the platform onto which the compressor had been raised and the dead-ends installed.

The effect of the transpositions was seen as soon as the lines were returned to service. Whereas neutral currents in the order of 90 to 100 amperes were measured before transpositions, these were negligibly small after transposing. Protective relays can now be properly set and induced voltages in the adjacent communication circuits have been reduced considerably, thus obtaining the objectives required.

AGM 63-ELEC-C

Installation sous Tension des Transportations dans des Portées de Lignes de Transport de 345 kV

R. M. Harvey, M.E.I.C.
Aluminum Company of Canada, Shipshaw, Que.

L'introduction de transpositions dan les lignes de transport n'a rien de neuf en soi. Toutefois, l'introduction de transpositions dans une ligne sous pleine tension est une entreprise unique en son genre.

Les lignes transposées sont deux lignes de 345 kV à simple terne à deux conducteurs de 850 mcm acsr par phase portées sur pylônes à taille étranglée (waist type) dans un profil horizontal.

L'expérience démontra après un an et demi d'exploitation que les déséquilibres constatés dans les lignes sans transpositions produisaient des effets nocifs sur les circuits de communication adjacents et entraînaient le déclenchement inutile des relais. On décida donc d'effectuer les transpositions requises. L'introduction des transpositions dans une portée se fait en ajoutant à chaque conducteur des chaînes d'isolateurs doubles à l'aide d'un joug spécial et en transférant chaque phase électrique à sa nouvelle position au moyen de cavaliers raccordés sous la ligne. On introduisit ainsi trois transpositions par ligne pour assurer une rotation complète, en les plaçant au sixième, à la demie et aux cinq sixièmes. Il y avait ainsi un groupe de transpositions aux tours d'extrémité et les deux autres aux tours de suspension.

La tension physique du conducteur devait être maintenue en tout temps durant les travaux de modification pour éviter tout effort excessif aux pylônes adjacents. Dans tous les cas, il s'agissait d'abraquer le mou des conducteurs sur une longueur de 200 pieds à partir du pylône, tel que décrit plus loin, de détendre une section et ensuite de couper un morceau de chaque conducteur pour permettre l'installation des isolateurs et des ferrures.

Aux pylônes d'extrémité, des tendeurs furent attachés à chaque conducteur d'une phase à 200 pieds du pylône. On les rattacha ensemble au moyen d'un joug spécial à un câble d'acier retenu lui-même au pylône par un tendeur de six tonnes. Cet outil abraqua le mou des deux conducteurs, pour détendre une section de 200 pieds. On coupa alors les conducteurs à 50 pieds du pylône et on laissa tomber les deux bouts au sol pour installer les isolateurs et les ferrures.

Aux pylônes de suspension on procéda à la modification des phases extérieures en laissant tomber les conducteurs au sol, en installant des tendeurs sur chaque conducteur en deux points distants de 200 pieds et en abraquant le mou à l'aide du tendeur de six tonnes. On procéda encore une fois au coupage et à l'installation des isolateurs et des ferrures dans la section détendue. La phase médiane présentait ici plus de difficulté puisqu'il était impossible de faire passer les conducteurs à travers le pylône pour les descendre au sol. Le bout le plus rapproché du pylône

n'avait que 50 pieds de longueur et il n'atteignait pas le sol pour permettre l'installation de manchons d'extrémité. Il fallut bâtir une plateforme spéciale et la suspendre à la traverse. Le conducteur fut alors ramené à la plateforme où on avait installé un compresseur et les manchons d'extrémité furent réinstallés.

L'effet des transpositions se fit sentir dès la remise en exploitation des lignes. On avait mesuré des courants neutres de 90 à 100 ampères avant les transpositions, et ces courants sont devenus négligeables après la modification.

Les relais protecteurs peuvent maintenant être parfaitement réglés: les courants d'induction dans les circuits de communication adjacents ont été sensiblement réduits, et l'objectif visé a été atteint.

AGM 63-ELEC-D

The NPD On-Power Fuelling Machines

W. M. Brown, P.ENG.
Canadian General Electric Company

The Nuclear Power Demonstration Station at Rolphton, Ontario, a joint project of Atomic Energy of Canada Limited, the Hydro Electric Power Commission of Ontario and the Canadian General Electric Company, employs two identical, semi-automatic remotely controlled fuelling machines in its on-power fuelling system. The machines handle the 3¼" diameter by 19½" long zircaloy sheathed uranium oxide fuel bundles for the NPD reactor. One machine operates at each reactor face. Each machine is capable of acting as a charge or discharge machine and normal fuelling is accomplished by inserting a new fuel bundle in one end of a reactor channel and simultaneously ejecting a bundle from the opposite end of the same channel. Each machine comprises a carriage and an operating head attached to it by a vertical telescopic tube and elevator assembly. During operation, the operating heads become part of the reactor coolant pressure boundary with full exposure to reactor vault irradiation flux and to heavy water at 1200 psig and 530°F. The paper will describe the design, development, commissioning and operation of these machines.

AGM 63-ELEC-E

Non-Icing Conductor

by Dr. A. S. Timascheff, M.E.I.C.
Laval University, Quebec, P.Q.

Conductor icing is an appreciable hazard for the reliable operation of transmission lines.

"De-icing" of ice-covered conductors is always difficult. One method is to melt the ice using largely increased currents; it is not suitable, however, for EHV lines; mechanical removal by insulated strips can be convenient in certain cases, but not in locations with restricted access, as i.e. in mountains or at river and lake crossings.

In such cases, the prevention of ice formation becomes particularly important; any device increasing the chances of ice prevention appears worth while consideration. The greatest danger arises when an ambient temperature just below 0°C coincides with a low conductor current. A solution could be provided by a cable which produces a small but appreciable temperature rise at low currents, and a relatively limited one at high currents.

The use of a special composite ACSR cable with one or several outside layers of high-permeability steel can be suggested. At low currents the permeability μ is high and the penetration depth $\delta \sim \sqrt{\frac{\rho}{\mu f}}$ very restricted; therefore, the effective AC resistance is increased several times against the DC resistance. At higher currents, μ drops rapidly and so does the AC resistance. Therefore, losses at small currents are relatively high and at high currents still tolerable.

Non-icing cable samples have been manufactured and tested by Alcan in respect of resistance and reactance vs current and in respect of temperature rise vs time and current under various ambient conditions including still air, wind and freezing rain. These tests confirmed the expected cable properties.

The non-icing cable should be useful for short endangered stretches with difficult access. The highly increased losses and the increased reactance of the short stretch are effective only during periods of small loads and do not affect appreciably the over-all operating and economic conditions of the transmission line.

AGM 63-ELEC-F

A Modern DC Supply System for an Electro-Chemical Zinc Refinery

A. Ludbrook,
Switchgear & Control Div.,
Can. Westinghouse Co. Ltd.,
Hamilton, Ont.

AGM 63-GEOTECH-A

Composite Design of Underground Steel Structures

G. G. Meyerhof, M.E.I.C.,
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Nova Scotia Technical College,
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C. L. Fisher, M.E.I.C.,
Chief Engineer,
Armco Drainage and Metal Products Co. of Canada,
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As part of a study of the ultimate strength of corrugated metal arches and culverts under earth fills an investigation was made at the Nova Scotia Technical College of the collapse load of curved plain and corrugated steel sheets bearing against compacted sand backfill. The laboratory test results are found to support an approximate formula developed from the theory of elastic stability of curved plates supported by an elastic subgrade.

Field studies on the strength of underground steel structures in different soils are analyzed to obtain information about the strains, deflections and pressures exerted on such structures and their relation to the soil properties and backfill support. On the basis of these laboratory and field tests a method of composite design of underground steel structures is proposed. This approach is illustrated by some examples from recent applications in practice. Various construction problems of underground steel structures are outlined and their relation to composite design is indicated in the proposed paper.

AGM 63-GEOTECH-A

Composite Design of Underground Steel Structures

G. G. Meyerhof,
Directeur, School of Graduate Studies,
Nova Scotia Technical College,
Halifax, N.S.
G. L. Fisher,
Ingénieur en chef,
Armco Drainage and Metal Products Co. of Canada,
Winnipeg, Manitoba

En marge d'une étude sur la résistance des arches et des ponceaux en métal ondulé sous les remblais de terre, le Nova Scotia Technical College a fait des recherches sur la charge de rupture des plaques d'acier planes et ondulées appuyées sur un remblai de sable compacté. Les résultats des essais en laboratoire concordent avec une formule approximative dérivée de la théorie sur la stabilité élastique des plaques courbes supportées par un sous-sol élastique.

Des études en chantier sur la résistance de structures d'acier placées sous terre dans différents sols ont été analysées pour obtenir des données sur les déformations, déflections et pressions exercées sur ces structures, et sur leur relation avec les propriétés du sol et la puissance de support du remblai. En se basant sur ces essais en laboratoire et en chantier, on a proposé une méthode de construction pour les charpentes souterraines en acier. Cette nouvelle méthode est illustrée par des applications pratiques récentes. On donne la description de différents problèmes de construction de structures souterraines en acier et leur relation avec la nouvelle méthode d'analyse.

AGM 63-GEOTECH-B

The Engineering Geology of the Bersimis No. 2 Site

Dr. D. H. MacDonald, M.E.I.C.
Director, H. G. Acres & Co. Ltd., Niagara Falls, Ont.
T. Wilson
Soils Engineer, H. G. Acres & Co. Ltd., Niagara Falls, Ont.

The Bersimis No. 2 power development is located on the Bersimis River in the Province of Quebec, approximately 45 miles upstream from its confluence with the St. Lawrence River. It has an installed turbine capacity of 637,800 kilowatts operating at a normal net head of 392 feet, and together with the Bersimis No. 1 development, which preceded it in construction, it develops the full potential of 1,533,000 kilowatts on the Bersimis River.

The Bersimis is one of the many rivers which flow southwards and drain the Canadian Shield into the St. Lawrence River. The Bersimis No. 2 site is located near the southerly edge of the Shield, and the rocks at the site are of metamorphic and igneous types typical of this geological region. The entire area experienced severe glaciation in the Pleistocene Epoch, and the Bersimis No. 2 site, in contrast to the Bersimis No. 1 site, is at a sufficiently low elevation that it also experienced the marine or estuarine inundations of the St. Lawrence Lowlands in late-Pleistocene times. Geologically, the site is characterized by competent rocks exhibiting considerable topographic relief and by deep terrace deposits of fine-grained marine or estuarine sediments.

The Bersimis No. 2 development includes a concrete gravity dam of 275-foot height, and two long, low earth dams founded directly on the terrace sediments. The underground works include a diversion tunnel of 33-foot diameter and 700 feet in length, a power tunnel of 38-foot internal diameter and 2,400 feet in length, five penstocks of 17- and 12-foot internal diameters and 3,000 feet in total length, and a surge shaft of 33-foot internal diameter and 300-foot rise. The powerhouse, containing five turbines, is of the outdoor type.

The paper describes the geological features of the site and their effects upon the layout of the development. Of particular interest are the origin and constitution of the deep terrace deposits, and the problems of stability and seepage which they presented. The foundation conditions beneath the main dam and the grouting and drainage provisions incorporated in its design are described. The design and construction of the tunnelling and other underground works are outlined, and the paper concludes with general comments on the operation and performance of the development.

AGM 63-GEOTECH-B

Geologie de Bersimis 2

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L'aménagement hydroélectrique de Bersimis 2 est situé dans le Québec, sur la rivière Bersimis, approximativement à 45 milles en amont du confluent de celle-ci et du Saint-Laurent. La puissance installée de 637,800 kilowatts, sous une hauteur normale de charge de 392 pieds, donne, avec Bersimis 1 eonstruit auparavant, le potential possible de 1,533,000 kilowatts de la rivière Bersimis.

Cette rivière est un des affluents de la rive Nord du Saint-Laurent qui drainent les eaux du Bouclier Canadien. Bersimis 2 est situé dans le Sud du Bouclier. Le roc, à cet endroit, est du type métamorphique et igné propre à la géologie de cette région. Pendant le pléistocène, la région entière a été soumise à l'érosion par les glaciers. Bersimis 2, étant à un niveau plus bas que Bersimis 1, fut, à l'instar des basses-terres du Saint-Laurent, submergé par les mers avant la fin du pléistocène. Au point de vue géologique, le site est caractérisé par des rochers à fort relief topographique et aussi par d'épaisses couches de sédiments marins à grains fins.

L'aménagement de Bersimis 2 comprend un barrage, en béton, du type gravité, d'une hauteur de 275 pieds et deux digues en terre, longues et peu élevées, posées directement sur les plates-formes de sédiments. Les ouvrages souterrains sont les suivants: un tunnel de dérivation dont le diamètre est 33 pieds et la longueur 700 pieds, un tunnel d'amenée dont le diamètre intérieur est 38 pieds et la longueur 2,400 pieds, cinq conduites forcées dont les diamètres intérieurs sont 17 pieds et 12 pieds et la longueur totale 3,000 pieds et une cheminée d'équilibre dont le diamètre intérieur est 33 pieds et la hauteur 300 pieds. La centrale contient cinq turbines et est du type extérieur.

La communication décrit les caractéristiques géologiques du site et leurs effets sur le traeé de l'aménagement. L'origine et la composition des plates-formes de sédiments, de même que les problèmes de stabilité et d'infiltration qu'ils présentent, sont d'un intérêt particulier. Le texte décrit les calculs relatifs au barrage et les problèmes concernant les fondations, tels que les dispositions nécessaires prises pour les coulées du béton et le drainage.

Le texte donne aussi un aperçu du calcul et de la construction des tunnels et des autres travaux souterrains. La communication se termine par quelques commentaires généraux sur le fonctionnement et le rendement de l'aménagement.

AGM 63-GEOTECH-C

Till Cofferdams Dumped in Water

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A number of cofferdams have been constructed by dumping till in water. At the St. Lawrence Project homogenous fills were constructed in water up to 25 feet deep, and subsequently subjected to drawdown. In northern Ontario till-faced rock-fill structures have been placed in water up to 40 feet deep. In view of the simplicity of the construetion method and the demonstrated success of the structures it was believed worthwhile to record specific case histories and to attempt to form a general understanding of their behaviour. Physical data on the structures and materials used, the results of borings obtained in several of the structures and piezometer measurements in one case, were included in the study. All of the examples of this type of construction behaved successfully over their construction life except one, and brief comment will be made on this in the text.

The principal observations of field behaviour have been that in all cases slips occurred during dumping. While this, at the start, led to concern for the stability of the structures particularly under drawdown condition, it has subsequently been believed to be the factor leading to their success. The mechanism of the slips allowed material to be placed below water level without the material settling through water. In fact, in no case did appreciable quantities of loose fill roll down the outside slope of the fill into the water, rather it was a consistent observation that the forward face of the fill advanced into the water more or less inact. Borings put down in the completed structures showed the material to be consistently in a low state of saturation. This led to the belief that construction pore pressures were low and this was confirmed by pore pressure measurements on one structure. The low state of saturation and the lack of pore water pressures also tend to be confirmed by stability analyses which indicate a reasonable factor of safety for structures where low pore pressures are assumed.

The use of till dumped in water has been successful for temporary de-watering for construction purposes. The long-term behaviour of the method has not been determined although analysis indicates that long term stability is probably adequate. It has been observed that the fill is advanced by a series of slips and that the resulting underwater is in a low state of saturation. It is believed that the slips are responsible for the low state of saturation, that this results in low porc pressures during construction, and consequently the demonstrated stability. It follows that the success of the structures is dependent on the use of relatively dry borrow material.

AGM 63-GEOTECH-D

Soil Sampling in Permafrost Areas

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The need for adequate subsurface explorations, particularly with regard to determining the ice content of frozen soils in permafrost areas is stressed. Methods and techniques for obtaining samples of perennially frozen ground are discussed under four main headings: sampling natural exposures, hand borings, test pits and core drilling.

Exposures can be examined by digging shallow trenches or test pits and by probing. Frozen soil samples, both disturbed and undisturbed, can be obtained by driving pipe and by hand auguring methods — or by a combination of these methods. Test pits can be excavated by natural or artificial thawing, pick and shovel, or power tools and permit detailed in situ examinations of frozen materials, particularly granular deposits. Core drilling is normally used to obtain undisturbed samples when an extensive subsurface exploration programme is proposed or when information is desired to depths exceeding 20 ft. Special drilling techniques have to be followed. Good core recovery can be obtained in frozen fine grained soils but coring of granular materials has proved to be difficult.

The application and limitations of each method are noted and lists of pertinent equipment required are given.

AGM 63-GEOTECH-D

Enchantillonnage du Sol Dans Les Regions de "Permagel"

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L'auteur fait ressortir le besoin d'explorations appropriées du sous-sol pour déterminer la teneur en glace des sols gelés dans les régions de "permagel" (permafrost). Il discute des méthodes et des techniques pour obtenir des échantillons de sol gelé en permanence, sous quatre aspects différents: échantillonnage des surfaces à nu, forages manuels, fosses d'essai et sondage à carottes.

Les surfaces à découvert peuvent être examinées en creusant des tranchées ou des fosses d'essai peu profondes et par exploration. Des échantillons de sol gelé, remué et tel quel, s'obtiennent en les extrayant à la main ou à l'aide d'un tuyau enfoncé dans le sol—ou en utilisant les deux méthodes. On peut creuser les fosses d'essai par dégel naturel ou artificiel, au pic et à la pelle, ou à l'aide d'outils électriques; ils permettent l'examen détaillé in situ des matières gelées, surtout des dépôts cristallisés. Le sondage à carottes sert normalement à obtenir des échantillons non remués quand on veut exécuter un programme élaboré d'exploration en sous-sol ou quand on désire des renseignements sur des matières à plus de 20 pieds en profondeur. Il faut se conformer à des techniques de forage spéciales. On peut obtenir une bonne extraction de carottes dans les sols gelés à fine cristallisation mais l'extraction des carottes de matériaux à forte cristallisation s'est avérée difficile.

L'auteur décrit l'application et les limites de chaque méthode et dresse une liste des pièces d'équipment appropriées.

AGM 63-GEOTECH-E

The Use of Probability Charts to Predict Ice Thickness

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Probability charts are presented giving rates of ice growth on lakes, rivers, and harbours for different regions in North America. These charts were prepared by a statistical analysis of available ice thickness records. Depth of snow cover on the ice is shown to have a marked effect on the rate of ice growth. Ice thickness and latitude are found to have a slight effect on rates of ice growth. The ice growth rates are converted to heat to provide regional estimates of heat loss from natural ice covers. From the ice growth rate analysis limits for maximum ice thickness are obtained and related to the length of the ice growth period which varies from a few weeks in the southern part of Canada to as much as 250 days in the far north. This analysis enables the thickness of ice to be predicted at any time after the ice cover forms and enables the maximum thickness of ice to be estimated in different regions. Information on ice thickness and maximum ice thickness is needed for engineering problems such as predicting the bearing strength of ice, obtaining design values for maximum ice pressures or designing water intakes installed under natural ice covers. The relationships established in this paper thus provide information on natural ice covers that will be useful for design purposes particularly for isolated sites where ice thickness records are not available.

AGM 63-GEOTECH-E

De L'utilisation des Tables de Probabilités Pour Prédire L'épaisseur de la Glace

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Les tables des probabilités donnent ici le taux de formation de la glace dans les lacs, les rivières et les ports dans diverses régions de l'Amérique du Nord. Ces tables ont été préparées en se basant sur une analyse statistique des épaisseurs de glace connues et consignées. On peut constater que la profondeur de la neige recouvrant la glace a un effet marqué sur le taux de formation de cette dernière. L'épaisseur de la glace et la latitude sont des facteurs qui influent sur le taux de sa formation. Les taux de formation de la glace sont convertis en chaleur pour permettre par régions l'estimation de la perte de chaleur des nappes de glace naturelles. De l'analyse du taux de formation de la glace, on obtient les limites analytiques pour l'épaisseur de glace maximum et on fait la corrélation avec la durée de la période de formation de la glace laquelle varie de quelques semaines dans les régions du sud du Canada jusqu'à 250 jours dans le Grand Nord. Cette analyse permet de prédire l'épaisseur de la glace en tout temps après la formation de la nappe de glace et de déterminer approximativement l'épaisseur maximum de la glace selon les régions.

Les ingénieurs ont besoin de ces données sur l'épaisseur de la glace et sur l'épaisseur maximum pour résoudre plusieurs problèmes, par exemple, pour prédire la résistance de la glace comme surface portante, pour obtenir les valeurs à déterminer contre les pressions de glace maxima ou pour dessiner les prises d'eau au-dessous d'une nappe de glace naturelle. Les rapports indiqués à la présente communication fournissent sur les nappes de glace naturelles des renseignements utiles pour les calculs de structures particulièrement dans les régions isolées où on n'a pas de données statistiques sur l'épaisseur de la glace.

AGM 63-GEOTECH-F

Soils and Foundations Aspects of the Rainy Lake Causeway

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The paper will describe the quite extensive subsoil investigation and soils engineering studies carried out at the site of the subject causeway, which is a major structure crossing Rainy Lake near Fort Frances, Ontario. It will also cover various foundation design aspects for both the rock fill embankments, and the part of the causeway which is a bridge type structure carried on piles.

The site is underlain by a variable thickness of normally loaded varved clay. The maximum thickness of the stratum is about 40 feet. The clay is underlain by a layer of sandy till, beneath which is bedrock.

A preliminary soil investigation was carried out to determine the most suitable alignment for the structure. This will be described in the paper, along with the detailed field

investigation and programme of laboratory testing carried out on the clay stratum at the chosen alignment. The causeway is located near to an existing railroad embankment which was formed by end-dumping of rock fill. As part of the investigation, drill-holes were put down through the railroad embankment and the amount of sinkage into the clay was measured. It was considered that the new embankment would also experience sinkage into the clay. A special problem existed at the join of the embankments to the bridge structure inasmuch as complete displacement of the clay was desirable at these points. It was considered that the clay could be remoulded by blasting, and a comprehensive series of strength measurements were carried out to determine the effects of blasting. The procedures used and the results of these blasts are given in the paper.

The design of the pile foundations for the bridge structure is described. The aim of the design was to obtain a flexible structure to allow for ice movement, yet rigid enough to resist wind and wave forces without excessive deflections of the superstructure.

Pertinent observations taken during the course of construction will be given.

AGM 63-GEOTECH-F

Aspects des Sols et des Fondations Chaussee du Lac Rainy

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La communication traite de l'étude considérable faite sur la reconnaissance des terrains en profondeur et la mécanique des sols, menée sur le chantier de la chaussée en question, ouvrage d'importance traversant le Lac Rainy, près de Fort Frances, Ontario. Le texte traite aussi des différents aspects du calcul des fondations pour les remblais en enrochement et de la partie de la chaussée qui est construite telle un pont reposant sur des pieux.

Le terrain sous-jacent se compose d'une couche d'épaisseur variable de glaise varvée chargée normalement.

L'épaisseur maximum de la couche est environ quarante pieds. La glaise repose sur une couche d'argile sablonneuse à blocaux, au-dessous de laquelle on retrouve le socle rocheux.

Une étude préliminaire du sol fut menée afin de déterminer le tracé le plus approprié pour l'ouvrage. Ceci est décrit dans le texte, de même que les détails des recherches faites sur le chantier et les détails des essais en laboratoire pour étudier la couche d'argile trouvée sur le tracé choisi. La chaussée est située près d'un remblai de chemin de fer construit par remplissage à l'avancement. Aux fins d'étude, des trous de forage ont été percés à travers ce remblai et l'enfoncement dans l'argile mesuré. Constatation faite, on se rendit compte que la chaussée à construire enfoncerait aussi dans l'argile. Un problème particulier se présenta à la jonction des remblais avec la structure des ponts vu qu'un déplacement complet de l'argile était souhaitable à ces points. L'argile pouvant être moulée à nouveau par l'emploi d'explosifs, un programme détaillé et complet visant à déterminer les effets des explosifs fut établi. Les méthodes employées et les résultats ainsi obtenus font partie de la communication.

Le calcul de la fondation sur pieux pour le pont est décrit. Le but de ce calcul était de trouver une structure assez flexible pour absorber le choc des glaces tout en étant assez rigide pour résister aux forces du vent et des vagues sans pour cela permettre un mouvement excessif à la superstructure.

Le fruit des observations pertinentes faites pendant la construction est aussi communiqué.

AGM 63-HYDEL-A

General Considerations on the design of surge tanks

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In this paper we will first discuss, in a very general way, all factors of technical and economical order that affect the design of a surge tank. This will show, in the final analysis, that the surge tank design is almost always made with the stability criterium.

It also indicates that designers should start their computations with this criterium instead of the more widely known approach of taking first into consideration maximum and minimum water levels in the tank.

This most important stability criterium is also the most inaccurate one in the theory of surge tanks. It gives only a limiting value to the size of the tank. To provide for and acceptable damping of the oscillations it is necessary to increase the area of the tank with the help of a certain safety factor, which, unfortunately, has no serious basis and varies from one country to the other and from one designer to the other. To state precise the value of this empirical coefficient we have to define a measurable quantity for the stability of a tank which makes possible the computation of the economic area to be given to the tank and the corresponding acceptable damping of the surges. This definition has the advantage of being analytic and universal and it can be applied to any type of surge tank. We have applied it, in this paper, to the particular cases of simple, overflow and expanded surge tanks.

AGM 63-HYDEL-A

Considérations Générales sur le Dimensionnement des Cheminées d'équilibre

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Dans cette article nous discuterons d'abord d'une façon très générale l'influence de tous les éléments d'ordre technique et économique qui entrent en jeu dans l'élaboration d'un projet de cheminée d'équilibre. Nous montrerons que l'on aboutit presque toujours, finalement, à dimensionner la section centrale d'une chambre d'équilibre par le critère de la stabilité.

Cela indique donc que les projeteurs auraient intérêt à commencer le calcul d'un projet de cheminée d'équilibre par les considérations de stabilité au lieu de celles relatives aux surpressions et aux dépressions maximales que l'on rencontre habituellement dans les exposés sur cette question.

Malheureusement, le critère de la stabilité, qui a une si grande importance, est le plus imprécis de la théorie des chambres d'équilibre. Il donne uniquement une valeur limite à la section de la cheminée. Pour assurer un amortissement convenable des oscillations il faut majorer la section par un certain coefficient de sécurité qui ne possède aucune base sérieuse et, par conséquent, varie d'un pays à l'autre ou d'un projecteur à l'autre. Pour préciser cette question, nous avons défini une valeur mesurable de la stabilité qui permet de calculer l'optimum économique à donner à la section d'une cheminée d'équilibre afin d'assurer cet amortissement convenable des oscillations. Cette définition a l'avantage d'être analytique et universelle, en s'appliquant à tous les types de chambres d'équilibre. Nous l'avons appliqué, ici, aux cas particuliers des cheminées simples, déversantes et des chambres à épanouissements.

AGM 63-HYDEL-B

Grand Rapids Hydro-Electric Project

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Manitoba Hydro is presently developing the Grand Rapids power site on the Saskatchewan River a short distance above where the river discharges into Lake Winnipeg. The initial installation comprises three 150,000 horsepower Kaplan turbines at 120 feet net head, each directly connected to vertical shaft generators having a nominal rating of 115,000 kva. Minimum provision is being made

for a fourth unit. Transmission of power to the Greater Winnipeg Area over a distance of 250 miles will be by means of two single circuit bundle conductor 230 kv lines. Initial operation of the station is scheduled for the fall of 1964 with completion during the following year.

Notable features of the development include: the geological formation which comprises a sequence of calcium and magnesium carbonate beds (limestone and dolomites) of Paleozoic age with infrequent but nevertheless significant thin horizons of clayey, silty or sandy materials; the extensive curtain grouting program requiring a single line of holes on five foot centres to a maximum depth of 200 feet over a distance of 18 miles; consolidation grouting under all major concrete structures; 16 miles of dykes having a maximum height of 100 feet and designed for severe set-up and wave action conditions; structure stability considerations and the very large capacity Kaplan turbines provided for in the design.

This paper will be so arranged to provide a very brief description of the overall developments as background for the unusual site conditions, major design problems and interesting design features, all of which will be dealt with in more detail.

AGM 63-HYDEL-B

Amenagement Hydroelectrique de Grand Rapids

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La Commission hydroélectrique du Manitoba aménage actuellement la centrale de Grand Rapids sur la Saskatchewan un peu en amont de la décharge de la rivière dans le lac Winnipeg. L'installation initiale comprend trois turbines Kaplan de 150,000 HP exploitées sous une hauteur de chute nette de 120 pieds, et chacune raccordée directement à un alternateur à axe vertical d'une puissance nominale de 115,000 KVA. On prévoit au moins un quatrième groupe générateur. Deux lignes de 230 kV à simple terne et à conducteurs groupés assureront le transport de l'énergie jusqu'à la région métropolitaine de Winnipeg sur un parcours de 250 milles. La mise en exploitation de la centrale est prévue pour l'automne de 1964 et le parachèvement pour l'année suivante.

Voici quelques caractéristiques de l'anénagement: la formation géologique qui comprend une série de couches de carbonate de calcium et de magnésium (chaux et dolomite) de la période paléozoique avec des infiltrations rares mais significatives de matière argileuse, d'alluvion et de sable; le programme important d'injection de voile nécessitant l'excavation d'une seule ligne de trous à intervalles de cinq pieds centre à centre jusqu'à une profondeur maximum de 200 pieds et sur une longueur de 18 milles; l'injection de consolidation sous toutes les grandes structures; 16 milles de digues d'une hauteur maximum de 100 pieds et conçues pour résister aux pressions et à l'action de la vague; les facteurs de stabilité de structure considérés et la très grande puissance des turbines Kaplan prévues.

Cette communication fournit une très brève description de l'ensemble de l'aménagement pour servir d'arrière-plan à l'étude du caractère inusité du site, des grands problèmes techniques et des intéressantes solutions apportées, dont l'auteur fait une présentation plus détaillée.

AGM 63 HYDEL-C

Sluice Gate Rating Curves by Model Testing

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Results of a model investigation designed to determine accurate rating curves for the deep sluice gates at the Passes Dangereuses Dam on the Peribonka River are presented. Formula for calculating discharge through sluice gates are compared and co-efficients of discharge are presented for both partial and fully opened conditions. Also presented is, a discussion of the important role of accurate gate rating curves in the computation of natural inflow into a reservoir.

During the period 1943 to the present, gate discharge has been calculated using rating curves issued by the designers at the time of construction of the dam. These design curves were no doubt accurate enough to be used for making decisions regarding placement of gates, number required and similar construction and planning problems. However, their use as operational rating curves has resulted in false discharge records.

Correction of these discharge records depends largely upon the establishment of accurate rating curves. Field testing was considered impractical.

Firstly, testing of a complex system of 13 gates, each capable of being operated at heads from 0 to 50 feet under both partially and fully opened conditions would require an extremely large number of field trips. Secondly, after the construction of the Chute-des-Passes powerhouse all gates have been closed and it is expected that water would not be available from the Passes Dangereuses reservoir for testing of discharge facilities. Model testing was then considered the only alternative if the rating curves were to be corrected.

The model constructed was a 1/30 model of a deep sluice gate, so constructed that boundary conditions could be varied to determine whether each of the 13 gates in the dam could be considered to be the same insofar as discharge capability was concerned. Results indicate that the boundary conditions and individual differences are important enough to be considered. Discharges are of the order of as much as 10% higher than those expected by the designers.

The constructed laboratory set-up has been so arranged that future tests can also be made on other spillways within the Alcan power system with the possibility of studying log sluicing operations.

AGM 63-HYDEL-C

Sluice Gate Rating Curves by Model Testing

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Cette communication traite d'une étude sur modèle en vue de déterminer avec précision les courbes de déversement des grandes vannes au barrage des Passes Dangereuses sur la Rivière Peribonka. Les formules pour calculer la décharge aux vannes sont comparées et des coefficients de débit sont donnés pour les écluses complètement ainsi que partiellement ouvertes. Il y a aussi discussion sur le rôle important de courbes précises pour le calcul de l'arrivée de l'eau dans un réservoir.

Depuis 1943, la décharge aux écluses a été calculée d'après les courbes fournies lors de la construction du barrage par les ingénieurs qui ont conçu le projet. Ces courbes étaient sans doute assez justes pour permettre de prendre des décisions sur la mise en place des vannes, sur leur nombre et autres problèmes de construction et d'aménagement. Cependant, en se servant de ces courbes pour la manœuvre des écluses, on a enregistré des débits inexacts.

La correction de ces enregistrements de débits inexacts dépend en grande partie de la précision l'establissement des courbes de déversement établies. Des essais sur place étaient considérés impracticables.

D'abord, il aurait fallu mettre à l'épreuve un système complexe de 13 vannes, chacune pouvant fonctionner avec une hauteur de chute variant de 0 à 59 pieds, selon leur ouverture. Ceci aurait nécessité un très grand nombre de voyages sur les lieux. Deuxièmement, après la construction de la centrale à la Chute-des-Passes, toutes les écluses étaient fermées et on ne prévoyait pas avoir d'eau du réservoir des Passes Dangereuses pour des essais de débit. La seule alternative était donc de s'en tenir à des essais sur modèle pour la correction des courbes de déversement.

Le modèle construit pour ces essais est une maquette de la grande vanne d'écluse, réduite à l'échelle de 1/30. Ce modèle est monté de façon que les conditions limites puissent être changées afin de déterminer si chacune des 13 écluses du barrage peut être considérée comme étant identique quant à sa capacité. Les résultats indiquent que les conditions limites et les différences dans chaque cas étaient assez importantes pour être considérées. Les débits

variaient jusqu'à 10% de plus que celles prévues par les ingénieurs du projet.

Le laboratoire fut construit de façon à permettre de faire des essais sur d'autres déversoirs faisant partie du réseau de centrales électriques Alcan, avec la possibilité d'étudier les passes de flottage.

AGM 63-HYDEL-D

Analyse et solution du problème d'étanchéisation du bactardeau amont à Manicouagan 5

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Quebec Hydro,
Montreal

Mise en œuvre exceptionnelle du procédé ICOS-VEDER afin de permettre la construction à sec des fondations d'un barrage dans un espace très restreint à plus de 250 pieds au-dessous du niveau de l'eau.

Voilà le problème difficile que les ingénieurs ont dû résoudre au barrage à voutes multiples de Manicouagan 5 où la rivière coule dans une gorge profonde remplie d'alluvions sur lesquelles les batardeaux furent construits. Un procédé positif d'étanchéité s'imposait dans le batardeau amont ainsi qu'à travers les alluvions sous-jacentes jusqu'au rocher.

On décrit les difficultés inhérentes aux travaux, telles que: profondeur de la gorge, perméabilité et hétérogénité des alluvions, programme très serré de construction, proximité de la fouille de la fondation du barrage. On traite en détail des recherches et analyses des différents procédés, des études techniques et économiques qui ont mené au choix de la solution adoptée ainsi que des particularités de son application et des résultats obtenus.

AGM 63-HYDEL-D

Analysis and Solution of Permeability Problems in the Upstream Cofferdam at Manicouagan 5

C. A. Dagenais, M.E.I.C.
Surveyor, Nenniger & Chenevert, Montreal, Que.
G. Turenne, P.Eng.
Quebec Hydro,
Montreal

An outstanding application of the ICOS-VEDER process to allow construction in the dry of a dam foundation 250 feet below water level within very close quarters.

Such was the challenge met by the engineers on the Manicouagan 5 multiple arch dam, where the river flows in a deep gorge filled with alluvial materials upon which the cofferdams were constructed. A positive water-tight diaphragm had to be built through both the upstream cofferdam and the underlying alluvium down to bedrock.

The difficulties encountered such as depth, perviousness and heterogeneousness of the alluvium, the tight construction schedule and the proximity of the excavation for the dam foundation, are fully described. The study and analysis of the different alternatives, the technical and economical factors that governed the final choice, particulars of this application and the results obtained are all discussed in detail.

AGM 63-HYDEL-E

L'Usine de Classification des Agregats Fins Manicouagan 5

M. J. Sequin, M.E.I.C.
P. Amyot, M.E.I.C.
Division des Amenagements Hydro-Québec

Le barrage à voûtes multiples de Manicouagan 5, exigera las mise en place d'environ 2,800,000 ver. cu. de béton. Environ 1,500,000 tonnes de sable classifié entrera dans la composition de ce béton. Le dépot de sable est d'origine fluvio-glaciaire et sa granulométrie naturelle est très imparfaite et varie d'un endroit à l'autre.

Le cahier des charges exige deux catégories de sable: le gros sable dont la granulométrie và de —⅜" à +16M, et le sable fin de —16M à +140M. La courbe granulométrique de chacun de ces sables doit se maintenir entre des limites très rapprochées.

La classification des sables sera faite au moyen de procédés mécaniques et hydrauliques.

Le procédé hydraulique est basé sur le fait que tout corps solide, constitué de particles insolubles et immergées dans un liquide en mouvement de densité inférieure, se déposera sur le fond du récipient à des distances du point d'immersion inversement, proportionelles au poids des particules.

L'usine de classification comprend donc essentiellement des tamis, un bac de classification, une série de vis essereuses, des alimentateurs vibrants et des transporteurs à courroie. Le tout est contrôlé automatiquement.

AGM 63-HYDEL-E

The Sand Classification Plant for Fine Aggregates Manicouagan 5

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The multiple arch dam at Manicouagan 5 will require approximately 2,800,000 c. yds of concrete. About 1,500,000 tons of classified sand will enter as fine aggregates for the composition of that concrete. The sand deposit is of fluvio-glacial origin and its natural granulometry is very erratic and varies from one spot to the other.

The specifications for aggregates required two categories of sand: the coarse sand with a granulometry going from —⅜" to +16M and the fine sand from —16M to +140M. For each of these sands, the granulometry curve must remain between very narrow limits.

The classification of these sands will be made by means of mechanical and hydraulic devices.

The hydraulic process is based on the fact that any solid constituted of small insoluble particles and dumped into a denser liquid in motion will settle on the bottom of the vessel at distances from the dumping point varying in inverse proportion to their weight.

So, basically, the sand classification plant will comprise screens, a classifying tank, dehydrating screens, vibrating feeders and belt conveyors. All those devices are controlled automatically.

AGM 63-HYDEL-F

L'évolution de la température de l'eau, en hiver, dans les réservoirs hydroélectriques et dans les rivières aménagées

A. R. Gagnon, M.E.I.C.
Ingénieur Hydraulicien
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La conception d'un aménagement hydroélectrique peut varier sensiblement selon qu'existe ou non la possibilité de formation de frasil et de couvertures de glace dans les retenues.

Ce travail a pour but l'étude de l'évolution des températures dans les réservoirs hydroélectriques artificiels et dans les rivières aménagées alimentées directement par ces réservoirs.

La première partie de la communication étudie l'évolution des températures dans un réservoir hydroélectrique. L'équation de l'équilibre thermique est déterminée en tenant compte de l'influence du volume de l'emmagasinement, du débit utilisé, du volume et régime de l'apport hivernal etc.

Les conditions limites sont déterminées de même que l'influence relative des divers échanges de chaleur.

La seconde partie étudie l'évolution de la température d'un cours d'eau qui perd de la chaleur à l'atmosphère. Une formule générale est choisie donnant la perte de chaleur par unité de surface libre et elle est introduite dans l'équation de la conservation de la chaleur appliquée au cours d'eau. La solution de l'équation donne les températures probables à différents points de l'écoulement et comme cas particulier, donne la distance que l'eau à une certaine température peut parcourir en rivière avant d'at-

teindre le point de congélation.

Plusieurs éléments des méthodes choisies ont été vérifiés expérimentalement en nature, et les résultats analytiques et expérimentaux sont comparés.

AGM 63-HYDEL-F

Variation of Water Temperature in hydroelectric Reservoirs and Developed Rivers during Winter

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The design of a power development can vary to a great extent depending on whether the possibility of frazil formation or ice sheets in the forebay exists or not.

This work has for object the study of temperature variations in the hydroelectric artificial reservoirs and in developed rivers directly fed by these reservoirs.

The first part of the paper studies the temperature variations in hydroelectric reservoirs. The equation of thermal equilibrium is determined by taking into account the influence of storage volume, potential used and volume and speed of winter river drift, etc.

Extreme conditions must be determined as well as the relative influence of various heat exchanges.

The second part studies the temperature variations of a stream which loses its heat in the atmosphere. A general formula is used giving the heat loss per unit of uncovered area and it is used in the equation of heat conservation transmitted to a stream. The solution of the equation gives the temperature probabilities at various positions of flow and in particular gives the distance that the water can travel in the river at a certain temperature before reaching the freezing point.

Various elements of adopted methods have been verified through experiments in nature and the analytical and experimental results compared.

AGM 63-HYDEL-G

Hydrologic Simulation of a River Basin—an Aid in Flood Control Planning

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The paper reviews briefly the history of hydrologic techniques, illustrating the trend to development of methods which take greater account of the natural runoff processes. A computer program which has been used to simulate the hydrologic characteristics of a river basin is described, and the methods used in calculating runoff from rainfall and snowmelt, and in routing flows through valley storage, lakes and reservoirs are outlined.

Examples of the accuracy of the results which can be obtained using the computer program are given. Hydrologic studies in which the simulation can be used with advantage are discussed.

AGM 63-HYDEL-G

Reproduction Hydrologique du Bassin d'une Rivière—un Aide pour Planifier le Contrôle des Eaux

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Chef du service hydraulique
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H. G. Acres Company Limited

Cete communication fait brièvement l'historique des techniques hydrologiques, mettant en lumière la tendance vers l'adoption de méthodes qui tiennent compte dans une plus large mesure du régime d'écoulement naturel. On y décrit une programmation par ordinatrice utilisée pour reproduire les caractéristiques hydrologiques du bassin d'une rivière, et les méthodes ayant servi à calculer l'écoulement de la pluie et de l'eau de la fonte des neiges et à retracer ce ruissellement emmagasiné éventuellement dans les dépressions ou vallées, les lacs et les rivières.

Les auteurs donnent des exemples de la précision des résultats qu'on peut obtenir à l'aide d'une programmation par ordinatrice. Ils discutent des avantages que comporte la reproduction des conditions hydrologiques.

AGM 63-MGMT-A

Critical Path Scheduling of Construction Projects

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Application of the Critical Path Method to scheduling construction projects is discussed. The general approach to be used in constructing an activity network is given in detail. Incorporation of management decisions, crew movements as well as physical sequences are illustrated. Rules are given for combining activties and eliminating unnecessary dummies. A numerical method for calculating the critical path and float is given. The significance of total float, free float and independent float is illustrated. Use of the diagram for both the field and top management is discussed. In all cases examples from actual construction projects are used. Other less frequently used features of the method are briefly discussed and references given for further study. These features include crashing, manpower leveling, multi-project scheduling, PERT and the use of computers. The paper assumes that the reader has little or no previous knowledge of this scheduling method.

AGM 63-MGMT-A

Critical Path Scheduling of Construction Projects

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L'auteur discute de l'application de la méthode du sentier critique dans la programmation des projets de construction, montre en détail la façon générale de construire un réseau d'activités, illustre l'incorporation des décisions de la direction, le mouvement du personnel ainsi que les séquences physiques et énonce les règles qui permettent la combinaison d'activités et l'élimination des contraintes superflues. De plus, il établit une méthode numérique pour calculer le sentier critique et la marche, et illustre la signifcation de la marche totale, de la marche libre et de la marche indépendante. L'utilisation du diagramme par le personnel du chantier et par la direction y est décrite et des exemples choisis parmi des projets actuels de construction servent à éclairer l'énoncé. D'autres caractéristiques de la méthode, moins souvent utilisées, sont néanmoins traitées dans l'ouvrage et des réferences permettant de poursuivre l'étude de cette méthode sont énumérées. Ces caractéristiques comprennent l'exécution rapide des travaux, le nivellement de la main-d'œuvre, la programmation de projets multiples, PERT et l'utilisation d'ordinateurs. L'auteur présume que le lecteur a une connaissance limitée ou aucune connaissance de cette méthode de programmation.

AGM 63-MGMT-C

Life Estimation and Depreciation of Physical Assets and its Use in Industrial Economics and Finance

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Public Utilities Board, Edmonton, Alta.

The paper first briefly discusses the history of depreciation, the different meanings attached to the word depreciation, the modern definition of depreciation, the interrelationship between life estimation of physical assets and depreciation, the different methods of allocation of costs and the modern statistical methods of life estimation of physical properties. Also some idea is given as to the relia-

bility of such life estimates when forecasts are made for thirty industrial plant accounts.

Second, the paper gives examples for use of life estimation and depreciation of physical assets in industrial economics and finance. Numerical examples given are:

(1) Estimation of rate base of public utility companies;
(2) Solving the question of owning versus leasing of equipment;
(3) Planning of capital exxpenditure due to expansion and replacements;
(4) Selection of equipment when several alternatives are feasible using the lowest annual costs criterion as basis for decision;
(5) Taxation of real property.

Attention is also drawn to other important fields in which life estimation and depreciation of physical assets could be used, such as taxation of income, determination of unit costs of products and services in manufacturing and other industries, valuation of properties, division of revenue for telephone companies, determination and distribution of profits and analysis of investment securities.

AGM 63-MGMT-C

Evaluation de la Durée de l'Actif Matériel et sa Dépréciation et leur Usage en Economie et Finance Industrielles

L. I. Szabo, M.E.I.C.
Public Utilities Board, Edmonton, Alta.

L'auteur fait brièvement l'historique de la dépréciation et traite des différentes acceptions du mot dépréciation, de sa définition moderne, de la relation entre la durée prévue l'actif matériel et la dépréciation, des différentes méthodes de répartir les coûts et des méthodes statistiques modernes d'évaluer la durée de l'actif matériel. Il indique aussi quel réalisme on peut prêter à une telle évaluation de la durée quand il s'agit de faire des pronostics dans le cas de trent comptes de propriétés dans le domaine industriel.

L'auteur donne ensuite des exemples pour aider à déterminer la durée de l'actif matériel et sa dépréciation en économie et finance industrielles. Voici les exemples par ordre numérique:

1) Evaluation de la base des tarifs des compagnies d'utilité publique.
2) Comment résoudre la question: doit-on acheter ou louer l'équipement?
3) Comment planifier les dépenses en immobilisations attributables à l'éxpansion et aux remplacements.
4) Le choix de l'équipment en présence de plusieurs alternatives en se basant sur le prix de revient annuel le plus bas pour en arriver à une décision.
5) Impôt sur la propriété réelle.

L'auteur attire aussi l'attention sur d'autres domaines importants où pourraient servir l'évaluation de la durée de l'actif matériel et sa dépréciation, tels que l'impôt sur le revenue, la déterminaiton du coût unitaire des produits et des services dans les industries de fabrication et autres, la division dans les industries de fabrication et autres, la division du revenu pour les compagnies de téléphone, le calcul des profits et leur répartition et l'analyse du portefeuille de placements.

AGM 63-MGMT-D

Under A Bushel

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His Royal Highness, The Duke of Edinburgh, charged those attending the Second Commonwealth Study Conference held in Canada in May and June 1962, "to forget for the time being the techniques of industry and concentrate upon people, their families and communities who service the whole industrial machine". This charge provided the official conference theme—The Human Consequences of the Changing Industrial Environment in the Commonwealth and Empire. The nearly four-week period during which the Conference members toured Canada provided the opportunity to observe and reflect upon the tremendous changes that have been wrought in Canada in the past several decades. It was, of course, obvious that the method, mode and manner of individual living has undergone drastic change but what was far from obvious was the realization that the nature of man has not changed. It is suggested that in dealing with people perhaps we have become so overcome by change that we have through neglect, "hidden under a bushel" some of the unchanging "lights" of human nature. It would be the purpose of this paper (address) to *remind* engineering personnel of some of the simple, well-known "lights" of human nature — the appreciation of which can enhance man's dealings with man.

AGM 63-MGMT-D

Sous un Boisseau

G. R. McMeekin, M.E.I.C.
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A la demande de son Altesse Royale, le duc d'Edinburgh, les participants de la deuxième conférence d'étude du Commonwealth, dont les assises eurent lieu au Canada en mai et juin 1962, durent "oublier, pour le moment, les techniques de l'industrie pour se pencher sur l'individu, sa famille et les groupements au service de la machine industrielle". Cette demande a servi de thème officiel à la conférence — Les conséquences humaines provenant de l'évolution du complexe industriel dans le Commonwealth et l'Empire. Au cours d'une période d'environ quatre semaines, les membres de la conférence ont visité le Canada et ont eu l'opportunité d'observer et de réfléchir sur les énormes changements qui ont transformé le Canada durant les dernières décades. Il était évident que la méthode, le mode et la manière de vivre de l'individu avaient subi des changements importants; toutefois, il était beaucoup plus difficile de comprendre que la nature de l'homme n'avait pas changé. Dans nos rapports avec l'être humain, nous avons peut-être été si renversés par les changements extérieurs que nous avons, par négligence, "caché sous un boisseau" quelques-unes des "lumières" fondamentales de la nature humaine. Le but de ce traité est de rappeler aux ingénieurs quelques principes fort simples de la nature humaine que tous connaissent et dont l'appréciation ne peut que revaloriser les relations humaines entre humains.

AGM 63-MGMT-E

Computers—A Modern Aid to Management

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AGM 63-MECH-E

The Punching of Sheet Metal with Rubber

P. B. Hertz, A.M.E.I.C.
Dept. Mech. Engineering, University of Saskatchewan
Professor S. Garber
Dept. Mech. Engineering, University of Saskatchewan

The effects of the rubber characteristics and tool geometry upon the punching of circular holes in aluminum sheet by confined rubber pads have been investigated. Fracture of the diaphragm occurs in two stages—primary and secondary. Modified empirical equations derived from a hydrostatic shear theory relate the experimental pressure required to start primary fracture to tool geometry, material resistance and rubber stiffness. For a given tool geometry the criteria for the initiation of primary fracture is a critical volume rubber displacement. Other features briefly considered are secondary fracture, influence of press pad thickness, multiple lamination of the pads, effect of lubrication and variation of the rate of loading.

AGM 63-MECH-E

The Punching of Sheet Metal with Rubber

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Des études ont été effectuées sur les effets des caractéristiques du caoutchouc et de la forme des outils lors du percement de trous circulaires à travers des feuilles d'aluminium au moyen de tampons resserrés de caoutchouc. La fracture du diaphragme s'accomplit en deux stages—primaire et secondaire. Des équations empiriques modifées dérivées d'une théorie de cisaillement hydrostatique, établissent la relation entre la pression expérimentale requise pour commencer la fracture primaire et la forme des outils, la résistance du matérial et la rigidité du caoutchouc. Pour une forme définie des outils, le critère au le début d'une fracture primaire est un déplacement critique du volume de caoutchouc. Les autres particularités considérées brièvement sont la fracture secondaire, l'influence de l'épaisseur du tampon-pressoir, les laminages multiples du tampon, l'effet de la lubrification et la variation du taux de chargement.

AGM 63-MECH-C

Engineering of Aluminum Pipelines

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Research, backed by experience in laying almost 300 miles of aluminum pipe in various parts of Canada over the past five years, has resulted in sound data upon which to base the engineering of aluminum pipelines. This paper deals with materials, design considerations, corrosion, welding, inspection and testing and presents data hitherto unpublished. Extensive testing programmes have proved the soundness and practicability of manual and machine welding and have established reliable mechanical property data. Also, much information has been gained on internal and external corrosion considerations and design criteria are suggested. Inspection and testing methods are fully described and limits of acceptability proposed.

AGM 63-MECH-C

Engineering of Aluminum Pipelines

J. F. Whiting,
Development Division,
Aluminium Laboratories,
Kingston, Ont.

La recherche, aidée par l'expérience acquise lors de la mise en place d'environ trois cents (300) milles de tuyaux d'aluminium en différents endroits du Canada durant les cinq dernières années, a fourni des informations précises sur lesquelles il est facile de projeter les pipelines en aluminium. Cette communication traite des matériaux, des considérations de l'avant-projet, de la corrosion, de la soudure, de l'inspection et des essais et présente des données inédites. De vastes programmes d'essais ont prouvé la solidité et le practique de la soudure à la main et à la machine et ont établi des données sûres quant aux propriétés mécaniques. De plus, beaucoup d'informations ont été obtenues sur les problèmes de corrosion interne et externe et des critières pour avant-projet sont suggérés. Des méthodes d'inspection et d'essai sont complètement décrites et des limites d'acceptation proposées.

AGM 63-MECH-D

Dragline Simulation on an Analogue Computer

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There is an ever increasing trend towards the use of large capacity excavating equipment. Large volumes of material must be moved quickly and operating costs kept at a minimum. Such is the case in the coal fields of southwestern Saskatchewan where draglines are used to strip large quantities of overburden leaving the coal exposed and readily available for removal.

As with other manually operated machines, there is very little information available which can be used as a basis for evaluating and improving dragline operations. It is for this reason that the project which is described in this paper was undertaken. It is concerned with the derivation of those equations which describe the operation of a large commercial type dragline and the solution of these equations by means of an analogue computer simulation. The results obtained from the computer simulation agreed very well with the operations of the actual system. An accurate computer model of the dragline is therefore available. This model could be used for improving the performance of existing draglines of similar construction, or for the design of draglines with improved capabilities.

AGM 63-MECH-D

Reproduction du Travail d'une Ligne de Halage par Ordinateur Analogique

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De plus en plus, on emploie des excavators de grande capacité. De grandes quantités de matériaux doivent être déplacées rapidement avec un minimum de frais d'exploitation. C'est particulièrement le cas des mines de charbon dans le sud-ouest de la Saskatchewan. Des lignes de halage sont utilisées pour enlever de grandes quantités de mort-terrain pour découvrir le charbon et en faciliter l'extraction.

On possède très peu de renseignements concernant les appareils manuels, qui pourraient servir de base pour supputer et améliorer les opérations de halage. C'est pourquoi, on a tenté l'expérience que relate cette communication. Il s'agit de l'utilisation d'équations décrivant le travail d'une ligne de halage de type commercial et de la solution de ces équations à l'aide de la représentation de ce travail au moyen d'un ordinateur analogue. Les résultats ainsi sont conformes aux opérations en chantier. On peut donc obtenir un modèle de ligne de halage à l'aide d'un ordinateur. Ce modèle peut être utilisé pour améliorer le rendement des lignes de halage existantes de fabrication semblable ou encore pour construire des lignes de halage à rendement supérieur.

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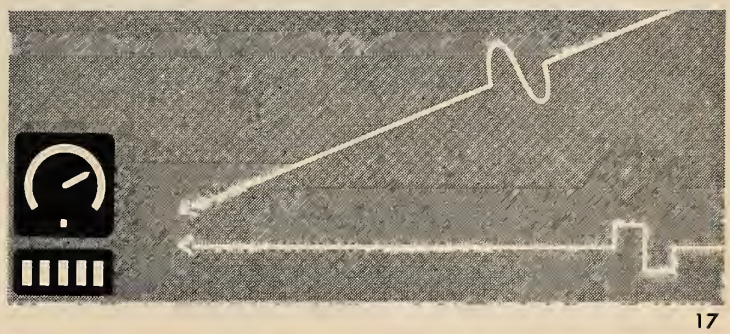

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AGM 63-MECH-E

Determination of the Pattern of Isotherms in a Metal Cutting Tool Using Infrared Photography

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The temperature distribution in a metal cutting tool during orthogonal conditions was determined experimentally by using Infrared Photography. The cutting tool was photographed by a single lens reflex camera loaded with sensitive infrared film. The developed film was projected on to a plate glass and the light intensities at various points on the projected image of the tool were measured by a sensitive light meter. Lines of equal optical density were drawn and thus the pattern of isotherms was determined.

AGM 63-MECH-F

Some Observations on Energy Methods Applied to Problems of Flexure of Beams and Plates

By J. B. Haddow,
Associate Professor of Mechanical Engineering, University of Alberta.
D. G. Bellow
Graduate Student in Mechanical Engineering, University of Alberta.

The purpose of this paper is to present certain aspects and techniques of energy methods which have not, up to now, been emphasized in engineering literature. Problems of equilibrium, stability and vibration of beams and plates are considered.

The convergence and accuracy of series approximations for deflected forms and moments are discussed in connection with the application of the Rayleigh-Ritz Method. A computer study of the convergence of a series representation for the deflected form and moments in a plate is presented.

AGM 63-MECH-F

Remarques concernant les méthodes énergétiques utilisées pour la flexion des poutres et des plaques métalliques

MM. J. B. Haddow,
Professeur adjoint de génie mécanique, Université d'Alberta,
D. G. Bellow
Diplômé en génie mécanique, Université d'Alberta

Cette communication veut faire connaître certains aspects et certaines techniques des méthodes énergétiques qui, jusqu'à ce jour, étaient inconnus du monde du génie. Il s'agit des problèmes d'équilibre, de stabilité et de vibration des poutres et des plaques métalliques.

Elle étudie la convergence et l'exactitude d'approximations en séries des déformations et des moments relativement à l'application de la méthode Rayleigh-Ritz. Elle parle d'une étude, fait à l'aide de la calculatrice, qui traite de la convergence d'une représentation en séries des déformations et des moments d'une plaque.

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AGM 63-MIN-A

Coal-in-Oil Pipelines

G. A. Vissac, M.E.I.C.,
(formerly member of Dominion Coal Board),
413 Roslyn Ave., Montreal

AGM 63-MIN-C

Underground Storage of Natural Gas in the South of Ontario and Quebec

R. P. Charbonnier,
Head, Petroleum Reservoir Engineering Section,
Fuels and Mining Practice Division, Mines Branch,
Department of Mines and Technical Surveys,
Ottawa, Canada

Following the recent completion of the Trans-Canada gas pipeline, the consumption of natural gas is expected to grow very rapidly in southern Ontario and Quebec—in a trend similar to that which has occurred in the eastern United States in recent years.

The United States data show the importance of underground storage of natural gas as a solution to irregular consumption problems and winter peak demand periods. The situation in Canada is likely to be very similar.

In the present study various aspects of underground gas storage are considered, including an example of evaluation of market requirements in southern Ontario, a survey of the design and operation of partly depleted fields and aquifer reservoirs, and some cost data.

The present facilities and future possibilities of gas storage in southern Ontario and Quebec are also studied, and show the desirability of further investigations of the storage gas pool possibilities in that area.

AGM 63-MIN-B

Physical Properties of Kingston Limestone Deleterious in Concrete

A. V. Corlett (Prof.) M.E.I.C.,
Head, Mining Engineering Dept.,
Queen's University

AGM 63-MIN-C

Stockage Souterrain du Gaz Naturel Dans le Sud de l'Ontario et du Quebec

R. P. Charbonnier,
Chef, Section du genie des gisements d'hydrocarbures,
Division des combustibles et du genie minier,
Direction des mines, ministere des Mines et des Releves techniques,
Ottawa, Canada

Apres l'achevement recent du gazoduc transcanadien, la consommation de gaz naturel devrait s'accroitre tres rapidement dans le Sud de l'Ontario et du Quebec, tout comme la chose s'est produite ces dernieres annees dans l'Est des Etats-Unis.

Les donnees relatives aux Etats-Unis demontrent l'importance du stockage souterrain du gaz naturel a titre de solution aux problems que posent la consommation irreguliere et les periodes de pointe en hiver. La situation est probablement analogue au Canada.

La presente etude tient compte des divers aspects du stockage souterrain du gaz; elle comprend un exemple de l'evaluation des besoins du marche dans le Sud ontarien, un examen de l'agencement et de l'utilisation de champs partiellement epuises et de reservoirs aquiferes, de meme que certaines donnees quant aux couts.

Les reservoirs actuellement utilises et d'autres qu'on pourrait utiliser a l'avenir pour y stocker du gaz dans le Sud de l'Ontario et du Quebec donnent egalement lieu a un examen, et l'auteur montre qu'il est souhaitable de poursuivre les recherches relativement aux endroits ou l'on pourrait stocker du gaz dans la region en cause.

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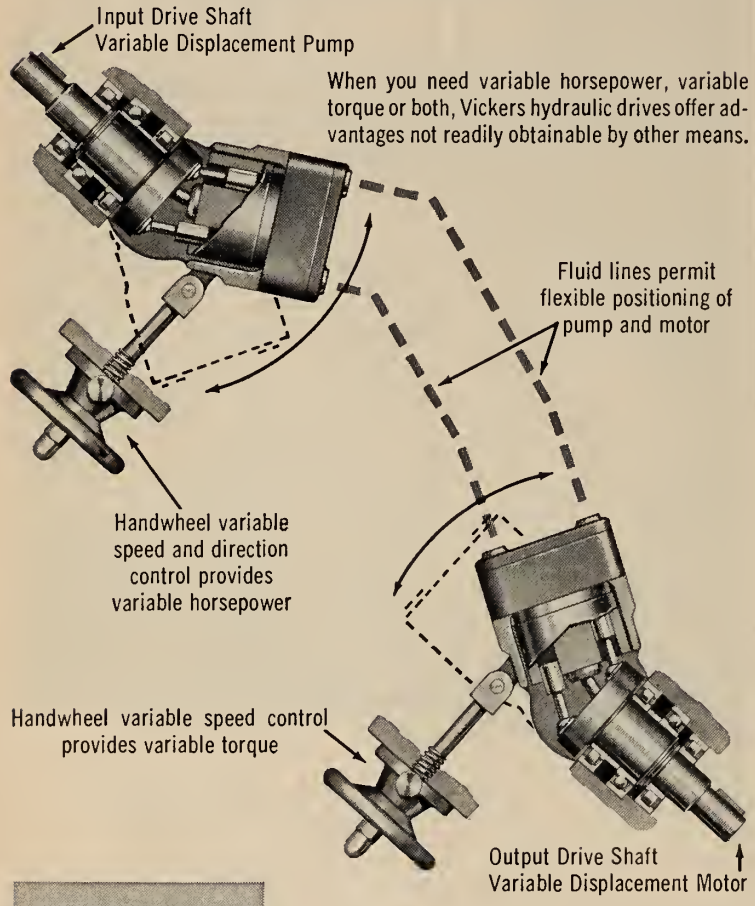

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AGM 63-RES-A

The National Research Council Industrial Research Assistance Program

R. E. McBurney, M.E.I.C.,
Chief Technical Information Service, National Research Council, Ottawa

The paper describes briefly the status of industrial research in Canada and the Federal Government's efforts to stimulate such research. The N.R.C. Industrial Research Assistance Program is described in considerable detail since it applies to any company incorporated in Canada, large or small. This program promotes new research facilities in Canada or the expansion of existing facilities by paying the salaries of scientists, engineers and their technician help to be directly employed on new or expanded research projects of the companies' own choice. The payments are non-recoverable grants. The new 150% tax exemption applies to the companies' expenditure, all patents and other rights remain with the companies and there is no direction or supervision of the research work by Government representatives. These and other aspects are covered in sufficient detail to enable companies to decide what projects might qualify and how to make application. The paper concludes with a review of progress and the current status of the plan.

AGM 63-RES-A

The National Research Council Industrial Research Assistance Program

R. E. McBurney, M.E.I.C.,
Chief Technical Information Service, National Research Council, Ottawa

Ce travail décrit brièvement l'état de la recherche industrielle au Canada et souligne les efforts du gouvernement fédéral pour stimuler cette recherche. Le programme d'assistance en recherche industrielle du Conseil National des Recherches y est détaillé, vu qu'il s'applique à toute compagnie incorporée au Canada, grande ou petite. Ce programme encourage l'établissement de nouveaux moyens de recherche au Canada ou l'expansion des moyens existants en payant les salaires des hommes de science, des ingénieurs et de leurs aides techniques. Ce personnel doit travailler directement à de nouveaux projets de recherches ou à des projets existants suivant le choix des compagnies. Les paiements se font sous forme d'octrois non-remboursables. La nouvelle exemption de taxe de 150% s'applique aux dépenses des compagnies; tous les brevets et autres droits demeurent la propriété des compagnies et les représentants du gouvernement n'exercent ni direction ni surveillance du travail de recherches. Tous ces sujets et bien d'autres encore sont traités suffisamment pour permettre aux compagnies de choisir les projets susceptibles d'un octroi et d'en faire la demande au gouvernement. L'auteur termine par une revue du progrès accompli et de l'état actuel de ce programme d'assistance.

AGM 63-RES-B

Engineering Research and Canada's Future

F. Noakes (Prof.) M.E.I.C.,
Head, Dept. of Electrical Engineering, University of B.C., Vancouver
D. M. Myers (Dean) M.E.I.C.,
Faculty of Applied Science, University of B.C., Vancouver

AGM 63-RES-C

Simple Reading Machines for the Blind

M. P. Beddoes,
Associate Professor, Department of Electrical Engineering,

The University of British Columbia

Reading machines for the blind include the simple machines (usually costing less than $500.00) and the more complex types which cannot yet be regarded as available to individuals. The literature deals with both types, but the blind have so far no machine which really enables them to read. This paper reviews the present state of research and development, and attempts to extrapolate an affirmative answer to the question: Will it be possible in the foreseeable future for the blind to read from the printed page by means of a simple machine costing less than a hired sighted reader?

It is extremely difficult to read with simple machines such as the English and American (Battelle) Optophones or the Canadian (Argyle) reader machines. Such machines produce an audible coded output, and the code is far from the optimum. An improvement may be possible by substituting for the present codes a multidimensional code. Comparison between the codes (based, admittedly, on rather questionable premises) shows a three-to-one speed advantage in favour of the multidimensional code.

Increased complexity of the machine can lead to easier reading; but the next step up in complexity involves a letter recognizer and, to date, such a device costs more than $50,000.00 because innumerable computer manipulations seem to be necessary. Were this problem to be solved cheaply, Spelled Speech, artificially increased in speed, would be an ideal audible code. It can be quite easily instrumented, and our experiments have shown that reading rates of 80 to 100 words a minute are possible without a very long period of learning.

AGM 63-RES-C

Appareils de Lecture Facile Destines aux Aveugles

M. P. Beddoes,
Professeur adjoint,
Département de génie électrique,
Université de British Columbia

Les appareils de lecture pour les aveugles comprennent les appareils simples (qui coûtent habituellement moins de $500) et les appareils plus complexes que l'individu ne peut encore se procurer. Les ouvrages publiés traitent des deux types mais les aveugles ne possèdent pas encore d'appareils leur permettant réellement de lire. Cette communication traite de l'état actuel des recherches et du développement et cherche à extrapoler une réponse affirmative à la question: Dans un avenir rapproché, sera-t-il possible à l'aveugle de lire les pages imprimées à l'aide d'un appareil simple coûtant moins que le salaire d'un lecteur?

Il est très difficile de lire à l'aide d'appareils simples comme l'optophone de conception anglaise et américaine (Battelle) ou encore de l'appareil canadien de lecture (Argyle). Ces appareils donnent un débit perceptible codifié qui est loin d'atteindre un rendement maximum.

On peut l'améliorer en remplaçant les codes actuels par un code à trois dimensions. La comparaison des codes (basée, il faut l'admettre, sur des prémisses plutôt douteuses) indique une vitesse trois fois plus grande en faveur du code à trois dimensions.

La complexité accrue d'un appareil peut faciliter la lecture, mais la prochaine étape implique l'utilisation d'un appareil à lire les caractères. A l'heure actuelle, cet appareil coûte plus de $50,000, parce qu'il exige d'innombrables manipulations à la calculatrice. Si on devait résoudre ce problème à peu de frais, le code Spelled Speech, qui augmente artificiellement la vitesse et est fort perceptible, serait excellent. On peut facilement le mettre en état d'utilisation et les essais effectués ont démontré qu'on peut atteindre une moyenne de 80 à 100 mots à la minute après une courte période d'adaptation.

AGM 63-RES-D

Magnetohydrodynamic Power Generation —Its Principles and Problems

W. Craig Moffatt, M.E.I.C.,
Assistant Professor of Mechanical Engineering,
Massachusetts Institute of Technology

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The increasing reliance on thermal plants for the production of electrical power has prompted a growing interest in unconventional power generation techniques. One of the most promising of these, and one which is the focus of a considerable research and development effort, is magneto-hydrodynamics. This scheme envisions the generation of power by passing an electrically conducting fluid, usually a high temperature gas, through transverse electric and magnetic fields. In its simplest form, this type of machine is exactly analogous to the conventional generator, except that a moving fluid conductor is substituted for a rotating wire-wound armature. In this paper the basic operating principles of an MHD generator are presented, and some of the major problems yet to be overcome before such devices become practical realities are described. Typical power plant arrangements incorporating MHD channels are set forth, and estimates of the relative costs of plants and power production for a number of configurations are presented.

AGM 63-RES-D

Magnetohydrodynamic Power Generation —Its Principles and Problems

W. Craig Moffatt, M.E.I.C.,
Professeur adjoint en génie mécanique,
Massachusetts Institute of Technology

L'usage de plus en plus fréquent d'installations thermiques pour la production d'énergie électrique a suscité un intérêt grandissant dans les techniques non conventionnelles de production d'énergie. Une de ces techniques qui promet, et vers laquelle beaucoup de recherches et d'efforts sont concentrés, est la technique magneto-hydrodynamique. Ce procédé permet la production d'énergie en passant un fluide conducteur d'électricité, généralement un gaz à haute température, au travers de champs magnétiques et électriques transversaux. Dans sa forme la plus simple, ce genre d'installation est exactement analogue au générateur conventionnel, sauf qu'un fluide conducteur est substitué à l'armature rotatrice enroulée de fil. On expose dans cette communication les principes fondamentaux du fonctionnement d'un générateur magnéto-hydrodynamique et on analyse quelques-uns des problèmes majeurs qui devront être résolus avant qu'une telle technique puisse être mise en practique. On décrit des aménagements de centrales utilisant les générateurs magnéto-hydrodynamiques et on donne une estimation du coût relatif de ces centrales en fonction de la production d'énergie dans divers genres d'installations.

AGM 63-THERM-A

Etude et Caractéristiques Techniques de la Construction de la Centrale D'énergie Nucléaire de Douglas Point

E. C. Smith, M.E.I.C.,
Layout Engineer,
Atomic Energy of Canada, Ltd.

La centrale de Douglas Point est le premier aménagement complètement nucléaire de notre pays. Cette centrale est actuellement en chantier. La communication contient des descriptions générales et brèves de la pile à eau bouillante, du turbogénérateur et des systèmes de confinement de l'édifice contenant la pile. Elle souligne aussi quelques-unes des caractéristiques visant à réduire le coût de l'investissement et des frais d'exploitation.

On a commencé les travaux de construction à la fin de 1960 et on prévoit que la centrale sera mise en exploitation au cours de 1964.

AGM 63-THERM-A

Layout and Building Design Features of the Douglas Point Nuclear Power Project

E. C. Smith, M.E.I.C.,
Layout Engineer,
Atomic Energy of Canada, Ltd.

The Douglas Point Project is the first full-scale nuclear power project in this country, and is now under construction. Brief general descriptions of the reactor/boiler, turbogenerator, and reactor building containment systems are given. Mention is made of some of the design features aimed at reduction of capital and operating costs.

Construction work was commenced late in 1960, and the Project is scheduled for commissioning during 1964.

AGM 63-THERM-B

"Design and Operation of Coal Handling Facilities at the Wabamun Steam Plant".

Mr. Zen Kolisnyk,
Montreal Engineering Co. Ltd.

This paper intends to present the coal handling methods used and the coal handling system design at the Calgary Power Ltd., Wabamun Steam Plant. The design considerations for the provision of a continuous flow of fuel to the steam generators at a minimum cost per ton are set forth and discussed. The paper outlines the development of the final design as the result of solving problems peculiar to the installation, selecting the most suitable alternatives and catering for the future exxtensions to ultimate capacity. The resulting design, equipment and controls are fully described.

The paper closes describing the subsequent operating experiences of the System.

AGM 63-THERM-B

"Design and Operation of Coal Handling Facilities at the Wabamun Steam Plant".

Mr. Zen Kolisnyk,
Montreal Engineering Co. Ltd.

Le but de ce mémoire est de décrire les méthodes employées pour la manutention de la houille ainsi que la conception du système prevu a la centrale thermique de Wabumun. On expose et discute les raisons qui justifient les dispositions adoptées afin d'assurer la fourniture continue du combutible aux chaudières. Le mémoire trace brièvement l'élaboration du projet dèfinitif qui découle de la solution des problèmes propres à cette installation, compte tenu de la nécessité de choisir les alternatives les mieux appropriées, et de pourvoir aux extensions futures jusqu'a l'achèvement de l'installation définitive.

On décrit en détail le projet qui en résulte, ainsi que l'outillage et les commandes. Le mémoire conclut avec la description des observations faites à la suite de la mise-en-service de l'installation.

AGM 63-THERM-C

Some Aspects of Commissioning and Early Operation of 200 Mw Reheat Units at R. L. Hearn GS. and 300 Mw Reheat Units at Lakeview GS.

E. D. Holdup,
Thermal Operations Engineer,
Hydro-Electric Power Comm. of Ontario,
Toronto, Ont.

AGM 63-WELD-A

Welding in Cold Weather

K. Winterton

For some time it has been recognized that problems exist when welding is attempted at low ambient temperatures. This is reflected in the restrictive clauses inserted in many specifications and codes. However, the nature and causes of these difficulties have never been clearly defined.

The welding of steel in cold weather has been considered under three headings: (1) the effects of cold on men, materials and machinery with practical experience from several countries and different industries, (2) the metallurgical factors involved, with controlled welding

experiments under laboratory conditions, (3) methods of overcoming or alleviating the metallurgical difficulties, and a consideration of code requirements.

AGM 63-WELD-A

Welding in Cold Weather
K. Winterton

Il est reconnu depuis quelque temps qu'il se présente des difficultés lorsqu'on tente de souder à basses températures ambiantes. C'est pourquoi des clauses restrictives sont insérées dans maints devis et codes. Toutefois, la nature et les causes de ces difficultés n'ont jamais été clairement définies.

Ici on étudie la soudure de l'acier par temps froid sous trois aspects: (1) les effets du froid sur les hommes, les matérieux et la machinerie ainsi que l'expérience pratique obtenue dans plusieurs pays et dans une variété d'industries, (2) les facteurs métallurgiques qui entrent en jeu lors d'essais de soudure exécutés en laboratoire, (3) les méthodes recommandées pour éviter ou amoindrir les difficultés en métallurgie et un examen des exigences du code.

AGM 63-WELD-B

Methods to Establish Procedures for Welding Low Alloy Steels
B. J. Bradstreet,
Head of the Metals Joining Research Laboratory,
John Inglis Co. Limited,
Toronto, Ont.

The crack resistance of arc welded low alloy steels can be determined experimentally using suitable weldability tests. One testing scheme, using the "CTS" test is outlined, and a new, alternative form of the CTS test is described. Another method of determining weldability entails working out the "carbon equivalent" of a steel from its composition; this can be related to the weldability as measured experimentally. Once the weldability of a steel has been established, it is shown how welding procedures can be worked out for any given joint geometry using simple tables or graphs.

AGM 63-WELD-B

Méthodes pour Etablir des Procédures pour la Soudure D'Aciers Faiblement Allies
B. J. Bradstreet,
Head of the Metals Joining Research Laboratory,
John Inglis Co. Limited,
Toronto, Ont.

La résistance aux fissures des aciers faiblement alliés et soudés à l'arc peut être déterminée expérimentalement par des essais appropriés d'aptitude de soudure. Un plan d'essai, utilisant le test "CTS" est exposé et un nouveau —une alternative du test "CTS"—est décrit.

Une autre méthode de déterminer la soudabilité consiste à calculer "l'équivalent en carbone" de la composition d'un acier; ceci peut être comparé à la soudabilité que l'on évalue expérimentalement.

Une fois la soudabilité d'un acier établie, on nous montre la façon de trouver des procédures de soudage pour n'importe quel joint géométrique, simplement à l'aide de tableaux ou graphiques.

AGM 63-WELD-C

Welding at Chalk River
Part I — A Progress Report,
H. D. Tiffin

Part II — Sealing Nuclear Fuel Cans,
M. B. Watson

both Atomic Energy of Canada,
Chalk River

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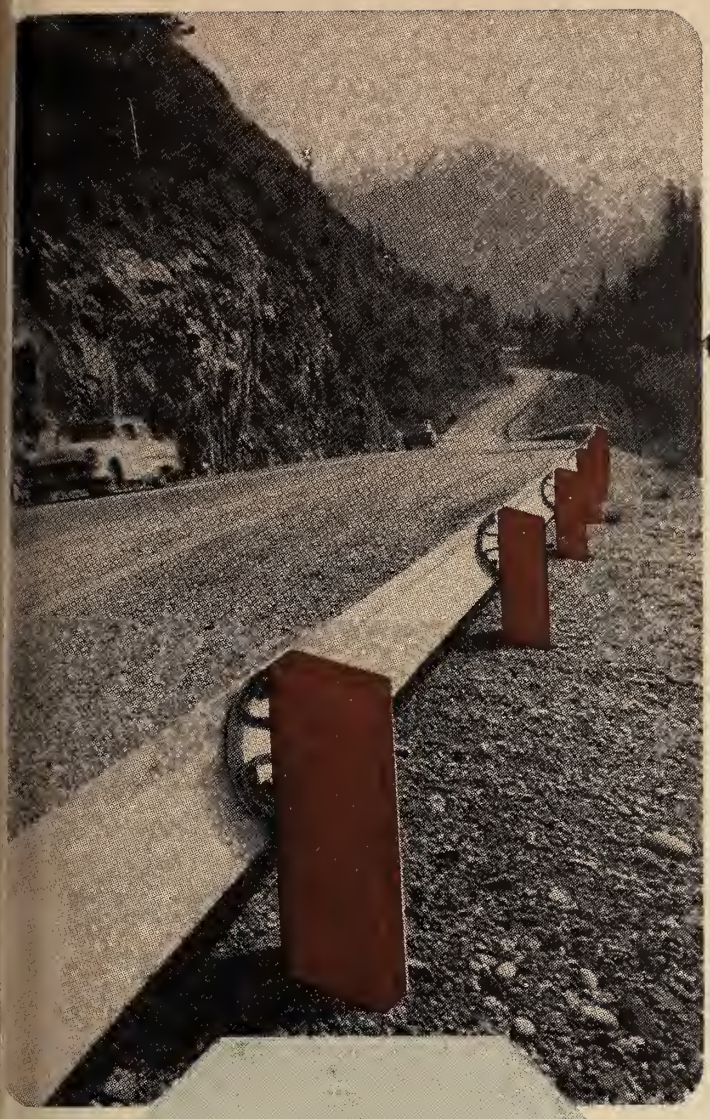

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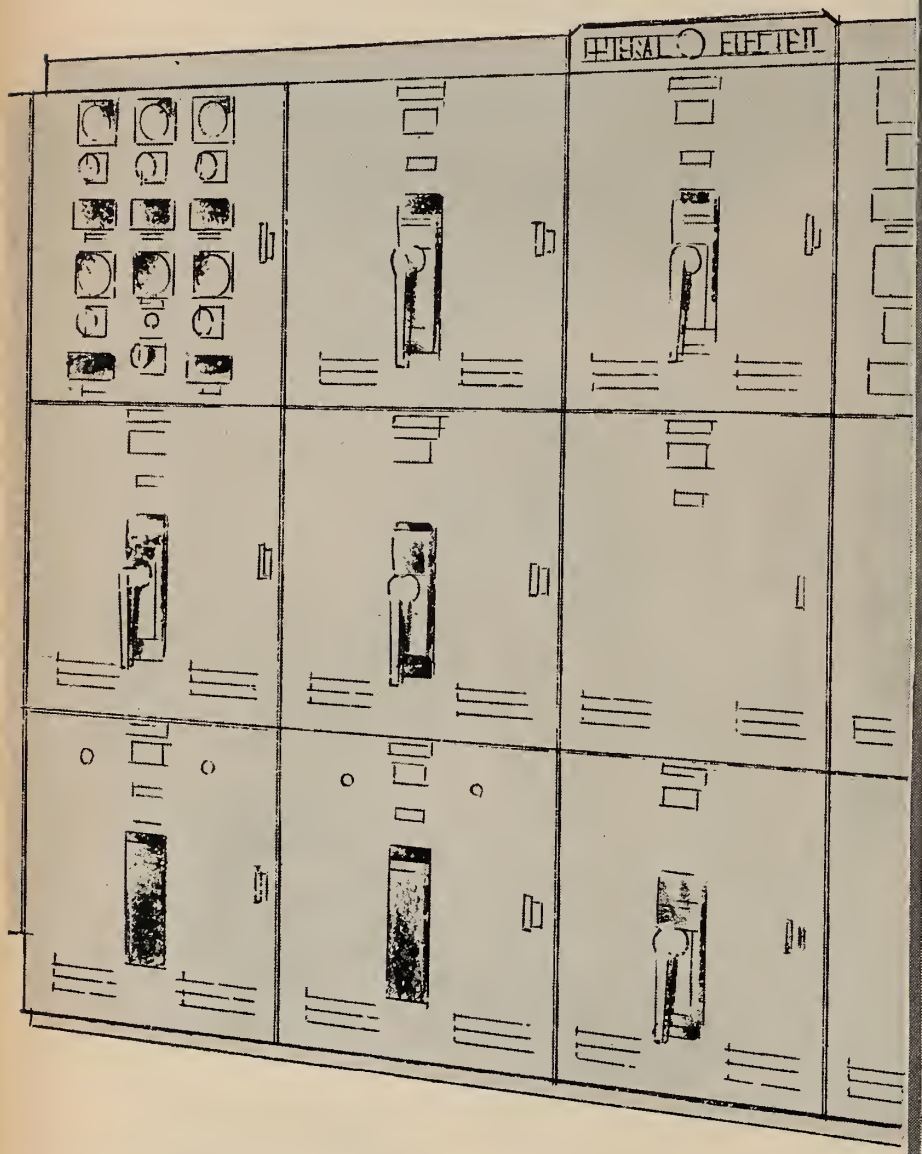
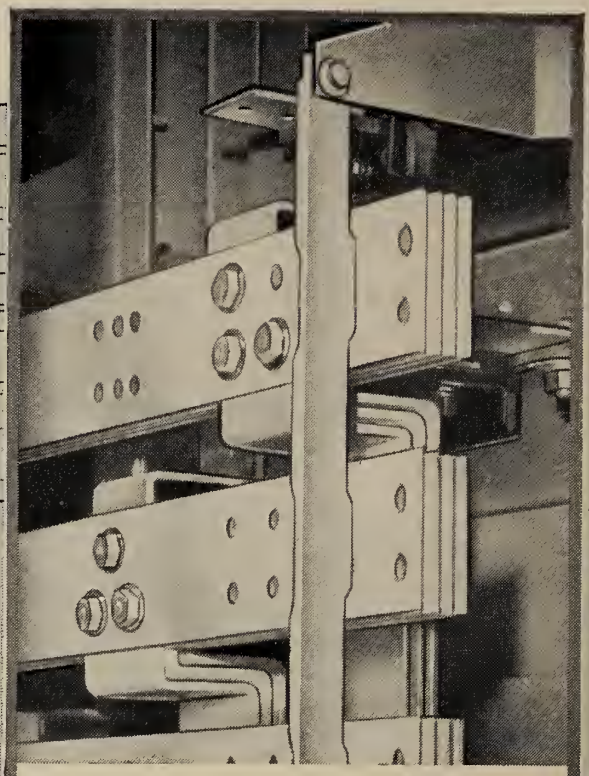
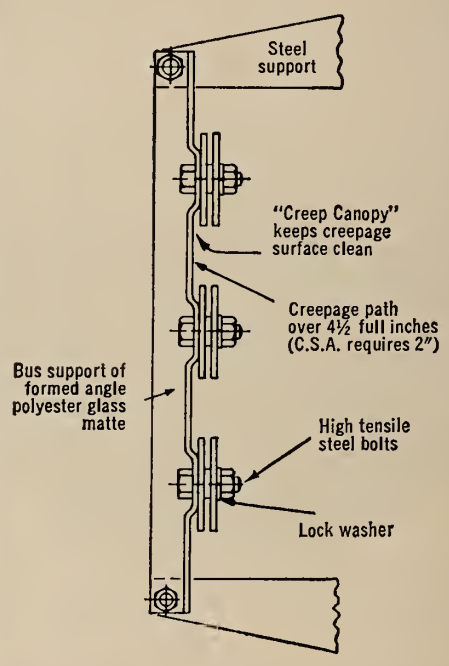




Here's a close-up of vertically mounted bus supports. Made from polyester glass matte, these supports are light in weight and flame retardant.



This drawing illustrates how the bus support forms canopies to protect creepage surface. The design incorporates a greater creepage surface than the required two inches of CSA standards.

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MESSAGE FROM THE PRESIDENT

ALLOCUTION DU PRÉSIDENT

The Engineering Institute of Canada, under the name of the Canadian Society of Civil Engineers, came into existence on February 24, 1887. It has never been a static organization, and almost from its inception it has changed and has become modified to suit the rapidly changing conditions in the profession. It is in this ability to adapt itself constantly that the great strength and usefulness of the Institute lies.

Although old in years—over 75 years—the Institute has retained its spirit of youthfulness and vigour. Why? Because it has always provided a high quality of service to its members, and through them to our various communities and our country as a whole. The world has witnessed greater changes during the life of the Institute than in any other similar period in recorded history, and the Institute has kept pace with these changes. As our Diamond Jubilee year closes we can be proud of our achievements and look to the future with confidence.

The past year has been one of progress. The Committee on Technical Operations has been most active, and its field of work has been expanded, so that now there are fifteen Engineering Divisions operating. The Publications Committee has provided for a "new look" for the Journal, the publication of Transactions has been revised to provide different series for various branches of engineering, and arrangements have been made for the publication of Divisional papers. Taken together these changes are greatly increasing the technical activities of the Institute.

In the matter of administration the Institute is better equipped than ever to serve you. The burden of routine administration is now entrusted by Council to the Executive Committee. The institution of the Regional Information and Co-ordination Centre (R.I. & C.C.) concept of regional focal points for improved communication on a two-year trial basis, has already proved to be very effective.

The Headquarters staff has been strengthened, and modern methods of records handling and accounting have been installed. The Institute has been remarkably fortunate in the loyal service rendered by its staff during the trying circumstances of the past year. Your President is particularly conscious of the outstanding service rendered by the General Secretary during a period of great physical strain.

I believe that the Institute's ability to serve you is growing day by day, and I look forward with confidence to a magnificent future for the engineering profession in Canada.

L'Institut canadien des ingénieurs fut créé sous le nom de Canadian Society of Civil Engineers le 24 février 1887. Ce fut dès le début un organisme très vivant qui n'a cessé d'évoluer et de se transformer pour s'adapter aux conditions rapidement changeantes de la profession. Et c'est dans cette faculté d'adaptation que l'Institut trouve sa grande force et sa grande utilité.

Malgré son âge respectable—plus de 75 ans—l'Institut a conservé jeunesse et vigueur. Pourquoi? A cause de la haute qualité du service qu'il a toujours donné à ses membres et, par leur entremise, à nos différentes collectivités et au pays tout entier. Durant l'existence de l'Institut le monde a connu des changements plus grands que dans toute autre période équivalente de l'histoire, et l'Institut a marché de pair avec ces changements. Alors que l'année de notre soixante-quinzième anniversaire touche à sa fin, nous pouvons être fiers de nos réalisations et envisager l'avenir avec confiance.

L'année dernière a été une année de progrès. Notre Comité technique a été des plus actifs et son champs d'activité s'est encore élargi, de sorte que nous avons maintenant 15 divisions techniques à l'oeuvre. Le Comité des publications a renouvelé la présentation de notre journal, la publication des transactions a été revisée dans le but d'offrir de nouvelles séries pour chaque branche de la profession et des ententes ont été conclues pour la publication des communications qui nous viennent des divisions. Mis ensemble, ces changements ont considérablement accru l'activité technique de l'Institut.

Du côté administratif, l'Institut est mieux en mesure que jamais de vous servir. A la suite d'une décision du Conseil, le fardeau des affaires courantes a été confié au Comité directeur de l'Association. L'idée de recourir à des Centres régionaux d'information et de coordination (R.I. & C.C.) devant servir de points d'attrait aux différentes régions afin d'améliorer les communications, à l'essai pour deux ans, s'est déjà montrée très efficace.

Le personnel du bureau principal a été augmenté et de nouvelles méthodes de classement des documents et de comptabilité ont été instaurées. L'Institut est grandement reconnaissent à son personnel pour les loyaux services qu'il a rendus durant les circonstances difficiles de l'année dernière. Votre président est particulièrement heureux de reconnaître les services éminents rendus par le secrétaire général durant une période d'intense surmenage.

On ne peut que constater que l'Institut est de jour en jour mieux en mesure de vous servir et envisager avec confiance le magnifique avenir qui s'ouvre à la profession d'ingénieur au Canada.

THE ENGINEERING INSTITUTE OF CANADA

annual report

for the year ended December 31 1962

REPORT OF COUNCIL

It is well to recall the objectives of the Institute from time to time. They are:

(a) to develop and maintain high standards in the engineering profession,
(b) to facilitate the acquirement and the interchange of professional knowledge among its members,
(c) to advance the professional, the social and the economic welfare of its members,
(d) to enhance the usefulness of the profession to the public,
(e) to collaborate with universities and other educational institutions in the advancement of engineering education,
(f) to promote intercourse between engineers and members of allied professions,
(g) to co-operate with other technical societies for the advancement of mutual interests,
(h) to encourage original research, and the study, development and conservation of the resources of Canada.

75th ANNIVERSARY

The highlight of the 75th Anniversary Year was the Annual Meeting held in Montreal. This meeting was very successful, both because of the comprehensive and excellent technical program arranged by the Committee on Technical Operations and the outstanding work of the local arrangements committee composed of members of the Montreal Branch. Messages of greeting were received from sister societies around the world. A special feature of the meeting was the 75th Anniversary Show staged by members of the Montreal Branch, their wives and their daughters. This original entertainment vividly portrayed a panorama of Canadian engineering accomplishment and service to the country. It has been preserved on motion picture film for the benefit of those who could not see it and for posterity, thanks to the Life Members Committee and several industrial organizations who supported the costs of the film.

Following is the schedule of future Annual Meetings:

1963 Quebec, May 22-May 24, Chateau Frontenac
1964 Banff, May 27-May 29, Banff Springs
1965 Toronto, May 26-May 28, Royal York
1966 Winnipeg, May 25-May 27, Royal Alexandra
1967 Montreal, May 31-June 2, Queen Elizabeth
1968 Halifax — —

Many Branches held special 75th Anniversary celebrations. Some recognized the event by preparing branch histories, and others used such devices as special stickers on stationery. Many were successful in arranging news stories on the E.I.C. and its 75th Anniversary in the press, radio and television.

ADMINISTRATION

The lack of effective focal points for the exchange of ideas and information between Branch Executives, Councillors and senior officers of the Institute was recognized by Council in the institution of a regional plan of organization on a two-year trial basis. This Regional Information and Co-Ordination Centre concept of organization involves the division of Canada into ten regions on a basis which attemps to provide a practical solution to many diverse geographical and other problems. This basis may be changed after some experience. Initial R.I. And C.C. meetings have been held and plans laid for others in all regions before the 1963 Annual Meeting. The initial and unanimous reaction has been that this concept fulfils a long-felt need very successfully.

Tied in with each regional conference was a regional conference of Branch officers. This new activity permits adequate discussion of details between Branch officers and Headquarters staff, which was not always possible previously.

More than 500 members who serve on committees and representatives appointed by Council continued to make important contributions to the efficiency of the Institute's operations. Not only did they study proposals which were referred to them by Council, but each kept in touch with situations and attitudes within its terms of reference and recommended action when necessary.

The Headquarters staff was consolidated, with particular attention being paid to the expansion and reorganization of the technical operations department and the advertising sales staff.

Detailed reports of these committees and representatives follow.

They are the detailed story of your Institute's progress.

BY-LAWS

In 1962 the membership approved many significant changes in the by-laws by a substantial majority. Perhaps the most important of these changes was the establishment of the Executive Committee of the Council. This committee is charged with the responsibility for the conduct of the routine administrative business, much of which previously occupied a large portion of the time of Council. The Council has thus been freed for the better exercise of its important function of formulating policy. It is expected that Council will

normally meet a minimum of three times a year and the Executive Committee will meet seven or eight times a year. Other changes related to the method of nominating and electing officers, and adjustment of the scale of membership fees to bring them in line with current operating costs.

CONFEDERATION

On June 9, 1962, representatives of the Executive Committees of the Canadian Council of Professional Engineers and of the E.I.C. met to discuss further the possibilities of agreement on their outstanding differences with respect to the proposals made in the Final Report of the Engineers Confederation Commission. Exhaustive discussion revealed that agreement was impossible. However, it was decided to recommend that the E.I.C. put the issue to its members by ballot if the Councils of the eleven constituent member associations of the C.C.P.E. would put the same question to their individual members on the same date. On June 10 the E.I.C. Council agreed to this, and empowered the President to appoint a special committee of Council, with Dr. B. G. Ballard as Chairman, to prepare a draft statement of Council's opinion concerning the proposal for "unity" by the method set forth in the report, to obtain an opinion of the proposal from our legal counsel, and to develop a suitable question to be used on the ballot paper. The C.C.P.E. advised the E.I.C. officially on October 30, 1962, that the eleven Associations and Corporation which are the constituent bodies of the Canadian Council of professional Engineers, had agreed to conduct a letter ballot of their membership in accordance with the conditions referred to above. Steady progress was made in the completion of this task, but it was only near the end of the year that the work was near completion.

ENGINEERING EDUCATION

The Deans of almost every faculty of engineering in Canada met under the Institute's auspices during the 1962 Annual Meeting. At the request of this meeting, the group has been constituted a committee of Council, called the "Dean's Committee".

The Institute continued to maintain its close and effective relationship with universities, appropriate agencies of the Federal government and with the Canadian Education Association in the interests of the best possible engineering education in Canada.

EXTERNAL RELATIONS

The Institute continued to enjoy its respected place in the world community of learned societies. Cordial relations and close work continued with the Canadian Aeronautical Institute, the Canadian Institute of Mining and Metallurgy, the Chemical Institute of Canada, and the Canadian Council of Professional Engineers.

Extremely friendly relations were maintained with Institutions in the United Kingdom, other Commonwealth Societies, the founder Societies in the United States, the representative national organizations in Europe, the Far East and Latin America. These contacts were in addition to the formal meetings between representatives of the member societies of such international organizations as Union Panamerica de Asociaciones de Ingenieros and the Conference of Engineering Societies of the British Commonwealth.

These frequent exchanges of information and assistance have proved invaluable to the Canadian engineering profession.

The co-operative agreements between the Engineering Institute of Canada and the Institution of Civil Engineers, the Institution of Electrical Engineers and the Institution of Mechanical Engineers provide members of any one of the participating bodies with the opportunity for participating in the technical activities while in the country of the host body, on payment of a nominal fee. By providing a technical home for such members full membership in the host society is more readily sought after.

On the invitation of the Institute, the Conference of Engineering Institutions of the British Commonwealth was held in Canada in September, 1962. This important conference was an outstanding success and resulted in improvements for the already well-developed relationships that exist.

GOVERNMENT LIAISON

Close liaison with the Federal Government was continued by the Institute. This involved working co-operatively with many agencies and departments on a day-to-day basis in the interests of Canadian engineering. Many problems were referred to the Institute either directly or by virtue of the Institute's membership on committees and boards established by the government. The Branches in the Province of Quebec made a constructive submission to the Royal Commission on Education, in cooperation with Corporation of Professional Engineers of Quebec.

EMPLOYMENT SERVICE

The following statistics summarize the Institute's employment activities to engineers and their employers during the year.

Yearly Report – 1962

	Atlantic	*Central*	*Prairies*	*West Coast*	*U.S.A.*	*Foreign*	*Total*
SITUATIONS VACANT							
Registered	16	266	19	9	3	4	317
Advertised	23	294	42	17	6	14	396
Total							713
SITUATIONS WANTED							
Registered	21	221	24	11	5	23	305
Advertised	38	57	69	21	7	12	204
Total							509
VISITS and INTERVIEWS			Employers—81 Employees—1,060 (including students and recent immigrants)				
FOREIGN requests for employment in Canada	243		Requests and General Inquiries				2,340

HEADQUARTERS

With a view to providing suitable Headquarters accommodations, a Committee on a Headquarters Building Program, with Dr. J. B. Stirling and Dr. R. E. Heartz as co-chairmen, was appointed. This committee is examining the general situation and the various possible ways of providing adequate Headquarters facilities. The present accommodation is no longer adequate to serve an Institute of over 24,000 members. It is considered that, in addition to physical accommodation for the staff, equipment and records, the Headquarters building should be appropriate for Canada's largest learned technical society.

HONOURS, AWARDS, MEDALS AND PRIZES

Awards presented during 1962 were: —

Honorary Memberships:
Robert S. Eadie
John Jeffrey Hanna
Thomas R. Loudon
Dr. E. W. R. Steacie
Dr. D. M. Stephens

Gzowski Medal
R. A. C. Hauser
E. F. Pariset

Duggan Medal and Prize
A. Hrennikoff

Robert W. Angus Medal
John Young

Canadian Lumbermen's Association Prize
B. Madsen

Julian C. Smith Medal
T. W. Eadie
F. H. Peters

Leonard Medal
T. W. Wlodek

Plummer Medal
D. S. Scott

Sir George Nelson Award
K. H. Williamson

R. A. Ross Medal
Dr. R. C. Langille

Ernest Marceau Prize
Guy Laberge

LIBRARY

Following a letter ballot of members of Council on the issue of the Library, which resulted in a small majority in favour of abandonment of this activity by the Institute, the Executive Committee left the implementation of this decision to the President. Initial appropriate action has been taken. Possibilities for replacement of this service are under review.

PROFESSIONAL DEVELOPMENT

The Institute was represented at the Annual Meeting of the Engineers Council for Professional Development as well as at the meetings of the Executive Committee and the Council. An increasing interest in local Professional Development courses was shown at Branch level in many parts of Canada. This is co-ordinated by the National Committee on Professional Development Programs.

PUBLICATIONS

The Publications Committee made an outstanding contribution to the operation of the Institute by completely revising and re-orienting the format of the Engineering Journal and by providing for five series of Transactions and for Divisional Papers. These two groups will be published as papers separate from the Journal and thus the time between receipt and publication of papers will be greatly reduced.

TECHNICAL PROGRAM

The outstanding technical program at the annual meeting and conferences sponsored by the EIC is a tribute to the work of the Committee on Technical Operations (CTO). This Committee is demonstrating in a very positive manner the essential value of the members' voluntary contribution in the area of technical activities. C.T.O. has made marked progress in the development of its own organization to enable it to establish a more effective liaison with branches in their technical activities—the real service which the Institute can provide to its members. C.T.O. has given much thought to the increasing necessity for technical conferences based on Divisional areas of interest in addition to the more general type of program associated with regional technical conferences. One such conference planned for 1964 will have as its theme "The Relation of Research to Engineering Progress". The President emphasized, in discussions with Branch Executives, the extreme importance and appeal which excellent technical programs have for the Branch membership.

The Institute actively participates in sponsoring the programs of international technical organizations. Included in these international activities are participation in the work of the ASME Committee on Air Pollution Controls, the Column Research Council, the International Association for Bridge & Structural Engineering, the International Federation of Chemical Engineers, the International Electrotechnical Commission, and the Inter - Society Management Engineering Conference.

VOCATIONAL INFORMATION

Through many of its branches and Headquarters staff, sometimes acting together, the Institute has pursued its work in the important field of vocational guidance. Branch activity is normally through committees and individuals assigned to this work, who give talks on engineering to students in high schools and junior colleges, and assist their staffs.

Headquarters again received many inquiries which were usually requests for literature or advice on engineering careers and technical courses. Guidance pamphlets, both Canadian and from E.C.P.D. are available for these purposes, and are distributed free.

The Institute continued its affiliation with, and support of the Canadian Science Fairs Council. Details will be found elsewhere in this report, from the E.I.C. representative on the Council.

WIVES ORGANIZATIONS

The Institute assists engineers' wives associations. The purpose of these groups is to welcome newcomers to their centres thus promoting cordiality and friendship among the wives of the members of the Institute, and of all members of the profession.

Respectfully submitted on behalf of the Council.

F. L. Lawton, M.E.I.C.
President,
Garnet T. Page, M.E.I.C.,
General Secretary.

Statement of Revenue and Expenditure

Year ended December 31, 1962 (with comparative figures for 1961)

REVENUE	1962	1961
MEMBERSHIP FEES	$212,138	$189,525
PUBLICATIONS	343,551	384,847
INCOME FROM INVESTMENTS	8,126	12,108
VOLUNTARY CONTRIBUTIONS	13,747	—
MISCELLANEOUS	5,276	6,604
TOTAL REVENUE	582,838	593,084
DEFICIT FOR THE YEAR	57,669	68,924
	$640,507	$662,008

EXPENDITURE	1962	1961
ADMINISTRATIVE EXPENSES:		
Staff salaries and benefits	$144,037	$149,584
Travelling—secretariat	9,957	9,898
Other, less recoveries, 1962—$2,223, 1961—$1,362	46,761	44,418
	200,755	203,900
Deduct allocation of expenses to Publication expenses	51,100	51,706
	149,655	152,194
DIRECT SERVICE EXPENSES:		
Annual and regional meetings	8,393	6,720
Branch rebates, stationery and achievement awards	37,501	35,305
Committees	556	1,490
Institute medals and prizes	1,129	640
Employment service	5,027	6,168
Engineering education	1,060	1,254
International activities	4,859	1,743
Library	18,684	19,427
Memberships	1,715	3,176
Official reception and hospitality	1,036	1,116
Professional development	2,731	2,485
Student affairs	9,031	7,283
Travel and meeting expenses	7,529	8,377
	99,251	95,184
Deduct allocation of expenses (employment service and library) to Publication expenses	—	2,592
	99,251	92,592
PUBLICATION EXPENSES:		
Staff salaries and benefits	60,025	43,542
Commissions	10,804	17,528
Printing and mailing	203,707	222,070
Other	45,253	56,670
	319,789	339,810
Add:		
Administrative expense allocation	51,100	51,706
Direct service expense allocation	—	2,592
	370,889	394,108
BUILDING AND RENTAL EXPENSES	14,717	13,571
EXTRAORDINARY EXPENSES:		
Confederation	1,001	3,075
Consultants' fees—data processing	—	929
Loss on investments	2,287	5,539
Loss on sale of furniture and equipment	2,707	—
	5,995	9,543
	$640,507	$662,008

TREASURER'S REPORT

Your treasurer respectfully submits herewith the financial statements of the Institute for the year ended December 31, 1962, together with the report of the Institute's auditors.

Gross revenue amounted to $582,838 compared with $593,084 a year ago.

The deficit for the year amounted to $57,669 compared with $68,924 for the previous year and $55,772 in 1960. This deficit is a continuation of a deterioration in the financial position of the Institute which has persisted for the past several years and has resulted in a significant depletion in its resources. As a consequence of these recurring deficits the market value of the investment now rests at $157,170 compared with $328,800 in 1958, a drop of 52 per cent. During the year $52,776 of the Institute's investments were liquidated to provide working capital and reduce the bank loan to manageable proportions.

It was gratifying indeed, for those responsible for the financial operations of the Institute, to have the needed increase of fees receive the approval of the membership. With this additional revenue forthcoming in 1963 a much improved position is anticipated next year.

A. W. HOWARD, M.E.I.C.
Treasurer

Balance Sheet

December 31, 1962 (with comparative figures for 1961)

ASSETS	1962	1961
CURRENT ASSETS:		
Cash	$ 12,300	971
Accounts receivable, less allowance for doubtful accounts	29,561	33,608
Arrears of membership fees, estimated	6,500	6,500
Sundry advances and deposits	2,082	1,440
Inventory of supplies for resale, at cost	1,045	—
Miscellaneous supplies and prepaid expenses	22,815	13,351
Total current assets	74,303	55,870
INVESTMENTS, AT COST less amount written off:		
Securities (quoted market value 1962 $157,170, 1961 $216,079)	164,384	219,447
Less held for special funds	39,315	38,338
	125,069	181,109
FIXED ASSETS, AT COST LESS AMOUNTS WRITTEN OFF:		
Land and building	36,000	36,000
Furniture and equipment	18,761	24,450
Library	1	1
	54,762	60,451
DEFERRED CHARGES, AT COST LESS AMORTIZATION:		
Data processing conversion expenses	14,150	—
ASSETS OF SPECIAL FUNDS:		
Equity in investments shown above	39,315	38,338
	$307,599	$335,768

LIABILITIES	1962	1961
CURRENT LIABILITIES:		
Bank overdraft—secured	$ —	$ 27,452
Bank loan—secured	30,000	—
Accounts payable and accrued charges	86,751	67,881
Fees paid in advance	14,976	3,561
Total current liabilities	131,727	98,894
OTHER LIABILITIES:		
Life members' fund	6,710	7,340
Other unexpended contributions for special purposes	5,189	8,869
	11,899	16,209
RESERVES AND DEFICIT, per accompanying statement:		
RESERVES:		
Building	172,000	184,000
Building maintenance	1,500	1,500
Contingencies	4,500	4,500
Publications	1,500	27,232
	179,500	217,232
DEFICIT	(54,842)	(34,905)
	124,658	182,327
SPECIAL FUNDS:		
Memorial and prize funds	5,490	5,498
Other trust funds	33,825	32,840
	39,315	38,338
	$307,599	$335,768

Statement of Reserves and Deficit

Year ended December 31, 1962 (with comparative figures for 1961)

	1962	1961
RESERVES:		
Balance at beginning of year	$217,232	$242,232
Transfer to deficit	37,732	25,000
Balance at end of year	$179,500	$217,232
SURPLUS (deficit):		
Balance at beginning of year	(34,905)	5,221
Transfer from reserves	37,732	25,000
Library deposits written off	—	3,798
	2,827	34,019
(Deficit) for the year	(57,669)	(68,924)
BALANCE AT END OF YEAR	$(54,842)	$(34,905)

AUDITORS' REPORT

We have examined the balance sheet of The Engineering Institute of Canada as of December 31, 1962 and the statements of revenue and expenditure, reserves and deficit for the year ended on that date and have obtained all the information and explanations we have required. Our examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as we considered necessary in the circumstances.

In our opinion, and according to the best of our information and the explanations given to us and as shown by the books of the Institute, the accompanying balance sheet and statements of revenue and expenditure, reserves and deficit are properly drawn up so as to exhibit a true and correct view of the state of the affairs of the Institute at December 31, 1962 and the results of its operation for the year ended on that date, in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

PEAT, MARWICK, MITCHELL & CO.,
Chartered Accountants

MONTREAL, P.Q., MARCH 5, 1963.

REPORTS OF THE COMMITTEES

STANDING COMMITTEES

ADMISSIONS COMMITTEE

Statistical Report

During 1962, the Admissions Committee held six regular meetings.
In all, the applications of 329 candidates were considered, including 54 Special Cases.

Admitted for Corporate Membership		245	
Admitted for Affiliate		4	
Transferred to a higher grade of membership		15	
Special Cases			
Referred to the Board of Examiners	10		
Rejected	35		
Held for further investigation	20		
	—	65	
**Student Admissions		1577	1906
**Admissions and Transfers through Provincial Associations			
Admitted for Corporate Membership		54	
Transferred to a higher grade of membership		62	
Student Admissions		304	420
			2326

**These figures are included for the sake of completeness, although these categories are not reviewed by the Admissions Committee.

WILLIAM BRUCE, M.E.I.C.
Chairman

COMMITTEE ON BRANCH OPERATIONS

In 1962 the Branch Model By-Laws were completed and forwarded to Council with a recommendation for their approval. This approval was given and the Model By-Laws have been distributed to the Branches. During the past year, several Branches have submitted amendments to their By-Laws and these amendments have been considered by the Committee and appropriate action recommended by Council. It is now felt that Branches should consider the Model By-Laws when undertaking any future revisions to their By-Laws.

Last year the Committee reviewed the schedule of Branch rebates, and at that time decided that changes were not required. However, in view of the increased fees now in effect it was considered that this matter should be reviewed again, and a sub-committee has been set up to study this further.

The sub-committee on Branch Model Accounts is still working on this project to set up a sample of Branch account books. It is expected that this will be finished in the near future.

Several years ago the Institute published the Branch Operation Manuals which have proved to be most helpful in the operation of the Branches. It was felt that consideration should be given to insure that these Manuals remain up to date and a sub-committee has been appointed to review them and incorporate any revisions considered advisable.

Another matter under study at present is a recommendation in regard to the advisability of having a uniform year for all Branches.

The Committee was indeed sorry to lose Mr. E. D. Gray-Donald, who resigned as Chairman to join the Institute staff at Headquarters. Mr. Gray-Donald is a senior member of the Institute who has played an important part in E.I.C. affairs for many years and, as Chairman of C.B.O., he brought a wealth of knowledge to this position. It is gratifying to know, however, that he is still actively associated with the Institute.

R. H. STEVENSON, M.E.I.C.
Chairman

FINANCE COMMITTEE

Your Finance Committee met 11 times during 1962. At each meeting the monthly reports prepared by the Controller were analyzed, the financial aspects of the operation of the Institute were studied, and reports of the Committee's findings were presented for discussion and approval by Council and its Executive Committee.

The original budget prepared in the fall of 1961 was reviewed at about mid-term and corrections applied to suit the flow of income, actual and forecast at a closer range. Even after effecting the most rigid economies and after reducing the cost and extent of services to a minimum, your Committee advised you that a deficit of $63,730 could be expected. It is pleased to report an improvement of more than $6,000 in this sector due to a large extent to the generous answer of the members to the President's plea for voluntary contributions.

As recommended by this Committee, Council ballotted the membership and obtained its consent to raise membership fees to a level which should produce a balanced budget while permitting a substantial improvement in the number and quality of the services rendered by the Institute. Among other services, this Council has approved the publication of Transactions of a broader aspect and of Division papers. Allowance has been made in the budget to finance a small deficit in the publication account in 1963. In addition, senior staff appointments have been made at Headquarters to improve its effectiveness and to provide better communications with our members and Branch Regional organizations.

The installation of the electronic data processing equipment for use in the membership and accounting areas now is virtually complete. The cost of operating these two departments in the future will be contained as it will not grow at the same rate as the membership.

As predicted last year, some of our securities had to be sold to meet cash requirements. Adjustments have also been made in the reserves to bring them in line with the related assets.

COMMITTEE MEMBERS:

Chairman: G. N. Martin
Treasurer and Vice-Chairman: A. W. Howard
Members: J. H. Budden, Brig. Maurice Archer, E. B. Jubien, E. E. Orlando, W. I. M. Turner, J. J. Rowan, A. J. Groleau, W. G. Hole

G. N. MARTIN, M.E.I.C.
Chairman

LEGISLATION COMMITTEE

The new membership of this Committee was established by the Council under date of June 13, 1962.

Under the terms of reference, the Committee was to consider all suggestions and reports concerning legislation which may be made by a Branch or Provincial Division. No such reports having been received, no meetings of the Committee were held. However, it is proposed that a meeting would be held during the Annual Meeting in Quebec City to consider any suggestions for revised terms of reference which may be submitted to the Council.

The Committee is comprised of the following

Chairman: G. B. Williams
Members: Col. W. A. Capelle, C. L. Fisher, Dr. T. A. Monti

G. B. WILLIAMS, M.E.I.C.
Chairman

LIBRARY AND HOUSE COMMITTEE

Library

The E.I.C. possesses one of the finest private collections of books on engineering matters in Canada. This collection, which had its beginning in 1890, now contains more than 7,000 books on all branches of engineering and allied subjects, many of them being of unique historical interest. The Institute's prestige is such that many publishers send books which are listed in the Engineering Journal and are added to the Institute's collection. In addition, more than 500 technical journals are being received from more than 30 countries.

Since Council approved the Second Report of the previous Library and House Committee, and since the Second Report recommended the discontinuance of the E.I.C. Library services, the former Library is no longer operating as such but as an Information Service.

The present status is:

(a) The staff consists of one Information Officer and one clerk.

(b) The service being supplied to members is limited to answering telephone and written requests for information and lending reference books and periodicals in so far as they are readily available. As the staff does not include a professional librarian, and is restricted to the minimum number necessary to provide staff services, including listings of new books in the Journal, the services rendered to the membership must of necessity be very limited.

(c) The Committee, with Headquarters staff assistance, has carried out a program of tidying up and maintaining the collection, and infrequently used material has been placed in storage.

At the present time the Committee is prepared to assist the officers and Council of the Institute to improve and expand the Information Service to make it more useful to the membership.

House

The Committee's policy has been to carry out only those repairs to the E.I.C. headquarters building which are deemed absolutely essential. This policy is necessary pending solution to the headquarters building replacement problem being investigated by the Committee on Institute Building Program. In addition, the status of the Library has also contributed to a degree of uncertainty to any space planning.

Emergency repairs to the present headquarters building included repairs to the mitoyen wall on the north side of the building, and repair work to an unused chimney.

The Committee is aware of the inadequacy of the present office accommodation, but this problem cannot be solved until the other problems affecting the building occupancy are solved. It is to be noted that the auditorium has been in use as office space during the entire 1962-63 program year, and that the Montreal Branch has been holding its meetings elsewhere.

COMMITTEE MEMBERS:

Chairman: Leo J. Hammerschmid
Members: Orby Brumell, W. C. M. Luscombe, R. E. J. Layton, C. R. Parke, E. Lavigne
Secretary: T. R. Montgomery

LEO J. HAMMERSCHMID, M.E.I.C.
Chairman

COMMITTEE ON MEMBERSHIP

The gradually increased momentum of the Branch membership activity, together with efforts on the university campuses, have resulted in another good year. The total enrolled membership at the close of 1962 stood at 24,131 which is a rise of 6.8% since 1961. The slope of the membership graph has risen over the two previous years. Details are available elsewhere in the Report of Council.

The national Committee on Membership continued its work through 1962, under the same terms of reference, and the largest meeting of the Committee ever held was convened during the 75th Anniversary Annual Meeting in Montreal. Ways and means of promoting interest in membership, and improving its administration, were examined and action recommended to Council.

The principal liaison with the Branches, as an outlet for the Committee's ideas, and for Headquarters' administrative guidance, has been maintained through a series of circular letters on membership topics. These are issued about once a month except during mid-summer. The Branches were again encouraged to form membership committees, or at least to appoint membership representatives.

Two new pieces of promotional literature were produced, published and distributed for Branch use. The important one of these is a completely revised version of the "Reasons for being a member of the Institute". This was attractively printed, and has been well received. The membership application form was thoroughly revised and brought up to date, in accordance with By-law amendments, and to suit the new I.B.M. records. It now is in use, and the French equivalent will be out in the new year.

Membership Statistics

As of December 31, 1962

	1962
Honorary M.E.I.C.	48
Life Members	726
M.E.I.C.	11,913
A.M.E.I.C.	5,291
S.E.I.C.	6,089
Affiliates	64
TOTAL	24,131

J. TAYLOR FISHER, M.E.I.C.
Chairman

PUBLICATIONS COMMITTEE

The Committee devoted most of its effort in 1962 to the development and implementation of a new plan for the publishing of technical papers. Because of the growth of engineering activities in Canada and in the size of the membership a new approach was needed to enable the Institute to continue to fulfill some of its main objectives, which are to facilitate the interchange of professional knowledge among the members and to encourage original research and the study, development and conservation of the resources of Canada.

The specific objectives sought with the new plan were: to stimulate Canadian engineers to prepare more papers; to publish papers more promptly; to publish more technical papers; to divide Transactions into broad, logical technical areas; to help members get more of the specific type of Transactions they want; to achieve the highest respect by authors and readers for Transactions; and to enable Engineering Journal to become even more current, and of the widest possible interest to its readers.

The new plan was announced in the November, 1962, "Journal" and was commenced in January, 1963. The fee bills for 1963 made provision for members to subscribe to one or more "series" of Transactions. Subscriptions received from members in the first two months have encouraged the Committee to believe the plan is in the right directions.

To make this expanded publications service feasible financially it was necessary to utilize lower cost reproduction methods than had been used with Transactions in the past and also to obtain papers from authors in a form that could be reproduced directly. To give authors guidance as to the requirements for this a detailed "Information and Advice to Authors" was prepared. Any members desiring a copy may obtain one on request to the General Secretary.

To assist in more prompt publishing of papers a new procedure for reviewing papers was evolved. This procedure, which is described in the "Information and Advice to Authors" involves a Papers sub-committee and an Editorial Review Board, with a member and several reviewers for each of the technical divisions of the Institute. These groups ar integrated carefully in the reviewing process with the Editor and the Manager, Technical Services.

The Committee has been studying requests for other forms of publications of engineering information, such as, a journal to cover in a vertical sense a wide variety of material of special interest to those concerned with a particular field of engineering. Appropriate methods are being sought to put the Institute in a position to fulfill such requirements as they arise.

"Careers" was not published in 1962 because of difficulties in obtaining advertising and interference with advertising subscriptions of the "Journal". "Careers" is being published on a self-supporting basis in early 1963 to cover requirements until mid-1964.

R. A. PHILLIPS, M.E.I.C.
Chairman

COMMITTEE ON TECHNICAL OPERATIONS

The Committee on Technical Operations for the year 1962-1963 has been constituted as follows: (Division and their Chairmen)

Bridge and Structural, A. M. Bain, Montreal; Chemical Engineering, Dr. G. W. Govier, Edmonton; Civil, Dr. R. M. Hardy, Calgary; Communications, Electronics and Automation, Prof. G. S. Glinski, Ottawa; Electrical, A. J. Girdwood, Guelph, Ont.; Engineering Education, Prof. Arthur Porter, Toronto; Geotechnical, Dr. R. F. Leggett, Ottawa; Hydro-electrical, J. A. Thomas, Montreal; Management Engineering, W. L. Hutchison, Toronto; Mechanical, Prof. A. R. Edis, Montreal; Mining and Metallurgical, Dr. R. P. Charbonnier, Ottawa; Oil and Natural Gas, A. F. D. Short, Calgary; Research, Dean D. M. Myers, Vancouver; Thermal Power, D. L. Harris, Montreal; Welding, R. M. Gooderham, Toronto.

Annual General Meeting

The number of papers and symposia offered for the Annual General Meeting has been gratifying in that we have been able to be selective to some extent in deciding on our final program rather than having to accept every paper offered to make up a program of reasonable scope, as has some times been the case in the past. However, we are faced with a serious problem of hotel accommodation for the number of simultaneous sessions required and it is becoming evident that in future years we will have to reconsider our policy with regard to the A.G.M.

It is apparent that we will have to arrange Annual Divisional Meetings in various parts of the country to provide adequately for presentation of all of the technical papers that become available during the year in different fields of engineering covered by the E.I.C., and that the A.G.M. program will have to be limited to a relatively small number of papers of general interest rather than encompassing all fields of engineering in detail.

We have set an objective of 25% of our papers in French for the A.G.M., but it appears at the time of writing that we may fall short of this objective. This indicates a need for more French-speaking members on our Divisional Committees.

Re-organization of C.T.O.

A plan for the re-organization of C.T.O. was presented and approved by Council and is in the process of being implemented. Briefly this involves the following:

a. The appointment of a C.T.O. representative by each Branch and each Region and a Vice-Chairman of C.T.O. in charge of Regional and Branch Liaison to co-ordinate the activities of these representatives. This change is designed to ensure the closest co-operation between C.T.O. and the Regions and Branches in developing the technical program of the Institute.

b. The appointment of a Vice-Chairman of C.T.O. in charge of Divisional Operations to co-ordinate and assist in the development of the activities of the Divisional Committees, the creation of new Divisions, etc.

New Divisions

The Research and Welding Engineering Divisions under the respective chairmanship of Dean D. M. Myers and R. M. Gooderham, the establishment of which was decided upon by Council during the current year, started operations during the current year and are developing their progams in a gratifying manner.

The formation of the Oil and Natural Gas Division was recommended to and approved by Council during the current year. The Chairman, A. F. D. Short, is in the process of forming his Committee.

Divisional Annual Reviews

Ways and means of implementing that part of the Terms of Reference of C.T.O. requiring the preparation of Divisional Annual Reviews are under investigation and it is hoped that such reviews will be available by the end of the current calendar year.

The co-operation of the members of C.T.O. during the past year has been appreciated greatly and it is felt that considerable progress has been made in developing the technical activities of the Institute, but it is nonetheless recognized that much remains to be done, and that even greater efforts will be required in the future.

F. W. GOOCH, M.E.I.C.
Chairman

SPECIAL COMMITTEES

BOARD OF EXAMINERS

The Board of Examiners held one meeting in 1962, at which 14 candidates were considered. The draft statement of policy, covering the work of the Board, was again discussed, and unanimously supported. The whole question of the examination of candidates for admission, where further examination appears necessary, is still under review by Council. For this reason it has not yet been possible to obtain approval of the Board's statement of policy. It was re-submitted in December, 1962.

Six candidates were referred to Council with recommendation for acceptance as Members. It was also recommended that one candidate be offered Affiliate grade membership. Three candidates were referred to the Provincial Associations for completion of their qualifications. One candidate was referred to the Montreal Branch E.I.C. Admissions Committee and three candidates were still under consideration.

Chairman: R. Boucher
Members: A. Leclerc
V. W. G. Wilson
L. Laflamme
G. R. Garby

RAYMOND BOUCHER, M.E.I.C.
Chairman

THE INTERNATIONAL ASSOCIATION FOR THE EXCHANGE OF STUDENTS FOR TECHNICAL EXPERIENCE

The Canadian IAESTE Committee wishes to report that 1962 was an average year of participation, in the light of present business conditions. Eighty foreign students took jobs in Canada, and 19 Canadian students went abroad, for a total of 99. This is slightly less than the 1961 total.

Economic and business conditions in Canada, being still sub-normal, have an adverse effect on IAESTE, as compared with four or five years ago, and the plan has to compete with a growing demand for summer employment by Canadian students seeking work in this country.

It is not expected that any large growth can be anticipated in Canadian participation in the near future for several reasons: a. business improvement is moving slowly; b. travel distances remain a serious problem; c. the facilities available to the Committee, for which it is grateful nonetheless, do not provide scope for much development work.

To try to counteract these factors the program for 1963 will be an expanded one, involving contact with many new Canadian firms, by individual letters. Interest among Canadian students will also be encouraged as much as possible.

E. A. CLARK, M.E.I.C.
Chairman

BY-LAW COMMITTEE

No meetings of this Committee were held during 1962 as no work was referred to it during the year.

J. W. DOLPHIN, M.E.I.C.
Chairman

COMMITTEE ON PLANNING FOR THE FUTURE

This Committee functioned during the first year of its existence under certain difficulties. Because of our wide geographical coverage it was possible to hold only one meeting. This took place on the Sunday afternoon prior to the Institute's Annual Meeting in Montreal. The question of Confederation has also made the picture somewhat indefinite, hence any long-range plans were difficult to promote to the point where they could be realistic. However, by utilizing the services of the members who attended the meeting on June 10, and by a considerable amount of correspondence, we studied two important projects and handed our recommendations on these to Council.

The first was the matter of regional groupings. This scheme has been adopted by Council and now is in operation on a trial basis. The entire territory has been divided into regions, each under the care of a Vice-President, and assistants. Several regional meetings have been held and others are planned. The main objective in this is to provide more efficient means of communications between individual members and Council, so that better understanding of problems can be achieved and better liaison accomplished. Each Vice-President has had his duties more clearly defined and each is performing his appointed tasks so as to be of greater help to the President.

The Committee has also studied — and this matter is gaining importance — the part taken in our technical set-up by technicians. There is gradually developing a more comprehensive appreciation of the levels of activity in our technical life and an awareness of the need to utilize in the most efficient manner the qualifications of each member of society. Those who have had the opportunity to acquire complete university training should be used on problems requiring and challenging their maximum ability, while other duties and assignments, equally important but nevertheless not so complicated, can more economically be accomplished by those with less training and experience. Hence the gradual use of our technical school system and its technical graduates. Some of our Provincial Associations are already recognizing these technicians by suitable status and regulations. The significance of this movement to the members of the E.I.C. now is under study by your Committee and recommendations will be made to Council soon.

Some other matters of equal significance are also being looked into and the Committee will continue its studies in an effort to assist Council and the Institute in keeping a watch on these important items which have future implications and which can be better considered if studied well in advance.

GEORGE MCK. DICK, M.E.I.C.
Chairman

COMMITTEE ON HEADQUARTERS BUILDING PROGRAM

In September last, at a meeting of Council during the Maritime Professional Engineers meeting at Digby, N.S., a committee composed of the undersigned was appointed to investigate and report upon the feasibility of The Engineering Institute of Canada securing for itself a new Headquarters Building.

Your committee has had several meetings and has given consideration to three approaches to the subject:

1. The purchase of an existing building;
2. The purchase of a property and the construction of a building jointly with another organization, or organizations, by means of a lease-back method, where, after a period of years the Engineering Institute, or its associate, or both, would become the Owner or Owners.

The most suitable location for the Headquarters Building was considered to be within the limits

of Sherbrooke, Guy, Dorchester and University Streets in Montreal and our discussions were confined to this area.

The first alternative mentioned above was rejected on the grounds that it is extremely difficult, if indeed not impossible, to find a building which is suited to the requirements of the Institute.

The second alternative appeared to have dubious value as it is questionable whether resources of the Institute would justify the Institute going it alone on a project of the size required, particularly as the land values in the area mentioned above are such that a multi-storey building would be required to make the project economically sound.

The third alternative appeared to us to have some merit. We believe that certain organizations could be found—organizations of high standing in the community—which would be willing to investigate with us the feasibility of the lease-back arrangement. We are encouraged to believe that the existing property on Mansfield Street could be sold at a reasonable price, thus contributing to a measureable degree to our capital resources available.

We have not yet added to our committee for the purposes of broader discussion because we believe that on account of the forthcoming ballot on Confederation it would be embarrassing to the Institute to get into detailed discussion with anyone concerning properties or possible co-operation with other organizations and then have the whole proposal wrecked by an adverse vote on Confederation.

Should the result of the Confederation vote indicate a continuation of the Institute as we now know it, it is our recommendation that our committee be immediately enlarged and our invesigations proceed with the greatest speed possible in keeping with the drastic urgency of our need for space.

J. B. STIRLING, HON. M.E.I.C.
R. E. HEARTZ, M.E.I.C.
Co-Chairmen

PRIZES AND AWARDS COMMITTEE

The 1961-62 Prizes and Awards Committee proposed a revision in the method of handling the various awards and prizes presently available to Institute members. This proposal is under review by the current Committee, and further recommendations will be submitted to Council. Many of the awards commemorate outstanding engincers of the past, and it is imperative that no change be made which would break faith with the donors.

B. G. BALLARD, HON. M.E.I.C.
Chairman

STUDENT POLICY COMMITTEE

Student interest in the Institute and the participation in the activities has maintained a high level during 1962. This is reflected by another increase in Student Membership to above 6000, despite the transfer of an exceptionally large number of students to Associate Membership (one year instead of two—By-law change). The addition of another Student Section at Sir George Williams University, Montreal, is noted.

Forty delegates and observers representing engineering student leadership from 24 Canadian universities and colleges attended the 1962 Annual Student Conference in Montreal concurrent with the 75th Anniversary Annual Meeting. Besides getting together socially as a result of a fine program arranged by the Montreal Branch Associate Section, these students spent three afternoons discussing their problems, exchanging ideas, and planning the future within the framework of the E.I.C. One of the results of these sessions was a recommendation for a semi-annual conference delegate news letter, which now is being put into effect. Another result was to change the tie clip given to new student members to the E.I.C. bronze lapel buttons.

The E.I.C. continued its policy of providing support and administrative help to the Athlone Fellowships and the International Association for the Exchange of Students for Technical Experience. Through these two plans engineering students and graduates can obtain excellent technical training and job experience in countries other than their own. Many letters of appreciation were received from those who have participated.

Among the many items discussed by our Committee, one of the most important has been the problem of the Branch-Student relationship. Meetings were held with the Membership Committee, the Committee on Branch Operations, the President, and the General Secretary. A write-up on the activities of the Student Guidance Committee of the Montreal Branch Associate Section has been prepared by John Walton of our committee for possible use by other Branches to improve the Branch-Student relationship — one of the major problems facing us during the coming year. We hope we can come up with some good recommendations.

Despite these shortcomings, much has been accomplished and thanks are due to all who take a deep interest in E.I.C. student affairs.

J. HAHN, M.E.I.C.
Chairman

ENGINEERS' CONFEDERATION COMMISSION

For the past year, the Engineers' Confederation Commission has remained in a "stand-by" position, pending instructions yet to be received from the Canadian Council of Professional Engineers and the Engineering Institute of Canada.

Until decisions are taken in regard to the results of a membership referendum yet to be held, it is obvious that there cannot be any activity until further instructions are received from the Executive Committees of the two organizations.

JOHN H. FOX, M.E.I.C.
Chairman

TRUSTEES

HARRY F. BENNETT FUND COMMITTEE

It was reported in 1961 that, owing to the increased availability of funds to assist students in engineering courses, the demand for loans from the Harry F. Bennett Fund had decreased in recent years. This trend continued in 1962 so far as the older schools in Central and Western Canada are concerned, but there was a burgeoning demand from some of the newer schools and from the Maritime Provinces.

New loans in 1962 amounted to $3,450 compared with $4,000 in 1961. Repayments were $3,625 in 1962 compared with $4,339 in 1961. Loans outstanding at December 31, 1962, totalled $17,820 and the amount of cash and investments in the Fund at year end was $19,785.

The cash position of the Fund remains high even though loan repayments fell off during the year. Despite sustained best efforts it is noted that a number of overdue loans dating from 1950 to 1959 are still outstanding as well as a number of more recent date. A serious and continuing effort is being made to secure repayment..

Finally, I would like to record my appreciation of the help of my co-trustees, Professor Wilson and Mr. H. A. Mullins.

HOWARD W. UMPHREY, M.E.I.C.
Chairman

BRACE BEQUEST COMMITTEE

Following the promulgation of "Conditions and Rules of Procedure Covering the Use of Funds Earned by the Brace Bequest" which were drafted in the first instance by the Committee and subsequently approved by Council, copies of these Conditions and Rules of Procedure were distributed to all Branches of the Institute for information and comment.

These Conditions and Rules of Procedure were also intended to have effect and to form the framework within which requests by the Branches could be made to the Committee for the rendering of assistance in such needy cases as might come within the terms of the Conditions and Rules of Procedure.

If and when comments are received which indicate the need for substantive change or revision, the Committee would stand ready to review and consider same.

During the year under review no applications were received such as would have involved the use of earnings from the Brace Bequest.

In conformity with the Conditions and Rules of Procedure Governing the Operation of the Fund the earnings have been accumulated and credited to the account of the Fund as follows:

Balance of Fund on December 31, 1961	$28,560.00
Interest for 1962	857.00
Balance of Fund on December 31, 1962	$29,417.00

D. M. STEPHENS, M.E.I.C.
Chairman

REPORTS OF REPRESENTATIVES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The Council of the American Society of Mechanical Engineers

Unfortunately the Summer Meeting of the Council of the A.S.M.E. in 1962 coincided with the Annual General Meeting of the E.I.C. and therefore the undersigned was unable to attend. He has, however, been kept informed of A.S.M.E. activities through the medium of the Minutes of both Council and Executive Committee Meetings. In addition he was able to attend part of the Council Meeting that took place in New York City on Sunday, November 25, 1962.

It is noteworthy that the A.S.M.E. and the E.I.C. have many problems in common and it appears that there is much to be gained by close liaison between the two societies on such problems. Typical of these are the following:

Finances

The A.S.M.E., as well, is having difficulty in balancing its budget and is faced with the necessity of raising fees from the present level of $25 to $30. It is to be noted that Transactions are extra to the Membership Fee and cost $7.50 per Division or a total of $37.50 for subscriptions to all five Divisions.

The A.S.M.E. has also found it necessary to ask for voluntary contributions and collected slightly less than $1 per Member on this basis during the last fiscal year.

Divisional Annual Meetings

The various Divisions of A.S.M.E. hold annual meetings either singly or in combination in various parts of the country, since they find it impossible to provide sufficient time for an adequate technical program for each Division at the Annual Meeting of the Society in New York in spite of the fact that they have some 25 simultaneous sessions at the latter.

Special Publications

The A.S.M.E. publishes a large number of special publications, i.e. publications other than periodicals, such as manuals, handbooks, codes, etc. These publications are more or less self-sustaining and greatly enhance the stature of the A.S.M.E.

Other matters of common interest that cannot be covered in detail are: the qualification and selection of Fellows, the relationship of the scientist and the engineer in the eyes of the public and the fall-off in engineering registration, the provision of an organization adequate to ensure a sound and satisfactory technical program, the development of research activities and many others.

P. W. GOOCH, M.E.I.C.
Representative

Committee on Air Pollution Control

The heavy fogs that have occurred recently, with attendant loss of life and impairment of health, have occasioned great concern regarding the incident of air pollution. The ever-increasing concentration of population and industry has added complexity to a problem that was sufficiently complex already. These factors have added to the difficulties encountered by the A.S.M.E. Committee but, in June, 1962, that Committee prepared a draft Information Bulletin to assist communities to maintain desirable standards of atmospheric cleanliness.

This publication amounted almost to a skeleton by-law but, it contained recommended limits to which several industries, both in the U.S.A. and Canada, took violent exception. The limits in question have been adopted, tentatively, by the C.S.A. Committee on Air Pollution Controls and had been incorporated in the Fourth Draft of a proposed Canadian Code. Following a discussion in the C.S.A. Commitee on October 24, 1962; a special sub-committee was set up to study the matter further. The C.S.A. Committee also considered the problem of controlling obnoxious emissions from automotive vehicles, but it was advised by a special sub-committee, that the time was not yet ripe for making definite recommendations in this regard.

Five papers on Air Pollution were presented at the Annual Meeting of the A.S.M.E. on November 27 and 30, 1962, and it is interesting to note that one of them was entitled "Air Pollution with Radioactive Materials". With the projected installation of large atomic power plants near to large centres of population, the people in the United States are already experiencing qualms — with some justification.

It is about time that Canada began to treat this potentially lethal hazard more seriously. Recommendations were also made by the A.S.M.E. Committee regarding the disposal of domestic and other wastes, with particular reference to the incinerator problem.

Other useful publications were "Guide to Research on Air Pollution" (U.S. Dept. of Health), and "Ringelman Smoke Chart" and "Heating and Power Plant Specifications" (Air Pollution Control Division of Metropolitan Toronto).

It is hoped that a Fifth Draft of the proposed Code on Air Pollution Control in Canada, will be considered by the C.S.A. Committee in the spring of 1963.

E. A. ALLCUT, M.E.I.C.
Representative

ADVISORY COMMITTEE ON BUILDING RESEARCH

The Committee met once during 1962, on October 17, and reviewed the activities of the Division of Building Research of the National Research Council. These activities are described in detail in the annual publication of the Division called "Building Research".

It was the unanimous opinion of the Committee members that all of the work of the Division was useful, should be actively pursued, and was of vital importance in the attainment of improvements and economies in the construction industry in Canada.

E. R. SMALLHORN, M.E.I.C.
Representative

CANADIAN STANDARDS ASSOCIATION

Committee on Structural Timber

The Committee has been engaged in revising two specifications, namely — CSA 043-1953 on Structural Timber and CSA 0122-1959 on Glued Laminated Softwood Structural Timber. These specifications refer to and are referred to by CSA086, the general specification on Engineered Design in Timber.

During the year, revisions and amendments to CSA 0122 were considered preliminary to the publication of a CSA standard covering all requirements of glulam quality control. The CITC Qualification Code, now being used by industry, was considered for interim use and to form the basis for the standard.

Regarding CSA-043, the advisability was discussed of producing a new specification which would include Douglas fir and Pacific Coast hemlock as well as all other woods with structural possibilities.

C. R. CORNISH, M.E.I.C.
Representative

Technical Council

During the year 1962 we received a total of 103 proposed standards on which we were requested to vote "approval" or "disapproval". These standards involved a total of 1054 pages of reading material which had to be gone over and digested. As a result of this we had 11 proposed standards which we questioned and this involved correspondence.

E. B. JUBIEN, M.E.I.C.
Representative

CANADIAN RADIO TECHNICAL PLANNING BOARD

This self-sustaining Board was set up nearly 20 years ago as a technical advisory body to the Government of Canada (Department of Transport), specifically for conservation and effective use of the radio frequency spectrum. Its membership is drawn from sponsor organizations and includes users of radio communications and allied equipment, manufacturers, and engineering groups.

The Board's 12 active committees have involved a great many people in these investigations during 1962. Furthermore, in the radio work (C.C.I.R.) of the International Telecommunications Union, the D.O.T. study groups include several members of the Board.

Notable progress was reported at the annual meeting, December 6, 1962, in Ottawa, in the following fields:

1. Radio Relay (combining former Microwave and Tropospheric Scatter committees)—study of U.S. Government document, "Preliminary Views of the U.S.A. on Frequency Allocations and Space Radio Communications".
2. Interference—through representation on the International Electro-technical Commission's Canadian committee which was established to promote international agreement on many aspects of radio interference, with the primary objective of fostering satisfactory reception of sound broadcasting and television services and of facilitating international trade.
3. Frequency Tolerance and Stability—completion of a report stemming from extensive use of mobile radio assignments and preparation of mobile equipment specifications.
4. Standards and Allocations—revision of the Board's Canadian Radio Frequency Allocations Chart.

E. H. HAYES, M.E.I.C.
Representative

COLUMN RESEARCH COUNCIL

The Column Research Council of the Engineering Foundation concerns itself with problems relating to the strength, design, and behaviour of columns and other compression elements in metal structures. The Engineering Institute of Canada is one of a number of technical and professional organizations represented on the Council.

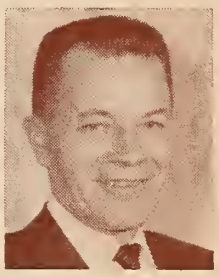
The Council is concerned with co-ordination and review of various researches, carried on through the work of committees and through annual technical meetings. The Council is presently interested in experimental studies on the behaviour of welded built-up columns, columns of heat-treated alloy steel, the post buckling behaviour of stiffened plates, and the stability of plate girders.

The Column Research Council has published a "Guide to Design Criteria for Metal Compression Members" which has evidently been popular as a reference for designers and people concerned with the codification of design procedures. A new edition of the "Guide" is being prepared to include the results of recent studies on high strength steels, the effects of residual stress distributions, and the post buckling behaviour of plate girders.

The Annual General Meeting of the Column Research Council in 1962 was held in New York City, and the 1963 Meeting will be held in the spring at the University of Illinois at Urbana.

D. T. WRIGHT, M.E.I.C.
Representative

CANADIAN SCIENCE FAIRS COUNCIL



The year 1962 was most active and progressive. Twenty regional fairs and 22 science fairs were held throughout Canada. Sixteen hundred and seventy-five projects were displayed and seen by 78,000 visitors. The highlight of the year was the First Canada-Wide Science Fair held at Carleton University, Ottawa, on May 11 and 12, 1962. Forty-five finalists came with their adult sponsors from Toronto, Richelieu Valley, Windsor, Kingston, Sarnia, Belleville, Brockville, Calgary, Winnipeg, Montreal, Ottawa and Hamilton. The winners, Carol Blane of Verdun and Pierre Racette of Joliette, each received an expense-paid trip to the International Youth Science Fortnight, London, England, July 20 to August 3.

Already 16 regional fairs are planned this spring, with all of these scheduled to send finalists to the second Canada-Wide Science Fair at the Casa Loma, Toronto, May 3-4. Much of the success of this new aid to education stems from the endorsement of school boards and from the encouragement of students by parents and individual teachers. Science fairs are a recognized and proven educational aid to motivate and stimulate those who have the ability and interest to become scientists and engineers. The Canadian Science Fairs Council is a non-profit organization composed of the following societies: The Canadian Association of Physicists; The Canadian Conference on Education; The Canadian Education Association; The Canadian Teachers' Federation; The Canadian Universities Foundation; Chemical Institute of Canada; The Engineering Institute of Canada; The Geological Association of Canada; Canadian Federation of Biological Societies; Canadian Dental Association; Canadian Medical Association; and the Royal Astronomical Society of Canada.

The Council endeavours to assist and encourage the Science Fair movement by encouraging the development of Science Fairs in the provinces, concentrating initially in those areas where no local or regional organization is already functioning, and then working towards the establishments of a national competition from all the provinces and territories. More than 50 finalists from across Canada are expected to compete at the Second Canada-Wide Fair at Toronto on May 3-4. Many E.I.C. Branches across Canada are providing valuable assistance and co-sponsorship to local fairs. It is sincerely hoped that additional E.I.C. Banches will assist this most worthwhile movement throughout 1963. Headquarters staff or your local Science Fair representative can provide complete particulars.

H. A. MULLINS, M.E.I.C.
Representative

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

The year 1962 marked the 30th anniversary of the Engineers' Council for Professional Development. The best way to examine the progress made by ECPD is to examine the accomplishments of its committees. For, in fact, ECPD has performed its functions through a group of committees whose memberships consist of individual members representing all the participating bodies. Thus, engineering unity is personified best through the workings of such committees.

While the Committee on Education and Accreditation in the past has placed its major emphasis on the review, study and accreditation of the various undergraduate curricula, the events of the last decade have pointed to the fact that undergraduate engineering education is only one leg of a three-legged stool. If stability is to be maintained in engineering and in the field of engineering education, the other two phases of engineering education must be given equal attention and study by ECPD. The other two legs of the education stool are: a. education beyond the first degree at the graduate level; b. the education of engineering technicians and engineering aides. ECPD has taken the initiative and requested the American Society for Engineering Education to make a three-point study of engineering education at the pre-baccalaureate, or technical institute level, at the baccalaureate level, and at the post-baccalaureate or graduate level.

The major function of the Guidance Committee is to provide information to the prospective young engineer and to his parents and to help the young man to understand what is needed in education in this technologically complex world and to assist him in finding the place where he will contribute best, whether it be as 1. a technician, graduated from a technical institute, 2. as an operating man in industry, a technical salesman or one who wants to advance through the management ladder from the base of a baccalaureate degree in engineering, or 3. whether he wishes to proceed with his education to become a designer of new things, devices and processes or to a career in development, in research or in education. All of these latter usually require education beyond the baccalaureate degree.

The function of the Student Development Committee is to mold the student along the lines that he should follow as an engineer after he has once selected engineering as his curriculum. During the past year, the committee has proceeded on two of its major objectives: development of a brochure for sophomores in engineering colleges designed to promote professionalism, and study of a development of a ritual which will indoctrinate the neophyte engineer into his profession.

Development of Young Engineers Committee has taken as its responsibility the crucial first five years after the receipt of the baccalaureate degree. Thse five years are the critical ones and determine the young man's direction and ultimate contribution to the profession of engineering. During the past year, the committee has re-written its Selected Bibliography of Engineering Subjects.

The Recognition Committee has produced a definition of engineering as follows:

"Engineering is the Profession in which a knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgement to develop ways to utilize, economically, the materials and forces of nature."

During the past year, the Ethics Committee has been concerned with the development of a statement of the canon of ethics to which all engineers can subscribe. It is a belief of this committee that general canons for all engineers can then be supplemented by specific guiding principles of ethical practice in each of the branches of the profession. The Canons of Ethics for Engineers is proposed to read:

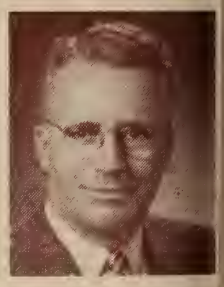
"The Engineer, in keeping with appropriate standards of ethical conduct and to uphold and advance the honor and dignity of the engineering profession in its endeavor best to serve mankind,

1. will be honest, just and courteous,
2. will use his knowledge and skill for the advancement of human welfare,
3. will strive to increase the competence and prestige of the profession."

Although the proposed merger of E.I.C. and E.J.C. has not materialized, substantial progress has been made by E.C.P.D. in promoting unity in the engineering profession. Thus, while unity in fact, as typified by a unity organization, does not seem any closer in 1962 than it did in 1932, co-operation by men of good will acting for the profession as a whole has, in fact, brought about better co-operation than has existed heretofore."

W. A. CAPELLE, M.E.I.C.
Representative

Recognition Committee



Definition of Engineering—In 1961, the Recognition Committee produced a definition of engineering which resulted in great many comments. The one major criticism of that definition was that it did not include the phrase "for the benefit of mankind". As a result, the committee recommended in 1962, that the following definition be adopted by the E.C.P.D.:

"Engineering is the profession in which knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind."

Professional Title for Engineer—Subject to ratification by the constituent societies, the Council accepted the 1961 committee's recommendation that the abbreviated title "Ing." be adopted, as a symbol of recognition for members of the engineering profession. To date, no society has adopted this recommendation and there seems little likelihood that it will be accepted. The committee has, therefore, recommended that this subject be dropped.

Membership Grades—Work toward uniformity in membership grades is continuing.

Program for 1962-1963—The committee plans to examine specific ways by which the engineers may secure greater recognition in two principal fields:

1. To investigate the various types of propaganda which would present to the public a clearer image of what the engineer is and what he does.
2. To examine how the individual engineer can secure further recognition of his profession through participation in the various levels of government and community life.

JEAN DESSAULLES, M.E.I.C.
Representative

EMERGENCY MEASURES ORGANIZATION

Technical Advisory Committee

This Committee took over the duties of the Engineering Advisory Committee of the Civil Defence Organization which was disbanded when its duties were taken over by the Emergency Measures Organization, which now operates under the Privy Council.

An organization meeting was held in March, 1962, at the Civil Defence College at Arnprior, Ont. This meeting established basic terms of reference and expanded its membership to include other organizations which could contribute their special knowledge to assist the Emergency Measures Organization in its work.

The group now consists of representatives from the following bodies: The Engineering Institute of Canada; Canadian Council of Professional Engineers; Royal Architectural Institute of Canada; The Chemical Institute of Canada; Canadian Society of Mining and Metallurgy; Canadian Construction Association.

This Committee has been asked to fulfil the following functions: a. consider problems referred to

it by E.M.O. and to recommend the best approach to the solution; b. bring new ideas from the professional bodies to E.M.O.; c. disseminate information provided by E.M.O. to all participating professional bodies.

A second meeting was held on November 8, 1962, at which time various problems were discussed in a general way and the published literature of E.M.O. reviewed.

A further meeting was scheduled for February 8, 1963, at which time further discussion was to have been held to determine ways and means that assistance can be given E.M.O. by the participating bodies.

A list of technically qualified people who would be available to speak at Branch meetings, on E.M.O. now is available from headquarters.

Literature on many aspects of the studies carried out by E.M.O. is also available from Emergency Measures Organization, Privy Council Office, Ottawa. It is anticipated that specific problems will be referred to the Technical Advisory Committee for study by their societies and special committees made up of members particularly knowledgeable in the specific problems.

It is also anticipated that E.M.O. would be prepared to subsidize such studies. Your liaison officer is also pleased to report that the special emergency hospital power plant mentioned in last year's report now is undergoing qualification tests at the National Research Council.

R. E. HAYES, M.E.I.C.
Representative

NATIONAL JOINT COMMITTEE ON STANDARD DOCUMENTS, RAIC-ACEC-CCA & EIC

This committe now has been constituted on a continuing basis bringing together representatives of the Royal Architectural Institute of Canada, the Association of Consulting Engineers of Canada, the Canadian Construction Association and the Engineering Institute of Canada. Its purpose is to review and to bring up to date and to a uniform standard for use by the construction industry generally, standard forms of construction contract and general conditions, standard forms of tender and related documents, for the mutual convenience and protection of the public and the industry.

The committee is an advisory one, recommending to its constituent bodies the scope, form and details of the documents considered suitable for approval and use as national standards. Its most important accomplishment during the current program has been to provide the basis for a new approach whereby unnecessary differences and divergences between forms used by architects, engineers and other bodies can be eliminated in favor of uniform standards acceptable to all parties. During 1962, two full meetings were held, resulting in a new draft for the "A Standard Lump Sum Contract Form and General Conditions," which is expected to be made final and recommended for approval early this year.

This document will form the basis for appropriate revisions to the "Standard Forms for Cost Plus Work and Unit Price Work," to be undertaken during 1963. It is intended that these and other documents to be considered for adoption as national standards will be the subject of periodic review by the continuing committee. Comments and suggestions are invited, and should be addressed to the National Joint Committee, c.o. EIC or CCA.

The EIC has been represented on this Committee by me, with Edgar Cross, M.E.I.C., available as an alternate member.

E. R. DAVIS, M.E.I.C.
Representative

UNION PANAMERICANA DE ASOCIACIONES DE INGENIEROS

The year 1962 was an active one for UPADI affairs. In addition to the meetings of the Board of Directors and the regular administration carried out at Montevideo Headquarters, the VII UPADI Congress was held at San Juan, Puerto Rico, August 26 to September 1.

The Colegio De Ingenieros, Arquitectos Y Agrimensores De Puerto Rico proved to be excellent hosts. They organized and directed the program ta the Congress. It was one of the best meetings held since UPADI was organized at Havana, Cuba, in 1951.

Canada was represented by F. L. Lawton, president of the E.I.C. who headed the Canadian delegation; C. R. Vegh-Garzon of Montevideo, Uruguay, Canada's alternate representative; Dean H. G. Conn; W. H. Beaton; Garnet T. Page, General Secretary; and Dr. James A. Vance, member UPADI Board of Directors.

Members of the Canadian Delegation attended committee meetings and round-table conferences. Such subjects as Administration, Relations, Budget, Legislation, Technical Programs, Engineering Education and Standards were dealt with.

Many personal contacts were made. Much has been learned about the role of the engineer in South America and how he functions. Each time we meet, more is learned about the problems of development and the opportunity for Canadian engineers in South America.

The round-table discussions concerning Standards indicated a need to establish good uniform standards in South America. The Canadian Standards Association could play an important part in this field. It would help develop greater trade opportunities for Canadians in these countries.

We are represented at Headquarters in Montevideo by a very distinguished engineer and citizen of Uruguay in the person of Carlos B. Vegh-Garzon. He has been our representative since the inception of UPADI and I would like to express appreciation for the dedicated service he has given to Canada.

May I express the hope that Canada will continue to support and play an increasingly active role in UPADI affairs. There is a great potential in this organization for Canadian engineers. It can provide opportunity for Canadians to take part in the development that is needed in these countries.

They should become better acquainted with the two hundred million Latin Americans who live south of the United States. It might be suggested that a group of Canadian engineers tour South America.

In conclusion, may I suggest that a committee of E.I.C. members be formed to study the South American countries and the activities of UPADI.

JAMES A. VANCE, HON. M.E.I.C.
Representative

TABULATION OF BRANCH ACTIVITY ANNUAL REPORTS

Branch	No. of Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
Amherst	10			Functions of the EIC (1) Functions of the APE (1) Confederation (1) Resolutions on Confederation (1) Economic Growth in Atlantic Provinces (1) Town Planning (1) Annual Meeting (1) Students Night (1) Ladies Night (1) President's Visit (1)	25 25 25 25 25 30 20 60 100 60			Students of Mount Allison University were guests of the Branch with Hon. Henry Hilks, Vice-President, Dalhousie University as guest speaker.
Baie Comeau	7	Education (1) Civil (3) Paper Making (1) Hydro-Electric (1) Regional Technical Conference (1)	22 31 28 29	President's Visit Annual Dance	100 100		5	High School Student Counselling provided on request.
Belleville	7	Electrical (1) Mechanical (1) Civil-Mechanical (1)	20 15	President's Visit (1) Annual Meeting (1) Outline of Operation of Air Transport Command by RCAF (1)	30 14 18	APEO-EIC (1)	6	$75 prize presented to high school student for obtaining highest average in specified subject in Grade XIII, and enrolling in an engineering course at a recognized university.
Border Cities	11	General (5) 4th Southern Ontario Regional Conference Students' Paper Night (1)	35	Dance (2) Tour (1) Picnic (1)	97 93 80	Joint APEO-EIC (1)	11	Ladies Auxiliary
Brampton	6	Mechanical (1) Structural (1) Aeronautical (1) Civil (1)	45 25 38 19	President's Visit (1) Inauguration (1)	14 72		12	
Brandon								
Brockville	9	General Industrial (6)	30	Dinner Dance (1) Annual Meeting (1)	50 30	CIC-EIC (1)	8	1962 Science Fair was organized by EIC and CIC. It was successful and is being continued in 1963/64.

Branch	No. of Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
Calgary	59	Petroleum (15) Mining (5) Civil (4) Electrical (6) Mechanical (5) University of Alberta, Conference on Education (1)	43 30 28 32 32 7	Annual Slide Rule Soiree (1) Annual Cocktail Party (1)	370 250	EIC-CIMM Coal vs. Gas in Generating Stations (1) EIC-Canadian Army (1) Survival	9	The 1962 PD program was held throughout the winter in co-operation with the Alberta Society of Petroleum Geologists, Canadian Institute of Mining and Metallurgy. The students of the University of Alberta have been assisted in organizing a Student Engineering Society. Counselling at Careers Night at high schools. The Branch also sponsored a successful Science Fair. The Branch members voluntarily sponsored two East African students at the University of Alberta. Wives Club was active. They assisted with the Soiree and Cocktail Party. An annual golf tournament was held.
Cape Breton	7	Mechanical (1) Steam Power Plant Mechanical and Civil (1) Water System	40 35	Talk on Ice Breaking Operations (1) Social Evening (1) Annual Lobster Party (1) Past Chairmen's Night (1) President's Visit (1)	45 80 85 50 12	APENS-EIC	8	A committee in co-operation with the local Rotary Club, sponsors an Annual student counselling program. Branch is building a scholarship fund.
Central B.C. Branch	6			Annual Meeting Films Shown General Secretary's Visit Talk on Dam Construction around the World President's Visit Tour of Rogers Pass President of APE and Secretary Talk on Confederation	27 25 31 56 55 27	6		
Chalk River	7	Municipal Projects (2) Aerodynamics (1) Automotive (1)	15 35 25	President's Visit (2) Talk on Population and Genetics as Affected by Radiation Field Trip to TV Station	25 50 25	EIC-CIC Reactor Fuel EIC-Deep River Science Association	12	
Corner Brook	5	Municipal (1) Maintenance (1) Budgeting (1) Non-destructive Testing (1)		Annual Meeting (1) Dinner Dance Election of Officers				

Branch	No. of Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
Cornwall	9	Education (1) Costs, Municipal Engineering Confederation (1) Engineers and Management(1) Municipal Engineering (1) Physics (1) Rockets and Missiles (1)	33 27 25 65 30 25	Engineering History, Education, EIC Activities (1) Dance (1) Plant Tour (1)	32 70 14		11	Branch arranged for speakers on Engineering for Career Day at two local high schools. Magwood Bursary of $1200 awarded to two engineering students. Preparation of history of engineering in Cornwall area by EIC 75th Anniversary Committee.
Eastern Townships	8	Water Conservation (1) Underwater Construction (1) Atomic Fallout (1)	60 45 30	CPEQ Presidential Visit (1) General Meeting (1) Golf Tournment (1) EIC President's Visit (1)	25 40 40 90 40	EIC-Illuminating Engineering Society (1) EIC-CIMM	8	PD program first formative meeting. A University of Sherbrooke professor is Branch representative to the student body. "Science Week" was held in cooperation with the Faculty of Science, University of Sherbrooke. Eastern Townships Branch Bursary, and EIC prize awarded to two students in the Engineering Faculty at the University of Sherbrooke.
Edmonton	14	Civil (1) Structural (2) Electrical (2) General (6) Zone "A" Regional Technical Conference (1)	60 60 40 100	Picnic (1) Supper Dance (1)	300 200	EIC-NRC	9	Engineers' Wives Club was active during the year.
Estevan	9	Mining (2) Potash Drilling Power: Dams (1) Engineering Technicians (1) Corrosion (1) Investments (1) SAGE Air Defence (1) Communications (1) Ceramic Engineering (1)	39 15 20 22 29 22 35 12 18	Barbecue (1) Social (1)	40 50		10	Group from Branch talked to the Graduating class from Estevan Collegiate Institute, and arranged to have a speaker from the Moose Jaw Technical School talk to students on careers as engineering technicians. A $100 scholarship was awarded to a student from Estevan Collegiate Institute at entering Engineering at the University of Saskatchewan. Engineers' Wives contributed $25 towards this scholarship.
Fredericton	11	Civil (2) Electrical (2) Mechanical (2) Professional Technical Conference (1)	60 60 60 40	World Affairs Conference (1) Social (3) Business (2) Student Smoker (1)	60 150 50 100		8	Student Technical Competition. $100 Prize for student Technical paper competition.

Branch	No. of Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
Halifax	6	Hydro-Electric (1) Aeronautics (1)	 50 35	President's Visit (1) Panel Discussion (1) Productivity (1) Lobster Party (1)	 150 130 71 170	EIC-Canadian Aeronautics and Space Institute	2	President Lawton spoke to students during his visit, and presented prizes. A Branch meeting was held for graduating NSTC students. $100 expenses was contributed for two student delegates to the Annual General Meeting in Montreal. The Branch presented an award for the best exhibit prepared for the "Tech Ball." Engineers' Wives organization was very active during the year.
Hamilton	9	Management (1) Mathematics for Engineers (1) Mechanical (1) Electrical (1) Steel (1) Research (1) Civil (1) Civil Section Technical Conference (4)	55 60 60 55 65 70 40 20	Stag (1) Annual Ball (1) Ladies Night (1)	35 264 140	EIC-ASQC EIC-AIEE	10	PD program active since 1951 with 105 registered. An engineering student loan fund of $1000 was established for McMaster University Student counselling at the University as well as local high school. An Engineering Week was held Nov. 4-10 honoring EIC's 75th Anniversary. A luncheon for chief engineers of local industry, tours of educational, commercial, industrial highlights in Hamilton, plaque of the first EIC President, T. C. Keefer unveiled. Full page ad in Hamilton Spectator on engineers' role, science teachers dinner.
Huronia	1			Dinner Dance for President's Visit (1)	43		3	
Kingston	9	Student Papers (1) Chemical (1) Management (1)	33 34 28	Annual Meeting (1) President's Visit (1) Canadian Peace Research Institute (1)	102 63 120		7	Part of the PD program included a panel discussion. Participants were top management representatives from local industry (DuPont, C-I-L, Alcan). Student open house, Jan., Oct. Three awards given for papers submitted by engineering undergraduates.
Kitchener								
Kootenay	7	Civil (1)	24	Confederation (1) Talk on Duke of Edinburgh's Conference (1) Plant Tour (2) Annual Meeting (1)	34 31 22 36		8	

Branch	No. of Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
Lakehead	8	General (4) General (1)	28 30	Annual Dance (1) Annual Meeting (1) President's Visit Dinner (1)	120 45 40	All Meetings organized with APEO	9	
Lethbridge	8	Civil (3) Mechanical (1) Agricultural Research (1)	34 24 21	Legal History (1) Social Stag (1) Engineers' Ball (1)	35 30 50		10	A field trip to Great Falls, (Anaconda Copper Plant and USAF Missile Base). Ladies Auxiliary was active.
London	10	Traffic (1) Electrical (1) Space Travel (1) Civil (1) General Tour—Civil (1) General Tour—Mechanical (1) Regional Technical Conference (1)	40 60 35 30 55 50 150	Dance (1) Golf President's Visit (1) Feather Party (1)	200 25 25 30	EIC-AIEE EIC-AIEE-MEAC-APEO	8	PD program includes course in Political Science at University of Western Ontario. Students Night, Panel Discussion.
Lower St. Lawrence	5	Water Purification (1) Electrical (1)	20 8	Annual Party (1)	62	All meetings organized with the APEQ.	3	
Moncton	8	Civil (1) Education (1) Municipal (1)	35 36 46	Dinner Dance (1) Annual Meeting (1) Cruise (1) President's Visit Luncheon (1)	133 24 35 20	Meeting with Amherst Branch EIC-President's Visit	7	Relations between students at St. Joseph's University co-ordinated by Branch member. Branch executive sponsored conference with senior grades of Moncton high school.
Montreal	37	Management (5) Chemical (5) Civil (9) Electrical (8) Mechanical (10) Conference on Urban Transportation	38 44 72 71 32	Annual Dance February (1) Dance October (1) Oyster Party (1) Golf Day (1)	332 282 81 102	EIC-CIC (6)	10	
Moose Jaw	6	Civil (1) Mechanical (1)	23 10	Annual Banquet (1) President's Visit (1) Curling Night (1) Stock Exchange Visit (1)	48 23 9 15		3	
Newfoundland	6	Student Public Speaking Contest (1) Dinner Meeting (1) Business Meetings	26 36 28		6			$50 prize awarded for engineering students public speaking contest. Engineers' Wives Club presented $100 scholarship to second year student at Memorial University, and contributed technical books to University library.
Niagara Peninsula	9	General (8)	30	Ladies Night (1)	60		10	
Nipissing and Upper Ottawa	9	Electrical (1) Communications (1) Civil (1) General (1) Chemical (1)	22 35 20 43 29	Students Night (1) Annual Meeting (1) President's Visit (2)	45 25 60		5	Each member brought a student from the final year at the local high schools. The speaker was selected to be of particular interest to those contemplating engineering as a career.

Branch	No. of Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
North Eastern Ontario								
Northern Nova Scotia	3			President's Visit (1) Tour of Trenton Works— Lobster Party (1)	22	EIC-APENS		Tour and Lobster Party was organized for the students of St. Francis Xavier University. $100 gift to the University.
North Shore Lower St. Lawrence	10	Steelmaking (1) Bridge Construction (1) Plywood Applications (1) Iron Ore to Steel Mill (1) Rail Wear (1)	25 15 29 39				5	
Northern New Brunswick								
Oakville								
Ontario	1						1	
Ottawa	13	Field Trips (1) General (4)	56 50	Annual Meeting (1) Golf Tournament (1) Dance (1) President's Visit (1) Dinner	50 100	EIC-MEA-APEO EIC-APEO EIC-ITE	11	PD program active participation, runs from September to April, attendance 35-40. Students open house was held. $50 to Carleton University and University of Ottawa.
Peterborough	7	Cybernatic Machines (1) Project Planning (1) NRC and Space (1) Atomic Exhibition (1) Public	36 32 29 115	Engineers Ball (1) President's Visit (1) Political Meeting (1)	55 39 130		14	Four awards of $15 to local high school students.
Port Credit								
Port Hope	4	Economics (1) Space Travel (1) Education (1)	14 16 50	Dance (1)	80	EIC-APEO	2	Counselling to local high schools.
Prince Albert	28	General Dinner Meetings		Social (3)		EIC-APE		
Prince Edward Island	3			Social (3)	25		6	

Branch	No. of Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
Quebec, Que.	10	Conference sur aciere structuraux (1) Conference sur la force de cisoillement du argeles compactes (1) Methods of Ground Water Development (1) Rapport sur conference internationale tenue a San Francisco sur les coques minces (1)	23 31 26	Assemble Annualle (1) Tournoi de Golf (1) Buffet-Visite du President (1) Buffet-Visite d'un delegation d'ingenieurs de l'Empir bretannique (1) Danse du Carnaval (1)	18 31 34 18	EIC-Corporation des Ingenieurs Professionals EIC-Association des Constructeurs de Quebec		
Regina	12	General (10)	40	Annual Meeting (1) President's Visit (2)		Social (5)	3	PD program divided into two groups concerned with Humanities and Current Events. Engineers' Wives were active.
Richmond Hill	3	Highways (1)	10	Plant Tour—Printing & Publishing (1)	8	EIC-APEO	4	
Saguenay	8	Metallurgy (2) Hydro-electric (1) Industrial Development (1)	31 28 12	Political (1) Confederation (1) Annual Dance (1) President's Visit (1) Annual Meeting (1)	32 42 182 50 15	EIC-CPEQ	8	In co-operation with the local chapters of the CPEQ and CIC, the Branch conducted a student guidance program. Films on careers in engineering were shown. A total of 505 students attended.
Saint John	4	Plant Tour (1)	30	Mixed Dinner (1) Tour (1)	40 40	EIC-APENB	11	Three meetings were held in the PD program. These included talks on public speaking, engineering law and labor relations.
Saint Maurice Valley	10	General (5)	17	Annual Dance (1) Annual Dinner (1) President's Visit (1)	34 52		5	
Sarnia	11	Communications (1) Engineering Profession (3) General (1) Southern Ontario Regional Conference (1)	71 125 67	President's Visit (1) Business (3) Stag (1) Ladies Night (1)	110 52 42 155	All meetings held with the Sarnia APEO	15	PD program included public speaking and lab relations. Addresses given to local high schools on engineering as a career. Prize of $50 or equivalent in books to student with highest standing entering engineering. Wives group was active.
Saskatchewan		see reports for Prince Albert Saskatoon Yorkton Regina Estevan						
Saskatoon Section	6	Technicians in Engineering (1) Pipeline-Film (1) Zone "A" Technical Meeting (1)	36 24	Annual Meeting (1) Presidents' Visit (1) Supper Meeting (1)	25 25		5	

Branch	No. Meetings	Technical Meetings		Social and Other Activities		Joint Meetings	No. of Executive Meetings	Other Activities
		Field	Attendance	Nature	Attendance			
Sault Ste. Marie	9	Water Resources (1) Vocational Guidance (1)	26 18	Annual Meeting (1) President's Visit (2)	16 48	EIC-APEO	7	Engineers' Wives held three meetings during the year.
Sudbury	9	Civil (1) Mechanical (1) Electrical (1) Mining (1) Field Trip—Chalk River (1) Chemical (1) General—Telstar (1)	27 37 43 48 55 37 61	Ladies Night(1) President's Visit (1)	97 61		8	Plans being made for establishing a PD program in co-operation with Laurentian University. Students from the University are invited to attend the technical meetings at the Branch. Careers Night attended by Grade 12 and 13 students. Major fields of engineering discussed by members in each field. Other activities included curling and golf.
Swift Current	7	Luncheon Meetings (7)	30					
Toronto	26	Management (3) Electrical (6) Power (5) Civil (6) Plant Visit (1) General (1)	54 40 49 100	Annual Meeting (1) President's Visit (1) Ladies Night(1) 75th Anniversary Meeting (1)	168 70 240 35	EIC-ASME IEC-Canadian Aeronautical Institute	9	PD program is divided into three groups with a total attendance of 118. One student counselling session by PDP members was very successful. The Wives Auxiliary held four general meetings, three receptions for local students, foreign students, and engineers.
Vancouver	22	Civil—Structural (6) Management (1) Natural Resources (3) Mechanical (1) General (2) Field Trip (1) Seminar: Concrete Technology (1)	30 26 65 27 20 50 175	Annual Meeting (1) Ladies Night(1)	60 40	EIC-APEBC	10	Lectures on modern architecture were given by members of the Architectural Institute of B.C. A students night dinner was held. Six papers were presented by students. EIC prizes of $100 and $50 were awarded.
Vancouver Island	28	Civil (4) Public Health (1) Forest (1)	40 17 21	President's Visit (1) Secretary's Visit (1) Ladies Night(2) Informal Lunches (8)	52 66 46 20	Monthly meeting held jointly with local APEBC	10	Talks by prominent members to local Rotary Club, Kiwanis $100 scholarship to Victoria University. Engineers' Wives active.
Whitby								
Winnipeg	23	Civil (7) Electrical (8) Civil—Soils (2) General (6)	31 39 50 60	Spring Smorgasbord (1) Fall Dinner—Dance (1)	264	EIC-APEM	24	Donation to University of Manitoba for library. Regular meetings of the student section were held. Student representative to AGM. Three summer thesis prizes and three papers awards.
Yorkton Section								
Yukon	7	Civil (3) Mining (1)	21 15	Banquet—Secretary's Visit (1) Banquet—Confederation (1) Annual Meeting (1)	15 10 10		7	

MEMBERSHIP AND FINANCIAL STATEMENTS OF THE BRANCHES AT DECEMBER 31, 1962

BRANCHES	Amherst	Baie Comeau	Belleville	Border Cities	Brampton	Brockville	Calgary	Cape Breton	Central British Columbia	Chalk River	Corner Brook	Cornwal	Eastern Townships	
MEMBERSHIP														
Hon. Members	..	..	..	..	..	..	1	..	..	1	..	..	..	
Life Members	4	..	5	8	..	2	12	7	8	..	..	3	7	
Members	25	33	49	128	39	51	575	66	38	36	29	44	96	
Associate Members	10	16	24	47	7	17	119	14	13	29	16	18	79	
Students	19	6	9	64	11	9	113	9	24	8	17	8	188	
Affiliates	..	5	1	..	..	..	2	2	1	..	..	..	..	
Total	58	60	88	247	57	79	822	98	84	74	62	73	370	
FINANCIAL STATEMENT														
Revenue														
Rebates from E.I.C. Hq. (1)	67.70	..	277.18	601.20	50.00	124.00	128.00	69.55	251.22	207.47	62.00	265.06	210.00	
Remittances from Prof. Assns.	76.35	..	..	..	..	..	1,789.63	209.10	..	..	..	..	..	2,
Branch Affiliate Dues	43.00	..	4.00	20.00	..	45.00	396.00	372.00	111.10	..	..	20.00	256.00	
Interest	..	..	..	..	..	..	79.00	22.76	..	..	..	..	.63	
Miscellaneous	659.50	..	213.75	939.85	152.75	219.50	3,173.02	1,123.92	4.64	6.95	142.25	613.75	885.50	
Total Revenue	846.55	..	494.93	1,561.05	202.75	388.50	5,565.65	1,797.33	366.96	214.42	204.25	898.81	1,352.13	2,
Expenditure														
Printing and Communications (2)	38.98	..	68.92	206.90	66.43	64.28	924.60	36.73	76.54	22.61	13.00	63.19	127.12	1,
Meeting Expenses (3)	691.08	..	384.95	1,285.01	128.44	406.75	3,442.19	1,323.25	..	73.74	286.20	786.27	1,237.10	
Honoraria and Steno Services	..	..	..	21.76	..	5.92	699.59	..	..	..	..	13.37	..	
Travelling Expenses (4)	..	..	..	13.49	..	..	23.70	..	..	26.47	..	..	..	
Subscriptions (5)	..	..	..	..	..	32.00	..	..	..	..	..	..	52.00	
Special Expenses	..	..	79.00	50.69	..	8.00	294.70	..	104.95	20.11	..	..	77.77	1,
Total Expenditure	730.06	..	532.87	1,577.85	194.87	516.95	5,384.78	1,359.98	181.49	142.93	299.20	862.83	1,493.99	3,
Surplus for 1962	116.49	..	..	..	7.88	..	180.87	437.35	185.47	71.49	..	35.98	..	
Deficit for 1962	..	..	37.94	16.80	..	128.45	..	..	..	..	94.95	..	141.86	1,
Balance at Dec. 31, 1961	205.34	..	140.02	1,223.28	100.00	380.42	1,535.06	937.66	313.65	118.52	150.82	312.86	260.73	3,
Balance at Dec. 31, 1962	321.83	..	102.08	1,174.98	107.88	251.97	1,715.93	1,375.01	499.12	190.01	55.87	348.84	118.87	1,

(1) Includes all rebates, whether for E.I.C. or Commonwealth fees.
(2) Includes general printing, meeting notices, stationery, postage, telephone and telegrams.
(3) Includes rental of rooms, projectors, operators, slides, dinners, entertainment, social functions, etc. for both general and special.
(4) Includes speakers, councillors, or branch officers.
(5) Includes all publications.

Membership Totals

	Total	Hon. Members	Life Members	Members	Associate Members	Students	Affili
Total Branch Members	22,207	41	662	11,464	4,423	5,565	52
Address Unknown	354	..	..	41	97	216	..
Non-Branch Members	1,173	10	59	752	261	86	5
Grand Total	23,734	51	721	12,257	4,781	5,867	57

BRANCHES	Fredericton	Halifax	Hamilton	Huronia	Kingston	Kitchener	Kootenay	Lakehead	Lethbridge	London	Lower St. Lawrence	Moncton	Montreal	Newfoundland
MEMBERSHIP														
lembers	1	1	2	..	1	..	..	..	1	1	..	..	9	..
embers	7	20	23	1	11	7	1	4	6	12	..	5	167	2
rs	113	407	302	29	119	104	59	76	48	188	23	76	2,662	90
te Members	110	121	103	9	102	37	18	40	17	92	19	44	1,050	52
ts	193	244	62	16	145	77	19	13	11	188	15	57	1,452	171
es	..	1	..	1	..	..	..	2	..	..	..	..	13	..
l	424	794	492	56	378	225	97	135	83	481	57	182	5,353	315
ANCIAL STATEMENT														
s from E.I.C. Hq. (1)	436.42	306.18	592.00	90.00	641.75	530.19	253.97	368.54	20.00	280.00	111.95	275.48	10,942.00	468.68
ances from Prof. Assns.	164.00	1,227.40	..	..	..	..	..	..	193.50	..	..	102.00	..	..
Affiliate Dues	..	..	117.80	..	60.00	38.15	72.00	..	60.00	..	..	50.00	..	20.00
t	12.21	32.00	69.10	..	..	..	..	..	..	..	..	40.73	290.00	..
aneous	2,621.98	221.47	2,594.55	..	445.00	..	331.00	290.50	9.25	1,786.31	264.48	1,028.94	2,909.51	773.19
l Revenue	3,234.61	1,787.05	3,373.45	90.00	1,146.75	568.34	656.97	659.04	282.75	2,066.31	376.43	1,497.15	14,141.51	1,261.87
ture														
g and Communications (2)	60.14	571.10	496.70	26.62	134.21	80.04	49.22	100.51	85.01	362.67	43.55	42.89	4,452.43	39.57
g Expenses (3)	2,457.08	890.07	2,746.41	45.59	828.50	517.64	634.51	331.04	148.12	657.83	..	1,242.41	6,911.19	818.14
ria and Steno Services	75.00	331.92	75.00	..	..	..	..	..	40.00	..	..	50.00	900.00	..
ing Expenses (4)	50.00	..	..	..	..	..	..	..	29.75	..	..	..	..	..
ptions (5)	..	..	..	..	24.15	..	..	..	..	..	..	20.15	948.61	8.00
Expenses	45.00	285.41	105.65	..	423.00	60.45	..	7.16	19.60	985.55	386.34	88.55	923.93	93.88
l Expenditure	2,687.22	2,078.50	3,423.76	72.21	1,409.86	658.13	683.73	438.71	322.48	2,006.05	429.89	1,444.00	14,136.16	959.59
lus for 1962	547.39	..	..	17.79	..	..	..	220.33	..	60.26	..	53.15	5.35	302.28
it for 1962	..	291.45	50.31	..	263.11	89.79	26.76	..	39.73	..	53.46	..	..	.
nce at Dec. 31, 1961	367.38	1,087.85	538.95	491.50	1,062.21	719.72	455.63	120.58	342.21	509.18	126.57	1,066.30	4,344.08	599.06
nce at Dec. 31, 1962	914.77	796.40	488.64	509.29	799.10	629.93	428.87	340.91	302.48	569.44	73.11	1,119.45	4,570.66	901.34

ludes all rebates, whether for E.I.C. or Commonwealth fees.
ludes general printing, meeting notices, stationery, postage, telephone and telegrams.
ludes rental of rooms, projectors, operators, slides, dinners, entertainment, social functions, etc. for both general and special.
ludes speakers, councillors, or branch officers.
ludes all publications.

BRANCHES	Niagara Peninsula	Nipissing and Upper Ottawa	North Eastern Ontario	Northern New Brunswick	Northern Nova Scotia	North Shore Lower St. Lawrence	Oakville	Ottawa	Peterborough	Port Credit	Port Hope	Prince Edward Island	Quebec
MEMBERSHIP													
Hon. Members	1	..	..	..	1	..	..	3	1	..	..	..	2
Life Members	21	1	..	..	1	..	2	70	10	..	1	2	19
Members	158	51	23	29	27	54	66	657	120	73	24	24	227
Associate Members	57	22	9	24	15	29	10	231	16	14	4	18	128
Students	39	9	8	18	18	5	5	234	16	6	4	35	256
Affiliates	2	1	..	..	..	1	.	2	..	..	..	..	..
Total	278	84	40	71	62	89	83	1,197	163	93	33	79	632
FINANCIAL STATEMENT													
Revenue													
Rebates from E.I.C. Hq. (1)	260.00	264.99	126.19	..	43.86	357.70	..	2,360.81	441.13	..	137.64	50.77	802.96
Remittances from Prof. Assns.	..	..	..	..	76.50	..	..	..	..	..	..	..	..
Branch Affiliate Dues	..	10.00	..	..	..	..	..	10.00	..	..	..	..	..
Interest	7.50	..	..	..	..	..	..	16.24	..	..	..	..	..
Miscellaneous	396.02	987.40	..	..	27.40	86.00	..	1,985.72	..	..	..	..	..
Total Revenue	663.52	1,262.39	126.19	..	147.76	443.70	..	4,372.77	441.13	..	137.64	50.77	802.96
Expenditure													
Printing and Communications (2)	97.49	66.02	..	..	25.13	15.68	..	1,047.69	77.75	..	..	..	135.75
Meeting Expenses (3)	488.46	1,219.10	..	..	234.03	301.95	..	2,724.55	524.16	..	..	..	260.75
Honoraria and Steno Services	89.15	..	..	..	..	..	..	200.00	..	..	..	..	200.00
Travelling Expenses (4)	..	..	..	..	..	..	..	..	..	..	..	..	..
Subscriptions (5)	..	..	..	..	..	..	..	..	..	..	..	..	..
Special Expenses	122.96	4.25	..	..	100.00	2.50	..	295.00	71.12	..	..	..	31.17
Total Expenditure	798.06	1,289.37	..	..	359.16	320.13	..	4,267.24	673.03	..	..	194.77	627.67
Surplus for 1962	..	..	126.19	..	..	123.57	..	105.53	..	..	137.64	..	175.29
Deficit for 1962	134.54	26.98	..	..	211.40	..	..		231.90	..	..	144.00	..
Balance at Dec. 31, 1961	801.57	302.76	412.21	..	437.25	499.34	..	2,674.19	359.22	..	37.70	(211.00)	424.75
Balance at Dec. 31, 1962	667.03	275.78	538.40	..	225.85	622.91	..	2,822.72	127.32	..	175.34	(355.00)	600.04

(1) Includes all rebates, whether for E.I.C. or Commonwealth fees.
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(3) Includes rental of rooms, projectors, operators, slides, dinners, entertainment, social functions, etc. for both general and special.
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(5) Includes all publications.

BRANCHES	Saguenay	Saint John	St. Maurice Valley	Sarnia	Saskatchewan	Sault Ste. Marie	Sudbury	Toronto	Vancouver	Vancouver Island	Whitby	Winnipeg	Yukon
MEMBERSHIP													
Members	..	..	..	..	2	..	..	7	1	2	..	2	..
embers	1	4	4	1	8	3	2	81	36	39	1	25	..
ers	135	85	109	121	790	36	69	1,228	569	118	42	480	10
ate Members	41	42	75	20	316	16	26	360	182	41	13	262	7
ts	30	25	58	12	362	8	15	223	362	68	8	467	1
es	..	1	..	..	..	..	2	8	2	1	..	2	..
l	207	157	246	154	1,478	63	114	1,907	1,152	269	64	1,238	18
NANCIAL STATEMENT													
e													
s from E.I.C. Hq. (1)	262.00	132.00	..	559.00	..	86.00	184.00	2,226.00	2,112.12	266.00	278.92	325.00	100.00
tances from Prof. Assns	36.93	104.00	..	..	..	..	..	..	..	..	..	1,485.00	..
Affiliate Dues	..	76.00	..	..	..	18.00	120.00	..	..	6.00	..	224.00	20.00
st	16.06	..	..	24.87	..	..	..	97.72	15.77	..	..	101.50	..
laneous	500.00	377.25	..	..	..	23.00	1,773.00	3,125.13	811.69	440.20	..	428.32	..
l Revenue	814.99	689.25	..	583.87	..	127.00	2,077.00	5,448.85	2,939.58	712.20	278.92	2,563.82	120.00
ture													
g and Communications (2)	72.99	75.87	..	225.04	..	10.50	228.15	2,622.07	1,128.34	97.05	6.80	813.30	6.48
g Expenses (3)	927.17	591.70	..	239.42	..	75.74	1,823.82	3,898.99	1,297.60	570.20	..	277.73	124.91
aria and Steno Services	60.00	37.50	..	16.48	..	25.00	50.00	216.00	125.63	52.65	..	442.50	..
ling Expenses (4)	51.00	..	..	165.00	..	..	..	87.21	20.00	..	..	..	..
iptions (5)	..	16.60	..	..	..	..	40.00	..	60.00	10.30	..	343.23	..
l Expenses	35.77	..	..	100.33	..	14.00	46.19	100.00	100.00	100.00	..	364.71	50
l Expenditure	1,146.93	730.47	..	746.27	..	125.24	2,188.16	6,924.27	2,731.57	830.20	6.80	2,241.47	131.89
lus for 1962	..	..	..	..	..	1.76	..	..	208.01	..	272.12	322.35	..
cit for 1962	331.94	41.22	..	162.40	..	..	111.16	1,475.42	..	118.00	..	..	11.89
nce at Dec. 31, 1961	1,076.01	585.47	..	1,148.31	..	396.75	322.01	5,102.95	2,096.20	252.98	13.04	2,521.11	206.93
nce at Dec. 31, 1962	744.07	506.77	..	985.91	..	398.51	210.85	3,738.89	2,304.21	134.98	285.16	2,843.46	195.04

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EIC-63-Br & Str 4 "TCA Overhaul and Maintenance Base" by E. A. Dahl

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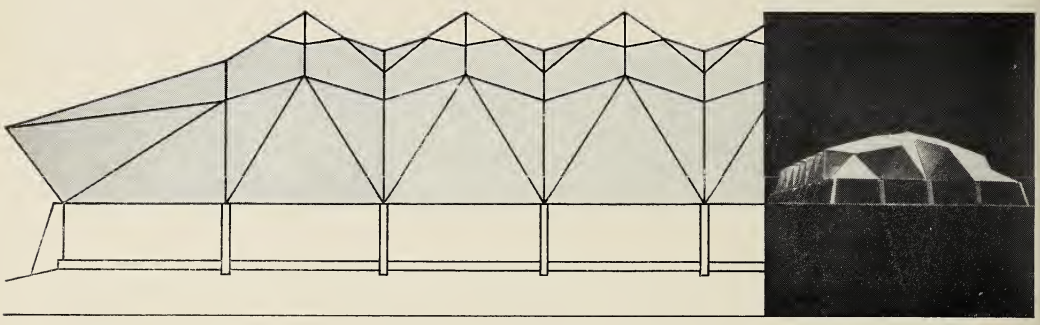
An imaginative adaptation of the plywood stressed skin panel is displayed in the roof design for the new plywood testing laboratory in North Vancouver, B.C. The roof utilizes 86 plywood panel components in triangular and trapezoidal shapes, covering a total area of 7,200 square feet. From an exterior view, the roof presents an intricate pattern of light and shadow, while inside it inspires a sense of soaring space. Within the open area of the laboratory the repeated peaked arches of the roof system add a richness of design unusual in a large spanning structure of this type.

Aside from its aesthetic appeal, the roof is designed to take advantage of plywood's structural properties.



VARIATIONS ON A PANEL COMPONENT

The plywood panel components are partially self-supporting, serving to strengthen the light glue-laminated arches spanning the roof area. Components were largely preassembled, with a glass-reinforced plastic coating applied in the plant. Translucent sky-lights were added at peaks after the components were installed.

The variety of shapes utilized in the laboratory roof indicates the design possibilities of plywood panel components. Information on new uses of waterproof glue fir plywood, in component and other forms, is available from your Association field man.

The plywood testing laboratory is the work of: J. O. McCutcheon, M.Eng., consulting engineer; R. J. Thom, MRAIC, consulting architect; F. R. Brown, P.Eng., consulting electrical engineer.

Waterproof Glue
FIR PLYWOOD
Plywood Manufacturers Association of B.C., Vancouver, B.C.
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ABSTRACTS

Transactions of the E.I.C.

EIC-63-CIV 10

"The Effect of Slimes in Open Channel Transport of Fluidized Solids"

R. W. Ansley

This paper discusses some aspects of research carried out on high-density fluidized solids transport in open-channel flow at the University of Alberta. Commercial operators have noticed that flume transport of tailings is facilitated by the addition of slimes or sludges to the tailings slurry. A laboratory program evaluated the effect of blending of slimes and tailings. Results to date show a substantial increase in percentage tailings transported for a given hydraulic gradient at a constant discharge due to the addition of slimes. The data and discussion of this program are presented in this paper.

Division Papers of the E.I.C.

EIC-63-CIV 9

"Soil Cement and Examples of Construction in Alberta and Saskatchewan"

E. B. Garrett

This paper briefly describes the history and the development of soil cement in the United States and Western Canada. Soil cement is defined and some of the engineering properties are given. Also, the different uses of soil cement are described along with its growth in western Canada during the last 27 years. The adaptability of soils to soil cement and the laboratory testing required to determine proper cement contents are discussed. Examples of construction procedures used by Edmonton, Saskatoon and Alberta Department of Highways are given. Methods of curing and bituminous surfaces are described along with the basic fundamentals of inspection and field control. The paper closes by showing some of the factors effecting the costs of soil cement and discussing design criteria now being used.

EIC-63-BR & STR 4

"TCA Overhaul and Maintenance Base"

E. A. Dahl

TCA has recently put into operation its $20 million Jet Maintenance Base at Dorval, Que. The buildings alone cover 14 acres. Two of these buildings are hangars. One, a series of 175 ft. span cantilevers supported on a mast and anchor, is unique in the length of the cantilever; the other, a 90 ft. series of cantilevers suspended from the edge of 150 ft. span reinforced concrete rigid frame, is unique in its design. Both hangers are among the largest in existence. The paper describes the structure as such, and deals with some of the unique problems of the design that were encountered, and their solution, in a descriptive fashion.

The Seventy-Seventh Annual General Meeting of the Engineering Institute of Canada will be held on Wednesday, May 22, 1963, at the Chateau Frontenac Hotel, Quebec, P.Q., between the hours of 9:00 a.m. and Noon. This meeting will receive the report of the official auditors, the Annual Report of Council, Reports of Committees, Representatives and Branches, and such other business as may come before the meeting.

Garnet T. Page, M.E.I.C.

General Secretary

La 77e réunion générale annuelle de l'Institut canadien des ingénieurs aura lieu mercredi le 22 mai 1963, au Château Frontenac, à Québec, entre 9 heures du matin et midi. Au cours de cette réunion, les membres entendront le rapport des vérificateurs, le rapport annuel du Conseil, les rapports des comités, des représentants et des sections et discuteront de toutes les questions qui pourront être soulevées.

Garnet T. Page, M.E.I.C.

Le secrétaire général

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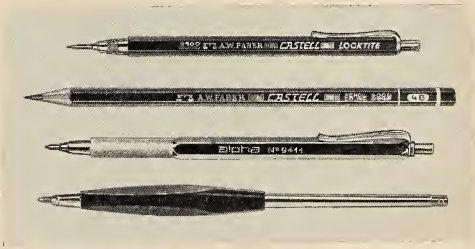

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Branch News

SUDBURY

E. W. Mitchell

On January 24 the Branch held a joint meeting with the local chapters of the A.P.E.O. and the C.I.M.M. which 140 attended. The guest speaker was Dr. R. J. Uffin, Principal of the University College, University of Western Ontario, and Chairman of the Canadian Scientific Committee for the Upper Mantle Project. Dr. Uffin's address was based upon the work that will be done by scientists of a dozen nations including the United States, Russia and Canada on the Upper Mantle Project. Dr. Uffin stated that backed by years of theorizing, based upon recordings of earthquakes and artificial explosions, scientists have been able to develop a theory on the composition of the earth. In order to plot the thickness and composition of the Upper Mantle, test drillings to a depth of 20 miles will be made by the U.S.A. and Russia. Canada's contribution will be a series of 29 seismic stations throughout the Dominion and test sample drill holes of 10,000 feet. In Canada, there are more interesting, accessible and easy-to-study geological formations of types which provide clues about the interior of the earth than anywhere else in the world. The Sudbury area is a prime example.

During the question-and-answer period which followed his talk, Dr. Uffin presented some of his own ideas and theories on this project. These included the "Demagnetization Theory" which attempts to explain the mutations that occur in nature and, the lack of a magnetic field around Venus as discovered by the U.S. satellite Mariner II.

A dinner meeting was held February 20 with Dr. A. D. Misener, Director of the Ontario Research Foundation as guest speaker. His subject was, "The Role of the Ontario Research Foundation in Canadian Industry".

AMHERST

G. C. L. McEnery

The regular monthly meeting of the Branch held at the Fort Cumberland Hotel February 22 took the form of a Students' Night. Approximately 20 students in third year Engineering at Mount Allison University attended the dinner and took great interest in the speech presented by G. A. Hillier, Industrial Relations Officer with the Nova Scotia Light and Power Company Ltd. Mr. Hillier spoke on Effective Administrative Behaviour. He was introduced by W. D. Hagen, Branch Chairman, and thanked by John Baird. Head table guests included: N. T. Avard; David Hickey, President of the Mount Allison Engineering Society, and Dr. G. G. Meyerhof, of the Nova Scotia Technical College.

From left to right: J. N. Raftis, Branch Chairman; A. Durnford, a member of the Papers and Publicity Committee; Dr. R. J. Uffin, Guest Speaker; D. A. Fraser, M.E.I.C. and Chairman of the local C.I.M.M. Branch.

BAIE COMEAU

G. W. Scott

Captain E. S. Brand, Director of Marine Operations, Federal Department of Transport, addressed a combined meeting of the Branch and the Baie Comeau Chamber of Commerce on February 13. Captain Brand's remarks covered three phases of Marine Operations which account in total, to about $22 million of the Federal budget.

The first phase dealt with the maintenance of all buoys, lighthouses, radios and beacons which guide shipping around Canada's coastlines. Each year approximately 1500 buoys have to be lifted at the close of the normal shipping traffic and replaced after servicing. Captain Brand described the Department of Transport's Northern Marine Operations which are carried out in the summer and early autumn. These operations cover the vast area from Labrador, Hudson Bay and the Mackenzie River, to the northern shores of Melville Sound. The wide variety of work done by the Department includes opening Hudson Bay for shipping in July, welfare work with the Eskimos, and the servicing of a great number of outposts in the Canadian north, such as the oceanographic expeditions and defense posts in the GAP, PINE and DEW lines. Some 100,000 tons of supplies and equipment are delivered in these servicing operations. Landings are made on open beaches by means of LST 8 and LSM craft transported by the main supply vessels.

Captain Brand then described the winter ice-breaking activities of the Department. Much of this work is aimed at keeping the St. Lawrence open for shipping and accelerating the opening of the Seaway in the spring. Some excellent pictures of ice-breaking ships John A. Macdonald and the Iberville at work were shown to illustrate Captain Brand's description of this phase of the Department's operations.

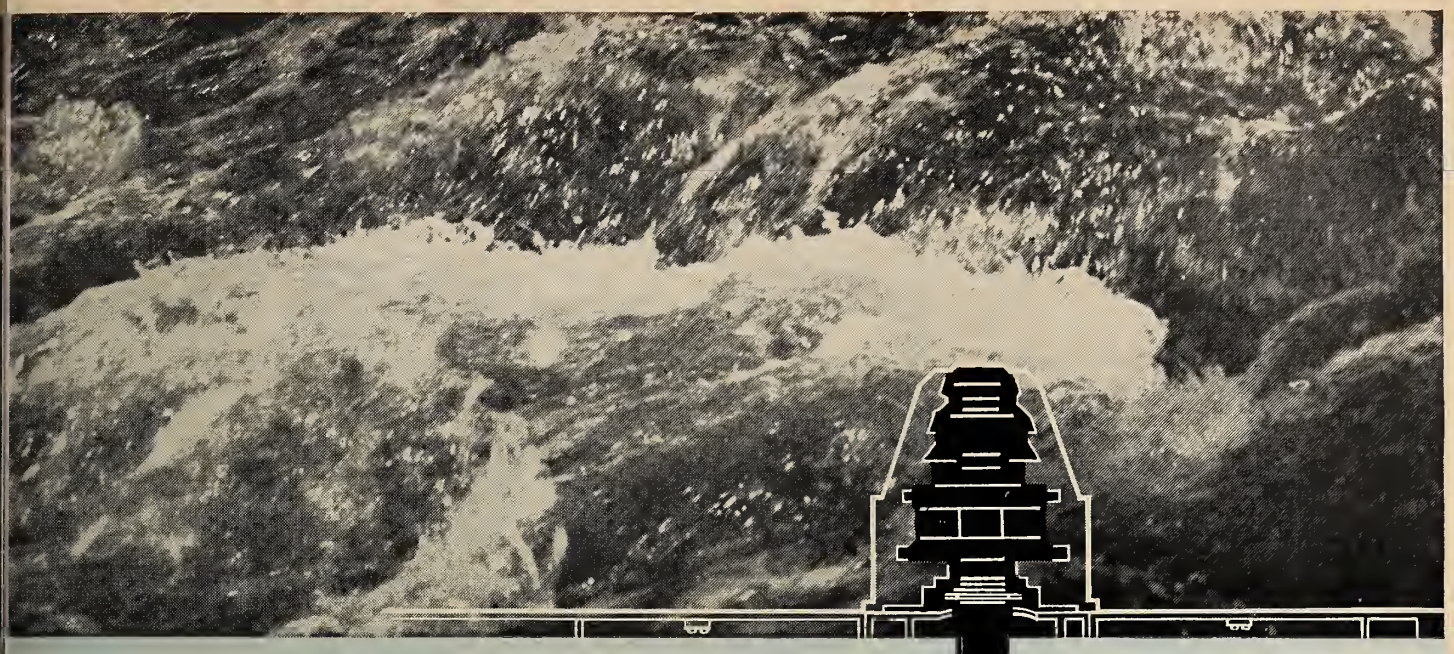
LAKEHEAD

W. Burynuik

The Seabar Mark II Grain Car Dumper was the subject of the talk presented by R. Nash to the Branch's February meeting. In this talk, Mr. Nash outlined the design and development features of the grain car dumper. He was thanked for his interesting talk by Mr. Halter, a Branch member. A report was presented by President Hardiman.

On January 24, a speaker from the Society of Quantity Surveyors presented a talk on their role in a contractors organization.

(Continued on page 128)



Imperial products protect vital hydro plant mechanisms

Imperial research developed Argon EP O to meet and beat extreme pressures of centralized lubrication systems. Argon EP O is recommended for hydraulic vane spindles, where long dispensing lines, low temperatures, excessive water conditions and heavy loads are encountered. Lotemp Moly Grease for very low temperatures is now available in cartridges...free from pail contamination. Lotemp Moly is well suited for lubricating elevating screw mechanisms on sluice gates. For information on lubricants and fuels call the trained Imperial Industrial Sales Representative, at the nearest Imperial Oil Office.

ALWAYS **LOOK TO IMPERIAL** FOR THE BEST

Esso

Personals

Karl H. Eardmann has been named plant manager of Cal-Sil Products Ltd., a new company which will produce calcium-silicate building brick. **L. J. Doucet** has been appointed sales manger for the company. Mr. Erdmann holds a degree in mechanical engineering from Germany where he was active in the building materials industry before coming to Canada in 1953. His extensive experience includes active participation in the design and construction of brick plants. He is a member of the Canadian Ceramic Society. Mr. Doucet has had more than twelve years' experience in the construction field.

Douglas P. Robinson, QC and **Kenneth A. West**, Ph.D., have been elected Vice-Presidents of Shell Oil Company of Canada, Limited. Mr. Robinson practiced law from 1928 until 1942. He was then appointed Assistant to the Oil Controller in the Federal Government. He joined Canadian Oil as General Counsel in 1945. Dr. West joined Canadian Oil in 1951 as Chief Process Engineer, and the following year was appointed Refinery Production Superintendent. In 1961 he was named a Vice-President of the company.

John Kazakoff, M.E.I.C. (McGill '35) has been appointed Vice-President of International Power Company Limited. Mr. Kazakoff has been associated with the company since 1938 and has been assistant vice-president since 1960, and was elected a director in 1962. He is also a director and vice-president of Bolivian Power Company, Limited.

Reginald A. Darke, M.E.I.C. (Toronto '50) has become an associate in the firm of Levin, Pierce & Wolf, Consulting Engineers, Detroit, Mich. Mr. Darke formerly held positions with Smith, Hinchman & Grylls; Ford Motor Company of Canada and Canadian Westinghouse Company.

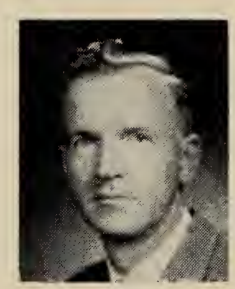
J. Kazakoff, M.E.I.C.

R. A. Darke, M.E.I.C.

R. H. Griesbach, M.E.I.C. (McGill '42) has joined the firm of Surveyer, Nenniger & Chenevert, Consulting Engineers, Montreal. Mr. Griesbach has had broad experience in the design of harbour and terminal facilities for various commodities. Prior to joining the company, he was a principal engineer with O. J. McCulloch & Company.

From left to right: Brigadier J. L. Melville, Colonel Commandant, Corps of Royal Canadian Engineers; Gilles Chenier, in uniform; Colonel A. Mendelsohn, M.E.I.C., Director, Royal Canadian Electrical and Mechanical Engineers; Colonel R. J. Carson, M.E.I.C., Chief Engineer of the Canadian Army.

Gilles Chenier, M.E.I.C. a 2nd Lieutenant in the University of Ottawa's Canadian Officers Training Corps has been awarded a Royal Canadian Engineers Scholarship.



J. Howes, M.E.I.C.

A. Fromanger

Armand Fromanger has been named Assistant General Manager at Syntron (Canada) Limited. He joined the company in 1958 after many years' experience in electronics engineering development work.

John Howes, M.E.I.C. (Toronto '49) has been appointed General Manager at Syntron (Canada) Limited, Stoney Creek, Ont. Mr. Howes joined Syntron in 1960 and was appointed assistant to the general manager for Canada in 1962.

William Armstrong, M.E.I.C. (McGill '35), formerly General Manager, has been promoted to a position of greater responsibility with the company's United States office.

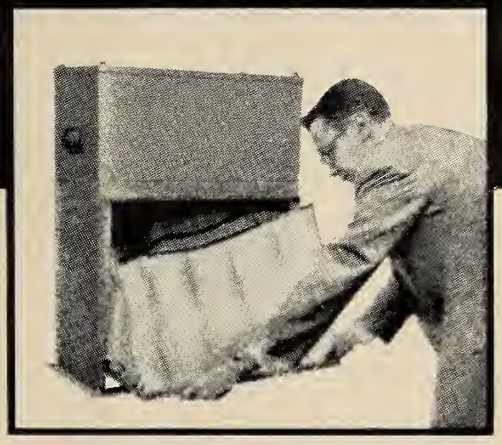
George M. Bain has been appointed Vice-President (Sales) at Abitibi Power & Paper Company, Limited. Mr. Bain joined the company in 1949 as General Sales Manager, Provincial Paper, Limited. He is a Director of Abitibi Sales Co. Ltd., Provincial Paper Ltd., and Canadian Pulp & Paper Export Ltd. **J. Elliot Cottrelle**, now a Vice-President, Abitibi Power & Paper Co. Ltd., assumes the additional responsibility of President, Canadian Pulp & Paper Export Limited.

V. Larkin

G. Laflamme

Guy Laflamme has been appointed Eastern Regional Service Manager, and **Victor Larkin** has been appointed Western Regional Manager for Black & Decker, Mfg. Co. Ltd. Mr. Laflamme will be responsible for Quebec, Ontario and the Maritime Provinces. Mr. Larkin will cover Manitoba, Saskatchewan, Alberta and British Columbia.

NEW LOW-COST WAY TO STOP OIL MISTS



AAF collector provides efficiencies equal to electrostatic precipitators at less than half the cost

Here's a new way to eliminate oil mists, smoke and fumes caused by wet-machining operations. AAF's new, high-efficiency Oil Mist Collector, with its unique disposable cartridge, offers an unmatched combination of advantages:

High cleaning efficiency permits recirculation of clean air in the work area.

Amazing low cost — less than half that of an equal-volume electrostatic precipitator unit.

Large-capacity, disposable cartridge is easy to change. Simply slide out old and slide in new. Cartridge maintains constant high efficiency over its entire life.

Built-in filter-change indicator automatically signals when it's time to change the filter cartridge.

Small, lightweight design affords great flexibility during installation. Can be installed close to the machining operation — even in the hood. Available in 500 cfm, 750 cfm and 1,000 cfm capacities.

No expensive electrical connections or heavy wiring. Can be wired directly to machine tool.

For complete product information, call your nearby AAF representative, or write direct to American Air Filter of Canada, Ltd., 400 Stinson Blvd., Montreal 9.

AAF CANADA

American Air Filter OF Canada LTD.

400 Stinson Blvd., Montreal 9

for storing feed

Ten steel ingredient bins, each with a capacity of 60 tons, were designed and fabricated in Winnipeg by Manitoba Bridge to specifications laid down by the consulting engineers.

the simple and the complex...

Both are shown in this round-up of contracts from D.B. plateshops across the country. Large fabricators build up experience and take many complex jobs in their stride but every once in a while a problem comes along. When this happens new techniques are developed. This is a big responsibility for failures in the field not only cost a fortune, they can be dangerous.

When you buy welded fabrications be very sure of your supplier's ability. The Platework Division of Dominion Bridge maintain well equipped shops from coast to coast* and their total experience is unmatched in Canada.

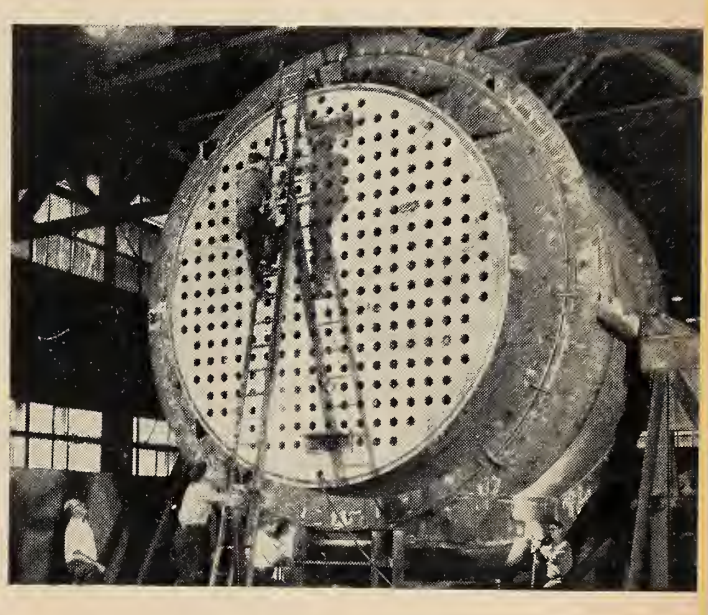
*In Winnipeg: Manitoba Bridge & Engineering Works.

130

PLATEWORK DIVISION
DOMINION BRIDGE

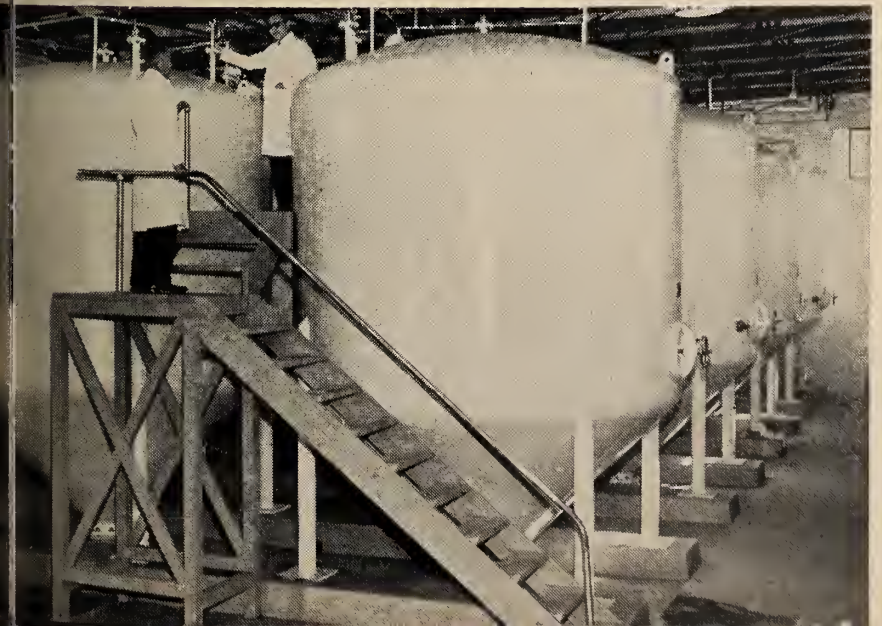
for chemical processing

One of five catalytic reformer reactor shells being made in Montreal from 1-¾ inch monel clad chrome-nickel steel. Special welding techniques were necessary to provide a satisfactory result.



for nuclear power

This is the calandria for A.E.C.L.'s new Candu reactor as it appeared during fabrication at the Dominion Bridge plant in Montreal. It is one of the most precise fabrications ever undertaken by the Company.



for making wine

These eight 5,000-gallon fermentation tanks were made by Dominion Bridge in Vancouver on very short delivery to meet the customer's needs. The material is mild steel lined with epoxy resin.

Employment Service

THE ENGINEERING INSTITUTE OF CANADA

This service is operated for the benefit of members of the Engineering Institute of Canada and for organizations employing engineers.

SITUATIONS WANTED

Advertisements are inserted free of charge for members of all classes. Maximum length is 60 words, and repeat insertions must be separately requested in writing for each desired appearance.

SITUATIONS VACANT

Rate: Six dollars per column-half-inch per insertion.
Replies to advertisements should be addressed to the file number, Employment Service, 2050 Mansfield Street, Montreal. Interviews with the Employment Service may be arranged by calling VI 2-8121 at the above address.

SITUATIONS WANTED

STRUCTURAL ENGINEER — available April 1963. Competent designer and good organiser of design, drafting and procurement. Experience of fabrication and erection of steelwork and heavy equipment. Fifteen years in electric power and chemical plant fields. Prefer non-metropolitan city. File No. 396-Str.

CIVIL ENGINEER— A.M.E.I.C., Athlone Fellow, B.Sc. (U.N.B. 1960). Diploma of Imperial College 1961. Presently investigating the inelastic behaviour of reinforced concrete for M.Sc. (London). Available February 1963. Age 24, married. Willing to work anywhere in Canada. Desires position that offers experience in design and construction. File No. 273-C.

REGISTERED ENGINEER — M.E.I.C., B.E. 1959, M.Sc. 1962, A.S.A.E. Desires position in design, development, teaching and/or research, preferably in timber structures. Location open. File No. 103-Agr.

CIVIL ENGINEER — M.E.I.C., B.Eng., P.Eng.(Que.). Age 41, married. Completely bilingual. 12 years commercial heavy industrial and marine design and construction experience as project manager and resident engineer. Present location central Canada but will relocate anywhere. Desires responsible and challenging position with consulting engineering firm or general contractor. Complete resume upon request. File No. 112-C.

CIVIL ENGINEER — S.E.I.C., B.A.Sc. Waterloo (June 1963). Age 29, married. 7 years pre-graduate experience in highway and municipal engineering. Desires position with municipality in Southern Ontario. Resume on request. File No. 455-C.

CIVIL ENGINEER — M.A.Sc. (Toronto '54), M.E.I.C., P.Eng. (Que.). Age 32, married. Experience: 3 years in hydraulic structures design; 4 years in teaching and 2 years in steel structures design. Seeks position as senior design engineer, or in a University. File No. 420-C.

ELECTRICAL ENGINEER — M.E.I.C., P.Eng. Mechanical and Electrical experience. Certificate in Business Administration. 12 years diversified experience in construction, plant engineering and maintenance. Seeks challenging position in engineering or management. Will relocate. Resume upon request. File No. 460-E.

MECHANICAL ENGINEER — M.E.I.C., P.Eng. Sask. Age 26, married. B.Sc. University of Saskatchewan 1960. Presently employed in the petroleum refining industry. Desires position as a plant maintenance or production engineer with a progressive organization. File No. 419-M.

MECHANICAL ENGINEER — A.M.E.I.C., B.Sc. 1962 (Alberta) Mechanical Engineering. Age 22, married. One year's experience in communications equipment manufacture. Desires position in mechanical engineering, consulting firm or similar field. Prefer Edmonton area but willing to work anywhere in Western Canada. File No. 458-M.

CIVIL AND MINING ENGINEER — M.E.I.C. and P.Eng. 24 years Manager — Construction, Manufacturing and Mining; record of turning an annual loss to profit, living within budgets, meeting schedules, controlling multi-million dollar multi-location projects, revitalizing demoralized organizations, handling touchy union relations, improving public relations. Married, prepared to travel or relocate for a challenging job. File No. 311-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. Desires position City Engineer approximately 50,000 population. Fifteen years experience. Location open. File No. 459-C.

ENGINEER - ECONOMIST — M.E.I.C., M.A.S.C.E. (Civil), McGill '57. Diploma in Management and Business Administration. Experienced in various phases of structural steel and reinforced concrete design. Has been in charge of multi-million dollar erection projects. Project managing, market research, planning and co-ordination, economic appraisals, feasibility studies, estimating and pricing, contract negotiation and liaison. Seeks position where technical, managerial and administrative aspects are of an asset. File No. 6482-C.

ENGINEERING EXECUTIVE — M.E.I.C., P.Eng., Mechanical Engineer (1936). 20 years experience mechanical, industrial, management, consulting engineering; metal-working, rubber and plastics industry, consumer goods, ordnance. Last 9 years works Manager largest Colombian furniture manufacturer. Seeks challenging senior assignment, Canada, USA, foreign. File No. 456-M.

CIVIL ENGINEER — A.M.E.I.C., B.Eng. (McGill '60). Age 24, single, bilingual. One year post-graduate studies in hydraulics (Grenoble, France). Two years experience in general hydraulics and in power plant design. Desires position involving hydraulic design, preferably in hydro-electric field. Montreal area only. Available on short notice. File No. 457-C.

NOTICE TO ADVERTISERS

DEADLINE — Please note that requests for insertions must be submitted in writing not later than the **15th of the preceding month.** Cancellations: same as above.

SITUATIONS VACANT — Classified rate: $6 per column-half-inch per insertion. Display rates: Per insertion — 1/12 page — $100; 1/8 page — $120; 1/6 page — $195; 1/4 page — $215; 1/3 page — $285; 1/2 page — $345.

DATE IN CIRCULATION — 20th of month.

SITUATIONS WANTED — Accepted free of charge from Members of The Engineering Institute of Canada only.

MECHANICAL ENGINEER

Applications are invited for the position of Mechanical Engineer in the Woodlands Operations of The Great Lakes Paper Company, Limited. Duties to include development design and modification of mechanical logging equipment, engineering studies and appraisal of new methods and equipment.

Successful applicant must be a graduate from a recognized university and must have five to seven years experience, preferably in the pulp and paper industry.

Salary open and commensurate with ability and experience. The company has established pension and welfare benefits.

All applications will be treated in confidence and should be addressed to:

Manager, Industrial Relations

THE GREAT LAKES PAPER COMPANY, LIMITED

P.O. Box 430, Fort William, Ontario.

SITUATIONS VACANT

CIVIL

CIVIL OR PROFESSIONAL ENGINEER required by a firm of Consultants in Hamilton, Ontario. A minimum of 5 years' experience in design and supervision of construction of separate sewers and roadways. Preference will be given to those experienced in the various phases of municipal engineering. Please give full information and complete experience, together with photo and salary required. Position supplies room for initiative and responsibility, together with excellent salary and bonus. File No. 385-V.

STRUCTURAL ENGINEER—Required for project studies, detailed design and specification writing relating to hydro-electric and commercial developments. Should have at least 5 years' related experience and be capable of supervising draftsmen and junior engineers in the production of final designs and drawings. Knowledge of either India, Ceylon or South America would be advantageous. Salary open and will depend on experience. Apply to: Ingledow Kidd & Associates Limited, Consulting Engineers, Suite 800, 1112 West Pender Street, Vancouver, B.C.

CHEMICAL ENGINEER OR CHEMIST

Challenging assignments in process problem solving in all phases of pulp and newsprint manufacturing are offered to Chemical Engineers or Chemists.

Vacancies exist at our bleached sulphate pulp mill and newsprint mill located in the modern Northern Ontario communities of Terrace Bay and Kapuskasing, respectively.

Graduates with up to 6 years experience will be considered — pulp and paper not essential.

Excellent salary, working conditions and company benefits.

Reply giving detailed account of education, experience and personal data to:

Industrial Relations Division,
KIMBERLY-CLARK CANADA LIMITED,
2 Carlton Street,
Toronto 2, Ontario.

JUNIOR ENGINEER required by consultant specializing in Foundation Engineering. Opportunity for training in site and laboratory testing techniques and foundation design. Applicant must be prepared for intermittent supervisory duties at sites throughout Ontario. Participation in a limited research project may be available to applicant depending on qualifications. Reply to File No. 336-V.

ELECTRICAL

CANADIAN NATIONAL TELECOMMUNICATIONS — COMMUNICATIONS ENGINEERS. This leading communications company requires graduates in electrical engineering or engineering physics with approximately three to five years' transmission experience in one or more of the following fields: Data — Facsimile — Telephone — Teletype switching — Carrier telephone & telegraph. The work will involve engineering planning of systems and equipment to meet the many specialized requirements of customers as well as general engineering associated with the marketing of new applications in the communications field. These are responsible positions within the Headquarters Engineering Department in Toronto. Please apply in writing with details of education, experience, personal history, to: Personnel Supervisor, Office of the Chief Engineer, 151 Front St. West, Toronto, Ontario.

ELECTRICAL ENGINEER required with the following qualifications: Recent graduate in Electrical Engineering, ability to get along with others, and in good physical condition. Duties will be planning and design work in the Electrical Engineering Department. Written applications should contain resume of qualifications, experience, personal history and salary expected, sent to: Personnel Supervisor, Nova Scotia Light and Power Company, Limited, P.O. Box 848, Halifax, Nova Scotia.

ELECTRICAL AND MECHANICAL ENGINEERS
PATENT EXAMINATION
DEPARTMENT OF SECRETARY OF STATE
OTTAWA
UP TO $7140

Electrical and Mechanical Engineers preferobly with some industrial experience to:

- Exomine patent opplicotions for legal and technical details
- Search all literoture for similar inventions
- Prepare reports and conduct interviews.

Write today for detoils concerning these ottroctive positions to:

CIVIL SERVICE COMMISSION, OTTAWA 4 and quote Competition 63-1075.

MECHANICAL

MECHANICAL ENGINEER for consulting office in Southern Ontario with several years of experience relevant to design heating, ventilating, air conditioning and plumbing systems for buildings. Future participation in company for right man. Send resume and salary expected to File No. 392-V.

MISCELLANEOUS

ELECTRICAL AND CIVIL ENGINEERS required for a public utility company in Lower Lawrence region. Salary depending upon qualifications. Good opportunities in a progressive firm. Reply giving complete resume to File No. 388-V.

ENGINEERING OPPORTUNITY — Excellent opportunity open for position of Chief Engineer at an integrated steel and pipe manufacturing operation in Western Canada. The position offers an imaginative engineer wide scope, responsibility and excellent potential. The company is looking for a qualified engineer with experience in steel mill operations and capable of assuming responsibility for the overall maintenance program. In addition, the successful applicant will participate in a new product development program, including lay-out, design and supervision of construction, installation and "break-in" of additional production facilities. All replies held in strict confidence. Please mail comprehensive experience resume, including present salary, to: Personnel Director, Interprovincial Steel and Pipe Corporation Ltd., P.O. Box 1670, Regina, Sask.

MOVING?

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Journal's Circulation Department

2050 Mansfield St., Montreal, P.Q.

SPERRY

ELECTRONIC ENGINEERS

THIS IS A UNIQUE OPPORTUNITY to fully utilize your present knowledge — to expand that knowledge and broaden your scope and experience.

Expansion and diversification of product lines have made available positions at supervisory, senior, and intermediate levels, working on highly interesting projects.

These projects involve the application of radar, gyros, servo systems, digital circuitry, logic, switching and analogue circuitry on both a system and a detailed basis.

A university degree in electrical engineering or engineering physics, 3 to 10 years' experience in the electronics field, together with a strong desire to create and learn are the major prerequisites.

You are invited to discuss these positions with us. Please forward your resume, or telephone for information.

Industrial Relations Manager

SPERRY GYROSCOPE COMPANY OF CANADA, LTD.

P.O. Box 710 Montreal 3, Que.

MISCELLANEOUS

NORANDA RESEARCH CENTRE is the research division of the Noranda Mines Group of Companies. A new research and engineering laboratory is now under construction in the Montreal area at Pointe Claire, Quebec. Candidates are presently being sought for the following two positions in the Technical Economics Department of the Research Centre. MARKET RESEARCH ANALYST — Person capable of carrying out market studies which will include surveys, forecasts, product uses and product development. Collaboration and liaison with the Sales Division of the Company would be necessary. Desired qualifications would be an engineering degree together with a degree in economics or a graduate business administration degree. PROJECT ENGINEER — Person capable of carrying out engineering studies, development of process flow sheets from laboratory results, design of equipment, plant lay-out, capital and operating cost estimates. Essential to have some experience in cost-estimating. Desired qualifications would be a B.Sc. or M.Sc. degree in engineering, preferably chemical engineering, together with a few years of relevant experience. Send complete resume in confidence to Personnel Manager, Noranda Research Centre, 550 Sherbrooke Street West, Montreal, P.Q.

METALLURGICAL

METALLURGICAL ENGINEERS — Large progressive Corporation with subsidiary Companies in several provinces in Eastern Canada requires Metallurgical Engineers. Excellent opportunities for advancement. Reply in confidence to: File No. 292-V.

TEACHING

UNIVERSITY OF WINDSOR has the following academic vacancies available from September, 1963: Three Assistant or Associate Professors for teaching in undergraduate, graduate courses and research in Soil Mechanics, Foundation Engineering and Transportation Engineering; in Advanced Hydraulics and Hydrology; in Engineering Mechanics, Graphic statics and Mechanics of Materials. Prefer men with a Ph.D. degree or working toward it. Salary open, dependent upon education and experience. Apply to Dr. H. P. Herbich, Head of Civil Engineering Department, Assumption University of Windsor, Windsor, Ontario.

McGILL UNIVERSITY — Applications are invited for the position of Associate Professor of Mechanical Engineering in the field of mechanical design. It is essential that applicants have had extensive engineering design experience in addition to possessing appropriate academic qualifications. Responsibilities will include instruction at graduate and undergraduate levels. Some specialty research interests are desirable. Write to the Chairman, Department of Mechanical Engineering, McGill University, Montreal, P.Q.

INSTRUCTORS REQUIRED — For the following technologies: 1. Chemical, 2. Electronic & Electrical, 3. Mechanical (Applied Thermodynamics or Modern Manufacturing Processes & Tool Design). Applicants require a Bachelors Degree in Engineering, Physics or Science, or be eligible for registration as a Professional Engineer in Ontario. They should also have a minimum of two years experience in an industrial, teaching or research position. Salary $6,600-$9,000. Opportunities for further education. Write to the Principal, The Western Ontario Institute of Technology, 815 Mercer St., Windsor, Ontario.

UNION CARBIDE CANADA LIMITED

offers

attractive career opportunities for Engineers at its plant in Beauharnois, Quebec — less than 20 miles from Montreal.

ELECTRICAL OR MECHANICAL ENGINEER — The duties of this position will include Engineering and Maintenance responsibilities with eventual direction of important areas of Plant Engineering.

METALLURGICAL OR CHEMICAL ENGINEER — PRODUCTION — The duties of this position will include familiarization with the technology of ferro-alloy manufacture and the eventual direction of important areas of alloy furnace operations.

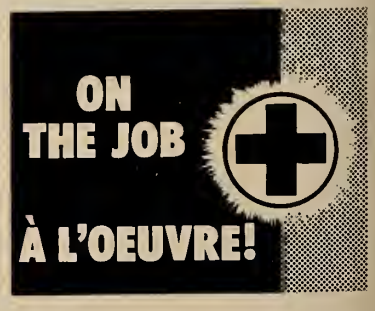
METALLURGICAL OR CHEMICAL ENGINEER — SALES — The duties of this position will include familiarization with the ferro-alloy usage in industry and the eventual assignment as Company Sales and Technical representative. Candidates for these challenging openings should be engineering or honors chemistry graduates between the ages of 24 - 35 and preferably bilingual.

Union Carbide Canada Limited is an aggressive and diversified Company with advancement opportunities. The Company has a full range of employee benefits including an attractive Employee Savings Plan. Salaries for the above positions are open and will be commensurate with experience. Write full details of education, experience and present salary, in strict confidence, to

C. J. Lamarche
Union Carbide Canada Limited
Metals and Carbon Division
Beauharnois, Quebec.

TEACHING

TECHNICAL INSTRUCTORS — Applications are solicited from qualified and interested persons to fill vacant posts in the following branches of technology (1) Architectural, (2) Civil (Construction), (3) Mechanical, (4) Electrical, (5) Electronics, (6) Mining. DUTIES: To instruct student technicians in the College of Trades and Technology, St. John's, Newfoundland, in the above and related subjects, in a program under the Technical and Vocational Training Assistance Agreement with Ottawa. QUALIFICATIONS: (A) Engineering degree, or the equivalent where applicable, in the appropriate branch, and at least three years experience in industry preferred; **or** (B) Graduation from a recognized Technical Institute, in the appropriate branch, with at least five years experience in industry preferred; **or** (C) Hold a Higher National Certificate or equivalent, with endorsements in the appropriate branch, and have at least five years experience in industry. Teacher training and/or teaching experience would be desirable. Interest in teaching essential. Salaries will be open to negotiation, but in general will approximate those applicable to similar posts in other provinces. Applications should be addressed to the Director of Vocational Education, c/o P.O. Box 1566, St. John's, Newfoundland. Successful applicants should be on staff on or before June 30, 1963.



Engineering Information Service

The following books have recently been received.

SPACE LOGISTICS ENGINEERING, Edited by K. Brown and L. D. Ely, Wiley, New York, $16.95.

METAL STATISTICS 1952-1961, 49th Annual Issue, Frankfurt.

SURVEY OF MINES 1963, The Financial Post, Maclean Hunter, Toronto, $5.

ENGINEERING: Principles & Problems, L. H. Johnson, McGraw-Hill, Toronto, $6.75.

ALBERTA HIGHWAY RESEARCH REPORT 62.1, Hydraulic Tests on Pipe Culverts, C. R. Neill, Res. Council of Alberta, $1.

GAS DISCHARGE & THE ELECTRICITY SUPPLY INDUSTRY, Proceedings of the International Conference, Butterworths, Toronto, $38.

INVOLUTE GEAR GEOMETRY, W. A. Tuplin, Clarke, Irwin, Toronto, $8.40.

THE SECOND CANADIAN CONFERENCE ON EDUCATION: Report, Montreal 1962, Univ. of Toronto.

APPLIED CRYOGENIC ENGINEERING, edited by R. W. Vance & W. M. Duke, Wiley, New York, $17.50.

RUSSIAN METALLURGY AND FUELS, Vol'skii Chief Ed., London, $68.

WORK DESIGN, G. Nadler, Irwin, Illinois, $16.

ETUDE CRITIQUE DU SYSTEME METRIQUE, D. M. Danloux, Gauthier-Villars, Paris, 45NF.

USINES DE RETENUE, USINES DE PLAINE, H. Varlet, Eyrolles, Paris, 79NF.

ELEMENTS DE THERMODYNAMIQUE STATISTIQUE, A. Pacault, Masson, Paris, 46NF.

THE ROYAL CANADIAN NAVY REQUIRES A LIMITED NUMBER OF CIVIL ENGINEERS FOR EMPLOYMENT AT NAVAL HEADQUARTERS, OTTAWA.

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Further information can be obtained from the nearest RCN Recruiting Office, or by writing to:

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DEVELOPMENTS IN THEORETICAL & APPLIED MECHANICS, Vol. I.

(Continued on page 144)

(Continued from page 118)

CAPE BRETON

Lloyd Boutilier

On February 6, J. R. Wallace, Chief Metallurgist with the Dominion Steel & Coal Corp. Ltd., Sydney, N.S., presented a talk to the Branch. In his address on structural steel, Mr. Wallace gave a detailed description of the properties of structural steel and pointed out such features as its toughness, ductility, resistance to sudden impact, high fatigue limit, weldability and corrosion resistance. He stressed the metallurgical specifications of the steel and explained how a high carbon content can cause brittleness, how the addition of manganese improves ductility, and how a large section of the steel would have higher impact strength. He pointed out how vanadium increases impact value and grain structure, and columbium increases yield and ultimate strength, copper aids in resisting corrosion. Mr. Wallace mentioned briefly how drilled holes are being used as crack arresters, and how heat treatment improves greatly the properties of the steel. Mr. Wallace was thanked by J. Vincent Palmer.

A special feature of this meeting was the presentation of a souvenir keychain to William Dodson commemorating the 75th Anniversary of the Institute and also in recognition of Mr. Dodson's service as Branch Chairman in 1959. He was unable to attend the Past-Chairmen's Night which the Branch held in December.

Special visitors at this meeting included Mr. Lahiri of India; Paul Dawson, Montreal; Bill Johnson, Saint John; Mr. Addison, Toronto; Walter Leonard, Neil Gillis and Burke MacIntosh.

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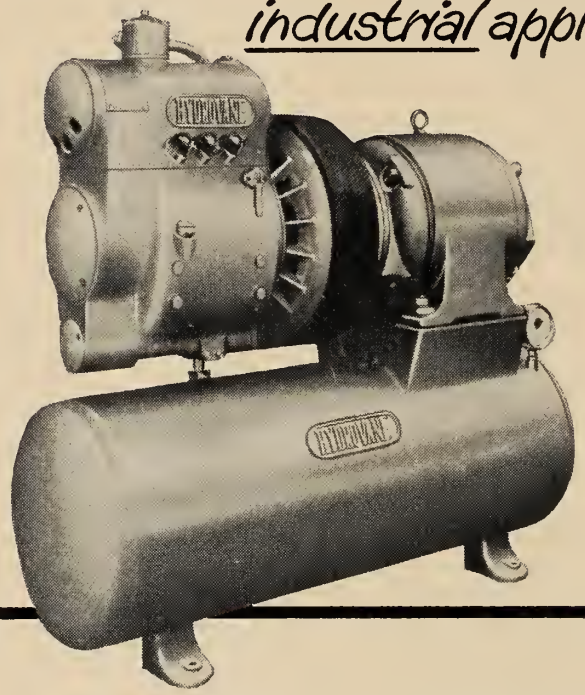

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R. J. Allman

Dr. E. J. Wiggins, Director of the Research Council of Alberta addressed the January meeting of the Branch. Dr. Wiggins' talk was entitled "Long-distance Solids Pipelining". In his talk, he explained that moving solids through pipe line is not a new concept. The study and transport of different slurries has been a reality for a number of years by companies in the United States and other parts of the world. Dr. Wiggins explained that the key to transporting a slurry is to keep the solid material in suspension. The power requirements depend on the viscosity of the transporting fluid and the optimum velocity of the slurry. Successful coal slurry pipe lines have been built in various parts of the United States and there has been a copper-ore slurry line built in Chile. A 72-mile six-inch gilsonite slurry pipe line has been constructed in the United States to move approximately 700 tons per day of gilsonite. Hydraulic mining is stimulating the study of slurry lines for movement of ore from the bottom of mines to the surface. The main costs involved in moving a slurry through a pipe line are in the preparation of the slurry into the proper size range of solids and dewatering the slurry at the receiving end of the line.

A coal slurry in oil has been studied by the Research Council of Alberta and it appears to have advantages over that of a coal slurry in water. The corrosion problem is reduced considerably, and there is the added advantage of moving two saleable commodities. There is however, the problem of separating the coal from the oil at the receiving end of the pipe line.

Dr. Wiggins described the work of the Research Council in transporting solids in capsules and stated that the Council has pioneered this type of study. The concept was first discovered when slugs of oil were noticed forming in a moving stream of water in the pipe line. These slugs were stable and moved faster than the water. As studies pro-

(Continued on page 138)

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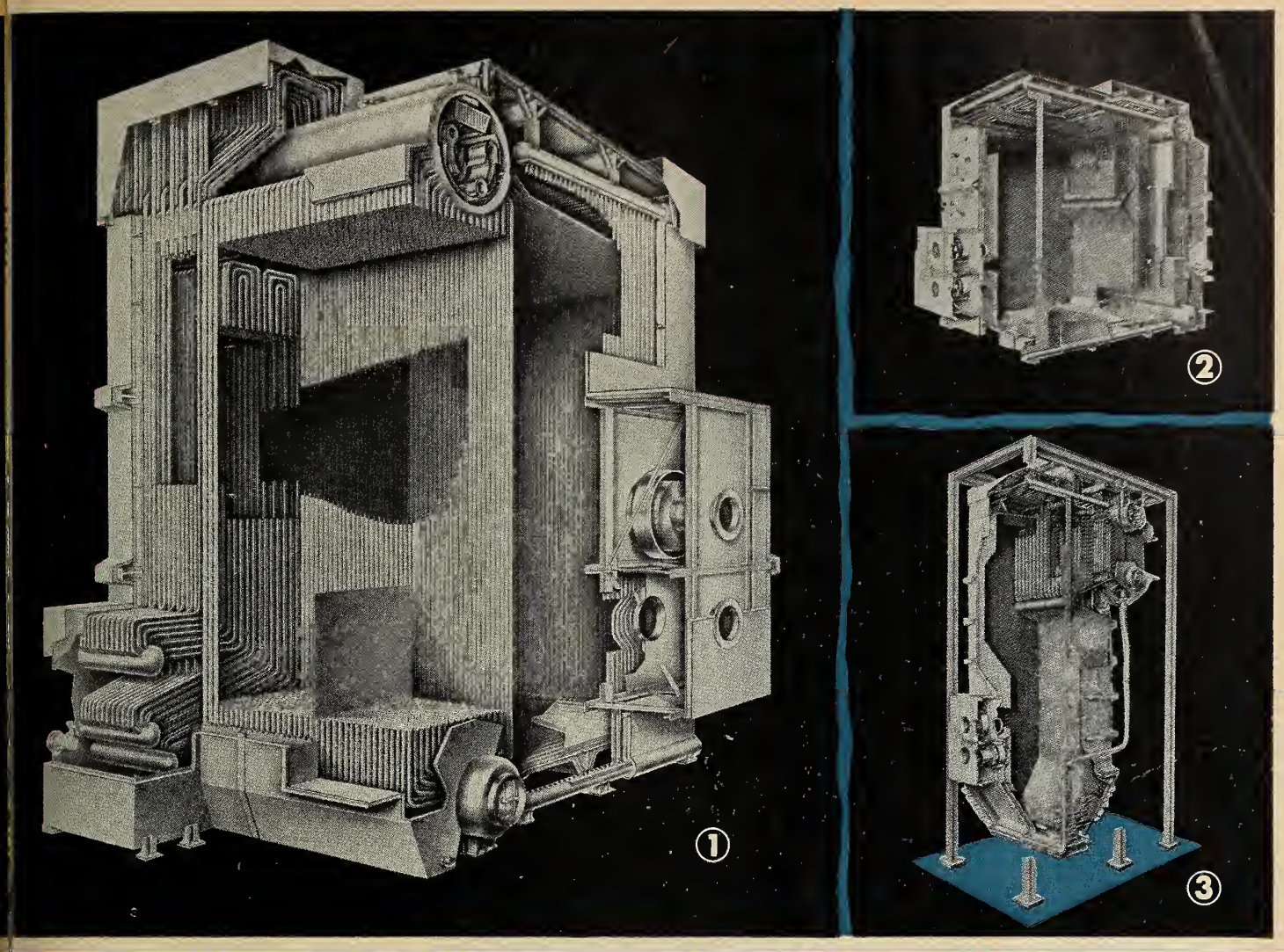

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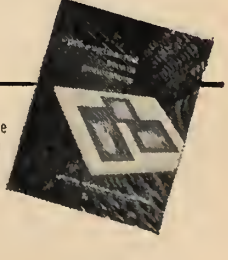

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Discussion

(Continued from page 50)

In summary then we conclude that the Columbia River Treaty is not as great an example of co-operation as it might or should have been, and it undoubtedly favors the biggest and wealthiest party.

If the co-operation in developing the Upper Columbia and Kootenay Rivers is to be real, costs as well as benefits must be shared, and the operation and plan of development should be the best from engineering and economic considerations, not the best to suit the national interests of hardest bargainers.

By agreeing not to divert, except as provided in the Treaty, Canada has yielded a great bargaining point, and by agreeing to the construction of Libby Dam has made it extremely difficult to divert even within the boundaries of the basin.

As Canada is in a less advanced stage of development than the United States, one of her main objectives should have been to ensure that the United States does not establish prescriptive rights now, to flows that Canada will need in the future.

Discussion by

J. F. Muir, M.E.I.C.

Head, Department of Civil Engineering
University of British Columbia

and

Eugen Ruus
Assistant Professor
Department of Civil Engineering
University of British Columbia

This paper gives valuable background information about the international negotiations and enlightening discussion of the economic and controversial aspects of the Columbia River projects in Canada.

The writers are not critical of Mr. McMordie's objective paper or of proposals for international cooperation in utilizing the Columbia River upstream storage. They believe, however, that the economic factors of the alternative schemes of development of the River in Canada require re-assessment and that some of the terms of the proposed treaty of January 17, 1961 warrant further study in order that a re-negotiated treaty could be made beneficial to both Canada and the United States.

One objection that the writers have to the terms of the treaty is the regressive decline in Canada's share of the downstream benefits. This results from the evaluation of downstream benefits from U.S. hydro electric capacity and hydro-electric energy on the basis of Canadian storage. If more consideration were given to benefits from water flowing into the United States from the upper Columbia River and less consideration given to the benefits from provision of storage volume in Canadian reservoirs, then presumably the value of the water to the United States for power, irrigation, navigation, industry, and other purposes would increase with the passage of time.

The water flowing in the upper Columbia River is a valuable asset to the United States. As General McNaughton has pointed out, it may be advantageous to Canada at a later date, to divert water from the Columbia into the Fraser River system. This is precluded by the terms of the Treaty

Mr. Udall[1] says of the treaty: "It will remove the potential diversion of the upper Columbia River into the Fraser River which could have resulted in disastrous power losses in the United States estimated by the Corps of Engineers to be in excess of $50 million annually even before the addition of Priest Rapids, Wanapum, and Rocky Reach dams to the main stem of the Columbia."

In benefit-cost studies of power projects on the upper Columbia River, a yardstick is required for evaluating costs of energy from various sources in British Columbia. The writers believe that large amounts of energy could be delivered to the load centre in the lower mainland from the Moran and other projects on the Fraser River for about 2¾ - 3 mils per kwh at 60% load factor. Four mils per kwh for energy in the lower mainland from gas-fired thermal plants should be regarded as the highest price that need be paid under present circumstances.

Under the terms of the treaty, the High Arrow and Duncan Lake storage would very likely result in low-cost energy to Canada. The Mica storage, however, would result in costs which might be as much as 11 - 12 mils per kwh. This is an indefensibly high rate unless on-site generation of firm power, to be proceeded with at the time of construction of the dam, would result in overall costs per kwh not more than the cost of energy from other sources in the province. Otherwise there does not appear to be a compelling economic incentive for Canada to proceed with the High Arrow, Duncan Lake, and Mica storage projects in return for downstream benefits. Mr. McMordie says that these storage projects would result in energy delivered at a cost to Canada less than 4 mils per kwh. The writers wish to point out that if the decline in downstream benefits were allowed for in this cost analysis, the lifetime average costs would be substantially higher.

It is true that one achievement of the treaty is the recognition of the principle that the downstream country shares the benefits it will get from storage in the upstream country. In this instance the writers believe that Canada's benefit would consist of energy as a substitute for cheaper energy available in great quantities from other sources.

It seems reasonable to suggest therefore that in a re-negotiated treaty, the cost to Canada for a 50% share of the downstream benefits, non-declining during the life of the treaty, should be not more than 2¾ - 3 mils per kwh, equivalent to the cost of energy from the cheapest alternative source.

Much could be achieved toward this objective by financing the Canadian storage projects with a 60 year loan from the U.S. Government at about 4% interest, equivalent to the current rate payable on long term government bonds. Energy costs relative to those based on Canadian interest rates at 5½% would be about 20% less.

REFERENCE

1. *Statement of Stewart L. Udall,* Secretary of the Interior, on Treaty Between Canada and the United States of America Relating to Cooperative Development of the Water Resources of the Columbia River Basin.

Author's Reply

It may be noted that, in general, the discussers did not differ with the facts presented in the paper, with the possible exception of Mr. Purcell in his comments regarding the origin of the "no boundary" principle. Clarification of the background of the development of this principle is most welcome.

Most of the discussion relates to criticism

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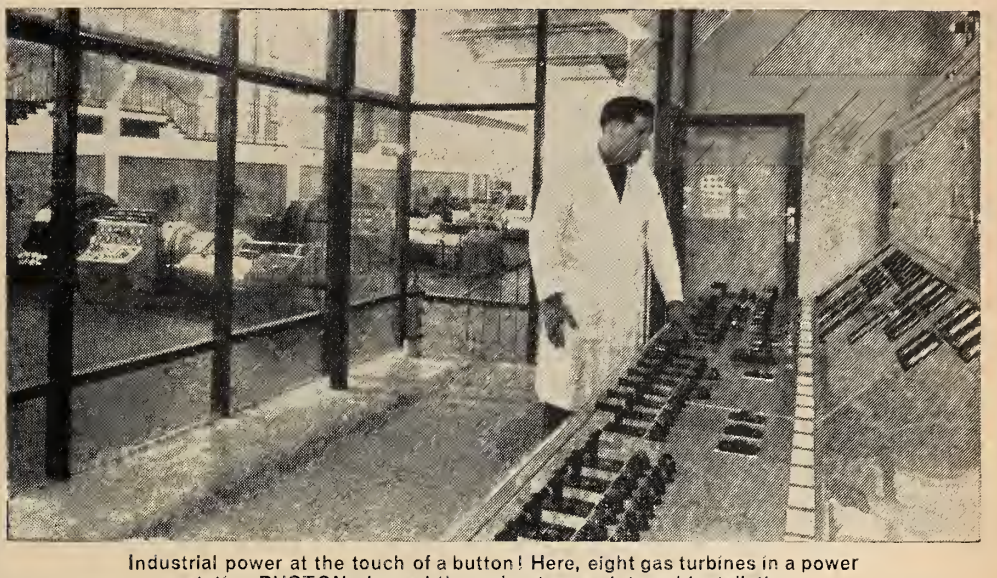

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of the Treaty and although it is not the intention to evaluate here the results of such a negotiated settlement, which took into account other matters in addition to engineering facts, it does seem appropriate for the correctness of the record to comment where errors of fact seem to have arisen or important features have not been taken into account.

General McNaughton discussed the location of major storage reservoirs in Canada and, particularly, the provision in the Treaty which gives the United States the option to construct the Libby storage reservoir. It is believed that the plan set forth in the Treaty was adopted on economic grounds with due consideration being given to the human interests involved due to the raising of Arrow Lakes, alternatively to the even greater flooding which would occur in the Upper Columbia Valley if the Dorr-Bull River-Luxor storage and diversion scheme were followed. A second point relates to the measure of control which the Treaty confers on the United States. Obviously the United States, which will be making substantial payments to Canada for the benefits resulting from Canadian storage, is entitled to participate in determining how this storage is to be operated to produce such benefits. This participation is provided for in the Treaty through the terms under which the Canadian and United States' entities will agree annually on operating plans of the Canadian storage five years in advance. This arrangement is intended to make possible the orderly planning of power production for both countries. Such joint planning would appear to obviate the possibility of any unreasonable order from the United States' entity, as suggested by General McNaughton.

In criticism of the Libby Project and the requirement that Canada must pay for the reservoir clearing costs in Canada, General McNaughton as well as Messrs. Bartholomew and Glennie, have not noted the considerable recompense which would occur to Canada from this Project. It has been estimated that Canada will receive about one-third of the total power benefits resulting from the Libby Project for about 4% to 5% of their cost. It is understood that the United States' negotiators would only waive construction of the Libby Project in favour of Canadian alternatives if Canada would make certain concessions, including an agreement to sell to the United States 275,000 kw of firm power on a long-term contract basis at existing BPA rates. The incremental cost of producing this power from the Dorr-Bull River-Luxor scheme would be about twice the price the United States was thus prepared to pay.

Another factor which does not seem to have received full recognition is that the Arrow and Duncan Projects yield the highest benefit-to-cost ratio of any of the schemes considered, a principle enunciated by the I.J.C. as the criterion for determining the order in which projects should be constructed.

The additional information and clarification of aspects of the negotiations contained in the informed discussions of Mr. Paget and Mr. Purcell is most interesting and worthy of careful perusal.

Both Mr. Paget and Mr. Purcell have referred to the limitations basic to the 1959 Report of the International Columbia River Engineering Board. These assumptions, particularly those relating to the International Boundary, the arbitrary interest rate on capital (3%), and the treating of projects as if they were constructed simultaneously, were necessary for the preparation of a report which could serve as a basis for negotiations. However, a very wide gap exists between the conclusions of such a report and the working-out of a negotiated treaty, which latter must take into account all factors, not only engineering, but also economic, legal, and political.

Mr. Purcell and Mr. McQueen have referred to the degree of flexibility contained in the Treaty. While the Treaty expresses certain principles and stipulations, it leaves the actual working arrangements to be developed by the entities who will be responsible for its implementation. As Mr. Purcell points out, such matters as adjustments in the load factor of power supplies are subject to variation from time to time by mutual agreement.

In discussing the Mica and Arrow Lakes Projects, Mr. Bartholomew and Mr. Glennie have not recognized the fact that for projects to be entitled to "first added" position, where they receive credit for the greatest benefit to the system, they must be capable of being constructed quickly. Because the Arrow and Duncan Lake Projects had the highest benefit-to-cost ratio and could be constructed prior to any of the American projects they were accepted as "first added" projects. Mica was precluded from this position because of the much greater time required for its construction. Hence, comparisons of the value of Mica as a "first added" project in comparison with High Arrow or Low Arrow as "first added" projects is unrealistic and academic. This point is well brought out in the discussion by Mr. McQueen in which he notes that "the Treaty stands or falls as a whole".

Mr. Glennie favours the "net" approach to the Treaty; that is, to divide benefits and costs between the two countries. This is understandable as being defensible in principle. There seems insufficient support, however, to his conclusion that the division of downstream benefit power on a 50-50 basis as adopted, with each country bearing its own share of costs, is unfair to Canada. It is not correct to assume that the United States has only to install generating units. It has also to develop head; that is, to construct dams and provide flowage. The American negotiators could not be expected to overlook the fact that the large dams, intakes and powerhouses already constructed in the United States were also part of the cost of providing downstream benefit power to Canada; nor does Mr. Glennie mention the considerable investment which the United States will have to make in transmission lines to transmit Canada's share of the downstream benefits to the Canadian border near Oliver. Again, the Canadian dams will be used for generation in Canada as well as to supply regulated flow to the United States. These facts and others have to be recognized in determining an equitable division of the benefits. It is very advantageous to arrive at a simple and manageable formula for this division, as was done in the Treaty.

Referring to the Kootenay, Mr. Glennie seems to consider that the provisions for future diversion will be ineffective because of prescriptive rights to river flow built up in the United States. Actually one of the purposes of the Treaty is to define Canadian rights and to exclude future claims based on prescriptive rights. The Boundary Waters Treaty of 1909 might not be effective in achieving this result since it is terminable on one year's notice by either party and any large diversion harmful to either party might be prevented by termination of that Treaty.

Mr. Glennie refers to the fact that it was unfortunate that the principles adopted by the I.C.R.E.B. regarding the "no boundary" concept were not followed throughout the negotiations. However, the I.C.R.E.B. realized this concept was too theoretical a limitation, as previously stated, and reiterated by Mr. Paget in his discussion.

Mr. Glennie's points regarding the "Libby-Arrow Lakes" plan versus the "Dorr diversion" plan overlooked the fact mentioned earlier that the American negotiators would only drop the Libby Project if substantial and costly power concessions were made by Canada.

Mr. Bartholomew mentions a number of aspects in which he believes the Treaty, as negotiated, is unsatisfactory. It must be agreed that if the Treaty had not been a matter of negotiations, the Canadian representatives would no doubt have written it differently.

Mr. Bartholomew also mentions the need for a defined coordination agreement and believes the permissive clause of the Treaty useless. He refers to I.J.C. Power Principle No. 3, although it would appear that his discussion really relates to I.J.C. Power Principle No. 7 which reads as follows:

> "In addition to benefits from cooperative use of stored water, interconnection and co-ordination of the electric power systems to the extent that they are practicable and desirable would also provide many mutual benefits which should be shared. Co-ordination being a continuing function would require specific arrangements on the part of the operating agencies as the need arises."

It is evident from the full statement including the phrases "extent that they are practicable and desirable" and "continuing function" that the I.J.C. realized there were limitations to outlining a coordination agreement in detail many years in advance. Nothing in the Treaty precludes the working-out between the entities of mutually beneficial coordination arrangements. In fact, the making of such arrangements is envisaged in the Treaty.

Concerning Mr. Bartholomew's comments about the storage credit position, there is no ambiguity in the Treaty regarding the "first added" credit position of Canadian storage committed under the Treaty. The Treaty very specifically states that the Canadian storage shall be considered as "next-added" to existing facilities, which are listed in the Treaty. In this connection Mr. Bartholomew is in error in stating that the Treaty credits Libby with "first-added" storage. Libby storage does not occupy a "first-added" credit position. It follows the "first-added" 15.5 maf. credited to Arrow Lakes, Duncan Lake, and Mica.

Unlimited right by Canada to adjust its entitlement as between capacity and energy would be desirable but Canada does receive a rather favourable right in the provision that energy is to be returned with sufficient capacity to ensure power supply at less than a 60% monthly load factor.

Mr. Bartholomew's discussion regarding Arrow Lakes and Mica is difficult to follow. The Treaty provides for transfer of storage allocated for U.S. flood control from Arrow Lakes to Mica when, and if, considered desirable. This, however, does not detract from Arrow Lakes' value as the storage reservoir to produce downstream benefit energy in the United States nor as a re-regulating reservoir necessary in order to maximize this downstream benefit energy production from flows to be discharged by Mica following installation of generating facilities.

Dr. Ruus and Mr. Muir express concern that a present review would indicate that the recommendation contained in General Principle No. 2 of the International Joint Commission has not been adhered to by Canada. This Principle states that each country should receive benefits from the Treaty greater than those to be obtained from alternatives available to that country. In substantiation of this concern, it is pointed out by the discussers that some studies, completed since the Treaty was signed, indicate that unit costs of energy produced by complete development of the Peace River and the Columbia may not, under certain assumptions, differ greatly. Reference has also been made to the estimated low cost of certain large projects on the Fraser, such as the Moran Project. Considerable caution is necessary in using these figures for economic comparisons. Generally they do not relate to the same load areas, nor is account taken of the costs during the period of load build-up. The capital investment in both the Fraser and Peace projects is relatively heavy in the early stages. It seems unrealistic to regard as available for development Moran and some other Fraser River schemes as long as their construction is firmly barred by unresolved fish problems.

Dr. E. Ruus and Mr. J. F. Muir in their discussion of the paper also refer to the possibility that the waters of the Columbia could be diverted into the Fraser River System and that preclusion by the Treaty of the right to do this is a serious loss to Canada. It should be noted, of course, that the salmon fishery agencies, both U.S. and Canadian, are resolutely opposed to power development on the Fraser. The concession made by Canada to drop the diversion of the Columbia into the Fraser, in a sense was no concession at all since diversion was earlier, and continues effectively to be, barred by U.S.-Canadian agreements and by Canadian legislation.

The high cost of the downstream benefit returns attributable to Mica Dam alone is recognized. However, the group of storage projects, Mica, Arrow Lakes, and Duncan, negotiated under the Treaty are a "package deal". Mica's primary function is future power generation in Canada.

The suggestion of downstream benefits "non-declining during the life of the Treaty" was undoubtedly considered by the negotiators. On such a basis the benefits during the early years would be lower than the Treaty now provides and higher in the later years. The difficulties of computing the benefits would be very great, involving much conjecture and bargaining on factors of a very uncertain character relating to the U.S. load developments and future values.

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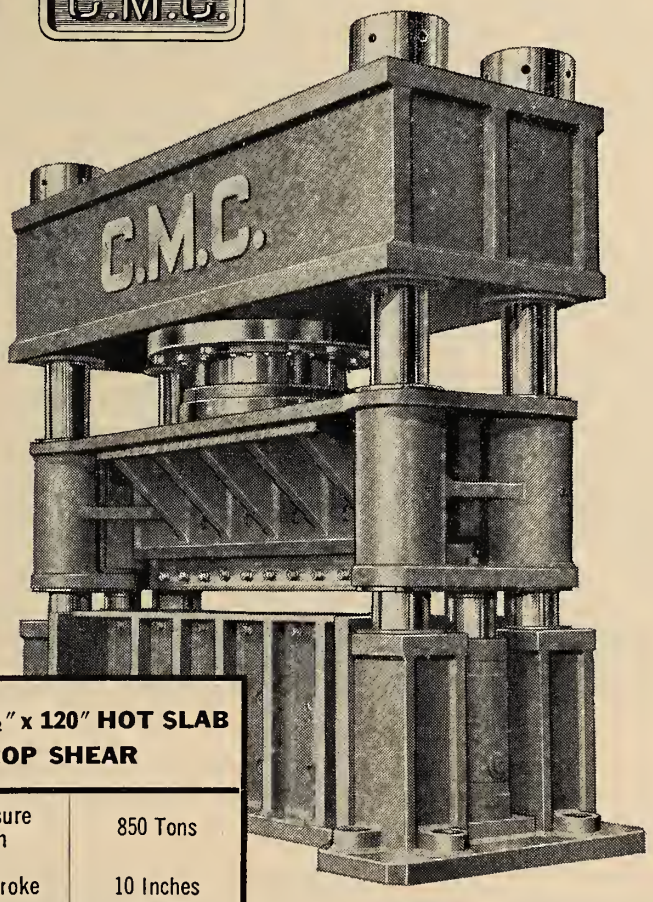

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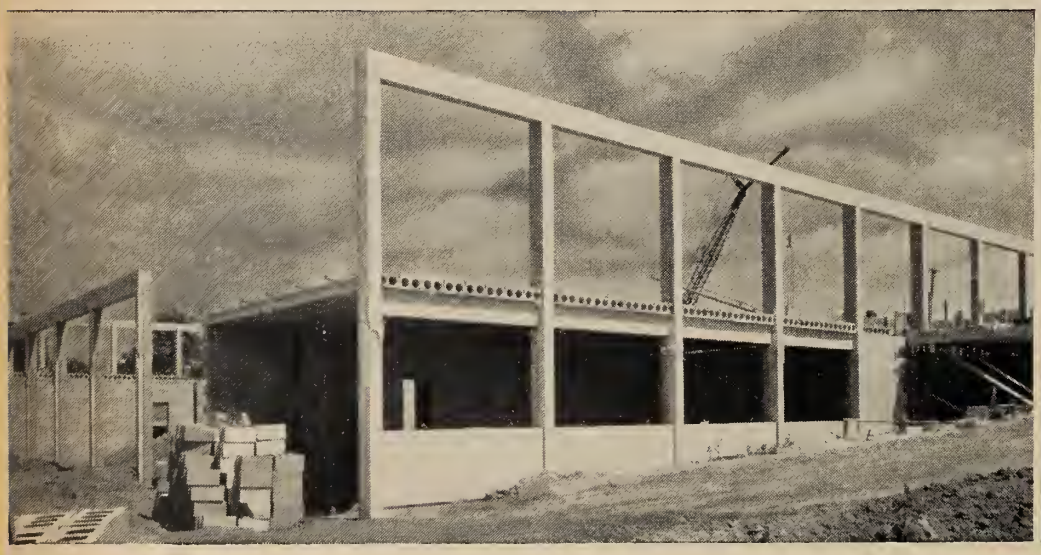

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3 Marquette Park Recreation Centre, Montreal. Owned and designed by: City of Montreal. General Contractor: Omega Construction Co. Ltd. Precast concrete members by: Siporex Company, Division of Domtar Construction Materials Ltd.

4 Riverview United Church, Calgary. Architects: H. W. R. McMillan and Associates. General Contractor: Bird Construction Co. Ltd. Supplier of precast concrete bell tower: Con-Force Products Ltd. Supplier of Ready Mixed Concrete: Consolidated Concrete Ltd.

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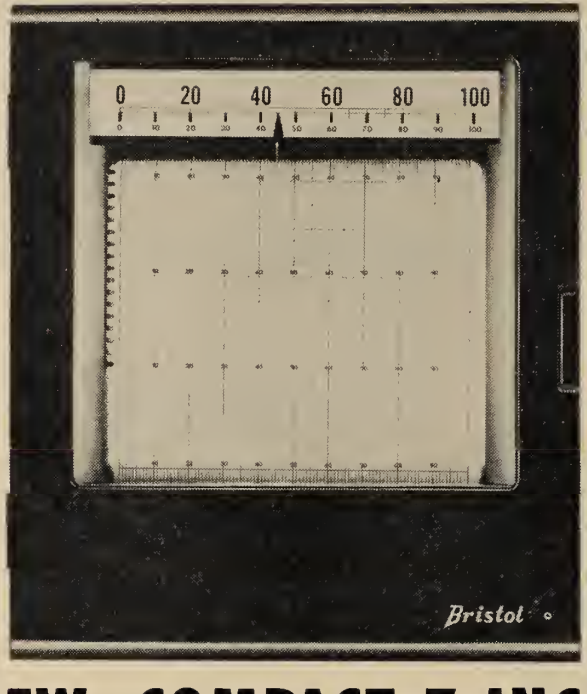
(Continued from page 128)

gressed, solid capsules were substituted for the slugs of oil, and the flow characteristics were studied. It was found that the velocity necessary to keep the capsules in suspension was less than that for keeping a slurry in suspension. The capsules being regular in shape offered less resistance than irregular particles and these capsules tended to align themselves in the fastest moving part of the stream. The capsules moved more smoothly than a slurry because the interparticle interferenee was eonsiderably reduced. The limitations of capsule transport at this time seem to be the eost of encapsulation and a method of bypassing eapsules around pumping equipment. It might also be possible to transport high-density materials such as metals enelosed in some kind of capsule. Dr. Wiggins went on to say that a new approach is being studied by the Research Council in the movement of solids through pipe lines by making a paste of the material to be transported. This paste would be inserted into the liquid stream and slugs would break off during the journey through the pipe line. The cost of encapsulation would thus be avoided.

Dr. Wiggins said that the Research Council experimental pipe lines have been limited to date to 1¼-inch and 1½-inch diameter. The time has now arrived when large-scale lines appear to be required to duplicate more exactly the conditions of the field. Experiments have been carried out on an existing 8-inch line 66 miles in length that was being prepared for a test by a pipe line company in Alberta. Permission was given to insert a variety of capsules in this line at the time the test water was being removed. Early in the test, the front capsule broke and nullified the results to a large extent since all the capsules then grouped together and moved as a single unit. However, some worthwhile readings were taken and it was found that the capsules moved at approximately 1.3 times the veloeity of the water.

A committee of industry representatives has been formed to study the economies of capsule pipelining and a survey is now underway. The results of this survey will determine whether industry is prepared to go ahead with a sealed-up program in the field.

Dr. Wiggins eoncluded his talk with a brief summary of the applications of solids pipelining and stated that he could foresee the time when commodities such as grain, sulphur, potash and coal would be moved through pipe lines. At this time it appeared that approximately 1,000,000 tons per year of any given commodity would have to be shipped through the pipe line to be ceonomically feasible. He stated that pipe lines for short hauls might also be considered in the future for such movements as sulphur from scrubbing plants to railheads and wood chips from mills to rail loading facilities. Some solids pipe lines may be designed as common carriers to move different commodities through the same pipe line.



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ESTEVAN

O. P. Lesiuk

A panel discussion on "Confederation and the Joint Agreement of A.P.E.S. and E.I.C.", was held as the February 4 meeting of the Branch. R. Bing-Wo, Registrar of the A.P.E.S., L. T. Holmes, Past-President of the A.P.E.S. and A. Guthrie, District Representative to both the A.P.E.S. and the E.I.C., were panel members. Mr. Bing-Wo gave the background of issues to be discussed at the next joint meeting of the E.I.C. and the A.P.E.S. He outlined the changes being sought, the disadvantages of the present agreement, and the benefits of Branch status. Mr. Holmes discussed features of the joint agreement, confederation and section status. He reviewed the advantages of sections becoming chapters of the A.P.E.S. rather than separate branches of the E.I.C. A lively question-and-answer period followed the panel discussion.

The 1963 Branch Executive are: Glen Hedges, Chairman; Roger Egglestone, Vice-Chairman; O. Lesiuk, Secretary-Treasurer; Bert Hamilton, Program Chairman and Bill Cunningham, Social Chairman. The Chairman was delegated to attend the Annual APES and E.I.C. meeting at Saskatoon and the E.I.C. co-ordination meeting to be held at Yorkton.

MONTREAL

E. C. Scott

About 65 engineers living in the western part of Montreal attended a meeting of the Management Section at Stewart Hall in Pointe Claire on February 21. Guest speaker of the meeting was E. R. Clark, Assistant General Manager, Industrial Development Bank, Montreal, who described the bank's activities in financing small and medium sized businesses. Mr. Clark said that in the 18 years since it was established by Parliament, the bank has made more than 8,100 loans, amounting to $462 millions, to more than 6,200 Canadian businesses for various purposes including the starting of a business or the modernization or expansion of facilities. He explained that the bank has engineers on its staff in its 22 offices across Canada to conduct "on-the-spot" investigations of customers' proposals for financing. After Mr. Clark's remarks, a film was shown describing a new business launched with the aid of a term loan from IDB.

E. C. Scott, vice-chairman of the Management Section was chairman of this meeting. Mr. Clark was introduced by C. F. B. Stevens and thanked by W. S. Martin, chairman of the Management Section. Mr. Martin said that Mr. Clark's address was one of a series planned for the Section covering topics of general interest.

ST. MAURICE VALLEY

Raymond Felix

Gaetan Cote and Guy Simard both of the Montreal Consulting Engineers firm of Cartier, Cote, Piette, Boulva, Wermenlinger & Associates, were the guest speakers at the February 19 meeting of the Branch. The title of their talk was "Perforated Breakwater-Wharf at Baie Comeau". The talk was illustrated with slides. The construction of the perforated breakwater-wharf at Baie Comeau was recently completed. The novel idea was credited to the engineers of the National Research Council Hydrodynamics Section. Basically, the perforated structure performs two distinct functions: it reduces the height of the stationary wave by dissipating some of the energy of the oncoming wave through friction and turbulence; and it counteracts the familiar undertow which tends to erode the foundations at the toe of vertical walls breakwaters. The thousand-foot-long breakwater-wharf is made up of nine reinforced concrete caisson units. To date, the structure has performed as had been predicted from theory and from models. The importance of the success of such projects, and the required help given by the National Research Council in the study and application of new hydraulic theories was stressed by Mr. Cote and Mr. Simard. The speakers were thanked by J. L. Carson.

(Continued on page 140)

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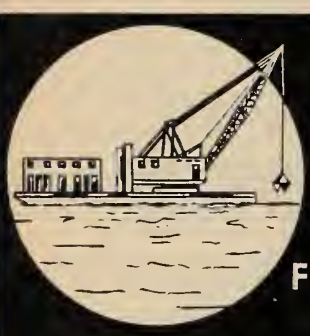

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WINNIPEG

ELECTRICAL SECTION

K. Hallson

The Branch held a meeting February 7, at which M. B. Raber, Medical Electronics Consultant, Winnipeg General Hospital presented a talk on Medical Electronics. In this speech, Mr. Raber gave a brief history of medical electronics, emphasizing the broadness of the field and the vast scope for research and development. He described some of the many electrical measurements that can be made on the human body, and indicated that at present, interpretation of these measurements can only be made empirically. Special reference was made, and examples shown of a typical electroencephalagraph. Extensive use is being made of computers to investigate the use of electrical measurements. Instruments are being used to a limited extent to monitor patients. This eases the load on nurses. An illustrated description was given on the installation of a "Pacemaker". The "Pacemaker" is a small device which is sewn into the patient's abdomen, and connected by wires to the heart. This stimulates normal heartbeat.

COMING EVENTS

Institute of the Aerospace Sciences. Second Manned Space Flight Symposium. Dallas. April 22-24.

American Welding Society. 44th Annual Meeting and Welding Exposition. Philadelphia. April 22-26.

11th National Conference on Electromagnetic Relays. Stillwater, Okla. April 23-25.

European Federation of Chemical Engineering. Annual Meeting. Frankfurt (Main). April 25-26.

American Institute of Electrical Engineers. Electro-Nuclear Conference. Richland, Wash. April 29-30.

The Iron and Steel Institute. 94th Annual General Meeting. London, England. May 1-2.

Institute of Aerospace Sciences, Society of Automotive Engineers, American Society of Mechanical Engineers. Aerospace Reliability and Maintainability Meeting. May 6-8.

Institute of Electrical and Electronic Engineers, American Institute of Aeronautics and Astronautics. Instrument Society of America. National Telemetering Conference. Albuquerque, N.Mex. May 20-22.

1963 International Symposium on Humidity and Moisture Measurement and Control in Science and Industry. Washington, D.C. May 20-23.

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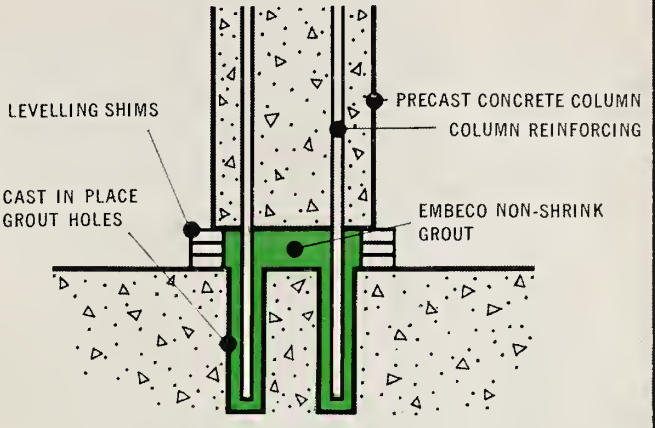

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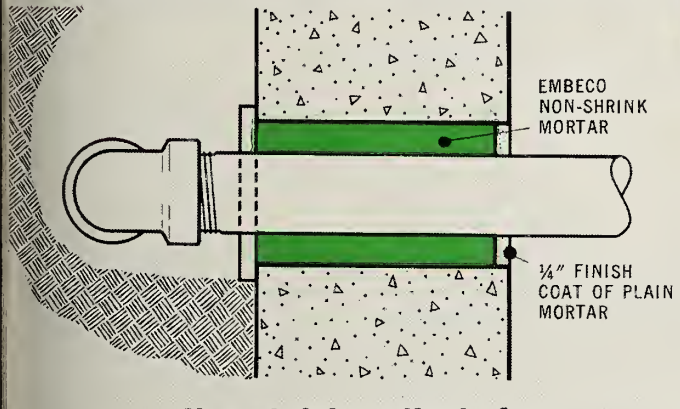

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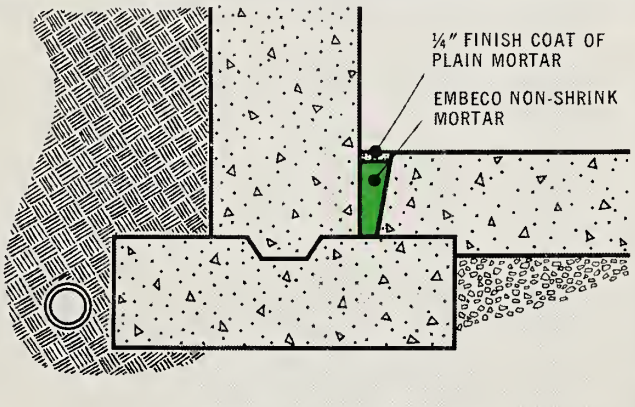

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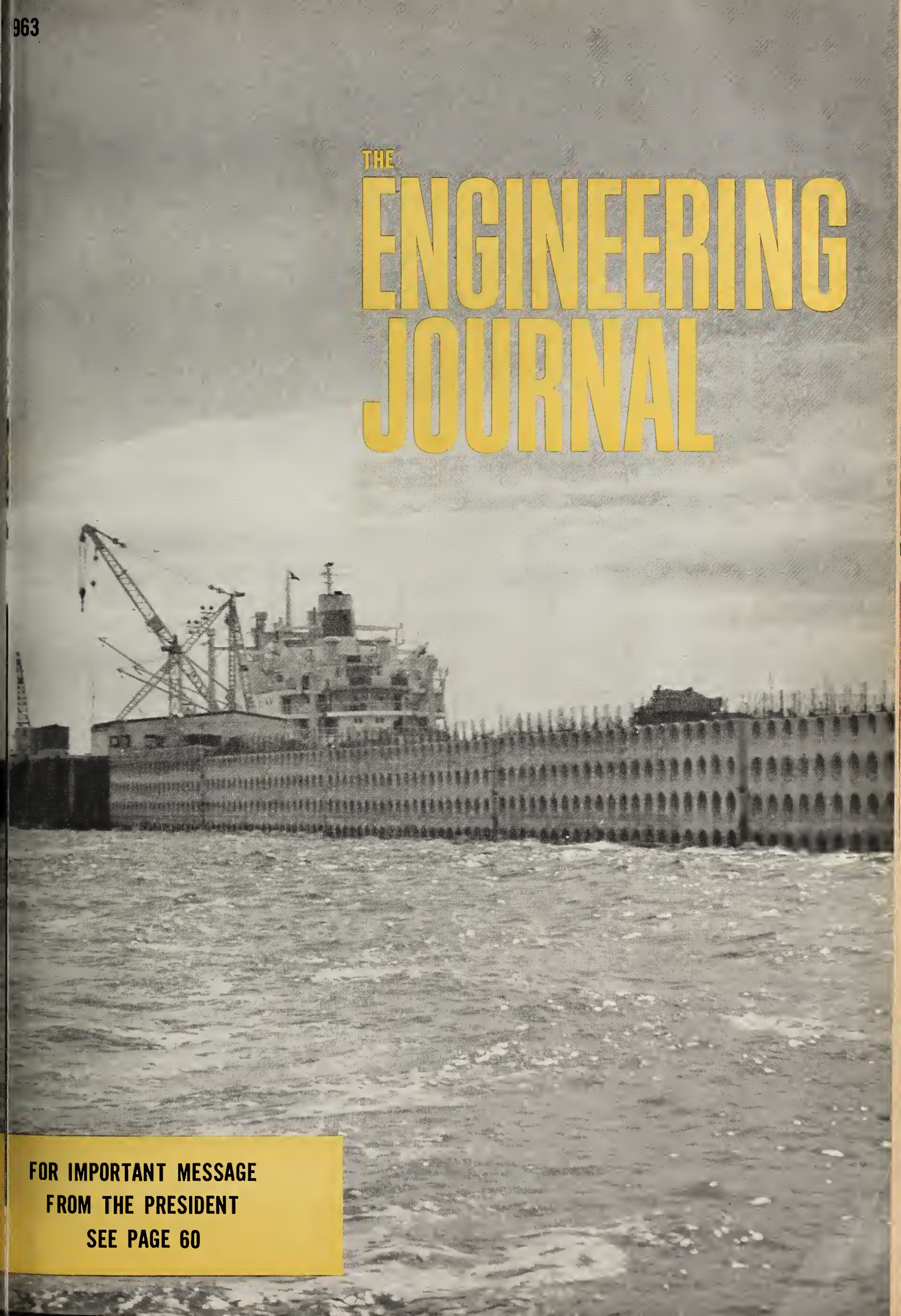

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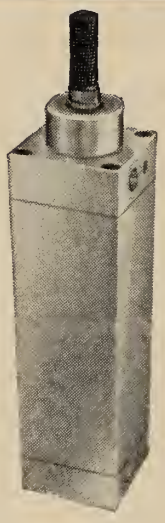

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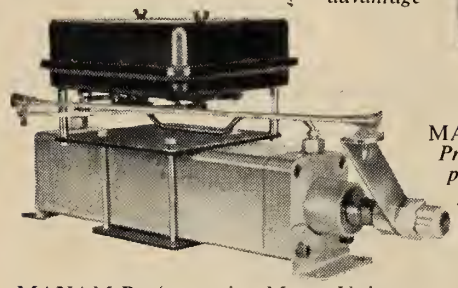

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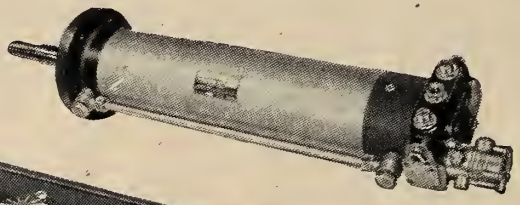

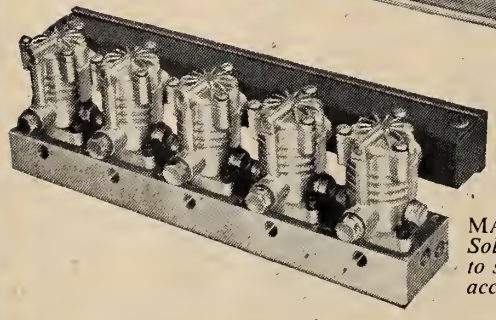

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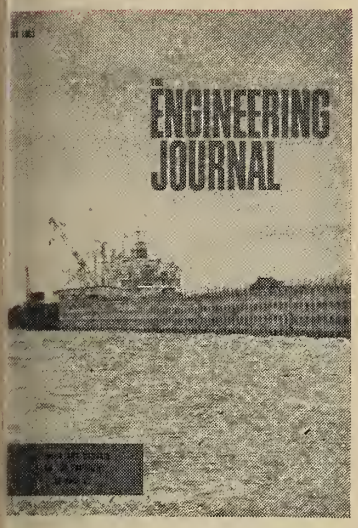

COVER ILLUSTRATION

nother example of Canadian engi-ering skill and ingenuity is shown this month's cover. The cover, and e lead paper, describe a perforated eakwater built at Baie Comeau, ue. (Photo courtesy McNamara En-neering Limited)

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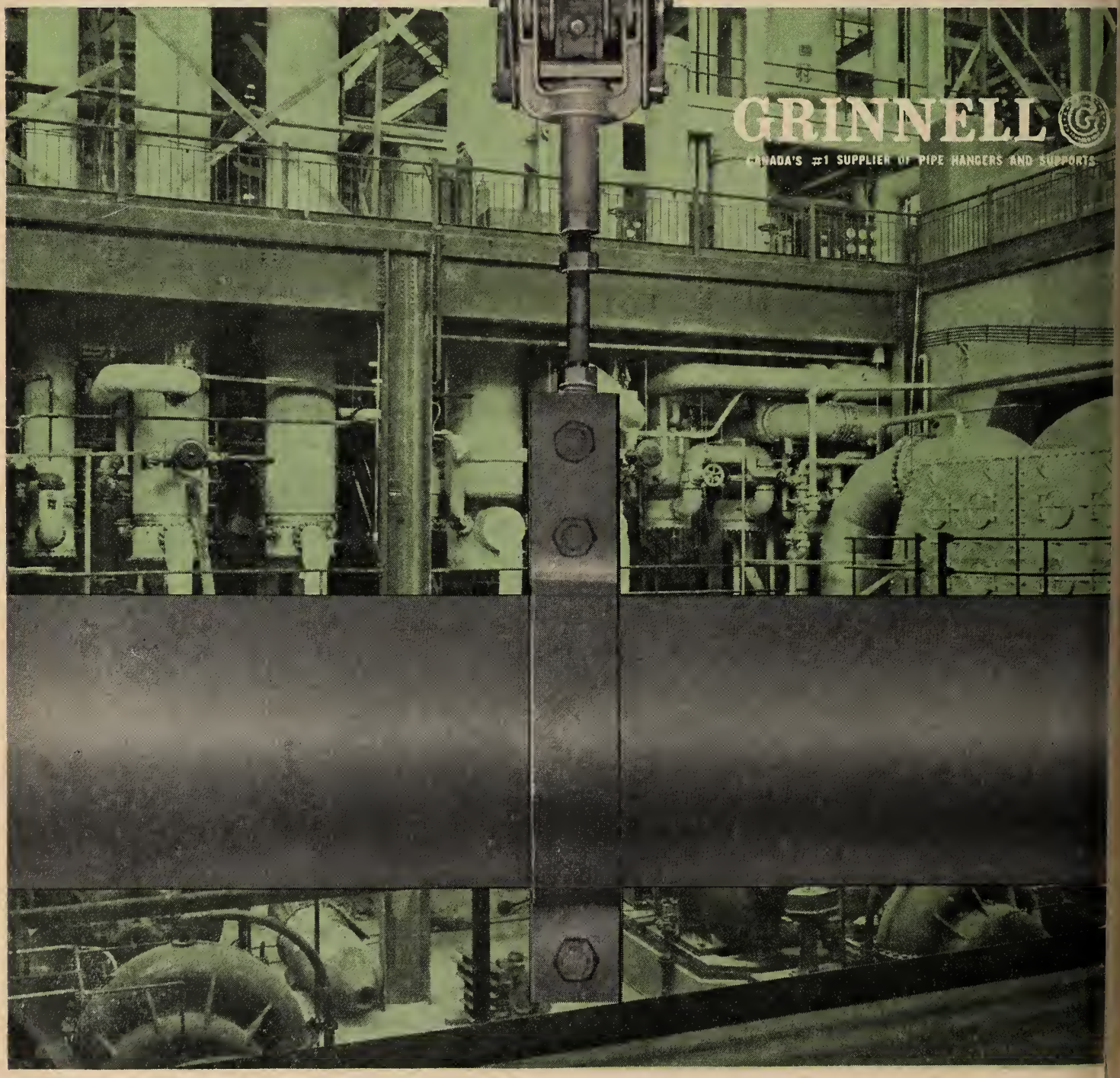

IN THIS ISSUE

Gaetan J. Cote, M.E.I.C., Consulting Engineer, Cote, Lemieux, Carigan & Bourque, Sherbrooke, and **Guy R. Simard,** M.E.I.C., Engineer, Cartier, Cote, Piette Boulva, Werminlinger & Assoc., Ville LaSalle, describe in their paper, **Le Quai Brise-Lames de Baie Comeau,** the newly constructed breakwater wharf whose novel design is credited to the National Research Council's Hydrodynamics Section. Basically, the perforated structure performs two distinct functions: it reduces the height of the standing wave by dissipating some of the energy of the oncoming wave through friction and turbulence; and it counteracts the familiar undertow which tends to erode the foundations at the toe of vertical breakwaters. The thousand-foot-long breakwater is made up of nine reinforced concrete caisson units. The structure is performing as had been predicted from theory and from model studies.

Dr. Jacob Feld, Consulting Engineer, in his paper, **Diagnosis of Distress and Failure in Structures,** states that design of structures and of erection procedures must provide sufficient resistance against gravity, minimum strength of the materials during the life of the structure, and provision against distress resulting from incompatibility of connected dissimilar materials. Any omission in any required sufficiency will result in a failure of the design. It may be a collapse during erection or after completion; it more often shows as a cracked or distorted structure with high maintenance cost and rapid economical depreciation. Practice of engineering is based on the application of proven scientific principles, but even more so on the accumulation of successful experience teaching one what to do. Often disregarded is the record of unsuccessful experience. This paper outlines how such record can become a most important safeguard in reducing and eliminating failure in design and construction operations. Examples are given of several incidents which show typical cases under various categories of failure and distress.

In his paper, **Programme D'Etudes Pour Un Ingenieur Electricien, Lionel Boulet,** M.E.I.C., approaches the problem of electrical engineering education with a broad viewpoint. Professor Boulet says his viewpoint is neither that of a market-oriented economist nor of a rigid, specialized engineer. Rather, he says, the viewpoint is that of an individual who is part scientist, part technician and part professor. The basis of the problem is that today's student must be presented a viewpoint of the situation which will exist in 1980 when he will be responsible for an important part of our technology. The author is a professor in the Faculty of Sciences at Laval University, Quebec City.

Reading machines for the blind include the simple, machines and the more complex types which cannot as yet be regarded as available to individuals. The blind have so far no machine which really enables them to read. **M. P. Beddoes,** Associate Professor, Department of Electrical Engineering, The University of British Columbia, reviews in his paper, **Simple Reading Machines for the Blind,** the present state of research and development, and attempts to extrapolate an affirmative answer to the question: Will it be possible in the foreseeable future for the blind to read from the printed page by means of a simple machine costing less than a hired sight reader?

Magnetohydrodynamic Power Generation — Its Principles and Problems, by **W. Craig Moffatt,** M.E.I.C., presents the basic operating principles of an MHD generator, and reviews some of the major problems yet to be overcome before such devices become practical realities. Typical power plant arrangements incorporating MHD channels are set forth, and estimates of the relative costs of plants and power production for a number of configurations are presented.

Discussions

Settlement Studies on the Mount Sinai Hospital, Toronto, by **C. B. Crawford,** M.E.I.C. Head, Soil Mechanics Section, Division of Building Research, National Research Council, Ottawa, and **K. N. Burn,** also of the Soil Mechanics Section, is discussed in this issue by Dr. G. G. Myerhof, Head, Department of Civil Engineering, Nova Scotia Technical College, Halifax. Other discussers of this paper are D. H. MacDonald, Director, H. G. Acres & Company Limited, Niagara Falls, Ont., and W. H. T. Wilson, Vice-President, Franki of Canada Limited, Toronto.

Carillon Foundation Studies, a paper which appeared in the October, 1961 issue of the Engineering Journal, and written by **C. H. Pigot,** M.E.I.C. Assistant Chief Engineer, Power Development Division, Quebec Hydro-Electric Commission, Montreal, and **I. D. MacKenzie,** M.E.I.C., Geologist, The Shawinigan Engineering Company Limited, Montreal, is discussed in this issue by Carl B. Crawford, M.E.I.C., Division of Building Research, National Research Council, Ottawa. Other discussers are Jerzy Gizycki and H. E. Marion, M.E.I.C.

Engineering Education, Have We a Problem?, by **W. F. McMullen,** Engineering Personnel Manager, Canadian General Electric Company Limited, is discussed in this issue by Ermo Kulmar of Vancouver.

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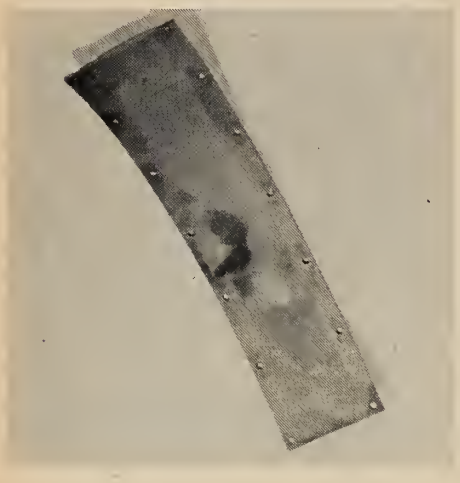
ADIPRENE has already survived:

HOT SAND

...outlasted alloy steel



Duct fitting for sand at 175° F. protected by ⅛" ADIPRENE sheet at 6 months.

Same fitting "protected" by ⅛" alloy steel plates after 2 months.

GLASS DUST

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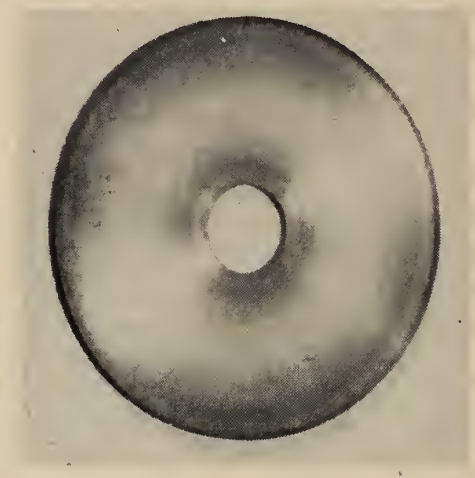

ADIPRENE textile machinery part withstands constant abrasion from glass yarn

Same part made from conventional rubber is badly worn from glass particles

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Plastic heel lift after only 200-hour wear test

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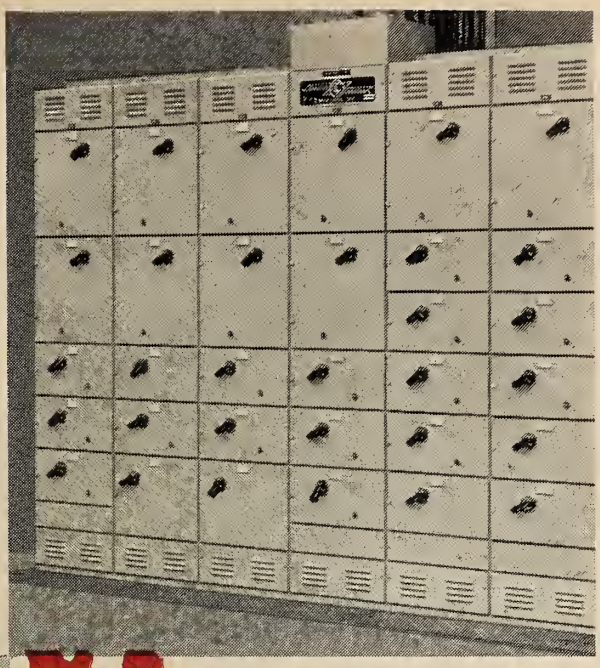

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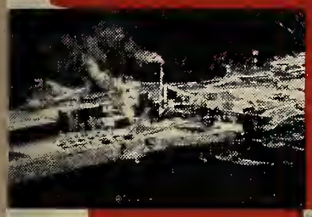


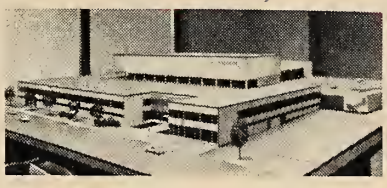
CASTLEGAR, BRITISH COLUMBIA—the Celgar Pulp Division of Columbia Cellulose Company, Limited.

MONTREAL, QUEBEC—the new Wing of "The Forty-Three Hundred" Apartments.

EDMONTON, ALBERTA—the Bank of Montreal's new building.

MONTREAL, QUEBEC—National Harbours Board, Elevator No. 4.

SAINT JOHN, NEW BRUNSWICK — Atlantic Sugar Refineries Co. Limited.



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PV-6315

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...And Acme Steel can do the same for you if you have a packaging or packaging reinforcing problem.

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CME QUALITY—The finest steel strapping, ls and accessories available in Canada— ht on your doorstep for fast delivery and rvice.

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City ..... Prov. .....
Type of Business .....

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OWNER:
Department of Transport

LOCATION:
Winnipeg International Airport

STRUCTURE:
Powerhouse

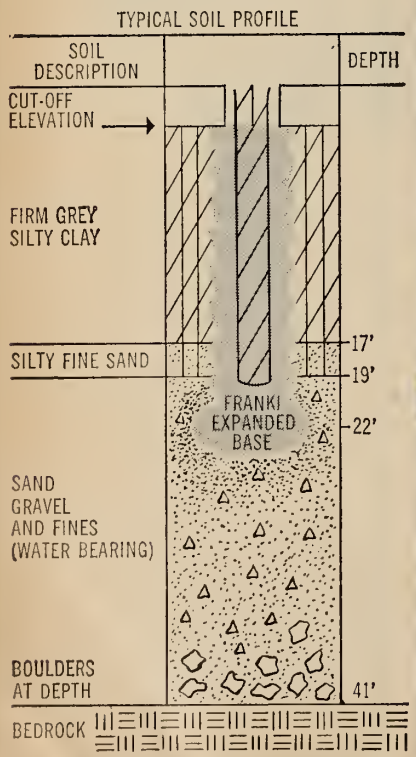
ARCHITECTS AND ENGINEERS:
Green, Blankstein, Russell & Associates

GENERAL CONTRACTOR:
Drake Construction Co. Limited

NUMBER OF FRANKI UNITS:
50 Standard and Medium Displacement Caissons all fully reinforced

DESIGN LOADS:
42 to 123 tons

DEPTH OF CAISSONS:
Average Driven Length: 22'
Average Concreted Length: 20'



FRANKI CAISSONS INSTALLED EASILY WHERE OTHER METHOD FAILS

Problem

A non-uniform soil condition existed over the site. The troublesome stratum was a thic deposit of silty sand and gravel, with boulders at depth, and which contained water und considerable excess hydrostatic pressure.

Excavated caissons could not be based satisfactorily despite considerable pumpin and could not be installed within a reasonable length of time.

Solution

After the job had come to a standstill, with half of the foundation work incomplete Franki were called in. The excavated caissons were replaced on a one-for-one basis b Franki Displacement Caissons, containing full reinforcing steel and made with sulphat resistant cement.

Satisfactory bearing capacity for the Franki caissons was obtained after driving a sho distance into undisturbed sand and gravel. Except where attempts had been made to insto the excavated caissons, this bearing was obtained in the upper part of the sand and grav stratum. The enlarged concrete bases were formed by compacting zero slump concrete, ar the surrounding soil, with high energy hammer blows. The Franki method provides unifor bearing capacity despite difference in working load and subsoil through control of the amou of energy expended in forging the base. The safety factor against bearing capacity failu in a granular soil is at least 5.

The Franki portion of the job was completed in 9 working days and our usual f guarantee applies.

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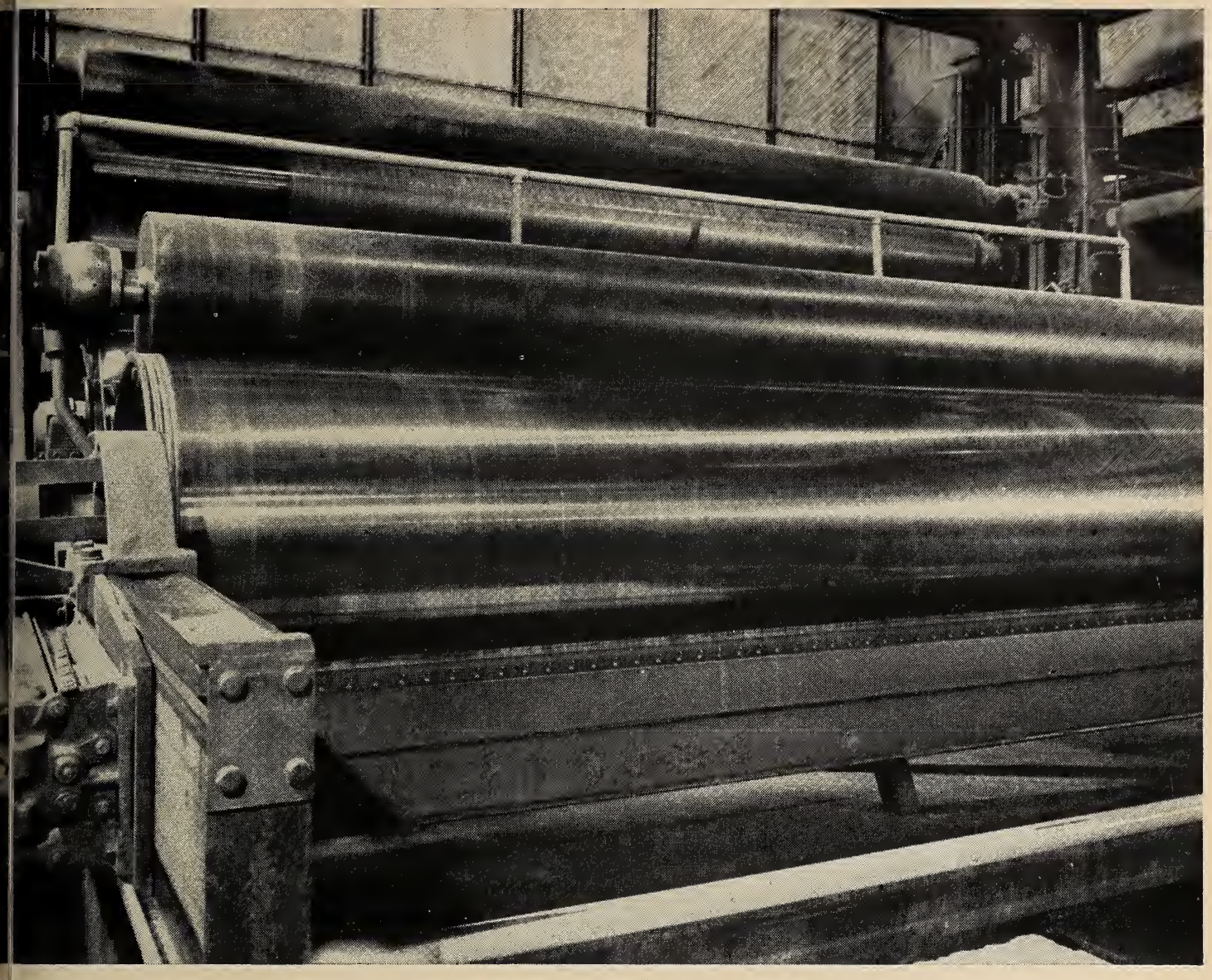
Literature - This series of job highlights, as well as other descriptive literature, will be sent to you upon request to Franki of Canada Ltd., 187 Graham Blvd., Montreal 16, P.Q.



Who can afford idle machines when downtime costs $4,000 an hour

Faulty lubrication practices in any equipment can take a huge bite out of capital investment, by drastically shortening the potential life of your equipment. Unnecessary downtime can skyrocket your maintenance costs. Finally — and most important — improper lubrication cuts man-hour productivity by lowering equipment availability.

Properly organized lubrication offers potential savings of many hundred times the cost of the lubricants themselves. But only management has the authority to make these potential savings an actuality.

With the help of a Texaco Lubrication Engineer you can institute a programme which will achieve your objectives. If your present policy permits lubricant recommendations to be made by department heads, foremen and operators — the savings from centralized control *alone* can be surprisingly great.

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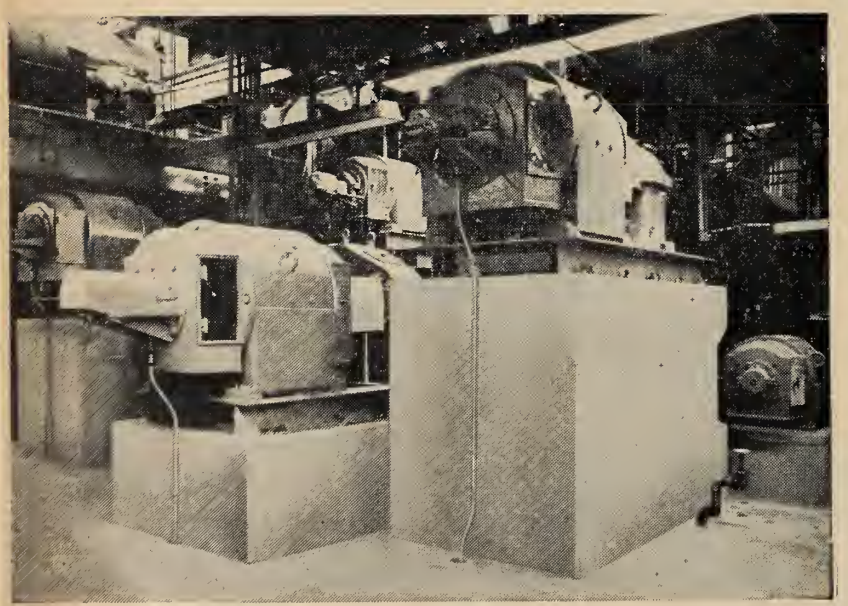
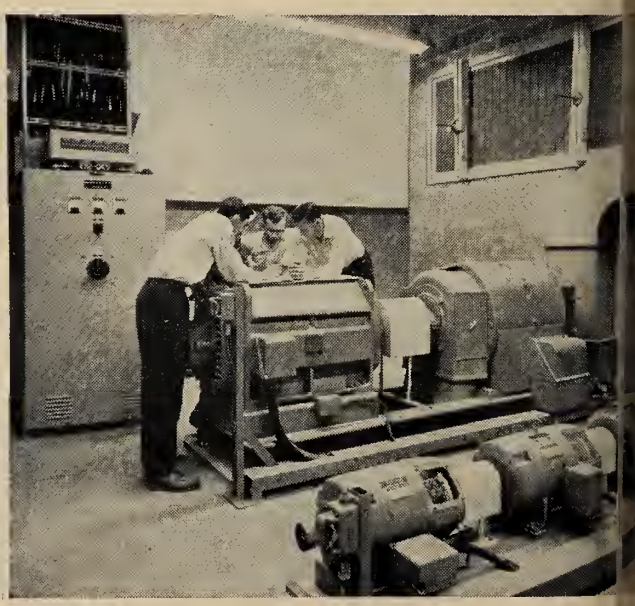
CGE SECTIONAL DRIV

General view of Main DC Control panel at Tasman Pulp and Paper Mill at Kawerau. Also, in background, at left is shown the 1750 HP 11,000 volts Synchronous Motor driving a series of DC generators. At left, centre, is a 30 HP Induction Motor driving a series of Amplidyne generators and in foreground, a 100 HP Motor driving 60 KW Exciter.



View of wet end of paper machine showing a cluster of DC drive motors for Couch 400 HP—Wire Drive 400 HP, 3-Press Motors each rated at 300 HP, and 2 Helper Motors.



Control panel (in background), Main M.G. set (350KW an iary M.G. set for the 7000 ft.-per-minute mechanical te

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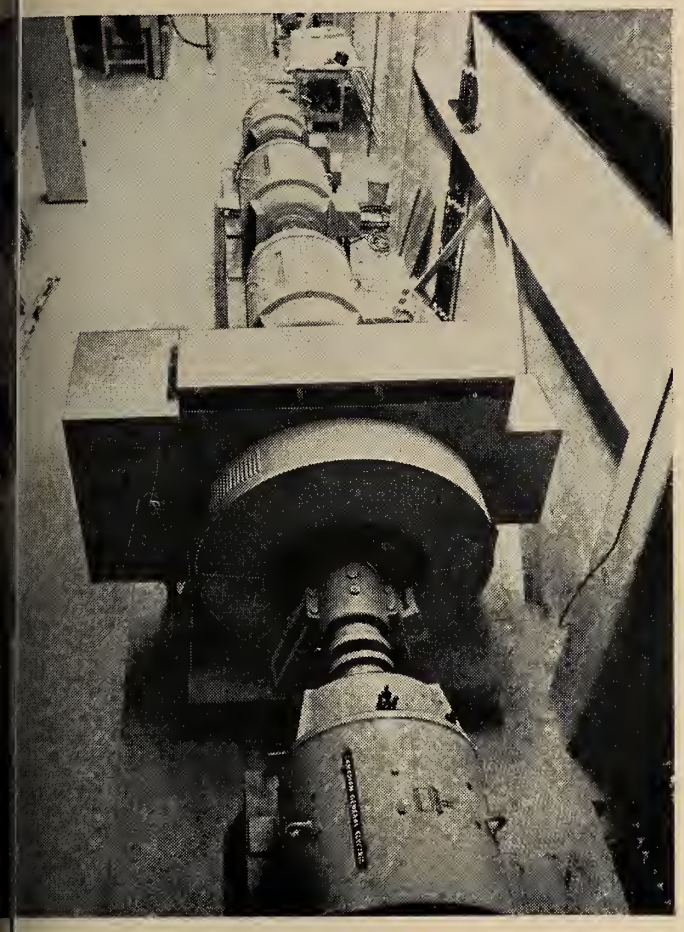
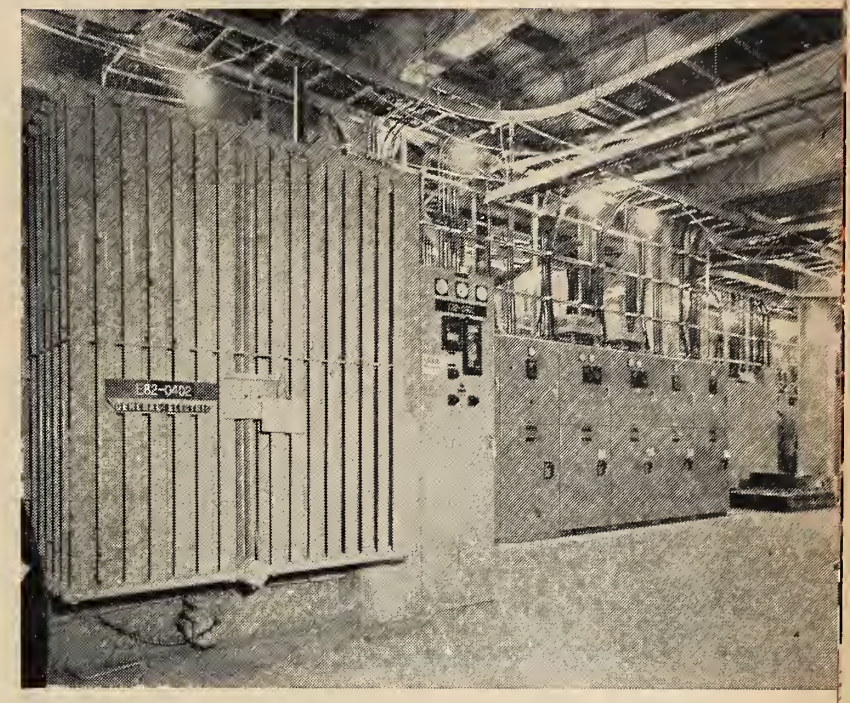
chosen by New Zealand aper mill...



Overhead view of dry end of M.G. Set showing the 1,750 HP, 1,000 volt, 1,000 RPM Synchronous motor, with main sectional generators—ranging from 400-150 KW.



Shown at left is the 3000 KVA Step-down Power Transformer (from 11,000 to 3,300 volts) for auxiliary motors. *Limitamp Controls for these motors are shown at right.

Tasman Pulp and Paper Company Limited ntly expanded its Kawerau Newsprint Mill New Zealand.

o meet the exacting demands and rigid specitions stipulated to drive the new 290″ wide hine—at an ultimate speed of 3,000 feet per ute—a CGE Sectional Drive was chosen bese of its efficiency, ease of operation, precision minimum maintenance requirements.

he flexibility of this Sectional Drive, with E's Multiple generator system, is one of its t important features, making extra functions sible for maximum production and quality.

The operator has draw control at his finger tips, without backlash or delay and once set, draws are precision held. It is possible to monitor and regulate tension continuously, and since the power input to each motor is measured, the operator can "spot" unusual conditions on the machine, set up draws as desired and check for other variables.

Full range regenerative braking means quick stops. Controlled acceleration means minimum time to get back on the line. These two features alone assure less down time. There are no mechanical brakes to maintain, and the compact CGE section drive unit takes up a minimum of space.

For further information on a full range of Paper Mill Drive Equipment, contact the CGE Sales offices nearest you, or Apparatus Department, Canadian General Electric, Peterborough, Ontario.

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ALLEN and GWYNNES experience is unsurpassed throughout the world in pump engineering, and behind it stands a record of design, craftsmanship and production technique which extends well over 100 years Today the research and testing facilities of ALLEN and GWYNNES are in the forefront in this field of engineering.

Both ALLEN and GWYNNES pumps of all types, sizes and capacities up to the largest needed in modern service, are employed for essential services and in many industries in every part of the world.

The new ALLEN-GWYNNES pump test house at Bedford, believed to be the most advanced of its kind in the world, is capable of testing very large pumps to the highest standards required commercially, including medium and low head pumps with both horizontal and vertical branches.

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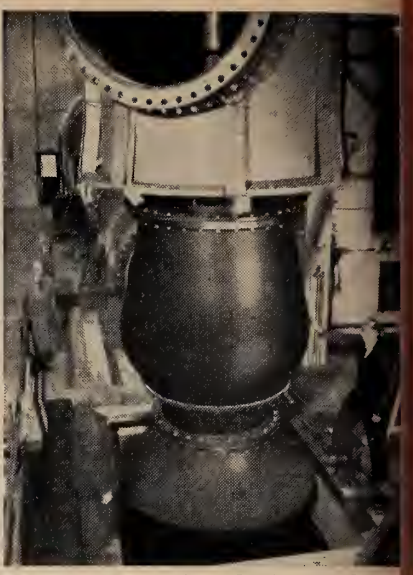
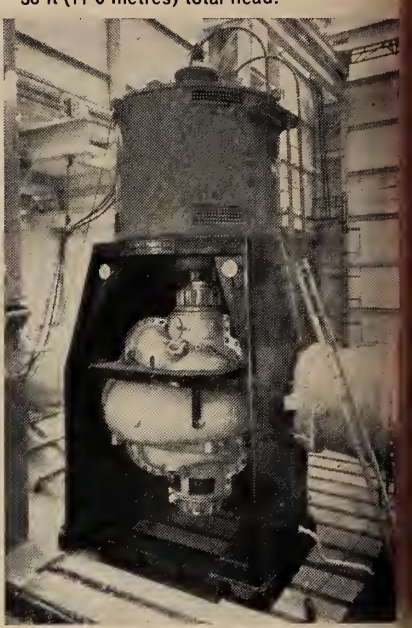
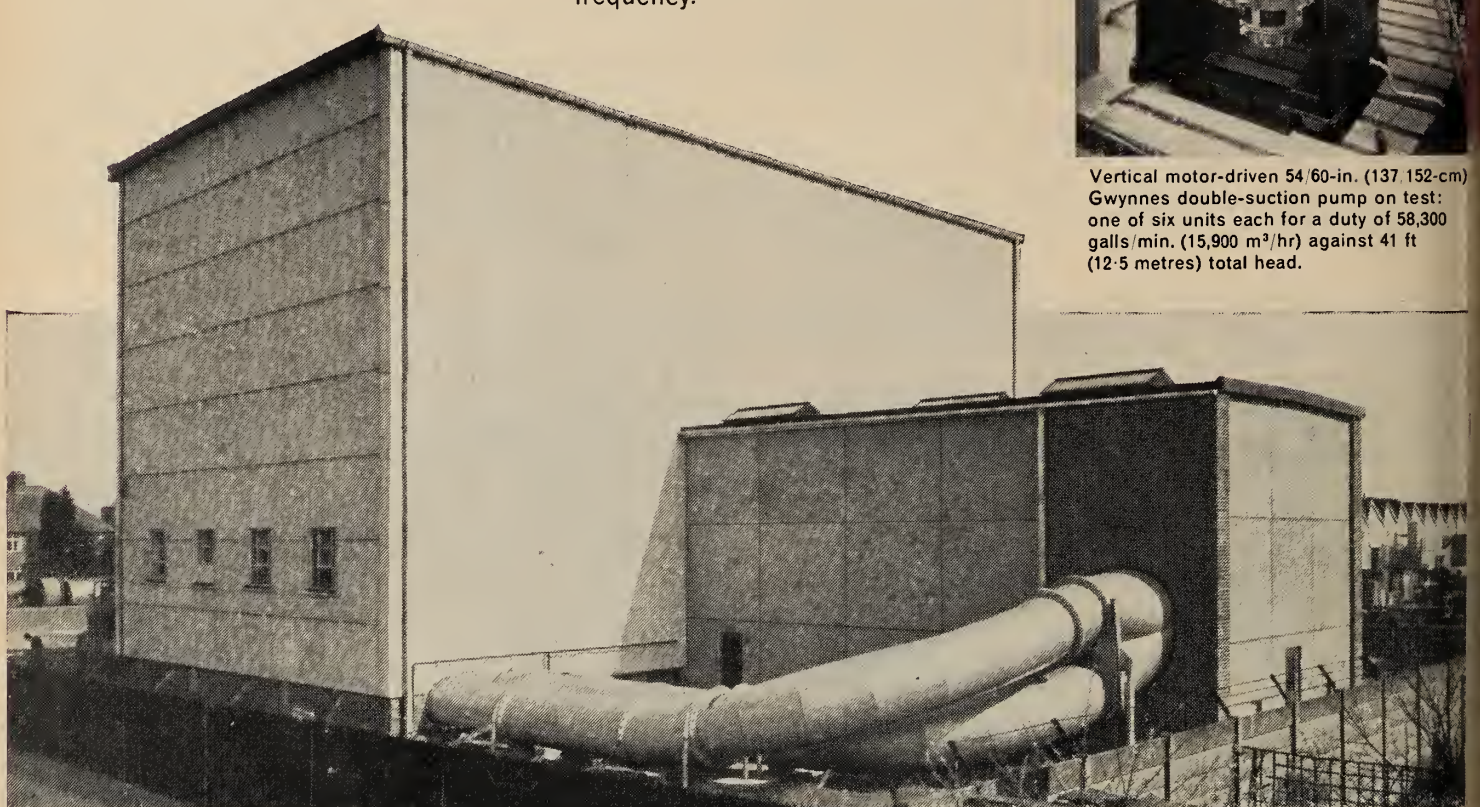


A 54-in. (137-cm) Allen-Stork mixed-flow suspended pump being lowered into position in the test sump. Pump duty: 64,000 galls/min. (17,400 m³ hr) against 38 ft (11·6 metres) total head.



Vertical motor-driven 54/60-in. (137 152-cm) Gwynnes double-suction pump on test: one of six units each for a duty of 58,300 galls/min. (15,900 m³/hr) against 41 ft (12·5 metres) total head.



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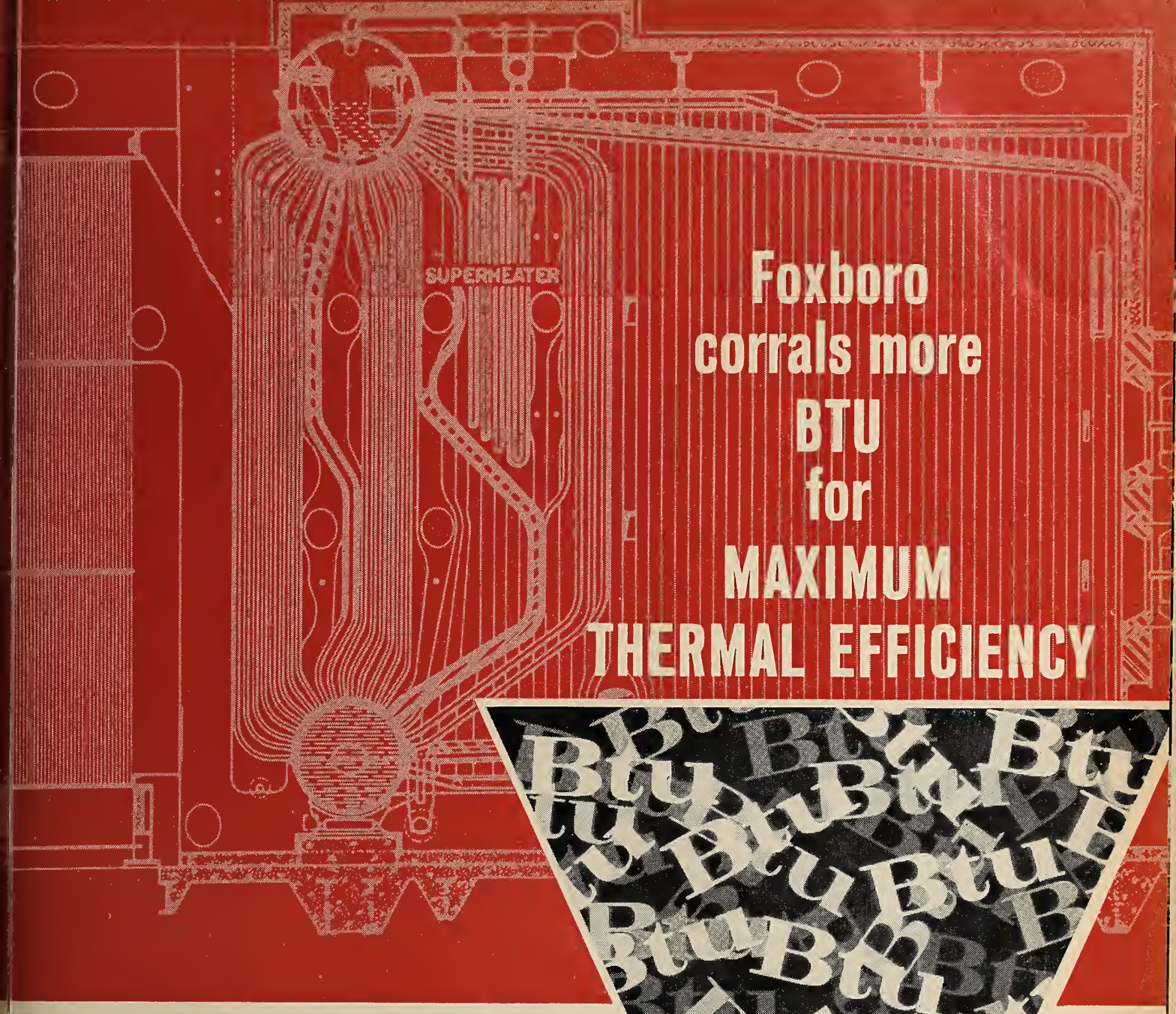

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The Foxboro Company's capability for waste heat or power boiler control is clearly demonstrated by the installation shown below.

Here, the accuracy of Foxboro Electronic Consotrol* instruments assures maximum use of waste Btu by maintaining extremely close control over flue draft and other variables. Measurements are electrically transmitted over standard 2-wire leads, unaffected by dust or freezing weather conditions. The simple, maintenance-free Foxboro system controls all boilers from a single, central location.

Waste-heat, power, chemical recovery—whatever your boiler control problem—you can rely on Foxboro systems—engineered instrumentation to help you solve it better. For detailed information contact the Foxboro branch office nearest you. A Foxboro sales engineer will be happy to discuss your problem with you. For Bulletin 21-10 ELECTRONIC CONSOTROL INSTRUMENTS, write: The Foxboro Company, Limited, 707 Dollard Avenue, LaSalle, Quebec.

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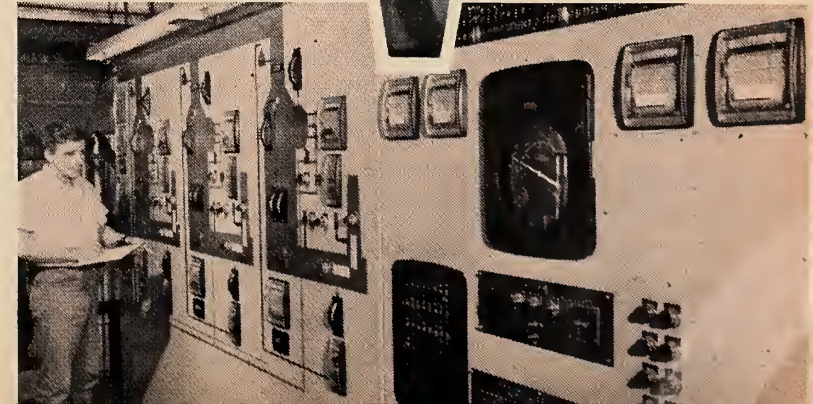
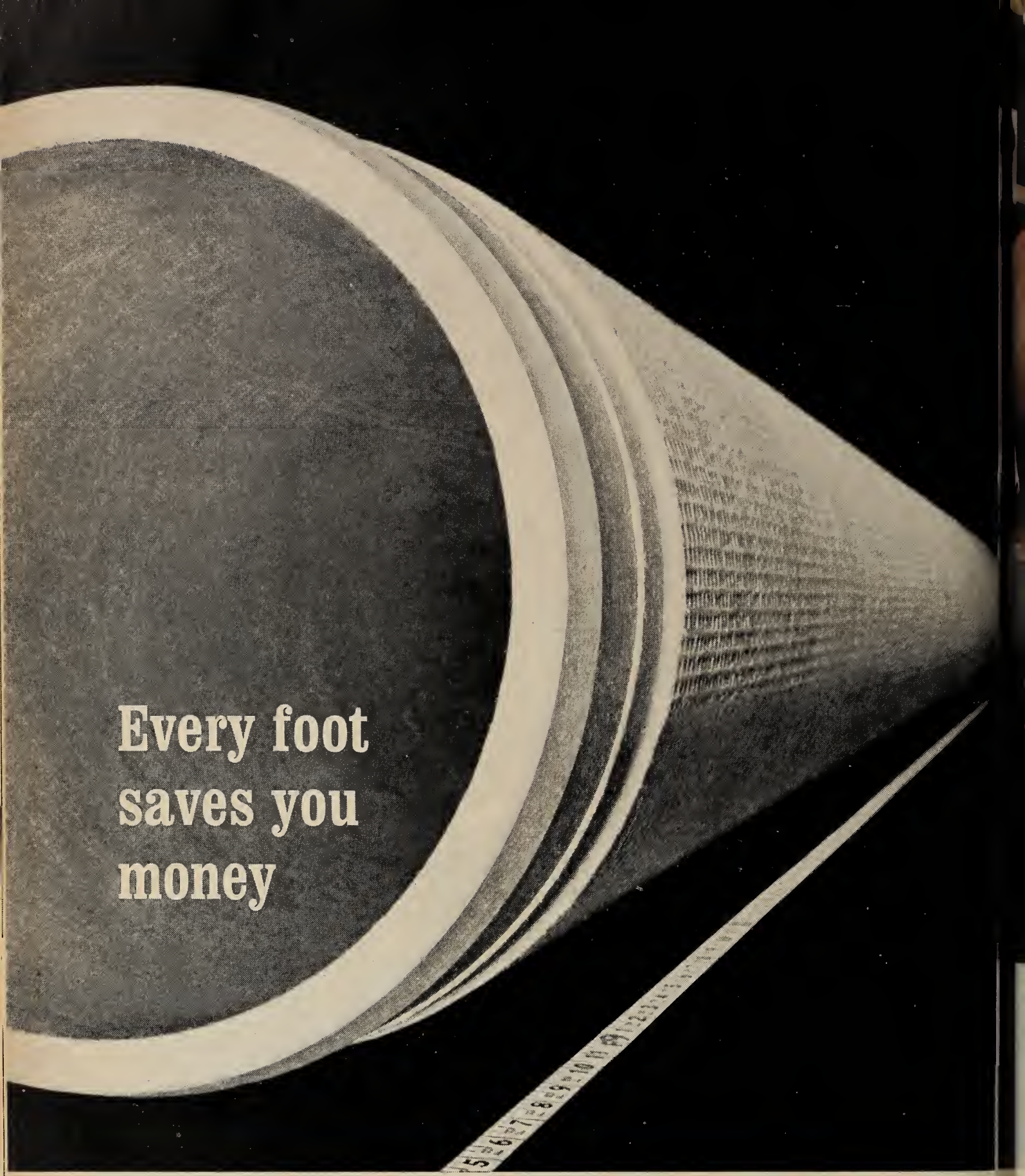


Operator checks readings on Foxboro Electronic Consotrol all-solid-state indicating recorders and controllers. System controls three open hearth waste heat boilers.



When you figure installed cost, Johns-Manville Transite* pipe is the most economical water pipe you can use. It's lighter. You can haul more of it per truck. In most cases no mechanical equipment for handling or assembly is needed. It goes in fast.

Pre-belled with exclusive Ring-Tite* Couplings, you get a water-proof seal at every joint . . . flexibility that lets you lay Transite around 5° bends without special fittings. Add to this the economy of longer life and no maintenance and you see why it's easy to save your community up to 15% on every foot of pipe insta ed. Let your local J-M representative work out the sa ng you can realize by using Transite pipe on your ex job. Or write to Canadian Johns-Manville, Port C dit Ontario, for full particulars and technical data.

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These are the reasons why important cable orders of recent years have been placed with Phillips.

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WIRES CABLES

6033

OUTSIDE HELP WITH INSIDE KNOW/HOW

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Giving your repeat orders the same detailed attention as initial projects. Working for you—but paid by Armco. Seeing every job through to completion. Achieving the finest results at the lowest cost—with Canada's widest range of engineering products for drainage and construction. Use his expert know/how to solve your problems. Head office at 1805 George Street, Guelph, Ontario.

ARMCO Drainage & Metal Products of Canada Ltd.

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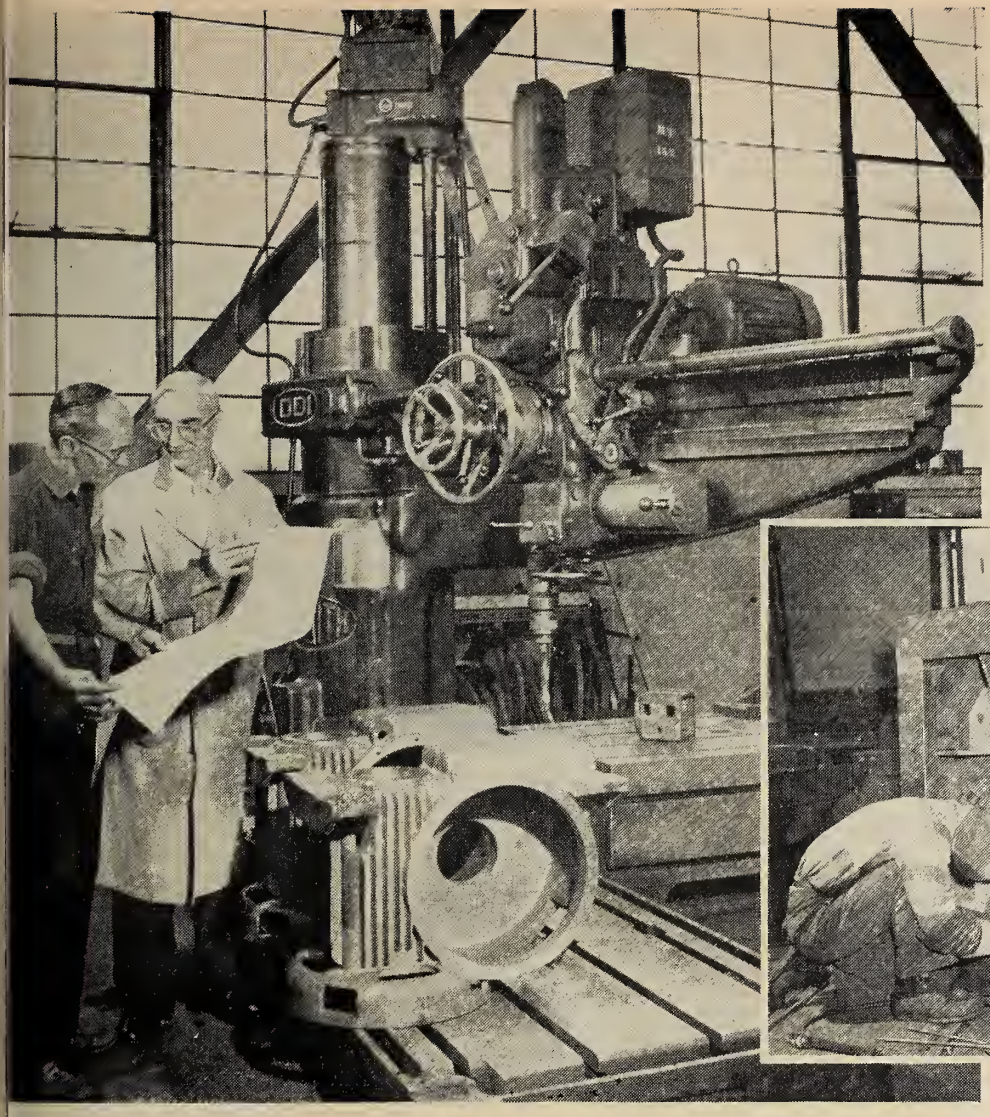
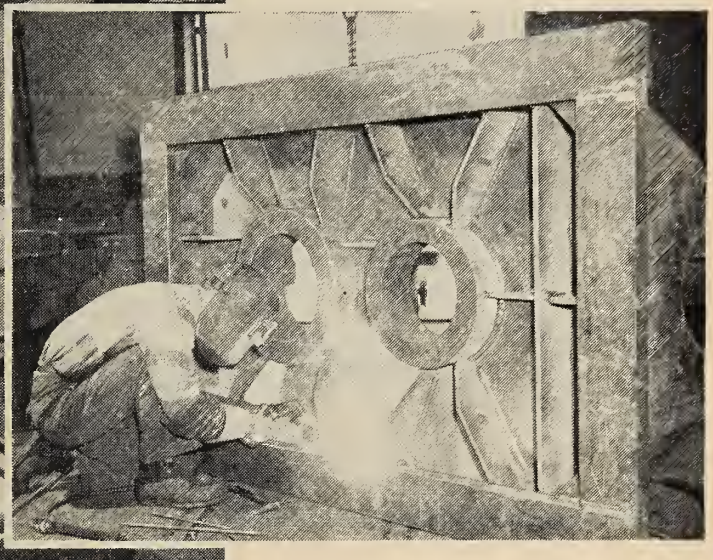


Housing for special motorized worm gear unit for custom application

Welding the steel housing of a custom designed gear unit



HAMILTON GEAR is fully equipped to design, engineer and produce all types of Gear units

Hamilton Gear is equipped to engineer and design all types of standard and special gear units which are completely produced in our own plant.

Hamilton Gear's facilities include shop equipment capable of producing heavy duty gears up to 21-foot diameter; the complete machining and assembling of components; and custom weldments for special housings and bed plates, etc.

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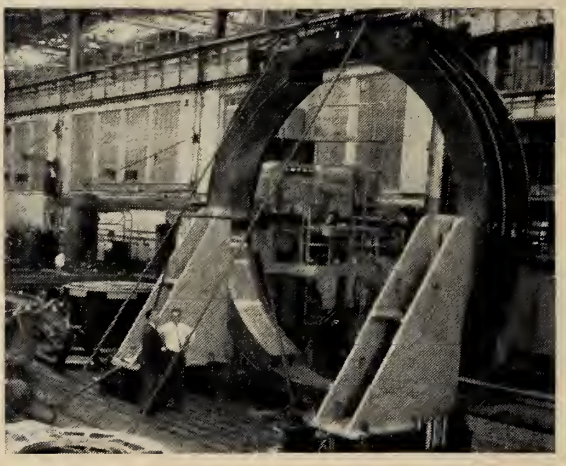

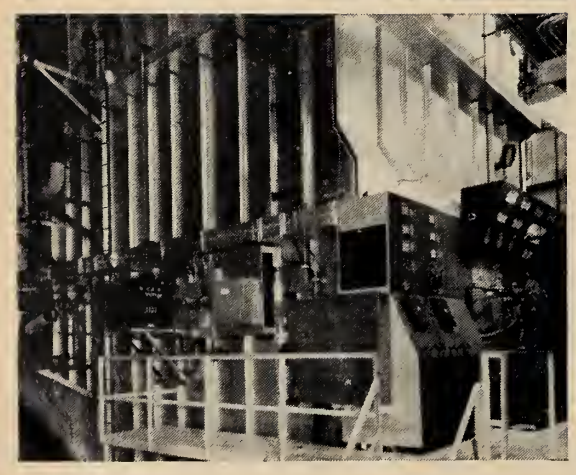

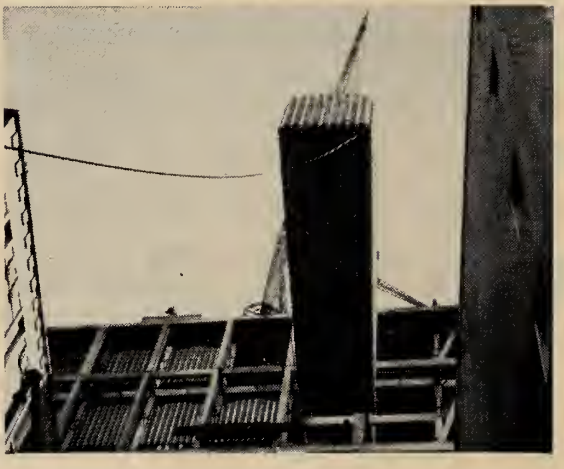

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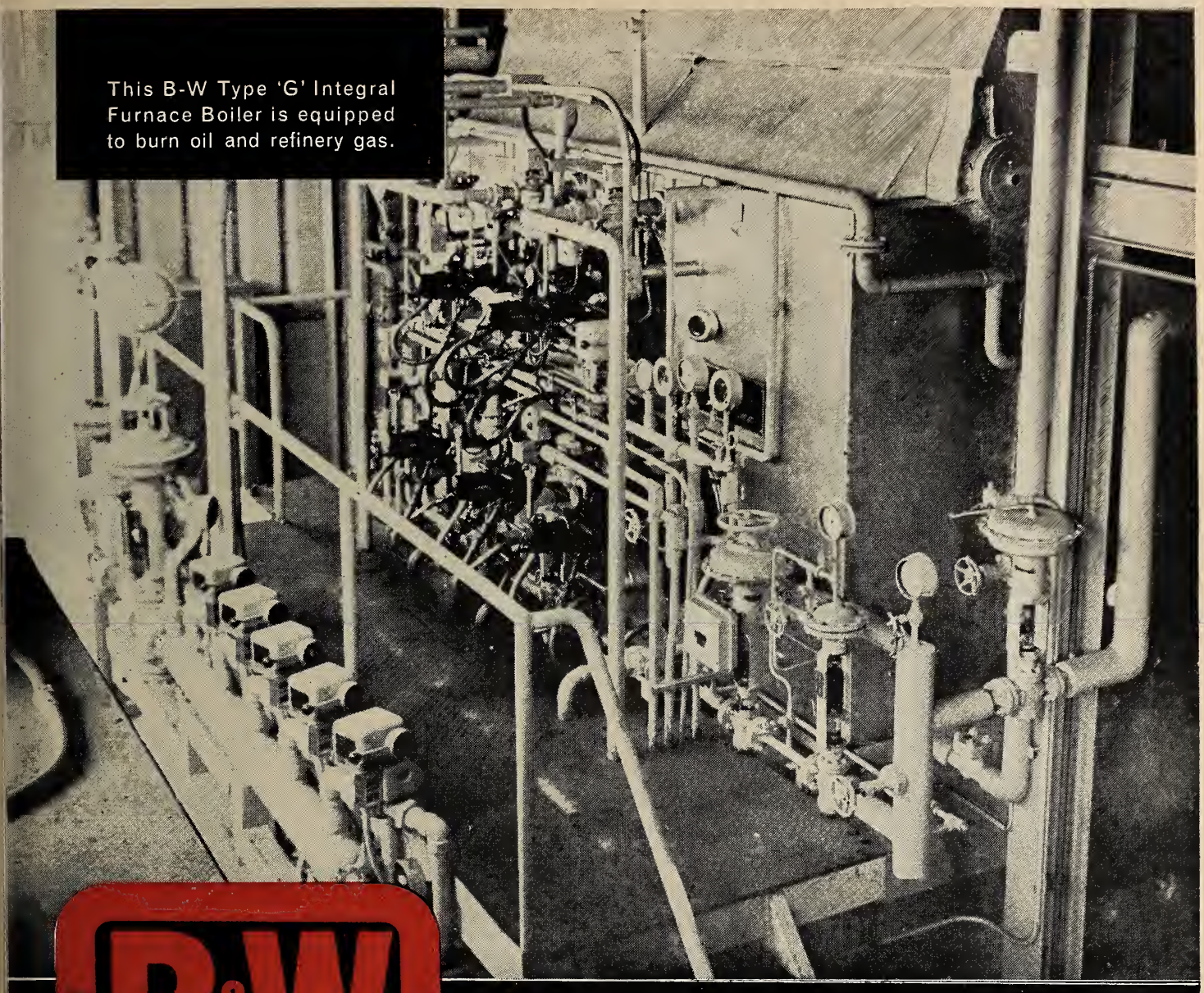
1. Sluice gates for Hydro-Quebec elect power development at Carillon, on Ottawa River
2. End shields for CANDU nuclear pov project, Douglas Point, Ontario
3. 100,000 lbs. per hr. steam generator McGill University, Montreal
4. 32,500 gal. stainless steel fermen tanks for Molson Breweries Ltd. in Montreal.



This B-W Type 'G' Integral Furnace Boiler is equipped to burn oil and refinery gas.

B&W BOILER ASSURES UNION CARBIDE CANADA LIMITED OF 100,000 LBS. OF SUPERHEATED STEAM PER HOUR

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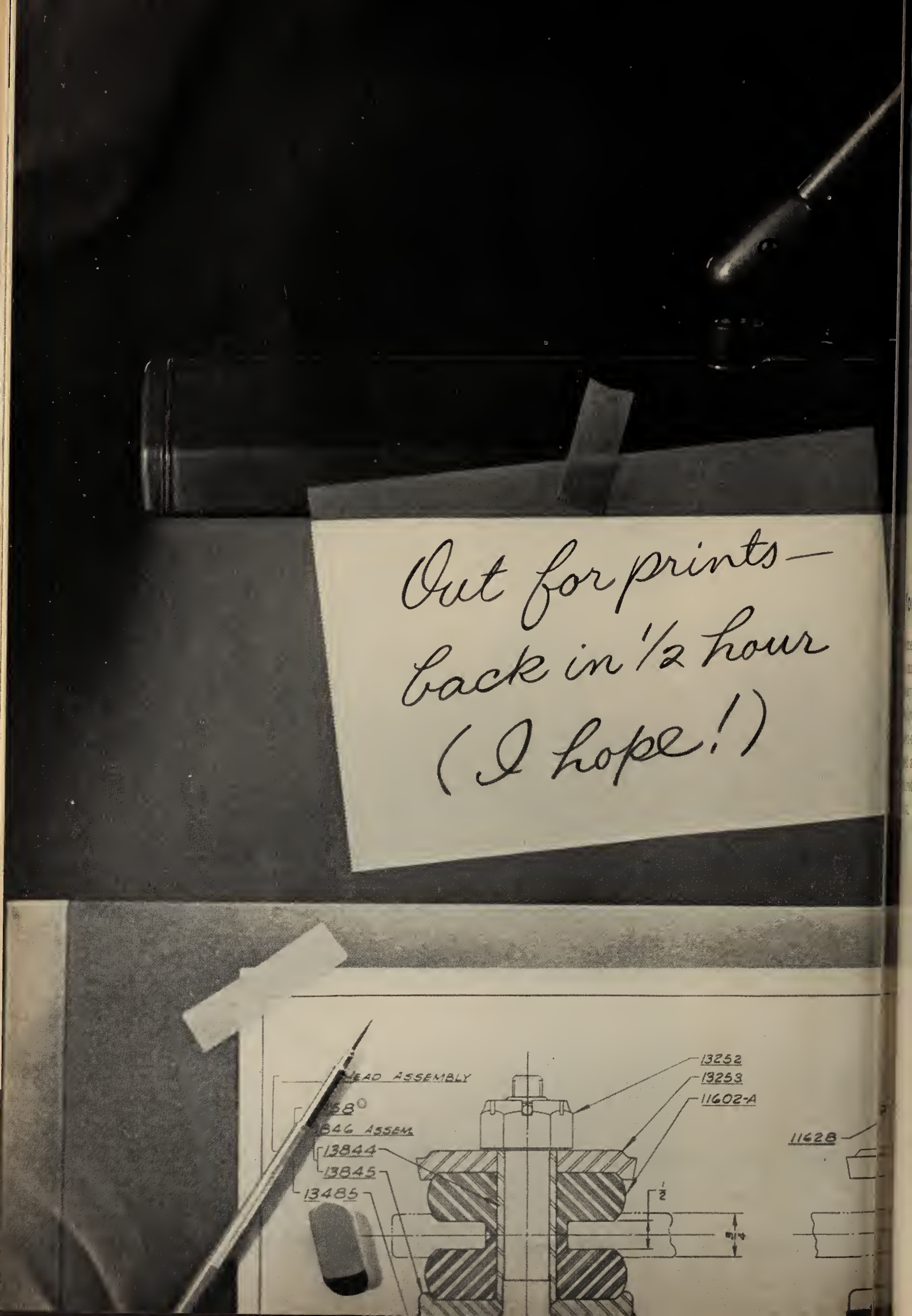
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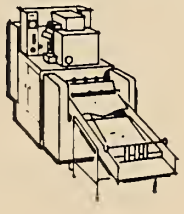

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You really could use our new Westinghouse PB chiller as a desk—it's that quiet and that free of vibration. Handsome enough for an office, too. Doesn't even look like a chiller. Admittedly, it makes a pretty expensive desk, but as a chiller, it's a real bargain! In popular 20, 25 or 30 ton capacities, PB chillers feature exclusive Westinghouse Guardistor motor protection . . . the most sensitive protection against motor burn-out ever developed. You also get two-way freeze-up protection. So versatile and light you can hang it . . . but, hang it, there's not enough space to give you the whole story. Better find out for yourself. PB chillers are the latest Westinghouse products dedicated to highest performance at low installed cost. Want more facts? Call your nearest Westinghouse office or write Sturtevant Division, Galt, Canada.

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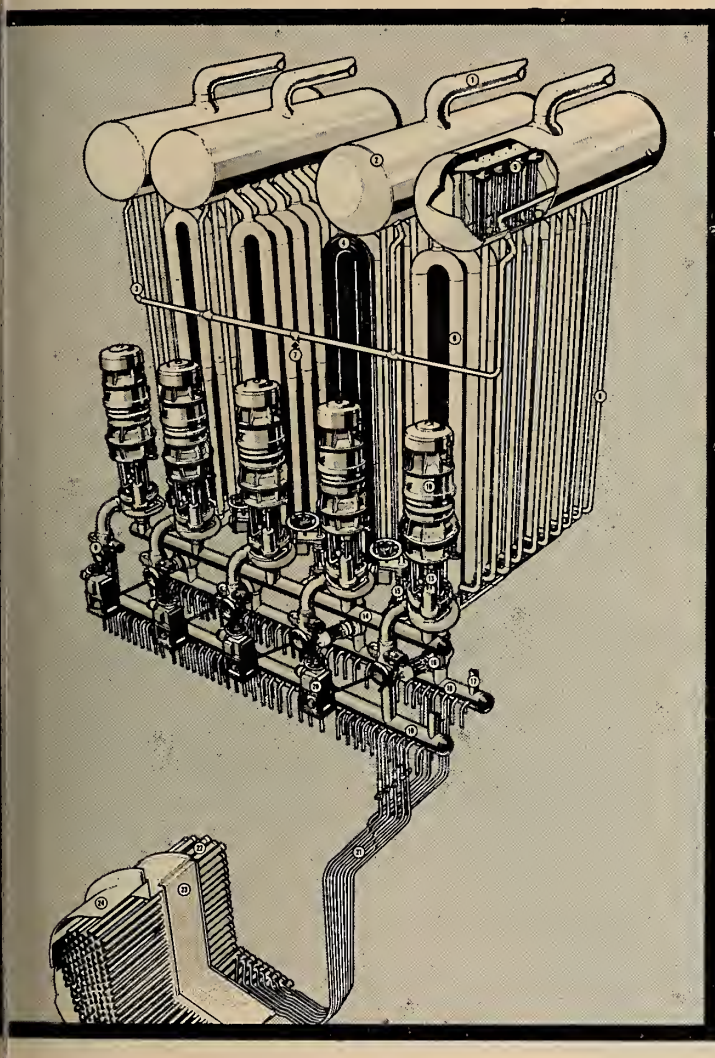
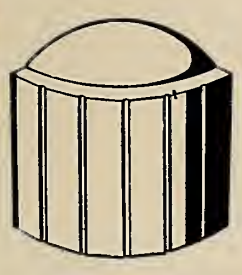
CANADIAN WESTINGHOUSE COMPANY LIMITED

MLW meets the challenge of ATOMIC ENERGY...

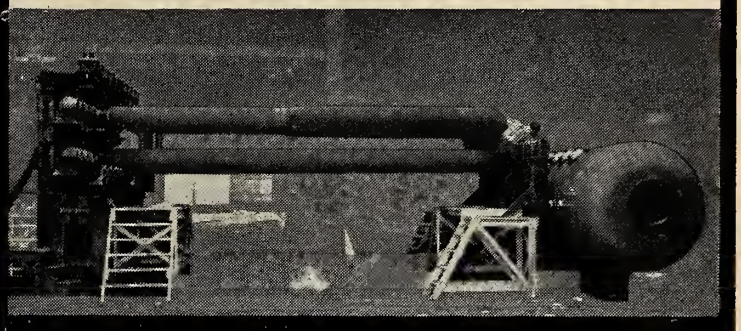
MLW experience and facilities are put to a new test on the nation's first full-scale nuclear power project.

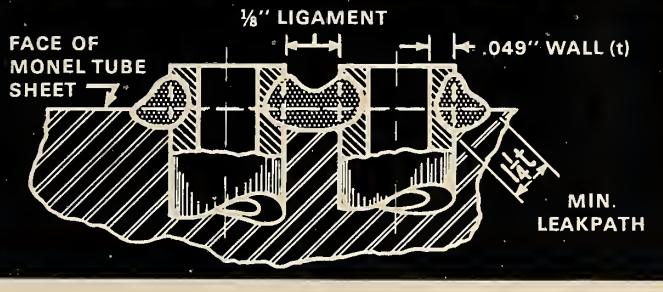




Shown at left are four of eight steam generators being made by MLW for the Nuclear Power Station of Atomic Energy of Canada Limited at Douglas Point, Ontario. This reactor, code-named CANDU (Canadian Deuterium Uranium) will use natural uranium as a fuel and deuterium oxide (heavy water) as a coolant and moderator.

(below) Check assembly in shop.
(bottom) Integrity of tube end welding is critical.





vital part of the Douglas Point CANDU" reactor is the group of eight enerators which produce steam by exanging heat from heavy water. Genering 2,500,000 lbs. of steam per hour ey have to be of unquestionable quality, erefore thermal engineering and fabrition ability of the highest order are perative. A major goal is to minimize th hold-up and leakage of high-cost heavy water (about $1500 per cubic foot). For this new challenge, MLW is employing new techniques, equipment, and procedures for producing tube to tube sheet welds of extraordinary integrity and dimensional consistency. In addition, new scientific inspection methods are demanded... new shop assemblies are necessary...new solutions to many other problems have had to be worked out. All this is being achieved by combining up-to-date knowledge with time-proven experience and skills.

As additional nuclear energy stations are built in Canada and overseas, MLW stands ready to provide the unique combination of knowledge, skills and special equipment which are going into these steam generators.

MLW

For further information write to:
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MONTREAL LOCOMOTIVE WORKS LIMITED
1505 Dickson Street, Montreal 5, P.Q., Phone CL. 5-3681

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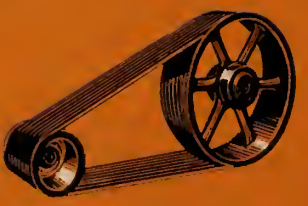
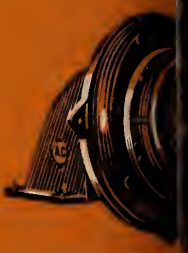
Motors

Pumps



Texrope Drives



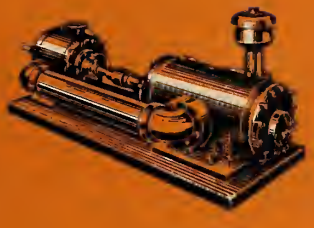
Centrifugal blo

Hydraulic Turbine

Condensers

High voltage

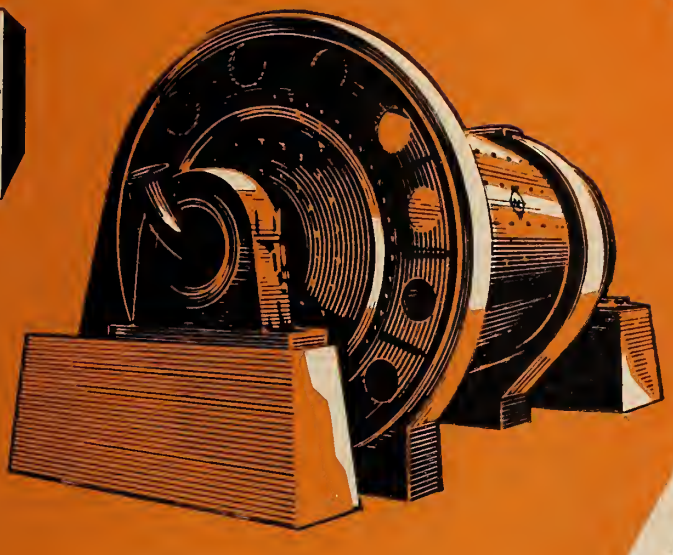
Low voltage control



Crushers

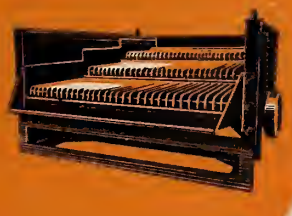
Rotary compressors

Switchgear



Valves

Grinding Mills



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"Hydromex" M-2, the first of a new series *metallized* slurry blasting agents, having a high detonation temperature than regular grades Hydromex, generates a greater gas volume a about 30% more energy. This extra energy pr duces excellent fragmentation, improved heavi action and effective dispersion of muck piles. Co can be reduced through wider blasthole spaci and more efficient shovel operations.

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Because of its semi-fluid nature and high densit "Hydromex" M-2 provides more energy per fo of borehole, a decided advantage in overcomi difficult toe conditions in tough-breaking rock.

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Because of its water compatibility "Hydrome M-2 can be pre-loaded in wet holes.

LOW SENSITIVITY

"Hydromex" M-2 is one of the safest blasti agents to handle and use. It is not sensitive

MEX M

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Complete information on "Hydromex" M-2 and its use in your own blasting operations is available from your C-I-L Explosives representative or by writing to *Canadian Industries Limited, P.O. Box ., Montreal.*

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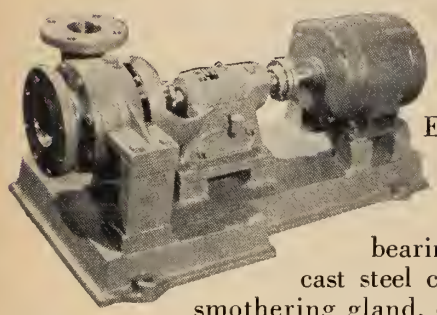
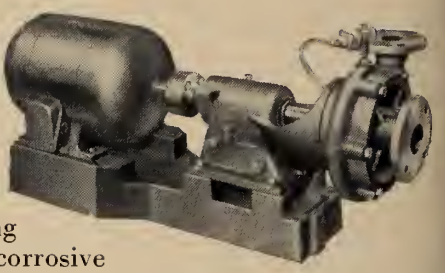
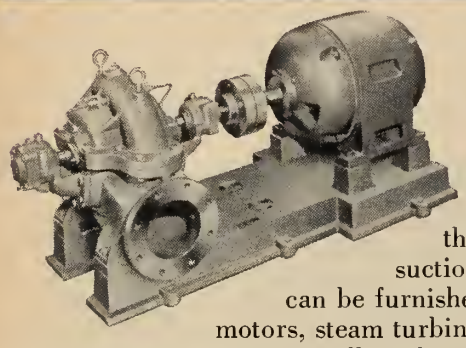


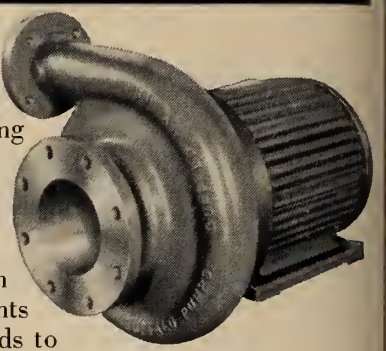
HEAT TRANSFER PUMPS — Equipped to handle high temperature liquids up to 750°F. Features include water-cooled bearings and stuffing boxes, cast steel casings and side plates, smothering gland, colmonoy-coated shaft sleeve, and flexible all-steel coupling. High efficiency, single suction, solid shell design. Heads to 360 ft. Capacities from 5 to 1,100 gpm. Write for details.



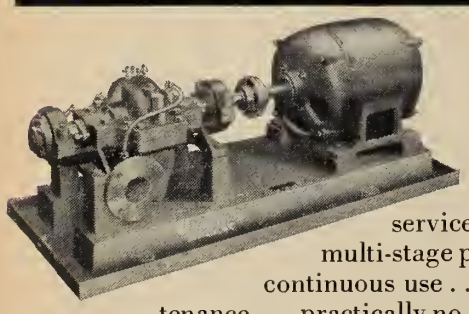
CHEMICAL LIQUID PUMPS — Single suction, full ball-bearing design for the severest applications involving corrosive and non-corrosive liquids, saturated refrigerants and other liquids in the air conditioning industry. An excellent line for many other applications including industrial water supply, and irrigation. Heads: 5 to 360 ft. Capacities: 5 to 1,100 gpm. Request Bulletin 976.



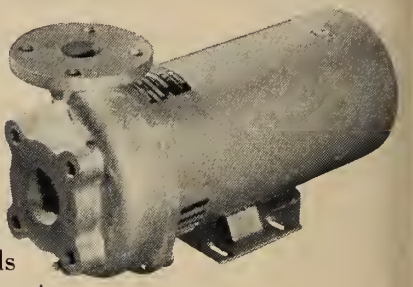
DOUBLE SUCTION PUMPS — Designed for peak efficiency performance in clear water service, these rugged double suction, single stage pumps can be furnished for connection to motors, steam turbines, pulley drives, or gasoline engines. Horizontally split casings simplify impeller inspection. One series of this line fully approved by National Board of Fire Underwriters. Heads: 10 to 400 ft. Capacities: 20 to 14,000 gpm. Request Bulletin 995.



CAN-O-MATIC PUMPS — Leakproof, totally enclosed, hermetically sealed design for safe, economical handling of toxic, volatile, and corrosive liquids. Unique, self-adjusting bearing absorbs radial and axial thrusts . . . assures precision fit at all times. No lubricants required. No packing glands to maintain. Choice of 26 sizes; 1″ to 6″ discharges; 1150, 1750, or 3500 rpm models. Standard units for pressures to 125 psi . . . special units for 600 psi and 400°F temperatures. Special materials, alloys available. Request Bulletin 977-A.



MULTI-STAGE PUMPS — Designed for boiler feed and other hot or cold clear water service, these single-suction, multi-stage pumps stand up under continuous use . . . require little maintenance . . . practically no repair. Hydraulically balanced and efficient, they deliver more water at lower power costs. Semi-steel, horizontally split casings. Bronze impellers, diaphragm, and renewable liner. Two-Stage Models — 60 to 750 ft. heads . . . 20 to 900 gpm capacities. Four-Stage Models — 160 to 1,500 ft. heads . . . 40 to 900 gpm capacities. Request Bulletin 980.



BP CLOSE-COUPLED PUMPS — Save space with no sacrifice of efficiency. Compact size, low cost, and the ability to handle 40° through 200°F. liquids make them one of the most adaptable pumps in fresh water applications involving air conditioning, cooling tower, air and dishwashing equipment. Vertical or horizontal installation. 75 psi working pressure. Heads to 80 ft. Capacities to 130 gpm. Request Bulletin 970-A.

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Photomicrograph courtesy Forest Products Research Branch, Department of Forestry, Ottawa showing the innocent looking, bamboo-like tubes called hyphae, (or, in mass, mycelium) which cause wood rot. They are an air-borne form of plant life of a very low order.

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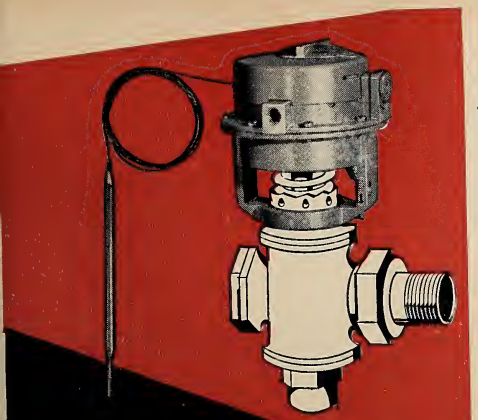

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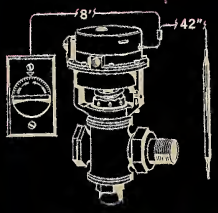
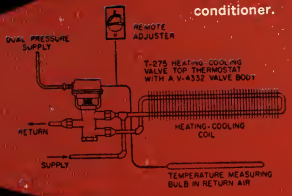
NEW VALVE TOP THERMOSTAT BY JOHNSON

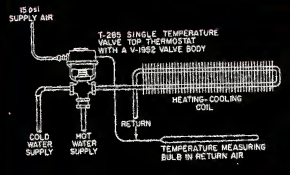
. . . for proportional flow control through fin-tube coils in heating or air conditioning units



. . . with remote adjuster for units that are ceiling-mounted or otherwise inaccessible.

Heating-cooling Valve Top Thermostat installed in a unit air conditioner.





Single temperature Valve Top Thermostat installed in a unit air conditioner.

Here's the first really practical way to cut first costs and still provide the lifetime economy and superior performance of pneumatic proportional flow control: Johnson's Valve Top Thermostat, a combination valve operator and integral thermostat with remote bulb liquid filled element.

Designed primarily for controlling fan coil and induction units in two- or three-pipe systems, this versatile controller mounts on a variety of globe and three-way mixing valve bodies from ½" to 1¼" size and provides rapid, accurate response to temperature changes. It's furnished with built-in or remote adjustment dial and is available in both single temperature and heating-cooling models.

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Get complete details on the Valve Top Thermostat now. It's another exclusive new development by Johnson, world leader in automatic control systems. Call your local Johnson Branch, or use the coupon.

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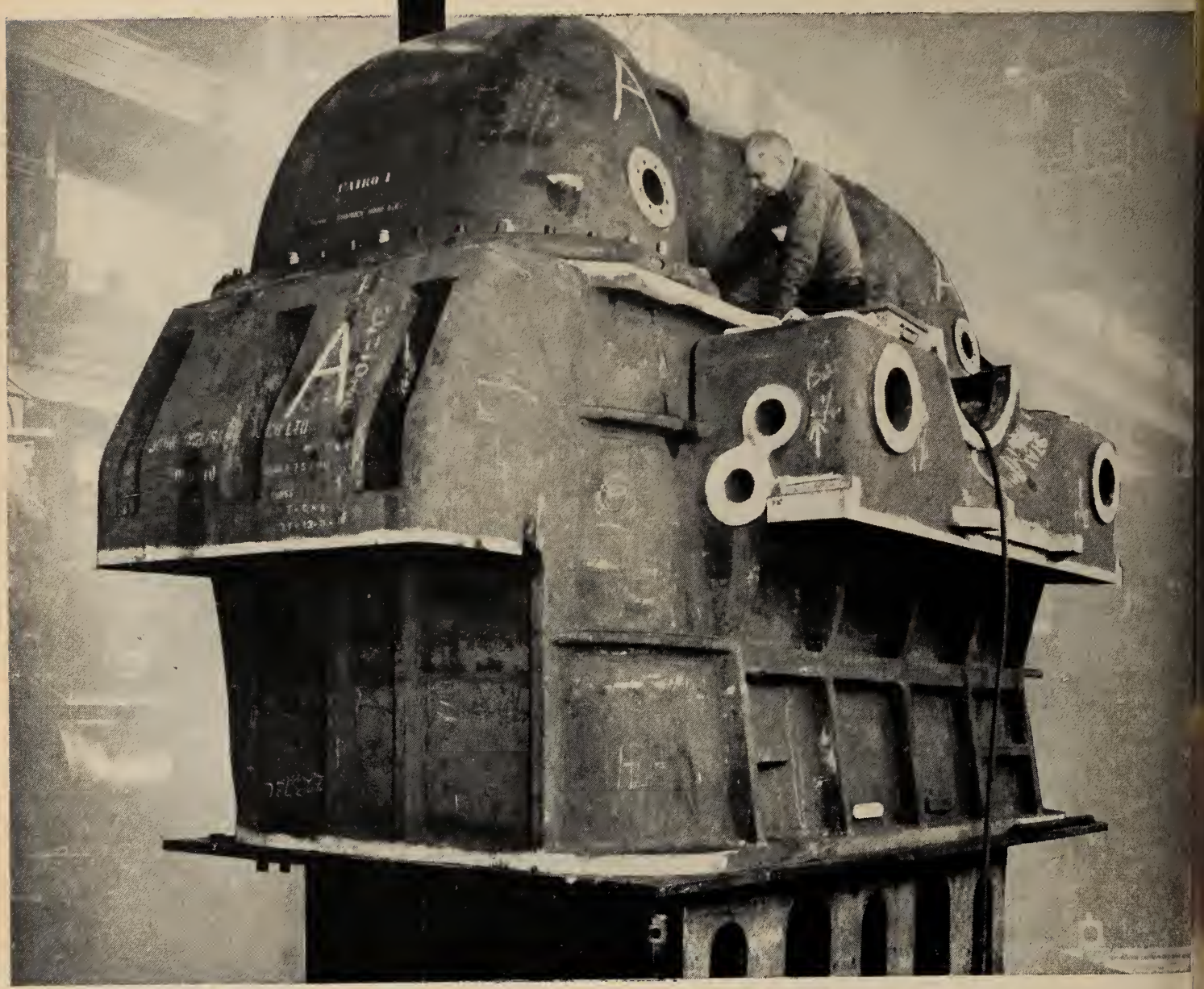

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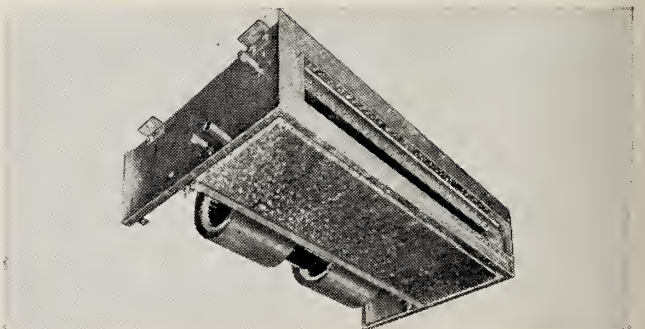

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LE QUAI BRISE-LAMES DE BAIE COMEAU

Gaétan J. Côté, M.E.I.C.,
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Cartier, Côté, Piette, Boulva, Wermenlinger & Associés,
Ingénieurs-Conseils, Montréal.

BAIE COMEAU est le centre industriel et commercial d'une région qui doit sa croissance à l'exploitation accélérée de son potentiel en énergie électrique. La ville est située en effet à proximité de l'embouchure de la rivière Manicouagan, sur la rive nord du bas St-Laurent. Les travaux d'aménagement de la Manicouagan et l'activité industrielle locale alimentent progressivement un commerce maritime de toute saison. L'importance de ce commerce découle en partie de l'éloignement relatif du site, ainsi que de l'absence de communications ferroviaires.

Description du Port

Le port de Baie Comeau se divise en deux ensembles distincts, situés l'un vers le fond de la Baie des Anglais, l'autre près de son entrée. Le premier ensemble comprend des terminus se rattachant aux installations industrielles des compagnies Cargill Grain et Canadian British Aluminum. Le deuxième ensemble comporte des structures adaptées pour la plupart à un traffic d'ordre général, même si l'activité maîtresse y est encore l'expédition de bois de pulpe et de papier journal par la compagnie Quebec North Shore Paper.

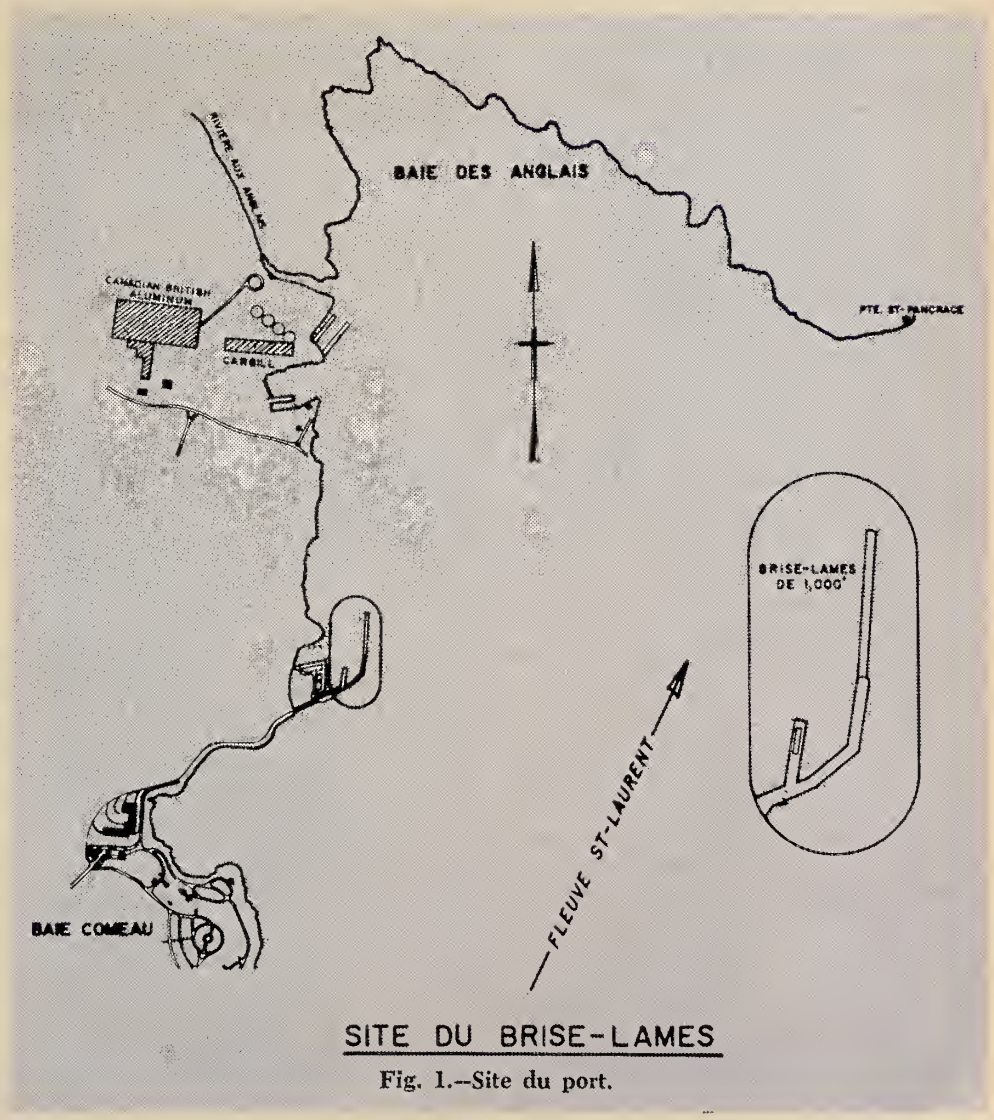


Fig. 1.—Site du port.

Le site du deuxième ensemble est mal protégé du fait de sa nature contre les tempêtes provenant de l'est et du sud-est. On y a donc édifié les ouvrages sous la protection d'un brise-lames dont la face non exposée sert pour l'accostage. C'est ce brise-lames qu'on a récemment prolongé, afin de suivre et même de devancer la croissance des installations le long de la rive.

Description du Quai Brise-Lames

La nouvelle structure comprend neuf caissons s'alignant sur une distance totale de 1000 pieds. Les caissons sont d'un type original conçu aux fins d'atténuer les défauts inhérents aux brise-lames à paroi verticale.

Principes de Base

Lorsque la houle se réfléchit au contact d'une paroi verticale, il y a création d'une onde stationnaire qu'on désigne sous le nom de clapotis. L'amplitude du clapotis peut atteindre une valeur allant jusqu'au double du creux de la houle. La paroi risque donc d'être submergée, à moins que sa hauteur moyenne de franc-bord ne soit supérieure en tout temps au creux de la houle.

En général, la houle déferle lorsqu'elle aborde un littoral où la profondeur est de l'ordre de son amplitude. De façon analogue, le clapotis brise, au contact d'une paroi placée en petits fonds. Aux pressions hydrostatiques s'ajoutent alors d'importants efforts dynamiques résultant de la libération d'énergie de la vague déferlante. A toutes fins pratiques, la paroi verticale n'est pas recommandable là où la profondeur minimum est inférieure au double de l'amplitude de la houle. Et il y a pour ceci une autre raison: les lignes d'écoulement du clapotis sont telles que la composante horizontale du mouvement au creux de l'oscillation peut atteindre une valeur doublant la cérérité de la vague incidente. Théoriquement, le maximum se produit à une distance de la paroi égale au quart de la longueur de l'onde. Au voisinage de la paroi, cette vitesse d'oscillation demeure très appréciable et il y a effet de frottement à la surface du lit. Cet effet est amplifié si des courants transversaux se font sentir en profondeur. A moins donc que les fonds ne soient très durs, il y a risque d'érosion. Pour parer à ce risque, on recouvre habituellement le lit d'un matelas de pierres ou de fascinage. Le recouvrement doit s'étendre sur une distance au moins égale au quart de la longueur d'onde, à partir du pied de la paroi.

Si la profondeur est faible, on ne peut guère se fier à la paroi verticale. De même, si la rigueur de l'assaut dicte des dimensions prohibitives, ou impose aux sols des contraintes inadmissibles, il ne reste en général que le recours à la digue en enrochement ou à la structure du type mixte.

Lorsqu'une houle s'approche d'une digue en enrochement, elle rencontre un point du plan incliné dont la profondeur voisine son amplitude; la houle déferle, et il y a libération de l'énergie destructrice sous forme de turbulence due aux frottements sur la surface irrégulière. Cette dissipation de l'énergie permet de réduire la hauteur du franc-bord de la digue. En général, on choisira cette hauteur à peu près égale à l'amplitude des lames non brisées. Pour des raisons d'économie, on ne tente pas, en général, de construire une digue en enrochement qui puisse subir indéfiniment et sans dommage l'assaut des vagues de tempêtes: les frais d'entretien sont rarement élevés, mais ils reviennent périodiquement.

La construction de ces digues présuppose de plus l'abondance locale d'un roc dense et non friable, qui puisse se briser en gros blocs au tirage.

Le volume de l'enrochement augmente très vite avec la profondeur; il est donc souvent impératif de construire la digue à proximité du rivage, quitte parfois à rétrécir le chenal d'un port ou l'étendue de la zone protégée.

Travaux de Recherches

On a depuis longtemps cherché à combiner les avantages respectifs des deux types principaux de brise-lames. Les nombreuses structures du type mixte représentent le plus souvent un compromis visant à éliminer un inconvénient particulier. Plus récemment, les efforts ont porté sur la conception d'un système à paroi verticale, capable de modifier les phénomènes de réflexion ou de libérer une partie de l'énergie potentielle et cinétique de la lame.

Au Conseil National des Recherches, on étudia le problème par analogie aux théories relatives à la propagation des ondes acoustiques à travers un plaque trouée. On essaya de trouver, pour l'eau en mouvement oscillatoire, l'aire, le nombre et la longueur des trous auxquels correspond le plus faible coefficient de réflexion. Les dimensions d'essai furent établies comme suit:

aire pleine/aire totale = 0.75
longueur et diametre des trous = L/100
"L" représentant la longueur de l'onde significative.

Etudes en canal. — La maquette d'une chambre à mur perforé fut soumise à l'essai dans un canal à houle. Pour une période de valeur représentative, soit 8 secondes environ, le coefficient de réflexion variait entre 10 et 20 pourcent. L'impédance des trous paraissait suffisante pour assurer un important déphasage entre les oscillations au dehors de la chambre et les fluctuations de niveaux à l'intérieur. On constata que la largeur de la chambre n'a pas de valeur critique: l'amortissement est tel en effet qu'il n'y a aucun risque de résonance. Par ailleurs, l'angle de déphasage variait suivant la cambrure de la houle, c'est-à-dire, suivant le rapport de la hauteur à la longueur d'onde; il semble donc que le choix d'une largeur ne devrait être influencé que par les valeurs extrêmes de cambrure auxquelles on peut s'attendre à un endroit précis.

Fig. 2.—Essais en canal—Remplissage de la chambre à t = 0.

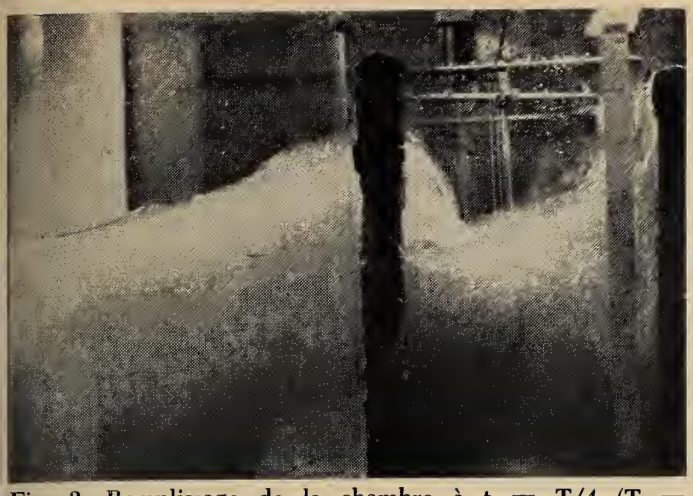


Fig. 3.—Remplissage de la chambre à t = T/4 (T = période de la houle).

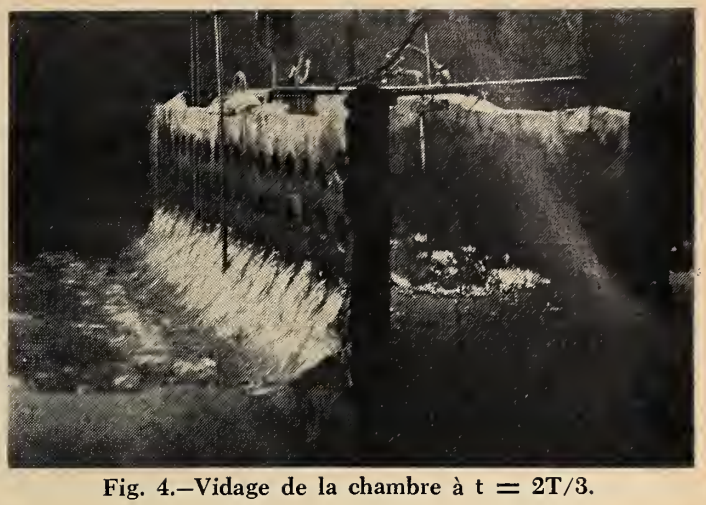


Fig. 4.—Vidage de la chambre à t = 2T/3.

Lorsque la chambre se vide, la diffusion des jets crée dans la masse liquide une turbulence qui amortit le front de la vague suivante. Les figures Nos 2, 3 et 4 illustrent les positions d'équilibre à différentes étapes d'une même période. La figure No 5 fait voir la nature des phénomènes d'interception, au contact d'une paroi pleine. Dans les deux cas, la hauteur de la houle est de 20 pieds. On observe aisément les écarts dans l'amplitude du clapotis et dans la pente de la surface libre.

Les essais ont aussi révélé la présence d'un fort courant de surface s'éloignant de la paroi. Ce déplacement provient de la diffusion des jets; bien qu'il y ait diffusion par tous les trous, l'effet est naturellement plus accentué près de la surface. On a pu vérifier que ce courant s'accompagne d'un mouvement vertical donnant lieu à un transport de masse orienté vers la paroi en profondeur. Ce phénomène est en accord avec le principe de continuité. Des essais additionnels ont démontré la présence d'une circulation ascendante dans la chambre: des particules introduites en profondeur sont promptement rejetées par les trous en surface.

On a trouvé enfin que la composante horizontale de la vitesse maximum sur le fond n'est que la moitié de la valeur théorique calculée pour le cas d'une paroi pleine. Selon toute évidence, la résultante des courants se superpose à l'oscillation et s'oriente vers les chambres. Il existe ainsi un écoulement cumulé qui tend à empêcher l'érosion du lit au voisinage de la paroi; ce qui constitue un important facteur de stabilité.

Etudes en bassin — On voyait dès lors la possibilité d'appliquer le système dans la conception du brise-lames alors projeté à Baie Comeau. Pour évaluer les risques d'affouillements dans ce cadre donné, on entreprit une nouvelle série d'essais, cette fois en bassin. Sur la maquette du port, on aligna les modèles réduits d'un caisson à paroi perforée. Le brise-lames ainsi formé fut soumis à l'assaut d'une houle d'incidence oblique. L'amplitude de la houle imposée variait de neuf à quinze pieds, et la bande spectrale du train d'onde couvrait des périodes comprises entre 3.5 et 12 secondes. On constata l'enlèvement de matériaux meubles dans les espaces ouverts entre les caissons. Le dommage s'arrêtait là; il y avait même engraissement par dépôt, en certains points du talus. Les essais furent repris en présence d'un courant de marée dirigé suivant la magistrale du brise-lames; la vitesse de ce courant était d'environ 1.7 nœuds. L'apparence du talus demeura inchangée. Pour fins de comparaison on répéta l'étude avec une série de modèles d'un caisson du type conventionnel: le clapotis s'amplifiait, et, tel qu'on l'avait prévu, l'agitation augmentait à l'intérieur du port. A la fin des essais, le talus et les fonds portaient les marques d'une érosion sérieuse.

Fig. 5.—Clapotis au contact d'une paroi pleine.

Entre-temps, on effectuait un relevé sommaire des courants de marée dans le port de Baie Comeau. D'après ce relevé, des courants assez vifs se produisent durant les périodes de bourrasques du sud-est; leur vitesse au fond ne dépasse toutefois pas un nœud, soit tout juste 60% de la valeur adoptée dans les essais.

Caractères du Sous-Sol

La figure No 6 montre une coupe du sous-sol suivant l'axe du brise-lames. Le lit superficiel est fait d'un sable gris plutôt fin et de bonne densité. La charge que peut tolérer ce sable est d'environ 4 tonnes par pied carré de radier. Le lit sous-jacent se compose de couches stratifiées d'une argile grise de caractère alluvial. L'argile est préconsolidée à près de 5 tonnes, et sa consistence varie de moyenne à tenace suivant la profondeur. On estimait à 2 ou 3 pouces l'affaissement du lit de sable sous le poids des charges verticales prévues. Quant au lit d'argile, il ne peut guère se tasser en raison de l'épaisseur du couvert de sable et du taux de la surconsolidation. L'affaissement devant donc être instantané en bonne partie, on était libre de concevoir un caisson recouvert d'une simple dalle monolithique plutôt que d'une système d'éléments se prêtant mieux à des corrections subséquentes de niveaux.

Critères de Base

Les dimensions de l'ouvrage ont été fixées dans une large mesure par des critères plus ou moins étrangers à la nature d'un brise-lames. La structure doit être en effet utilisable comme jetée-débarcadère. Cette dernière fonction impose des limites en ce qui regarde la largeur de la plate-forme,

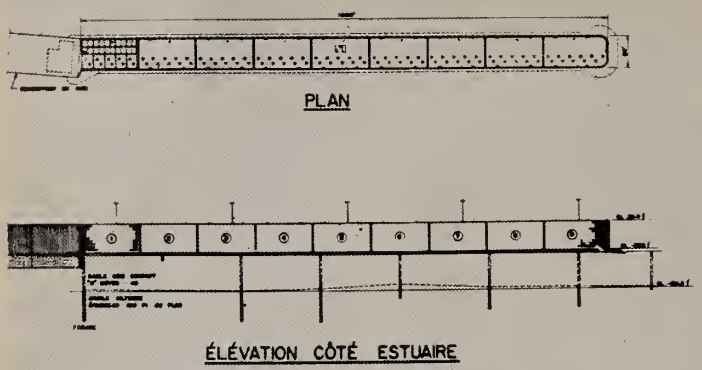


Fig. 6.—Vues d'ensemble du brise-lames.

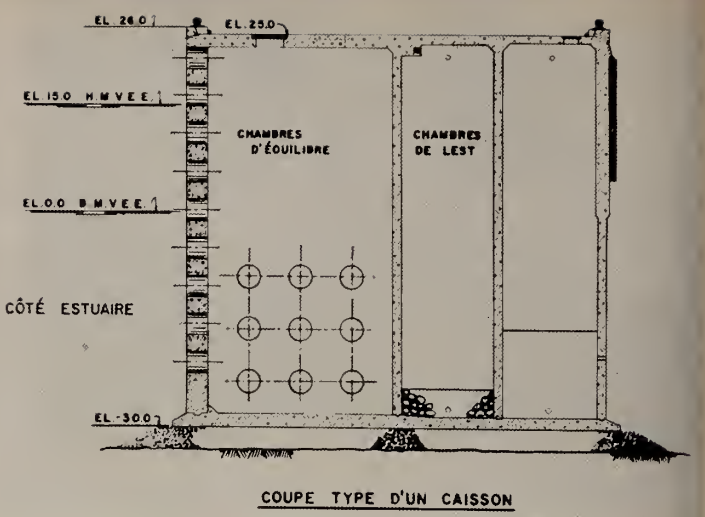


Fig. 7.—Coupe type d'un caisson.

la hauteur du franc-bord et la profondeur d'eau du côté aval. Le platelage n'est qu'à 10 pieds du niveau des hautes eaux. En pareilles conditions, un brise-lames du type conventionnel risquerait d'être submergé sous la charge d'une houle de moins de 8 pieds. Suivant les prédictions dérivées pour le site, l'amplitude significative est de 12 pieds. Les essais ont toutefois démontré qu'une houle de telle amplitude ne produit qu'un clapotis partiel de 14 pieds au contact de la paroi perforée. Dans des conditions idéales, la crête de ce clapotis n'est donc qu'à 9 pieds environ du niveau des hautes eaux.

Calculs et Dessins

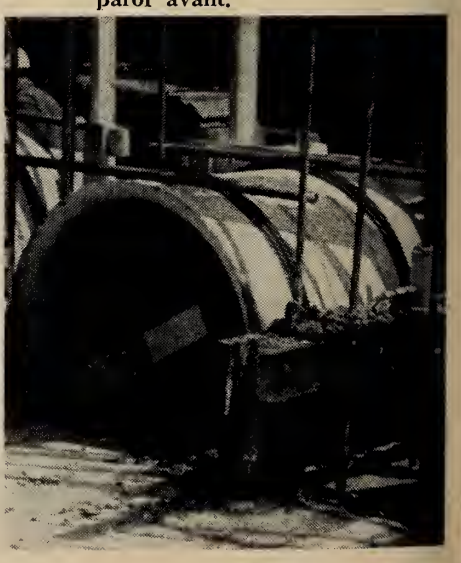
Stabilité et pressions de contact — On a jugé qu'il serait téméraire de fonder les calculs d'équilibre et de résistance sur des poussées correspondant aux amplitudes de clapotis mesurées en laboratoire. Dans les vérifications de la stabilité et dans la détermination des contraintes imposées au sol, on admit des valeurs correspondant à une réduction de 50 pourcent dans l'efficacité de la paroi perforée. La paroi elle-même peut admettre les pressions d'un clapotis pur, son épaisseur généreuse étant dictée par des considérations d'ordre hydraulique.

En vue de faciliter la construction et le flottage des caissons, on a disposé les murs internes de façon à réaliser l'équilibre approximatif des poids par rapport à l'axe géométrique. Seules les chambres médianes sont remplies de graviers; les pressions dues aux charges verticales sont ainsi uniformément réparties, et la structure est assez lourde pour satisfaire aux conditions prescrites de la stabilité, à toutes les phases de la marée. Du côté estuaire, les poussées décisives sont naturellement des pressions et des sous-pressions hydrostatiques dues au clapotis. Les combinaisons les plus défavorables produisent des contraintes maximum de 2.2 tonnes au pied carré, en bordure du radier. Sous le mur perforé, les pressions de contact ne sont jamais nulles et elles peuvent atteindre jusqu'à 1.7 tonnes au pied carré. La limite supérieure accompagne les accélérations séismiques de la structure et de la masse d'eau; ceci, en dépit du poids relativement faible de l'ouvrage. Le site se trouve en effet dans une zone de dommage majeur. L'accroissement normal des valeurs tolérables de contraintes a toutefois permis de proportionner la résistance du radier à des chargements de caractère plus probable. Dans le cas des dalles sous les chambres d'équilibre, la résistance est contrôlée par la grandeur des poussées dues à l'expansion thermique des glaces emprisonnées à l'intérieur du port. L'épaisseur du couvert de glace excéderait rarement trois pieds; la pression thermique correspondante pourrait aller jusqu'à une valeur de 14 kips au pied linéaire de mur. Cette valeur dépasse l'échelle des poussées dues à l'accostage de tout navire que peut normalement accommoder la structure. En deça des limites entendues comme valeurs d'accident, le système de défenses peut-repartir des poussées réduites à moins de 9 kips par pied linéaire de mur. Ce système est constitué d'une série continue d'amortisseurs faits d'un caoutchouc synthétique refoulé suivant la forme d'un cylindre creux.

Chambres d'équilibre. — La vitesse d'écoulement par les trous de la paroi externe peut atteindre une valeur de 25 pieds par seconde: l'effet d'abrasion peut donc être sérieux, à moins que la forme des trous ne soit correcte du point de vue hydraulique; à moins aussi que la surface ne puisse résister à l'usure. Pour ces raisons, on a choisi de former les trous au moyen d'encastrements de béton préfabriqués en moules rotatifs, à partir d'une mélange riche et très sec. La surface extérieure des encastrements est rendue rugueuse afin d'augmenter l'adhérence à la matrice de béton. Deux anneaux de caoutchouc achèvent d'étancher le joint.

Fig. 8.—Epreuve de l'étanchéité des bouchons.

Fig. 9.—Encastrement de béton dans la paroi avant.



Afin d'éviter les fluctuations de pressions d'air sous l'alternance des niveaux dans les chambres d'équilibre, on a ménagé de larges bouches dans le platelage superficiel. Ces bouches prennent la relève lorsque l'aération ne peut plus se faire librement par les trous de la paroi, soit qu'ils soient obstrués par les glaces, soit que le clapotis s'élève trop.

Joints et Recouvrements

On relie les caissons par un remplissage de pierre contenu entre deux clefs de béton. Les clefs sont disposées en retrait, de façon à simuler l'effet des chambres d'équilibre. Comme il y a quand même solution de continuité, une forte houle est susceptible de briser au voisinage des joints. Pour amortir les pressions de choc et entraver leur propagation, on a perforé la partie supérieure des murs de bout donnant sur les chambres d'équilibre.

Les essais en bassin avaient signalé les risques d'érosion dans ces joints; on protège donc le lit entre les caissons au moyen d'une lourde dalle de béton déposée à l'aide de goulottes. Quant aux talus, on les recouvre de pierres dont le poids varie de 100 à 1500 livres. Autour du musoir, l'enrochement comprend des blocs de deux à quatre tonnes, et il s'étend de façon à protéger le lit sur une distance d'environ 25 pieds de la face du caisson.

Rappelons qu'avec une structure du type conventionnel, il eût été normal en pareilles conditions, de prévoir une lourde armure et un vaste revêtement du lit sur tout le côté estuaire.

Construction

L'entreprise McNamara (Québec) s'était chargée de la construction du brise-lames. Les travaux ont pris fin au début de cette année. La fabrication des caissons s'est faite de la façon coutumière ici, c'est-à-dire, au moyen de coffrages glissants. Durant la phase initiale de la fabrication, on bétonnait le radier sur le pont d'une chaland submersible à faible tirant; suivait l'installation des coffrages, la coulée des murs jusqu'à une hauteur de 14 pieds, puis, le lancement. Au cours de la phase suivante, on montait les murs jusqu'au niveau du dessous de la dalle de chargement.

L'équilibre flottant du caisson perforé pouvait être assuré de diverses façons. On choisit d'étancher les chambres d'équilibre, et pour ce faire, on utilisa des bouchons en plaque, pressés d'affleurement contre le bout externe des encastrements cylindriques. A l'encontre des méthodes basées sur l'appoint de chalands ou de flotteurs internes, le procédé choisi

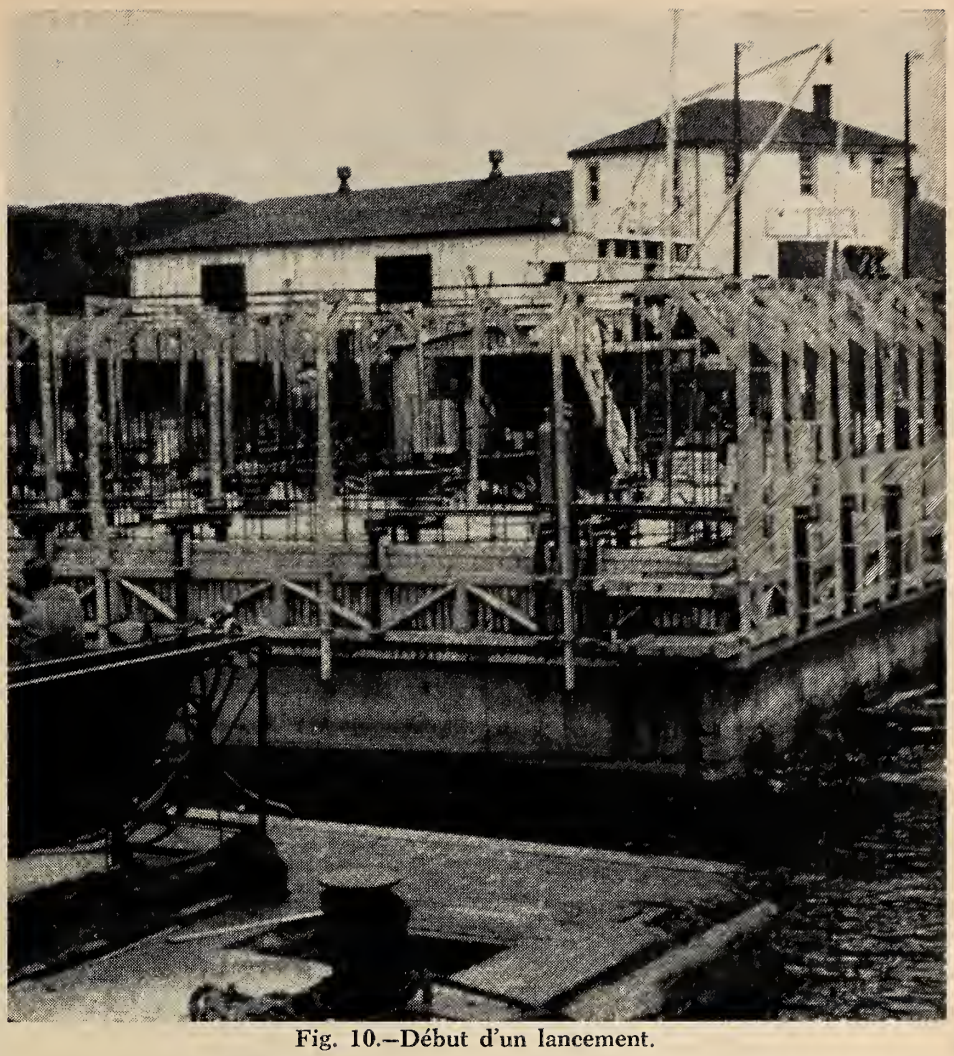


Fig. 10.—Début d'un lancement.

remplissait trois conditions jugées fort désirables:

— il permettait une augmentation graduelle de la flottabilité en cours de montée des murs;
— il se prêtait à l'opération normale et quasi continue d'un système régulier de coffrages glissants;
— il ne compliquait ni la manœuvre ni la descente des caissons.

Les plaques d'étachement étaient faites ou d'acier, ou de contreplaqué. Soit dit en passant, on s'aperçut vite que le contreplaqué ne résiste à l'usage répété que dans les zones de franc-bord. Sur la figure No 9, on remarque la façon dont on se servait des fers d'armature pour supporter et assujettir les encastrements. A l'arrière-plan de la figure No 8, on distingue les barils en feuillards qu'on utilisait pour mouler les trous des parois transversales. Ces barils devaient empêcher le déversement de la masse d'eau d'une chambre à l'autre s'il advenait qu'une plaque d'étanchement vienne à sauter. Cette mesure de prévention s'avéra justifiée; elle était malheureusement inadéquate. En deux occasions, quelques barils furent expulsés d'une pièce après s'être affaissés sous les pressions de la masse oscillante.

Il fallait interrompre le bétonnage des murs quand arrivait le moment de former une rangée de trous. Entre ces arrêts de 50 minutes environ, les coffrages montaient au taux moyen de cinq pouces à l'heure; ce rythme fut maintenu, même durant les froids d'automne. Pour hâter le durcissement du béton fraîchement moulé, on suspendait alors aux coffrages extérieurs des toiles atteignant jusqu'au plan d'eau. On chauffait aussi les chambres du caisson, l'eau du mélange et l'huile du système de levage.

La descente des caissons se faisait à la marée. On lestait tout juste assez pour échouer la structure un peu avant l'étale de basse mer. En général, le matelas de pierre n'était apprêté à l'avance que sur la longueur d'une élément du brise-lames. Chaque caisson servait donc successivement de point d'attache pour les treuils du chaland niveleur; la longueur réduite des câbles favorisait la précision de la manoeuvre tout en permettant l'utilisation d'un équipement plus léger.

On procédait au chargement d'un caisson sitôt que son emplacement avait été relevé et trouvé exact. Entretemps, des plongeurs travaillaient à libérer les trous des chambres d'équi-

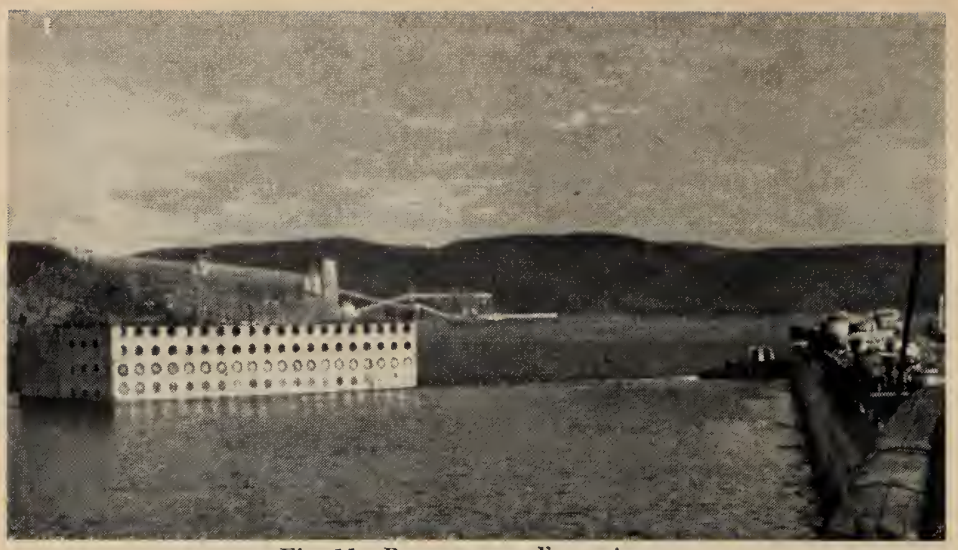


Fig. 11.—Remorquage d'un caisson.

libre: les plaques détanchement étaient détachées, puis ramenées à la surface; quant aux barils d'acier, on les brûlait tout simplement au chalumeau.

Sous le poids d'un caisson et de son remplissage de gravier, le coussin de pierre et le lit s'affaissaient d'environ cinq pouces. Comme le tassement s'arrêtait peu après l'application d'une charge, il n'était pas nécessaire de retarder plus longtemps la construction de la dalle.

Efficacité de la Structure

Au cours des travaux, quelques dures tempêtes permirent d'évaluer les mérites de la structure. Le 27 octobre en particulier, des vents violents du nord-est balayèrent la côte pendant près de huit heures, produisant des houles dont la hauteur atteignait plus de dix pieds. Sur la dalle du vieux brise-lames, la tempête laissait partout des marques: voitures tamponnées, wagons déraillés ou renversés, éclats de béton, roches et graviers éparts. A certains endroits, les paquets de mer avaient sapé la dalle, puis l'avait fracturée. Il y avait alors huit caissons sur l'assise du nouveau brise-lames. Ils n'étaient pas tous complètement chargés. Sur les dalles déjà en place, on avait laissé quantité de matériaux tels que fers d'armature, madriers, poutrelles légères. Rien ne fut emporté. Il se fit toutefois un lavage sérieux dans les espaces encore mal fermés entre les caissons. Les essais sur modèle avaient d'ailleurs permis de souligner un risque pareil dans la phase d'exécution.

Continuation de la Recherche

Le fonctionnement du nouveau brise-lames est suivi de près. Le programme de recherches se poursuit maintenant à l'échelle de la nature. La phase présente vise tout d'abord à déterminer l'ordre et la distribution des contraintes dans la paroi perforée, sous l'effet des pressions de la lame. A cette fin, le Conseil National des Recherches a procédé à l'installation d'une réseau de jauges de contraintes dans la paroi avant de l'une des caissons. Les caractéristiques de la houle sont données par un enregistreur graphique ancré en eau profonde à quelques milles pieds au large de la structure. Les poussées agissant sur la paroi sont mesurées à l'aide d'un groupe de cellules de pression.

La fin secondaire du programme en cours est la vérification de résultats notés durant les essais en canal. Cette vérification comporte les mesures de la hauteur et des pressions du clapotis qui correspond à une houle de données connues.

On se propose enfin de relever les changements du modelé sous-marin, après certaines périodes initiales de service.

Les observations courantes amèneront peut-être un allègement des critères dans la conception de futurs brise-lames du même type. Quant aux relevés à venir, ils indiqueront plutôt l'étendue de la zone sécuritaire d'application, en permettant d'estimer les risques d'affouillements dans des endroits exposés, en eau peu profonde.

Evaluation

Le site choisi se prête à une expérimentation valable et complète en l'absence virtuelle de risques touchant la stabilité de l'ouvrage: le lit est résistant et la profondeur d'eau excède le minimum critique correspondant aux caractères particuliers de l'assaut.

En dehors du plan expérimental à long terme, le nouveau brise-lames satisfait déjà un objectif clairement formulé au départ du projet; il s'agit de la diminution du risque de submersion, en vue d'une utilisation plus continue et plus sûre de l'ouvrage comme jetée-débarcadère.

Remerciements

Pour la préparation de cet article, nous avons largement puisé dans les publications de monsieur G. E. Jarlan du Conseil National des Recherches. Nous tenons à le remercier de son aide généreuse.

Nous avons également profité du concours offert par les ingénieurs du Ministère, et ceux de l'Entreprise McNamara. Ils trouveront ici l'expression renouvelée de notre gratitude.

Fig. 12.—Vue aérienne du brise-lames.

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DIAGNOSIS OF DISTRESS AND FAILURE IN STRUCTURES

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Failure of concrete floors during construction due to a foundation deficiency.

DESIGN OF STRUCTURES and of erection procedures must provide sufficient (1) resistance against gravity, (2) minimum strength of the materials during the life of the structure, and (3) provision against distress resulting from incompatibility of connected dissimilar materials. Any omission in any required sufficiency will result in a failure of the design. It may be a collapse during erection or after completion; it more often shows as a cracked or distorted structure with high maintenance cost and rapid economical depreciation.

Practice of engineering is based on the application of proven scientific principles, but even more on the accumulation of successful experience teaching one what to do. Equally valuable, but often disregarded because it is not readily available, is the record of unsuccessful experience. The paper outlines how such record can become a most important safeguard in reducing and hopefully eliminating failure in design and construction operations.

A few failures stem from malpractice, lack of knowledge of how to do the job. More result from careless application of available knowledge. The use of more complicated statically indeterminate designs, where stress dependence on deformation conditions may not be properly evaluated, is one reason for some recent spectacular structural failures. The present fashion to use new materials, whose time dependent dimensional changes are not completely known and often in combination with incompatible adjacent materials, result in distress evident only after occupancy of the structure.

The pressure of financial controls of the construction industry is often the cause of an insufficient time schedule to permit a completely developed design, insufficient time to plan proper construction methods and insufficient time to perform a satisfactory work. The rapid development of urban areas requires, for a proper

result, greater numbers of technical and craft skills than are available. What is normally not considered good enough becomes accepted and covered, but the future results are not dead, only temporarily buried.

One unwanted and harmful side effect of greater incidence of distress and failure in structures has been the more common requirement that the technician carry professional liability insurance. Where the design office normally performs a satisfactory job and is properly engaged to and does properly provide competent supervision and inspection service, the insurance is not needed. Since no fire insurance has ever prevented a fire and no automobile insurance has prevented a traffic accident, except by educational and psychological impact on the insured, no "errors and omissions" insurance will prevent an error or omission. There is a likely state of affairs, that may give the opposite result. In addition, the knowledge of insurance coverage, exposes the designer to many more claims and suits, both as direct defendant and as third party involvement. These legal actions are time consuming, expensive and often mentally disturbing. The greatest value from the cost of such insurance would be an educational program by the insurer to further eliminate repetition of errors and omissions. Attempts at a number of technical meetings to have such data accumulated and publicized by membership organizations have been fruitless. Some of the writer's personal attempts to bring the available information to public knowledge and use, have had unpleasant results—correspondence of short-sighted reaction from thin skinned culprits, demands for retraction of statements of fact already printed, silly form letters from legal representatives threatening court action in which the same facts would be broadcast and directly tied to their clients' reputation. However, there does seem to be some progress in the awareness of the serious situation which the designer and constructor are facing. The exposure of truth cannot in the long run harm the industry. A confession of error may be a small localized hurt, but the resulting overall benefit should be worth the personal contribution of professional debt to civilization.

To only list the number of incidents which have come to the writer's attention would overfill the allotted space for this paper. Some references to the literature are listed as sources for further study by the interested reader. This paper will be restricted to a few typical examples, some of which have not previously been published, to illustrate pitfalls that must be watched.

Even though the physicist has not been able to explain the force of gravity, every engineer realizes that it is a basic enemy of man made structures. A structural design must guard against any combination of conditions that does not provide sufficient resistance against gravity force. Combinations of weight with lateral forces, from soil pressure, wind, shock or temperature, must be analysed for each component as well as the entire assembly. The design must be sufficient, the graphic representation in the form of drawings and details must be consistent with the design, and the performance must provide at least the minimum requirements.

Pure design errors

Pure design errors are not common. There have been some improper evaluations of roof loadings and even of complete omission of floor loads. The roof failure of the skating rink at Listowel, Ont., in 1959 has been thoroughly analysed by the Canadian Research Council and regulations to prevent such error given complete publicity. A rather peculiar incident was the unnoticed filling of the cellular structure of a metal roof deck with rainwater before applying the roofing and the later failure in bending when the completed roof was covered by wet snow. This incident in East Brunswick, N.J. in 1958, caused considerable damage to finished work when the deflection of the deck caused breaks in the welded seams and release of the trapped water without warning.

In the design of an additional tier of steel framing for the upper deck of a stadium in Birmingham, Ala., 1960, the centre part of the plan included an added mezzanine passageway suspended from the radial girders. After the steel had been completely erected and the concrete seating deck installed, a young field engineer of the steel erector questioned why the radial girders were all of the same section, with the middle group carrying the mezzanine in addition to the deck load and the two outer groups only carrying the deck. The design engineer immediately checked his notes and found that the hanger loads had been omitted in the design. With commendable honesty, the error was admitted, the use of the additional deck was prohibited and the girders were strengthened. This meant the moving of some important football games to other fields, but the possible avoidance of a catastrophic failure since under full loading the overstress would have exceeded safe limits.

Retaining walls can be designed to stay in place even though as Robert Frost has said in one of his poems: "Something there is that doesn't love a wall, that wants it down". But some designs are just not strong enough. In 1958, a 70 ft. high retaining wall in Portland, Ore., built along a railroad track rotated as a unit and fell over the tracks.

Walls must be designed for all possible soil and water pressures. At a housing project in Hartford, Conn., concrete basement walls backfilled with a clay soil were completely stable until, after a long dry period during which the clay dried and shrank away from the wall, a heavy rain filled the thin gap imposing full hydrostatic pressure and the walls failed. Strangely enough, the lesson was not learned and reconstruction was identical with the first procedure. About two months later, another storm caused a repetition of the failures. Then the backfill was changed to a granular material.

A concrete crib wall enclosing a steel bulk fuel oil tank in Brooklyn, N.Y., was properly constructed and backfilled, but the face bulged badly and the wall was on the verge of collapse and was removed. Study of the plans showed the error. The base was on wood piles designed to carry the vertical loadings, with no regard to lateral earth pressure. The toe piles, driven to a value of 15 tons, were carrying about 70 tons. The base had rotated and unbalanced the crib.

Prestressed precast roof beams designed to sit on shoulders of precast columns collapsed at Harrisonberg, Va. in 1961. Beams were 40 ft. long and the bearing was a 2 in. angle imbedded in the concrete shoulder. Shrinkage of the manufactured beam and also deflection resulted in an actual bearing of much less area and the designed unit bearing load of 2780 p.s.i. was greatly exceeded, shearing off the seats.

A two story department store built on a sloping terrain in West Orange, N.J. in 1962, has the main entrance at the second floor level and the delivery entrance at the lower level along the rear. When the concrete wall was backfilled, the earth pressure pushed the entire upper floor rearward 2 in., tilting all of the lower columns.

The design was adequate for vertical loads, with light floor construction and columns interrupted by continuous floor girders. The column orientation was also unfavorable. All of the lower columns had to be cut loose, plumbed and reinforced for the induced eccentricity of loading. A reaction must be provided for each action or else remove the action. The fill was removed and a reinforced concrete entrance walkway built to cover the void.

Concrete cantilevers are vulnerable to error in detail as well as construction. The misplacing of the tension steel is too common an incident. Failure to provide anchorage of bars past the furthest possible shear crack caused the ends of the double cantilever roadway frames to deflect and crack. The main bars had been carried 40 diameters beyond the point of maximum moment, but the shear crack followed a curve between the end of the cantilever and the end of the bars. Repair was relatively simple in the form of double post-tensioned bars reacting on heavy steel billets placed against the ends of the cantilevers. Gunite encasement of the bars formed architectural corbels to cover the repair, not shown on the original perspective picture of the viaduct.

Graphic Representation

The graphic representation of the design must be clear and legible. Two cases of failure caused solely by sloppy drafting will illustrate the importance of this requirement. A serious failure of a properly designed 20 ft. high reinforced stem retaining wall in Manhasset, N.Y., resulted from a mis-reading of the drawing when the one of the 1¼ in. bar indication was placed directly on a dimension line and the wall was actually built with ¼ in. wires as the main tension steel. The design had been checked but no one picked up the error in the steel order and no one on the job had enough experience to see the error being installed.

A recently completed monumental courthouse in Queens, N.Y. was faced with 4 in. limestone. The plans were carefully detailed with rigidly connected steel seat angles and lead relieving pads separating the bottom of the angles and the stone below. At the corners of the building, the steel angles were shown extended to 2 in. from the edge, to provide proper support and relief of compression in the stone. A sloppy figure on the steel detail, showing the projection of the angle beyond the corner column as 1'.2½" was taken as 12½ in. by the detailer computing the length of the angle. As a result, all corner angles are 2 in. too short and the corner stones were tightly bedded in mortar forming a stiff column. The end stones were then under an uneven bearing and acting like a loose door with a tight pintel which is under pressure, opened out from the face of the building. The repair and resetting of the stone is costly payment for such an unnecessary error.

Foundations

How many hidden deficiencies exist in foundations is a speculative discussion, but sometimes they exhibit themselves in serious failures or at the best, in unexplainable settlement distress. The five-storey concrete office building in Montreal where one end suddenly settled 20 in. was clearly explained when the intrusion type piles were exposed. Too rapid a withdrawal of the casing as the concrete was forced into position, permitted lenses of mud to intrude and form discontinuous shafts. The reinforcing bars of the piles were found bent outward and the loss in height at each pile exposed correlated remarkably with the settlement at that column line. The cost of demolition, replacement of all piles and reconstruction was the price of a little negligence in performance.

By a strange accident, an equally serious condition was discovered at the LaGuardia Airport Building in 1961. A small revision in plan required the cutting down of some piles for the burying of the heating fuel tanks. When cut down, some steel shells were found to be void of concrete filling. A random sampling of piles were then drilled and when found suspect, as indicated by a non-uniform drill resistance and change in the color of dust, were also cored. Sufficient number of piles were found improperly filled, two had voids over 30 ft. in length, to warrant a complete rejection of the completed pile job. Concrete caps were all removed, new piles driven and the work delayed about a year. Just how the concreting was so poorly performed, in spite of the most experienced performance and inspection personnel, is hard to explain. Some of the suspect piles were extracted and the coring record was found to be a correct indication of the continuity, density and mix deficiencies of the concrete within the pile shell. It makes one wonder how many such conditions really exist and have not been discovered.

Erection Failure

Failure during erection of steel frames, precast concrete and timber arches and shells is much too common. Although it does not seem proper that such intermediate steps in erection be less stable than the complete structure, temporary guys and braces are usually necessary for safety. As a single example of this type of failure, there is the one storey steel hangar at the Utica, N.Y. Airport erected in 1961 and completely collapsed by a 22 m.p.h. wind. A complete analysis of stability of the almost completed frame indicated that a lateral load of 1.8 p.s.f. on the exposed steel would cause overturning. As recorded at the weather station located 100 yards from this building and at the same height above ground, the wind built up that morning to 22 m.p.h. with 25 m.p.h. gusts at 11:00 A.M. when the steel fell with little warning. The best available data shows that 22 m.p.h. wind produces a load of 1.8 p.s.f. on the shapes used. About a hundred dollars worth of cable guys would have prevented the collapse.

Formwork Failures

There have been many collapses of formwork, all of which seem similarly caused. At the best, a form filled with concrete supported by thin shoring is at a point of neutral stability. The supports are not equally loaded until all the concrete is placed. As the filling progresses, reactions vary and with continuous timbers there is a possible uplift at supports located beyond the concrete placed. If the joints are not bolted and with a small lateral displacement, some supports become loose and may fall when loaded. This is especially true for high falsework where posts are in two lengths separated by a sill that is not bolted to both the lower and upper post sections. Horizontal impact forces from power buggies, unbalanced lateral pressure from wet concrete, effect of synchronous vibrators, can induce waves in the plastic concrete which cannot be stopped and are enough to cause a collapse.

Form failures are common experience in construction and seldom is the static design improper. Failure cannot be avoided by signed approvals of drawings or by licensing of designers and contractors. There are

Failure to 2½ million gal. concrete tank.

so many possible weaknesses that can be built, either by error or omission, into a form system that reliance must be had on the experience and integrity of the workers. At present, any wood butcher is considered good enough to build forms. Formwork is the most costly single item making up the cost of reinforced concrete; it deserves specially trained workers to perform a proper and safe result.

Settlement

Minimum strength must be provided during the lifetime of a structure. Effect of future adjacent construction must be included either initially or when conditions change. The slight settlement of buildings on spread footings, if built in contact with an existing wall, will pull the completed unit and may cause serious distress. Failure of old sewers and drains alongside wall footings has several times caused collapse of usually old buildings. One case of slight settlement resulting from adjacent dewatering, previously described in the literature, was a serious interior column failure when grillage beams crushed down 12 in. The settlement affected an exterior masonry wall, 12 storeys high, and the building frame stiffness carried the load over to the interior columns.

Delayed differential settlement caused one corner of a six storey building to mysteriously crack away after 30 years of life. Claims of blasting and traffic vibration were found to be unfounded. The building was built on spread footings on loose sandy soil except the corner which separated was on a pinacle of bedrock.

Prestressed Concrete

Maximum local stress in prestressed concrete work usually occurs during erection, but not always is this true. At the Philadelphia Police Administrative Building, in 1961, post-tensioning of the main floor components induced high local stress from eccentric loading at tensioning of the first tendon in each pair. Unit stresses exceeded the design strength of the concrete, 4000 p.s.i., and the local failures caused so much furor that an order to demolish the partially completed building was issued. Reason prevailed after some conferences, and repetition of the distress was eliminated by a step sequence of loading the tendons, in 50% load increments.

On the other hand, at a large industrial plant on the West Coast, prestressed beams assembled into a roof framing were locked into position by a cast slab and large amounts of imbedded bars to provide continuity of the girders. Delayed shrinkage of the steam cured beams plus temperature stresses and deflection under loading, pulled the beams off their supports and uncovered a weakness at the ends, resulting in vertical and diagonal cracking. Had the beams been assembled to act as simple spans with freedom for shrinkage and deflection change, the costly corrective measures of providing new end supports would have been eliminated.

Structure Change

Prestressed tanks in which the liquid pressure is resisted by die stressed continuous wire wound around a concrete shell seem to have a time dependent failure possibility. Investigation of several nine-year-old tanks built by New York City for sewage digestion showed that the metal structure of the wires had changed. Probably the high heat gain during the die drawing in the field neutralizes all the heat treatment of the steel. Failures in the 2.5 million gallon tank at the Owl's Head plant and conditions of wires in several other tanks exhibit peculiar coarse crystal faces and laminar internal fracture. The concrete was sound and contained no calcium chloride or other admixtures. The sludge temperatures were below 90° F and the fractured concrete showed no sludge penetration. Some further study of tensioning procedure is needed before such designs can be considered proper for long life.

Rapid disintegration of an expensive moulded concrete screen wall in Oklahoma City in 1960 required careful analysis of climatic conditions which failed to elicit any possible cause. Especially noted was the fact that over half of the units remained in perfect shape. A visit to the manufacturing plant solved the mystery. The technicians were fine artists but did not know how to mix concrete. Strength of small cubes cut from the finished product varied from 600 to 6000 p.s.i. The help of a concrete technician soon corrected the condition, with a welcome saving in material and labor costs.

An interesting failure in desired exterior design was recently investigated with peculiar findings. A large government building is enclosed in a special marble known for its uniform white color. The building design called for large sheets of marble, full storey in height. The quarry consists of sheets of stone between joints about 2 ft. to 6 ft. apart. The stone was therefore sawn from the beds and set vertically into position. In a short time the color was an irregular mottled dirty gray and no amount of cleaning would restore the white color. When it was noticed that a number of rejected pieces remaining flat on the ground had retained the white color, but when set vertically, without any cement jointing, changed to gray in two days, a clue was found. The stone includes some fine open ripples filled with biotite mica, partly disintegrated. When used in normal bed position, these ripples are not exposed to the outer air and remain dormant. When the stone is rotated, the seams leach out on the face and discolor the stone.

The final reports on the failure of

the Texas Tower No. 4 outside of New York Harbor during a storm in January, 1960, have not been published. The structure was designed for the greatest expected wind and wave action. Flexibility of the framework under sequential impact loading of directional waves, coupled with some discontinuity of stiffness in the main members, seem to have induced a vibration with stress reversals beyond the strength capability of the structure. Incompatibility of shape change under loading conditions of structural components can induce local failure not normally discovered by a stress analysis.

Incompatibility

Incompatibility of physical action of connected dissimilar members is causing serious distress in many of the recently developed modern designs. Leakage of skin wall construction requires continuous expensive maintenance. A spectacular example is the Air Force Academy Chapel. The thiokel seal between aluminum panels has not been sufficient to keep the rain out of the building and a comprehensive reconstruction of the joints and addition of gutters and leaders is going on in a hopeful attempt to make the monumental structure useable.

A number of lightweight concrete multi-storey frames enclosed in glazed hard burnt brick in New York have shown delayed distress with vertical cracks in the corner brick areas and spalled brick at the lower lintel levels. In some of these buildings, stone facing at the street level is coming loose and has even fallen out. The defect seems to be the delayed shrinkage of the concrete, throwing unusual load on the more rigid brickwork which then buckles and spalls. The rapid construction schedule, with brickwork installed in the lower floors before the completion of the concrete, increases the relative compressive deformation. Plastic flow of the concrete in the columns will throw high load on the reinforcing with consequent high elastic shrinkage. The magnitude of the differential shrinkage need not be high. The difficulty can be easily eliminated, as proven by some examples, by introducing a caulked mastic joint under each angle lintel level, carrying the angles completely around the building perimeter.

Another recent error in this category is the use of aluminum conduit for electric circuits, imbedded in concrete slabs. The result, after about a year's use, is a cracked ceiling with spalls following the position of the conduits and in one case, a complete pattern of heaved cracks in the terrazzo floor outlining every conduit below. The aluminum disintegrates both on the outer and inner faces of the tube. Study is now going on to determine a corrective measure. Electro-chemical disintegration cannot be stopped. The wiring may in time be ruptured by the expansive force of the aluminum oxide formation. In the failure of the prestressed tanks described above, it was noted that the aluminum torpedo shaped connectors, used to splice out the steel wires, had completely disintegrated into a white powder which analysis showed to be pure aluminum oxide. Tests for stray electric currents were negative and the change was purely a contact phenomenon between aluminum and cement, in a conductor made up of two metals.

Similar trouble has been noted in Key West, Fla., in an area of high salt moisture conditions, where steel conduit imbedded in concrete, in a period of six years, rusted to such extent that the wires were broken. In the same buildings, a number of rooms which were air conditioned with humidity control, were found free of the trouble. However, with aluminum conduit, air conditioning does not seem to be a cure.

As a final example, is presented the case of the lean in the top 20 ft. of a radial brick chimney. One of two identical stacks above a power plant of a public hospital in Westchester County, N.Y., the clue to the cause was determined by a historical investigation of uses. The chimney that remained straight was used for the incinerator and a coal fired hot water boiler. The failed one had been connected to three coal fired steam boilers which had recently been converted to oil firing. Based on price quotations, the oil used was a Venezuela #6, known to contain considerable sulphur. The lean was towards the NE, the direction of the prevailing windy rain. There was a shoulder in the chimney lining at 20 ft. from the top where the wall thickness changed. Driving rain combined with the sulphur fumes and acid was collected on the shoulder along the SW quadrant. The sulphuric acid combined with the cement to form calcium sulphate which takes on water easily and expands as it crystallizes. The cement joint grew and pushed the chimney over, into the wind, without forming a single visible crack.

Investigations of this nature are extremely interesting and the results form a body of information which can be of invaluable use to the profession. It is hoped that this paper may instigate the release of similar study by others for the benefit of all.

It has been said that doctors bury their mistakes, architects plant ivy and engineers write top secret reports. It is time to do some declassification, open the files and make the reports of value to the entire profession.

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Programme d'Etudes pour Un Ingenieur Electricien

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DANS CET exposé, notre point de vue ne sera pas celui d'un économiste qui ausculte les marchés, ni celui d'un ingénieur spécialisé, mais plutôt d'un individu qui cherche à ne pas trop limiter son champ de vision et qui est à la fois un peu scientifique, un peu technicien, un peu professeur. Nous essaierons de proposer aux jeunes étudiants d'aujourd'hui la possibilité de s'adapter au point de vue de 1980 alors qu'ils seront responsables d'un secteur important de la technique.

On remarque actuellement un changement complet dans la mentalité de l'ingénieur. Durant la dernière guerre, l'ingénieur était considéré comme un type très conservateur, cramponné à sa machine et à peu près indifférent aux réalitiés sociales qui l'entouraient. D'un autre côté, le physicien était un type tout à fait différent, habitué qu'il était d'être à la recherche de quelque chose de nouveau. Ce dernier appliquait cette mentalité au monde social; ordinairement il était rebelle, aimant à protester, essayant de prévoir le monde de demain et de le modeler. On a remarqué que l'ingénieur (Américain, Russe ou Allemand) était attaché à son travail sans s'occuper du monde qui l'entourait. Durant cette période: les hérétiques, les martyrs, les traitres, n'étaient pas des ingénieurs mais des physiciens.

Cependant, depuis une décade, l'ingénieur, surtout l'ingénieur électricien, a pris conscience qu'il y a une science électrique et électronique; qu'elle travaille sur l'électron isolé dans le tube, puis sur l'électron inclus dans les réseaux atomiques et moléculaires des semi-conducteurs, puis sur d'autres électrons plus liés à la nature du solide, ou du gaz, que ce soit ceux des ferrites, ceux de la piézoélectricité, de la magnétostriction ou ceux des amplificateurs moléculaires ou paramétriques, ou ceux d'une électronique alors vraiment et justement moléculaire. Il côtoie alors de fait le physicien, il se met à chercher à énoncer des lois, il fait des synthèses et prend conscience qu'il y a de l'unité dans la foule des emplois techniques. La fabrication du matériel électrique et la fiabilité des composants ne sont plus sa seule occupation; il a maintenant la vision électronique des phénomènes.

"L'électronique qui était née de la technique d'utilisation devient la science du signal": elle donne naissance à la théorie du signal au service d'une théorie plus générale dite de "l'information."

L'Ingénieur électricien est passé du domaine exclusivement énergétique au domaine informationnel: il contribue maintenant au développement de l'inlividu parce que l'électricien aide l'intelligence: 1) dans son effort de recherche: que ce soit la perception, la conservation, ou la combinaison des informations. 2) dans ses calculs par les calculateurs digitaux et analogiques: la machine ne remplace pas seulement une portion technique de l'activité humaine, mais elle fait aussi certains travaux de l'intelligence humaine. 3) dans sa logique par une unité de calcul logique permettant l'analyse structurale de l'information.

C'est Shannon qui, en 1930, a montré l'intérêt prodigieux de l'algèbre

de Boole dans le traitement de l'information.

L'électricien qui, jusqu'à ce moment, était un être isolé, fait maintenant des recherches dans les domaines de la littérature, de la linguistique, de la phonétique, en psychologie expérimentale, en pédagogie, en musicologie, etc. . . . On trouve des électriciens faisant de la recherche dans tous les secteurs des sciences humaines: il étudie l'homme:

1) dans sa vie physico-chimique: on connaît les amplificateurs et les oscillateurs biologiques, les systèmes nerveux de l'homme et ses schémas cybernétiques, la théorie du robot, etc.

2) dans son information logique: une logique nouvelle de l'information et de la recherche, des circuits logiques et le fonctionnement de l'esprit, les machines et les modèles, l'étude de la complexité en soi et le passage de l'attitude expérimentale à l'attitude logique.

3) dans ses communications sémantiques: théorie et méthode des mesures en sciences humaines, théorie et méthode des statistiques, utilisation des machines à calcul, structure phonétique et linguistique.

4) dans son comportement, sa communication expressive et sa réaction esthétique, et finalement,

5) l'électronique aide dans l'action humaine: que ce soit dans la recherche opérationnelle (logique, analogique et numérique), ou dans la cybernétique et l'automation.

Sa méthode de procéder dans chacun des cas, dans chacune de ses études, suit celle que le physicien connaissait depuis longtemps: d'abord il analyse les signaux, puis il analyse les réactions, et finalement il est conduit à faire des synthèses partielles qui aident à mieux connaître l'humain.

Comme conséquence de cette révolution, l'ingénieur électricien est maintenant conduit à travailler et à contribuer aux recherches dans trois domaines, ainsi que l'a déjà indiqué le Dr. Weber:

I) en électronique et en science de base, i.e. science des matériaux;

II) dans la science des propagations;

III) dans la théorie des systèmes.

I) Le premier groupe pourrait encore se subdiviser en deux parties principales:

A) L'électronique de l'état solide et l'électronique quantique, mieux connues par l'ingénieur électricien, sous les titres de semi-conducteurs, de micro-électronique, de ferrites, de diéletriques, et d'aimplis paramétriques et moléculaires.

B) L'étude des plasmas, la propulsion ionique et les tubes électroniques.

II) Les sciences de la propagation deviennent de plus en plus importantes pour l'ingénieur électricien, surtout à cause du nouvel intérêt dans les recherches spéciales et dans une meilleure connaissance des planètes qui nous entourent.

Dans ce groupe de recherches, j'inclus l'étude des antennes, la propagation dans des milieux divers, et l'étude évidemment des radiations électromagnétiques, qui aide à accroître nos connaissances du système solaire.

III) Dans le troisième groupe, la théorie des systèmes et ses applications, on pourrait entrer la théorie des communications, la théorie de l'information, commande automatique, les machines à enseigner, les machines qui peuvent apprendre, les intelligences artificielles ou la cybernétique, la synthèse des systèmes de tous genres, en particulier des réseaux d'énergie (stabilité).

Cette division en trois groupes de travaux est assez intéressante parce que nous remarquons que, dans les deux premiers groupes, on fait usage de ce qu'on a appelé communément l'analyse en régime permanent sinusoïdal, tandis que le troisième groupe est concerné presque exclusivement de la dynamique des systèmes qui est ordinairement analysée au moyen d'équations différentielles. Cette subdivision est très importante; il me semble que beaucoup d'auteurs de livres de circuits ne considèrent que le dernier groupe et négligent l'importance des solutions en régime permanent qui sont nécessaires aux deux premiers groupes.

Ces quelques idées montrent bien qu'il devenait nécessaire aux ingénieurs électriciens, aux éducateurs, d'introduire de nouveaux concepts dans l'étude des circuits. De nouveaux signaux, de nouvelles formes d'ondes, deviennent importants, par exemple: impulsion, l'échelon unité, etc., et beaucoup de signaux maintenant ne sont connus que par la statistique. C'est à Mason, Huggin, et Zimmerman, que revient l'honneur d'avoir placé une nouvelle emphase sur la théorie des signaux.

On doit de plus remarquer que les anciens concepts de relations de puissance développés pour des systèmes linéaires en régime permanent ne s'appliquent pas à d'autres formes de signaux . . . On doit placer plus d'emphase sur le calcul de l'énergie et les concepts de la densité de puissance et la densité d'énergie dans les spectres doivent être considérés.

Nous croyons, au département du génie électrique, que la philosophie du modèle, ou de faire des modèles dans la représentation des systèmes est la base même de l'étude des circuits. Des idées élémentaires sur la statistique et la probabilité doivent être incluses dans l'étude de nouveaux signaux.

On doit aussi, parce qu'ils sont des ingénieurs, leur enseigner des mèthodes de rendre optimum certaines variables, même si ce n'est qu'à l'aide d'exemples. On doit aussi introduire les calculs digital et analogique, spécialement pour aider les étudiants dans les circuits non linéaires. Il faut introduire aussi les graphes linéaires afin de leur permettre d'avoir une représentation de systèmes plus complexes, et de pouvoir les résoudre.

Cette révolution n'a pas pour autant diminué l'importance des phénomènes électromécaniques; loin de là, les ingénieurs électriciens utilisent tous les jours la physique électrique pour mieux comprendre ces phénomènes: que ce soit la conversion de l'énergie, l'effet couronne et la stabilité des réseaux.

Il est vrai que plusieurs cours d'électrotechnique, qui étaient donnés dans le passé, ont disparu des programmes mais ces cours ont été, dans la plupart des cas, remplacés par de nouveaux cours qui permettent d'agrandir les horizons de l'étudiant.

Malheureusement, on rencontre encore beaucoup d'industriels qui mentionnent qu'ils n'obtiennent plus le genre d'ingénieurs dont ils ont besoin. D'un autre côté, si on leur demande ce qu'ils veulent chez un jeune gradué, ils répondront: beaucoup de mathématiques, de la physique, de la chimie, de la métallurgie, et beaucoup d'électricité, et surtout un esprit orienté vers les problèmes d'ingénieurs.

L'en seignement doit donc comporter une forte base de mathématiques et de physique, des cours avancés sur la théorie électrique, des cours d'application et un grand nombre d'exercices. Des travaux pratiques entraînent l'étudient à la technique des mesures, et le mettent en face des difficultés que présente l'application des données théoriques aux problèmes du génie. Dans l'établissement d'un programme il faut aussi tenir compte des trois principes suivants:

1) La majorité de nos étudiants nous quitte après leurs études sous-graduées;
2) le nombre de sujets auquel un étudiant doit être soumis durant chacun des semestres doit être petit, et
3) le travail personnel est absolument nécessaire pour former un bon ingénieur.

EIC—63—RES 4

SIMPLE READING MACHINES FOR THE BLIND

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RESEARCH INTO READING machines for the blind is currently attracting much attention. Research workers, seriously involved with the problem, include many already famous men and interdisciplinary co-operation is extended between psychologists, electrical and mechanical engineers, medical-surgeons and neuro-surgeons, and physicists. A fairly substantial measure of success will be needed to maintain this widespread interest at such a high level. As one eminent engineer recently remarked: "I shall spend four years in this field; but I'm waiting to see whether or not my time will prove to have been wasted". The workers in this field fall into two classes: the doubters and the others with the doubters, at present, the more numerous.

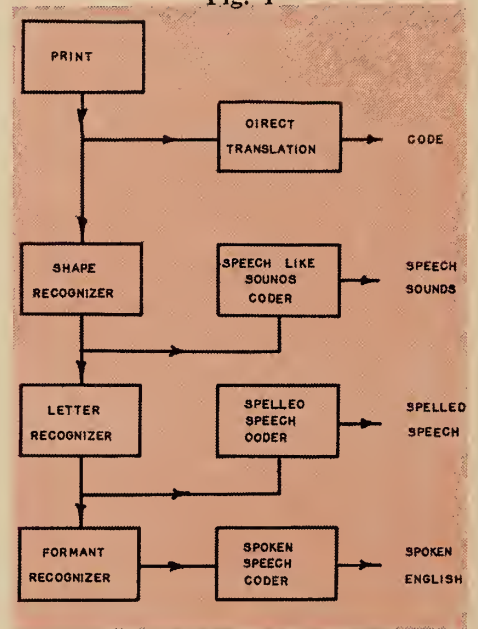
Simple machines exist at the present with roots back to 1914. One machine, the Optophone, has enjoyed a qualified[1] success in England and machines made on the same principle are being experimented with in America (the Battelle Optophone). The results of experiments on both sides of the Atlantic indicate that the Optophone's upper speed is probably 60 words a minute and this rate can be achieved only after a prolonged training period; and the subject must be extremely gifted. The most successful manipulator of the Optophone is Miss Jamieson: she is a prodigy in this field, and she has worked with this machine for most of her life. She remarked to the author last summer:

"I use the Optophone mainly to read back my typewritten letters: for this it is invaluable. I generally read five pages a day from a novel; more than this tires me."

The last sentence is significant. Sighted people can, with comparative ease, read a 200 page novel in a day. The contrast with Miss Jamieson's performance indicates the order of magnitude still separating the blind from the sighted in the matter of reading.

A comparison between experiments done by the author at the University of British Columbia with some experiments done by Clowes[2] at the National Physical Laboratories, England, shows that a substantial increase in speed is to be hoped for from the Optophone if its present sound code is changed to a multi-dimensional code called Tonal Morse. This is the main thesis of the paper. Tonal Morse originated with the author[1] and its performance in this context is the subject of continuing work using a machine similar to that shown in Fig. 2. The stage has been reached where some intelligent predictions can be made as to the performance of Tonal Morse with an Optophone print reader.

Fig. 1



The paper also describes results of recent experiments done at U.B.C. with a code called Spelled Speech Code. This Code originated with Metfessel[3] of the University of California: the work at U.B.C. produced Spelled Speech by a method different from Metfessel's. Unfortunately, Spelled Speech requires a very complicated operation to be made on the print information (by a 'letter recognizer') and a machine using this code will be more complex and expensive by an order of magnitude than the Optophone. The experiments with Spelled Speech are quoted mainly because they reinforce the promise of Tonal Morse operating with the Optophone.

Discussion of Reading Machines

Existing reading machines are classified into types: a. Direct Translation; b. Letter Recognition.

A third class has been proposed, 'shape recognizers', which lies in complexity between these two. A schematic showing the genesis of reading machines is given in Fig. 1. All machines are basically the same in their method of obtaining print information. They all scan along a line of print a letter (or portion of a letter) at a time.

The simplest machine, the Optophone[1] (invented 1914 in the U.K.)

and Argyle's Reading Machine[4] (invented 1952, Vancouver), are direct translation machines: they scan a narrow vertical slit which moves along the line of print: a series of very simple decisions are made by the machine and a sound is produced. The effort of reading is very great.

A more complicated machine, suggested by Mauch[5] (1958) works with a shape recognizer. In this machine, the print information is processed by the machine so that various shapes, e.g. straight lines, circles, closed loops etc., are recognized. Each shape then triggers an appropriate sound, and the statistics of the appearance of the shapes is is matched to the code so that noises are produced which are 'speech-like'.

A more sophisticated operation on the print information (a letter recognizer) produces letter information.[6-9] A suitable code would be Morse. Early work by the writer[1] (1959) resulted in Tonal Morse which was

Fig. 2

claimed to be more suitable for blind reading machines. But subsequent work by the writer and independent results of Metfessel of the University of Southern California have shown that artificially produced Spelled Speech, for this particular usage, is a more suitable code. Briefly, Spelled Speech is a means of conveying print information by spelling it aloud a letter at a time as in the elementary grades of school. For example, the message "the cat who sat . . ." would sound as follows: "Tee Aitch Ee: Cee Aye Tee: Double-you Aitch Oh: . . .". Each alphabet sound can be time compressed either by using a variable-speed tape recorder or by other means. Such artificially time-compressed Spelled Speech is easy to comprehend, after negligible practice, even at fast rates, and the instrumentation of a coder is quite simple.

Given a letter recognizer, it is possible to obtain the spoken output. Work reaching towards this goal is progressing mainly at the Haskins Laboratory, N.Y. under Cooper et al.: Instrumentation corresponding to the boxes designated in Fig. 1 as "Formant-Recognizer" and "Spoken-Speech" is very considerable and the cost would justify this approach for a large library only.

The machines shown in Fig. 1 and

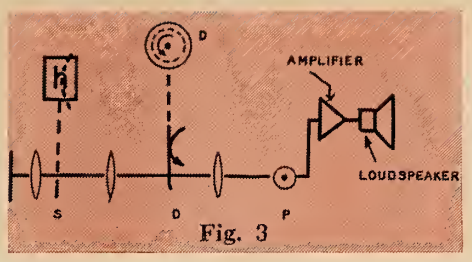


Fig. 3

explained briefly above are those on which most work is being done. A notable feature is the emphasis on aural communication. Some pilot work is being done exploring tactile and electrical channels (notably at M.I.T. and the National Physical Laboratories, U.K.).

Experimental Studies of Simple Machines

Experimental studies comparing Argyle's reader, the Optophone and a tactile reader are reported by Clowes et al[2] working at the National Physical Laboratories, U.K. Figures from their report will be contrasted with some results taken using a Tonal Morse machine at the University of British Columbia.

The Argyle reader (Fig. 2) was used in a simulated form and the apparatus is shown schematically in Fig. 3. The character to be read is imaged on a rectangular screen, s, for monitoring purposes: the light from the screen is scanned by a rotating disk, D, which contains (in the case of Argyle's original machine) eight holes equispaced at a constant radius. One hole at a time falls in the field of the letter and if the letter is stationary with respect to the pick-up device, the path traced out by the scanning hole is the arc of a circle shown in aperture s. High intensity variations in the object plane produce corresponding changes of signal from the monitoring photocell P. Letters are identified by their characteristic spectrum.

The Optophone is described elsewhere; but briefly, the feature of using a slit which moves across the letter is common to both Argyle's reader and to the Optophone. The latter avoids the scanning mechanism by using a number of photocells mounted along a vertical viewing slit; and the output from each cell varies the amplitude of a square-wave of characteristic frequency.

Tactile presentation consisted of embossed letters on a heavy paper. The letter occupied about 1 in. square, and a succession of letters were mounted on a paper tape which was driven past the subject's finger tips.

The results of a short learning session with a small number of subjects (a total of 14 took part) with the three devices is shown in Fig. 4. It will be noted that the speed is quite slow; corresponding to 18-25 words a minute. (These rates are based on the standard five letters to the word. They cannot be used to predict the learning rates in an actual reading situation because the tests were very short. They are used here to compare the performances of different codes.)

Learning sequences using a multi-dimensional code called Tonal Morse were obtained at U.B.C. using 37 sighted subjects and six blind ones. The results are plotted in Fig. 4 Tonal Morse consists of sounds from two sources: a variable-bandwidth noise generator, and a variable-pitch, variable-waveform tone generator. It has been shown[1] that permutations of the above variables allow 63 distinct sounds to be produced which are well differentiated from one another, and each letter of the alphabet is allotted one characteristic code combination.

From Fig. 4, it is seen that Tonal Morse with the sighted group gave much the same learning pattern as did the (sighted) subjects with the Battelle Optophone and Argyle's reader; but the reading rate exceeds the others by a factor of three. The performance using blind subjects was best of all, but this will not be used in the comparison between the various codes.

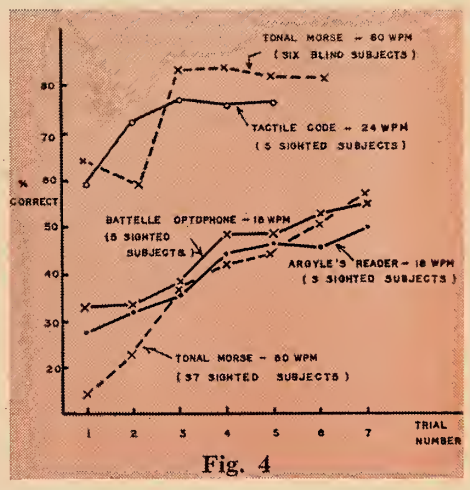


Fig. 4

Discussion of Results

The graphs shown in Fig. 4 were obtained from two groups of people and it may, on this account, be unfair to use them to compare the codes. But, taking them on their face value, what do they indicate?

Obviously Tonal Morse can be learned just as well per trial, as the present Optophone or Argyle's machine and at three times the speed.

The tests with Tonal Morse assumed that a single sound was used to represent each letter: a letter recognizer would be required. The print reader in the Optophone, on the other hand, produces three characteristic signals for each print letter (in time

sequence); and if the Tonal Morse generator were controlled by such a print reader, the rate of sounds to be decoded would be trebled and it might appear that the three to one speed advantage of Tonal Morse would be lost.

There is evidence that the present Optophone produces sounds (or clues) faster than the subject's decision rate. His slow performance is probably due to excessive decision periods needed to decode information from sounds which are very nearly alike. Some examples illustrate these points.

Corresponding to the letter 'h', the Optophone produces three sounds: a full chord followed by a single note taken from the chord, followed by a chord made from the middle and lower notes. At first, the subject will probably make a decision based on the chords which are loud and obvious. On their evidence, the letter could be an 'h' or perhaps a 'b'. Probably no further decoding is needed if contextual information can be used and only one decision needs to be made. But is this one decision easy to make?

Probably not. Early work with Tonal Braille[10] shows poor discrimination between two chords consisting of an open fifth and the major triad: this is supported by work by B. White of the Lincoln Labs, (Private communication). One decision is needed for the letter 'h'. Of course, it could be argued, contrariwise, that this decision is one of a hierarchy of decisions such as the following: is this a chord I am listening to?: is the top note of the chord present, is the next one present, etc. In fact in order to render the problem into a number of YES-NO decisions, a vast number of decisions would have to be made. In speech perception in particular, this sort of approach cannot be used by the human operator: he has slow reaction times of 0.2 to 0.5 second but, as Miller[11] notes, 'the time required to decide between two alternatives is effectively the same as that required for 30 alternatives'. Miller states also that one natural decision unit for speech is probably two to three words at a time. Thus in one form of aural communication, there is manifested a short term memory. This means that the speed limitation of decoding need not be set primarily by the number of sounds presented per second but by how easy these sounds are to decode after a number of them have been stored. A parallel between human decoding of aural signals and decoding long sequences of distorted signals can be drawn. Both require a memory. The larger this memory is the more effective and accurate the decoding becomes.

Corresponding to the Optophone's top speed of 60 words a minute, an average of 15 distinct sounds, chords and single notes, are presented to the subject each second. It is impossible to suppose that he can make a decision on each of these; and some discarding of information or, more likely, some short term storage is used to group the information into packets requiring a more leisurely decision rate for their decoding.

The great difficulty with the Optophone code is that some of the clues are nearly the same (e.g. the chords). This sort of difficulty can be avoided completely with Tonal Morse and the speed of this should be, consequently, much higher.

Spelled Speech Sound Code

If a cheap letter recognizer can be produced, and there is strong evidence to the contrary,[9] then Spelled Speech operating on a letter-by-letter basis performs in a much better fashion than any of the codes discussed in previous section.

Basically, Spelled Speech is the stuff which used to be taught in schools and on this account it is a very well known letter code. Metfessel[3] produced a form of artificial spelled speech by first tape recording an alphabet; then by judiciously eliminating parts of the sounds, he managed to collapse the time scale by a factor of two or more. He obtained comfortable decoding rates up to 90 words a minute. The author[12] has achieved the same sort of performance using a variable-speed tape-recorder; and he obtained top speeds of 120 words a minute. Subjects can learn to use Spelled Speech in a very short time possibly because of their previous schooling.

The work with Spelled Speech demonstrates an important point: that it is physically possible to assimilate at a very high rate printed information which is presented only one letter at a time. Thus, to the Times Square problem "How much of a sentence must be displayed at one time in order to read with ease?" the answer is one letter.

If the human operator is capable of storing at least one letter's information, when using the simple machine, then surely the performance with the well-designed multidimensional code can be made to approach that of Spelled Speech.

Conclusions

To sum up: in the very simple machine, use is made of various human capacities, e.g. short term storage, and ability to discriminate between a large number of alternatives; and if this ability can be exploited fully, then reading rates approaching those of Spelled Speech should be possible. The present simple machines are difficult to read because their sound output codes produce very nearly similar sounds. The human mechanism balks at the hurdle of decoding these sounds at high reading rates. It is believed that the substitution of a well designed multidimensional code such as Tonal Morse will remove the hurdle.

Experiments with Spelled Speech indicate that letters presented one at a time can be decoded very rapidly. The results confirm the promise of the simple machine. To be practicable, Spelled Speech requires a letter recognizer and this will add an order of magnitude to its cost and complexity.

Asknowledgements

The author thanks Dean Myers for suggesting that this paper would be written. He also acknowledges with pleasure the assistance of Edward Orme in the work with Reading Machines presently being undertaken at the University of British Columbia.

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EIC—63—RES 5

MAGNETOHYDRODYNAMIC POWER GENERATION— ITS PRINCIPLES AND PROBLEMS

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THE PAST TWO decades have seen in Canada a steadily mounting demand for electrical energy—a demand which, in spite of our vast resources of hydro-electric power, has prompted the construction of an ever-increasing number of large scale thermal plants (Fig. 1). In addition, the practical realization of nuclear power sources, as evidenced by NPD and CANDU, indicate that in the years to come hydro power will supply a continually decreasing proportion of the demand. By dint of many years of thorough and resourceful design, testing and manufacture, present-day hydraulic, gas and steam turbines, and their associated generators, have reached a virtual peak in refinement, so that today significant increments in efficiency are measured in tenths of a per cent. These two factors, the increasing use of thermal energy sources, and the advanced state of development of present-day rotating machines, have prompted a new, widespread interest in unconventional power generation.

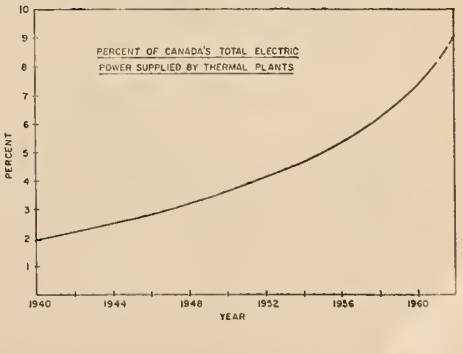
Basically, the efficiency of any thermal plant (and it is this type which will be considered in this paper) may be increased either by the use of better energy conversion devices, or by modification of the thermodynamic cycle itself. The prospect of being able to generate electricity without moving parts is particularly appealing; without them lubrication, vibration, cavitation, fatigue and all their associated difficulties become insignificant. Current research efforts on devices of this type are concentrated in several areas; thermoelectrics, thermionics, solar cells, and fuel cells are presently among the most promising. A fifth concept, and that which will be considered here, is magnetohydrodynamics, which, as the name implies, involves the motion of electrically conducting fluids in the presence of magnetic fields. What follows is a general discussion of the basic operating principles of this last power generation scheme, and a brief outline of some of the major problems that will have to be overcome, before practical large scale devices can become a reality.

Operating Principles

It is a well-known phenomenon that when an electrical conductor, such as a wire, is moved through a magnetic field so that it cuts the magnetic flux lines, an emf is induced in the wire. This, of course, is the principle upon which the operation of all rotating electric generators is based. In addition, we know that a current-carrying conductor in a magnetic field experiences a directed force—electric motors and galvanometers are two practical applications of this phenomenon. While the vast majority of familiar devices incorporate solid electrical conductors, there is no reason why liquid or gaseous conductors cannot be made to interact with magnetic fields in similar fashion, provided suitable constraints are imposed on the fluid motion.

A possible geometry could be as shown in Fig. 2. The electrically conducting fluid moves in the x-direction (the motion caused by an axial pressure gradient in the fluid) and cuts the lines of flux of a magnetic field (B) in the z-direction. The emf induced in the fluid produces a current through the load resistance, R_L, if the side walls (shaded in Fig. 2) are made electrically conducting, and the top and bottom walls are insulators. The magnitude of this current may be found from Ohm's Law

Figure 1. Graph of electric power developed in thermal plants as a per cent of the total. (Ref. 1 and Ref. 2).



$$\bar{j} = \sigma(\bar{E} + \bar{V} \times \bar{B}) \qquad (1)$$

which for the simple one-dimensional case of Fig. 2 reduces to:

$$j = \sigma(VB - E) \qquad (2)$$

where

j = current density in the z-direction (amps/m^2)
σ = electrical conductivity (mhos/m)
V = fluid velocity (m/sec)
B = magnetic field intensity (weber/m^2)
E = electric field strength (volts/m)

and the bars denote vector quantities. In equation (2) the product VB is analogous to the familiar counter- or back-emf induced in the armatures of conventional machines, and E corresponds to the voltage measured across the load. It is convenient to define a loading parameter K as follows:

$$K \equiv (E/VB) \qquad (3)$$

so equation (2) may be rewritten in the form

$$j = \sigma VB(1 - K) \qquad (4)$$

The force (Lorentz force) which acts on the fluid is given by

$$\bar{F} = \bar{j} \times \bar{B} \qquad (5)$$

which again, for the geometry of Fig. 2, reduces to

$$F = -jB = \sigma VB^2(K - 1) \qquad (6)$$

where F acts in the axial, or x-direction. The power output of the machine is given by

$$P = \bar{j} \cdot \bar{E}$$
$$= jE$$

Therefore

$$P = \sigma V^2B^2K(1 - K) \qquad (7)$$

where P is the power density in w/m^3. When K is less than unity, P is positive; that is, the machine delivers power to the load. This is consistent with equation (6) which shows that for $K < 1.0$, the force on the fluid tends to retard its flow. Conversely, if K exceeds unity, power must be supplied to the machine, the Lorentz force tends to accelerate the fluid, and the device may be considered a magnetohydrodynamic (hereafter abbreviated to MHD) accelerator. Because of the current j in the fluid, there will be Ohmic heating, which is given by:

$$Q = (j^2/\sigma)$$
$$= \sigma V^2B^2(1 - K)^2 \qquad (8)$$

It should be remarked that this expression is always positive, regardless of the value of K, and represents a dissipative process in either a generator ($K < 1.0$) or an accelerator ($K > 1.0$). If we denote the quantity $(-F)$ by $\underline{F}$ then the rate at which work is done on the fluid is obtained by multiplying $\underline{F}$ by V, and this "flow power" is converted to electrical power and Ohmic heating. Therefore

$$\underline{F}V = P + Q$$

which may be confirmed by substitution of equations (6), (7), and (8). The efficiency of the generator may be defined as the ratio of the electrical power to the flow power:

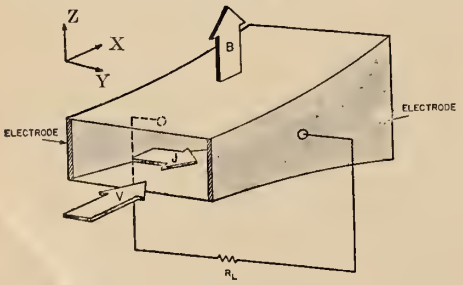
$$\eta = (P/\underline{F}V) = K \qquad (9)$$

Thus, the efficiency is given by the value of the loading parameter K.

If we differentiate equation (7) with respect to K and equate to zero, the value of K for maximum power is found to be 0.5. A reasonable compromise is therefore required between the conflicting requirements for maximum efficiency and maximum power; $K = 0.8$ is a generally accepted value.

If the device shown in Fig. 2 is operated open-circuited, K will be equal to unity (from equation (4)) and the voltage appearing between the two side walls will be a measure of the fluid velocity in the channel (Eq. (3)). Electromagnetic flowmeters, in their simplest form, are based on this principle, and in recent years have seen widespread application as metering devices for nuclear reactor coolants, sewage, and blood in veins and arteries. These devices are of particular value where it is desired to obtain instantaneous recordings of flow rates, with no obstruction appearing in the passage.

Figure 2. Schematic diagram of a plane-electrode MHD generator.



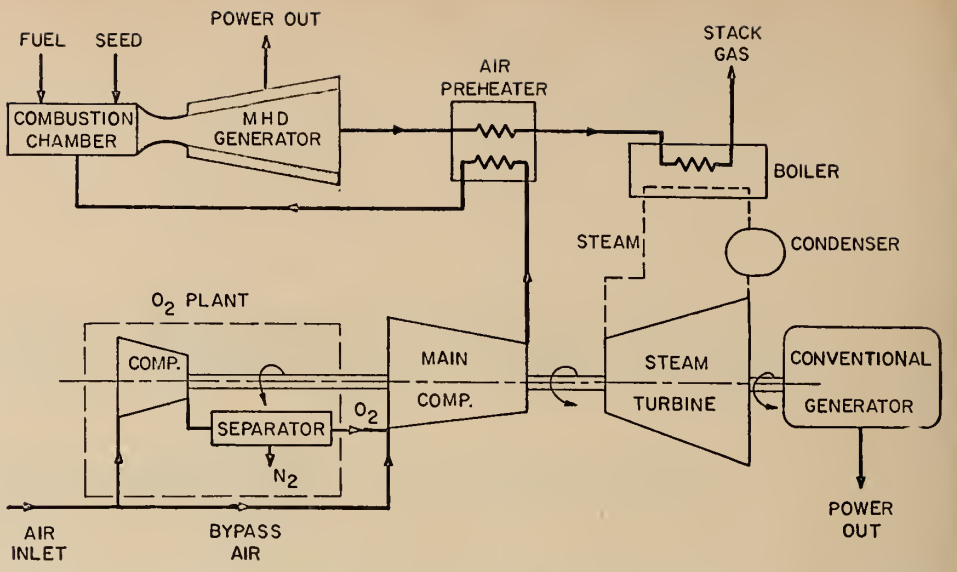


Figure 3. Schematic diagram of a combined MHD-steam open-cycle power plant. (Ref. 8).

Working Fluid

The first obvious question to be asked is: what would be a suitable working fluid? Clearly the prime requirement is that it be electrically conducting. Also, if an open cycle is to be used, the fluid must be inexpensive. Pure combustion gases, even at the maximum temperature attainable with preheating and oxygen enrichment are very poor electrical conductors, and some means of increasing σ must be devised. For open cycle application, the best solution is to seed the gas mixture with a small amount (about 1% by weight) of an easily ionizable material—alkali metal salts appear the most reasonable to use at the present time. These salts dissociate in the combustion gases, and even at 5000°F, a typical inlet temperature for an MHD generator, some of the alkali metal atoms are stripped of their outer electrons.[3] For instance, the first ionization potentials of cesium and potassium are 3.9 and 4.3 volts respectively, whereas for CO_2 it is 14.4 volts. Thus, the addition of a small amount of seeding material can increase the electrical conductivity by a factor of as much as 10^6. The gas consists therefore of a large number of neutral particles through which are scattered the ions and electrons of the alkali metal. It is these charged particles which interact with the electric and magnetic fields in the generator; the bulk flow of the fluid is then altered by collisions between the charged particles and the neutral atoms and molecules.

It can be seen from equation (7) that the power per unit volume generated varies directly as σ, so that if the machine is to assume an acceptable size, the electrical conductivity must be kept high. As a matter of interest, if the conductivity is 10 mho/meter (a typical value for seeded combustion gases) a generator of about 30 feet in length is necessary to produce 100 megawatts.

In a closed cycle, where a nuclear reactor would in all likelihood be the high temperature energy source, there is considerably greater flexibility in the selection of working fluid. Helium seeded with cesium appears particularly promising at present[4] for gas cycles, but

Rankine cycles using rubidium are also being studied. A phenomenon known as non-equilibrium ionization is also receiving considerable attention since it promises to yield electrical conductivities as much as 30 per cent higher than those anticipated from equilibrium considerations.[5] This theory assumes the gas is treated as essentially two separate fluids at different energy levels (or temperatures). It is postulated that the electrons reach an equilibrium Maxwellian distribution by virtue of electron-electron collisions, but do not exchange significant energy with the heavy particles (ions and neutrals) which have their own equilibrium distribution at a lower energy level. Thus, with the expenditure of a small amount of energy, usually in the form of an electric field, the electron temperature can be raised above the bulk temperature of the fluid. Since the electrical conductivity of the gas depends on the electron concentration, and since this concentration in turn depends upon the electron temperature, nonequilibrium effects may be of considerable importance in determining MHD generator performance.

Materials

Possibly the largest single problem to be overcome before MHD machines become a practical reality is that of material selection. For the insulating walls (those parallel to the pole pieces of the magnet), refractory oxides such as zirconia or magnesia are eminently suited and tests[6] have shown that these materials can withstand high velocity gases at temperatures up to 4400°F without appreciable deterioration. The electrodes, however, pose a more serious problem, since in addition to being heat resistant, they must be good electrical conductors. In conventional generators the current is drawn off the armature by means of brushes or slip rings, with metal-to-metal contact. In an MHD machine, the electrons must be emitted from the cathode into the ionized gas stream, and therefore must possess sufficient energy to overcome the work function of the electrode material. Thermionic emission, the principle utilized in vacuum tubes, is limited by the current densities available, and for graphite electrodes would require wall temperatures in excess of 5000°F. Since for many materials, the microstructure has an important bearing on their electrical and thermal properties,[7] careful consideration will have to be given to techniques of fabrication of the channel walls. In addition, the materials' resistance to oxidation and thermal shock, and their thermal expansion coefficients will be important physical properties.

Application

How is MHD to be utilized as a practical electrical power source? Obviously, because of the high temperature of the MHD channel exhaust gases (σ becomes too low below about 3500°F), the duct must be used as a topping device in conjunction with a conventional plant.

(a) Open Cycle

The variety of cycle arrangements incorporating an MHD channel is unlimited ; there are however a number of ground rules which have been established. The temperature range within the MHD machine must fall in the limits 5000°F–3500°F, and the exhaust pressure must be something greater than atmospheric. Air preheating must be incorporated, and oxygen enrichment of the combustion air is desirable. A simple schematic diagram of a possible plant is shown in Fig. 3.[8]

A portion of the inlet air is passed through the oxygen plant and the remainder bypassed so that oxygen-rich air passes into the main compressor. The air is compressed to approximately 8 atmospheres, passes through the preheater, and then burns fuel (either oil or coal) in a combustion chamber. The seeded combustion products are then expanded in a nozzle to a high velocity (for the importance of this, see equation (7)), and then pass through the MHD generator. At this point, the pressure is about 18-20 psia, and the gases flow successively through the high temperature side of the air preheater and the boiler of a conventional steam power plant. The conventional plant in turn produces power to drive the compressors and auxiliaries, and also provides a useful electrical output.

An ingenious modification of this system has been proposed by Allis-Chalmers in conjunction with Babcock & Wilcox[9] to eliminate the problems arising in the design of the high temperature air preheater. In the Allis-Chalmers cycle, high pressure combustion air is first preheated by the relatively low temperature stack gas, and is then passed upward through a vertically mounted chamber where it encounters a downward shower of hot (4000°F) liquid slag. The slag results from the combustion of coal in a cyclone burner (the main combustion chamber of the plant), and is heated in a similar vertical chamber arrangement located just downstream of the MHD generator. A block diagram of this arrangement is shown in Fig. 4. By using this scheme, it is estimated that the inlet air temperature to the combustion chamber can be as high as 3800°F.

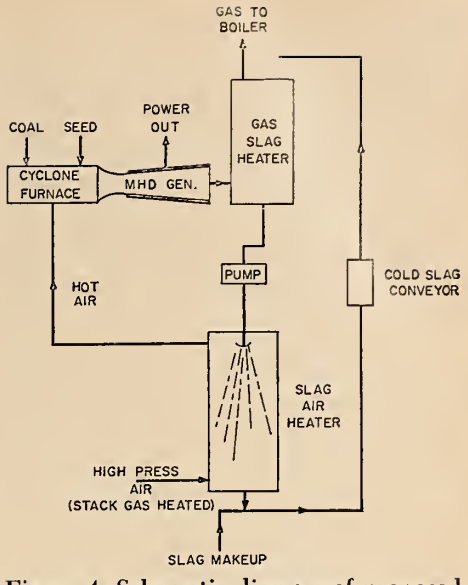


Figure 4. Schematic diagram of proposed air preheater system using hot slag. (Ref. 9).

For the typical power plant analyzed in detail in Ref. 6, the total output of the plant is 520 mw, 343 mw of which are supplied by the MHD generator and 177 mw by the steam plant. The net output of the plant is 497 mw, 23 mw being used for auxiliary power. Table I shows expected heat rates, plant costs, and power costs for several different power plant arrangements.

(b) Closed Cycle

A simplified block diagram for a typical closed cycle using a nuclear reactor heat source is shown in Fig. 5[10]. The cycle would be similar to a regenerated gas turbine or Brayton cycle, and as mentioned previously, would likely use cesium-seeded helium as the working fluid. In space power plants, for which this type of cycle is particularly well suited, the conventional plant would be replaced by a radiator, since in space applications, compactness and light weight carry a premium over efficiency.

The use of a gas such as helium has

TABLE I

Estimated Plant Costs, Heat Rates and Generation Costs for Several 500 mw Power Plants. (Ref. 6)

	Plant Cost	*Heat Rate*	*Generation Cost**
MHD-Steam (Natural Gas Fired)	127 $/kw	7200 BTU/kw-hr.	5.3 mills/kw-hr.
MHD-Steam (Coal Fired)	147	6800	5.6
Conventional (Natural Gas Fired)	105	8900	5.0
Conventional (Coal Fired)	120	8800	5.3
Gas-Steam Turbine (Natural Gas Fired)	105	8300	4.9

*Includes capital cost (14% capital charge and 0.8 load factor), fuel costs (30c/million BTU), operation, maintenance and seed costs.

several distinct advantages, and reduces the problems to be overcome in the MHD channel itself. Its low molecular weight and small electron-atom collision cross-section make for larger electrical conductivities than are achievable in combustion gases. Since there is no ash, and the gas is non-corrosive, heat exchanger and generator wall material problems are minimized. Analysis[10] of a cycle similar to that shown in Fig. 5, with the substitution of a radiator for the boiler, has shown that for a peak helium temperature of 4500°F, the overall thermal efficiency would be 59%. Temperatures this high are beyond the capabilities of present-day reactors, but again the development of more exotic materials does not make 4500°F an unduly optimistic figure.

The possible arrangements of closed cycle MHD plants are numerous; for instance, if a liquid cooled reactor is to be used, a secondary heat exchanger is required between the liquid loop and the gas loop. An intriguing possibility would be to operate the system on a Rankine cycle, using rubidium both as the reactor coolant and as the MHD working fluid. Unfortunately, high temperatures are again necessary to give sufficient ionization of the rubidium vapor.

An even more futuristic scheme that has been proposed[10] would use a cavity reactor surrounded by a moderating blanket of D_2O. Into this cavity would be introduced a mixture of helium containing about 1 per cent uranium and 12 per cent potassium at a pressure of 120 atmospheres. The mixture would heat itself by fission to a temperature of about 9000°F, and then expand directly through an MHD generator. A typical such plant would have a maximum linear dimension of 20 feet, a specific power of about 50 kw per pound and would produce 10,000 mw.

Losses

Let us return briefly to the MHD generator and examine several of the severest limitations inherent in such a machine.

(a) Hall Effect

This effect is of particular significance in MHD generators; so important is it, in fact, that practical generators with the electrode configuration shown in Fig. 2 will not likely be feasible.

An electron in an electric field tends to move in a direction opposite to the field. However, this motion causes an interaction with the transverse magnetic field, given by the right-hand rule, which causes the electron to move in a curved path in a plane normal to the magnetic field. Since the mean free path between collisions is the same regardless as the direction of motion of the electrons, the component of the electron drift per collision in the E direction is

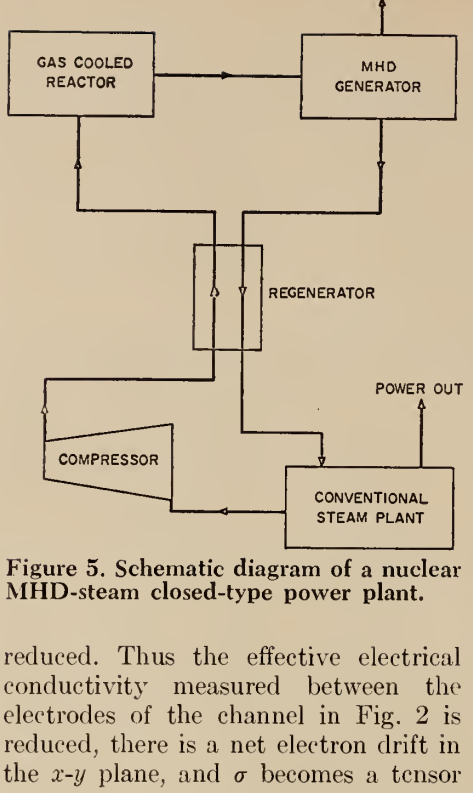


Figure 5. Schematic diagram of a nuclear MHD-steam closed-type power plant.

reduced. Thus the effective electrical conductivity measured between the electrodes of the channel in Fig. 2 is reduced, there is a net electron drift in the x-y plane, and σ becomes a tensor property.

The significant parameter in determining the magnitude of this so-called Hall effect is the product $\omega_e\tau_e$, where ω_e is the electron cyclotron frequency and τ_e is the mean time between collisions for the electrons. The product $\omega_e\tau_e$ varies directly as the magnetic field strength B and inversely as the electron density.

If Hall effects are considered, Ohm's Law (equation (1)) becomes

$$\bar{j} = \sigma(\bar{E} + \bar{V} \times \bar{B}) - \left(\frac{\omega_e\tau_e}{B}\right)\bar{j} \times \bar{B} \qquad (10)$$

The x and y components of equation (10) become

$$j_y = \frac{\sigma}{1 + (\omega_e\tau_e)^2}[VB - E_y + \omega_e\tau_e E_x] \qquad (11)$$

$$j_x = \frac{\sigma}{1 + (\omega_e\tau_e)^2}[(\omega_e\tau_e)(VB - E_y) - E_x] \qquad (12)$$

where E_x and E_y are the electric fields in the axial and transverse directions respectively. E_x is often referred to as the Hall field and j_x as the Hall current.

In the linear generator pictured in Fig. 2, the electrodes are continuous in the axial direction, and since their conductivity is much larger than that of the gas, they effectively short out the axial field E_x. The useful power output of the machine is j_yE_y, which becomes, after substitution of $E_x = 0$ in equation (11),

$$P = \frac{\sigma V^2B^2K}{1 + (\omega_e\tau_e)^2}(1 - K) \qquad (13)$$

where $K = E_y/VB$. Com
equation (7) shows that th
reduces the output power of
by the factor $[1 + (\omega_e\tau_e)$
typical MHD generator u
combustion gases, $\omega_e\tau_e$ may l
from unity to as high as 7. I
instance, the power is theref
to 2% of the value compu
effects are neglected!

This severe limitation ma
come by constructing a mac
porating segmented electrod
in Fig. 6. Each pair of electr
connected through a separa
each circuit will float at
potential. In this arrangem
current component j_x will
E_x will have some finite va
the net electric field will b
angle to the generator axis
equation (12) for $j_x = 0$ yields

$$E_x = (\omega_e\tau_e)(VB - E_y$$

which when substituted into
(11) gives

$$j_y = \sigma(VB - E_y)$$

The power thus becomes

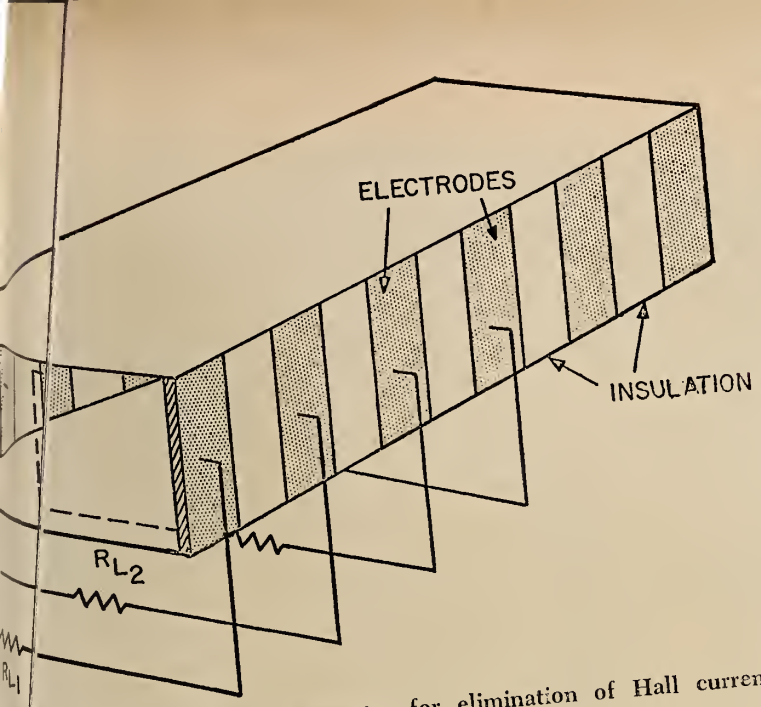
$$P = \sigma V^2B^2K(K - 1$$

and is identical with that found
continuous electrode machine
Hall effects. Obviously the se
electrode geometry introduces
of power distribution, but the
culties do not appear serious
time.

(b) Boundary Layers

As in any aerodynamic devi
formation of boundary layers
channel walls results in significant
In addition to fluid friction an
transfer (this latter is particular
portant in view of the strong te
ture dependence of the electrica
ductivity) the boundary layers p
a short circuit path for current
the channel. Considering the insu
wall, and recognizing that the v
boundary layer is a region whe
velocity is less than that in th
stream it can be seen from Ohm'
(equation (2)) that the boundary
current will depend on distance fro
wall. If B and E are assumed co
in the layer, it is evident that the c
will flow in the opposite direct
that of the free stream current fo
region near the wall where uB
than E (u is the local velocity)
reverse current flow can be cons
a shorting current which in turn
Ohmic heating and unexpected L
force effects near the wall. Visco
thermal boundary layers on the i
ing wall have been analyzed fo
laminar and turbulent flow[11] and
to present no real limitation on ge
performance, particularly for lar
machines.

The problem of boundary layer



Segmented electrode MHD generator for elimination of Hall current.

ectrodes is more severe
ddition to the growth of
mal layers, the formation
ge sheath and a potential
ectrode surface as in con-
ischarges, compounds the
present the true mechan-
g on the conducting walls
y understood, and are the
considerable experimental
cal research effort.

rent Losses

of the large potential differ-
en the anode and cathode,
se currents can flow in the
egion immediately upstream
tream of the magnetic field[12].
called end losses may be mini-
establishing the magnetic field
it extends beyond the electrode
some distance, and by the in-
of baffles at the electrode
ies. A third suggestion for the
n of these end currents (and
nying pressure loss due to the
magnetic field interaction) is to
ne seed material into the moving
ne upstream end of the electrodes,
the end currents will be confined
downstream end of the channel.

agnet Coil Losses

n the power equation (7) it can
en that for a given power, the
e of the machine varies inversely
. However the power loss in the
etic field coil will vary approxi-
y as B^2, so that the total field loss
e more or less invariant for a given
r output. It is thus desirable to
ate at the highest possible magnetic
. For iron core magnets, fields are
ted by saturation to about 20,000
ss (2 weber/m^2) but air core coils
e no serious technical difficulties.
t can be shown [13] that in a 500 mw
nt the MHD generator field coil
l consume about 8% of the total out-
t if it is made of water cooled copper.

Recent developments in the technology of superconducting magnets have been very encouraging however, and experiments[13] indicate that a niobium-zirconium alloy wire .010-inch in diameter will carry 20 amperes at field strengths of up to 50,000 gauss. This current density is about 100 times that which is practical for copper, and the only losses resulting when applied to an MHD machine would be heat transfer to the liquid helium cooling bath. The cost of superconducting alloys is high (about $350 per pound for Nb-Zr) as is the cost of a suitable helium liquefaction plant, but even in the present early stages of development, these prices are competitive with conventional copper coils for MHD applications.

(e) AC Conversion

The machines so far discussed have been DC devices, whereas for efficient power distribution AC is required. Equipment for inversion is fairly standard at the present time, although the long-term reliability at high power levels required for central stations still poses a problem. Cost estimates for inversion equipment vary, but $20 per kw is a generally accepted figure, and was used in the calculations summarized in Table I.

The possibility of generating AC directly in an MHD channel is of some interest; electrodeless configurations to perform this are presently being investigated. By suitably arranging the magnetic field coils, and by supplying them with properly phased power, a sinusoidal magnetic field may be made to travel the length of the channel. If the speed of motion of this "wave" is less than that of the fluid, currents will be induced in the flow, which in turn will create a field inducing an additional emf in the magnet coils. The effect will be to retard the flow and generate power in the windings. To be effective, however, electrical conductivities considerably greater than those available in combustion gases are required, and until more is known about the process of non-equilibrium ionization, the scheme is of doubtful practical interest.

Conclusion

In this paper some of the basic ideas underlying MHD power generation have been outlined, and some of the more significant problem areas have been pointed up. The concept is of sufficient interest and merit that a widespread research and development effort on the part of government and private agencies is being undertaken, particularly in the United States and England. The scope of the difficulties yet to be overcome is extremely broad; materials, gas properties, heat transfer, fluid dynamics, structures, refrigeration, and power distribution are but a few of the areas in which a great deal of imaginative and practical engineering work remains to be done. However, should the MHD concept of power generation fulfill its promise, its impact on the power industry in Canada will be of far-reaching consequence.

Acknowledgement

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Discussion

SETTLEMENT STUDIES ON THE MOUNT SINAI HOSPITAL, TORONTO

C. B. Crawford
Head, Soil Mechanics Section, Division of Building Research, National Research Council, Ottawa

K. N. Burn
Soil Mechanics Section, Division of Building Research, National Research Council, Ottawa

The Engineering Journal, December, 1962, page 31

Discussion by Dr. G. G. Myerhof
Head, Department of Civil Engineering, Nova Scotia Technical College, Halifax

The authors' interesting paper indicates some of the difficulties involved in estimating the settlement of structures on raft foundations. They find that standard consolidation tests considerably overestimated the settlement and concluded that the observed movements are mainly of an elastic nature. However, for the relatively slow rate of loading of the structure extending over a period of more than two years, appreciable consolidation settlement would occur concurrently with the immediate settlement, and both types of movement are expected to be of the same order of magnitude. This is shown by the authors' deduction of a Poisson's ratio of about one-third, compared with a value of one-half corresponding to fully saturated soils subjected to elastic movements. Moreover, the average initial tangent modulus of elasticity of the present soil for rapid loading is likely to have been greater than the value of about 600 tons sq. ft. deduced from laboratory tests if the influence of the rate of loading had been determined from separate specimens instead of using the same samples for this investigation (Fig. 7). Finally, it is believed that the relatively wide foundation raft compared with the thickness of the compressible stratum produces considerable lateral restraint and thus reduces the elastic movements as shown in previous papers by the writer.[1,2]

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Discussion by D. H. MacDonald
Director, H. G. Acres & Company Limited, Niagara Falls, Ont.

This paper describes one of the very few settlement studies that have been carried out on the compressible glacial soils of the Toronto region. The structure in question is irregularly shaped and imposes comparatively light loads at a shallow depth on a moderately over-consolidated clay till by means of a reinforced concrete mat. In consequence of this the maximum total settlement has been small (not greater than about 0.6 inches), and the strains imposed upon the structure by the characteristically dish-shaped settlement pattern have been so small that no apparent damage to the building is recorded, or is likely to occur. The mat foundation chosen for the structure appears to have been a wise selection. The chief values of this paper are that it places on record one more case history on settlements, and it focuses attention on some of the unresolved questions in settlement analysis.

The writer was particularly interested in the process of reasoning that the authors seem to have followed. If this has been interpreted correctly, it seems to run as follows: The measured settlements are appreciably less than the estimated ones; the settlement appears to have occurred quickly, almost simultaneously with load application; this suggests that the settlement is largely elastic; perhaps we can compute settlements close to the actual ones if we use a sufficiently high modulus of elasticity and elastic theory only.

The writer wishes to make it clear that he does not disagree with some of this reasoning. However, it would seem to be an over-simplification of the settlement process, and one which does not contribute to our understanding of the problem. The similarity between the time-settlement and the load-application curves could suggest an elastic phenomenon, but it should be pointed out that the construction period for this building was relatively lengthy, and our knowledge of the soil property known as the coefficient of consolidation (C_v) is still rather limited. The probability that some of the settlement is due to consolidation is further reinforced by a consideration of the loading conditions and the "p-e" curve. It is quite possible that no swelling occurred during unloading of the foundation, and, if so, the rebound and recompression would be entirely elastic up until the condition of zero net load was re-established. As soon as a positive net load was applied, and if the soil was completely saturated, primary consolidation should have begun to occur, even though it might have been at a fast rate. It is the writer's belief that the settlement the authors term 'elastic' is only partly elastic and the remainder is in nature what has hitherto been termed primary consolidation.

The description of the testing to ascertain the modulus of elasticity of the soil and of the results obtained, is very interesting, and the correct evaluation of this property is essential for the furtherance of settlement analysis work. In the writer's opinion, however, there is one other difficult area of settlement prediction which is exemplified by the Mt. Sinai case, and that is the prediction of consolidation settlements when the applied loads are in close proximity to the preconsolidation pressure. Such is the case at Mt. Sinai and it makes the correct evaluation of the compressibility very difficult.

In the light of these comments it would be very interesting to learn whether any attempt has been made to estimate the settlements using one of the methods that combines elastic and consolidation movements, such as that suggested by Skempton and Bjerrum in 1957.[1] In closing, the writer would like to commend the authors for contributing this interesting settlement record to the literature on the subject.

Discussed in this issue is C. B. Crawford and K. N. Burn's paper "SETTLEMENT STUDIES ON THE MOUNT SINAI HOSPITAL, TORONTO"

Following the above are discussions on the papers – "CARILLON FOUNDATION STUDIES", by C. H. Pigot and I. D. MacKenzie, and "ENGINEERING EDUCATION, HAVE WE A PROBLEM?" by W. F. McMullen

REFERENCE

1. Skempton, A. W. and Bjerrum, L., (1957), **"A Contribution to the Settlement Analysis of Foundations on Clay"**, Geotechnique, V. 7, pp. 168-178.

Discussion by Wilson

It is, unfortunately, very rare that designers and builders of structures think of spending comparatively small amounts of money to ensure that the behaviour of foundations can be determined after the structure has been built.

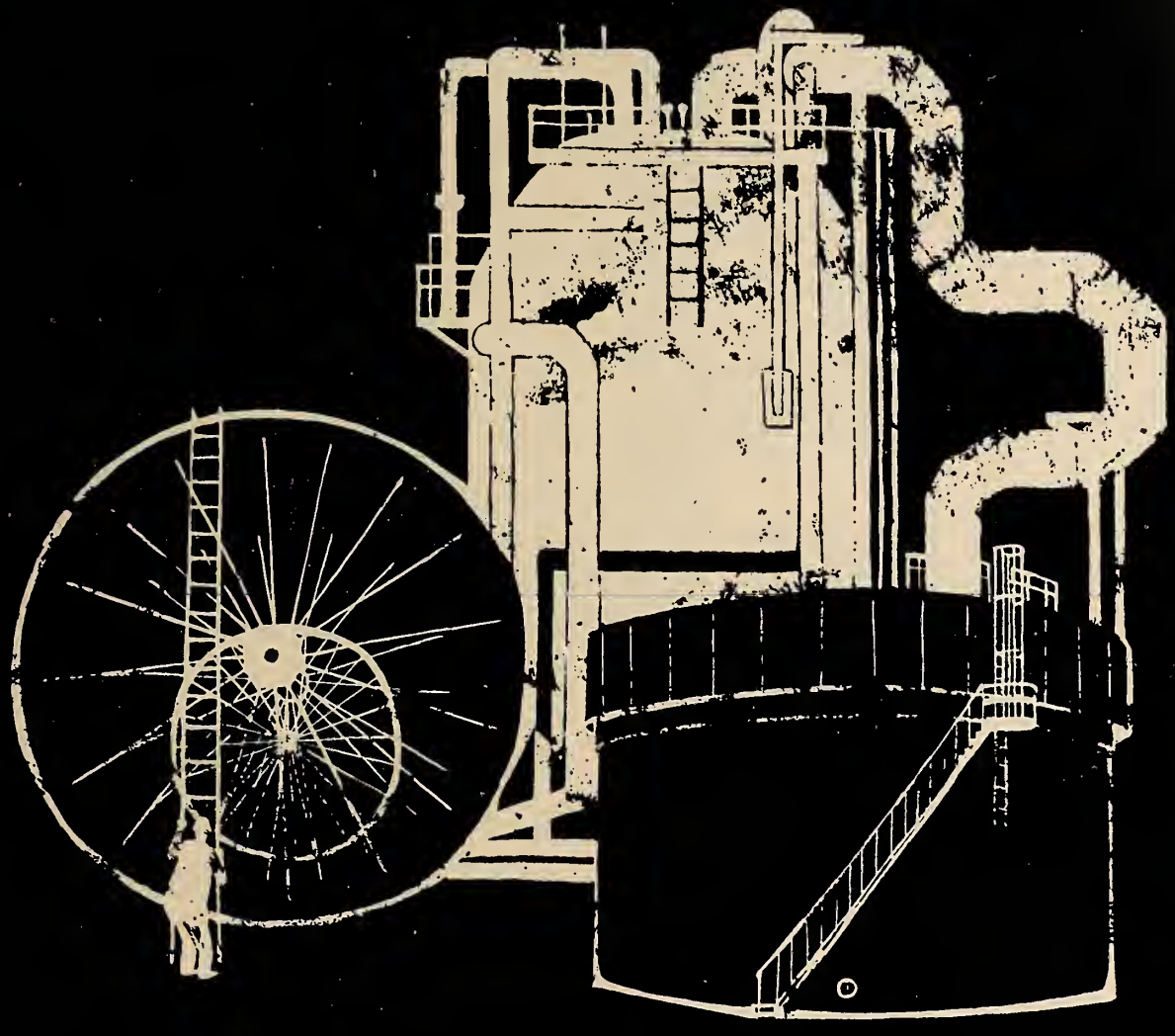
I am sure that a great deal of very valuable information in the science of soils information can be obtained in this manner by the expenditure of very little money.

Many buildings on three sides of the Mt. Sinai Hospital, and close to it, have been built since the latter was constructed, in 1950. Franki of Canada Limited, with whom I am associated, has executed contracts on excavated caissons down to rock for an extension to the Sick Children's Hospital across University Avenue to the east; 500 University Avenue, just to the south; and the School of Nursing, immediately to the west; among several others close by.

The caissons on these projects range from 30 in. to 6 ft. in diameter and have enlarged bases, up to 12 ft. in diameter. These caissons are based on the shale which is loaded to 25 tons per square foot.

At the time the Mt. Sinai Hospital was built, excavated caissons cost nearly double

(Continued on page 78)



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Dear Fellow Engineers

During the past year it has been my very great privilege to serve the Institute as your President. This has enabled me to visit most of our 62 Branches from coast to coast. I have had an opportunity to see the great outpouring of individual effort which characterizes the Branches and the Institute.

I am sure most of you will appreciate that the year has been one of solid achievement. The very strong majorities given the By-law amendments have put your Institute on a better financial basis. They have given us the Executive Committee of Council for more effective handling of administrative work and the freeing of Council for policy development.

I am confident the Regional Information and Co-ordination Centre (R.I. & C.C.) concept will prove to be one of the most constructive steps ever undertaken to provide a richer and more complete Institute service to its members.

Much time has been devoted by Council and its Special Committee on Confederation to the matter of practical unity. Real progress has been made.

On May 31st there will be mailed to voting members of the Engineering Institute of Canada a ballot on the proposal for unification of the engineering profession in Canada along the lines laid down in the final Report of the Engineers Confederation Commission. Members of the ten Provincial and Territorial Associations and the Corporation of Professional Engineers will be asked by their Councils to complete a similar ballot at the same time.

All engineers, I am confident, have long hoped that a sound basis for realistic unity in the profession could be found. I am confident the individual members of the Engineers Confederation Commission had such an objective in mind in their deliberations. However, the Report was not an unanimous report.

Your representatives, the Council of the Institute, have deliberated carefully and conscientiously on the proposal in the final Report. Council considers that the implementation of the Report is not in the best interests of the profession. Their reasons are given in the short document accompanying the ballot.

Your Council firmly considers an effective, practical, and economical solution lies in a closer liaison between the Engineering Institute of Canada and the Associations and Corporation of Professional Engineers. This can be achieved through separate but uniform agreements between the Institute and the Associations and Corporation. This has been demonstrated by the existing agreements between the Institute and six of the Associations.

The legal opinion contained in the document accompanying the ballot is unfavourable. The legal opinion supports the view of Council as to the best solution for achieving practical unity.

After long and anxious consideration I can only say that my heartfelt hope is that you will carefully read the document accompanying the ballot, think over the significance for our profession, and then vote.

I have referred to the growth of the Institute. It is my hope that the Provincial and Territorial Association and Corporation will also grow and thus be enabled to fulfill their role as licensing bodies operating under relevant legislation framed to protect the public.

I extend my warmest appreciation for your support during the past year. I know you will continue to build a stronger Engineering Institute of Canada.

Yours sincerely,

Cher confrères,

J'ai eu le très grand privilège d'être votre président au course de l'année qui vient de s'écouler et de visiter un grand nombre de nos 62 sections régionales, d'un océan à l'autre, ce qui m'a permis de constater l'effort individuel qui caractérise les sections régionales, et l'Institut.

Je suis certain que la plupart d'entre vous estime que cette année a été des plus fructueuses. Les amendements à la Constitution ont été approuvés par la grande majorité des membres, ce qui fait que l'institut est maintenant établi sur une meilleure base financière. Le Comité exécutif du Conseil s'est vu accorder une plus grande facilité dans le travail administratif et on a donné au Conseil une plus grande liberté de planification.

Je suis convaincu que la formation du Centre régional d'Information et de Coordination (R.I. & C.C.) est un pas vers un service plus complet et plus enrichissant pour les membres de l'Institut.

Les Conseil, en collaboration avec le Comité Spécial, a consacré beaucoup de temps à l'étude de l'unité au sein de la Confédération; de grand progrès ont été accomplis dans ce domaine.

Le 31 mai nous enverrons aux membres de l'Institut canadien des ingénieurs qui ont droit de vote un bulletin de vote sur le projet d'unifier la profession d'ingénieur au Canada suivant les recommandations formulées dans le rapport de la Commission chargé d'étudier le projet. Les membres des 10 associations provinciales et territoriales et de la Corporation des ingénieurs professionnels seront appelés en même temps à voter sur la même question.

Nous souhaitons tous, depuis longtemps, j'en suis sûr, q'un terrain d'entente solide soit trouvé pour réaliser une unité réaliste au sein de notre profession. Cet objectif était, j'en suis certain, celui de chacun des members de la commission durant ses délibérations. Son rapport, cependant, n'était pas unanime.

Le Conseil de l'Institut, qui vous représente, a soigneusement et consciencieusement examiné tous les aspects de la proposition dans le rapport final. Il a été forcé de conclure que la proposition qu'il contient ne servirait pas les meilleurs intérêts de la profession. Il expose ses raisons dans la courte lettre qui accompagne le bulletin de vote.

Veuillez ne pas oublier que votre Conseil est fermement convaincu qu'une liaison plus étroite entre l'Institut canadien des ingénieurs, les associations d'ingénieurs et la Corporation des ingénieurs professionnels est une solution beaucoup plus efficace, pratique et économique. Elle peut être réalisée par des ententes séparées mais uniformes entre l'Institut, les associations et la Corporation, comme il a été démontré par les ententes qui existent déjà entre l'Institut et six des Associations.

La lettre qui accompagne le bulletin de vote mentionne que nos aviseurs légaux ne sont pas favorables. Ces aviseurs appuient les vues du Conseil quant aux solutions les plus appropriées pour réaliser l'unité.

Après avoir longuement réfléchi, je ne puis qu'espérer que vous lirez attentivement la lettre accompagnant le bulletin de vote, que vous penserez à la portée de cette proposition, et qu'ensuite vous voterez.

J'ai parlé de l'ampleur qu'a pris l'Institut. J'espère que les associations provinciales et territoriales, et la Corporation grandiront aussi et pourront ainsi remplir leur rôle d'associations autorisées opérant sous une législation pertinente préparée pour la protection du public.

Veuillez croire à toute ma reconnaisance pour la coopération que vous m'avez accordée au cours de cette année. Je suis sûr que vous continuerez à faire de l'Institut Canadien des ingénieurs un organisme de plus en plus fort et solide.

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Branch News

BELLEVILLE
J. E. Tomlinson

President F. L. Lawton and Mrs. Lawton, Garnet Page, the General-Secretary of the Engineering Institute and Jack Waddington, Vice-President, Region V, visited the Branch March 4. Through the efforts of branch member, Squadron Leader K. Ridout, arrangements were made with Group Captain C. R. Thompson, Commanding Officer of No. 6 Repair Depot, RCAF Trenton, for a dinner meeting at the Officers' Mess. Group Captain Thompson personally conducted Messrs. Lawton and Page, and members of the Branch through the facilities of No. 6 R.D. early in the afternoon. As host for the evening, G/C Thompson spared no effort in his arrangement for a meal which tempted the palate of the most discerning.

Mr. Lawton, in his address, stressed the importance of engineering to Canada. He mentioned that although Canada was politically united by Confederation, it was not really united until the two transcontinental railways had been constructed. These railways were the direct result of engineering foresight and skill. More recently, these same engineering qualities continue to unit more solidly and so develop all of Canada. Such things as the Trans-Canada Highway, the railways both on the Pacific Coast and in Labrador to the iron ore bodies, the Caribou Trail, the Canso Causeway plus numerous bridges not only have furthered Canada's development, but have been acclaimed as some of the world's greatest engineering projects. Mr. Lawton noted that Canada and Canadian engineering took a back seat to no one in such fields as communications, newsprint, and cellulose development, mining, hydro developments, nuclear power, chemical and petro-chemical industries, and aluminum production. The greatest aluminum reduction centre in the world is located in Arvida, Quebec, 85% of whose total production is exported.

Mr. Lawton described the part that the E.I.C. was playing in co-operation with the provincial associations with regards to confederation, unionism, and publication of technical papers in foreign countries. He suggested we could all do more in regards to making it better known that Canadian engineers were contributing so much to foreign technical publications.

Mr. Lawton stressed the need for more research by Canadians and Canadian companies to maintain production of our natural resources especially in mining, oil and pulp industries. It is regrettable that we are exporting so many of our trained personnel to the U.S.A. Not only do we lose their brain power and work, but we lose financially. We pay to train them and then have to buy back at enormous cost, the result of their work. There is no need for the Canadian economy to become sapped to benefit our neighbours to the south.

Left to right: Mrs. C. R. Thompson; Group Captain C. R. Thompson; Mrs. F. L. Lawton; President F. L. Lawton; W. J. N. Throop, Chairman, Belleville Branch.

R. E. Curtis, of Deleuw, Cather & Company Limited, was the guest speaker at the Branch's February 11 meeting. Mr. Curtis spoke on the Ottawa Sewage Tunnel. The tunnel, 12 feet in diameter, and 7¼ miles long, runs under the city parallel to the Ottawa River, and is due to be completed sometime this year. The tunnel, running east-west, intersects the existing tunnel, and carries sewage directly to a new processing plant in the east end of the city. The original survey for this tunnel was carried out in 1958, and it was found that all but 5500 feet of the route consisted of rock. The 5500 feet made up the area of clay near the sewage plant. The cost of construction for the tunnel was close to $100 per foot through the rock, and $200 per foot through the clay.

Mr. Curtis illustrated his talk with charts and slides showing various aspects of the construction. Access to the tunnel for the men and equipment was through six 12 foot vertical shafts. Along the route, 6-inch test holes were drilled for alignment checks and concrete pours. The grading was designed to give full cleaning with a minimum flow of 2½ f.p.s. Due to the fall in the total length, three automatic underground pumping stations had to be installed, as well as a 75 foot lift at the sewage plant. Automatic regulators were installed at each interceptor to limit the flow into the tunnels. During flood conditions, the regulators will divert all excess flow directly into the river. This project is the first in the Ottawa area aimed at reducing the contamination into the Ottawa River.

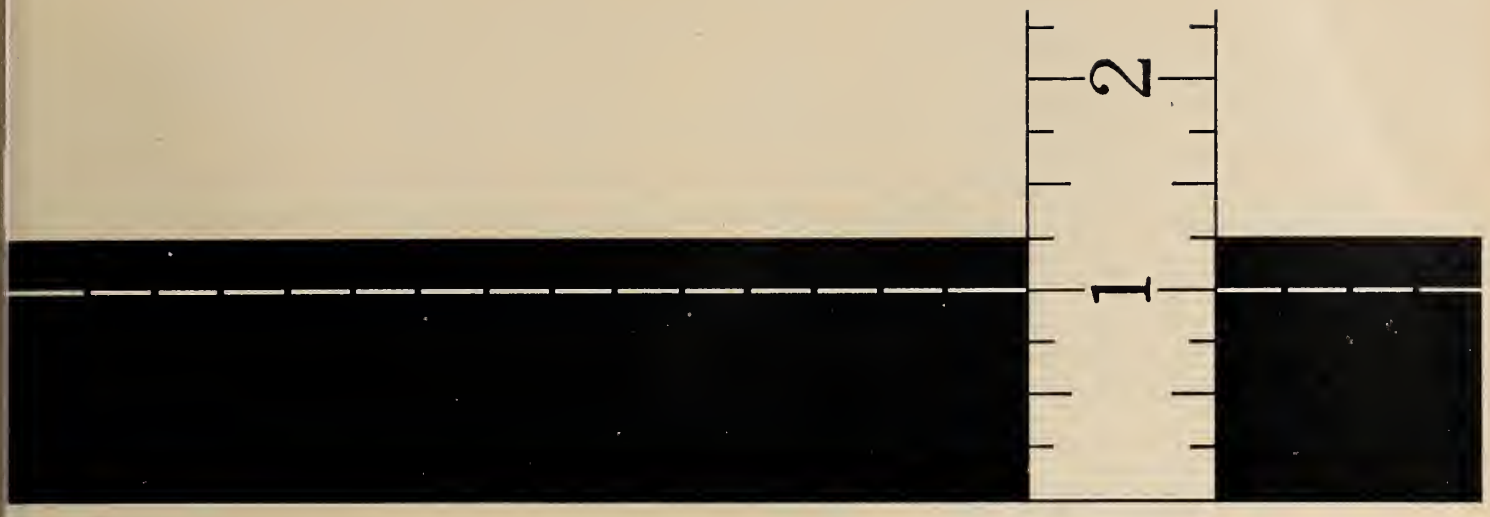
BORDER CITIES
J. E. Sinnott

The third annual Student Papers Night was held recently by the Branch at Essex College, Assumption University of Windsor. First Prize of $35. was awarded to Philip Alexander for his paper on Thermeonic Generators. Second Prize of $25. was awarded to Richard Shiner for his paper entitled, "The Cryotron — An Application of Super Conductivity". Third Prize was awarded to David Madill for his paper, "The Application of Automatic Gontrocs to a Water Treatment Plant". Guy Cataford won the fourth prize for "The Hazeman Crusher".

CORNWALL
G. Peter Schwarzkopf

On March 7, President Lawton and the General Secretary of the Institute visited the Branch. During the day they toured the Chalet Glass Ltd. and the Robert Saunders Generating Station. They also met with Mayor Nick Kaneb and signed the city's Golden Book. During the evening, Mr. Lawton addressed the members at the Parkway Hotel. Guests at the dinner meeting included N. I. Battista, President of Courtaulds (Canada) Ltd., and Lucien Lamoureux, MP for Stormont. A highlight of the evening was the presentation of a plaque to past-president G. B. Stidwell for his service to the Branch.

(Continued on page 100)



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S	.040 Max.	B	.0005/.005
Si	.20/.35	Ti	.01/.03

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Tensile Strength	115,000/135,000	115,000/135,000 psi
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Reduction of Area	40% min.	50% min.

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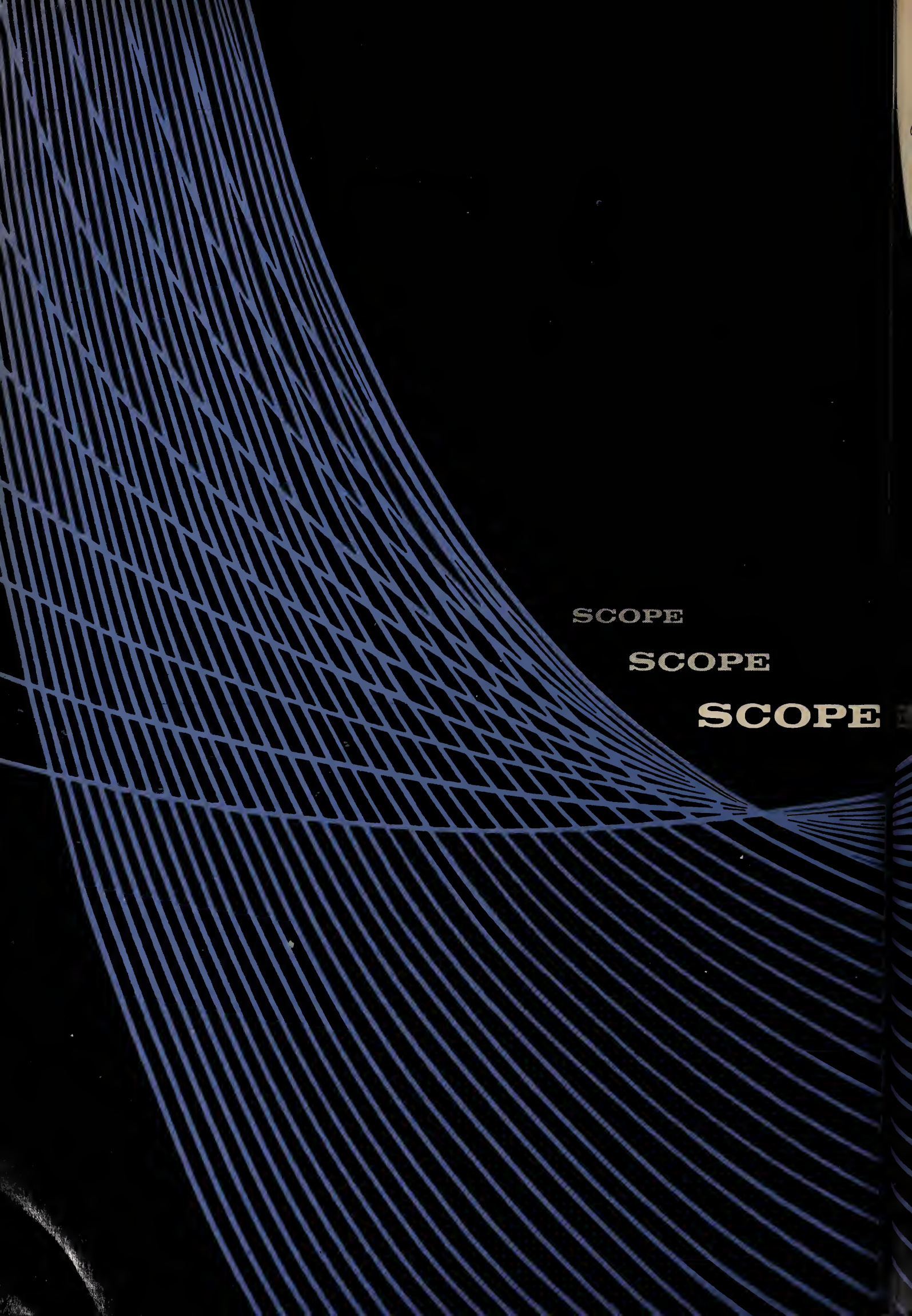
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Trent University Founded At Peterborough

Trent University, a new Canadian school of higher learning, has been founded at Peterborough in Central Ontario. The University, which will emphasize academic excellence, proudly bears the name of the valley traversed three centuries ago by Champlain and the Jesuit missionaries, and which was settled early in the 19th century by Irish and English pioneers.

About 100 students are expected to be enrolled when classes begin in September, 1964.

The University will first offer teaching for a three-year degree course in arts and science. About one dozen subjects will be represented in the first year, and these will be added to progressively each year.

Students intending to enter medical and dental courses at other universities will, from the beginning, be able to take their pre-professional training at Trent University. Some honours courses of four years, and some graduate teaching will be added as quickly as possible.

At the outset the University will operate in modest but adequate temporary quarters in the City of Peterborough. The first permanent building on a beautiful campus overlooking a 4,000 foot stretch of the Otonabee River, three miles north of Peterborough, at Nassau, will be ready for occupancy in the fall of 1966.

The site of the University — of which the core was a gift from the Canadian General Electric Co. Ltd. — contains several hundred acres of wooded hills and tablelands whose pleasing contours inspire the creation of one of Canada's most attractive campuses.

The need for such a university, indeed such universities, is obvious. By 1970 more than 100,000 qualified young men and women will be eligible for admission to university in Ontario alone. Enrolment in 1962-63 is approximately 35,000. This means that demands for university places will be tripled in seven years.

New universities must be founded because the older ones are rapidly reaching a size beyond which it would be unwise to expand. Most Canadians reject the idea of vast, ungainly institutions in which faculty-student relationships are non-existent. They wish to preserve, in both the old and the new universities, the educational advantages of relatively small institutions.

Many of the ambitious youths wishing to enter university in the years ahead will be from Peterborough and vicinity, a trading area with a population of 100,000. The enlightened citizens of the community are determined that no worthy student shall be denied the fulfilment of his ambitions because of lack of university space.

The immutable policy is to establish a University that is equal in academic excellence to any of the great universities of Canada. To assure such excellence, the founders have been given full co-operation of the Presidents of the University of Toronto, Queen's University and the University of Western Ontario. The three Presidents have appointed senior members of their faculties to a Trent University Liaison Committee, which has generously offered its advice to Trent's Academic Planning Committee and Governing Board.

Meticulous planning has gone into every detail of the development of the University. The Chairman of the Planning Committee has been Dean T. H. B. Symons of Devonshire House at the University of Toronto. Dean Symons, who holds degrees from Toronto and Oxford, is Trent University's first President and Vice-Chancellor. He will assume office on July 1, 1963, to direct the myriad details of planning during the year preceding the formal opening.

(Continued on page 68)

The following report of the LIFE MEMBERS COMMITTEE was received too late for publication in the April issue of the Engineering Journal as part of the ANNUAL REPORT OF THE ENGINEERING INSTITUTE OF CANADA. The Life Members Committee is a Special Committee of the E.I.C.

LIFE MEMBERS COMMITTEE

During the past year the Life Members Committee held three meetings, and in addition the committee sponsored an impromtu luncheon meeting of all Life Members who attended the Annual Meeting in June.

At this last meeting the work of the committee was discussed and its actions were given approval by those present. The meeting was declared a success and the suggestion made that one be held each year on the occasion of the Annual General Meeting.

We again assisted the Institute in bringing student delegates to the Annual Meeting, and subscribed money so that the value of the Students Prizes could be doubled.

We also assisted financially in filming the 75th Anniversary Show produced by the Montreal Branch.

The financial statement for the year is as follows:

Balance—December 31, 1961		$7,340.00	
Revenue—Contributions	$1,491.75		
Interest	207.63		
		1,699.38	
		$9,039.38	
Expenditures—			
Contribution to Student Prizes—20 at $50		$1,000.00	
1962 Student Activities		500.00	
Filming of 75th Anniversary Show		750.00	
Purchase of Typewriter		105.47	
Miscellaneous		30.46	
		$2,385.93	
Rebate		56.22	
			$2,329.71
Balance—December 31, 1962			$6,709.67

At the beginning of 1962 there were 749 Life Members. During the year we lost 38 members through deaths, which left a total of 711 at the end of the year.

Respectfully submitted.

C. KIRKLAND MCLEOD, M.E.I.C., *Chairman*
J. A. FREELAND, M.E.I.C., *Secretary*

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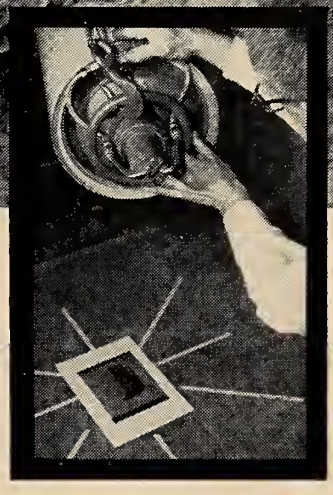

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Canadian Developments

(Continued from page 66)

Dr. A. E. Berry, Hon. M.E.I.C.

Dr. Berry Honored At Testimonial Dinner

Dr. Albert Edward Berry, Hon. M.E.I.C. Ontario's "Mr. Water" was honored April 25 at a testimonial dinner in Toronto. The dinner marked Dr. Berry's retirement after more than 40 years of service to the government and people of Ontario, firstly with the Department of Health and more recently with the Ontario Water Resources Commission of which he was General Manager and Chief Engineer.

Dr. Berry, a native of Ontario, was born in St. Mary's. He attended University of Toronto where he graduated with honors in 1917 from the Faculty of Applied Science. After graduation he served with the Royal Canadian Engineers.

He earned his Master's degree in 1921, and his Doctorate in 1926, both from U. of T. Prior to obtaining these degrees he joined the Ontario Department of Health as a sanitary engineer. In 1926 he was appointed Director of that Department's Division of Sanitary Engineering.

He became General Manager and Chief Engineer of the OWRC in 1956, and in April, 1957, relinquished his Health Department directorship when the Division was absorbed by the Commission.

Besides his OWRC responsibilities Dr. Berry has served since 1931 as Secretary-Treasurer of the Canadian Section of the American Water Works Association, and since 1932 as Secretary-Treasurer of the Canadian Institute on Sewage and Sanitation, now known as the Canadian Institute on Pollution Control. He is a member of the Advisory Board to the International Joint Commission on Pollution of Boundary Waters.

Dr. Berry has been an active Member of the Engineering Institute of Canada, having served as Chairman of the Toronto Branch in 1939-40, and as a Vice-President in 1952-54. He was made an Honorary Member in 1961.

Report Available On Use Of Computers In Engineering Education

The Final Report on a comprehensive project on the use of computers in engineering education has been published. This report, part of a project supported by the Ford Foundation and conducted by the University of Michigan College of Engineering, describes the current status of computer instruction at American and Canadian schools of engineering. It summarizes the College's current thinking on the role of computing work in the undergraduate engineering curricula.

In addition to this Final Report, nine other "curriculum reports" have been prepared by faculty members of various engineering departments at the University of Michigan. Each report describes computer use in a specific engineering curriculum and includes a set of completely - solved computer - oriented engineering problems suitable for undergraduate classroom use in that discipline.

These reports are being distributed widely to faculty members of accredited engineering schools in Canada and the United States. Those wishing a copy of one or more of the reports may request them through the: General Secretary, Engineering Institute of Canada, 2050 Mansfield Street, Montreal 2, Que.

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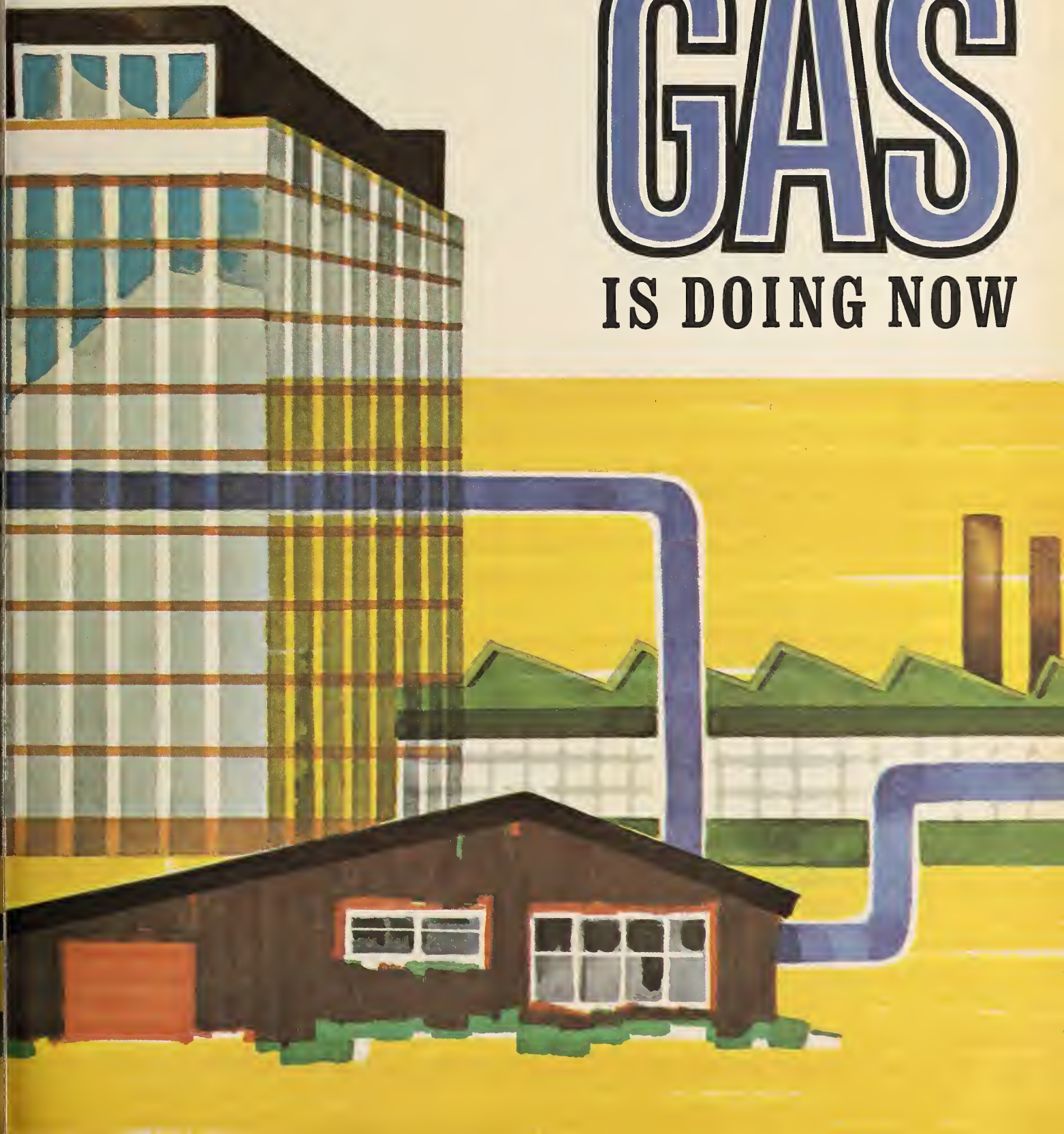

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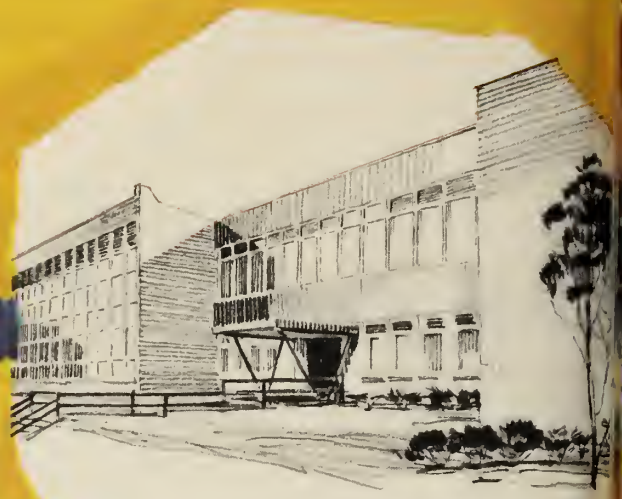
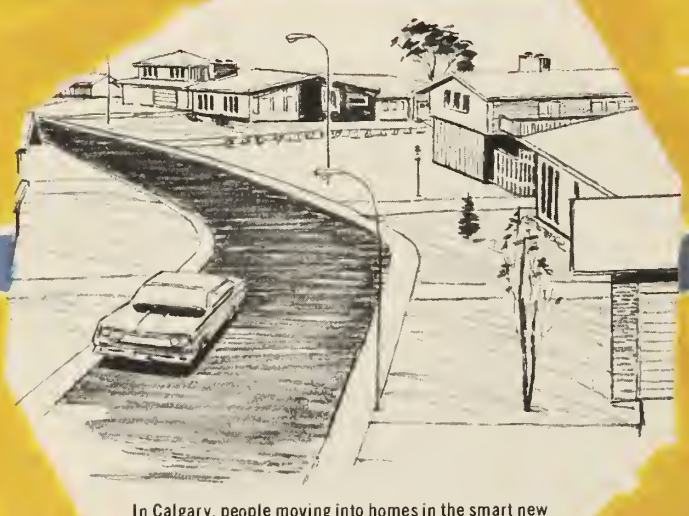


Gas helps the staff of the famous Winnipeg Winter Club provide top service and comfort for its members. It heats the building, provides an abundance of hot water and assists in better cooking. Gas even heats the fabulous swimming pool.



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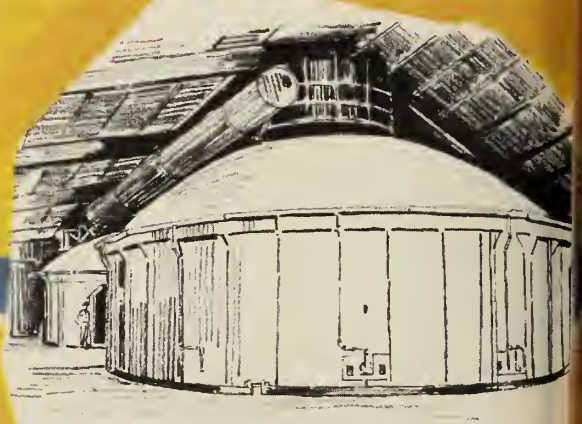
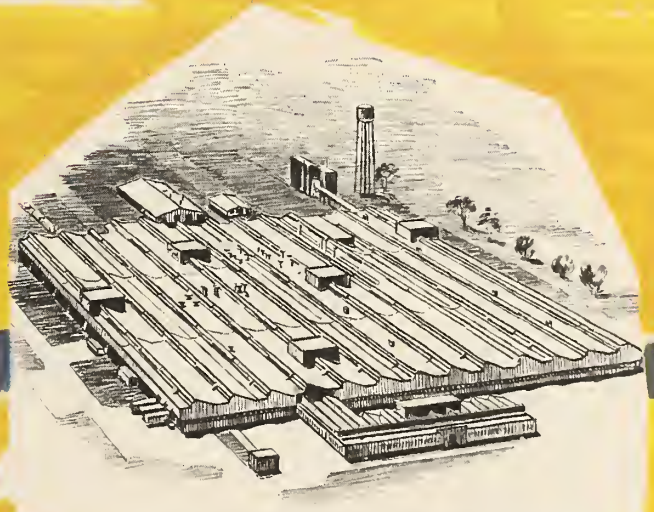


Gas-Fired Kilns are used by Saskatchewan Clay Products at Regina because temperatures can be controlled exactly. Economy, of course, is a further consideration. Adjoining offices of the plant are heated and air-conditioned with gas.

Vancouver's $6,000,000 Bayshore Inn uses gas in a variety of interesting ways: to heat an ancient Chinese oven used for the preparation of authentic Oriental foods, to fire romantic luau torches outside the hotel, and of course, for space heating.

Consolidated Building Corporation chooses gas for heating all homes it builds. The fact that people appreciate the economy and service of gas has been substantiated by the corporation's 3,000-home subdivision in Bay Ridges east of Toronto.

McIntyre Porcupine Mines Limited recently switched to gas heating for its gold mine at Schumacher, Ont. Savings on both fuel expense and labour prompted the management to make the change.



At its motor truck plant in Chatham, Ontario, International Harvester Co. of Canada Ltd. uses gas for brazing and cutting, for test-running engines, for heat-treating small parts and for space heating.

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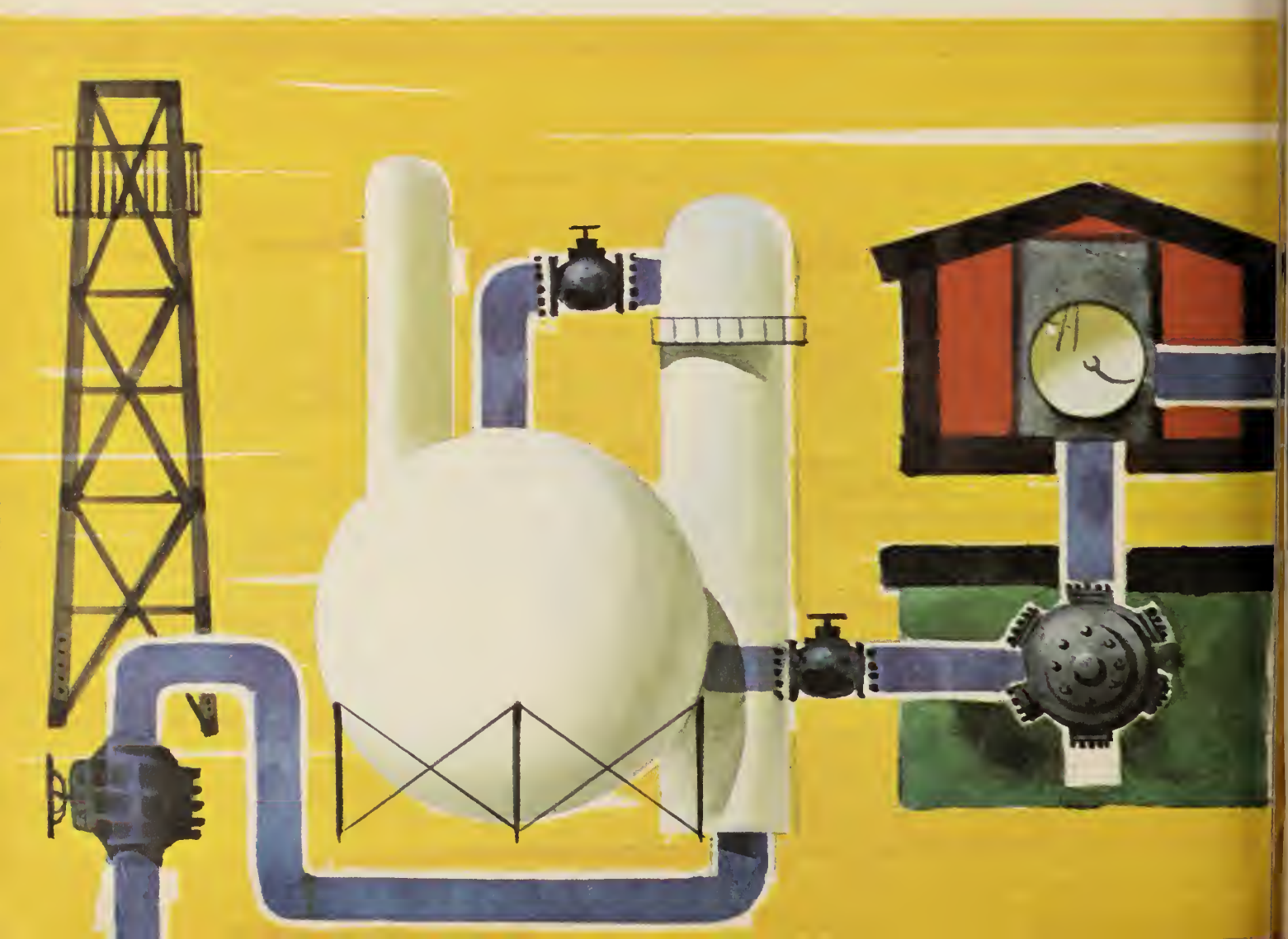

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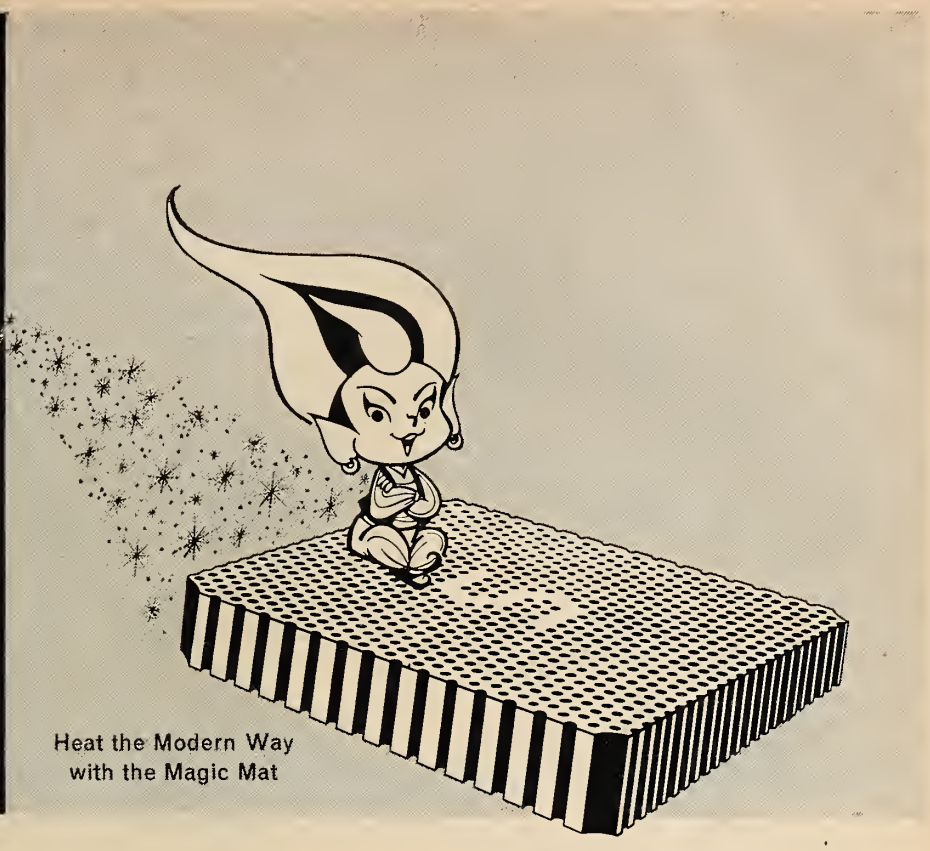

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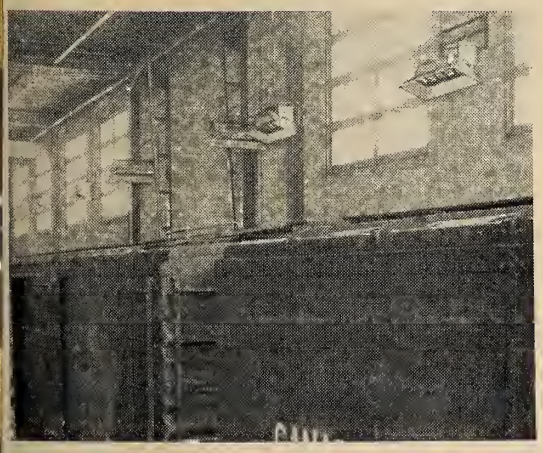

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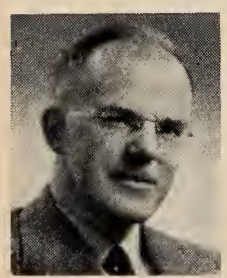
Personals

G. Ferland

M. Mooney

G. Ferland and **M. Mooney** have been appointed Technical Sales Representatives at Air Reduction Canada Limited. Mr. Ferland has had an extensive background in the metal fabricating and welding fields. Mr. Mooney was engaged in internal sales operations with the company and external sales with a major industrial supplier.

Jasper H. Ings, M.E.I.C. (Toronto '25) has been appointed Chairman and Chief Executive of the Niger Dams Authority. The appointment is effective for five years. Mr. Ings, Vice-President of H. G. Acres & Company Limited, Consulting Engineers, will assume his duties in Lagos, Nigeria. Since joining Acres in 1936, the major projects with which Mr. Ings has been associated include the Beauharnois development of the Quebec Hydro-Electric Commission, the Shipshaw development of the Aluminum Company of Canada Limited, the Chenaux development of the Hydro-Electric Power Commission of Ontario and the Pine Falls development of the Manitoba Hydro-Electric Board, as well as the Shadiwal and Warsak developments in West Pakistan.



J. H. Ings, M.E.I.C.

R. A. Greenbury, A.M.E.I.C.

R. A. Greenbury, A.M.E.I.C. (McGill '61) has been appointed General Manager for Canada of North American Car (Canada) Ltd., a newly formed subsidiary of North American Car Corporation, Chicago.

William Hopper, M.E.I.C. (Toronto '48) has been appointed marketing manager, special products at CLM Industries Division of McGraw - Edison (Canada) Limited, Scarborough. Mr. Hopper, who has been with the company for three years, has had many years experience in the electrical field.

Hal Young has been appointed sales and application engineer in Ontario for Flygt Canada Limited's complete line of sewage pumping equipment. Mr. Young, a 1951 graduate in electrical engineering from the Caulfield Senior Technical College, Victoria, Australia, has had ten years of widely varied experience in design, testing, installation and maintenance of electrical and mechanical equipment in Australia and Canada.

E. Roy Saunders has been appointed General Manager, Hydro - mechanics Division of Zurn Industries Canada Limited.

Obituaries

Major-General G. R. Turner, M.E.I.C., 74, died in an Ottawa hospital February 22 following a heart attack. General Turner, a Life Member of the Institute since 1955, was involved in the early planning for the Allied invasion of Europe during World War II. He was the personal representative of Gen. A. G. L. McNaughton, Hon. M.E.I.C., on the Chiefs of Staff of the Supreme Allied Command, and was one of the organizers of the Canadian Army overseas. Gen. Turner, a native of Fredericton, was a Commander of the Bath and earned the Military Cross and bar and the Distinguished Conduct Medal. He was an active Member of the E.I.C., and made important contributions to many of its activities.

J. F. Cunningham, M.E.I.C. died in March. Mr. Cunningham was a Student Member in 1928, an Associate Member in 1932, and became a full Member in 1940.

C. A. Abbott, M.E.I.C., a Life Member of the Institute died recently in England. Mr. Abbott who first became a Student Member in 1903, became a Life Member in 1941.

Clayton E. Bush, M.E.I.C. (Toronto '07) died March 17 in Toronto. Mr. Bush, a former head of the hydraulic section of the Department of Lands and Forests, first became an Associate Member of the Institute in 1921. He subsequently became a full Member in 1940, and a Life Member in 1956.

G. E. Vernot, M.E.I.C. (McGill '26) died recently. Mr. Vernot first became a student member of the Institute in 1923, while at McGill. In 1928 he became a Junior Member, and March 14, 1942, a full Member.

F. Alport, M.E.I.C.

Frederick Alport, M.E.I.C., (Toronto '36), a Councillor and Chairman of the Huronia Branch of the Institute died February 25 in an Orillia hospital. During his engineering career, which began in 1936 after he graduated from University of Toronto with a B.A.Sc. in Civil Engineering, Mr. Alport made signicant contributions both to the profession and to the Engineering Institute of Canada. He became a full Member of the E.I.C. in 1940.

A. C. M. Kerr, M.E.I.C., who earned an international reputation in the shipbuilding industry, died unexpectedly in a Saint John Hospital on March 24. He was 58. Mr. Kerr, who gained his early knowledge of the shipbuilding industry in his native Scotland, was General Manager of the Saint John Shipbuilding and Dry Dock Co. Ltd.

J. W. Young, M.E.I.C. died March 9. Mr. Young, a full Member since 1940, first became a member of the Institute as an Associate in 1936.

Louis Crepeau, M.E.I.C. (McGill '26) died February 14 in Quebec City. Mr. Crepeau had been Assistant Chief Engineer of bridges, Quebec Department of Public Works. He had been City Engineer of St. Hyacinthe from 1940 to 1950, then had practiced as a consulting engineer in the Montreal area from 1950 to 1960 when he entered the civil service in the position he held at his death.

Otto Doob, M.E.I.C. (Vienna '23) died January 31. Mr. Doob became a member of the Institute in 1945.

W. R. Lindsay (Washington '09) died January 11. Mr. Lindsay, a prominent mining engineer, for many years was in charge of the Granby Consolidated Mining, Smelting & Power Co. plants in Anyox, Copper Mountain and Allenby, B.C. Later he practiced as a consulting engineer in Eastern Canada as well as for international interests in Africa, South America and Mexico. Mr. Lindsay was the father of John R. Lindsay, M.E.I.C.

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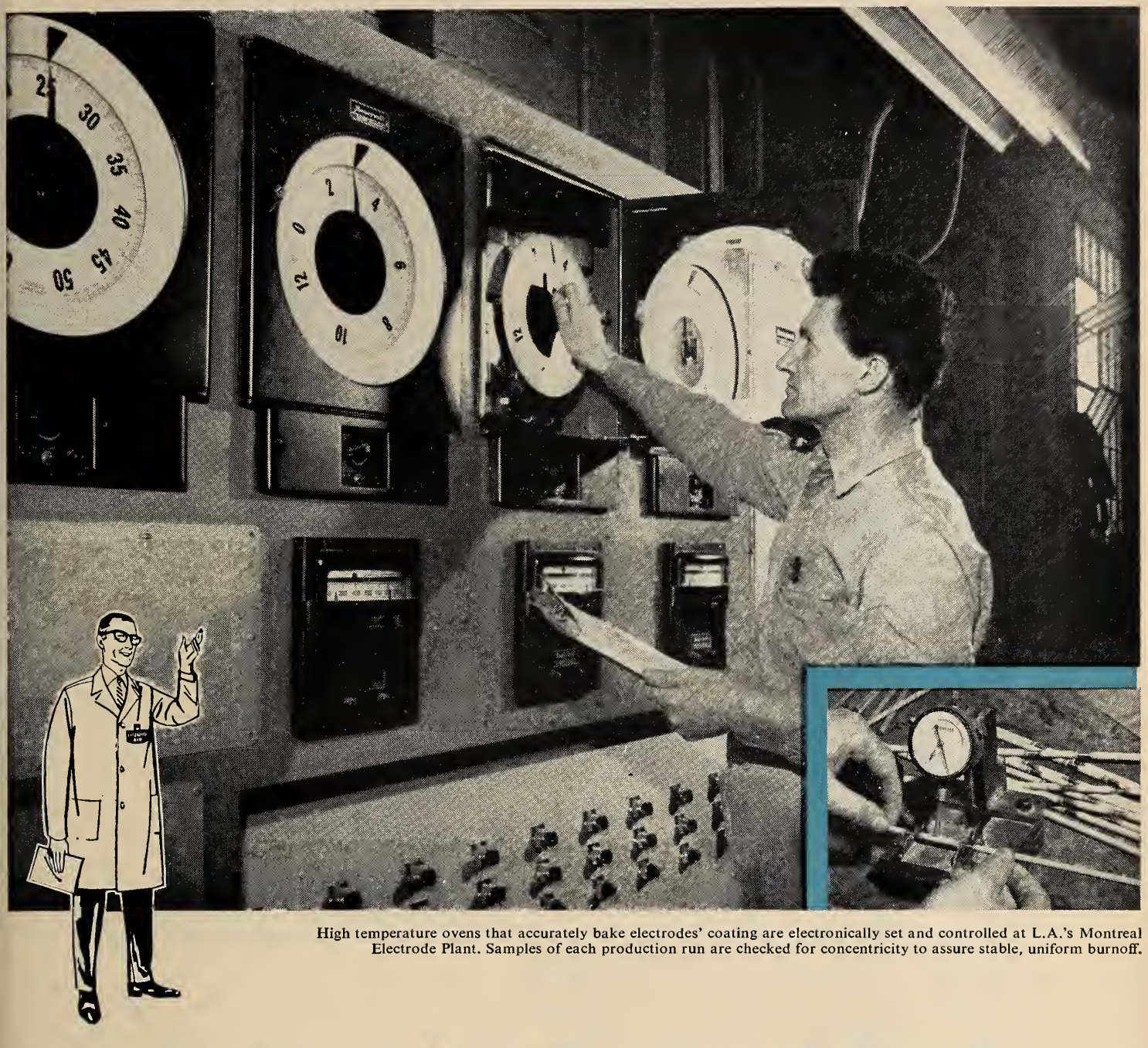

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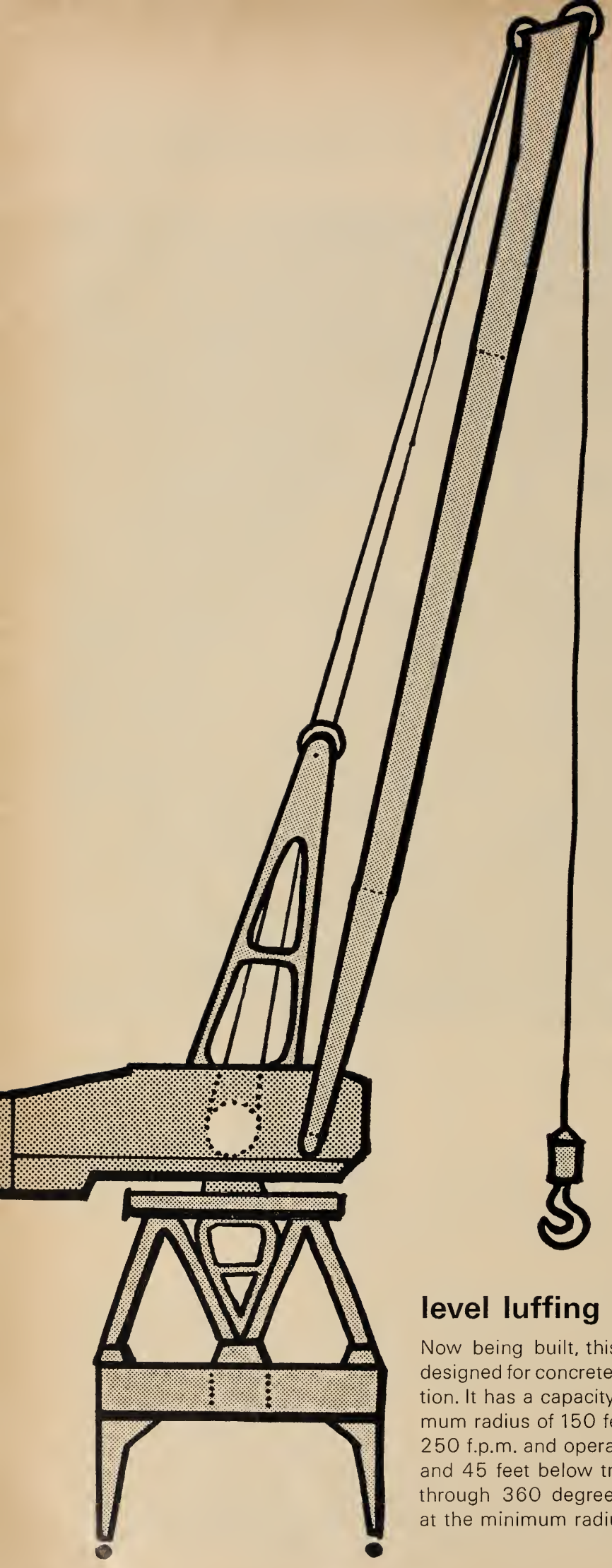

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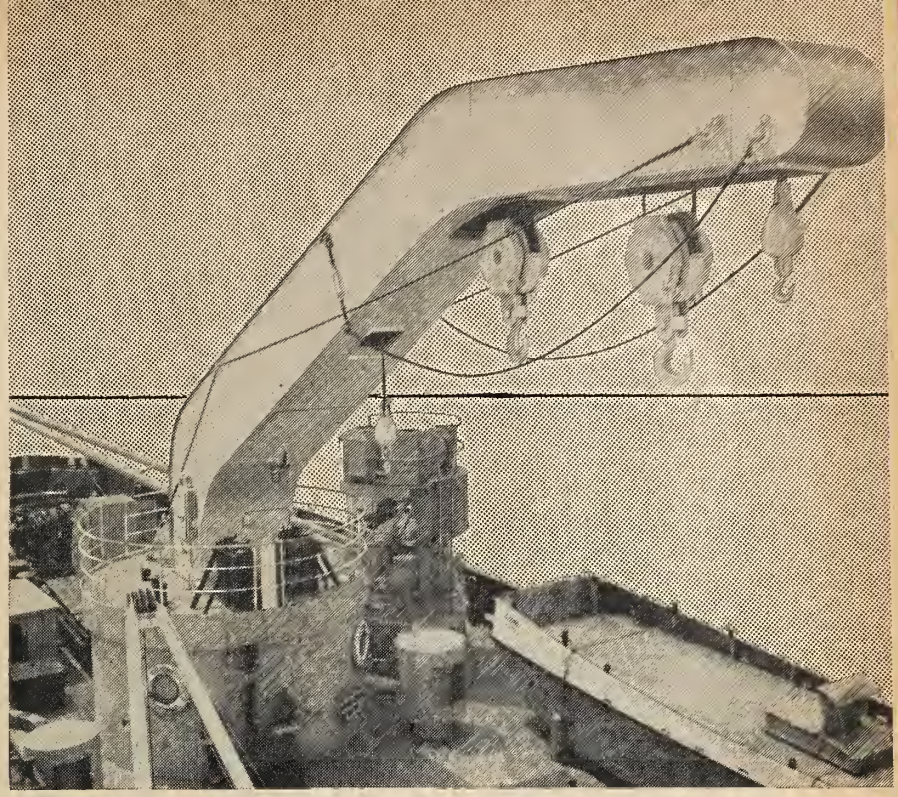
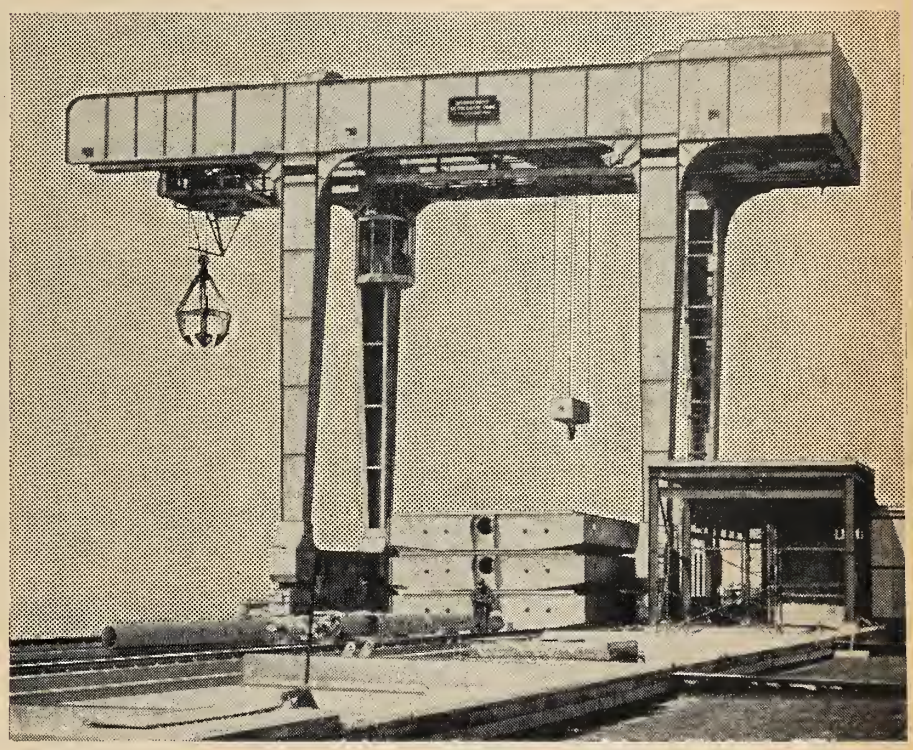


deck crane

This crane is used for handling navigation buoys on an arctic patrol ship. It has two main hoists and one auxiliary hoist all operating on fixed radii. The unit will turn through 360 degrees. Capacity: Two main hoists, 15 tons each; auxiliary hoist, 4 tons.

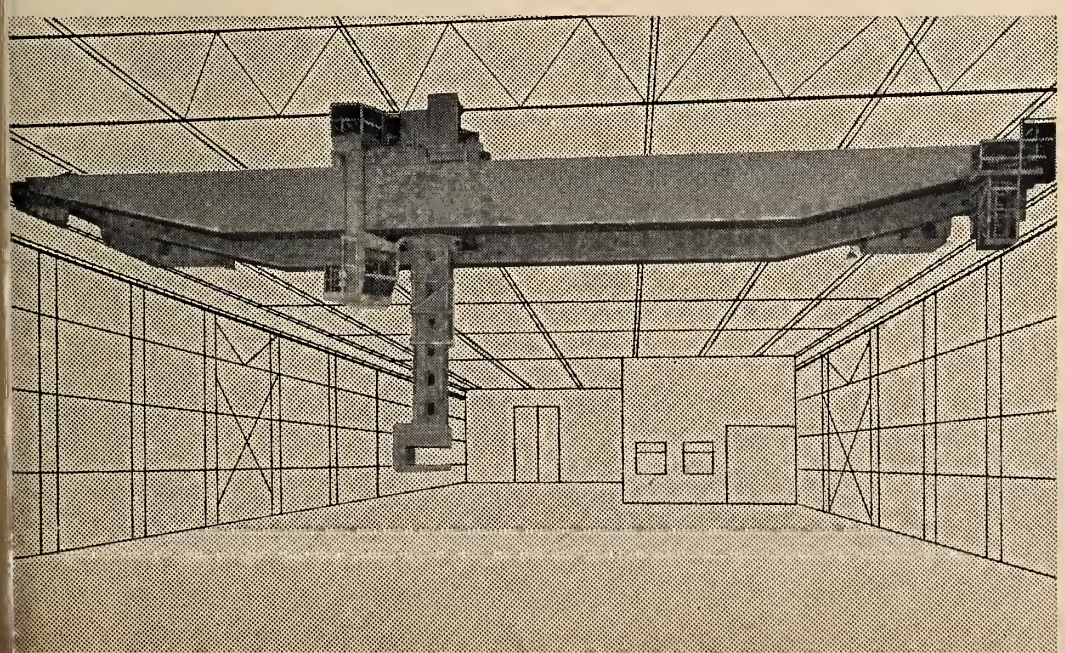
intake gantry

Broadly typical of many power house gantry cranes. This one has hoisting and trolley travel mechanisms located in a machinery house built over the downstream cantilever extension of the portal girders. A trash grapple is also fitted to the upstream side. Capacity: 80 tons. Hoist speed: 8 f.p.m. Trolley travel: 76 f.p.m. Gantry travel: 120 f.p.m.



stacker crane

The stacker crane is becoming increasingly popular for handling piece goods. This one is designed to handle steel billets in free standing stacks with alternate layers at 90 degrees to each other. No load slinging is required. Capacity: 30 tons. Main hoist speed: 50 f.p.m. Trolley travel: 200 f.p.m. Bridge travel: 450 f.p.m.



Discussion

(Continued from page 58)

their present cost. Approximate calculations carried out on the basis of the information contained in the paper indicate that the slab and caissons would cost approximately the same at today's prices, so that the large savings incurred at the time of construction would no longer reply.

Based on the above experience and on many borings taken in conjunction with these projects, the validity of the assumption that an accurate estimate of settlement could be obtained by applying the modulus of elasticity of the upper soil over a depth of 30 ft. is questioned. There is only 12 ft. to 15 ft. of the upper Sunnybrook Till of which the properties are known, then some 15 ft. of Toronto Formation which is practically incompressible, and 15 ft. of the very dense York Till which is also incompressible. It is considered that if the elastic properties for the upper soil are used a maximum equivalent depth of 15 ft. would be more appropriate.

Authors' Reply

The authors appreciate the critical comments of the discussers which have helped to draw attention to some of the uncertainties in predicting small movements of foundations. Only by observing full-scale settlements in the field and attempting to apply a rational analysis will the accuracy of the predictions improve. An attempt was made in the paper to demonstrate the difficulty of assessing settlement by conventional consolidation theory in the recompression range of stresses, and attention was drawn to possible merits in the elastic theory analysis. Because of the comments made in the discussion, a further clarification of the authors' reasoning is warranted.

The pressure imposed on the subsoil by Mt. Sinai hospital is less than the preconsolidation pressure for the soil. In this loading range, the compressibility of the soil is very small and errors due to sampling and routine consolidation testing become so prominent that they may completely mask the true properties of the soil. This is believed to be the case with the soil described in the paper.

Consider a 30 ft. layer of soil compressed a total of 0.6 in. This is the approximate situation under the hospital. If the subsoil were compressed uniformly, this would represent a compression of about 0.0014 in. in an element ¾ in thick (size of laboratory specimen). Obviously there is little room for experimental error if a realistic evaluation of the soil is to be obtained.

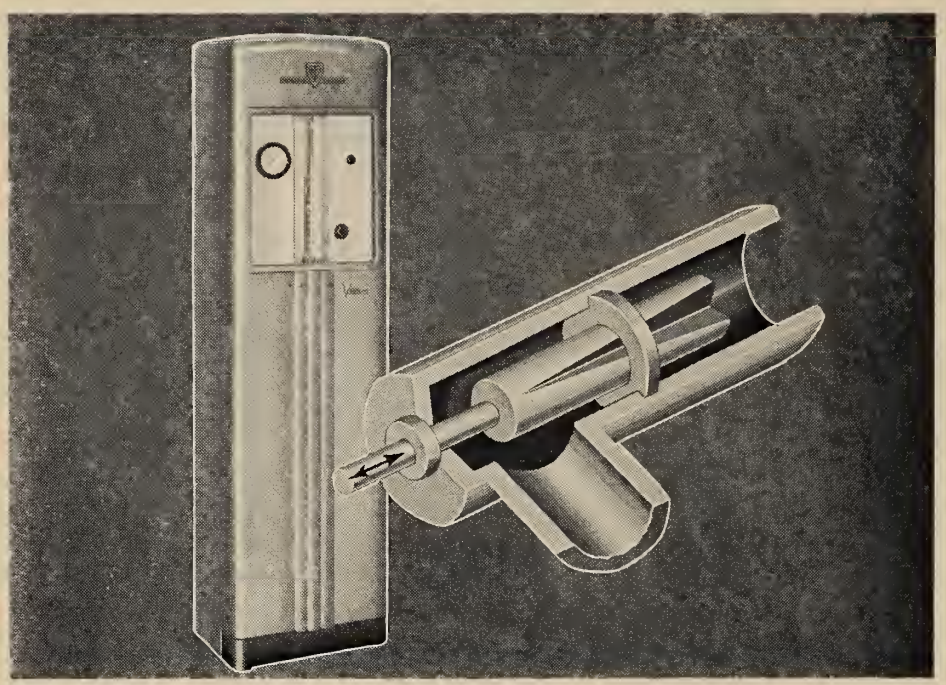
Several factors influence the test result. One of the most important is the fit of the specimen against the porous loading plates and in the consolidation ring. A second factor is the reduction of compression resistance due to disturbance. To reduce these influences the laboratory specimen is often loaded to overburden pressure, unloaded and reloaded, the reloading curve being considered the more realistic one to use.

Another factor that may be peculiar to the laboratory specimen is the compression of air or gas which has come out of solution due to stress reductions by sampling and has allowed the soil to expand without taking up water. This phenomenon is not completely understood. It is apparent that the specimen will be recompressed at least to its original volume under applied overburden pressure but it is equally apparent that if pore pressure is reduced to zero after each load increment the gas will re-form into bubbles. This process may have an effect equivalent to pumping water out of the specimen.

These are some of the factors that are thought to contribute to the unrealistic estimate of 5 in. of consolidation settlement based on an average of several loading curves. On the basis of cyclical oedometer tests made on this soil, the estimated consolidation settlement can be reduced by one-third to about 3.3 in. Applying the procedures of Skempton and Bjerrum, as suggested by Dr. MacDonald, a further reduction to about 2.2 in. is possible. The resulting figure is still about four times the actual settlement. If elastic settlement is even one-half of the total, the prediction from the consolidation test is in error by about 800%. It was such a discrepancy which led the authors to question the usefulness of the consolidation test as a realistic method of estimating settlement in the soil recompression stress range for this building or other buildings on similar soil.

The next step was to study the stress-deformation properties of the soil in the triaxial compression machine. The specimen could be maintained under pressure equivalent to overburden pressure (1.7 TSF) and this was expected to return any free air into solution. Further, the specimen could be load-cycled many times without drainage in order to ensure proper seating of loading caps. This resulted in a more realistic modulus of elasticity, much greater than previously obtained.

Using this modulus (600 TSF) the elastic compression of the subsoil under applied loads from the beginning of settlement observations is computed and shown in Table III. These computed values can be compared with the total settlement of less than ½ in. observed at the end of loading.



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As noted previously, the 30 ft. depth is considered to be most realistic because it compensates for the less compressible material at lower depths. If Poisson's ratio is assumed to be equal to 0.5, the maximum elastic settlement is only 40% of the measured settlement. If Poisson's ratio is assumed to be equal to 0.3 the computed elastic settlement accounts for about 90% of the measured settlement.

Both Dr. MacDonald and Dr. Meyerhof point out that due to the slow rate of loading an appreciable amount of consolidation could occur during construction. Dr. MacDonald suggests that this should be "primary consolidation." The authors were inclined to the view that "it is improbable that excess pore pressures were developed"

TABLE III

Elastic Settlement Computations
(E = 600 TSF)

Depth of Layer	Settlement, inches		
	μ=0.5	μ=0.4	μ=0.3
30	0.20	0.34	0.43
40	0.36	0.50	0.61

and suggest that "a plastic or secondary consolidation type of compression" may have occurred. In the absence of pore pressure measurement neither interpretation can be proved. Obviously some of the settlement must be due to creep as illustrated by continuing settlement after completion of the building (Fig. 5).

If as Dr. Meyerhof suggests, the modulus of elasticity is even greater than 600 TSF and if lateral restraint in this case is a significant factor, then the computed settlements in Table III would be correspondingly smaller. The critical question is the assumed value of Poisson's ratio because this value has a great influence on the magnitude of computed elastic settlement. It appears to be common practice in soil mechanics to always assume Poisson's ratio to be 0.5, on the ground that no volume change occurs in a saturated soil. The authors consider this to be a questionable assumption.

It is appropriate to quote Terzaghi (1948, p. 369): "For dense soils and solid granular materials such as concrete or sandstone Poisson's ratio increases from small values of the order of 0.2 at low stresses to more than 0.5 at very high stresses." The stresses beneath the Mt. Sinai hospital are considered to be in the low stress range, about one-quarter to one-third of the ultimate strength. It is interesting to note that the Poisson's ratio for ice, when loaded elastically, may be as low as one-third (Gold 1960). If the ice creeps as well, the apparent Poisson's ratio will increase the 0.5 or greater depending on the geometrical arrangement of individual ice crystals. Under creep conditions the deformation is not entirely elastic so the elastic theory cannot be applied by itself.

The authors know of no satisfactory experimental determinations of Poisson's ratio for soil. This is clearly a fertile field for research. In the meantime the observations on other materials scarcely confirm the usual assumptions for soil. Until more refined measurements of both elastic and plastic properties of soils are available, engineers will find it necessary to design, in the soil recompression stress range, on the basis of experience gained through careful field observations.

REFERENCE

Gold, L. W. (1960), Discussion to "**Microcracks and the static and dynamic constants of annealed and heavily cold-worked metals.**" British Journal of Applied Physics, Vol. 11, November, 1960, p. 522-523.

CARILLON FOUNDATION STUDIES

C. H. Pigot, M.E.I.C.
Assistant Chief Engineer
Power Development Division
Quebec Hydro-Electric Commission
Montreal

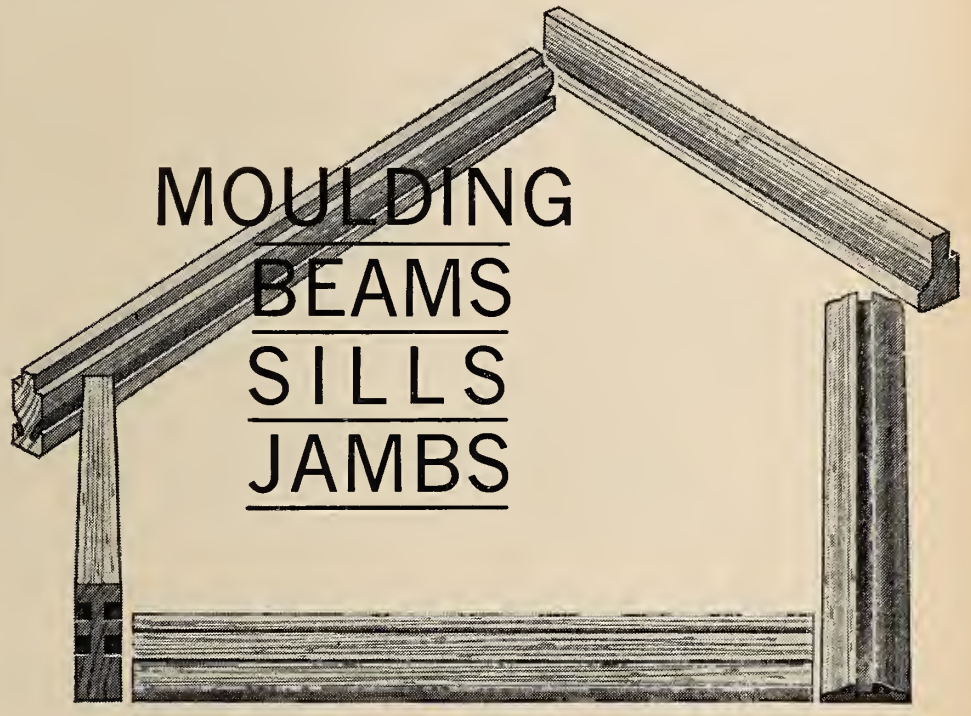
I. D. MacKenzie, M.E.I.C.
Geologist
The Shawinigan Engineering Company Limited, Montreal

The Engineering Journal, October, 1961, page 65

Discussion by
Carl B. Crawford, M.E.I.C.
Division of Building Research
National Research Council
of Canada, Ottawa

The reader is soon aware that the authors of this paper are reporting results of a remarkably extensive field investigation of the strength of shale in situ. The handling of 33,000 individual observations is a formidable task in itself.

(Continued on page 84)



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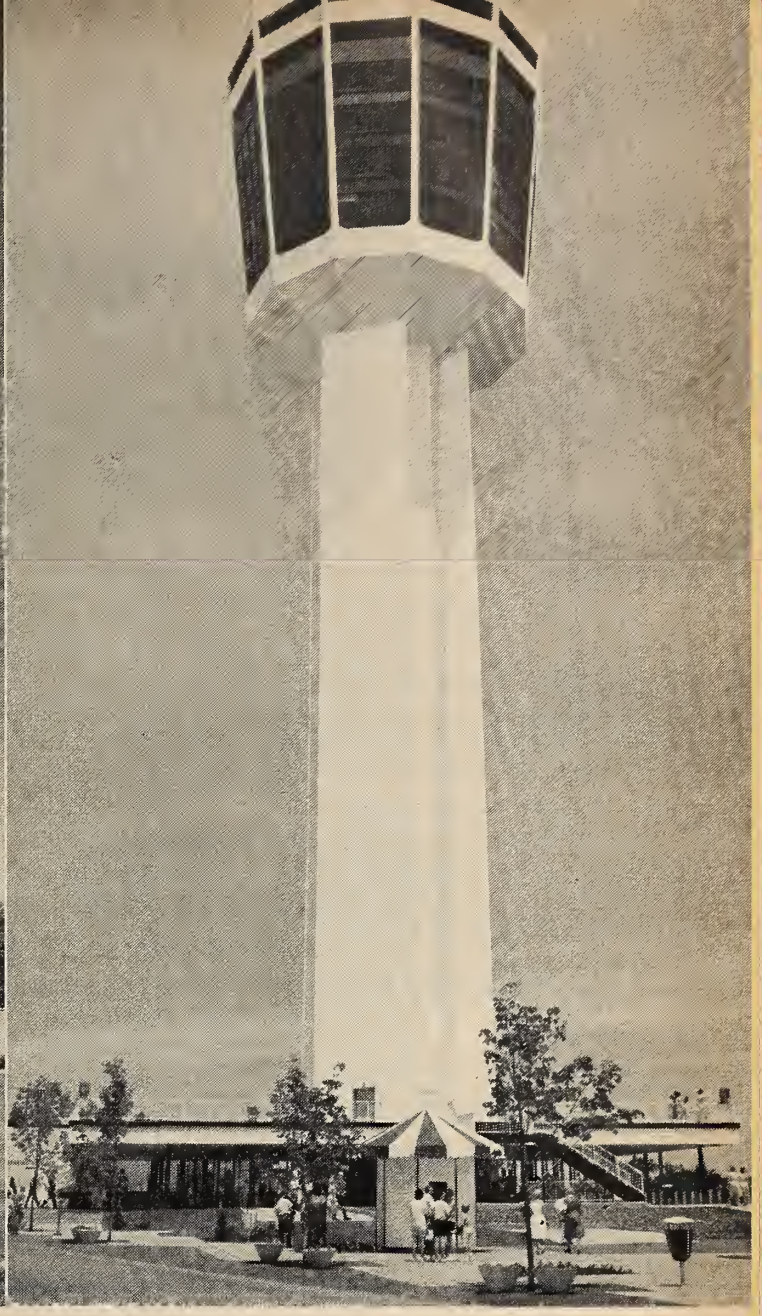

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BUSINESS ENGINEER — M.E.I.C., P.Eng., B.Sc. (U.N.B.) Civil, M.B.A. (U.W.O.). Age 35, single. 13 years experience as construction engineer and superintendent on large marine and industrial projects. Seek position where engineering and business can be maximized. Free to travel. File No. 444-C.

ELECTRICAL ENGINEER — 1950 graduate. Experienced in the manufacture of mercury arc rectifiers, application of general electrical controls and process instrumentation. Supervisory experience in project and plant engineering as related to the metallurgical and petrochemical industries. Desires to relocate from Montreal to Ontario. File No. 5962-E.

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CIVIL ENGINEER — M.E.I.C., B.Eng., P.Eng.(Que.). Age 41, married. Completely bilingual. 12 years commercial heavy industrial and marine design and construction experience as project manager and resident engineer. Present location central Canada but will relocate anywhere. Desires responsible and challenging position with consulting engineering firm or general contractor. Complete resume upon request. File No. 112-C.

CIVIL ENGINEER — Engineer Officer, A.M.E.I.C., P.Eng. (Ont., Yukon), R.M.C., U. of T., B.Sc., 1959. Age 28, married, 2 children. Instructor road/airfield design and construction, heavy earthmoving equipment, soils, surveying. 2 years Northwest Highway System, estimating, planning, scheduling, supervising, on-the-site engineering of bridge, major culvert, road relocation (designing also) projects. Desires position engineering firm. Location British Columbia, Ontario, Alberta. File No. 479-C.

PROFESSIONAL ENGINEER — M.E.I.C., B.Sc. (Civil) Queen's 1943. Age 44, married. Twenty years diversified experience as design and project engineer in Canada and abroad. Experience includes design, field supervision and investigation for hydro-electric projects, construction supervision, administration and project engineering in the chemical process industry. Presently located Eastern Canada. Seeks responsible position in industry, consulting or Government. File No. 477-C.

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CIVIL ENGINEER — M.E.I.C., B.Eng., P.Eng. (Sask.). Age 36, married. 14 years experience with Consulting Engineering firms. This experience includes office management and administration, structural design, construction of buildings (reinforced concrete, steel and wood). Presently located in Regina. Desires position in Western Canada. Will be glad to discuss any position which is open. File No. 478-C.

PROFESSIONAL ENGINEER — M.E.I.C., P.Eng. (Man.), B.Sc.E.E. University of Manitoba 1950. Age 34, married. 13 years plant experience (11 years in management capacity — now Chief Engineer) in installation, operation, maintenance, some design of all types of plant equipment. Wide experience in building maintenance and alterations and general construction. Also hold 2nd Class Stationary Engineer's Certificate (Man.). Field open. Available June 1, 1963. File No. 476-E.

CIVIL ENGINEER — M.E.I.C., P.Eng. (N.S.). Age 38, married. Five years with consultants on hydro and steam plant design both in office and field. Seven years with manufacturer of building products involving product development, quality control, plant design and equipment purchasing. Prefer position with consulting firm. Will locate anywhere. File No. 475-C.

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JUNIOR ELECTRICAL ENGINEER. A national association, located in Ottawa, is looking for a junior Electrical Engineer with several years of field experience. Duties will include project investigations, technical reports and meetings. Starting salary $6,000 - -7,000 range. Please reply, sending details and references, to File No. 411-V.

ELECTRICAL ENGINEER. The position of Distribution Engineer is open to a graduate Electrical Engineer with a few years experience in utility, consulting, manufacturing or a related field. Responsibilities will involve design of distribution system, construction standards, street lighting and other engineering studies. Location Ontario. Interested applicants are requested to submit a complete resume of their qualifications. Salary will be commensurate with experience. All replies in confidence. Apply to File No. 412-V.

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SALES ENGINEER — required for pulp and paper industry for leading stainless steel manufacturer in Montreal. Graduate Mechanical Engineer with sales experience in pulp and paper industry preferred. Sales territory Province of Quebec and Maritime Provinces. Starting salary commensurate with qualifications. Apply File No. 414-V.

MECHANICAL OR ELECTRICAL ENGINEER — wanted to join Consulting Engineering firm engaged in electrical-mechanical systems for buildings and industry, either on an associate basis or as a full partner depending on qualifications. Applicant preferably bilingual; office location Montreal. Reply in confidence to File No. 413-V.

KAISER CANADA has opportunities for Civil, Mechanical, Electrical, Process Piping Engineers for their Montreal Design Office, and Wabush Lake, Labrador. Interested applicants should forward detailed resumes to: Personnel Manager, Henry J. Kaiser Co. (Canada) Ltd., 4920 Western Ave., Montreal, Que.

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MANAGER REQUIRED — The Montreal Office of a growing Canadian sub-contracting firm in the construction industry has an opening for the position of Manager. This is an excellent opportunity for advancement and high remuneration depending upon the capabilities of the individual. Applicants should preferably be between the ages of 25 and 40, bilingual, experienced in assuming responsibilities, and in estimating, pricing and negotiating contracts. Written applications, giving a brief outline of qualifications, will be treated in the strictest confidence, and may be sent to File No. 407-V.

SALES ENGINEER — A Professional Engineer, preferably a graduate in Civil Engineering, is required as a Sales Representative for the Montreal area by a manufacturer of prestressed and precast concrete. Applicants must be bilingual. Experience should include at least one of the following: Experience in industrial building industry as a construction supervisor; or Engineering sales experience, preferably in construction; or Architectural design experience in an architectural or consulting engineering company. Resumes are invited in confidence. Apply File No. 409-V.

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INSTRUCTORS REQUIRED — For the following technologies: 1. Chemical, 2. Electronic & Electrical, 3. Mechanical (Applied Thermodynamics or Modern Manufacturing Processes & Tool Design). Applicants require a Bachelors Degree in Engineering, Physics or Science, or be eligible for registration as a Professional Engineer in Ontario. They should also have a minimum of two years experience in an industrial, teaching or research position. Salary $6,600-$9,000. Opportunities for further education. Write to the Principal, The Western Ontario Institute of Technology, 815 Mercer St., Windsor, Ontario.

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Discussion

(Continued from page 79)

Two comments might be made on the basis of experience with stress-deformation properties of soils. First, the observed compression of the test blocks (Fig. 1) is not of the nature of primary consolidation. Most of the observed compression appears to be practically instantaneous and is therefore of an elastic nature. The remainder occurs so quickly that it may be due to plastic creep rather than to consolidation. The observed movements are similar to those found during re-compression of soils and are therefore not explained by the classical theory of consolidation.

The second point concerns the rate of deformation. The authors deliberately chose a "very slow rate of deformation" but unfortunately the material failed at such a small strain that failure occurred in less than a minute. This means that, in soil mechanics terminology, a series of consolidated-undrained tests were carried out. After failure there was generally an increase in shearing resistance with further strain. This might be attributed to the creation of negative pore water pressure due to shear strains—a phenomena associated with heavily over-consolidated soils. It is doubtful if pore pressures could dissipate appreciably during the 1½ hour test on such a large specimen.

Test No. 5 is an exception. It is an unconsolidated-undrained test in which shear probably began while pore water pressure was positive but this would soon be reduced by the expected dilation of the material during shear. It is not inconsistent that positive pore pressure is developed during re-compression but as observed in the laboratory, the pore pressure increase is only a fraction of the applied load and it dissipates quickly since the material structure assumes the load with little deformation.

In view of the stress-strain characteristics of the material it might have been better to do controlled stress tests. This technique is often used for drained direct-shear tests on soils from which shear strength parameters can be obtained in terms of effective stresses. It is especially important to measure shearing resistance of heavily over-consolidated materials in terms of effective stresses because test values in terms of total stresses may be on the unsafe side due to temporary development of negative pore water pressures.

Do the authors have any laboratory tests on samples from the site? It would be of considerable interest to compare the stress-strain characteristics of laboratory specimens with those observed in situ.

Discussion by Jerzy Gizycki

The in situ shear test for the Carillon Hydro-Electric Development was designed to simulate the shear sliding conditions for the seam under load and to derive an empirical expression for the shear sliding resistance of the seam.

Two methods of approach were considered:

a) To concentrate the test primarily on the elastic range of shearing of the seam and to evaluate the maximum shearing resistance within this range, which involves small shear deformations of the order of 0.10 in. This elastic resistance is higher than plastic within 1 in. of travel;

b) To concentrate the test primarily on the plastic range of shearing, which lies beyond the elastic range and which would involve the measurement of deformations up to about 4 in.

These two approaches require entirely different instrumentation; and, to limit cost, it was decided to select one of the two.

Approach (a) would require accuracy in the measurement of deformation of the order of 0.0001 in. and a practical solution lies in the use of SR 4 electric strain gauges combined with a Baldwin indicator. One undesirable feature of this arrangement is that the strain gauge furnishes readings for only a very small range of deformation.

For Approach (b), "Synchro" gear boxes with an accuracy to 0.001 in. would provide a very satisfactory solution, as the readable displacement can be extended to about 4 in.

Furthermore, in considering the two methods of approach for measurement of vertical consolidation under load, these strain gauges are not suitable owing to the difficulty in predicting the settlement, and the use of dial gauges or synchros would be necessary. This would result in two undesirable features:

Firstly, it would be impossible to maintain a uniform rate of movement as it would be necessary to interrupt the test to take readings if dial gauges were used;

Secondly, there is danger of disturbance of the equipment while readings are being taken, and hence invalidation of the whole test.

Thus it will be seen that instrumentation which can be read and controlled remotely is very desirable. Synchro gear boxes with only an electrical connection to the direct reading dial, which can be located in another room, obviously have a claim for prior consideration.

There is another aspect in the selection of instrumentation which is of ultimate importance—soil mechanics. A strain gauge setup would provide very precise data concerning the entire elastic range (as in our case <0.05 in.). Movement of this order may easily occur, and our knowledge of shear resistance of the seam in its initial deformation provides no answer as to the safety of the structure for greater deformations. It was imperative that we should know what effect the variation of pore-water pressure and the change of void ratio would have on the shearing resistance of this seam. In other words, we had to know whether or not some of the strength was regained during a deformation in the order of up to 3 in.

The problems of soil mechanics were eventually solved by using the second of the two methods.

Shear/deformation curves confirm the correctness of the approach selected. The elastic range as proved by test is of the order of 0.02 in.-0.03 in., and shearing strength of the seam at this deformation is not sufficient to draw a conclusion with respect to stability of the structure. These curves, as obtained from the test, show a drop in shear resistance immediately after the elastic limit, with a mild regaining of strength in the plastic range.

Discussion by H. E. Marion, M.E.I.C.

This discussion is limited to a brief description of the horizontal jacking system.

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(Continued on page 91)

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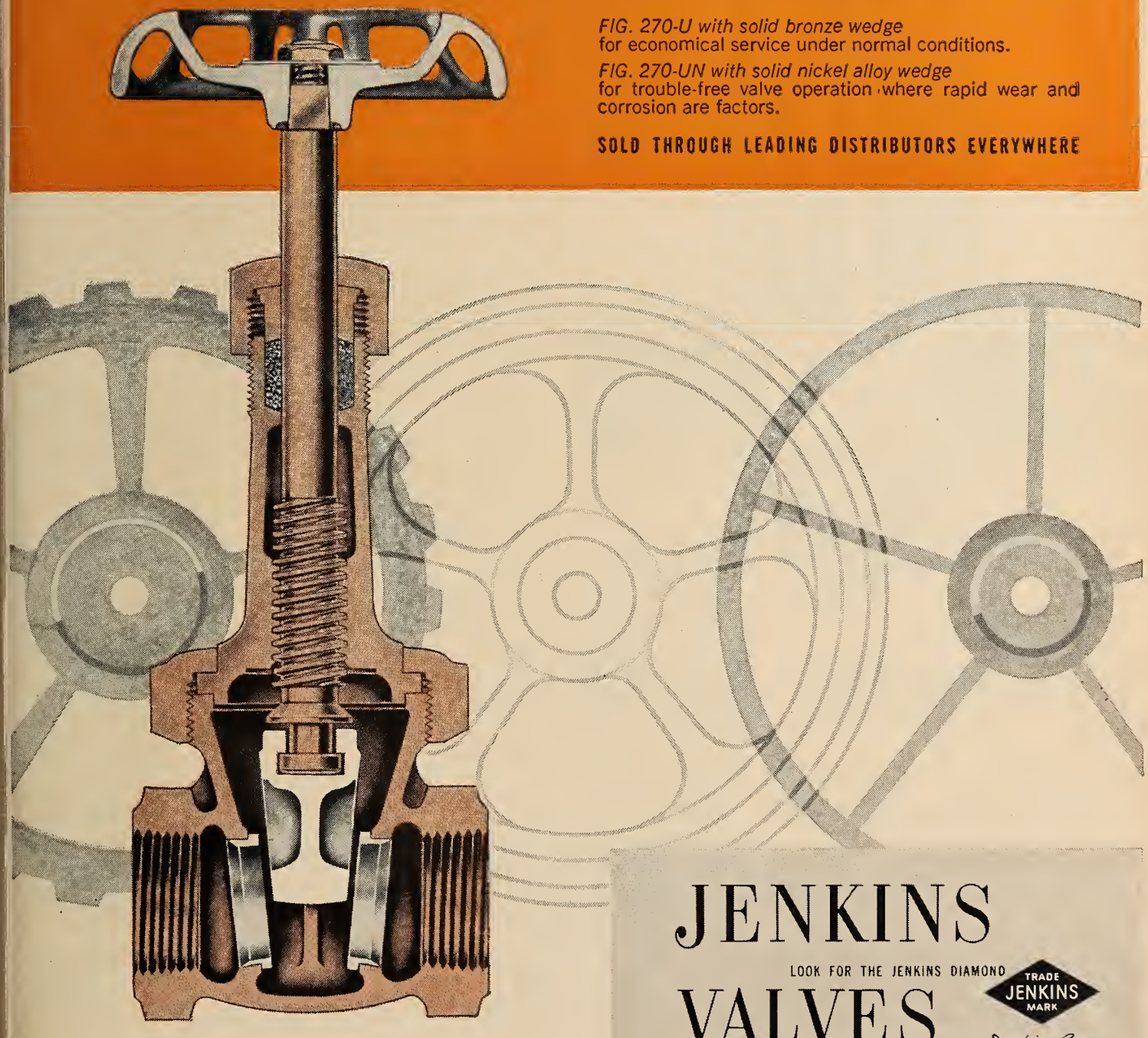

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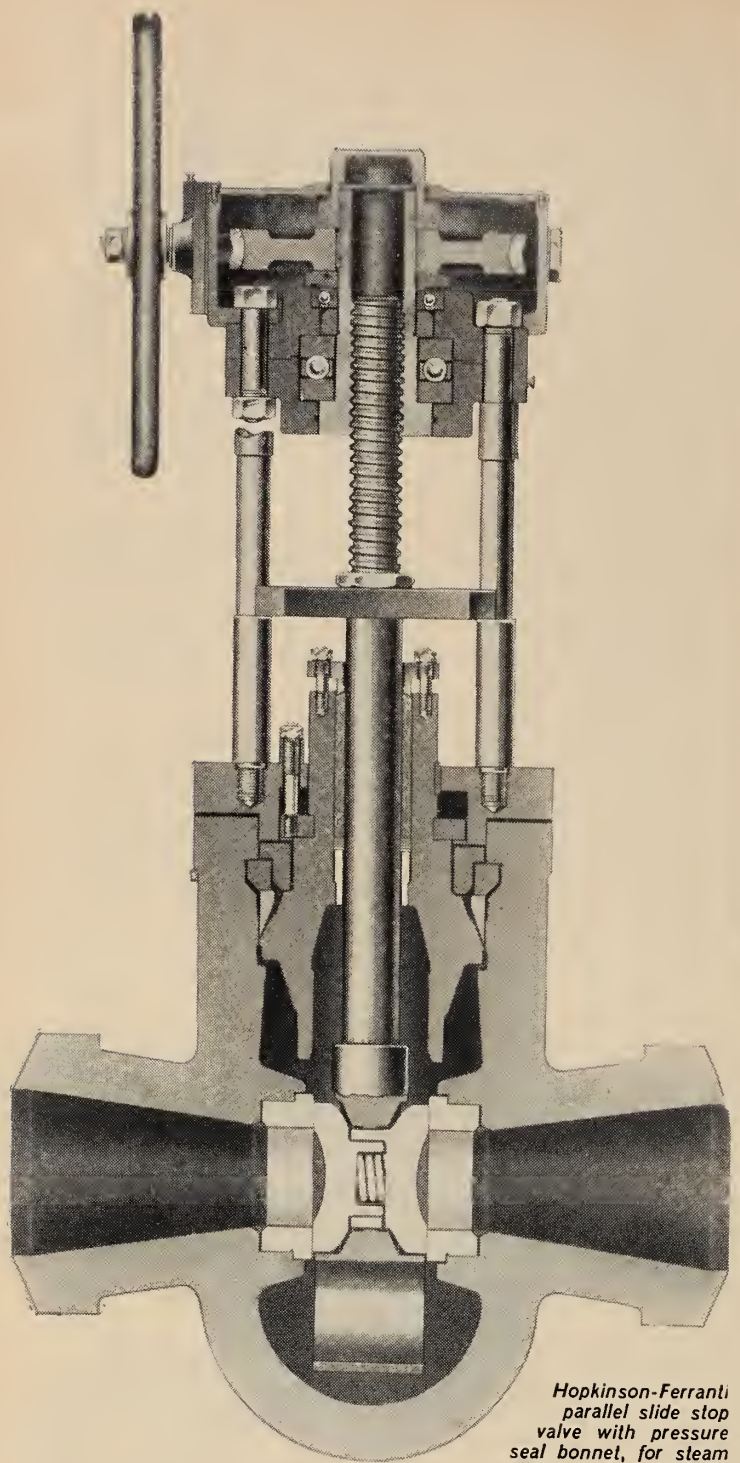

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Members Endorse New System for Publication

ANY member of the Institute who did not subscribe to one or more "Series" of Transactions when paying his 1963 fees may still do so by remitting $3. to Headquarters for each "Series" of Transactions he wishes to receive.

THE number of subscriptions to Transactions submitted thus far with the 1963 fees has encouraged the Publications Committee to believe that the new procedures for the publication and distribution of technical papers are in accord with the wishes of the members.

IN this system, which became effective January 1, 1963, all acceptable papers are to be published in one of the three following media:

1. The Engineering Journal which will feature a larger variety of shorter papers of current interest to a wide cross section of Canadian engineers;
2. Transactions of the E.I.C. will be published as separate papers promptly after being passed by the Review Board. Each paper will be identified as falling into one of five series:

Series A – Civil, Geotechnical, Bridge and Structural
Series B – Mechanical, Welding, Thermal
Series C – Electrical, Communications, Electronics & Automation, Hydro-Electric
Series D – Management, Research, Education
Series E – Chemical, Mining & Metallurgy, Oil and Natural Gas

MEMBERS of the E.I.C. may subscribe to any or all of the five series by paying an annual subscription of $3, per series. The number of papers per year in each series will be about equal.

THE Engineering Journal will carry advice of all Transaction papers as they are approved for publication. This will enable readers who have not subscribed to the Series in which a paper will appear to order a separate copy at a cost of fifty cents (.50) for Members.

3. Division Papers will be published as separate papers identified by the Technical Division covering the field of interest of the paper. These will be papers for which provision cannot be made in the Journal or Transactions but offer sufficient contribution to engineering knowledge to warrant publication.

The Journal will carry advice of all Division Papers as they are approved for publication to enable Members to order them at a cost of fifty cents (.50) each.

THE distribution to subscribers of Transactions which were reported in the January, February and March, 1963 issues of the Journal was delayed because of the tremendous amount of retyping of manuscripts to get them into a form for reproduction. By May 31, all Transactions notified in these issues of the Journal should have been received by subscribers. Henceforth, subscribers should receive their copy of Transactions within one month of notification in the Journal.

TO achieve this speed in publication and distribution within reasonable costs, it is necessary that final manuscripts be received from authors in a form that is directly, reproducible. To give authors guidance on the requirements for this, a comprehensive "Information and Advice to Authors" has been prepared. A copy may be obtained by requesting same from Headquarters.

THE Publications Committee would be pleased to receive comments from members on the new system and suggestions for improvement on the Publications services.

R. A. Phillips, M.E.I.C.
Chairman, Publications Committee

ANNUAL GENERAL MEETING

Simultaneous translation service will be provided for the Annual General Meeting of the Institute on Wednesday, May 22. Other features of this year's meeting are—

- Publication of abstracts of all papers in both languages in the Journal.
- Bilingual programmes, tickets, information leaflets, agenda, etc.
- Operation of a press room and publicity service, including translation of papers, in both languages.
- The Chairman of each technical session will be fluent in both French and English, to ensure that discussion may be carried on in either language.

CONGRES ANNUEL

Un service de traduction simultanée a été prévu pour le congrès annuel de l'institut qui aura lieu mercredi le 22 mai.

Cette année, le congrès présentera quelques particularités; entre autre:

- un résumé des travaux inscrits au programme sera publié dans le Journal, dans les deux langues;
- les programmes, billets, brochures, agenda, etc., seront bilingues;
- les services de la salle de presse, ainsi que le service de publicité seront également bilingues; les communications seront traduites;
- le président de chacune des réunions techniques sera bilingue afin d'assurer que la discussion se fasse indifféremment dans une langue ou dans l'autre.

COMING EVENTS

Engineering Institute of Canada. 77th Annual General Meeting. Quebec City. May 22-24.

Royal Society of Canada. Quebec City. June 3-5.

Canadian Pulp and Paper Association. Summer Meeting of the Technical Section. Quebec City. June 5-7.

European Federation of Chemical Engineering. 2nd European Symposium "Vacuum". Frankfurt (Main) June 5-7.

The Chemical Institute of Canada. 46th Conference and Exhibit. Toronto. June 6-8.

Italian Chemical Society, Italian Association of Chemical Engineering. 14th Congress "Chemistry Days 1963", 1st International Exhibition of Chemistry. Milan, Italy. June 7-16.

Society of Automotive Engineers, Inc. International Summer Meeting. Montreal. June 10-14.

Conference of Engineering Societies of Western Europe and the United States. Eighth Plenary Assembly. Munich, Germany. June 10-15.

Geological Society of America, Engineering Geology Division, Committee on Rock Mechanics. Conference on Rock Mechanics. Santa Monica, Calif. June 13-14.

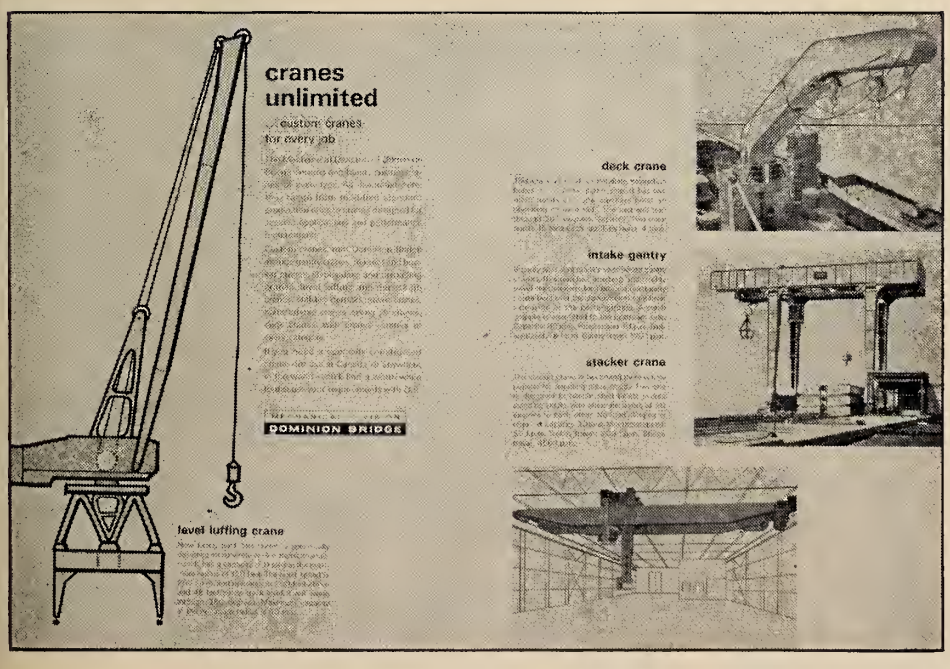
European Federation of Chemical Engineering. European Convention of Chemical Engineering. Frankfurt (Main). June 19-27.

National Society of Professional Engineers. Annual Meeting. Cleveland. June 26-29.

The Institution of Chemical Engineers. (England) Symposium on Catalysis in Practice. Yorkshire, England. June.

10th Industrial Waste Conference. Water and Pollution Advisory Committee, Ontario Water Resources Commission. Honey Harbour, Ont. June 23-26.

Tewksbury Symposium on Fracture. Faculty of Engineering, University of Melbourne, Parkville, Victoria, Australia. August 26-30.



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Discussion

(Continued from page 84)

sample and arranged so that the both rams moved forward at identical speeds. The low uniform speed was obtained partly by using the largest diameter jacks that space would permit and partly by the type of oil pump and flow control valve selected. The large diameter jacks and the pressure rating of the pump and auxiliary equipment provided more than adequate capacity.

The combination of oil pump and flow control valve which provided the very low and uniform rate of flow at the high pressure required warrants further description.

The oil pump was driven by compressed air supplied from bottles and regulated at a suitable pressure. It consisted of an air diaphragm, an oil piston and suitable intake and exhaust valves. The air diaphragm was directly connected to the oil piston so that when air pressure was applied to the diaphragm the oil piston was caused to move. In operation the pump was started against a closed valve. The oil pressure then rose quite rapidly to a point where the resisting force exerted by the oil equalled the force exerted by the air. At this point the pump stopped. When the valve was opened and a small amount of oil was permitted to flow the oil piston started to move again, maintaining pressure.

An accumulator which had previously been charged with compressed air maintained the pressure during the return stroke. This accumulator contained a floating piston to keep the air separated from the oil. For the small rate of flow employed this arrangement provided virtually constant pressure.

The function of the flow control valve was to regulate the rate of oil flow to the jacks. This valve contained a small fixed orifice across which a small constant pressure difference was automatically maintained. When supplied by the constant pressure pump this valve delivered a constant flow of a high order. Since the pressure difference was small, the orifice was small and the jacks were large, a very slow, as well as uniform rate of movement was obtained. The schematic diagram indicates how the system works.

The pump, supplied with compressed air from the air bottle, and assisted by the accumulator, provides oil at constant pressure. Three way valve SV 1 has forward, stop and reverse positions and controls the direction of movement of the jacks.

With the valve SV 1 in the forward position oil flows through the flow control valve FCV at a constant rate and into the input of Jack No. 1. As indicated in the diagram the jacks are of the double acting type. However, instead of returning the output of Jack No. 1 to the sump as would ordinarily be done, this output is fed into the input side of No. 2 jack. The output of No. 2 jack is then returned to the sump. With this arrangement, both jacks must move forward at identical rates. Since the rate of oil flow is constant the rate of movement is constant regardless of the resisting force encountered by either or both jacks.

With selector valve SV 1 in the reverse position the direction of flow is reversed causing the jacks to retract. However, a check valve in parallel with the orifice in the flow control valve now opens. Since this check valve is much larger than the orifice, the jacks retract at a much more rapid rate.

To put the system into operation it is of course essential that the jacks make contact with the load simultaneously. To accomplish this a 3-way selector valve SV 2 is used. This valve in effect short circuits one jack or the other rendering the jack in question inoperative. For instance, with D open and SV 2 in the proper position, pressure is transmitted from the input side of Jack No. 1 through valve D, valve SV 2 to common point X and down to the output side of Jack No. 1. The pressures in both sides of this jack are now equalized and it cannot operate. In the meantime oil flows from FCV through D, SV 2, common point X, and on to the input of Jack No. 2. Jack No. 2 therefore moves forward at the same slow rate while Jack No. 1 remains at a standstill. Reversing valve SV 2 and opening E causes No. 2 jack to stop while No. 1 moves forward.

Authors' Reply

The authors would like to thank Messrs. Crawford, Gizycki and Marion for presenting discussion on this paper.

Both Mr. Gizycki and Mr. Marion took an active part in the studies and their discussion elaborates on the problems involved and the methods used in carrying out of the tests.

Mr. Crawford has made pertinent comments on the method of test used and on the results obtained which should be given careful consideration by anyone confronted with the problem of carrying out a similar investigation.

The method of test adopted was that which was considered to duplicate most closely failure conditions in the prototype.

The shale bed tested with its central soft altered zone that contained fragments of unaltered shale, did not lend itself to the taking of undisturbed samples with any of the equipment that could be made available. It was not possible to determine the degree of overconsolidation or to carry out other laboratory tests.

Finally, mention should be made that a 16 mm. sound/colour film describing the work done, was made in addition to the photographic records mentioned in the paper.

ENGINEERING EDUCATION, HAVE WE A PROBLEM?

W. F. McMullen
Engineering Personnel Manager
Canadian General Electric Company Limited
Discussion by
Ermo Kulmar
Vancouver

Mr. McMullen's interesting paper arrives at the conclusion that "the shortcomings of which engineering students are accused . . . are due to the failure of the high schools".

The following random observations on Canadian educational policies and on technical education in particular, might throw some light on weaknesses in high schools, the effect of Royal Commission, improvements needed and progress underway.

1. Mr. McMullen's general criticism of high schools has been seconded by a few authorities. For example, Dean N. Searfe, U. of B.C., stated that "Canada's educational system is obsolete;" H. Trytten, Director of Office of Scientfiic Personnel, National Academy of Sciences has observed "inadequate preparation of sufficient young people for careers in engineering".

(Continued on page 92)

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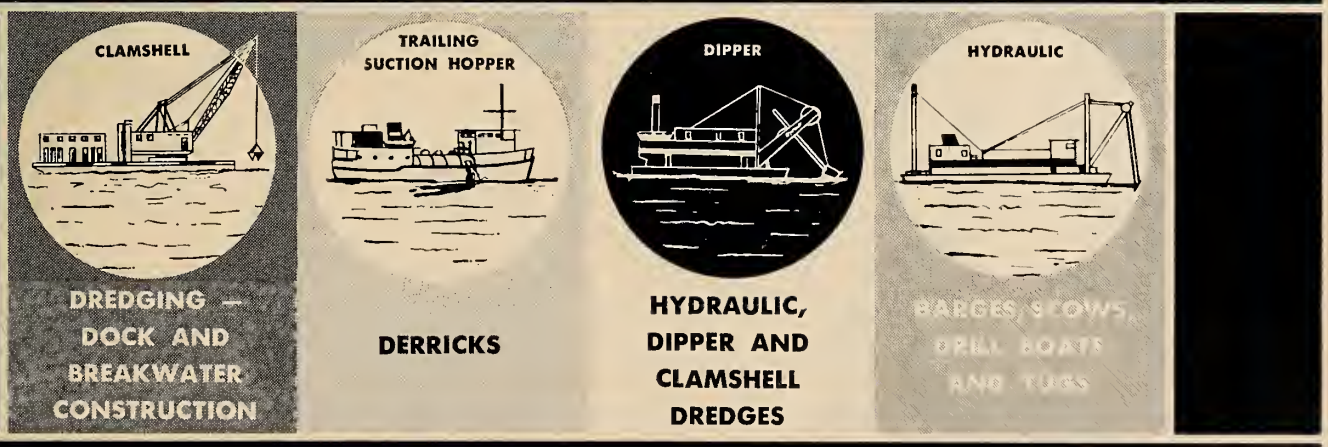

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Discussion

(Continued from page 91)

It appears that both Canadian and American curricula spend too much time on the preliminaries. For example, Dr. F. C. James, recently retired prinicpal of McGill, has stated: "Soviet education is superior to ours in almost every field. The normal pre-university schooling is 10 years, against 13 for Ontario. There are no elective courses". J. H. Burwell, Ottawa high school mathematics specialist has noted that "European schools are far ahead of Canada in teaching mathematics. Algebra and geometry taught in Grade X in Canada are studied in Grade VII in Europe". The Vancouver Sun of July 4, 1962, reports that a Miss Donkersley of Vancouver "who had only Grade VIII education a year ago, is going to university this fall. She passed her Grade XII with 'B' average. This summer she will round out Grade XIII". She said "I'm no genius, but I believe nothing is impossible if you work hard at it".

Around 1932, all technical high school graduates (Grade XI) in Estonia had studied calculus; a course in calculus is on the U.B.C. curriculum 1963 for the first year engineering, i.e. Grade XIV. As a matter of fact, the Florida Education Center is making this year "one of the boldest experiments in U.S. public schools" when "some 11th graders will be taking college level algebra and calculus". (Vancouver Sun, May 7, 1962)

Admiral H. G. Rickover, the "father" of the first atomic U-boat, states in his book "Education and Freedom", published in 1960, "we require two to three years longer to bring our students to approximately the same level of education as those in most European countries . . . This alone means 20% higher costs for the same end product . . . It is time we face up to the fact that not many American students at age 21 to 22 know as much after a four-year college course as European upper track secondary school graduates at the age of 18 to 19 . . . Most of the liberal-arts education given in our colleges has been absorbed into the curricula of the European academic secondary schools". Rickover's "Swiss Schools and Ours" published in 1962 shows again: "many American colleges now are giving remedial instruction in English and arithmetic. Inadequate university preparation belongs to a stage in the evolution of Continental education that has passed there more than a century ago . . . A great many American bachelor degrees fall below the Swiss maturity (senior high school) level . . . Swiss universities rarely accept Americans unless they have a bachelors degree . . . All three types (classical, semiclassical, mathematics and science) of (Swiss) maturity schools proceed at a pace a student (can) rarely be able to keep up unless his I.Q. is about 120 to 125".

2. One may wonder why the pace in North American high schools has been set to the low motivation or low I.Q. students? A few reasons can be derived from the following: The Vancouver Sun of July 12, 1962, quoted Chairman Edythe Quinell of the Vancouver School Board as saying "accelerated classes for bright students might breed intellectual snobs". The editor commented "the curse of our age and generation is its absurd worship of mediocrity. This is a high price to pay for coddling the vanity of intellectual inferiors. It deprives us of the intellectual elite we so badly need".

Dean H. C. Coutts, University of Alberta, stated at a recent conference of school principals in Vancouver that it is "downright poor business to spend so much money on education in Canada and so little on educational research. Lack of adequate research is a big stumbling block for persons charged with planning school curricula . . . Canadian education should be guided by scientific research and not social pressures. The delay in recognition of the need for educational research is alarming. We don't have sufficient facts to guide us".

Rickover has pointed out that "it makes little sense for us to go on refusing to profit from Europe's educational experiences . . . (and to) unshackle our talented youth from the lock step of the average and below average pupil who wishes only to have fun at school . . . There is little danger that intellectual excellence will ever be so highly rewarded in this country that it would create an elite". A survey made by E. R. Coffin in 1959 in a major Canadian city with the view of assessing the knowledge of the general public "showed conclusively that the public is ill-informed with respect to school matters". And yet "education is everyone's responsibility and the professional educators are only the methodologists who carry it out" (President R. E. Lester of the B.C. School Trustees Association).

3. The recent Royal Commissions on Education in B.C., Alberta, Manitoba and Ontario have produced many recommendations for improvements. There is little originality in the recommendations on "hard core" subjects, an increase in the school year's length, more homework, etc. But the "pills" described seem to be too mild to be good enough for Canadian education of tomorrow. Also, suggestions are expected to take a decade or more to implement mainly because "the teachers must accept the changes before they are to take effect in the classroom" and "teachers are reluctant to accept changes unless they have

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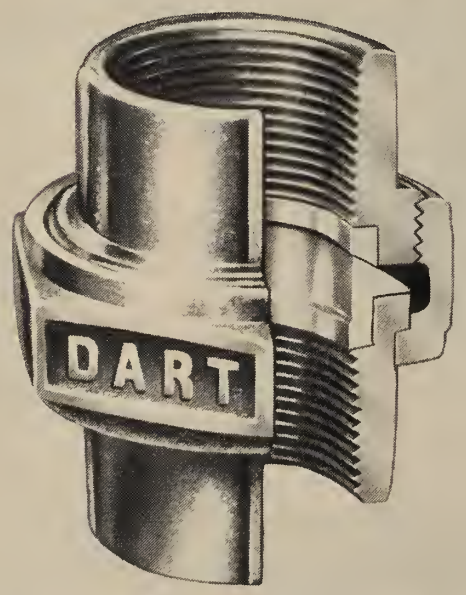

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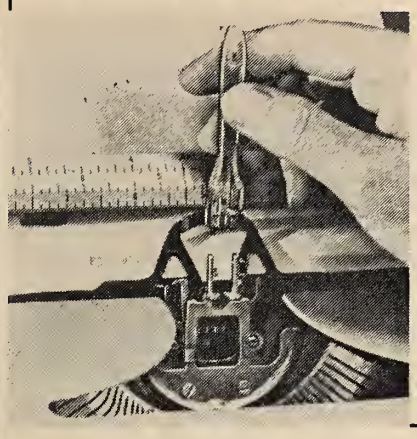
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time and money to continue their studies and keep abreast of new developments" (D. R. Campbell, Chicago University, speaking to school principals conference at U.B.C.)

After travelling around B.C. for about three years the Chant Commission has left quite a few questions unanswered and busied itself also with too many side issues:

a). Commission's Report in 1960, p.425 indicates that there has not been "any allowance made for (the) costs of teacher training". The Rockefeller Report on Education said three years ago — "until we pay teachers at least as well as the middle echelon of executives we cannot expect the profession to attract its full share of the available range of talents".

b). The Report fails to show how the educational gap between B.C. and other advanced countries can be closed. The Commission has recommended that "the secondary school day be six hours, the school year be lengthened to a minimum of 200 days, the pupils will be required to devote more time to school work out of school-hours (pupils in Grade VII to XII spent one to two hours on homework), the practice of social promotions be discontinued (i.e. being moved up along with one's age group), etc." The Commission has also stated that "the level of instruction must necessarily be pitched to an average level. This is a fault . . . of the system".

In contrast, Rickover's comparison of Dutch schools with U.S.'s six-year junior-senior high schools shows that "the Dutch school day is 10% longer (and) the school year last 240 days or 33% longer. The homework required is two to six hours daily. The Dutch student ends up with 40 points, or 66% more than we". Rickover indicates again that "our school Grades VII to IX) year has 180 days to (Swiss) 240, so that the very least nine of their school years contains as much instruction time as 12 of ours".

It is clear that there is a large difference in the knowledge acquired in the high schools of B.C. and those abroad. The Commission's inference that all schools have a common problem "the current dissatisfaction with their systems" is not quite sound. Europeans do criticize their education, but this is at a different level when compared with B.C. system. Therefore the suggestion (page 442) that "the B.C. public school system compares quite favorably with that of any other country" lacks reality. This conclusion is also supported by pres. R. E. Lester, who at the B.C. School Trustees Assoc. annual convention 1962 stated that "B.C. schools do not provide a high standard of education".

c). The Report mentions 16 studies which are still to be done, e.g. long-range population trends, a review of science courses, the arrangements for the departmental examinations, etc. The Commission did not seem to consider that part of educational research, special projects and data collecting can be done by some organization other than the provincial Department of Education?

The importance and extensiveness of the unstudied fields may mean that School Boards and educators will have to wait a long time before they get any real facts and the Commission's other recommendations (142) may look like an "educational facelifting". Some obvious trivialities are "the use of penholders and steel pen-nibs be discontinued, adequate locker space for hanging clothing, and regulations regarding school clothing or uniform".

d). D. H. Goard, Vancouver School Board, has said that "vocational school graduates would be recognized as failures" because the Commission recommends it for pupils "who fail to qualify for entrance to high school enter the junior vocational school course at the Grade VIII level". It is questionable why B.C.'s system should differ from Ontario's where "after Grade IX students would decide which stream they would follow and for how long (five, four and two-year options)".

The Commission's recommendations "Grade X be granted a high school certificate . . . the collegiate academy would include Grades XI, XII and XIII" and "pupils who completed Grade XII would receive a Collegiate Academy Graduation certificate" would make utter confusion out of B.C.'s certificates when compared with other countries.

e). Prof. A. M. Thomas, Department of Education at U.B.C. has stated that the Report "should have dealt with the need for adult learning through high schools, university extensions and private sources—after all, the instructions were for a Royal Commission on Education".

"At the time when we in B.C. have not even solved the problem of providing a sufficient initial education to our young people (to be skilled workers)—according to principal E. C. Roper of B.C. Institute of Technology, we are training only 2400 of the 8400 needed. Russia claims to be retraining eight million workers annually; France, 200,000 . . . Gen. Electric Co. in U.S. spends up to $40 million a year for the same purpose . . . (i.e.) merely to retain skilled status". (Vancouver Sun, Nov. 11, 1962)

4. A few examples may show what kind of an educational revolution is needed:

1). "Canada must devote a much larger proportion of its resources to education and training of all kinds" (Senate's Committee on Manpower and Employment, 1960). Spending for education is now 3% of the Canadian Gross National Product (GNP). "We (in U.S.) invest 3½%, Russia invests more than 6%, and some experts believe it may be nearer 12% . . . In the period 1940-54 we upped educational expenditures 78%, (and) we benefited from an increase in the GNP of 192% . . . To raise our GNP by 3% annually we must increase scientific and engineering man-power by 4½ to 5½% annually" (Rickover). "We have lived on the educational bounty, first of the British Isles, and now of the U.S. . . . We've let them think for us" (Dr. G. C. Andrew, Executive Director of the Canadian Universities Foundation).

There is frequently a large gap between what a Royal Commission says and what is actually put into practice. Let us hope that provincial governments, through additional educational research, will do more than suggested. Naturally, it can't be easy because the property owners are waiting for an ease of educational taxes by making these deductible for income tax purposes—"it is done in the U.S." (L. Place, Montreal school trustee). Owners also wonder about the proportionality of payments by apartment and "basement" dwellers for education, when compared with them.

2). The motivation is more important factor than inadequate funds in the loss of our talented youth. In some Vancouver high schools about 90% of the students take the university entrance program, but only 25% continue to university. In Sweden 70 to 80% of the students continue their studies.

"The basis of all good education is the sense of values parents give their children which will determine their intellectual development" (U.B.C. Chancellor Mrs. F. Ross); a child will not strive for excellence unless his parents believe that excellence is desirable. Also, to progress, the inequality of intellectual ability should be recognized and people should start to feel that there is nothing else we can afford more for our survival than knowledge.

3). The quality of teaching should be increased through better knowledge of the subject matter by educators. In North America too much of the teacher training seems to be devoted to the study of methods. "Despite the excessive emphasis given to pedagogy in teacher training here (in U.S.), techniques are obviously behind those in European schools where the teacher in addition is far better informed in his subject matter" (Rickover).

4). "Canada must produce a greater number of university students or suffer a

Discussion

(Continued from page 93)

lower standard of living" (Dr. F. C. James). Just now the college enrollment in Canada is about 7%, compared with the U.S.'s 33%. "One out of every two young people in Russia" reaches the university (Dr. J. B. Macdonald, President of U.B.C.).

A greater number of teachers will be necessary to keep the present ratio of 28 pupils per teacher. "Russian schools now average one teacher to every 17 pupils" and the limit seems to have been reached in English schools such as Eton or Harrow, which "contribute so large a percentage of England's leaders. Their ratio of teachers to pupils (is) one for every 12 students" (Rickover). "Teachers in Russian secondary schools teach 18 hours a week. B.C. secondary teachers frequently teach 30 hours a week" (Dr. N. A. MacKenzie, former President of U.B.C.).

Why can't the scientists and engineers employed by industry, business and government, be given sabbatical leave or time off to teach in our high schools?

5). The recent Canadian Conference on Education suggested the establishment of "a National Education Office which would be staffed by Ottawa and the provinces, because there is a need for National standards". National educational standards were started in European countries before year 1800 in five years Canada will be 100 years old and there is still no Federal Department of Education! The Canadian Labour Congress also recommended "there must be an agency that will have responsibility for the direction, administration and co-ordination of the provincial programs for training skilled manpower, that will meet the needs of the present and the future". Also "ours is the only major country where the public through its government does not set academic standards" (Rickover).

For a continuous study of the nation's educational needs, a federal drive is a must. But in times of austerity, there should not be 10 provincial Commissions on Education mainly duplicating each other's work.

6). "The economic future of the country . . . depends upon the quality and availability of technical and vocational training programs for both young and old adults alike". Also, "if more young people do not enter engineering in the next 10 years, national technical and scientific progress will be seriously impeded" (Eng. Manpower Commission of Eng. Joint Council, U.S.)

There seems to be a relationship between high technical education and employment. Switzerland, being most densly "populated" with engineers in Europe "has such a shortage of unskilled workers that she . . . imports each year 400,000 seasonal workers (almost 20% of the total number of Swiss employed)" (Rickover).

5. What then is the situation in the field of technical education on the pre-university and advanced Institute level? The A.P.E.B.C. Committee on Technical Education 1960, found that "three trained technicians for each practising engineer can be used in B.C.". The highest ratios for an engineering team has been estimated to be "as high as 150 skilled mechanics to 10 engineering technicians to one professional engineer or scientist" (Dr. G. Henninger, President of Ohio College of Applied Science).

Annual graduates in Canada include about 2,700 engineers and 6,000 technicians, the last-mentioned based on an enrollment of 8,300; B.C. had only 92 students in post-secondary schools in 1960 according to the Canada Yearbook for 1961. In his study of U.S. universities, Dr. S. Ingram, Chairman of the Eng. Manpower Commission, found that "engineering schools will probably turn out only about 37,000 graduates a year" and "at present, technical schools are graduating about 16,000 men and women a year". Dr. F. Lee, Manager of Training Services, Raytheon Corporation shows that "there are only seven technicians for every 10 engineers in the U.S., with the result that too many engineers are doing the work of technicians. Three out of every seven technicians must be educated by companies".

Using the low 1 to 3 ratio, because not all of the 2700 (or 37,000 in U.S.) graduates will be doing engineering, it can be guessed that Canada may need about 8,100 technicians a year and U.S. about 111,000. It is easy to foresee that Canada's probable oversupply of technicians due to new Institutes planned, can be quickly absorbed by the U.S. Also, if Canada is get full benefit of the tax dollars spent on education, some measures should be applied to slow down the export of our technically trained people. "In the past 11 years more than 43,000 technical and professional people left for the U.S.," (Dr. P. L. McGeer, U. of B.C.) where for at least the next decade, professional engineers and technicians will be on the wanted list.

The above-mentioned Manpower Commission found also that "one of the barriers to graduating more technicians, is the degree consciousness of the American Society. Almost any youngster who starts out in engineering and finds he can't make it, will transfer to an easier course of study which offers a degree, rather than sifting to a technical school where he gets only a certificate".

(Continued on page 96)

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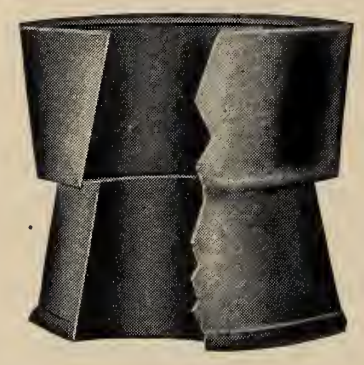

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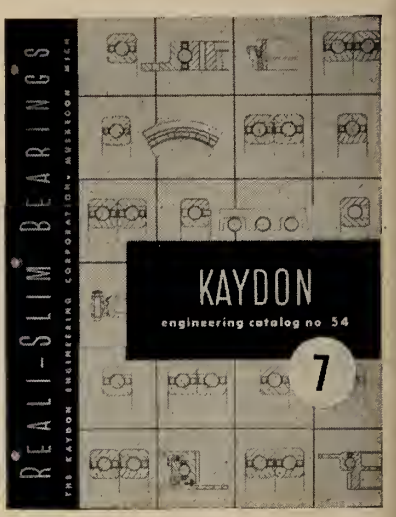

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Discussion

(Continued from page 94)

6. Our technical education might be improved by the following measures:

(A) next fall, Ontario will start in their high schools a three "stream" (academic, commercial, technical) system which has proven successful for many decades in European countries. B.C. Commission has suggested that in future "two programs would be available in the collegiate academies (Grades XI & XII)—an academic and a technical".

(B) the Canadian Government's $200 million program for vocational and technical education would do most good if it were followed up by larger grants for better engineering education at university level. Rickover observed "it has been estimated that the efforts of less than 1% of the total population move the world forward" and a Swedish Universities Investigation in 1955 concluded that "for a yearly increase in the GNP of 3½%, there should be an increase of working hours or capital of about 1½% and a technological evolution of about 2%".

Ontario, under the Federal program, according to B.C. Liberal leader R. Perrault, "is building 19 new vocational schools and 16 others were being expanded", at a cost of $289 million. B.C. has one Institute of Technology started at Burnaby with a few more planned at a cost of $17 million. Ontario has fewer than four times the population of B.C. so it looks as if one of the provinces is out of line with its program. "When it comes to the amount per capital each province proposes to spend B.C. drops to eighth place". (Vancouver Sun, Oct. 19, 1962)

W. Pitman has subjected to the Fed. Government's vocational and technical program a severe criticism in the House of Commons: "most of the new schools would be preparing people for employment opportunities that existed in the 1930's and 1940's (and) for which there was a declining demand in industry. The real deficiency is at the post-secondary, trade school level".

A warning is shown also in the words of Les Peterson, B.C.'s Minister of Education: "it's easy to say train our students as mechanics or carpenters, but the advances made in this scientific world in recent years have changed the kind of skills required by our young people".

(C) Perhaps a Canadian Society of Eng. Education, for pooling of knowledge and effort, should be organized instead of waiting studies from the Government? The Society could see that all practical ideas and research will be immediately passed on to the highest executives in the Government without being buried or wearing thin through, for example the sub-sub-committees of existing engineering organizations. At the same time Dr. C. Bissell, President of the University of Toronto, remarks that "current demands for increased technical and vocational training could be 20 years too late" which can be interpreted as the urgency for fast actions is very real.

The Canadian Council of Professional Engineers, Committee on Acceptable Curricula, shows in its progress (1962) report that—"some 139 engineering curricula presently offered—70 of these are acceptable to all the Associations (of provincial Professional Engineers)" and "complete acceptability of (all) curricula could not be achieved without first reaching agreement on basic policies and criteria". In recent international conferences on economic growth and investment in education, attended by representatives from 96 nations, it was decided that educational policy should be a part of over-all economic policy. From this it follows that no "basic policies and criteria" can be properly established for engineering education without knowing Government's economic policies. These policies will determine the various types of talented manpower needs and the design of a suitable educational program. Because any economic progress in this space age is largely dependent on engineering, then a Canadian Society of Engineering Education, if one existed, could give valuable aid to the Government's economic policy-makers.

The above discussion, by presenting enough figures "to put your teeth into", should arouse the curiosity of Engineers —both professional and technical—and perhaps other written thoughts will be forthcoming especially as to the type of society we seek for the future and what it takes to get there.

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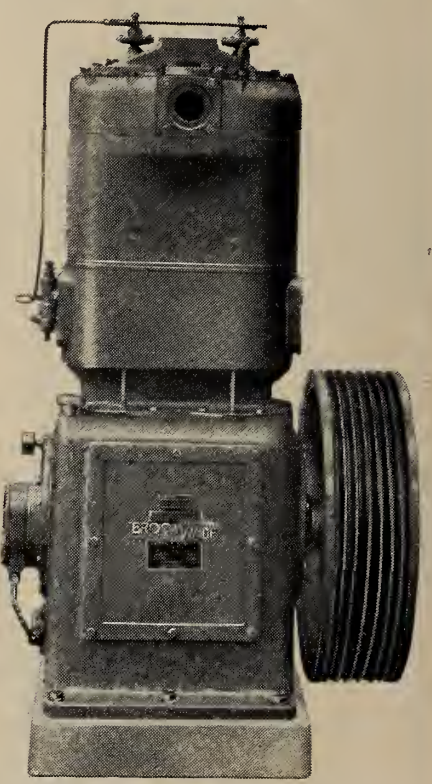

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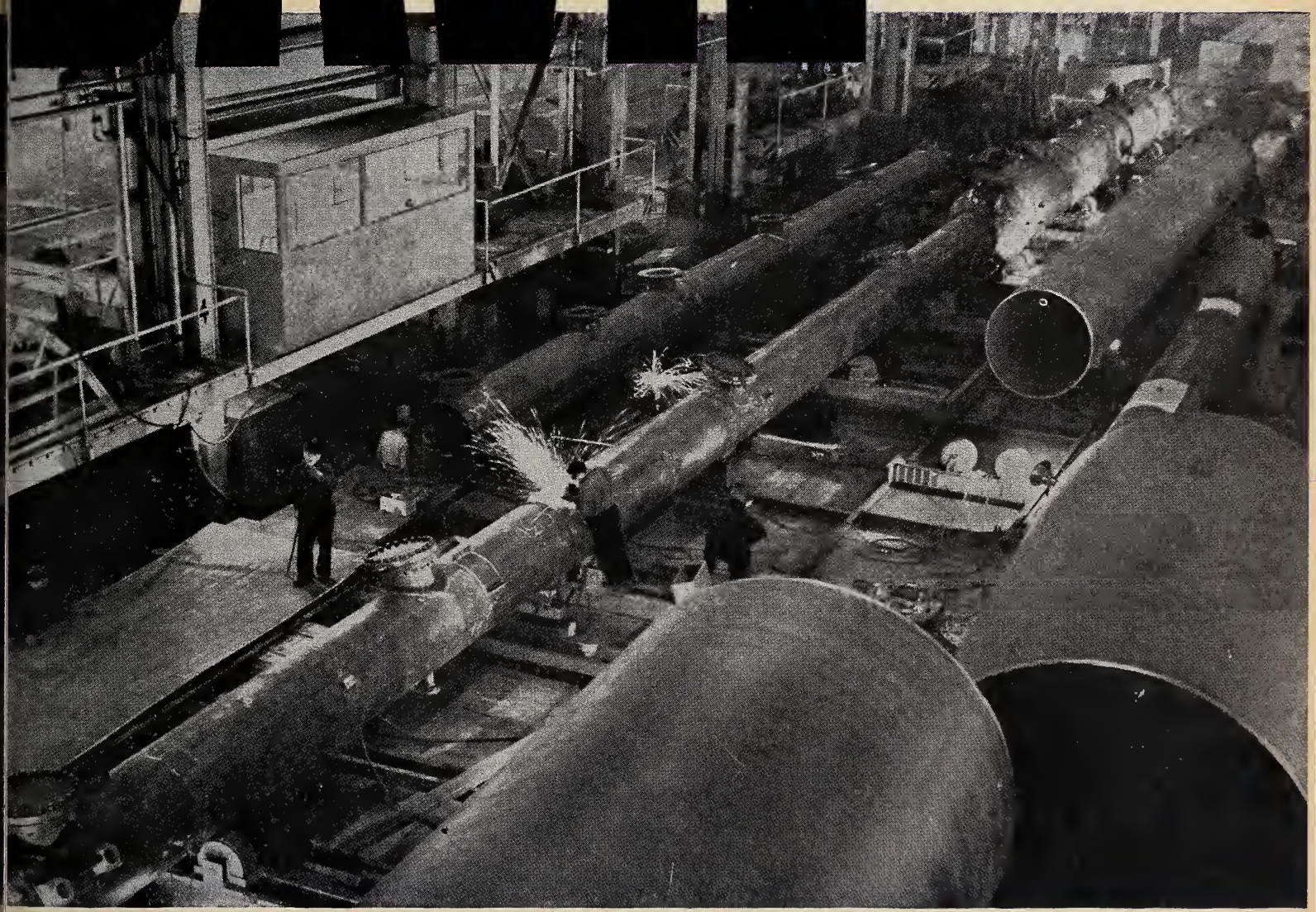

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Engineering Information Service

The following books have recently been received.

ELECTRONIC CIRCUITS AND INSTRUMENTATION SYSTEMS Jack J. Studer, Wiley, New York, $10.75.

INTRODUCTION TO ELECTROMAGNETIC FIELDS AND WAVES Charles A. Holt, Wiley, New York, $12.50.

ELECTRIC CIRCUITS E. Norman Lurch, Wiley, New York, $7.50.

MATHEMATICAL TABLES AND FORMULAS compiled by: Robert D. Carmichael and Edwin R. Smith, Dover, New York, $1.

HEAT AND ITS WORKINGS Morton Mott-Smith, Dover, New York, $1.

BASIC ELECTRICITY Bureau of Naval Personnel, Dover, New York, $2.65.

TECHNICAL SERVICE HANDBOOK E. Patrick McGuire, Padric, New Jersey, $9.50.

ENGINEERING DESIGN – A SYSTEMATIC APPROACH R. Matousek, Blackie, London, 45s.

METAL INDUSTRY–HANDBOOK AND DIRECTORY NO. 52 Illife, London, 21s.

THEORY OF PRESTRESSED CONCRETE Michael Chi and Frank A. Biberstein, Prentice-Hall, New Jersey, $7.30.

THERMODYNAMIQUE-CINQUIEME EDITION A. Kastler, Masson, Paris, 82NF.

DIGEST ON LITERATURE ON DIELECTRICS – VOLUME 25–1961 Edited by: Ann M. Parks, Publication 1034, National Academy of Sciences, National Research Council, Washington, D.C. $15.

BUILDING CONSTRUCTION COST DATA, 1963—21st Annual Edition, Means, Mass. $3.75.

SWEDISH STEEL MANUAL—The Swedish Iron Masters Association, Stockholm.

RECUEIL DE PROBLEMS – CINQUIEME EDITION J. Roig, Masson, Paris, 50NF.

GRINDING WHEELS AND MACHINES P. S. Houghton, Spon, London, 63s.

OLHYRAULIK Heinz Zoebel, Springer-Verlag, Berlin, $21.

FLACHENSCHLUF Heinrich Heesch and Otto Kienzler, Springer-Verlag, Berlin, DM 27.

PRINCIPLES OF STRUCTURAL METALLURGY B. Harocopos, Iliffe, London, 32s 6d.

PHYSIOLOGIE ET INDUSTRIE Lucien Brouha, Gauthier-Villars, Paris, 26NF.

EQUILIBRE LIMITE D'UN COIN DANS UN MILIEU NON PESANT R. L'Herminier et E. Absi, Eyrolles, Paris, 35NF.

BRITISH CONSTRUCTION EQUIPMENT The Federation of Manufacturers of Construction Equipment 1963, W. S. Cowell, London.

THE RADIO AMATEURS HANDBOOK 40th Edition, The American Radio Relay League, Hartford, Conn., $4.

AMERICA'S FORGOTTEN LABOR ORGANIZATION Arthur B. Shostak, Industrial Relations Section, Princeton University, $3.75.

ARCHITECTURAL SUPERVISION OF MODERN BUILDINGS Martin D. Dubin, Burns and McEachern, Don Mills, Ont., $12.

MAGNETOHYDRODYNAMIC SHOCK WAVES J. Edward Anderson, M.I.T., Mass., $6.50.

CORROSION AND CORROSION CONTROL Herbert H. Uhlig, Wiley, New York, $10.

DURO DYNE Catalogue and Engineering File, Duro Dyne of Canada Limited.

CONCEPTS OF STRUCTURES William Zuk, Burns and McEachern, Don Mills, Ont., $6.75.

NUCLEAR PHYSICS 2nd Edition Irving Kaplan, Addison-Wesley, Reading, Mass., $11.50.

PROCEEDINGS OF THE FIRST SYMPOSIUM ON ENGINEERING APPLICATIONS OF RANDOM JUNCTION THEORY AND PROBABILITY Edited by: John L. Bogdanoff and Frank Kozin, Wiley, New York, $8.75.

(Continued on page 109)

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(Continued from page 62)

EDMONTON

R. J. Allman

A meeting of the Branch was held early in March. A talk entitled, "Trends in the Development of Turbines for Driving Large Generators", was presented by Norman C. Parsons, Senior Turbine Design Engineer for C. A. Parsons & Company, Newcastle.

Mr. Parsons outlined construction details for turbines in the 200 to 550 megawatt size and presented a series of slides showing the importance of electrical power in our daily lives. He described in detail the engineering advancements made in the design of large modern steam turbines and sited a number of examples of these. The design of both high pressure and low pressure turbines and the various control systems associated with such turbines was discussed. Mr. Parsons stated that it was difficult to predict with any degree of accuracy the future development of steam turbines, but with the ever increasing demand for electrical power, he was certain that the present trend towards larger machines would persist. He expected that use of super critical steam pressures would be extended and that much would depend on metallurgical developments. He concluded his talk by stating that the development of steam turbines that had already reached an advanced stage, showed no signs of slackening and that the steam turbine designer would be kept busy on improvements for many years to come even though other fields such as nuclear power were receiving more and more attention.

Late in February, a meeting was held at which Lloyd Bellows, Northern District Engineer for the Oil and Gas Conservation Board of Alberta presented a talk entitled, "The Athabasca Oil Sands". The Athabasca Oil Sands area extending along the Athabasca River in the McMurray District is one of the largest potential oil developments known to man. The engineering advancements for the economic recovery of this oil and its potential value to Alberta was outlined by Mr. Bellows. He described in detail the location and size of the oil sands deposit, stating that these sands cover approximately 21,000 square miles and vary in depth from a few feet to 200 feet maximum thickness. The oil is heavy, viscous and sulphurous. It has been estimated that there are 300 billion barrels of oil in place, of which 50-70% is recoverable. Of this recoverable amount, approximately 1½ to 5 billion barrels can be recovered by mining methods.

Mr. Bellows gave a brief history of oil sands, stating that they were first discovered in 1778 and surface surveys were made as late as 1800. Drilling took place in 1900 and in 1919 the Research Council of Alberta investigated and later built the Clearwater Plant. In 1943, the Abasand Plant was built by the Federal Government. In 1951 the Provincial Government published all available literature regarding the oil sands and in the late 1950's, interest in commercial recovery became quite widespread.

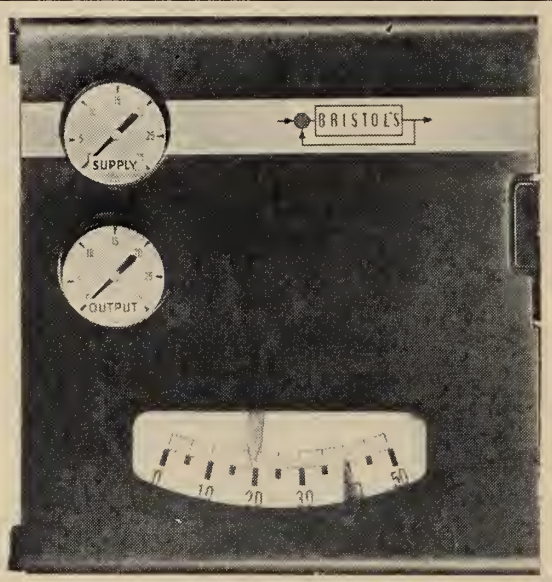
Three companies have since established pilot projects, and Mr. Bellows outlined these in detail. Two of the projects use hot water in their process to recover the oil and the third depends on the drilling of a series of wells and the pumping of steam and hot caustic solution down into the formation.

Mr. Bellows concluded his talk by outlining the Government's policy regarding the recovery of oil from the sands.

KAMLOOPS

J. W. Nelson

On March 29 a joint meeting was held at Kelowna in the Capri Motor Inn. This was the annual meeting to which the ladies were invited. Special guests were: Mayor Parkinson of Kelowna; F. L. Lawton, President of the E.I.C., and Mrs. Lawton. After an excellent smorgasbord dinner, the Chairman, M. G. Elston, welcomed approximately 60 members and their ladies. Appreciation was expressed to E. F. Lawrence, the convenor for the evening. An afternoon tea social for the ladies was held in the Lawrence home, with Mrs. Lawrence as hostess.



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Mayor Parkinson welcomed everyone on behalf of the City of Kelowna, with special greetings to Mr. and Mrs. Lawton. Mr. Lawton was described as a practical engineer who gets things done. Mrs. Lawton was presented with a crested spoon of the City. H. Hatfield gave further credit to Mr. Lawton as an engineer and organizer of the E.I.C. and gave some of Mr. Lawton's impressive background in this work.

Mr. Lawton began his address by praising the great natural beauty of the B.C. interior. He reminisced on the founding and purpose of the E.I.C., the subsequent setting up of the provincial licencing boards, presently the Associations of Professional Engineers, and commented briefly on the present status of the Confederation issue. Mr. Lawton stated that after many years of difficulties, a break-through to decide on the question of Confederation is imminent. Ballots and a draft outline of the proposals will be mailed to every member in the very near future.

Mr. Lawton stressed the need for the opportunity of individual development as an engineer and in research on a voluntary basis, instead of on a compulsory basis by state pressure. The last method was given by Mr. Lawton as the reason for the heavy uniformity and drabness he felt while visiting the U.S.S.R. some years ago. He warned against influences in this country which, according to Mr. Lawton, tended in the direction of curtailing individual freedom and urged engineers to use more widely their right of dissent.

Mr. Lawton was thanked by Mr. Harvey. A dance concluded the evening.

KITCHENER

W. N. Meikle

G. N. Soulis, Assistant Professor, Mechanical Engineering Department, University of Waterloo, spoke to the Branch's March 27 meeting. The title of his talk was, "Most Engineers Can't Design". In this talk Professor Soulis stressed the fact that in Canadian industry, engineers are not in a position to do creative design work, not that they are inherently incapable of it.

In Canada, most engineering has been of the production type where organizational structure is rigid to fit with management and sales procedure. When an engineer or a group of engineers are asked to set up a design department, they usually inherit the organizational structure which has been working for the rest of the department. This rather stringent set of guidelines is usually not conductive to innovative thought processes. The engineer is also, in most cases, a product of an educational system which has during his formative training years, put a premium on programmed thought processes. It is hard for a man so trained to bring himself to realize there may be more than one perfectly valid shower to any posed problem.

Canadian industry is only very recently beginning to realize the value of a distinctive design. To the present time, almost all manufactured goods have been made in the image of some foreign design with minor modifications to fit our production methods or costs. Engineers employed on this type of adoptive engineering are rather ineffective when it come to real imaginative thinking.

No situation can be completely clear cut, or generalizations permitted. Some engineers must function in both camps. The engineer in management for example, can plan and visualize for the overall good of his company for only short periods each day. The remainder of the time is usually spent in "paper pushing" to fit the corporate structure of today. The bridge designer is another example. As long as the bridge is only an idea, his creative ability is not hindered. But, once the design is set, he must conform to the same rigid structure of codes, triple checked calculations as the production engineer. Many companies are now realizing the need for original design and are attempting to establish an organizational structure which is conducive to creativity. Results have been gratifying in most cases where a genuine effort was put forth to achieve these goals.

LOWER ST. LAWRENCE

J. Y. Fortier

Le 16 février dernier avait lieu la soirée dansante annuelle de l'Institut

(Continued on page 102)

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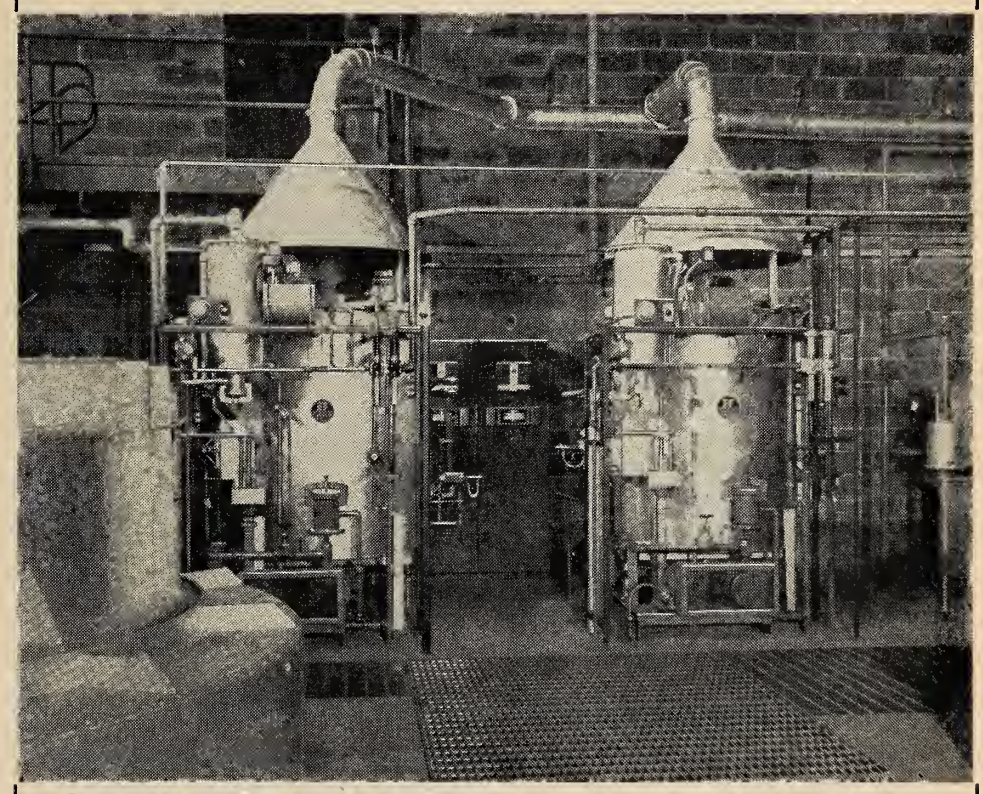

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Branch News

(Continued from page 101)

Canadien des Ingénieurs, Section du Bas St-Laurent ainsi que du Chapitre de Rimouski de la Corporation des Ingénieurs de Québec. A cette occasion, les ingénieurs avaient adressé des invitations à tous leurs amis et aux techniciens qui travaillent avec eux dans les différentes compagnies de la région. Tous apprécièrent cette soirée. Au nombre des invités, on remarquait la présence de M. T. A. Bernier, Ing. P., M.E.I.C. ainsi que Mme Bernier. Nous avons profité de la circonstance pour remettre à M. Bernier un cadeau souvenir à l'occasion de sa retraite de la Compagnie de Pouvoir du Bas St-Laurent.

Quelques jours auparavant, les ingénieurs de la région de Rimouski recevaient le président de la Corporation des Ingénieurs de Québec, M. Gilles Sarault, Ing. P. & M.E.I.C. Ils ont profité de l'occasion pour se renseigner sur les travaux effectués par le Conseil de la Corporation.

Le comité des conférences de la Section du Bas St-Laurent de l'Institut Canadien des Ingénieurs, qui est sous la direction de M. J. G. Marsan, Ing. P., A.M.E.I.C., présentait une conférence le 12 mars 1963. A cette occasion, nous recevions M. Yvon Montcalm, Ing. P., M.E.I.C., de Power Light Devices Limited de Montréal. M. Montcalm nous a entretenu de l'éclairage de rues, de terrains de stationnement, de parcs et d'édifices publics. Sa conférence était accompagnée de projection de diapositives illustrants les différents genres d'installations que l'on peut rencontrer en éclairage extérieur. Des invitations avaient été adressées aux Chambres de Commerce, Conseils Municipaux des localités avoisinantes et à tous ceux qui s'intéressent de près ou de loin à l'éclairage extérieur.

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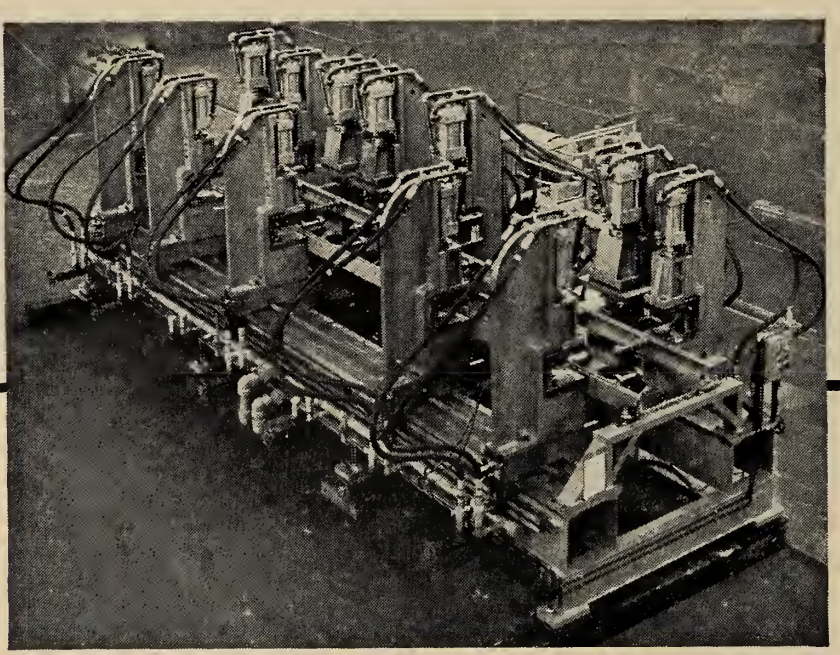

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LOYOLA

Origene Roy

Dr. L. Thompson of McGill's Mechanical Engineering Department, and C. Langlois, Town Planner of the City of Duvernay, were the guest speakers at the Branch's February 28 dinner meeting. Dr. Thompson gave an excellent talk on McGill's space gun. One of the important points of the talk was the discussion of the aim of the project. The study of the high altitude of the atmosphere is important for future weather control. The upper atmosphere was studied by the measurement of concentration of active particles in the atmosphere. The Barbados was chosen as the site of the project because it offered the scientists an opportunity to study the trade winds in that area as well as the upper atmosphere. Dr. Thompson gave an excellent explanation of the project with the aid of slides.

Mr. Langlois presented a talk on town planning in which he explained its importance to the community. He pointed out how, in Montreal, those who are financially successful live in a higher area of the city. Mr. Langlois indicated that buildings which will be constructed for the 1967 World's Fair, will be of little use after the Fair is over, unless good planning and government co-operation are utilized.

After the talk, those present retired to the C.O.T.C. for further questions to the speakers, and refreshments.

The new executive elected at this meeting are: Chairmen, Origene Roy; Vice-Chairman, Robert Michels; Secretary-Treasurer, Robert Thomas.

UNIVERSITY OF ALBERTA

R. B. Dunbar

In its second year of operation this Branch has made a great deal of progress. Student enthusiasm and interest has increased and membership is expected to increase in the future. The first year was almost solely an organizational year. This second year has seen a good deal of expansion. Two industrial tours, organized jointly by the Engineering Students' Society and the Branch, took place at the Anthes Imperial High Pressure Pipe Plant, and the Calgary Imperial Oil Refineries. The tours were organized with the aid of the Calgary Branch. The Calgary Branch also held a joint technical meeting with Student Engineers on February 6, at which a panel discussion of Engineering in Industry was held, and a film on the mining and

separation of oil from the Athabasca Tar Sands was shown. The meeting was well attended by both S.E.I.C. and Calgary Branch members.

Gary Hilton was elected 1963-64 representative. April 3, President Lawton visited the Branch and spoke to the students on the challenge to young engineers in Canada today.

VANCOUVER

L. B. Davies

"Aspects of Hydro-Electric Development and Construction under the Colombo Plan in Southern India" was the title of the talk presented by C. H. Maartman, M.E.I.C., J. H. Lyder and A. E. Lawrence to the Branch's February 26 meeting.

The speakers gave a brief summary of the history and operations of the Madras State Electricity Board, and of the Colombo Plan, under the provisions of which the Government of Canada is supplying generating equipment for the Kundah Power Developments of the M.S.E.B. The Kundah project, in its initial stage of development, includes two power stations, four dams, three major tunnels with a total length of 34,000 feet, and six penstocks with a total length of 28,000 feet. Ultimately, the project will consist of five power stations in cascade, utilizing the total available head of over 6000 feet. A notable feature of the construction of these projects is the use of manual labour on all phases of the work. The talk was illustrated with color slides.

On March 19, R. C. McMordie, M.E.I.C., Associate Manager, Engineering Division, B.C. Hydro and Power Authority, presented a talk entitled, "Columbia River Power". In it, he gave a brief outline of the investigations of the hydro power potential of the Columbia River in Canada which led to the formation of the International Columbia River Engineering Board Report of 1959. He also described the basic terms of the treaty, as yet unratified by the Government of Canada, by which the Governments of Canada and the U.S. agree to the sharing of storage benefits in Canada, to the payment of flood-control benefits by the U.S. to Canada, and to the possible integration of Canadian and U.S. to Canada, and to the possible integration of Canadian and U.S. power systems.

The talk was illustrated with slides of scenes in the Columbia River basin in both Canada and the U.S., and with a film of the 1961 floods in the Kootenay and Columbia valleys.

President F. L. Lawton visited the Branch March 28, where he was introduced to the members by F. M. Cazalet, Regional Vice-President of the E.I.C. He also explained the function of the new Regional Information and Co-Ordination Committees. A lively discussion on Confederation then took place. During the meeting, Mr. Lawton presented the Plummer Medal to Professor D. S. Scott, Department of Chemical Engineering, U.B.C., and the Duggan Medal to Professor A. Hrennikoff, Department of Civil Engineering, U.B.C.

On April 2, Dr. Arthur Casagrande of the Department of Engineering and Applied Physics of Harvard University, presented a talk on "Problems of Seepage Analysis in Connection with Alluvium-Filled Rock Channels". Dr. Casagrande spoke on the seepage problems encountered beneath the upstream and downstream cofferdams at the Manicouagan 5 Project in Quebec. The cofferdams, built to permit construction of the butressed multi-arch dam in the river channel, rest on some 200 feet of pervious alluvium. Sealing of the alluvium beneath the upstream cofferdam was effected by the construction of a concrete diaphragm down to bedrock by the Italian ICOS process; and beneath the downstream cofferdam by the Soletanche process. The results for both cofferdams were apparently 100% successful. Dr. Casagrande described in detail the mathematical treatment used to compute the seepage flow through the alluvium, and in the abutments by approximate method of Dupuit, and showed how such methods led to consistently lower value of permeability than those found by pumping tests. The speaker was thanked by C. F. Ripley who paid tribute to Dr. Casagrande's pioneering work in the field of Soil Mechanics.

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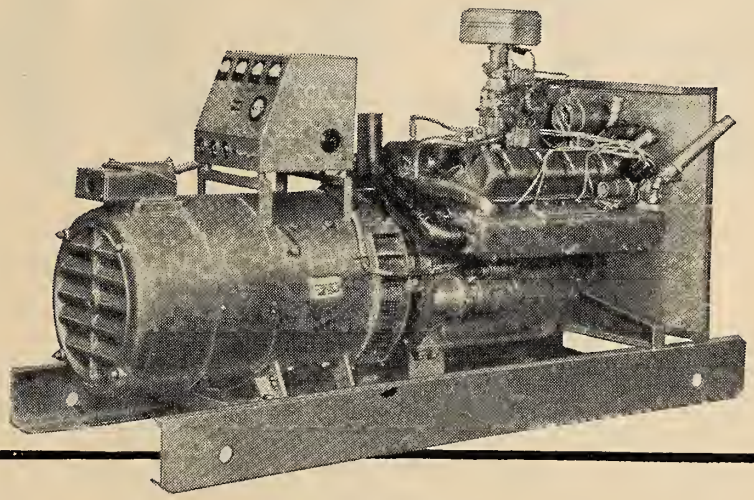

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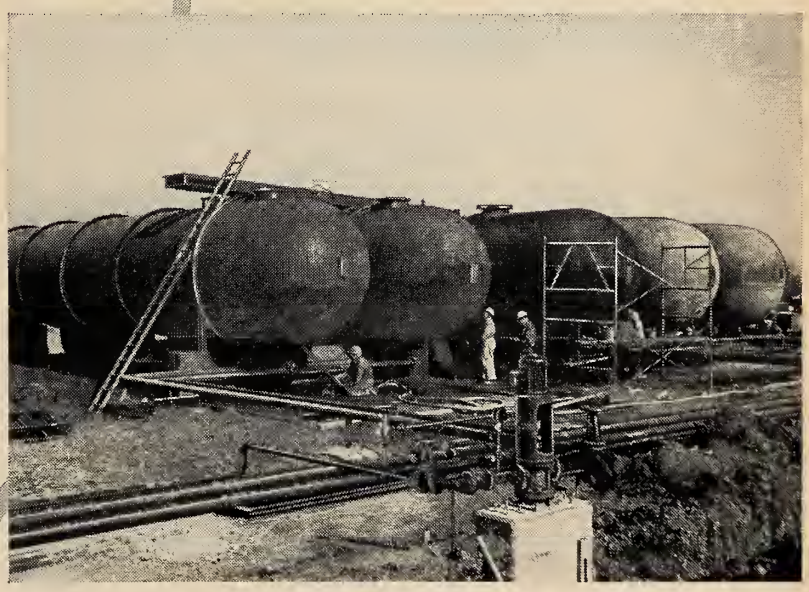

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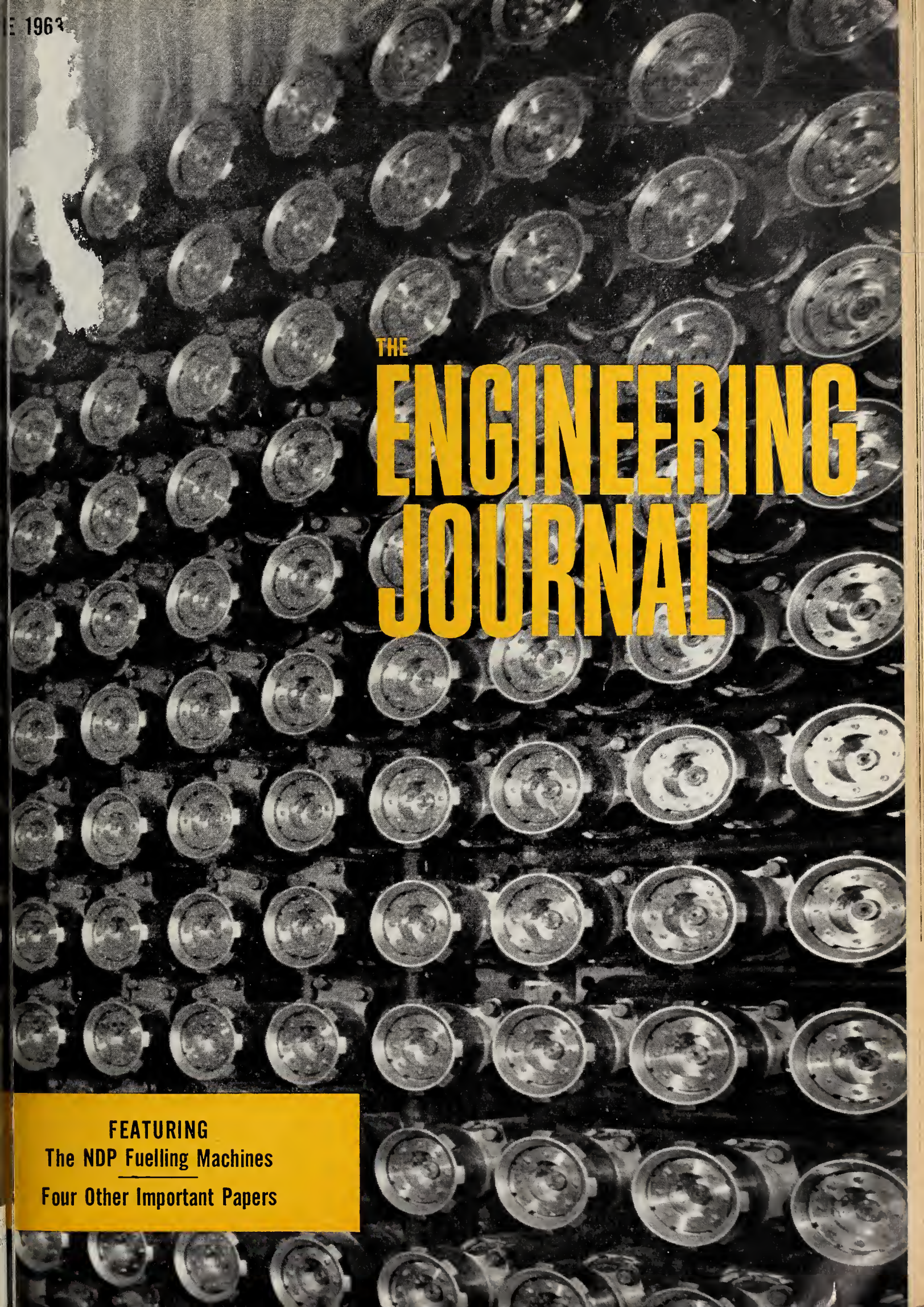
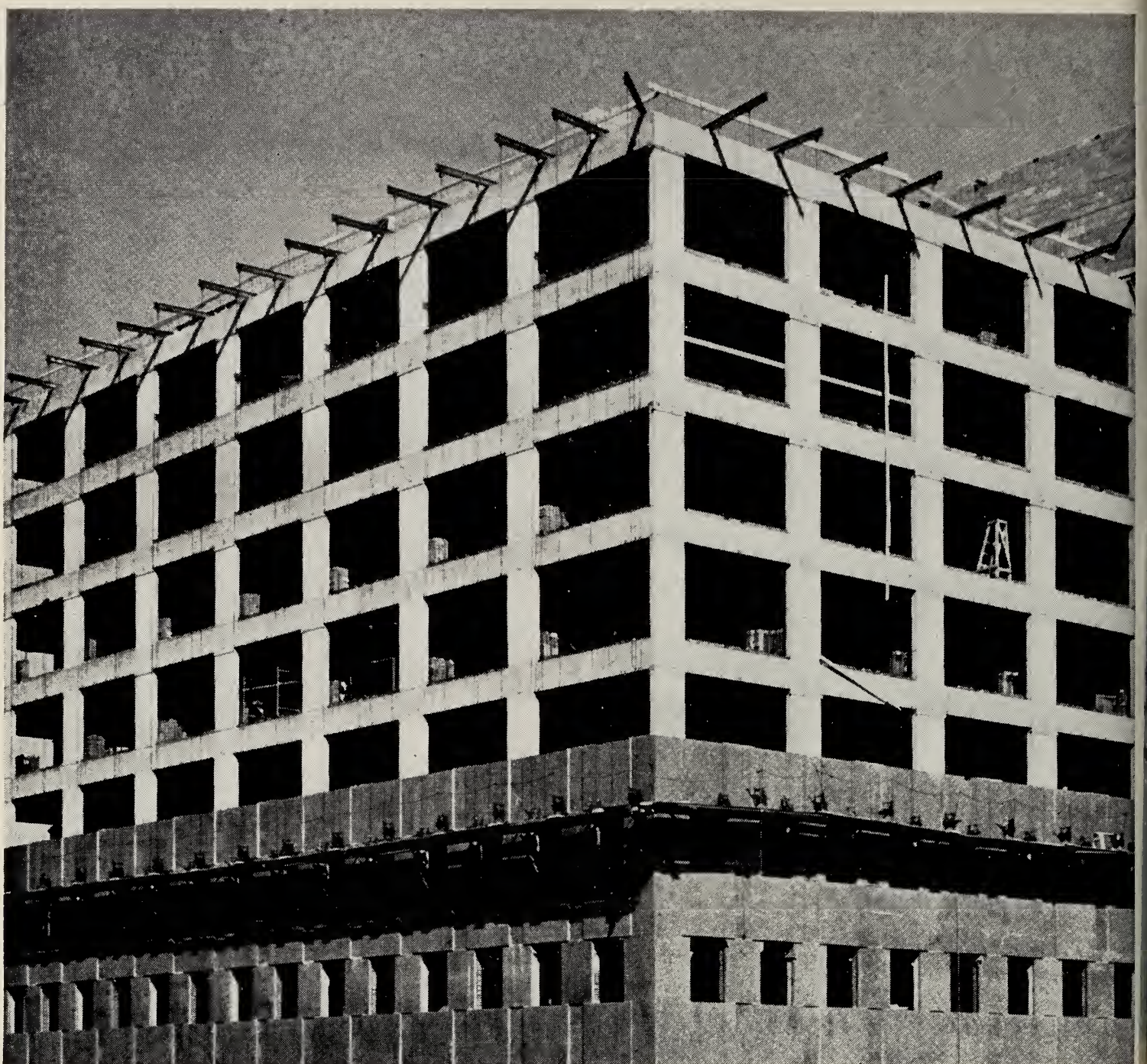


THE ENGINEERING JOURNAL

FEATURING

The NDP Fuelling Machines

Four Other Important Papers



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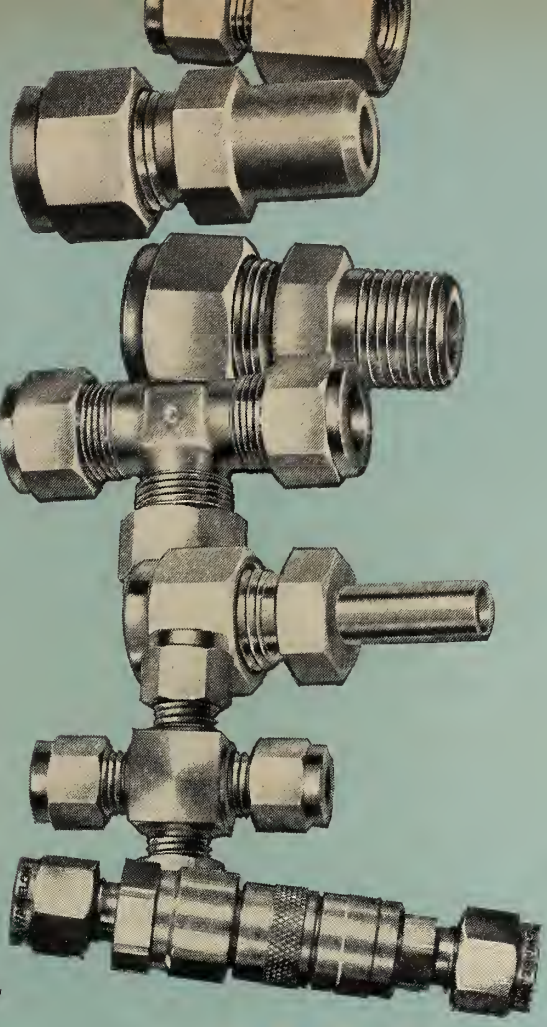

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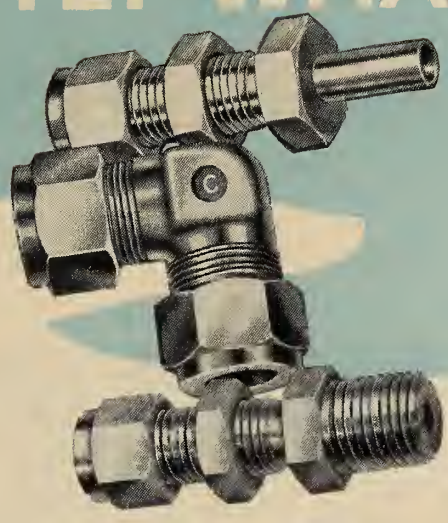

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June 1963 - Vol. 46, No. 6

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2050 Mansfield St., Montreal 2, Que., Canada

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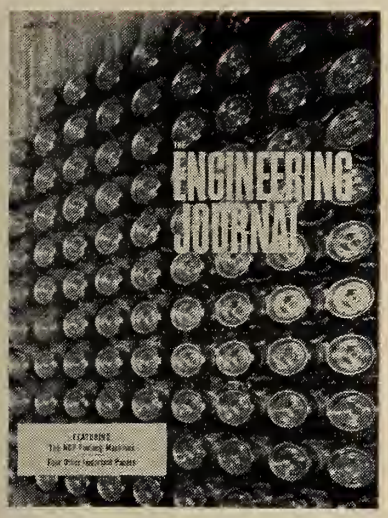

COVER ILLUSTRATION

The rather startling cover on this month's Journal is a photograph of a portion of the reactor face of the Nuclear Power Demonstration fuelling machine. Shown are most of the 132 fuel channel closures. The cover relates to the lead paper this issue — The NPD Fuelling Machines.

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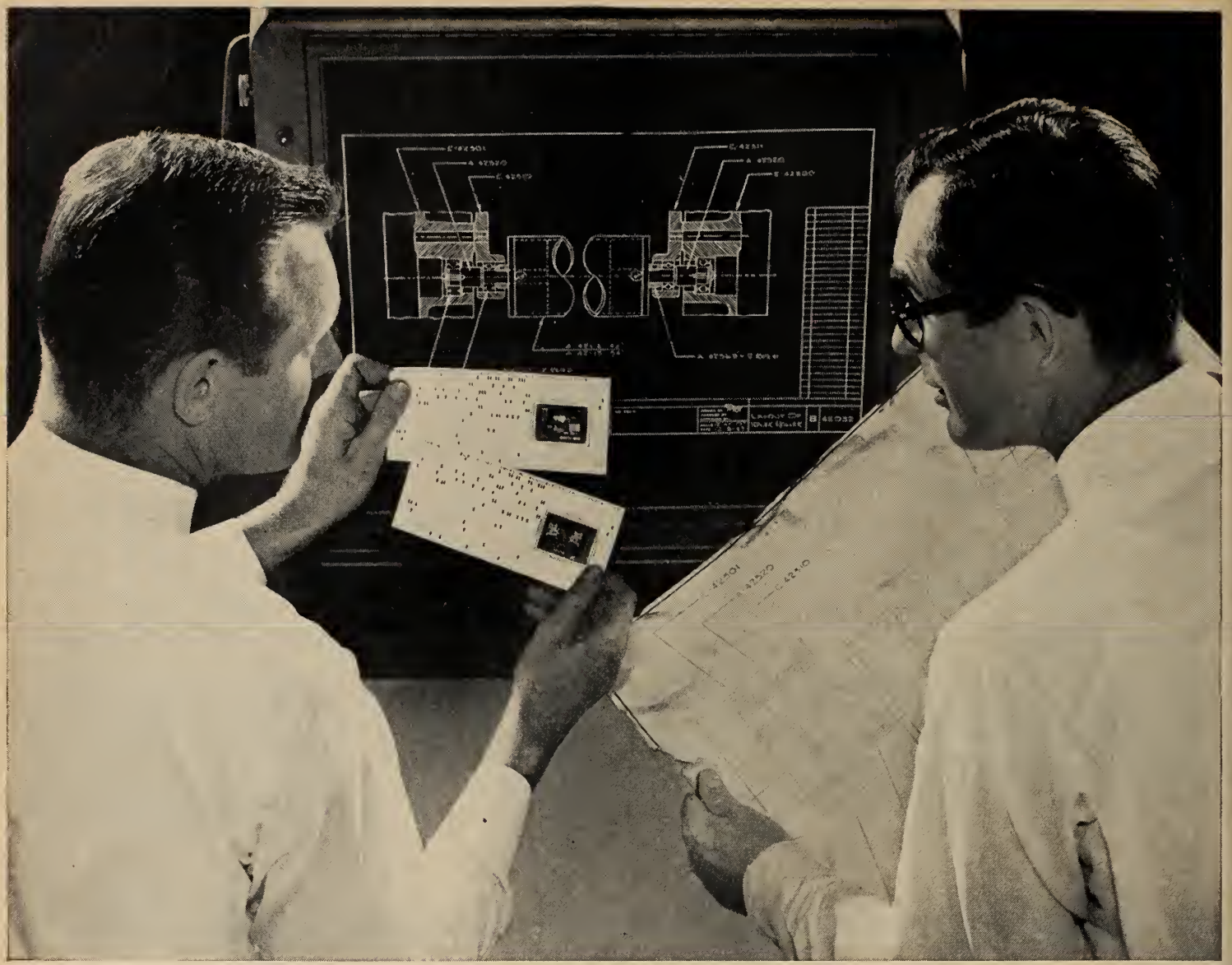

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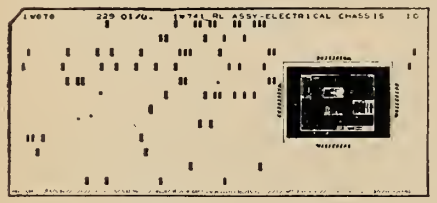

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IN THIS ISSUE

The Nuclear Power Demonstration Station at Rolphton, Ont., a joint project of Atomic Energy of Canada Limited, the Hydro Electric Power Commission of Ontario and the Canadian General Electric Company, employs two identical, semi-automatic remotely controlled fuelling machines in its on-power fuelling system. The machines handle the 3¼ inch diameter by 19½ inch long zircaloy sheathed uranium oxide fuel bundles for the NPD reactor. This paper, **The NPD Fuelling Machines,** by **W. M. Brown** of Canadian General Electric Company, describes the design, development, commissioning and operation of these machines.

G. P. Williams, M.E.I.C. of the Division of Building Research, National Research Council, Ottawa, states in his paper, **The Use of Probability Charts to Predict Ice Thickness,** that these charts were prepared by a statistical analysis of available ice thickness records. Depth of snow cover on the ice is shown to have a marked effect on the rate of ice growth. Ice thickness and latitude are found to have a slight effect on rates of ice growth. The ice growth rates are converted to heat to provide regional estimates of heat loss from natural ice covers. From the ice growth rate analysis, limits for maximum ice thickness are obtained and related to the length of the ice growth period which varies from a few weeks in the southern part of Canada, to as much as 250 days in the far north. The relationships established in this paper provide information on natural ice covers that will be useful for design purposes particularly for isolated sites where ice thickness records are not available.

In his paper, **Some Pertinent Questions Regarding Engineering Education, W. G. Heslop,** M.E.I.C., Associate Professor of Civil Engineering, The University of British Columbia, attempts to set forth his interpretation of what has been happening and to present to the Canadian engineer additional information to stimulate his interest in engineering education. Professor Heslop also urges engineers to express their approval or disapproval and to give constructive suggestions.

Hydrologic Simulation of a River Basin — An Aid in Flood Control Planning, by **I. W. McCaig,** M.E.I.C. Director of H. G. Acres & Company Ltd., Niagara Falls, Ont.; **F. H. Jonker,** Head of the Hydraulics Department with the company, and **J. M. Gardiner,** M.E.I.C., Project Engineer also with the company, reviews briefly the history of hydrologic techniques, illustrating the trend to development of methods which take a greater account of the natural runoff processes. A computer program which has been used to simulate the hydrologic characteristics of a river basin is described, and the methods used in calculating runoff from rainfall and snowmelt, and in routing flows through valley storage, lakes and reservoirs are outlined.

Examples of the accuracy of the results which can be obtained using the computer program are given. Hydrologic studies in which the simulation can be used with advantage are discussed.

In his paper, **The Canadian Topside Sounder Satellite Engineering Performance, R. K. Brown,** of the Defence Research Telecommunications Establishment, Ottawa, gives a summary of the main design features and design objectives which enable an evaluation of the spacecraft's performance. The spacecraft contained a primary experiment, ionospheric sounder and three secondary experiments — the energetic particle detectors, a very low frequency receiver and a cosmic noise experiment. To meet the objectives of these experiments, three distinct designs were required—electrical, thermal and mechanical. These are summarized in the paper. The paper reports the performance of the scientific experiments and the telemetry, command and power supply subsystems. The mechanical performance during lift-off and injection and the thermal performance in space is described.

ACTION!

Mr. Russ Hogue, Plant Superintendent at Pepsi-Cola's Ottawa Plant

For Speed and Efficiency PEPSI-COLA calls on JOHNSTON MATERIALS HANDLING EQUIPMENT . . .

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In its Ottawa operation, Pepsi-Cola uses BAKER HI-TAILERS for warehousing, loading, and unloading its fleet trucks. Greater efficiency is realized thanks to improved performance and drivers praise their fast smooth operation.

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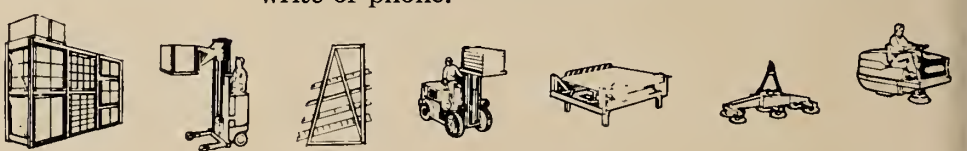

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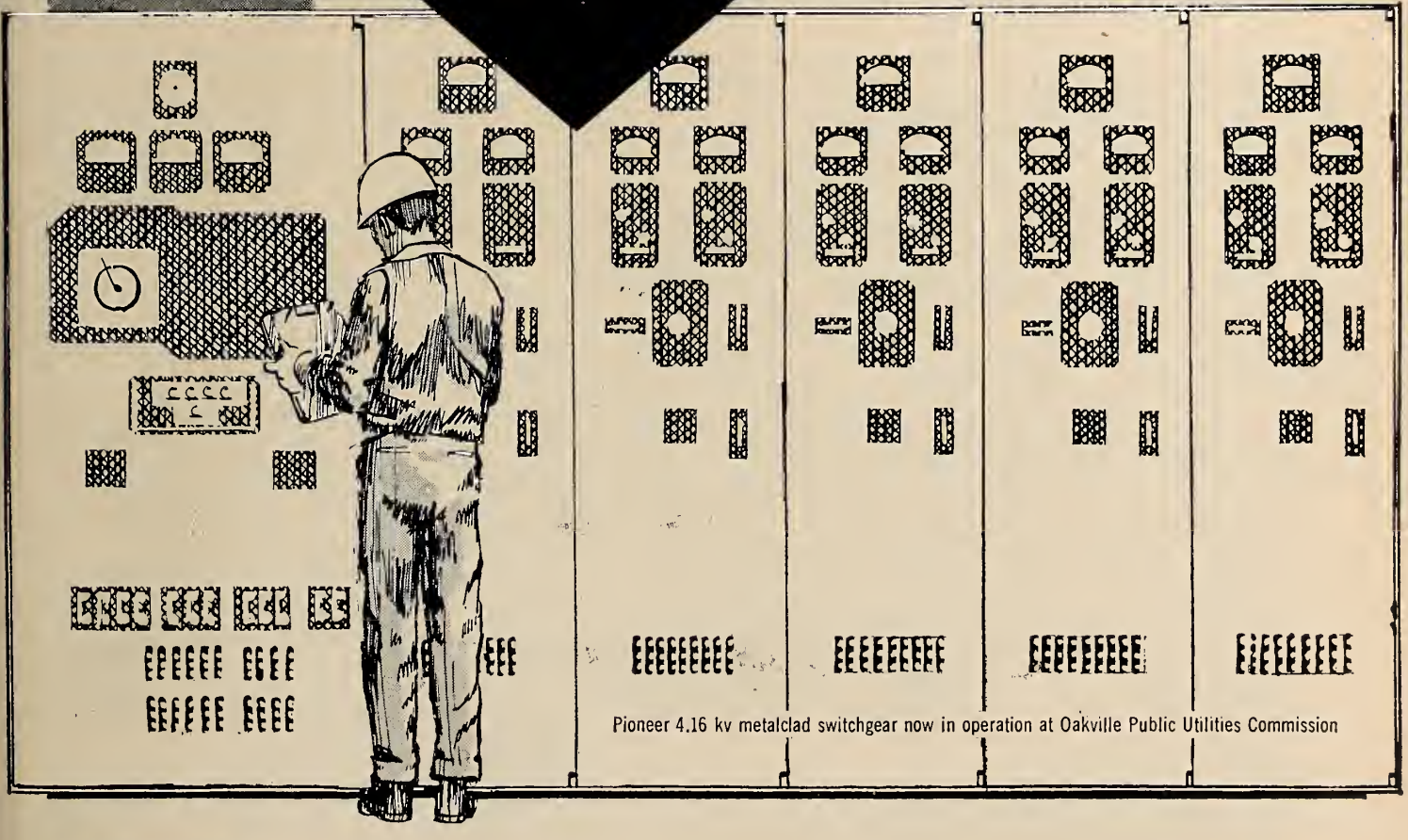

Pioneer 4.16 kv metalclad switchgear now in operation at Oakville Public Utilities Commission

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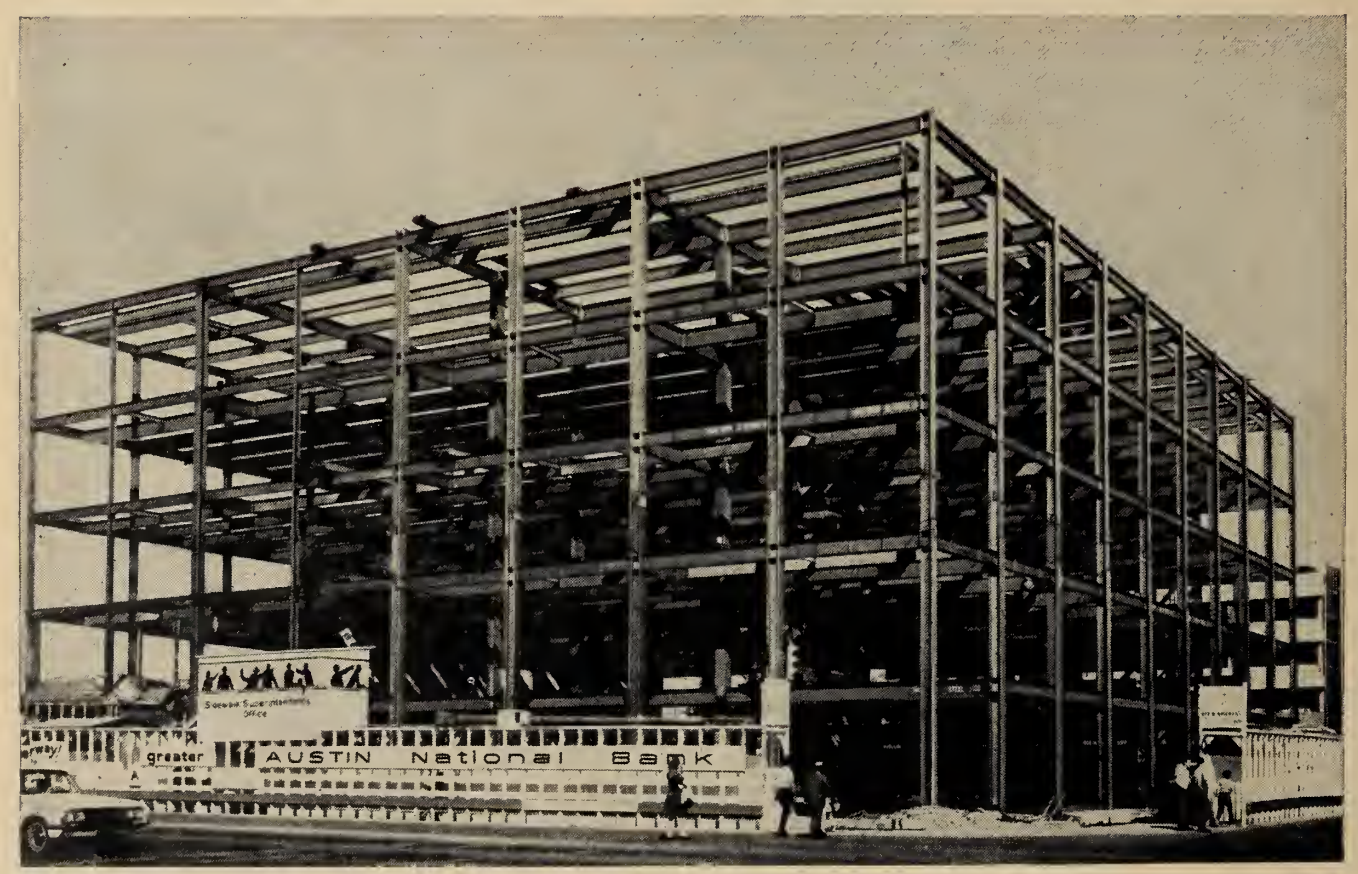
New second story is hung

All-steel second-story addition includes high-strength-bolted 460-ton structurol frome, steel joists, Slobform for roofing ond flooring, ond exteriar steel ponels. Bethlehem supplied most of the steel for this job.

Designed in steel to grow



Scheduled for completion early in 1963, the Austin Notionol Bonk Building will be sheothed with natural color oggregate sections ond verticol metol sun shields.

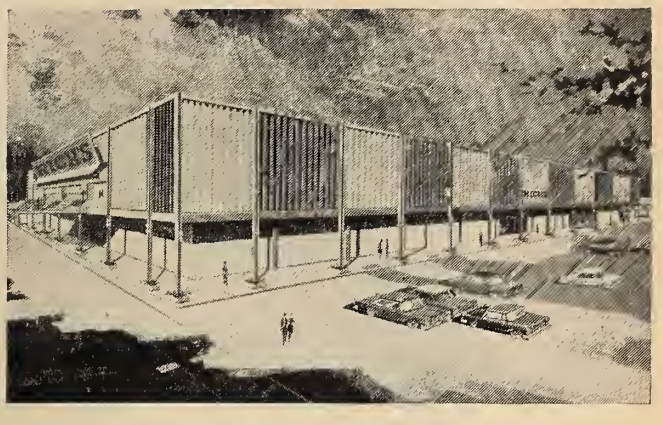
from steel trusses

The original one-story Belvedere Plaza branch store of Rich's, Inc., Atlanta, wasn't designed with expansion in mind. But expand it must . . . vertically . . . and without interfering with the normal operation of the store.

How to do it? First thought was to strengthen the existing foundation and frame to carry the weight of the new second story. But this proposal proved too expensive.

It was then decided to put a new building in the air immediately above the old building. So they (1) went outside the old building with new foundations, (2) erected steel columns to support steel trusses over the existing structure, and (3) hung the new second story from the trusses (the new roof is at the top chord of the trusses).

Everything worked out fine. No additional load was put on the old building. The store added 47,000 sq ft of floor space—*economically*. And it stayed open for business all through the new construction; all the steelwork was erected at night and on Sundays in less than two weeks.



Architects: Stevens & Wilkinson.
Engineer: Jock K. Wilborn.
General Contractor: Botson-Cook Company.
Fobricotor: Trojon Steel Corporotion.
Erector: Jimmy Hurst Steel Erectors, Inc.

Steel

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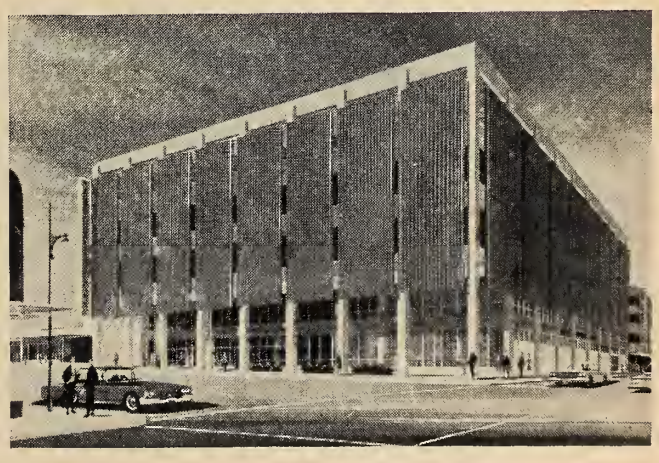
... economy
... versatility

from 5 to 22 stories

The Austin National Bank Building is the first multi-story structure to be built in Austin, Texas, in 20 years with a steel frame, rather than on a reinforced concrete skeleton.

Reasons for return to steel: (1) economy, thanks to higher-strength A36 steel, Bethlehem lightweight shapes, and a continuous welded frame, (2) "thinner" steel columns, which will provide maximum usable floor space in the future multi-story portion (three-column two-bay framing system), and (3) the ease and economy of adding on to a steel frame.

Although the building will have only five stories in its first phase of construction, the foundation and the steel frame are designed to support 22 stories. It will be a simple matter to tie in the new steel to the existing structure at a later date.



Architects and Engineers: Page, Southerlond & Page.
Associate Architects: Fehr ond Gronger.
General Contractor: Rex D. Kitchens Construction Co.
Fabricator: Tips Iron & Steel Co. (1,035 tons).
Erector: F. B. McIntire Erection Co., Inc.

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- 170 University Avenue, Toronto 1, Ontario.

A. L. Murray, Marine Building, Vancouver, British Columbia.

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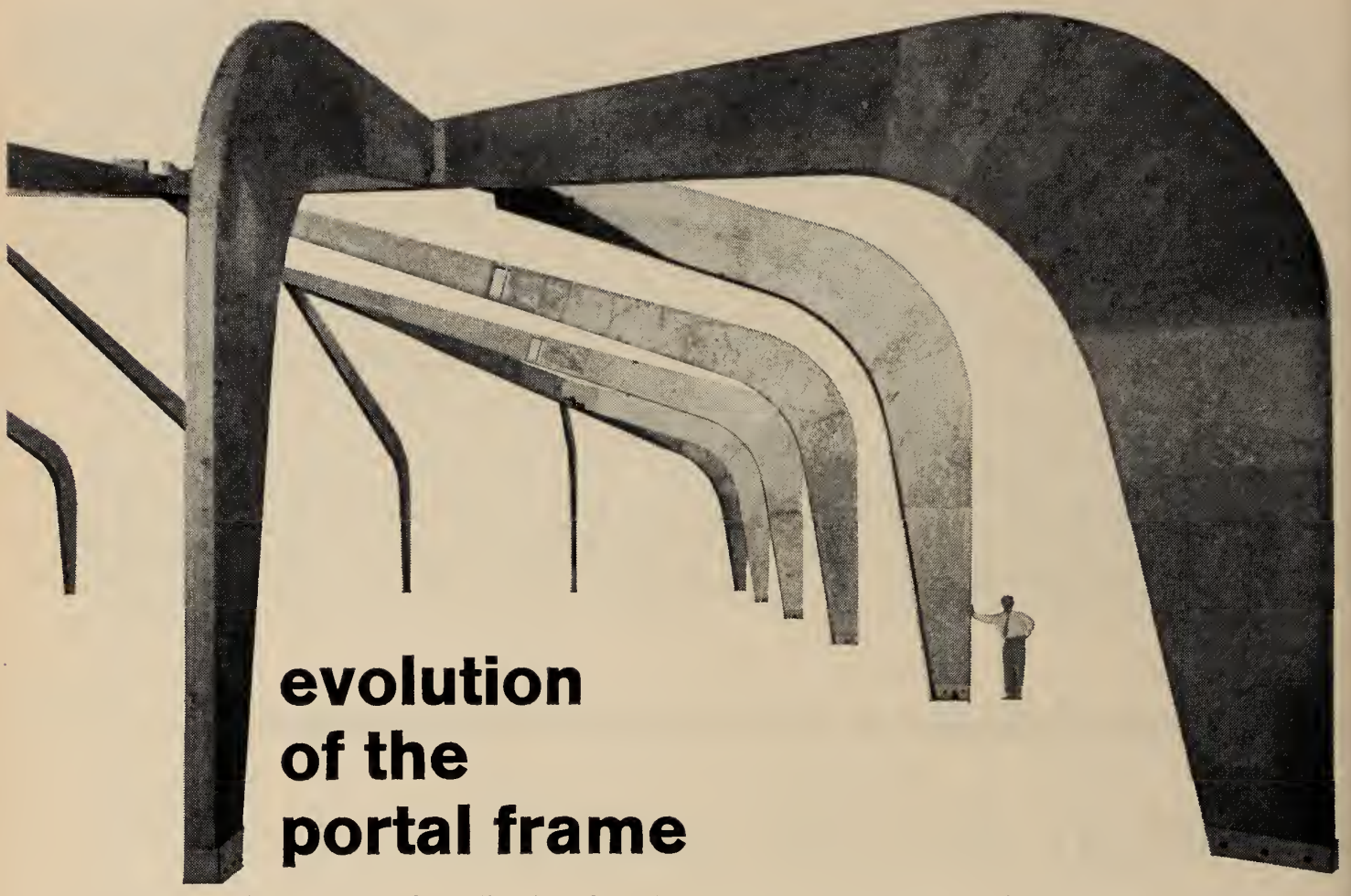

evolution of the portal frame

A wider range of application for plywood portal frames was indicated by the recent use of giant size frames in Sunderland, England. The huge plywood components served as supporting members in covering a 12,000 square foot playing field. The combination of plywood's light weight and structural strength proved an ideal solution to a load bearing restriction (imposed because of a feared subsidence cleavage at the site). In all, 20 portal frames were constructed. The largest, 62 feet in length, stretch from the 4 corners to a central 22 square foot area of plywood box beams. Of the others, placed around the perimeter, 8 are 44 feet long, the remainder 22 feet in length.

A new method of construction was employed in producing frames of this size, beginning with fabrication of a simple box core using 7″ x 2″ softwood members, with ⅜″ plywood both sides. Prelaminated chords were then glued to top and bottom of this core and, after planing, the entire structure was covered with a further skin of ⅜″ plywood. Finally, the portal frames were finished with polyurethane varnish.

The use of large plywood portal frames enabled construction of a covering area of the required size, within the limitations imposed and at a low cost. As a further step in development of this form, it indicates the increasing value of the portal frame as a structural and design element. Information about structural uses of fir plywood is available from the Association field offices.

Covering structure for the Sunderland playing field is the work of H.C. Bishop, A.R.I.B.A., and A. R. F. McGahan, A.M.I.C.E., A.R.I.B.A., A.I.W.S.C.

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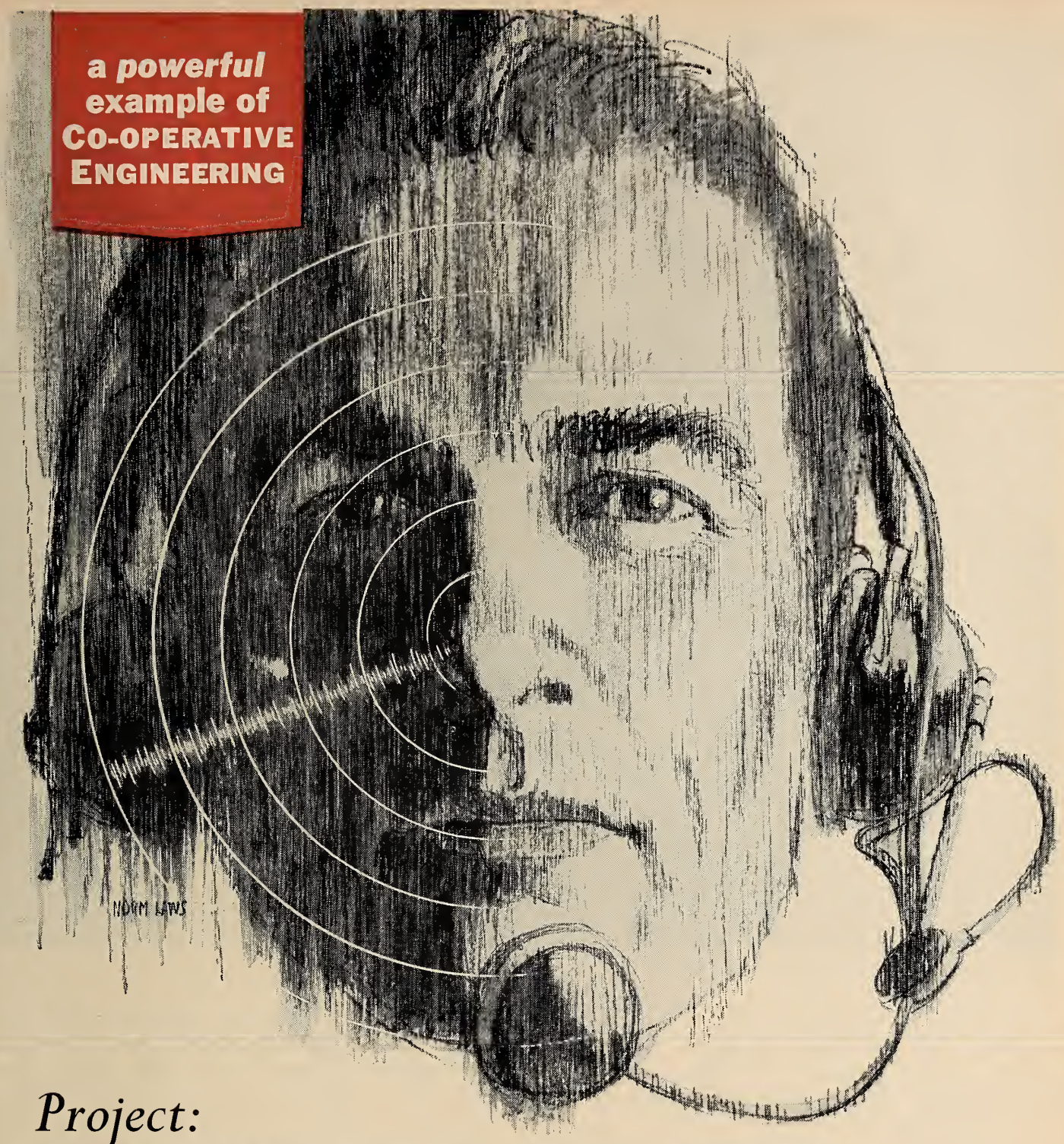

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The time lag is calculated, and if there's the slightest variation the pilot and his aircraft are in trouble. So the characteristics of the cable must remain constant, year in, year out, season after season.
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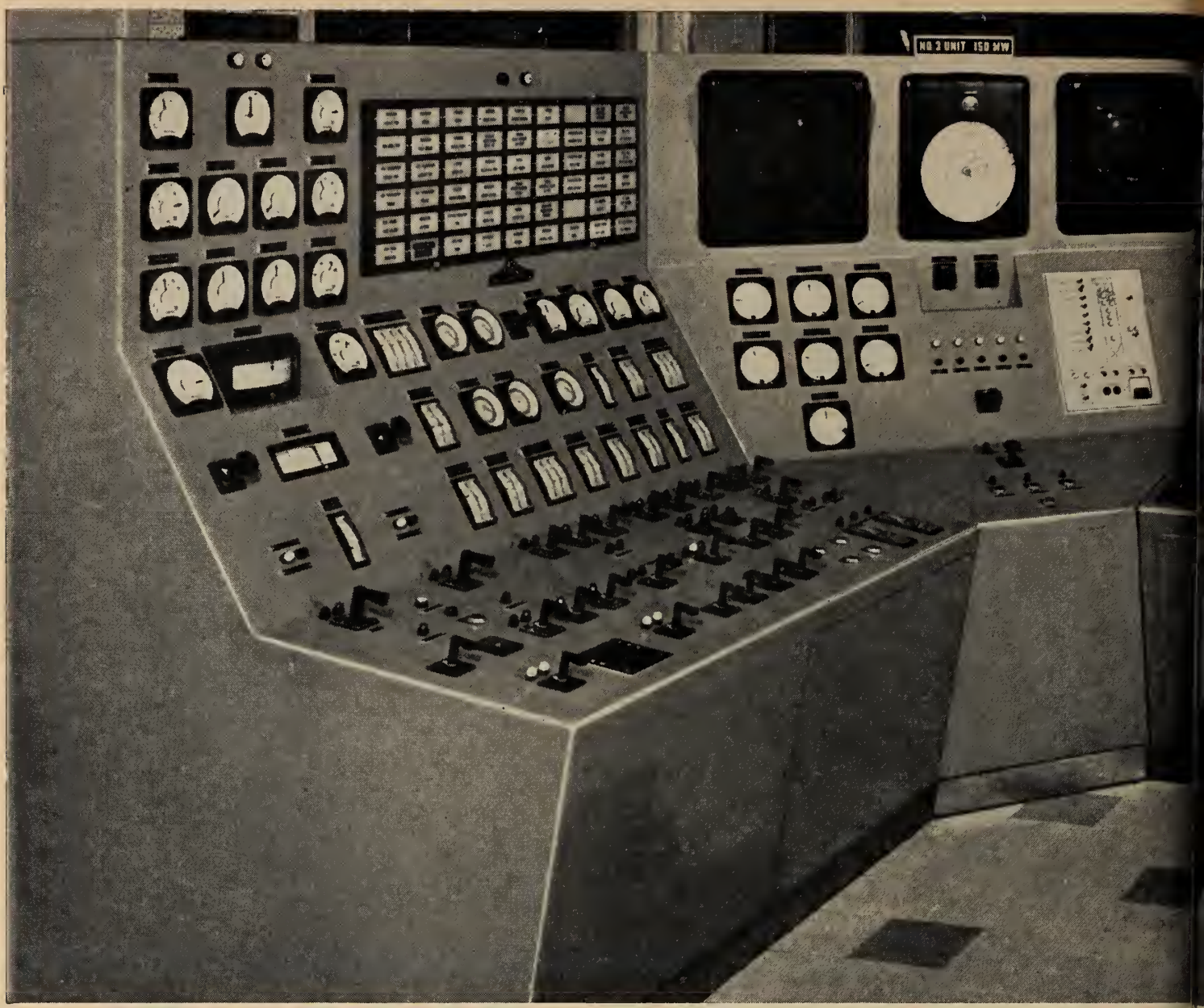
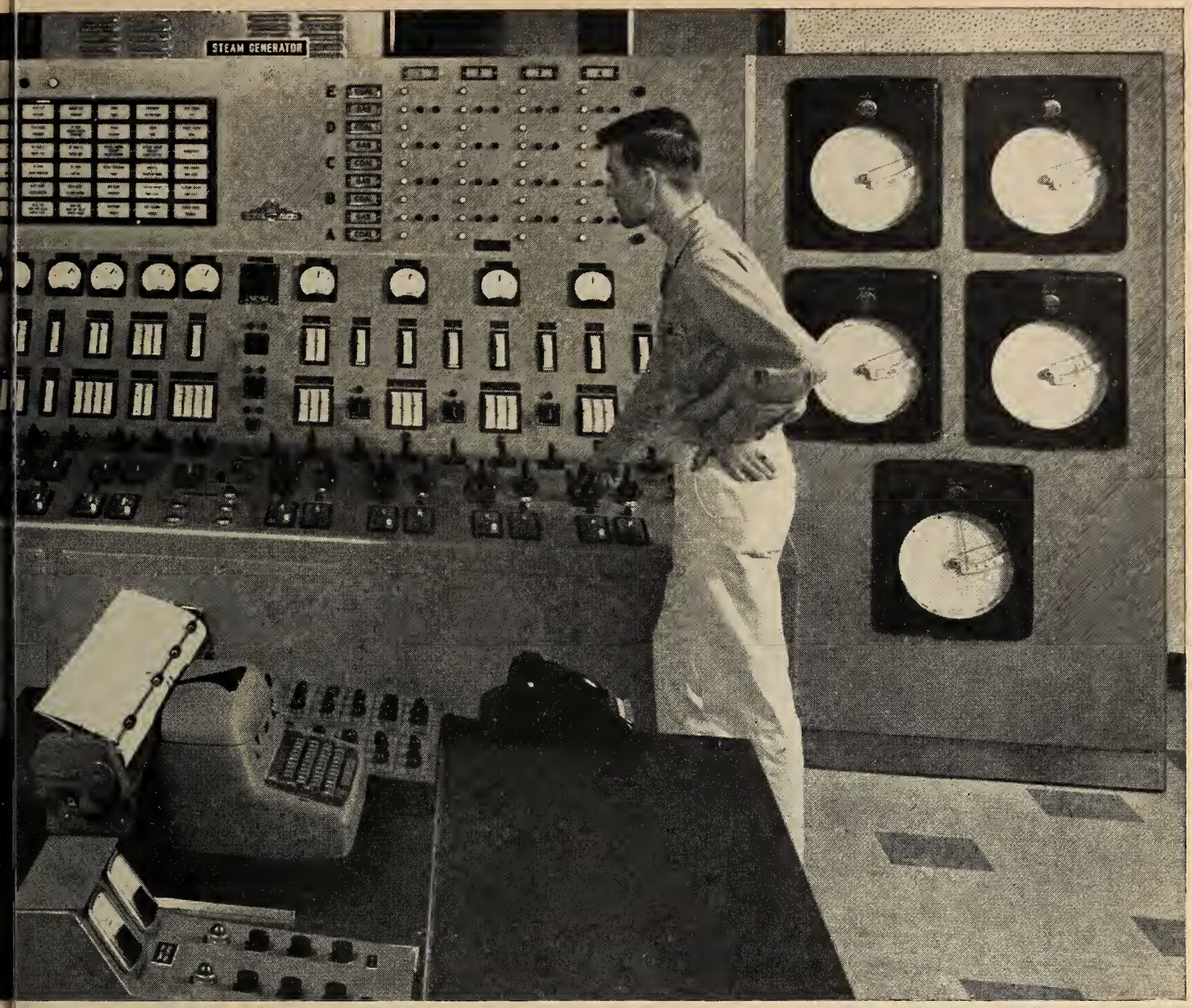


Bailey 720 Electronic Controls at Calgary Power Ltd., Wabamun

First solid-state electronic boiler control operating in a Canadian utility



Consulting Engineers: Montreal Engineering Company Limited, Montreal

Bailey 720 solid-state electronic boiler control at algary Power Ltd. is a Canadian first! In October 1962, o. 3 Unit at Wabamun Thermal Station was successlly commissioned, placing into operation the first olid-state electronic combustion, feedwater and steam mperature controls in a Canadian utility.

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They are built in various types, and the series-produced standard models cover the wide performance range without gaps. The principle of standardized interchangeable components has been consistently applied, resulting in:
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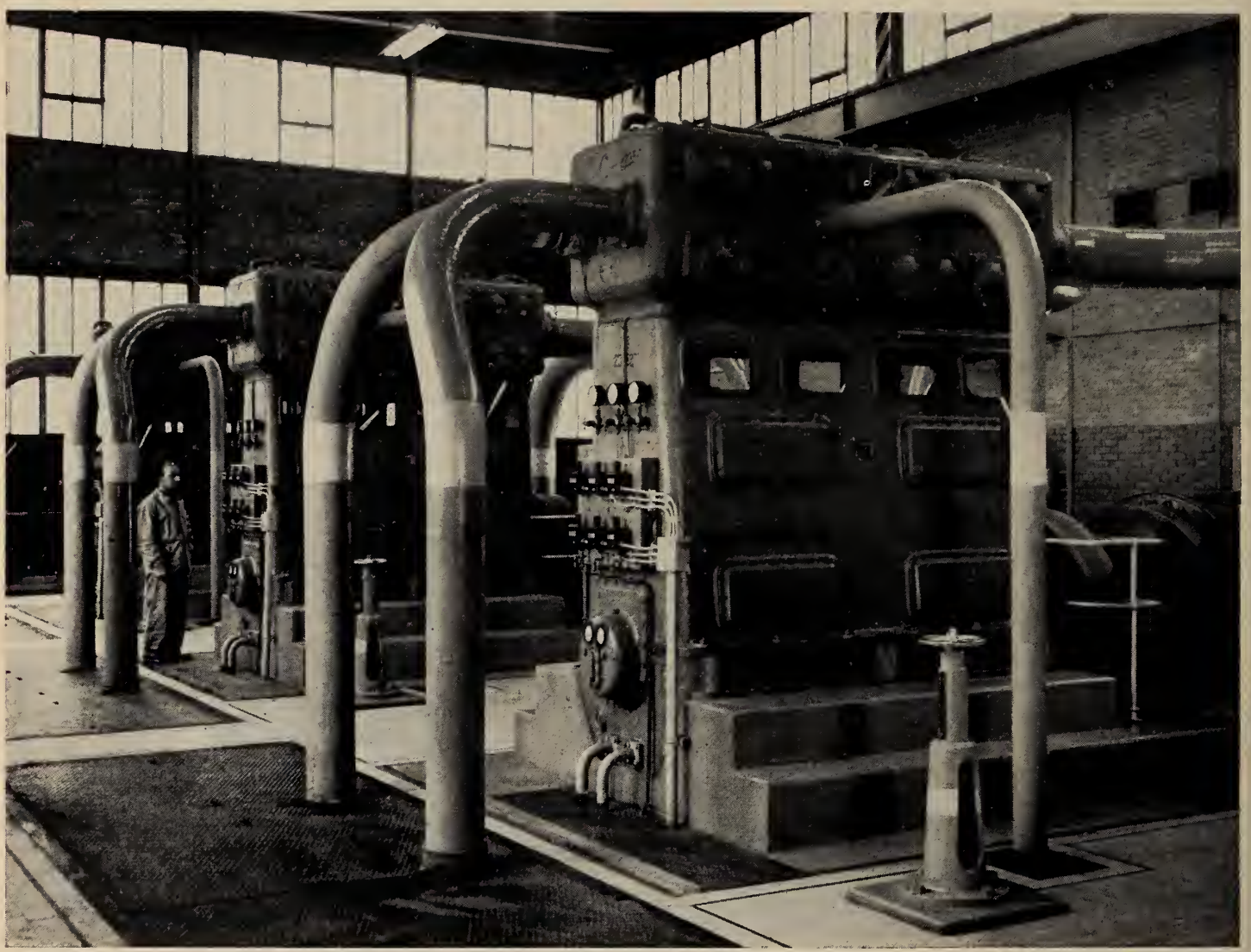

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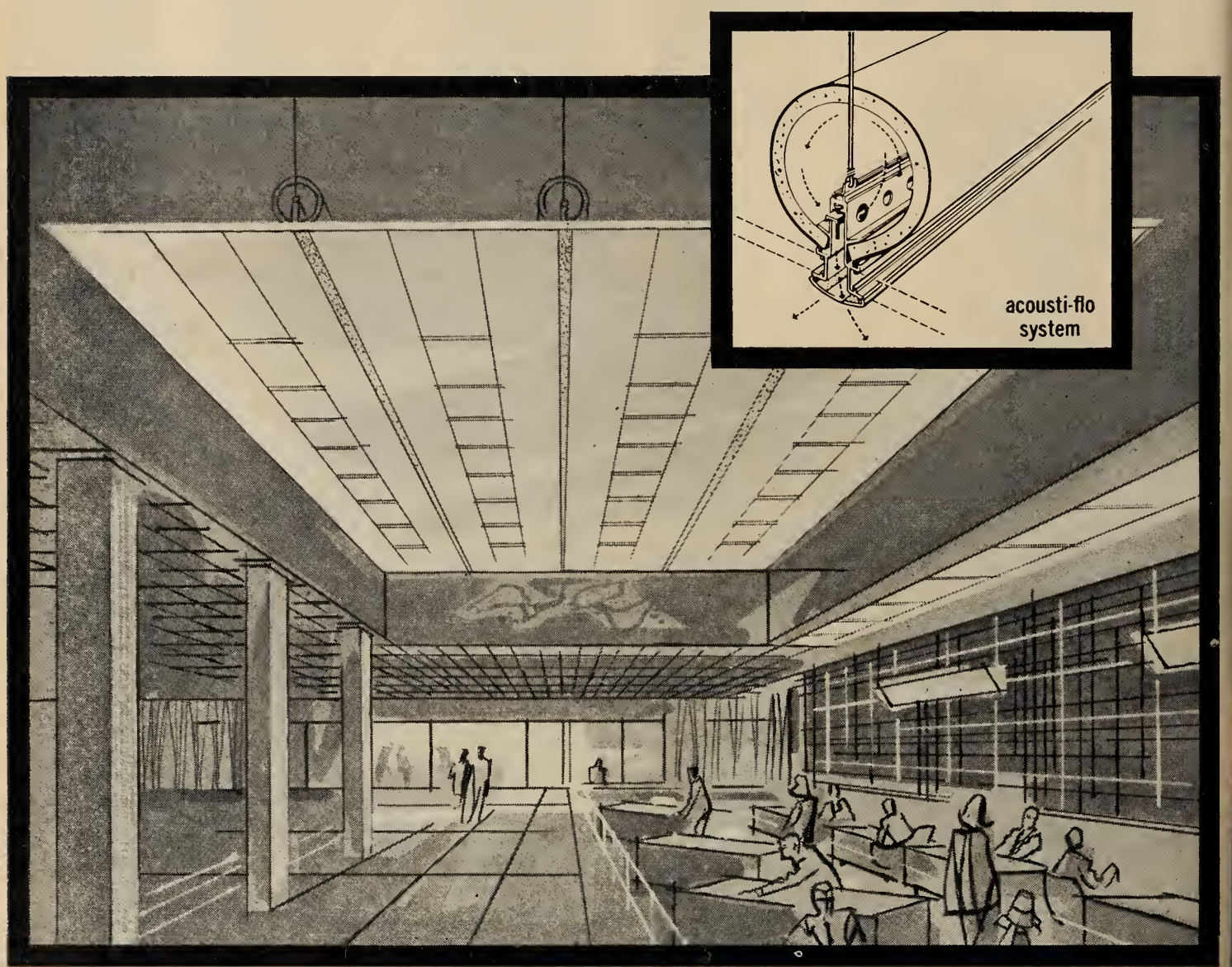

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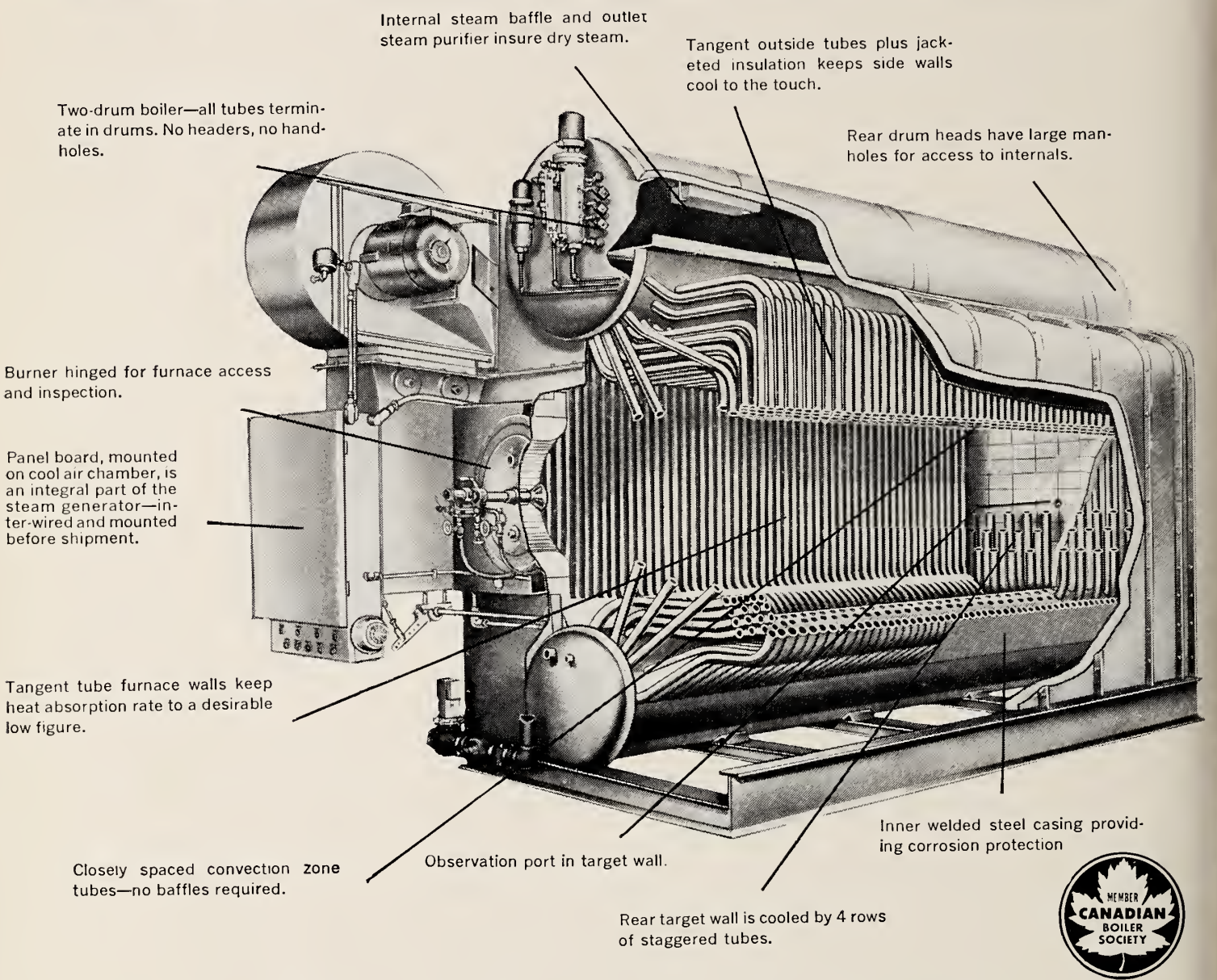

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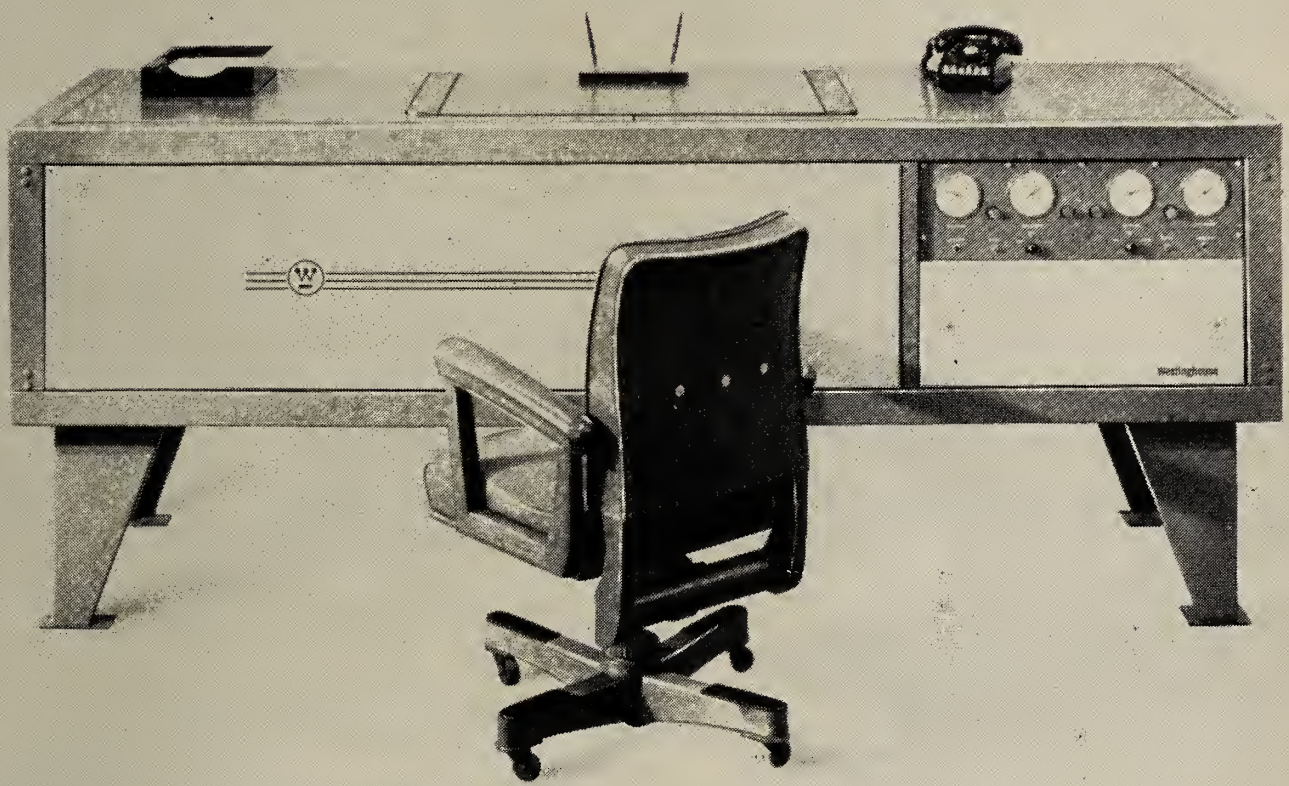

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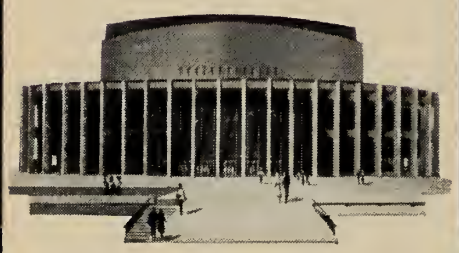

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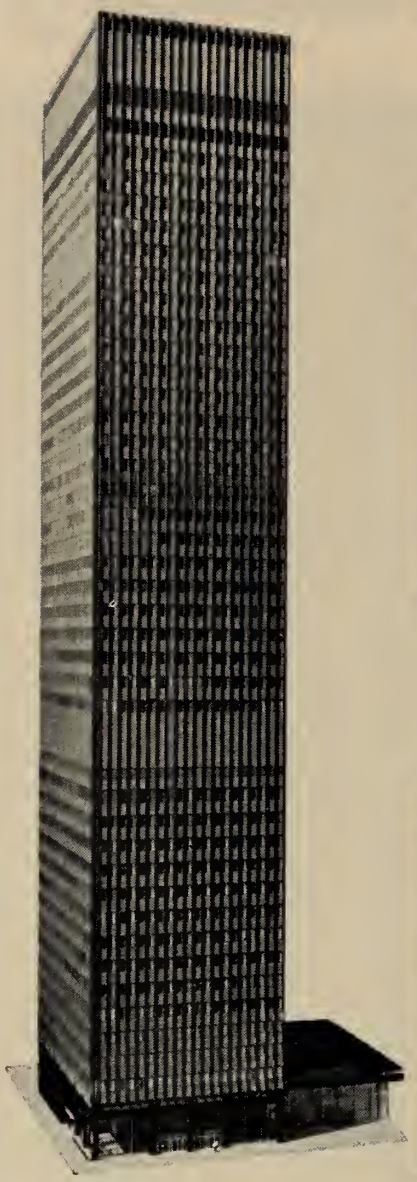

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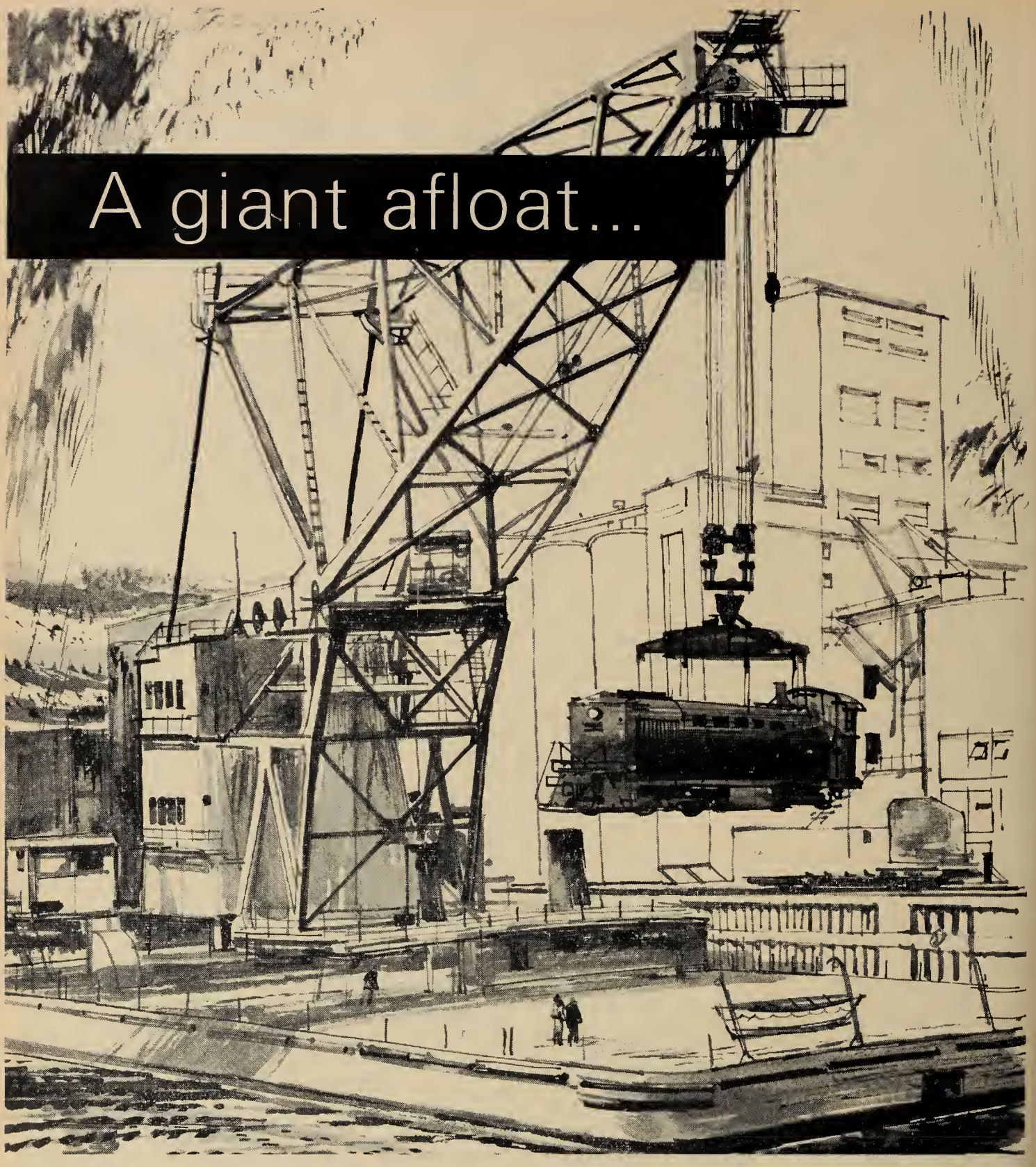

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The NPD Fuelling Machines

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Manager, Equipment Engineering Unit
Civilian Atomic Power Department
Canadian General Electric Company Limited
Peterborough, Ont.

THE 22 MWe NUCLEAR Power Demonstration Reactor, NPD, being operated by Ontario Hydro at Rolphton on the Ottawa River, employs two semi-automatic, remotely controlled fuelling machines in its on-power fuelling system. Although on-power fuelling of reactors is not a new venture, NPD is the first pressurized heavy water cooled power reactor to be so equipped. The provision of safe, reliable fuelling machines to operate remotely in a highly radioactive environment is at best a difficult task. When, in addition, the machines must also remotely break into and become part of the pressure boundary of an 1100 p.s.i.g., 500°F heavy water system, the difficulties are compounded, especially when considering heavy water costs of the order of $25 per pound. However, the attractions of on-power fuelling for use in Canada's power reactor program, especially in the interests of increasing fuel burn-up and station availability, led to the decision to demonstrate its feasibility in the NPD station. The decision was further influenced by other potential operating advantages such as reduction in thermal cycling of plant components, ability to quickly remove identified faulty fuel and avoidance of staff peaking during reactor maintenance shut-down periods.

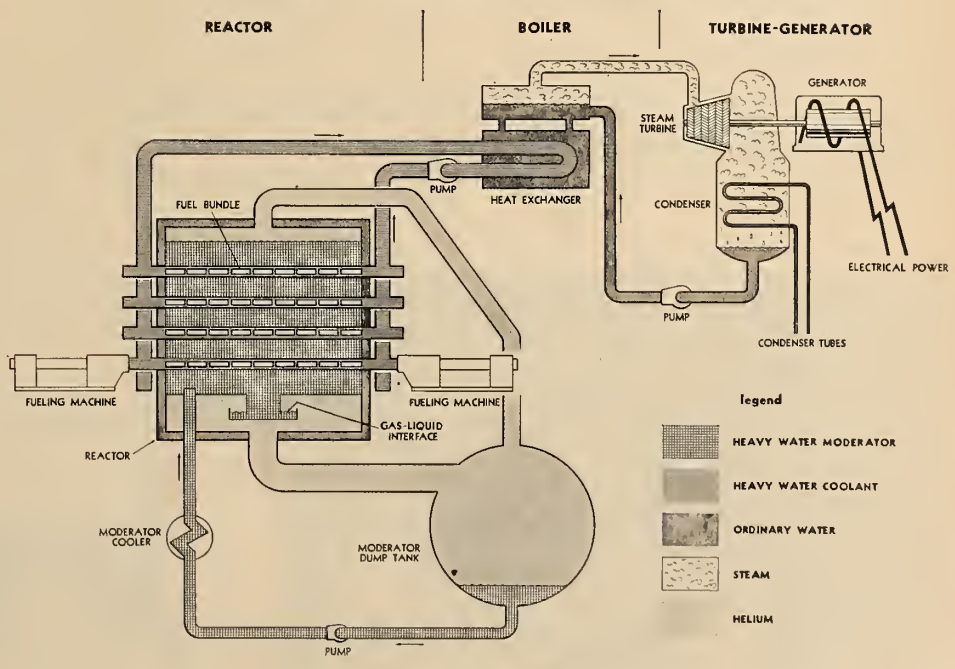
The requirements for fuelling machines for any reactor are naturally dictated by the fuel, its operating environment and its residence time and configuration within the reactor. Fuel for the NPD reactor is in the

Fig. 1 19 Element NPD Fuel Bundle

form of 7 and 19 element bundles of zircaloy sheathed, natural uranium dioxide pellets. Figure 1 shows a 19 element bundle. The bundles are approximately 3¼ in. O.D. by 19½ in. long and weigh in the order of 35 lb. Nine of these fuel bundles are contained in each of the reactor's 132 horizontal fuel channels. As graphically illustrated by Fig. 2, heat is extracted in the reactor from the bundles by heavy water coolant at approximately 1100 p.s.i.g. which enters the channels at 485°F and leaves at 530°F.

For the first year and a half to two years of operation, NPD will not require addition of fresh fuel. However, periodic shifting of fuel bundles within the core is required as an aid to reactivity control. During this

Fig. 2 NPD Graphic Flow Diagram



NPD FLOW DIAGRAM

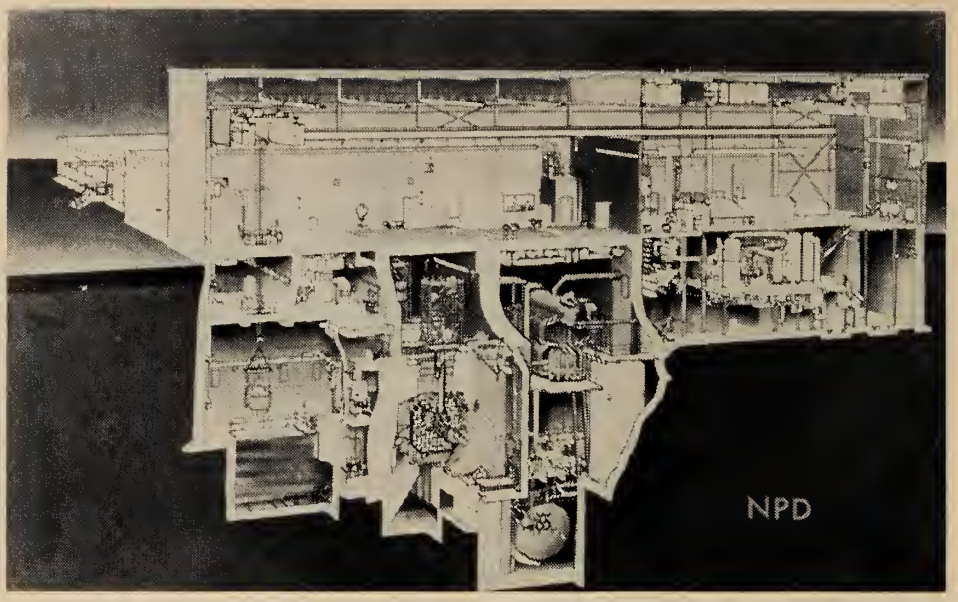


Fig. 3 Cut-Away of NPD Station

period, fission products gradually build up in the fuel until their neutron absorbing capacity is about balanced by the neutron producing capacity of the remaining fissionable material. Once this so called equilibrium core condition is attained, fresh fuel must be added and old fuel removed at the rate of between one and two bundles per day.

To satisfy the requirements of reactor operation, the fuelling machines must therefore carry unirradiated fresh fuel bundles to the reactor, break into the pressure boundary of the 1100 p.s.i.g., 530°F heavy water system, shift fuel bundles within a channel or from one channel to another, and finally, carry irradiated spent fuel bundles from the reactor to safe storage. Because of the highly radioactive environment, all these functions must, of necessity, be carried out by remote control with the operating personnel protected by heavy biological shielding.

In NPD, these fuelling functions are carried out by two identical machines which normally operate simultaneously on opposite ends of the same reactor fuel channel as shown graphically by Fig. 2. Each machine can act in a fuel charge or discharge capacity. For normal fuelling, one fresh fuel bundle is inserted into the channel from the charge machine. This action pushes all the fuel in the channel along one bundle length and ejects a fully irradiated spent fuel bundle into the discharge machine. In the interest of achieving maximum burnup from each bundle, adjacent channels are normally fuelled in opposite directions so that fresh fuel with excess reactivity will be adjacent to less reactive old fuel, and therefore extend its useful life.

Figure 3 is a cut-away illustration of the NPD station. The East fuelling machine is visible in its entirety in the foreground. Only the top of the West machine can be seen. The machines are constructed with traversing elevator carriages and operating heads which are suspended from the carriage elevators by vertical telescoping tubes. Each head has a capacity for five fuel bundles. When in operation on the reactor, the heads are lowered into the reactor vault as illustrated by the East machine in Fig. 3. Ninety degree azimuth rotation drives on the telescoping support tubes, permit rotation of the heads in the vault to align them with the reactor fuel channels. When not in operation, the machine heads are raised out of the vault and separated from it by remotely operated shielding gates. The fuelling machine room, in which the two machines reside, is normally accessible to station operating personnel when these gates are closed. Fresh unirradiated fuel bundles are loaded into the operating heads from special ports in the walls of the fuelling machine room. Irradiated spent fuel bundles are discharged in the reactor vault from the operating heads to inclined chutes which lead from each end of the vault to the water shielded spent fuel storage bay. These chutes are illustrated on Fig. 3. Controls for the fuelling machines, new fuel loading ports, shielding gates and spent fuel discharge chutes are integrated and interlocked and are located in the main station control room. A set of maintenance controls are located adjacent to each fuelling machine but outside the fuelling machine room shielding walls.

Figure 4 shows the two machines, with heads retracted, in the fuelling machine room. Also visible in the illustration are the closed shielding gates, one of the new fuel loading ports and, in cut-away, a portion of the shielding above the partially visible reactor vessel. The track assembly leading from the fuelling machine room to the spent fuel bay room, is available for remote transfer of fuelling machine heads to an underwater dismantling facility which could be used if excessive radioactive contamination of the heads occurred.

In a typical fuelling operation, the operator in the control room charges the required number of new fuel bundles into the head of the East machine from the new fuel loading port. Normal equilibrium fuel requirements, as mentioned previously, are

Fig. 4 General View of Fuelling Machine Room

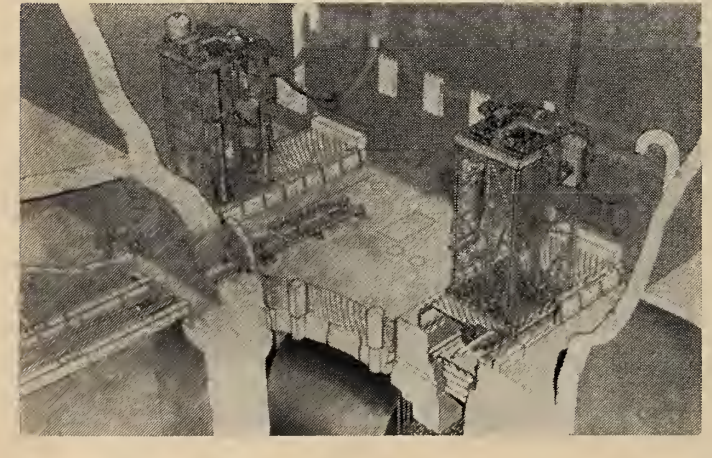
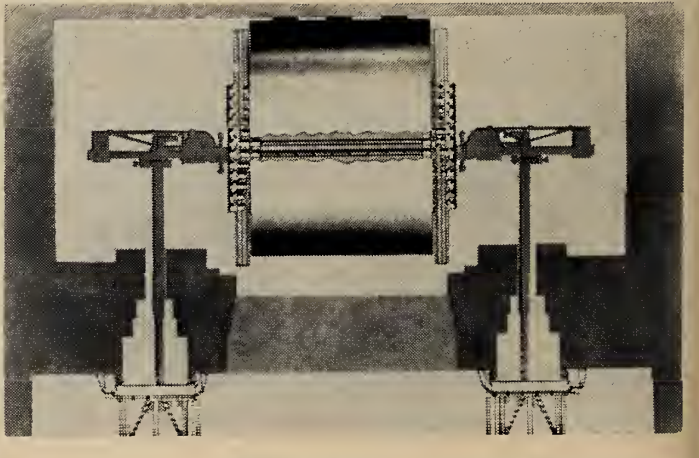


Fig. 5 Fuelling Machines on Reactor



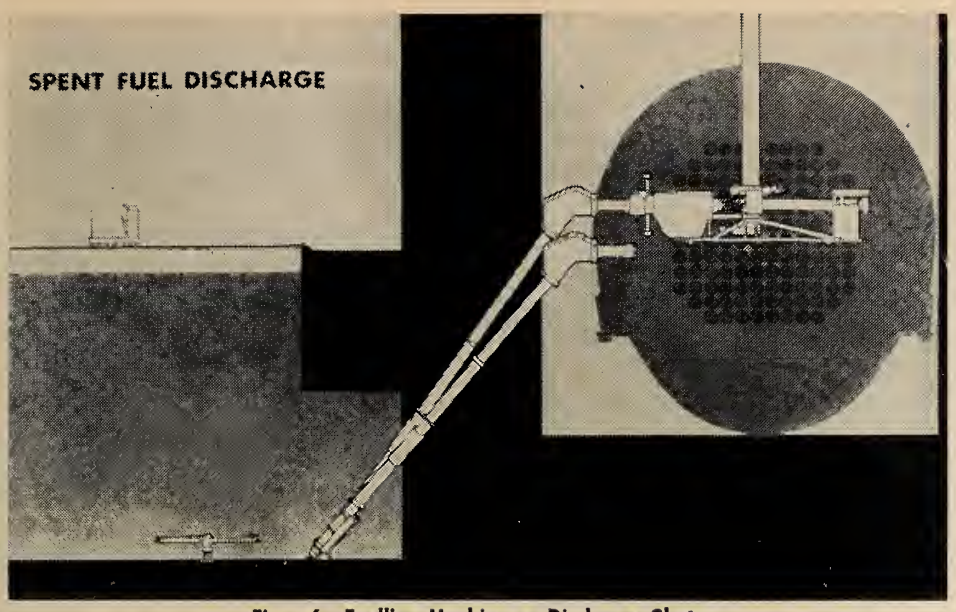


Fig. 6 Fuelling Machine on Discharge Chute

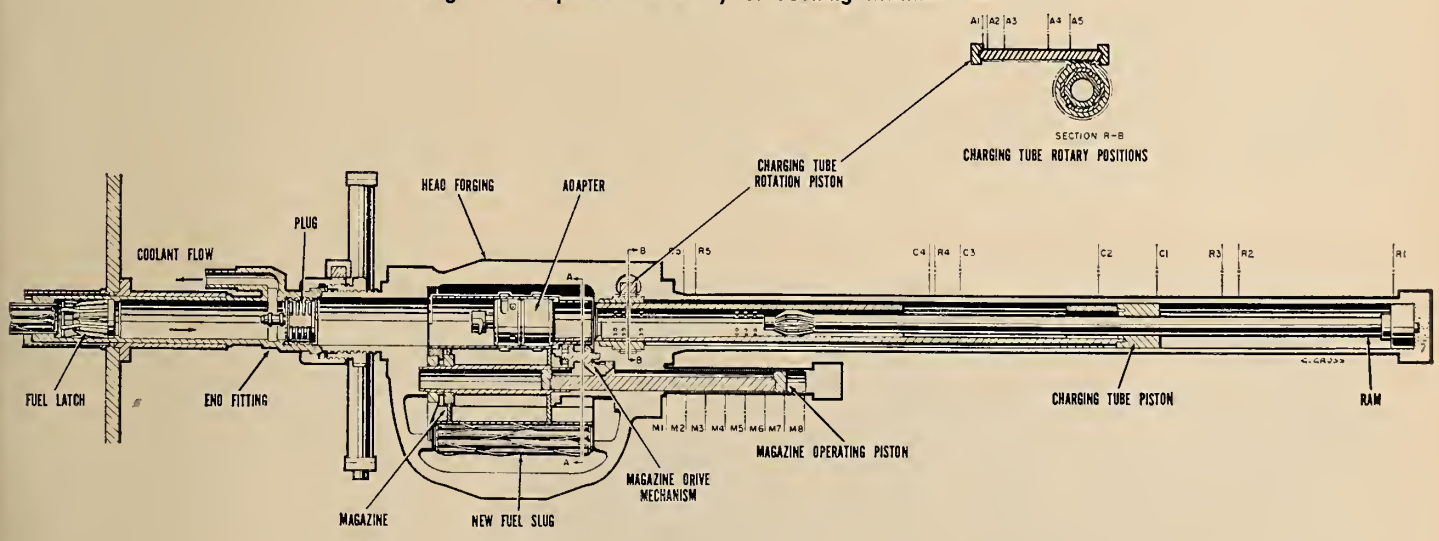
between one and two bundles daily. After automatic checks on ventilation control and personnel safety, the shielding gates are opened and the heads lowered through floor slots into the reactor vault where they home and lock on to opposite ends of the selected reactor fuel channel as shown by Fig. 5.

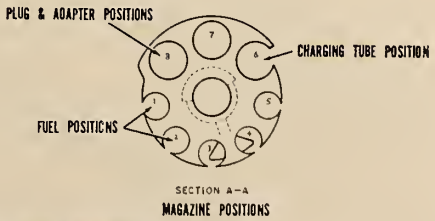
After the heads are filled and pressurized with heavy water, internal mechanisms in the heads remove and store the closure plugs from the ends of the reactor fuel channel. The East head then charges a new fuel bundle into the channel with the resultant receipt of an irradiated spent fuel bundle by the West head. Both heads then replace the respective channel closure plugs, cool down, depressurize and drop their heavy water levels to prevent overflow but to still retain sufficient for cooling of stored spent fuel bundles. The heads are then disconnected from the channel ends. If this completes the fuelling requirements for the day, the East head returns to the fuelling machine room and the West head rotates and seals to the vault end of the spent fuel discharge chute as shown by Fig. 6. After discharge of the irradiated spent fuel bundle to underwater storage, the West head is disconnected from the chute and returns to the fuelling machine room. The fuelling cycle is completed by the closing of the shielding gates beneath the retracted heads. All fuelling steps are controlled by the operator in the control room but sequences within steps are fully automatic. In addition to the straight-through cycle just described, the machines are also capable of recycling fuel bundles between channels and of moving fuel in the reverse to normal direction. Indication of a fault in a new fuel bundle is most likely to occur immediately on exposure to reactor operating environment. This reverse fuelling technique permits removal of such a bundle with minimum disturbance to the remaining fuel in a channel.

OPERATING HEAD DESCRIPTION

As would be expected, the major problems of design and development of the system were centered in the operating heads of the machines, their interconnection with the reactor fuel channels and the closure plugs of the channels which are removed and replaced by the machines. A more detailed description of the operation on a reactor fuel channel will give a clearer understanding of the problem areas which were encountered. Fig. 7 is a simplified cut-away of a head illustrating the main internal components. The head is shown locked to the coolant flow outlet end of a fuel channel preparatory to removing the closure plug and charging of a new fuel bundle into the channel.

Fig. 7 Simplified Cut-Away of Fuelling Machine Head





SIMPLIFIED CUT-AWAY OF HEAD SHOWING THE MAIN INTERNAL COMPONENTS.
(MACHINE SHOWN LOCKED TO OUTLET END FITTING PREPARATORY TO LOADING NEW FUEL)

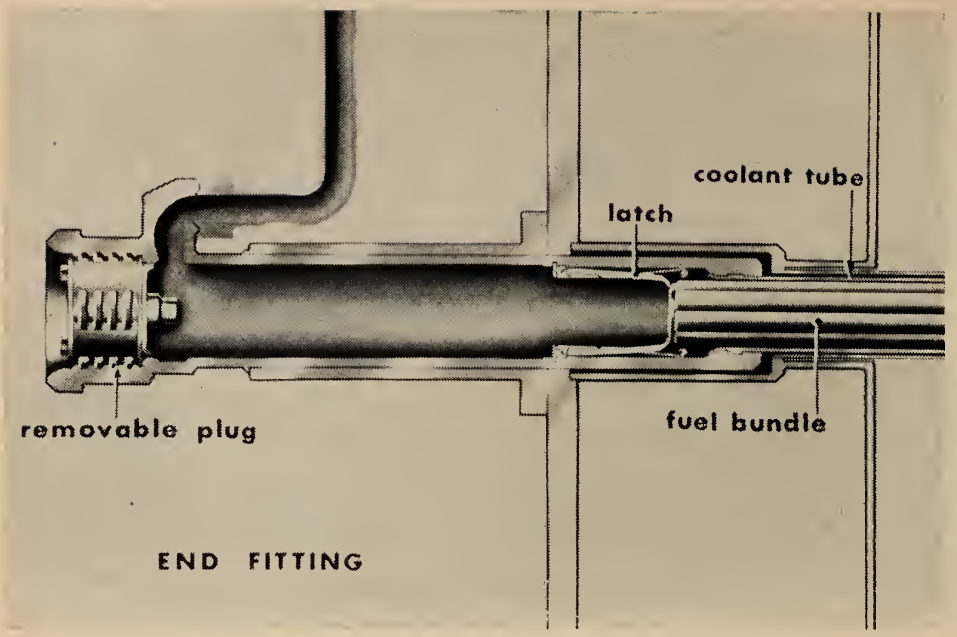
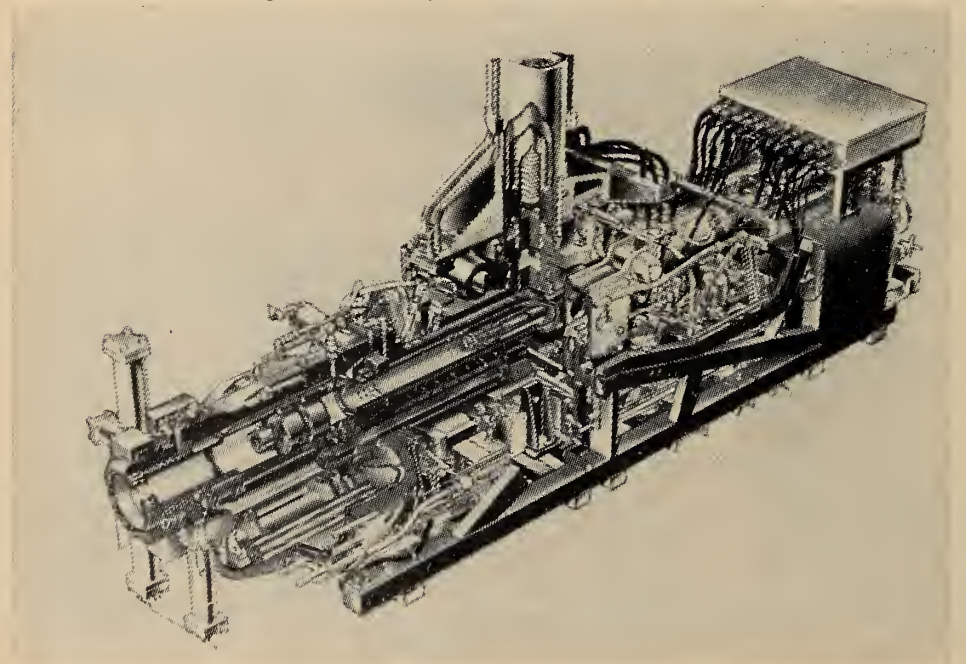


Fig. 8 Diagram of Fuel Channel End and Closure Plug

The head is secured to the end of the channel by a clamp ring. After accurate homing of the head to the channel by control feedback signals from four homing fingers which are mounted in the nose of the head and register on the end face of the channel, the clamp ring is advanced over the end of the channel and rotated to bring its internal lugs into alignment with external lugs on the channel end. The clamp ring is then retracted bringing the seal face on the nose of the machine into contact with the seal face on the end of the channel. Sealing is obtained by use of a Viton A elastomer "O" ring which is secured to the nose of the head. During this operation, the end of the channel has a temperature of approximately 530°F while the temperature of the head, immediately before attachment to the channel is about 100°F. Heavy water level in the head at this time and whilst in transit is slightly below the bottom of the nose bore.

After an air pressure leak test of the head-to-channel seal, the head is filled with heavy water from its reservoir tanks on the carriage via flexible hoses. The head pressure is then raised to approximately 1100 p.s.i.g., 20 or 30 p.s.i. in excess of reactor fuel channel pressure. A leak check is again performed. The next operation is removal of the reactor fuel channel closure plug. The head magazine, as shown by section A-A of Fig. 7, has five positions for fuel bundle storage, two for fuel channel plugs and one for passage of the head charging tube. Channel plug removal or replacement requires the use of a so-called plug adaptor. Two of these adaptors are normally carried in the head and one is equipped with a spare channel plug. To remove the plug from the channel, the head magazine is rotated to bring the adaptor position into line with the charging tube as shown by Fig. 7. The charging tube is then advanced into the adaptor. Rotary motion of the charging tube locks it into the adaptor and frees the adaptor from the bore of the magazine. Both the charging tube and adaptor are then advanced until the adaptor actuating head has entered a recess in the back of the fuel channel closure plug. Fig. 8 shows a diagramatic representation of this plug. Partial rotation of the charging tube locks the adaptor to the plug and frees the safety locking plate of the plug from the channel end. The ram of the fuelling machine head is now advanced inside the charging tube and brought to bear on the central pin of the adaptor which, in turn, dishes the flexible disc seal of the plug inwards against reactor pressure and removes the load on the breach block type threads of the closure. The closure plug is then rotated free of the channel end and withdrawn into the magazine of the fuelling machine head. At this instant, the 530°F heavy water in the reactor channel mixes rapidly with the lower temperature heavy water in the head. The pressure boundary of the head now becomes basically an extension of the reactor coolant system pressure boundary. The charging tube is next freed from the adaptor, locking it and the removed plug in the magazine. The charging tube and ram are then fully retracted and the magazine rotated to the charging tube position. With the ram still fully retracted, the charging tube is advanced through the magazine and into the reactor fuel channel until its inner end is very close to the channel fuel latch. Normal charging of fuel is against the flow of reactor coolant in a channel. The fuel latch holds the string of nine bundles in a channel against the hydraulic forces of the coolant. The bore of the fully advanced charging tube provides smooth passage for a fuel bundle in transit from the fuelling machine head to the reactor fuel channel. In its fully advanced position, a cut-out in the charging tube permits magazine rotation sufficient to align any one of the five fuel bundle positions with its bore.

Fig. 9 Cut-Away of Fuelling Machine Head



It will be appreciated that at this point in the cycle of operations, the fuelling machine head on the coolant flow inlet end of the channel has arrived at the same status with its charging tube fully extended into the fuel channel. Interlocking permissives on the controls for the two machines assure this condition. No fuel latch is located at the flow inlet end of the channel and the spent fuel bundle

position is such that its outermost end is partially entered into the bore of the fully extended charging tube of the receiving fuelling machine head.

Returning to the charge machine, its magazine is now rotated to align the magazine bore containing the fresh fuel bundle with the bore of the charging tube. The ram is then advanced and pushes the new fuel bundle through the charging tube and fuel latch to its resident location in the fuel channel. This action, of course, enters the spent fuel bundle at the other extremity of the channel fully into the bore of the charging tube of the other machine head where it is latched securely and withdrawn and stored in the magazine. Both machines then perform the necessary operations to replace the channel closure plugs. The machine heads are then cooled down and depressurized. After further leak checks, they are disconnected from the reactor fuel channel.

Fig. 9, a cut-away drawing of a machine head, illustrates more clearly the compact design of these components. The internal mechanisms of the head are driven hydraulically with heavy water to minimize pressure boundary penetrations and internal sealing problems. Control information is obtained by passing signals from magnets embedded in the internal mechanisms through the pressure boundary walls to external sensors. All up weight of a head is close to 7000 lb. Overall dimensions are approximately 2½ ft. wide by 3 ft. high by 12 ft. long.

Fig. 10 is a photograph of a machine head taken in the spring of 1962 in the reactor vault at the NPD station just prior to reactor criticality. The ends of the reactor fuel channels and the spent fuel discharge chute openings can be clearly seen.

DEVELOPMENT AND OPERATION

Design, development, manufacture and test of these fuelling machines has been underway for more than four years. A complete fuelling machine and control system together with a test rig operating with light water at reactor flow, temperature and pressure conditions and simulating one face of the reactor were put into operation in 1959 in the development laboratory of Canadian General Electric at Peterborough. This rig and the test machine are shown on Fig. 11. Two prototype heads, a specially instrumented thermal stress investigation head and four production heads have passed through this test facility.

To synchronize with the reactor commissioning schedule and to provide the maximum time for solution of problems associated with operation of heads at full reactor temperature, the program of supplying fuel handling equipment to the reactor site was carried out in two stages. The objective of the first stage was to provide machines and related equipment at the reactor site capable of initial fuelling of the reactor and of changing fuel with the reactor shut down, pressurized, but thermally cool (i.e., below 250°F). The objective of the second stage was the provision at site of proven machines for on-power operation on the reactor at 530°F.

Stage one achieved its objective early in 1962. The machines were successfully used to load the reactor with its full complement of 1188 fuel bundles in their cool pressurized heavy water environment in slightly under three weeks. The machines have since been used intermittently, as required, to shift bundles in approximately fifty of the reactor fuel channels as an aid to reactivity control.

As of December, 1962, stage two has reached the point where simulated on-power operation of machines on the test bed at Peterborough has been successfully demonstrated by a total of more than 70 hot runs, the site equipment has been progressively modified to "on-power standards", and a limited number of trial hot runs without actual fuel movement have been made on the reactor.

The major development effort has been expended on overcoming the problems arising from pressurized operation of the heads in the hot condition and in the transient temperature conditions which are created by rapid intermixing of coolant between the heads and the reactor channel at the instant of closure plug removal. Tests with the first prototype head confirmed the presence of high thermal shock and resultant thermal stresses in the head pressure boundaries during this later condition. In addition, 17-4 PH stainless steel castings, which were selected initially for the head magazine housings, failed to meet the specified standards of structural soundness and lacked the physical properties required to ensure adequate cyclic life. As a result of these first prototype tests, forged AM-355 stainless steel housings were selected and a design modification was made to incorporate an internal liner in the housings to protect them from excessive thermal gradients. As a check on the adequacy of these design changes, an instrumented thermal stress investigation head was built. This head, shown by Fig. 12, utilized forged AM-355 housings and was internally lined to provide a three-eighth inch gap through which coolant was circulated at slight positive pressure with respect to the internal magazine cavity. Slight leakage

Fig. 10 Fuelling Machine at Reactor Face

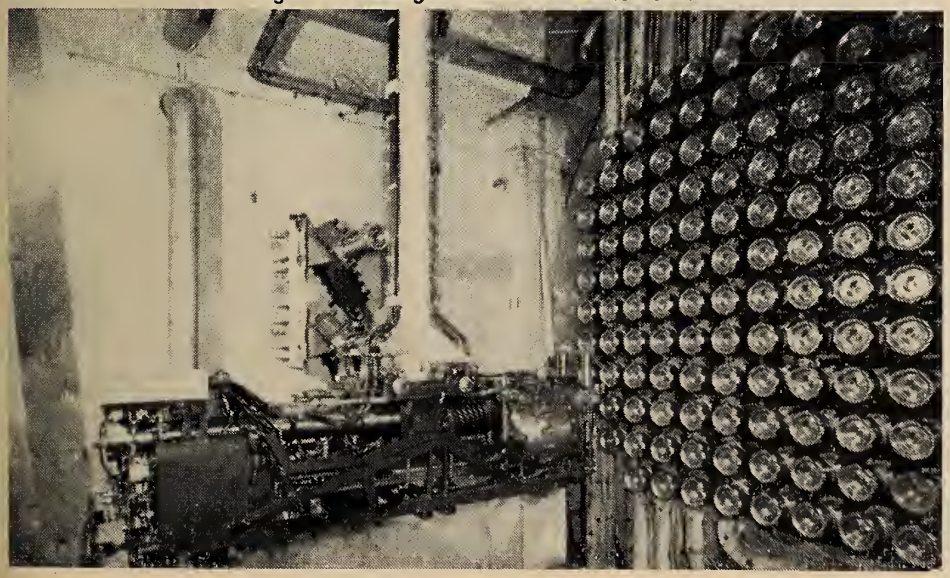
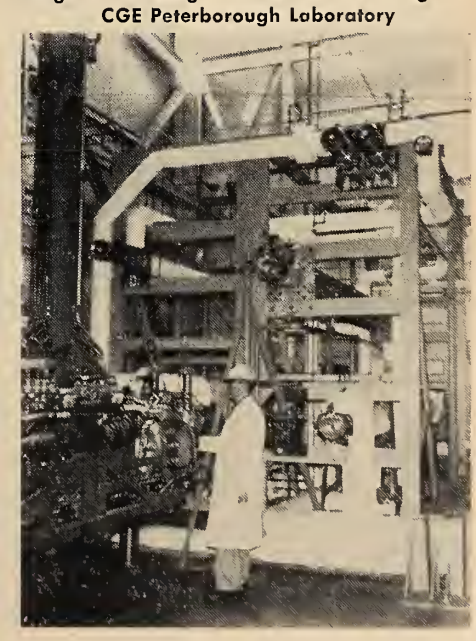


Fig. 11 Fuelling Machine and Test Rig in CGE Peterborough Laboratory



was permitted from this gap to the magazine cavity resulting in a net inflow of heavy water from the head to the fuel channel during operation. The liner was constructed as a sandwich of stainless steel sheet and mesh to provide a small amount of thermal insulation and achieve the desired balance between restricting excessive heat flow to the forgings and permitting sufficient heat flow to the coolant gap to accomplish reasonably quick cool-down of the head when the fuel channel closure plug has been replaced after a fuelling operation. Some 50 thermocouples were located on internal metal surfaces and in water passages of the test head. The thermocouple leads were connected to high speed recorders to provide basic temperature-time data for thermal stress analysis and subsequent analytical determination of safe operating cyclic life of the pressure boundaries. Twenty-eight hot test runs together with a number of minor modifications to the liner and cooling flow arrangement confirmed satisfaction of the design and confirmed expectations of infinite safe cyclic life for the AM-355 housings.

In parallel with work on the thermal stress head, a second prototype head was built and endurance tested for 250 cycles on the test rig to prove operational adequacy of the site machines for stage one of the program.

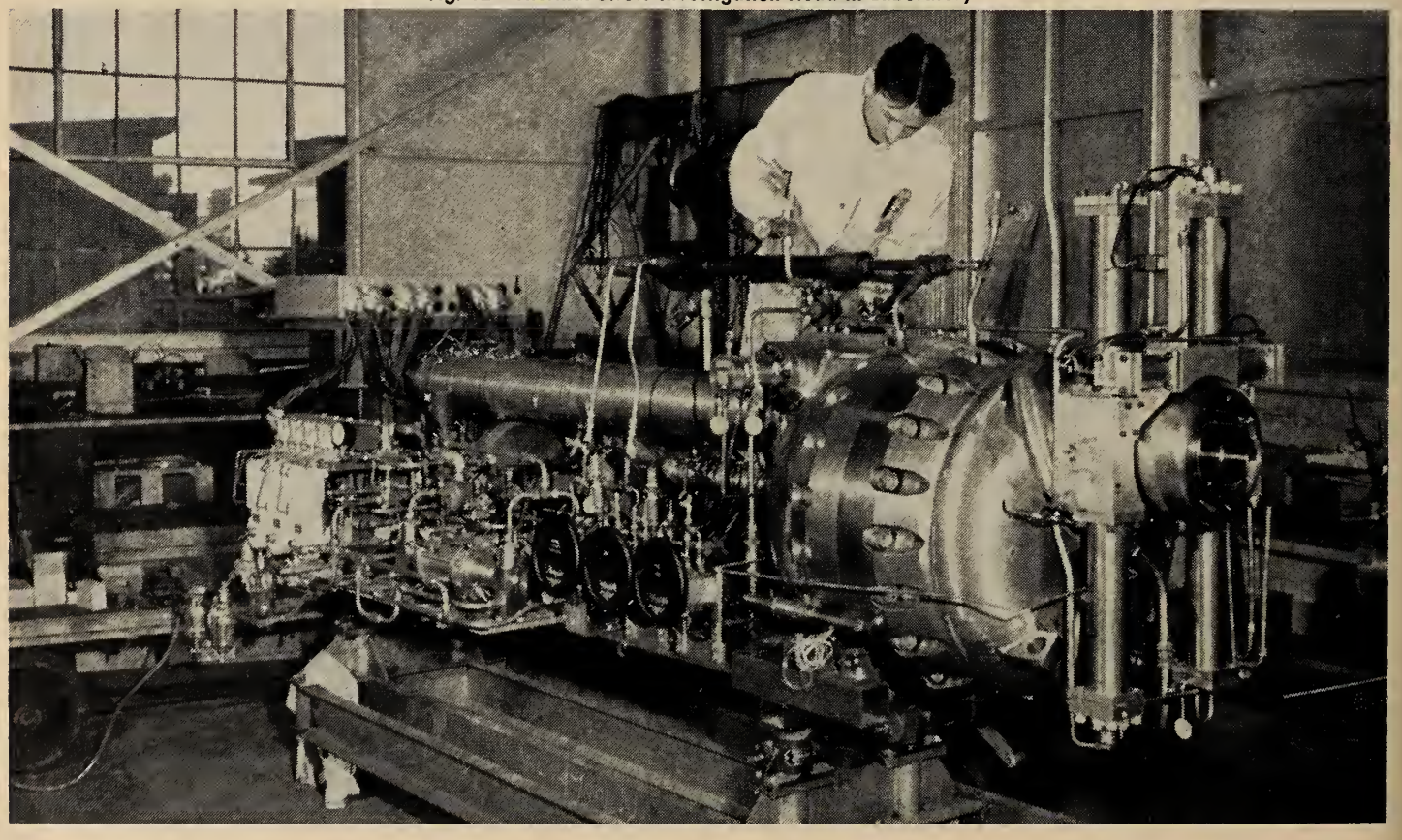
On completion of the thermal stress head work, the proven modifications have been progressively incorporated in the production heads. Each modified production head, prior to return to the site, has been subjected to extensive hot testing on the laboratory test rig at Peterborough.

In addition to development and commissioning testing of complete machines and heads, a significant amount of development has been required on components of the machines. The problems of finding compatible materials for rubbing applications in a hot pressurized, high purity heavy water environment have been present. These problems have been reasonably satisfactorily solved by minimizing metal to metal contact or by using hard chrome plate, stellite or bronze and by judicious application of molybdenum di-sulphide powder. Seals, valves and pumps all required either modification of conventionally available types or original design and development of new types. For example, a light weight, compact reciprocating piston, air to water intensifier pump had to be developed for heavy water hydraulic actuation of head internal mechanisms. As another example, commercial hydraulic selector valves were refitted, with the cooperation of the vendor, with aluminum bronze spindles, chrome plated discs and stellite port seats before satisfactory operation was achieved on 50,000 cycle bench tests. Organic seals, hoses and insulations were irradiated to establish their expected operational life. Many hours of bench operating time were logged on component sub-assemblies to establish satisfactory operating characteristics. Typical of these tests were the many cycles accumulated with an end fitting plug closure and fuelling machine adaptor under simulated reactor conditions. The control system for each machine with its 120 inputs, 105 outputs, some 500 logic relays and over 3000 interconnecting diodes, although using reliable and proven components, required considerable effort to develop as an integrated system.

CONCLUSION

The performance of the NPD fuelling machines based on off-reactor testing, initial reactor loading and limited reactor fuel shifting has been satisfactory. Evaluation of performance adequacy for sustained on-power changing will be forthcoming within the next few months. The possibility of unforeseen problems arising during on-power operation is fully realized. Basically, the NPD machines are still development machines in which there are known areas where improvements can be made. To this end, a limited development program of machine improvements is continuing along with sustained hot endurance testing of one machine at Peterborough. Whether or not the developed improvements are utilized on the existing site machines or reserved for future use will, of course, depend on the degree of reliability demonstrated by the present NPD equipment under continuous operation.

Fig. 12 Thermal Stress Investigation Head in Laboratory



EIC-63-GEOTECH 9

PROBABILITY CHARTS FOR PREDICTING ICE THICKNESS

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IN RECENT YEARS there has been an increase in available information on the thickness of ice covers at various sites in North America. In 1953 Currie[1] made a study of ice thickness and snowfall for the Prairie Provinces and the Northwest Territories; in 1954 Ryder[2] compiled ice thickness records in the Northern Hemisphere for the American Geographical Society; and during the winter of 1958-59 the Meteorological Branch of the Department of Transport established a continuing program of weekly ice thickness measurements on bodies of water adjacent to selected meteorological stations in Canada[3].

There are a number of reasons for this recent increase in ice thickness observations. Empirical and theoretical studies have shown that the bearing capacity of an ice cover is proportional to the square of the ice thickness[4]. Before the bearing capacity of an ice sheet can be estimated, therefore, the thickness must be measured or estimated. Ice thickness records are also required by engineers for predicting possible ice pressure against dams and for consideration in designing water supply intakes where the source of supply is a frozen lake, river or harbour. A record of expected ice thickness is useful also to hydrologists concerned with river run-off or the prediction of the amount of iee that will be melted during the spring break-up of lakes and rivers.

The most satisfactory method of obtaining information on ice thickness is by routine measurement of ice thickness for a number of years at a number of sites. In Canada, with its thousands of lakes, rivers and harbours frozen for many months of the year, however, it will always be difficult to have an adequate number of these ice observation stations. Often it will be necessary to estimate ice thickness at sites several hundred miles away from the nearest ice observation station.

Under these circumstances it is usual to estimate ice thickness using formulae that relate ice growth to meteorological factors. In this paper an alternative method of predicting ice thickness and rate of growth is proposed. Probability charts prepared from ice thickness observations now available in North America are presented. These charts provide information on the probable rate of increase of ice thickness during the ice growth period and the probable maximum thickness that will be attained under a wide variety of site conditions in North America.

Formation of Natural Ice Covers

To appreciate the limitations of probability charts or more elaborate methods for predicting ice thickness it is necessary to understand the various ways an ice cover can form. As several authors have described the formation and development of natural ice covers in detail[5,6], only a brief outline will be given in this paper.

Under normal conditions there is a temperature gradient in the ice cover. Heat flow along this gradient leads to an increase in the thickness of the cover by the formation of ice at the interface between the ice and water. If the ice is thin and the air temperature much below freezing, the temperature gradient and associated heat flow will be relatively large and a rapid increase in ice thickness will result. As the ice cover increases in thickness the temperature gradient usually decreases and the ice grows at a progressively slower rate. Frequently, the average air temperature decreases at the same time and partly offsets the effect of increasing ice thickness on the temperature gradient.

If there is an insulating layer of snow on the ice cover it will reduce the temperature gradient through the ice and the rate of growth will decrease accordingly. If the snow cover is deep enough, the temperature at the ice-snow interface can be very close to 32°F and ice growth will be negligible. As the insulating value of snow can be as much as ten times that of ice, depending on its density, snow cover on the ice has an important influence on the rate at which an ice cover thickens.

Ice does not always grow downward from its lower surface. If the snow cover is heavy enough the upper surface of the ice can be depressed beneath the hydrostatic water level so that water is forced up through holes and cracks and floods the sur-

Fig. 1—Regions used for ice thickness probability studies

face. The slush that forms and freezes on the top is sometimes called white ice because of its colour. Its growth depends on the amount of snow that falls on the ice cover and on the meteorological conditions that prevail after the surface has been flooded. If the weather is cold enough, the freezing slush on the surface can produce a rapid increase in total ice thickness. If mild weather prevails, especially if the snow is not wetted to its full depth, a layer of slush can remain unfrozen. Sandwiched between the snow and the ice, or between two layers of ice, this slush can produce poor conditions for vehicle traffic. Such water or slush layers can also be produced by melting and run-off during mild periods.

From a consideration of the process of ice cover formation, it is clear that the thickness of ice and the depth of snow on the cover are major factors in determining the rate at which ice will thicken. The weather conditions that occur during the period of ice formation are also important in determining the rate of heat loss from the surface. The main meteorological variables affecting heat loss at the surface are the air temperature, total net radiation, wind velocity and relative humidity. Of these air temperature is the most important for ice thickness predictions normally required by engineers.

If theoretical or empirical formulae are used to predict ice thickness, quite detailed observations on weather, ice and snow cover conditions are required. The accuracy of the prediction will depend not only on the validity of the formulae used but also on the accuracy with which weather conditions and snow and ice cover properties required for the calculation, can be predicted. Because of the difficulties at many sites in measuring and predicting the required variables, the use of these formulae is often unsatisfactory. Probability charts based on past ice thickness observations offer a useful alternative for predicting ice growth rates and ice thickness, particularly for sites where details of weather, snow and ice conditions are not available.

Analysis Procedure

Two sources of ice thickness records were used in the analysis. These were Ryder's study of ice thickness on lakes and rivers in the Northern Hemisphere[2], and a recent compilation of ice thickness measurements taken by the Meteorological Branch of the Department of Transport[3]. The records compiled by Ryder were somewhat sporadic, usually with only two or three years of continuous observation at a site. Details such as depth and density of snow or quality of ice were often not recorded. Nevertheless, these records were useful as they were from many different geographical locations in the Northern Hemisphere and probably covered a wide range of conditions. Most of the ice thickness observations taken by the Meteorological Branch were obtained in the Arctic and sub-Arctic at weekly intervals.

As the available records were limited and covered a large geographical area, no attempt was made to make a detailed analysis of individual stations. Rather, the total area was broken down into six general regions (Fig. 1), which are listed in Table I with the number of ice observations used in the analysis.

From these observations the average rate of ice growth was calculated for two-week periods from the time ice first started to form until maximum ice thickness was attained. On the average, this ice growth period varies from about six to seven months in the Far North (October-April) to about two to three months in the south (December-February). Growth rates were grouped according to initial ice thickness in the following manner:

(1) Initial ice thickness at the beginning of two-week period less than 10 in. for all regions (for a comparison of ice-growth rates when the ice is thin).

(2) Initial ice thickness at beginning of two-week period from 0 to 20, 20 to 40 and over 40 in. in Regions 3, 4, 5 and 6. (As ice thicknesses are normally less than 20 in. in Regions 1 and 2, the records available were not complete enough to warrant subdividing these areas further.)

The above classification of ice-growth rates by region and ice thickness was selected after several trial classifications. These preliminary studies indicated that the break-down is adequate for the purposes of this paper. A more detailed classification was not justified because of limitations on the accuracy and length of ice thickness records available for analysis.

The growth rates were divided into class intervals covering the observed range of ice growth on lakes, rivers and harbours. Frequency distributions were then made of ice-growth rates for each region and range of initial ice thickness. These distributions were then plotted as cumulative frequency curves on arithmetic probability paper. Several of these frequency curves were then plotted on one diagram to make up what is termed, in this paper, a probability chart.

Probability Charts Obtained From Analysis

Figure 2 shows the frequency curves plotted on probability paper for all the observed ice-growth rates, without regard to snow depth, for the different regions and ranges of initial ice thickness.

Figure 2a gives the distribution curves for the six regions when ice thickness at the beginning of the two-week averaging period was less than 10 in. Region 4, fresh water lakes and rivers from latitude 60 to 70°N, was not included because there were insufficient observations to warrant analysis. The distribution curve for salt water indicates that sea-ice thickens more rapidly than fresh-water ice, probably because the heat of fusion of salt-water ice is less than that for fresh-water ice and the ice-growth rate is larger for the same rate of heat loss. The fresh-water curves indicate a slightly higher rate of growth for more northerly regions, although not as much as might be expected; the difference is not great because the weather conditions that prevail during freeze-up are approximately the same for all regions. A map giving average freeze-up dates and months when average air temperature is 32°F was prepared by Burbidge and Lauder[7]. It shows that the average date of freeze-up almost coincides with the date when the average air temperature is 32°F. In the Far North of Canada freeze-up occurs during September, whereas in the south it is early in December.

Figure 2b gives distribution curves for Regions 3 and 4 for different ranges of ice thickness. There is comparatively little displacement in the frequency curves for different thickness ranges, and it is apparent that as the winter season progresses the decrease in rate of heat loss due to increasing ice thickness and snow depth is largely offset by more severe weather conditions. Hence the range of ice-growth rates is only slightly higher for ice thickness under 20 in. than for ice thickness in the range 20 to 40 in. or 40 in. and greater. The reason the probability curve for ice thicknesses of 40 in. or more is apparently slightly higher than that for the 20- to 40-in. range may be due to insufficient observations.

Figure 2c, showing the distribution curves for salt water in Regions 5 and 6, indicates that the rate of ice growth decreases with increasing ice thickness. This decrease may be due in part to the dependence of the specific heat of sea ice on temperature.

Figure 3a and 3b are frequency

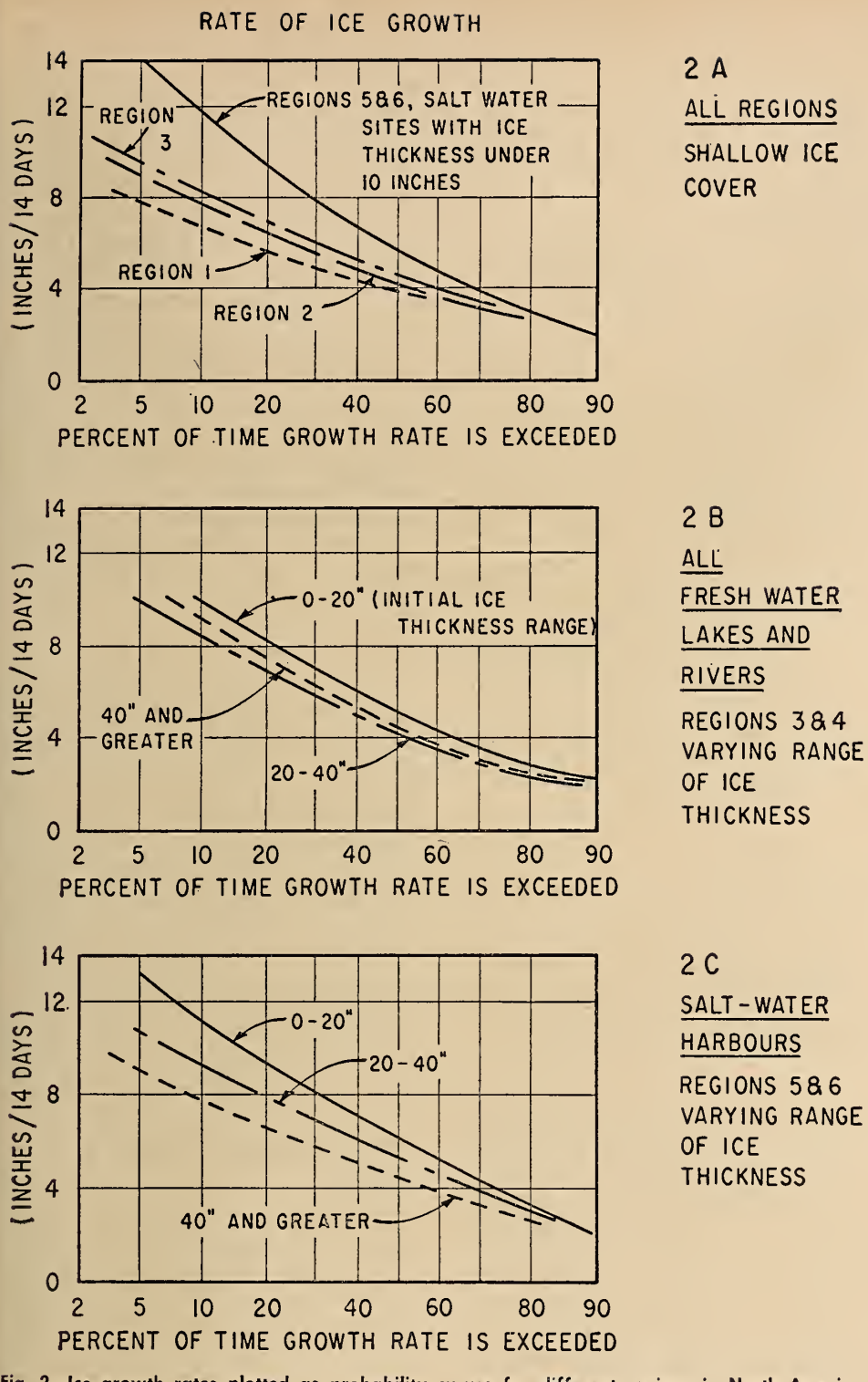

Fig. 2—Ice growth rates plotted as probability curves for different regions in North America

plots showing the effect of snow depth on ice-growth rates. Probability curves have been prepared showing ice-growth rates with snow cover depths less than 2 in. and 6 in. or more for all stations where snow depth was recorded.

Figure 3a shows that the average rate of ice growth with snow cover less than 2 in., for ice thicknesses from 0 to 20 in., is from 2 to 2.5 times as great as that when the depth of snow exceeds 6 in. The limited records available for analysis indicated that the rate of sea-ice growth was higher than that of fresh-water ice for these ranges of ice thickness and snow cover depth. Again, this is probably the result of the lower heat of fusion of sea-ice.

Figure 3b shows that for an ice thickness range of 20 to 40 in. the average rate of ice growth with snow cover less than 2 in. is more than twice the growth rate with a snow cover 6 in. deep or greater.

In this analysis of the effect of snow cover on ice-growth rates at least three cases were noted where the ice-growth rate was extremely high although snow cover was deep. These were not used in preparing Figs. 3a and 3b. The growth rates (in these cases) varied from 8 to 10 in. per week for snow cover over 10 in. deep and initial ice thickness under 20 in. During these periods of rapid growth the reported depth of snow decreased from 10 to 6 in. or less. It would appear that these ice-growth rate anomalies were related to white ice or "snow ice" formation.

If meteorological conditions are highly favorable for ice growth, particularly when the ice cover is thin, large rates of ice growth can probably occur during one or two-day periods. It is unlikely that such extreme conditions would continue for two weeks. The probability curves shown on Figs. 2 and 3, therefore, give the average upper and lower limits of ice-growth rates that can be expected for two-week periods. It would be expected that the deviations on either side of the 50% time line should correlate with the deviation of the actual average weather for the period from the climatological average. Unfortunately, the number of ice thickness records available was not sufficient to check this hypothesis.

Use of Probability Charts to Predict Ice-Growth Rates

Probability charts are based on observations taken from the time ice first starts to form until maximum ice thickness is developed and are valid for this period only. With these charts the probable rate of ice growth and ice thickness can be estimated at a site at any time during this ice growth period.

If, for example, the ice cover on a fresh-water lake is 6 in. thick, and 16 in. is required for a given load, how long will it take for the thickness to increase from 6 to the required 16 in.? From Fig. 2b one can say that 50% of the time the ice cover will grow at a rate of 5 in./14 days. Thus on the average it will take four weeks to increase 10 in. in thickness. If, however, there is deep snow on the ice and the weather is relatively mild the growth rate could be as low as 2 in./14 days (90% of time). Conversely, if the air temperature is below normal during this period and there is no snow cover the growth rate could be as high as 10 in./14 days or greater (10% of time), and the required growth would occur in two weeks.

It is evident that the rate of ice growth can vary widely, depending on snow cover and weather conditions. With the aid of past weather records and predicted weather conditions, an observer can put limits on the expected rate of ice growth and ice thickness obtained from the probability charts and make operational decisions based on this information.

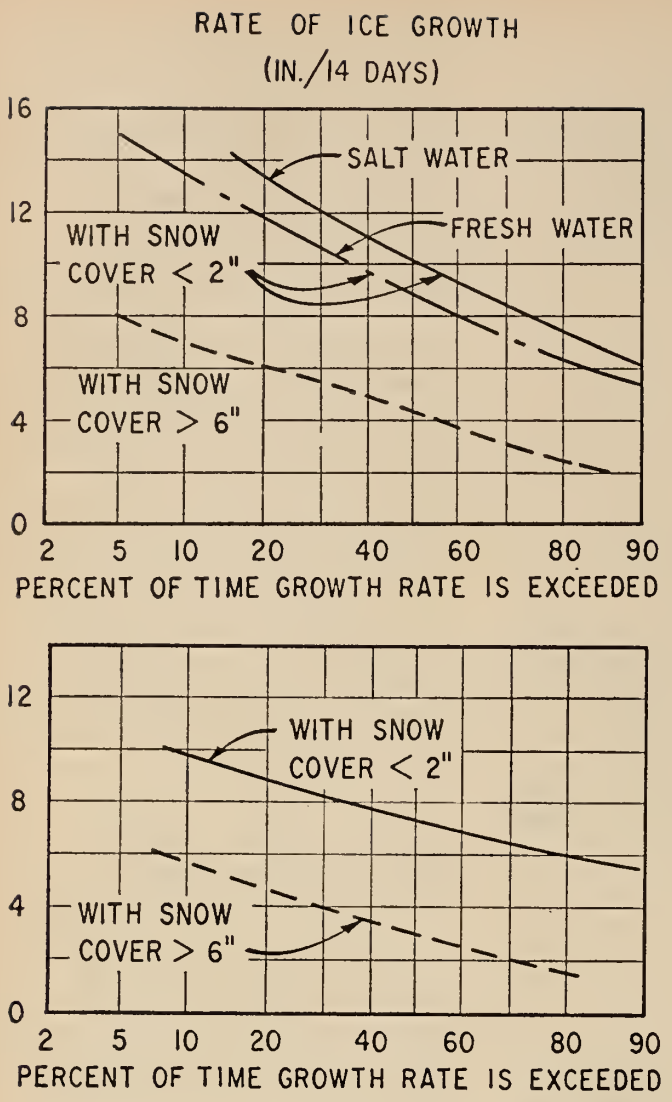

Fig 3—Ice growth probability curves showing effect of snow cover on ice growth rates

The merits of removing the snow cover or of accelerating ice growth by flooding or snow compaction can be more readily assessed with this knowledge of the possible limits of natural ice growth.

It should be kept in mind that the main reason for variation in observed ice-growth rates is the natural variation that occurs in snow depth and weather conditions. This natural variation introduces uncertainty into estimates of ice-growth rates, whether the estimates are made by use of formulae or by probability charts. Prediction of ice-growth rates from probability charts based on actual observations are probably at least as reliable and usually more convenient than predictions based on formulae.

Maximum Ice Thickness

An estimate of maximum ice thickness is often required in such engineering problems as the design of dams for maximum ice pressure or the design of water intakes operating under winter conditions. If ice thickness observations are not available at a site, an estimate of the thickness can be obtained from the information on the rate of ice growth compiled in this study. Using average ice-growth rates it is possible to relate ice thickness to the length of the period of ice growth. The average rates of growth for average weather conditions, snow cover less than 2 in. and snow cover greater than 6 in., have been used to plot the ice-growth lines shown on Fig. 4

Observations on maximum ice thickness for cases where the date of freeze-up was recorded were plotted on Fig. 4 against the number of days from freeze-up to the time of maximum ice thickness. The observed values fall within the limits obtained from the probability curves. It was noted that for areas in the Far North plotted points tend to be near the upper limit of no snow cover. An explanation could be that at these northern sites ice covers are blown clear of snow; a cover greater than 6 in. seldom persists for the entire ice formation period. Similarly, in southern regions plotted points tend to be nearer the lower limit, indicating that significant snow cover occurs more frequently on ice in these areas. It should be noted that there is an upper limit to maximum ice thickness at every site, governed partly by the length of the ice-growth period; this varies from a few weeks in the south to as much as 250 days in the Far North.

As maximum ice thickness at a particular site will vary from season to season, observed maximum ice thicknesses should be used whenever available in preference to other information. In a recent circular the Meteorological Branch compiled information on maximum ice thicknesses on lakes and rivers in Canada[8]. Bilello has prepared preliminary climatological maps of maximum ice thicknesses for Arctic and sub-Arctic regions[9]. For sites where maximum ice thickness observations are not available the limits shown on Fig. 4 can provide useful information that may be satisfactory for many design problems.

Heat Conduction Through Ice Covers

It is possible to estimate the limits of the expected heat loss by conduction through ice covers by converting ice-growth rates given in the probability charts to rate of heat loss. This information might be useful for certain design problems.

Table II gives the probability of occurrence of a given heat loss through freshwater ice, assuming the heat of fusion for ice is 144 Btu/lb.

TABLE I

Location and Number of Observations of Ice Thickness Used in Analysis

	No. of Observations	*Classification*
Region 1 — Mid-western states and Southern Manitoba	107	Fresh-water lakes and rivers
Region 2 — New England States	105	Fresh-water lakes and rivers
Region 3 — Canada east of Rockies and south of latitude 60°N	261	Fresh-water lakes and rivers
Region 4 — Latitude 60°N to 70°N	385	Fresh-water lakes and rivers
Region 5 — Latitude 60°N to 70°N	488	Salt-water harbours
Region 6 — Above latitude 70°N	577	

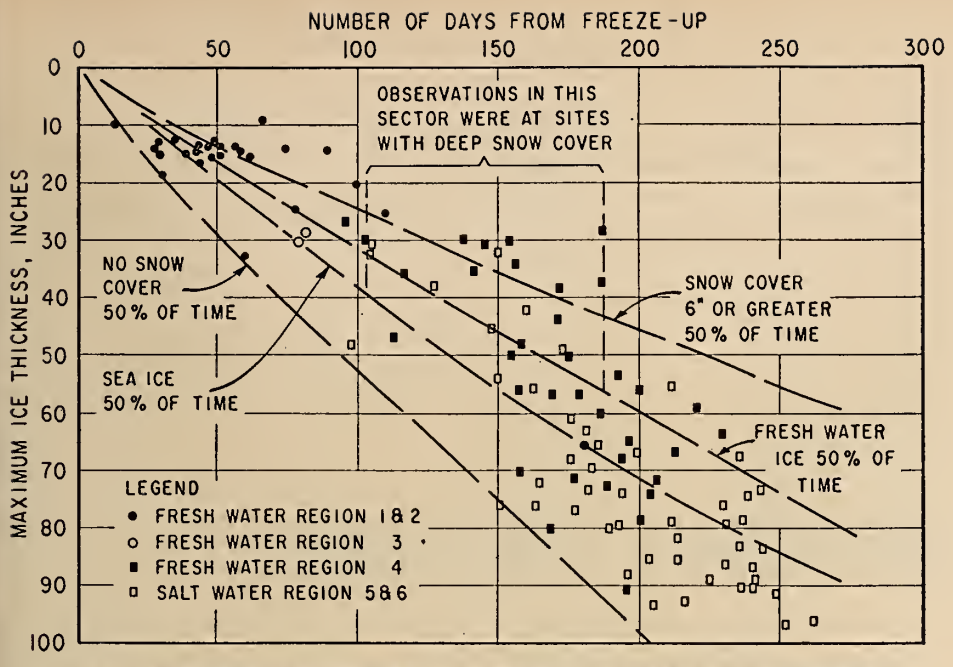

Fig. 4—The relationship between the number of days from freeze-up to maximum ice thickness

The calculation was not carried out for sea-ice; this calculation is not difficult, but it does require a knowledge of the dependence of the heat of fusion of sea water on salinity and of the dependence of the specific heat of sea-ice on temperature and salinity.

For shorter periods heat conducted through the cover can exceed the rates listed in Table II, but for periods of two weeks or more the values given should be quite representative of the average heat loss that will occur.

In the Far North where there is no short-wave solar radiation during the mid-winter months, the heat conducted through the cover equals the heat losses due to long-wave radiation, evaporation and convection. In southern areas the amount of short-wave radiation absorbed by a snow or ice surface should be added to the values in Table II to give the combined heat loss due to evaporation, convection and long-wave radiation. In December at latitude 45°N the average short-wave radiation absorbed by an ice cover would be about 200 to 275 Btu/sq ft/24 hr, or about equal to the 50% value listed in Table II.

CONCLUSIONS

This analysis of ice-thickness observations on a regional basis indicates that probability charts can be used to obtain a reasonable estimate of the probable rate of ice growth and ice thickness at any site in Canda. The average ice growth rates shown on the probability charts can also be used to relate maximum ice thickness to the length of the period of ice growth. The ice growth rates can also be converted into average heat loss from the ice cover to provide information on the rate of heat loss from ice covers in different regions.

Depth of snow cover on ice is shown to have a marked effect on the rate of ice growth. The average rate with a snow cover of 6 in. or more is about one-third to one-half that with a snow cover under 2 in.

Because the rate of ice growth depends on highly variable snow and weather conditions, the only sure way of obtaining satisfactory information on ice conditions at a particular site is to make appropriate measurements of ice thickness for a number of years[10]. As these records improve ice thicknesses can then best be estimated in the same way as air temperature is now estimated from climatological records. When such records are not available at a site, ice probability charts used with discretion can provide a useful method of putting limits on the rate of ice growth and maximum ice thickness to be expected.

TABLE II

Heat Loss Through Fresh-Water Ice Covers (for all regions, all snow cover conditions, and all ranges of initial ice thickness)

Probability of Occurrence	*Ice Growth in./ 14 days*	*Heat Loss*	
		cal/sq cm/24 hr	*Btu/sq ft/24 hr*
Percentage of time equal to or greater than			
10	8.7	126	465
20	7.0	104	376
30	6.2	90	332
40	5.3	77	284
50	4.8	69	256
60	4.2	61	225
70	3.6	52	192
80	3.0	43	159
90	2.0	29	107

Acknowledgements

The work of the many observers who obtained the ice thickness observations used in this paper is gratefully acknowledged. The author also wishes to acknowledge the help of Mr. P. Montford in analysing many of the observations, and the encouragement of L. W. Gold in the preparation of this paper. This is a contribution from the Division of Building Research, National Research Council, Ottawa, and is published with the approval of the Director of the Division.

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SOME PERTINENT QUESTIONS REGARDING

NGINEERING

DUCATION

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The author is a civil engineer and has been teaching general engineering and civil engineering topics for the last 18 years. He entered University work after 15 years of practical engineering experience and has been a little uneasy about some of the changes that have been taking place in engineering education. The author would hesitate to set forth his views were it not for the fact that during the summers of 1961 and 1962 he attended special summer schools at large American universities. and met civil engineering professors from 20 to 25 American universities who are also concerned with some present trends in engineering education.

The author would feel reassured in his work if he felt that the changes were taking place with the knowledge and approval of the engineering profession.

This article is an attempt by the writer to set forth his interpretation of what has been happening and to present to the Canadian engineer additional information to stimulate his interest in engineering education and to entreat him to express his approval or disapproval and give constructive suggestions.

WHY SHOULD ENGINEERING curricula be changed? A number of possible reasons for changing the engineering curriculum at a university can be listed.

(1) There have been great changes and advances in the sciences that the engineer or applied scientist is supposed to apply.

(2) There are new mathematical and mechanical tools to use.

(3) The old type of graduate cannot cope with the nuclear and space age.

(4) The graduates are not accepted by industry or by leading graduate schools.

(5) Certain industries asked for changes.

(6) The profession asked for changes.

(7) M.I.T. and other leading U.S. schools have made changes so others should copy them.

(8) To specialize in certain fields and get publicity for the university or the individual and perhaps attract research grants.

Everyone would agree that (1) and (2) are good and valid reasons for change, but the remainder are worth considering.

Coupling (3) and (4) it should be remembered that the directors of the teams which led us into the nuclear and space age were engineers of the old school, industry has always wanted our graduates and Canadian B.A.Sc's have always been welcome at the leading graduate schools. (I have personal knowledge of a large American engineering university that boasts that it has made very few changes in the last 30 years and because of the great demand for its graduates by both industry and government research institutions is not contemplating any at the present time.)

Regarding (5), some large Canadian industries have suggested changes, but here the motive must be questioned. Would it benefit the whole industry, looking many years ahead or was it for the short-term benefit of the particular firm to reduce the cost and time of their own training program? (One of the largest employers of engineers in Canada recently showed irresponsibility in asking the universities to turn out more of a certain type of engineer to meet its requirements and then two years later hiring almost none.)

Number (6) should normally be a valid reason if the request comes from a responsible engineering society but in Canada probably very few changes have had their origin from this source.

Reason number (7) is probably responsible for many of the changes that have taken place at Canadian universities but surely it is not a good one. If it is apparent that changes have to be made, it is not likely that copying some other engineering institution will be the best solution. A better answer can surely be found closer to home. Changes made merely to "keep up with the Joneses" are not valid and when the "Joneses" happen to be institutions such as M.I.T. and Cal. Tech., they are quite illogical. I see no reason at all why what is right for a large wealthy American institution interested mostly in graduate training, should be good for an expanding Canadian university doing mostly undergraduate training.

Number (8) is a fairly good reason if it is properly controlled. If it is for the good of the whole institution it is good. If it is done by an individual to "build himself an empire" it is not so good. It should be remembered that with the shortage of funds at most Canadian engineering schools there is a danger that if one department or individual is permitted extra money, others are going short.

What changes have been made?

The main changes that have taken place in engineering education in the last 10 or 15 years are, better and more advanced mathematics, physics and chemistry and more of it. There has also been a curtailment in many cases of English, essay and report writing, surveying, drafting and subjects pertaining to economics and management. In general there is less laboratory work, especially in physics and chemistry and more time is devoted to problems. Many practical design courses have also given way to more theory—theory that used to be at the post-graduate level.

Many of the changes appear to be both necessary and desirable, but if one goes along with the idea that the "meat" of engineering is a method or a systematic practical approach to scientific problems, it is rather disturbing to realize that the number of hours that a student is being taught by engineers is decreasing. Moreover, the students time with engineering faculty is taken up more with theory than in the type of course that uses and teaches the engineering approach. The engineer teacher may have had little if any practical engineering experience and there is an increasing danger that because of insufficient money and staff he may be merely a student in the graduate school.

Whereas 30 years ago an engineering student was given too few mathematical and scientific tools but used them repeatedly until he was almost bound to understand their fundamentals thoroughly, there is now a tendency to give him so many tools to use that with reduced practice in the use of each, a sound grasp of fundamentals may not be achieved.

My experience, confirmed by many of my colleagues, is that engineering students can somehow follow, supposedly understand and work problems in mathematics and physics, yet have no real comprehension of them until they have applied them repeatedly to engineering problems. The question bothering me is—are our present students getting enough of this type of training?

Who has been responsible for changes in Engineering Education?

Irrespective of why changes have been made in engineering education and whether they have been necessary or imagined, good or bad, it is perfectly clear that they have been made voluntarily by engineering educators themselves. They and nobody else have to take the credit or the blame for engineering education as it is to-day. Whether policy should ever be made by the same people that implement it is of course open to question.

What type of person is on our Canadian engineering faculties?

The type of person appointed to our engineering faculties depends on who is available at the time a vacancy or new position occurs and who can be attracted by the salary that can be offered. The finances and management of many universities is such that the time for hiring is often quite short, the salary is not large and the pension and like benefits are not particularly attractive. There are a few successful practicing engineers who for idiological reasons or great interest in theory are willing to make financial sacrifices to join university staffs, but the majority of applicants are young engineers who have just finished their masters or doctors degree and have had almost no practical experience. Most of these have great potential and really want to teach and keep learning and doing research but there are always a few who are attracted to the academic life because they lack the confidence to fend for themselves as practicing engineers. A few not-so-successful practicing engineers would like to join the academic ranks for the same reason.

Because of the time element and lack of funds, the choice of whom to appoint to the faculty is not a large one and unfortunately some deans and department heads have had to hire almost anybody available. It should be clearly understood that in most cases, ability to teach has nothing to do with the appointment.

I would like to emphasize the fact that though university enrollment is increasing, engineering enrollment in Canada and the United States is remaining the same or decreasing slightly. Engineering at most universities is therefore receiving a smaller and smaller percentage of the total university budget and having a smaller and smaller voice in university affairs. Budgets are on a year-to-year basis and though a dean of engineering may know that by 1970 or 1972 he will have to double his staff there is little he can do to built for the future.

Once an engineer becomes a member of faculty he must compete for advancement not only with his engineering colleagues but also with all others at the university. His achievement must measure up favorably with that of professors on other faculties and the measuring is often done by people with no knowledge of engineering or of the individual and who rely almost entirely on the amount of research he is doing and especially on the amount of material that he is publishing. His ability to teach and his achievement with undergraduate students receives little if any consideration.

Pressures are such that it is almost inevitable that fewer and fewer members of faculty are really interested in undergraduate teaching. The engineering professor must continually brush up on his mathematics and science and the particular research he is interested in and he may have little time or concern for what is happening in engineering practice.

Are there alternatives to the present trend in engineering education and are they being considered?

I believe that there has been little if any consideration given to alternatives. Educators are sure that the answer to the nuclear and space age is a man who is part engineer, part mathematician and part pure scientist. They also admit that there is a trend to greater specialization. It is difficult to see how a specialist in some branch of engineering, a mathematician and a pure scientist all rolled into one can be developed in four years, yet that is what is being attempted. The educators admit that they need extra years to accomplish the job but it is possible that the task still can not be done if the student is to receive enough drill in basic engineering problems from engineers.

It could be that the task is not possible no matter what changes are made and that the "Jack of all trades and master of none" engineer-mathematician-scientist should be replaced by a team consisting of a number of specialist engineers plus an applied mathematician and a scientist. This is a pattern already developed by some large firms and perhaps it should be sold to the engineering profession as the accepted way to cope with present day needs. With engineering enrollment falling or remaining static but with that in mathematics and science expanding it is a system that could easily be developed. I can visualize some very capable teams with all or almost all members having only Bachelors degrees.

There is already a definite trend towards the training and use of technicians to help the engineer and relieve him of some of the routine drudgery of engineering. Why not add to this team the necessary mathematicians and pure scientists so that the engineer can concentrate on engineering? The engineer would then not have to endeavour to become as proficient in mathematics and science as at present and as an undergraduate could receive more rigorous training in engineering from engineers.

This and other alternatives have not received wide consideration from engineering educators who seem loath to surrender any part of applied science to the pure scientist and mathematician. The claim that the engineer has to become his own mathematician and pure scientist because mathematicians and pure scientists lack the practical approach, is not as valid as it was. These people are now in good supply and there is no reason why their training should not be modified to better meet the requirements of the engineering profession. There is also the possibility that the engineer who tries to take on a double or triple role will never have time to develop the practical approach either.

Conclusion

In conclusion I would like to ask a few questions of Canadian engineers.

(1) If the situation in Canadian engineering education is as I have indicated, are Canadian engineers satisfied with it?

(2) Are Canadian engineers so uninterested in engineering education that they prefer not to act on education committees of our technical and professional societies? Why are the few committees composed almost entirely of faculty members from our universities?

(3) Are they satisfied that deans and department heads at our universities can fight the battle for more money, equipment and staff without assistance from the profession?

(4) Do they know what salaries are being paid at our universities? Are they satisfied to have members of the engineering profession teaching at the universities for the same salaries as professors in the non-professional faculties while medical, dental and legal faculty usually receive special consideration?

(5) Can changes and emphases in engineering education be left safely in the hands of the engineering faculty members, considering the types of persons they are and the environment and pressures to which they are subjected? Should the same people who are implementing policies on engineering education also be making these policies without outside help?

(6) Should practice and teaching be more integrated as in medicine, dentistry and law, in which a large number of lectures are given by successful practicing members of the profession?

(7) Are engineers satisfied that letting engineering faculties at our universities develop on their own is preferable to the attitude of medical doctors, dentists and lawyers who take an active interest and part in education in their particular fields?

(8) Does the engineer realize that enrollment at our engineering schools is not increasing and that lack of publicity about engineering achievements gives young people of to-day the impression that satellites, space probes and nuclear reactors are almost entirely the work of pure scientists? Does he intend to do anything about it?

I most definitely am not asking Canadian engineers to interfere with our universities and dictate curricula. I am well aware of some of the detrimental effects of the accrediting of American schools by professional groups and have been appalled by the influence on some of them of neighbouring aircraft manufacturers.

If Canadian engineers kept themselves well informed about engineering education in Canada and gave it more consideration they surely could find ways to give help and constructive suggestions. They might also be able to head off any too radical changes in the direction of pure science, changes which according to my associates in the United States are proving to be unsatisfactory.

EIC-63—HYDEL 10

HYDROLOGIC SIMULATION OF A RIVER BASIN — An Aid In Flood Control Planning

I. W. McCaig M.E.I.C.
F. H. Jonker
J. M. Gardiner M.E.I.C.

IN NORTH AMERICA the study of hydrologic phenomena received little attention until the early part of the twentieth century. At that time, major programs of flood control were being undertaken, spurred by the mounting toll of damage from great floods such as the Miami River flood of 1913 in Ohio. The development of hydro-electric resources to meet the demands of a rapidly expanding economy was also increasing, and the need for efficient utilization and control of water resources was becoming vitally important. These activities exposed the inadequacy of the hydrologic data and techniques then available, and promoted extensive research in hydrology.

In addition, with the magnitude and number of hydraulic developments becoming greater, the potential damage attendant upon failure, and in the case of a hydro-electric development, the potential loss from inefficient utilization of flow was increasing. This again stimulated the demand for more reliable hydrologic design criteria, and justified greater expenditures on hydrologic studies than previously.

Development of Hydrologic Techniques

STATISTICAL ANALYSIS—Most of the accepted hydrologic relationships and techniques have been developed during this century and hydrology is, therefore, a relatively new science. In its infancy, reliance was placed on empirical, or what might be described as "rule of thumb" methods of flood estimation. In many cases, spillways for dams, culverts and bridges over rivers were designed, hopefully, on the basis of the maximum flow experienced at the site of the structure. The inadequacy of early methods of flood estimation is evident from the many recorded failures of hydraulic structures due to faulty design from hydrologic rather than from structural considerations.

Statistical methods of analyzing stream flow as a basis for estimating probable future flows were then developed and continue to be widely applied. The introduction of probability paper by Hazen[1] in 1914 possibly stimulated the use of these procedures. Based on past flow records statistical methods are, in a sense, an extension of the earlier empirical methods, and have similar limitations in that their reliability is dependent to a large degree upon the length of the period for which flow records are

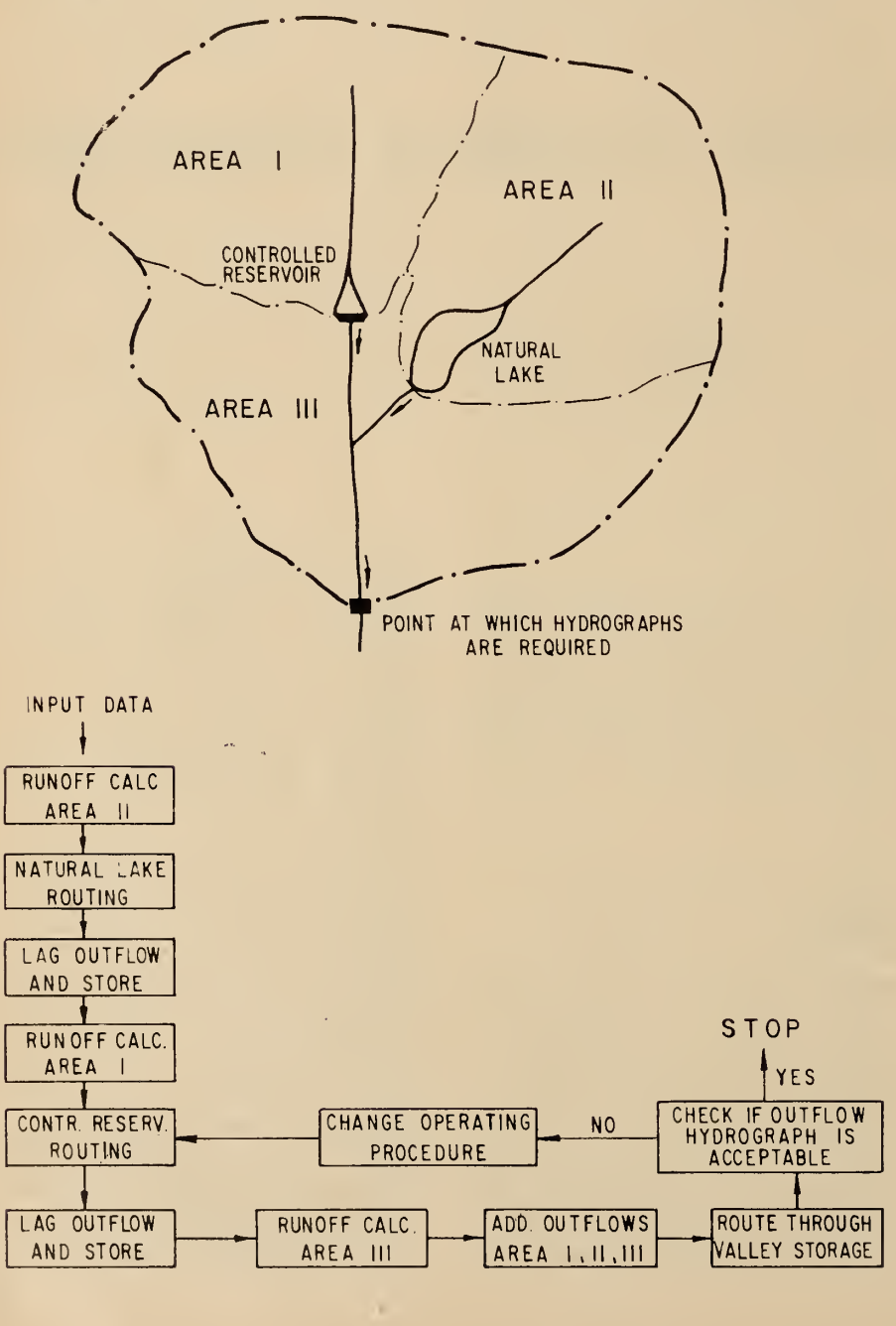
available. Even today, relatively few streams in North America have adequate hydrometric records to allow statistical analysis to be used with confidence and for many streams no flow records whatsoever are available.

Unit Hydrograph Method

In the application of statistical methods, no attempt is made to analyze the phenomena causing floods. The first milestone in understanding the processes involved was reached in 1932 when Sherman[2] postulated the unit hydrograph concept, which is probably still the mainstay of flood hydrologists. He demonstrated that for a given drainage area, hydrographs resulting from isolated storms of the same duration have approximately the same length of time base, and that when adjusted to correspond to the same volume of runoff they have similar shapes. The unit hydrograph is that which results from one inch of runoff, and its shape is governed by such characteristics as the topography and shape of the drainage area, and the extent of natural storage.

Application of the unit hydrograph method is usually limited to relatively small drainage areas for which areal variations in runoff will be small. However, this limitation can be circumvented by dividing large basins into several subareas to which the unit hydrograph method can be applied. Outflows from the subareas must then be routed through the basin to the point at which estimated flows are required. For stream flow routing, various methods both analytical and graphical have been developed, the Muskingum method being a well-known example.

Fig. 1.—Simplified Computer Flow Sheet for a Typical Application.



Storm Runoff and Snowmelt

In the past, estimation of the volume of storm runoff, that is rainfall excess, as a fraction of precipitation was standard practice and, in fact, this method is still used in the design of storm drainage systems. Although the value of the coefficients to be used for a specific storm may be estimated with reasonable accuracy by an experienced hydrologist, the method leaves much to be desired. Again, no account is taken of the natural processes involved. In 1933, Horton[3] presented his theory of infiltration, possibly the most significant of his many contributions to the science of hydrology. This, together with the results of investigations into the effects of such factors as evaporation, transpiration and interception by vegetal growth, led to the development of more realistic procedures for estimating runoff, although much work remains to be done in this area.

In the field of snow hydrology, the degree-day method is perhaps the best known and has been used successfully on a number of studies of river basins where air temperature was the principal factor influencing the rate of snowmelt. In many cases, however, and notably in basins which are largely open and without forest cover, the relationship between air temperature and runoff was not found to be consistent.

In 1945 the U.S. Corps of Engineers, together with the U.S. Weather Bureau, began an intensive program of research into the mechanics of runoff from snowmelt. In these investigations the influence of various factors, including air temperature, rainfall, ground elevation, forest cover, the water content of the snowpack and snow surface albedo, were examined and equations relating them to snowmelt were developed.

Hydrologic Simulations using Electronic Computers

This brief history of methods of flood estimation illustrates the trend to more detailed examination of the hydrologic phenomena involved. Much research remains to be done, but the hydrologic techniques and relationships which have been developed to date are, in most cases, adequate for obtaining accurate flood estimates and determining flood control procedures which can be used with confidence.

While these hydrologic tools have been available for some time, their use has been limited because of the vol-

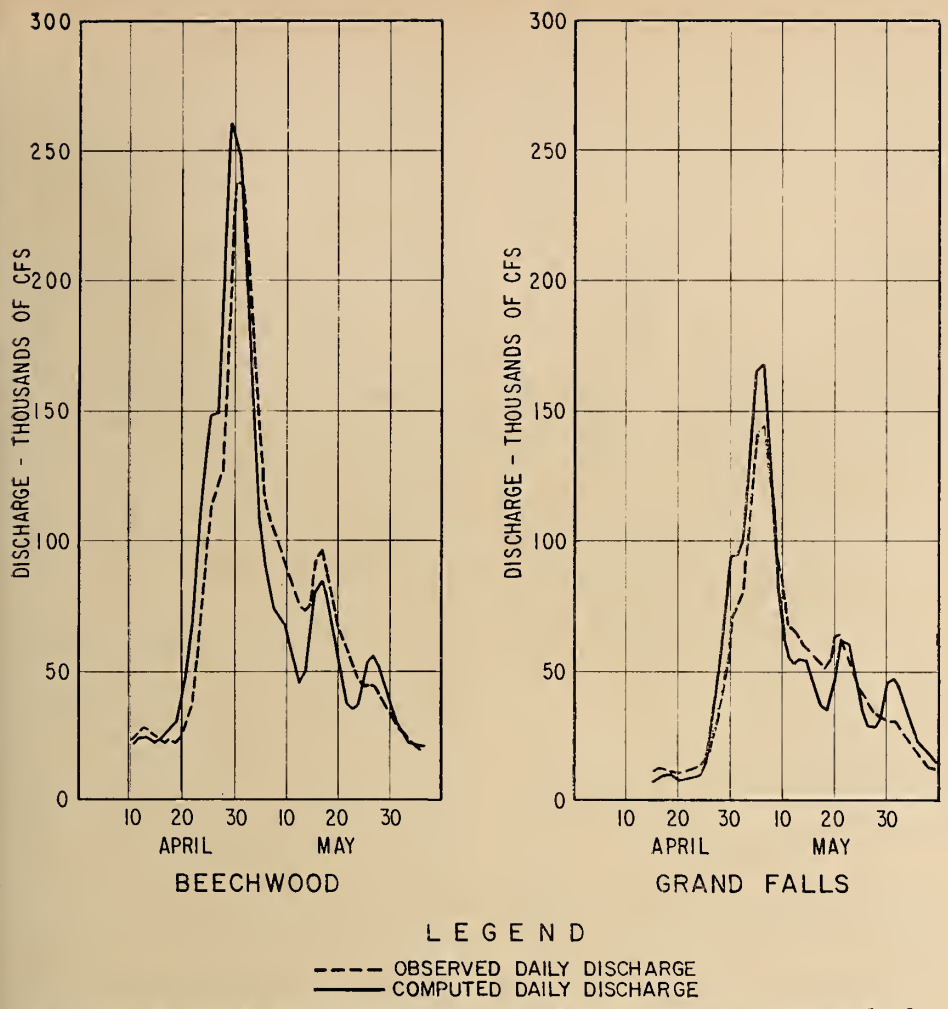


Fig. 2.—Saint John River Comparison of Observed and Computed Spring Flood Hydrographs for year 1958.

ume of computations involved. As a result, 'short-cut' methods in which parameters or groups of variables were considered, have tended to be used. While the volume of computation is lessened, so also, in most cases, is the accuracy of the results. Fortunately the advent of the electronic computers, which are ideally suited for computations involving large numbers of variables, complex relationships, and repetitive operations, has now made it possible to use the latest hydrologic procedures at moderate cost.

During the last few years, hydrologic studies in connection with flood control and power generation have been made of several Canadian river basins using electronic computers. The computer program used is basically a hydrologic simulation[4] of a drainage basin, that is a mathematical model in which the natural hydrologic processes and storage control procedures are represented by mathematical functions. It consists of five subroutines and a control program which directs the order in which each subroutine is used. Although the number and form of the subroutines can be extended still further, the program at its present stage has provided an economical method of obtaining accurate flow estimates and of determining optimum flow control procedures.

In the simulation, the drainage basin under consideration is divided into a number of small sub-basins for which it can be assumed that the hydrometeorological conditions are uniform, and for which the unit hydrograph method and snowmelt formulae for calculating runoff are applicable. The first subroutine is the basic computation of runoff which is applied to each sub-basin in turn. The remaining four subroutines all deal with flow routing through storages either in the form of a controlled level reservoir, a natural lake, valley storage, or a river reach subject to backwater effects. A typical flow sheet for the simulation is shown on Fig. 1, and computational procedures incorporated in the various subroutines are described below.

Calculation of Runoff (Inflow into End of Reach)

This routine computes the runoff from rainfall, snowmelt, or from snowmelt and coincident rainfall. For snowfree conditions runoff is computed by standard methods such as the unit hydrograph or lag and route methods, depending on the basic data available. In calculating runoff due to snowmelt or snowmelt with coincident rainfall, the formulae developed by the U.S. Corps of Engineers are used. These formulae are described in detail in the Corps' Snow Manual, and are given in Table I for reference. It will be noted that the appropriate formula must be selected for rainy and non-rainy days and according to the degree of forest cover on each sub-basin. In the subroutine, provision is made for dividing each sub-basin into four sections according to the amount of forest cover.

As air temperature, which is one of the most important meteorological variables affecting snowmelt, varies with elevation, provision has been made in the subroutine for dividing the sub-basin into four elevation bands. In calculating snowmelt, the potential melt as determined from the formulae is adjusted for evapotranspiration losses and is then multiplied by a coefficient obtained from an area contributing curve. This curve takes account of the percentage of snow already melted and of the effect of the initial priming (wetting) of the snowpack.

After the total runoff due to rainfall, snowmelt, or snowmelt and coincident rainfall, has been computed, it is divided into components of direct and indirect runoff to which varying lag times are applied. For the period under investigation, the lagged flows in each time interval are added together. From this total, the infiltration losses of the sub-basin are subtracted to give the outflow hydrograph. Addition of the outflow hydrograph to base flow in the river at the downstream end of the sub-basin gives the 'inflow-into-end-of-reach' hydrograph. Alternatively, where hydrometric records suitable for unit hydrograph analysis are available, the outflow hydrograph from each sub-basin may be obtained by means of distribution graphs supplied as input to the simulation.

At the present time, the infiltration losses and the base river flows are supplied to the computer as input data. It is anticipated that when more is known about these phenomena they can be calculated in the program.

Routing of Inflow Through a Controlled Reservoir

If the area for which a hydrograph has been obtained terminates in a controlled reservoir, the runoff is routed through this reservoir in a manner determined by established control procedures. Since the com-

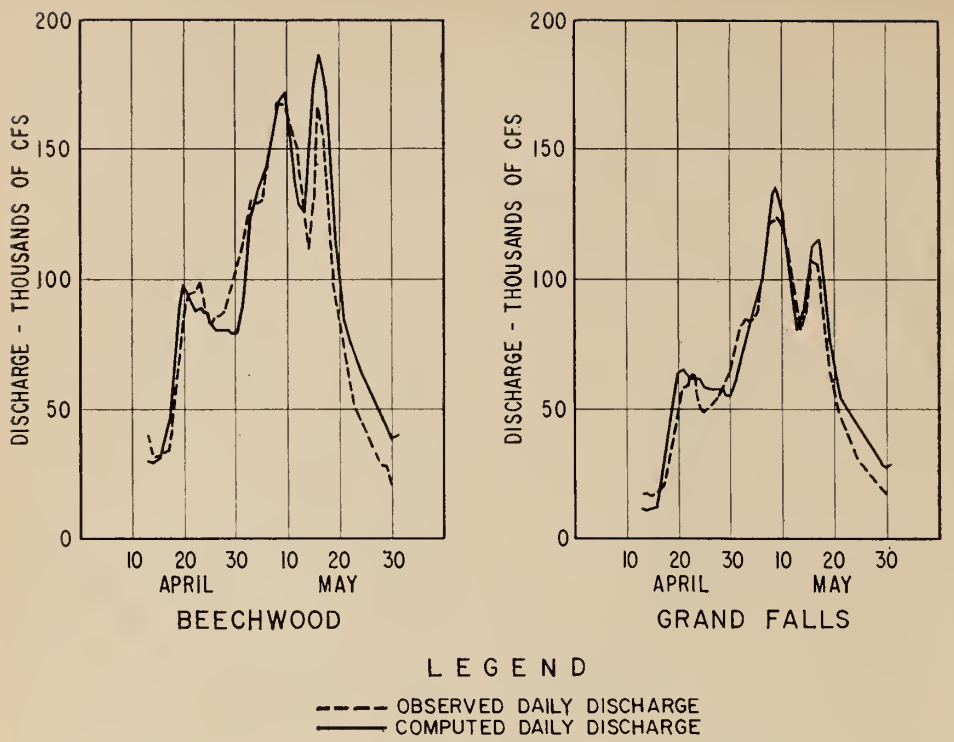


Fig. 3.—Saint John River Comparison of Observed and Computed Spring Flood Hydrographs for year 1960.

puter program has been set up for the most general case, the subroutine is written for a reservoir which has the following discharge works:

(a) Hydraulic turbines
(b) Low level outlets
(c) Controlled spillways
(d) Uncontrolled spillways

A controlled reservoir can be operated in many different ways, and rules must, therefore, be provided for either storing or releasing the water. This is accomplished in the subroutine by providing a rule curve which gives for each time interval the desired reservoir level.

The input data required are rating curves for the discharge works, rule curves for reservoir operation and the reservoir storage curve.

Routing of Inflow Through a Natural Lake

The flood hydrographs in a river can be considerably modified by natural lakes which may exist in the drainage area. To simulate this effect in the computer program, the runoff above a lake is calculated and routed through the storage in the lake. If the drainage area contains a large number of small lakes, the lakes may be combined in the simulation to form one large hypothetical lake through which the combined inflow into each lake is routed.

It is assumed that the lakes have horizontal water surfaces so that routing can be performed using standard techniques. The only input data required consists of the lake storage curve and the rating curve of the lake outlet.

Routing of Inflow Through Valley Storage

In this subroutine, the effect of valley storage is simulated using the Muskingum routing method. This method can, however, only be applied with confidence when recorded inflow and outflow hydrographs are available for the reach of river under consideration.

Routing of Inflow Through a River Reach with Backwater

This subroutine is used to simulate pondage upstream from a proposed dam or other river control, or where the Muskingum routing method is not applicable. Rating curves for various points along the reach and channel storage curves are supplied as input data, and the routing proceeds from point to point along the river. This subroutine can be applied where water levels along the river during floods are to be computed.

Computer Input Data

Few of the hydrologic characteristics of a river basin are susceptible to direct measurement, and analysis of existing hydrometeorological records is generally the prime method of determining their values. Where suitable hydrometeorological records are not available, hydrologic characteristics of a basin are often synthesized, using methods such as those developed by Snyder,[4] and by Taylor and Schwarz.[5]

It should be emphasized that the accuracy of the results obtained from a computer simulation is just as dependent upon adequate hydrometeorological records as that obtained with other modern hydrologic techniques. However, the use of high-speed electronic computers does offer accuracy, speed and flexibility in hydrologic studies at relatively low cost. In cases where the amount of basic data is limited, it offers a fast and economical method of assessing the effects of any indeterminate variables and the accuracy of the results obtained.

The hydrometeorological variables supplied as input to the simulation include base flow and infiltration losses, together with such meteorological variables as air temperature, precipitation, cloud cover, wind speed and solar radiation. In the hydrologic simulations which have been made, base flows and infiltration losses were generally estimated from analysis of existing streamflow and meteorological records. Insolation was estimated from sunshine records while the albedo factor, which expresses the percentage of radiation reflected by a snowpack, was obtained from data published by the U.S. Corps of Engineers.

Where possible and practicable, basin characteristics were measured or estimated from available information. Storage curves for reservoirs and natural lakes, and rating curves at points on rivers usually fall into this category. Characteristics which are frequently not susceptible to measurement or accurate estimation are the degree and density of forest cover on each sub-basin, the lag times within each sub-basin, and the area contributing curves. In estimating the values of these variables, it was generally necessary to resort to trial and error methods as described hereafter.

Simulation of Past Floods

As mentioned previously, a great advantage of using high-speed electronic computers in hydrologic studies lies in the fact that the influence of each parameter or variable can be assessed quickly and at relatively low cost. This capability has proved most useful in studies of large river basins for which hydrometeorological records were available, and where measurement or accurate estimation of some of the hydrologic characteristics by the usual methods was not practicable. The procedure used to deter-

mine the unknown basin characteristics is briefly as follows.

From streamflow records, a basin outflow hydrograph is selected for which the corresponding hydrometeorological records are available. These records, together with best estimates of the unknown basin characteristics, are used as input data for the simulation. An outflow hydrograph is then computed and matched with that actually recorded. In most cases, it is necessary to adjust the values of the unknown parameters several times before a satisfactory match is obtained. The combination of values with which the recorded hydrograph is best reproduced is then retained as input and used in the simulation to reproduce another recorded hydrograph, preferably of dissimilar shape to the first. The process is repeated as often as required and when several hydrographs can be reproduced with sufficient accuracy, the values of the basin characteristics thus obtained may be used for other computer runs.

Examples of the degree of accuracy which can be obtained with this technique are illustrated on Figures 2 and 3. These show computed and recorded hydrographs of the Saint John River at Grand Falls and Beechwood for the years 1958 and 1960. In this study, the unknown basin characteristics were determined by simulating the hydrographs for the year 1958. The values obtained were then used to calculate the hydrographs for the year 1960, which was selected because the records showed two pronounced flood peaks caused respectively by snowmelt, and by snowmelt and coincident rainfall. It was considered that reproduction of the 1960 flows would give a rigorous test of the validity and accuracy of the simulation.

Application to Flood Estimation and Control

The computer program which has been described in this paper can be used to solve a wide variety of hydrologic problems. Possibly its greatest value, however, is in fields where the optimum solution can only be obtained by evaluating alternative procedures and criteria, and where it is necessary to carry out repetitive operations such as flood routing which, by the usual manual methods, are extremely time consuming.

Flood control planning, for flood protection, power generation or other purposes, involves hydrologic analyses of this nature, and is an obvious field for application of simulation techniques. A computer simulation offers a rapid and economical method of calculating design floods at various points on the river, of evaluating the degrees of control provided by various volumes of storage at various locations in the river basin, and of determining optimum reservoir operating procedures for controlling floods of varying magnitudes. Flows and water levels along the river can also be readily obtained to delineate flood vulnerable areas and allow the protection provided by flood control measures to be assessed. The program has proved useful in predicting seasonal runoff from large watersheds, and in estimating the magnitudes of extreme floods by maximizing hydrometeorological conditions. It is also useful in evaluating combinations of hydrometeorological conditions capable of producing large floods which may be used as the basis of design of such structures as spillways, culverts, etc.

In flood forecasting also, the simulation can be used with advantage. At the beginning of a rainstorm or period of snowmelt, for example, hydrometeorological data can be fed into a computer as it is recorded, and continuous estimates of flow obtained. Where a computer is not available for continuous forecasting, the simulation can be used in the preparation of forecasting charts by computing hydrographs for a wide variety of hydrometeorological conditions. In similar fashion, rule or guide curves for operation of flood control works can also be determined for a large range of floods. The speed with which accurate flood forecasts can be obtained is also of great value in improving flood warning services, a not unimportant aspect of flood control programs.

The hydrologic simulation of a river basin, programmed for use on an electronic computer, can thus play a significant role in flood estimation and forecasting and has special application in flood control planning.

Acknowledgements

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TABLE I

Snowmelt Formulae

A—Snowmelt During Dry Periods

(i) Heavily Forested Areas (80%-100%) $M = 0.074\ (0.53T_a + 0.47T_d)$

(ii) Medium Forested Areas (60%-80%) $M = 0.0084\ KV\ (0.22T_a + 0.78T_d) + 0.029T_a$

(iii) Partly Forested Areas (25%-60%) $M = 0.0040\ K^1\ (1\text{-}a)\ I;\ (1\text{-}F) + 0.029T_a\ F + 0.0084\ KV\ (0.22T_a + 0.78T_d)$

(iv) Open Areas (0-25%) $M = 0.0051\ K^1\ (1\text{-}a)\ I_i + 0.029N\ (T_a - 5) + 0.0084\ KV\ (0.22T_a + 0.78T_d) + (1\text{-}N)\ (0.022T_a - 0.84)$

B—Snowmelt During Rainfall Periods

(i) Forested to Heavily Forested Areas (60%-100%) $M = T_a\ (0.007r + 0.074) + 0.05\ (2\text{-}F)$

(ii) Open to Lightly Forested Areas 0-60%) $M = T_a\ (0.0084\ KV + 0.007r + 0.029) + 0.05\ (2\text{-}F)$

Legend

Symbol	*Units*	*Designation*
M	Inches of Water	Potential Snowmelt
T_a	°F	Air Temperature Minus 32
T_d	°F	Dew Point Temperature Minus 32
K	—	Basin Convection —Condensation Melt Factor
V	Mph	Wind Velocity
K^1	—	Shortwave Radiation Melt Factor
F	Per Unit	Effective Forest Cover
a	Per Unit	Albedo of Snow Surface
I_i	Langleys	Incident Shortwave Radiation
N	Per Unit	Cloud Cover
r	Inches of Water	Rainfall

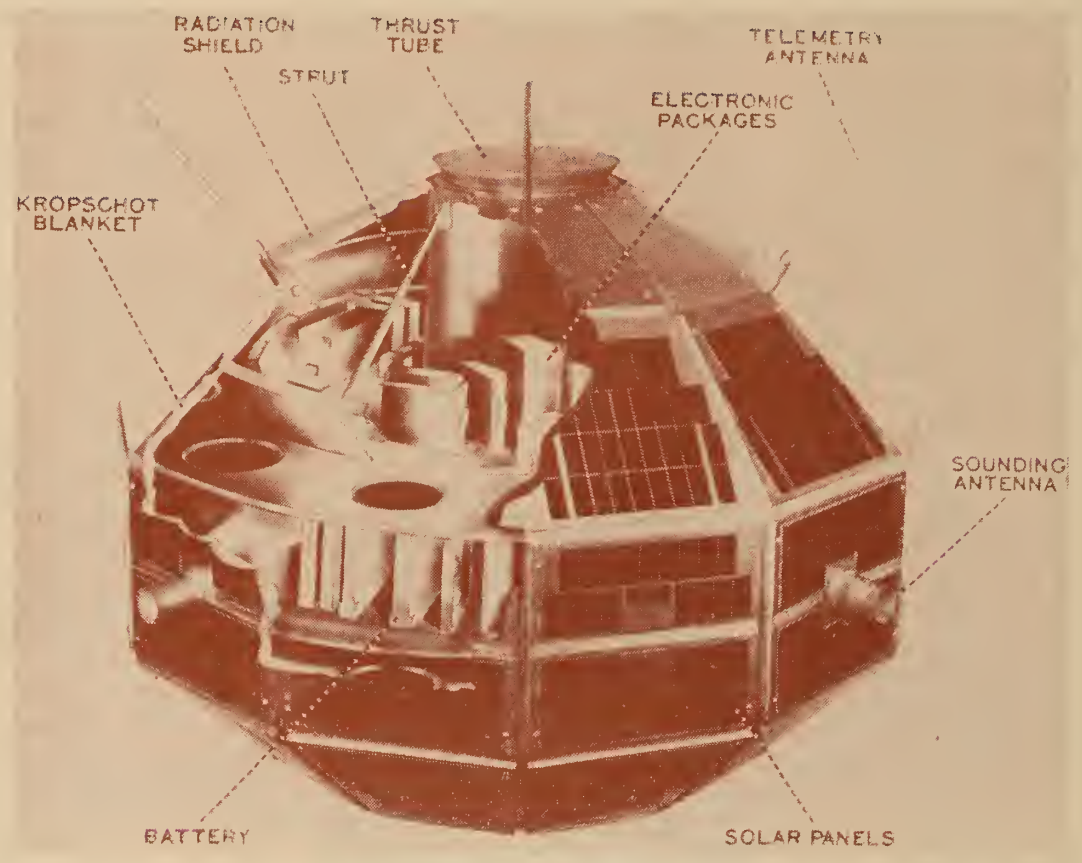
Reference

"Application of Snow Hydrology to the Columbia Basin", Johnson and Boyer, J. A. S. C. E.—Hydraulics Division—Vol. 85, January 1959.

EIC-63—CE & A 6

THE CANADIAN TOPSIDE SOUNDER SATELLITE ENGINEERING PERFORMANCE

R. K. Brown,
Defence Research Board, Ottawa



THE PRIMARY OBJECTIVE of the Topside Sounder projeet was to determine the eleetron density distribution in the ionosphere at altitudes between 300 and 1000 km. It was desired to study, for a period of a year, variations of this distribution with time of day, with latitude, and under varying magnetie and auroral conditions. Secondary objectives involved the determination of eleetron densities in the vicinity of the satellite by means of eosmie noise measurements and the observation of the flux of energetie partieles.

An altitude of 1000 km was ehosen for the satellite as a eompromise between various requirements. The ionosphere extends considerably beyond 1000 km. However, if the satellite had been plaeed in orbit substantially higher than this, (1) higher power would be required for the soundings, (2) poorer height resolution would have been aehieved, and (3) damage to the solar eells would have been eaused by energetie partieles.

It was desired to examine the ionosphere at all latitudes whieh indieated a polar orbit. In order to reduee the time required to observe the full diurnal variation at any one telemetry station, the orbital ineliination has been set at 80° toward the east. This results in precession of the orbital plane in such a direetion that the rotation of the plane of the orbit relative to the earth-sun line is approximately doubled. The eomplete daily variation ean then be obtained in three months instead of six.

To meet the objeetives set out above, one primary and three seeondary experiments were planned as follows:

Primary

Topside Ionospherie Sounder

Secondary

1. Energetie Particle Experiment
2. Very Low Frequeney Receiver
3. Cosmie Noise Measurement

Spacecraft Design

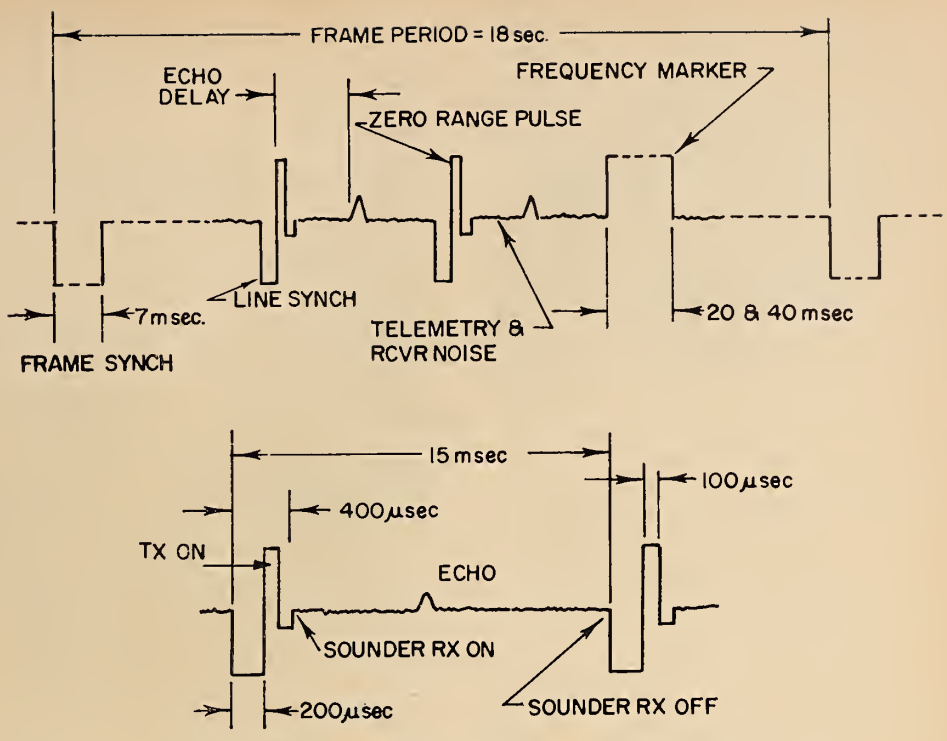
Three distinct spacecraft designs were required to meet the needs of the experiments listed above—elee-

trical, thermal and mechanical. These will be described in turn.

The electrical system includes six sub systems—the sounder, telemetry system, command system, energetic particle equipment, VLF receiver and the power supply. The satellite orbit and characteristics of the sounder and the command and telemetry systems are shown in Table I.

The sounder is a swept frequency pulsed sounder covering the frequency range 1.6 to 11.5 Mc/s. A 100μ sec pulse is repeated at a rate of 67 pulses per second. All the essential components are shown in Fig. 1. A variable frequency oscillator (VFO) sweeping from 19.5 to 32 Mc/s. is mixed with a 19 Mc/s. fixed frequency oscillator to produce the required frequency sweep. It should be noted here that it is desired to operate the sounder receiver over the frequency range 0.5 to 13 Mc/s. even though the antenna matching networks are efficient only over the frequency range 1.6 to 11.5 Mc/s. This is done to provide for the reception of cosmic noise over an extended frequency range, although the response falls off very rapidly below 1.6 Mc/s, being approximately 40 db down at 0.9 Mc/s. The increased cosmic noise intensity at the low-frequency end of the spectrum will partially offset this decrease in the overall sensitivity of the receiving system.

Pulse timing circuits provide a sync pulse to initiate the ground display or analysis sweep, a pulse to gate the transmitter on, and a pulse to open the receiver input during transmission. The frame sync pulses are obtained from a separate source from that which provides all the other timing pulses. The resulting video format is shown in Fig. 2. No attempt is made to synchronize the two sources and the frame sync pulse blanks all the other timing pulses during its ON period. Frequency markers are obtained by mixing a sweep frequency signal with two oscillator outputs—a 1 Mc/s oscillator generating all harmonics up to at least the 12th and a 2.5 Mc/s oscillator with fundamental and a 3rd harmonic only. The swept frequency signal is obtained by mixing 18.5 Mc/s with the VFO and is therefore at any instant, 0.5 Mc/s higher in frequency than the transmitter. The resulting frequency markers occur at 0.5, 1.5, 2.5, 3.5 Mc/s, with additional markers at 2.0 and 7.0 Mc/s. The last two markers provide positive identification of the main series. The 18.5 Mc/s FFO was used instead of the 19.0 Mc/s oscillator because coupling between the sweep cal. mixer and the receiver mixer resulted in the injection of an undesirable 19.0 Mc/s signal into the receiver IF amplifier.



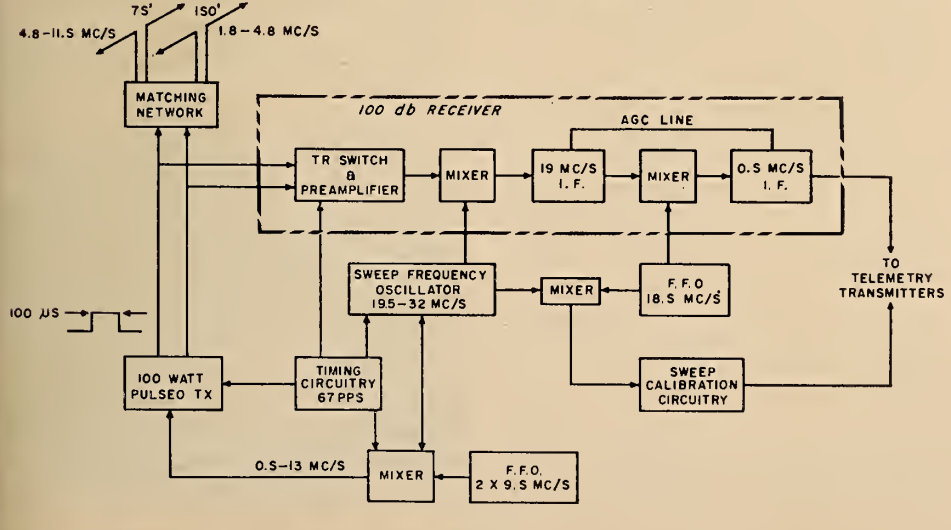
VIDEO FORMAT FOR IONOSPHERIC DATA LINK.
Fig. 2.

The received signal from the antenna matching network is mixed again with the VFO output to produce a frequency of approximately 19 Mc/s. This is amplified in a 19 Mc/s IF with a bandwidth of 120 kc/s in order to raise the signal level well above the noise level of the next mixer. A 500 kc/s amplifier having a log-linear amplitude response and a bandwidth of 30 kc/s follows the second mixer and an envelope detector provides the wide band telemetry output.

To ensure reasonable radiation efficiency for the sounder it was necessary to provide an antenna which was an appreciable fraction of a wavelength in length—preferably one half wavelength. Consequently the sounding antenna system consists of two dipoles—one 75 ft. and the other 150 ft. from tip-to-tip—and a pair of wide band matching networks. The longer dipole and associated network handles the frequency range from 1.6 to 4.5 Mc/s and the shorter dipole with matching network operates over the frequency range 4.5 to 11.5 Mc/s.

An early decision was made to use two telemetry transmitters to handle the data transmission requirements. The video signal produced by the ionosphere sounder, including line and frame synchronization pulses, and frequency markers, is modulated directly onto a 2 watt carrier at a frequency of 136.080 Mc/s (see Table

Fig. 1. Sounder Block Diagram.



I). The video signal bandwidth is ½ cps to 10 kc. A 22 kc subcarrier (carrying redundant engineering data) also modulates this transmitter. A second transmitter operating at a power level of 0.25 watts and a frequency of 136.590 Mc/s is phase modulated by four subcarriers. These subcarriers are in turn modulated by the data from the auxilliary experiments—energetic particle, VIF receiver and cosmic noise—and engineering data representing spacecraft operation such as temperature, battery charge and discharge currents and the state of the battery switching matrix.

The command system used in the topside sounder satellite is based on the transmission of a radio-frequency signal which is amplitude modulated by sequentially-coded combinations of seven discrete audio tones. These seven tones are decoded in a 4 by 3 matrix to provide control of twelve ON-OFF command functions in the spacecraft. Four of these commands are used to switch in spare units, six to achieve specific modes of satellite operation, one to turn off the beacon transmitter for space silence and one for a general turn-on of the sounder. Associated with the command system is an automatic turn-off unit which turns off any satellite function (subsystem or whole system) 10 minutes after it has been commanded on. The complete receiver-decoder system is redundant for increased reliability. The main features of the telemetry and command system are shown in Fig. 3.

The energetic particle experiment and the VLF experiment will not be discussed in this paper. The former was conceived, designed and constructed by the Cosmic Ray Section of the Division of Pure Physics of the National Research Council and the results are being analyzed and reported by them.

TABLE I
S-27 Satellite Characteristics

Orbit	
Circular	625 miles (1000 km)
Inclination	80 toward the east
Sounder	
Transmitter Frequency Sweep	1.6 to 11.5 Mc
Receiver Frequency Sweep	0.5 to 13.0 Mc
Transmitter power	100 watts pulsed
Modulation	100 sec pulse with 67 cps prf
Telemetry No. 1	
Frequency	136.080 Mc
Transmitter Power	2.0 watts nominal
Modulation	FM ± 40 kc maximum deviation
Data Inputs	1. Sounder receiver output 2. Sounder line and frame sync pulses plus frequency markers 3. 22 kc subcarrier carrying redundant data
Telemetry No. 2	
Frequency	136.590 Mc
Transmitter Power	250 milliwatts
Modulation	PAM/FM/PM ± 0.8 radians rms deviation by four IRIG subcarriers
Data Inputs	1. Channel 9—3.9 kc 35 point PAM commutator Battery voltage Temperatures Charging currents 2. Channel 11—7.35 kc Particle detector 3. Channel 12—10.5 kc particle detector 4. Channel 13—14.5 kc Cosmic noise data, frequency marker pulses
Beacon	
Frequency	136.980 Mc
Transmitter Power	50 milliwatts
Modulation	None
Command Link	
Seven tone AVCO system	12 commands

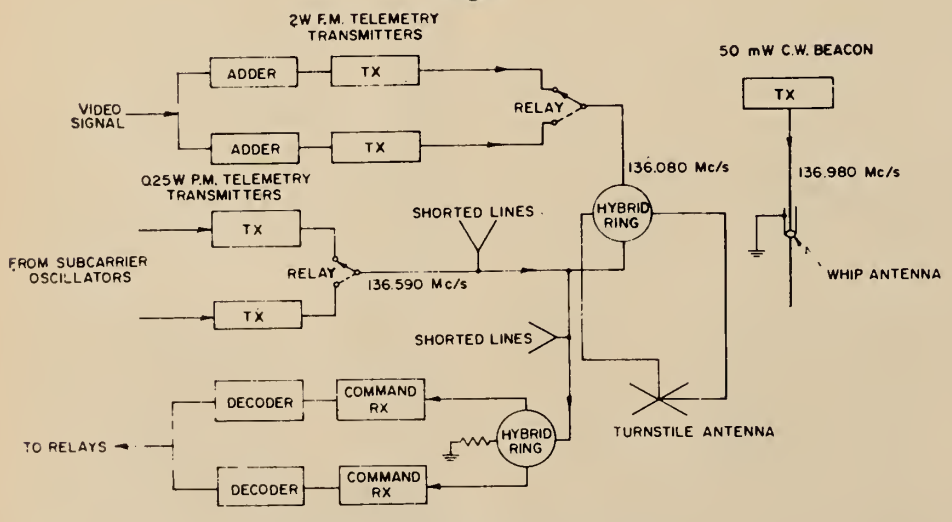
The power source consists of nickel-cadmium batteries recharged by silicon solar cells. DC-DC static converters supply the necessary voltage levels. A total of 6480 solar cells, arranged in 144 series groupings of 45 cells each, provide the charging power for four separate 12 battery Ni-Cd battery supplies. The solar cell efficiencies (9 percent), arrangement (aspect ratio 4.25), operational temperature (0°C), together with factors for micrometeorite damage, transmission losses, and safety margin supply an input to the batteries that has a design minimum of 22 watts.

One of the four battery supplies provides power for most of the continuously operating circuitry. The remaining three operate the command part of the instrumentation. These three supplies have capacities proportionally much larger than necessary when considered in the light of charging power per orbit. This excess capacity will be used to supply sounding power for the greater part of two successive orbits, recharging taking place over many following orbits. Construction techniques developed for presently orbiting satellites have been used in all phases of the power source construction. However, thicker (0.012 in.) than average solar cell cover glasses have been used to protect against higher energy electron damage.

The thermal control of the spacecraft is passive. The desired a/e ratio was obtained by the use of optically coated glass covered solar cells on anodized aluminum (a/e = 0.95), and polished aluminum surfaces (a/e = 2.5). The resultant spacecraft a/e is 1.15.

A near spherical spacecraft shape was chosen as this was most convenient from the standpoint of passive temperature control and constant solar cell illumination aspect. View

Fig. 3.



ALOUETTE TELEMETRY SYSTEM.

or shape factors governing receipt of radiation do not change appreciably with position in orbit. In addition, as the spacecraft is spin-stabilized, radiation is conveniently averaged around the outer shell. The payload electronics dissipate 35 watts when fully operating. However, the central mass of the spacecraft has a large heat capacity so only the average power dissipation, averaged over a number of orbits, is significant. This is 10 watts. For a 320 lb. spacecraft, this power dissipation is small; hence, a design providing poor radiative and conductive coupling between outer shell and inner payload was most effective in achieving the system requirement that solar cells operate as near 0°C as possible to gain maximum cell efficiency while the inner instrument package and NiCd storage batteries be held near room temperature (20°C).

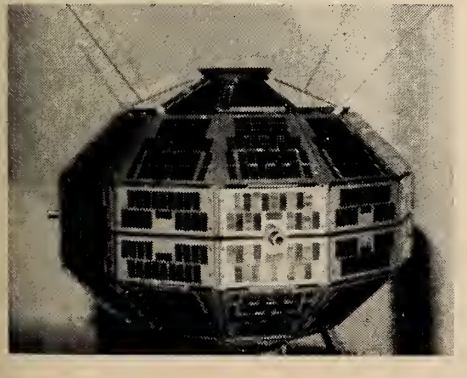
Radiative isolation of the inner payload from the outer shell was obtained by placing a radiation insulator consisting of several layers of ½ mil aluminized mylar inter-leaved with unbonded glass paper, on the inner surface of the outer shell. The poor conductive coupling of the inner payload to the outer shell was achieved through special structural design. The net effect of this design was that orbital temperature excursions of the inner payload would be much less than that of the outer shell.

A preliminary adjustment of the thermal model based on thermal-vacuum tests of the prototype spacecraft indicated the following mean orbital temperatures:—

	100% Sun	*66% Sun*
Instrument package	30°C	0 to 5°C
Outer shell	28°C	−15 to +10°C

The shape and general structure of the spacecraft are shown in Figs. 4 and 5. It approximates an oblate spheroid and the design is a compromise between two requirements—first that the electronic packages be accessible and easily removed and second, that the solar aspect ratio

Fig. 4. Spacecraft Flight Model.



be constant. The aspect ratio is the effective fraction of the total surface area illuminated. A constant aspect ratio is desirable to maintain constant solar cell output power.

Electronic components are mounted on the platform on each side of the central structure which contains the sounding antenna modules and the batteries (see Fig. 5). Attached to the periphery of the central structure are two half-shell aluminum spinnings which form the stabilizing shell. Onto this spun shell are attached the solar cell panels and both heat control end caps. The central structure is attached to the thrust tube through which the entire load is transmitted.

The result is a vehicle with a good mechanical access to solar cells and electronics, and an aspect ratio constant to within 10%. The aspect ratio varies from 3.8 to 4.2 over all possible orientations of the satellite relative to the sun.

The satellite dimensions are 42 in. in diameter and 34 in. in height. The total weight is approximately 319 lb. with the following weight breakdowns:—

	Pounds
Central structure including thrust tube	30
Spun aluminum skin and outer structure	31
Solar cell panels including glass-covered cells	21
Sounding antennae plus drive mechanism	45
Telemetry antennae	2
Electronic package including wiring and connectors	115
NiCd storage batteries	75

The roll and pitch moments of inertia of the spacecraft prior to sounding antenna extension are 7.9 and 5.5 slug-ft.^{2}, respectively. These values increase to 577 and 255 slug-ft.^{2} with antennae unfurled.

The sounding antenna system consists of crossed dipoles one of which measures 150 ft. tip-to-tip and the other 75 ft. tip-to-tip. Individual poles are 73½ ft. long and 36 ft. long, and 0.90 in. in diameter. The novel feature of this antenna design is the manner in which it is stowed within the spacecraft in a relatively compact volume. Fig. 6 shows an antenna module with a 75 ft. pole wound on the storage spool. The unit is about 20 in. long. An antenna tube consists of a strip of spring steel 0.004 in. thick and 4 in. wide, formed and annealed into a circular section with an overlapping but open seam. For stowage the tube is drawn through a

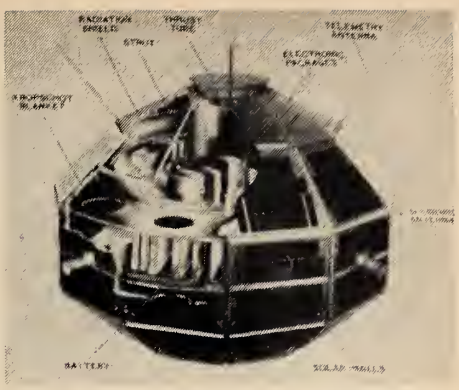


Fig. 5. Cutaway View of Spacecraft.

set of guides which force the tube to open and return to the first strip shape. The strip is then wound tightly on a storage spool.

Two flat rubber friction-drive belts, each about ¼ in. wide and driven by a set of pulleys, are used to pull the spring steel off its storage spool during antenna extension. Since the steel antenna strip stored on the spool is not in its stress-free state, there is a tendency for the material to unwind in a fashion similar to a clock spring. Consequently, the rubber drive belts serve a second purpose in constraining the antenna on its storage drum.

All four antenna poles are driven out in unison during extension by a single motor and gear train. The shorter poles are declutched from the drive when fully extended while the longer two continue to drive out. The rate of extension of each tube is C.17 ft. per second. Antenna poles formed in this fashion have the necessary rigidity and at the same time can be stowed in a small space.

Engineering Results

The overall performance of the satellite can only be described as very good. At this writing (five months after launch) all components are functioning normally. No sub systems have failed and there is no indication of any circuit component failure.

To assess the performance of the ionospheric sounder it is useful to set down the factors which were considered in the system design to determine the required sounder transmitter power level. These are shown in Table II. In addition to the factors shown, loss by absorption in the ionosphere was considered. Estimates for this factor varied from 0 to 10 db which would have placed the required transmitter power between 400 w and 4 kw. In fact a 100 w transmitter was used and the resulting ionograms, with notable exceptions, show 10 db signal noise or better. The exceptions are ionograms obtained at night over Ottawa and over northern Europe at night and to a lesser extent during the day. Ionograms ob-

tained under these conditions have a much poorer S/N ratio and in some cases are useless. This phenomenon has not been definitely explained. However there is strong indication that signals from two more high power broadcast stations are producing cross-modulation in the receiver with resulting spurious signals which increase the noise level markedly.

The 2 watt telemetry system is producing a signal about 4 db better than expected. The receiver threshold is 100 dbm and the predicted signal strength at 2000 miles was 96 dbm, whereas the received signal is equivalent to 92 dbm at 2000 miles. Since we do not normally attempt to record data at distances greater than 1500 miles, the quality of data received over this link is excellent.

The primary power supply was so designed that the solar cell output could suffer 25% degradation due to micrometeorite erosion of the cover plates. However, shortly before launch, a high altitude nuclear explosion produced an artificial radiation belt which has been responsible for additional degradation in the solar cell charging currents. The NASA scientists have calculated the expected damage to solar cells due to

TABLE II

Sounder Power Requirement

KT		—204 dbw
Cosmic noise (2 Mc)	+ 45 db	
Receiver Bandwidth (30 kc)	+ 45	
O and X Splitting	+ 3	
Polarization loss	+ 3	
Antenna Mismatch	+ 10	
Receiver S/N	+ 10	
Path Loss, 1000 miles (2 Mc)	+108	
Antenna pattern fading	+ 6	
	+230 db	+230 db
		+ 26 dbw
∴ Power Required		= 400 watts
If 6 db visual integration is assumed		= 100 watts

this radiation and the performance of our primary power supply is following this prediction very closely. At this writing (February 23, 1963) the solar cell charging currents are about 63% of the value at launch. Despite this we have not had to curtail the sounding program appreciably due to power limitation.

A detailed report of the mechanical and thermal performance is not possible since the spacecraft was not instrumented to supply such information in detail. However, the following specific measurements are of interest:

1. The spacecraft had a major structural resonance in the region of 20 cps. It was expected that it might

Fig. 6. Sounding Antenna Module.

be subjected to a 4.0g vibration along the spin axis at this frequency and therefore was tested to this level. Subsequent to launch, records obtained from instrumentation in the structure supporting the spacecraft have shown that the input vibration levels to the spacecraft during rocket accelerations were never greater than 2.9g.

2. The long sounding antennae were the longest ever to have been extended in space. They had been tested in a probe rocket with partial success and extensively tested on the ground. Laboratory tests cannot simulate the orbital environment but they had indicated that the steel tubes should extend at a rate greater than 2.0 in./sec but not greater than 5.0 in./sec. The lower rate was set by the power available in the battery driving the antenna motor and the upper rate by the maximum bending moment which the steel tubes could withstand. We have an accurate record of the antenna system extension which shows that the long antennae extended fully in 3 minutes, 19 seconds, an average of 4.5 in./sec.

3. As noted above, the temperatures predicted for the main instrument packages were 30°C when in a 100% sun orbit and 0-5°C when in a 66% sun orbit. The spacecraft has experienced each of the limiting orbital conditions twice and the recorded temperatures were 33°C for 100% sun and 10°C for 66% sun. It will not be possible to check the predictions for the outer shell temperature. The numbers given in the thermal design are average values whereas the actual temperature of the shell varies sharply from point to point and from minute to minute. It was intended that the satellite should be oriented in orbit with the spin axis not more than 13° from the perpendicular to the ecliptic plane. It was however inclined at an angle of 57 ±5° to the perpendicular on October 15, 1962. Consequently, the end caps have experienced extremes of temperature far beyond those indicated above (+100°C at the hot end and −20°C at the cold end). On the other hand there is every indication, both from recorded temperatures at 22 specific points, and from equipment performance, that all operating equipment — solar cells, batteries, electronic circuits—is running at temperatures which are well within design limits.

4. The spacecraft was required to spin about an axis along the center of the thrust tube. Such spin distributes the heat energy from the sun around the periphery and also guarantees that a sounding antenna null will not point at the ionosphere throughout a complete pass over one station. The lowest acceptable spin rate during the year of operation was 0.1 rpm and the spin half life was predicted, very approximately, to be seven years. Accordingly, a spin rate of 150 rpm was specified at injection. A rate of 120 rpm was actually achieved and this reduced to 1.4 rpm when the sounding antennae were fully extended. About three months later on December 27, 1962, the spin was 1.33 rpm which indicates that the prediction was the right order of magnitude but probably high.

CONCLUSION

The design philosophy throughout the program has been conservative by space standards. Power dissipating components have been derated by a factor of 10 and other components have been operated as conservatively as possible consistent with realistic engineering. The experience of a components group with a background in reliable components has materially aided the project. The desired result has been achieved. Five months of operation without failure and without observable performance change in any sub system (with the exception of the solar cells) probably constitutes a record for satellites of such complexity.

Acknowledgements

This project was carried out by the Telecommunications Establishment of the Defence Research Board. A large number of people must share the credit for the success of the project. It is not possible to name them all but the following people have made major contributions to the project:

Dr. J. N. Barry, Dr. C. A. Franklin, J. Mar, W. E. Threinen, Dr. A. R. Molozzi, H. R. Raine.

Dr. J. R. Chapman, Deputy Chief Superintendent of the Defence Research Telecommunications Establishment had responsibility for the over all program.

THOMAS CLINTON HIGGINSON

President
The Engineering Institute of Canada
1963-1964

"Clint" Higginson, the 1963-64 President of the Engineering Institute of Canada, has an incisive understanding of the needs and responsibilities of today's engineers.

This understanding has matured during an engineering and business career which started in Montreal and led him eventually to Saint John, N.B. and the kernel of his attitude is that Canada cannot be assured of a bright future unless engineers make full and responsible use of their skills and training.

Higginson was born in Montreal in 1909. He received his primary education at Strathcona Academy in Outremont. For personal reasons he continued his higher education during a period of years, giving special attention to mechanics and hydraulics.

He is a registered Professional Engineer with the Association of Professional Engineers of New Brunswick and has served the Engineering Institute of Canada as Chairman of the Saint John Branch, Councillor, and Vice-President for the Atlantic provinces.

Higginson's professional and business life started with Willis Overland in Montreal, where he became Assistant Manager. He left Willis Overland to enter the engineering department of Automatic Sprinkler Company of Canada and rose to the position of Manager of Engineering and Sales. In 1946 he moved to Saint John where he formed and still operates the Maritime Division of Automatic Sprinkler with branch operations in Halifax.

In the same year he formed Eastward Industries Limited, and continues as President and Managing Director of this firm. In 1949 he entered the land development business and is President of Country Club Heights Limited.

Higginson, who takes a serious interest in charitable, local and national affairs, is a past President of the Saint John Board of Trade and of the Community Chest. He has served as Chairman of many fund-raising drives for the improvement and development of his fellow man. He has served 12 years as an elected member of the Rothesay School Board and exerts a strong interest in educational matters.

He is a member of the Electric Power Development Committee of the Atlantic Provinces Economic Council, and takes an active part in Atlantic industrial development.

As an engineer Higginson holds patents and design registrations in Canada and other countries. His development of moisture and heat control systems for control of dote in veneer logs was of great assistance to Canadian producers, during World War II. He has been active in all parts of Canada in the development of fire control systems for strategic buildings, production systems, munition dumps, etc.

Higginson is an individualist in the true sense of the word. He accepts the full and independent rights of others, but is also convinced that there is a common ground available for those who believe in mankind.

His father was born in England. moved to the United States, then at the turn of the century came to Canada. The elder Mr. Higginson is a Life Member of the American Society of Mechanical Engineers.

In 1935 Higginson married Jean Beryl Towne of Danville, Que., a graduate of Bishop's University. They had one son, Thomas Henry, who died in 1949. Higginson has one brother, who lives in Montreal.

Mrs. Higginson has many personal interests, including education, painting and pottery. The Higginsons live in the Saint John suburb of East Riverside and enjoy common interests in reading. music. art. and travel.

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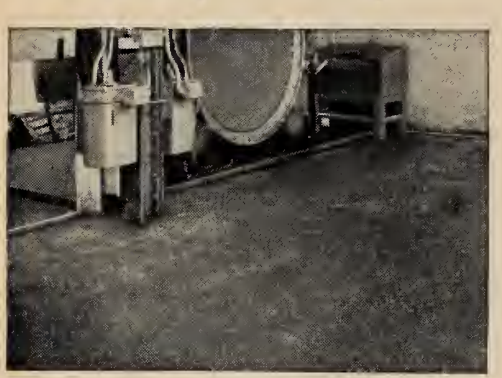

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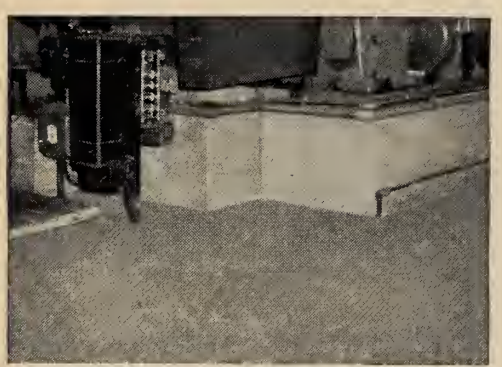

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Branch News

BAIE COMEAU
G. W. Scott

F. P. Whittingstall, Overhaul Superintendent, Trans-Canada Air Lines, Dorval, Que., was the guest speaker at the Branch's March 27 meeting. In the first part of his talk, Air Line Economy and Its Effect on Aircraft Design, Mr. Whittingstall summarized the growth of TCA and the various operating expenses which contributed to the airline's economy. It was interesting to learn that in spite of the vast increase in the cost of aircraft during the last 12 years (a DC 3 cost $150,000 then, whereas a DC 8 now costs $6 million), the actual cost to the passenger per seat mile has fallen by more than 4%, while the cost of living during this time has risen by more than 30%.

In the second part of his talk, Mr. Whittingstall dealt with factors relating mainly to aircraft maintenance and the part power plant maintenance played in the overall economy of airline operation. While a modern jet engine is costly (for example the price tag on a Rolls Royce Conway is $200,000), they enjoy a much longer life between overhauls. According to Mr. Whittingstall, Canada should be proud that TCA and the Canadian Department of Transport have led the world in the field of airline jet engine life development.

In the third and final part of this talk, the developments in aircraft design for the future were summarized. Mr. Whittingstall mentioned the apprehension felt by civil airlines today regarding the development of supersonic aircraft for long-range operation. This apprehension is due to the cost which would be involved with such aircraft. More likely to be in use in the next few years would be the medium to short haul fan jet aircraft which can be operated from runways 6000 ft. long and which could be used economically for flight distances of from 250 to 1500 miles. According to Mr. Whittingstall, the immediate outlook for the fast efficient very short-range aircraft was not as promising as many have expected. There is little doubt that an enormous market could be tapped here if a safe, economical vertical and short take-off aircraft could be developed to operate between city centres. However, owing to the technical problems yet to be overcome, it would be at least 15 years before economical transport aircraft in this category would be made available.

The talk was concluded with a reference to air-cargo which might present the greatest potential revenue growth in the airline business in the near future. Most of Canada's potential air cargo was one way, either across Canada, or across the Atlantic. It was for this reason that TCA had recently purchased four DC 8F Jet Traders which can be converted between flights for either cargo or passenger or a combination of both.

CORNWALL
G. Peter Schwarzkopf

Dr. John H. Hodgson, director and vice-president of the Seismology Society of America told members of the Branch that the Cornwall area is one of the more likely places in the country to be hit by an earthquake. Dr. Hodgson, who spoke to the members at their April 4 meeting, explained that this conclusion had been drawn after a study of earthquakes in the area since 1650. He said that properly constructed buildings could lessen the possibility of injuries. Dr. Hodgson said that the 1944 earthquake in Cornwall was 1.7 times more intense than a quake in Morocco which killed 12,500 people and injured about as many. He explained that the Cornwall earthquake caused less damage because it was centred much deeper in the earth than the Moroccan quake. A question-and-answer period followed Dr. Hodgson's talk.

KITCHENER
W. L. Bulmer

Assistant Professor George N. Soulis, University of Waterloo, was the guest speaker at the Branch's March 27 meeting. The title of Professor Soulis' talk was, "Most Engineers Can't Design". In this talk, he spoke of the recent transfer of skill from the craftsman to the engineer. Unfortunately, in this transfer, the engineer has become remote from the concept that a design is not an end in itself. Twenty-six members attended the meeting.

LAKEHEAD
W. Buryniuk

Structural Steels and Their Characteristics was the title of the talk presented to the April 17 meeting of the Branch by W. C. Kimball, Assistant Chief Metallurgist, The Algoma Steel Corporation, Limited. In this talk, Mr. Kimball dealt with the various strengths of steel presently available and in use. He outlined some of the unsolved problems in steel research. The talk was illustrated with slides. Mr. Kimball was thanked by C. Byers.

(Continued on page 72)

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cable is the work-horse of the power cable field. Its extensive background of long trouble-free service makes it one of the most dependable power cables presently available. It is relatively low in cost, has high ampacity and is suitable for all types of feeder and distribution work. As examples of its versatility, it can be used underground directly buried, in ducts, in tunnels or in submarine crossings. It can also be installed above grade on poles or on racks and trays. For complete details please write for Bulletin P6-A.

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Our laboratories, our resources and experience are at your disposal. If you are concerned with the design or installation of cable, it will pay you to consult Northern Electric.

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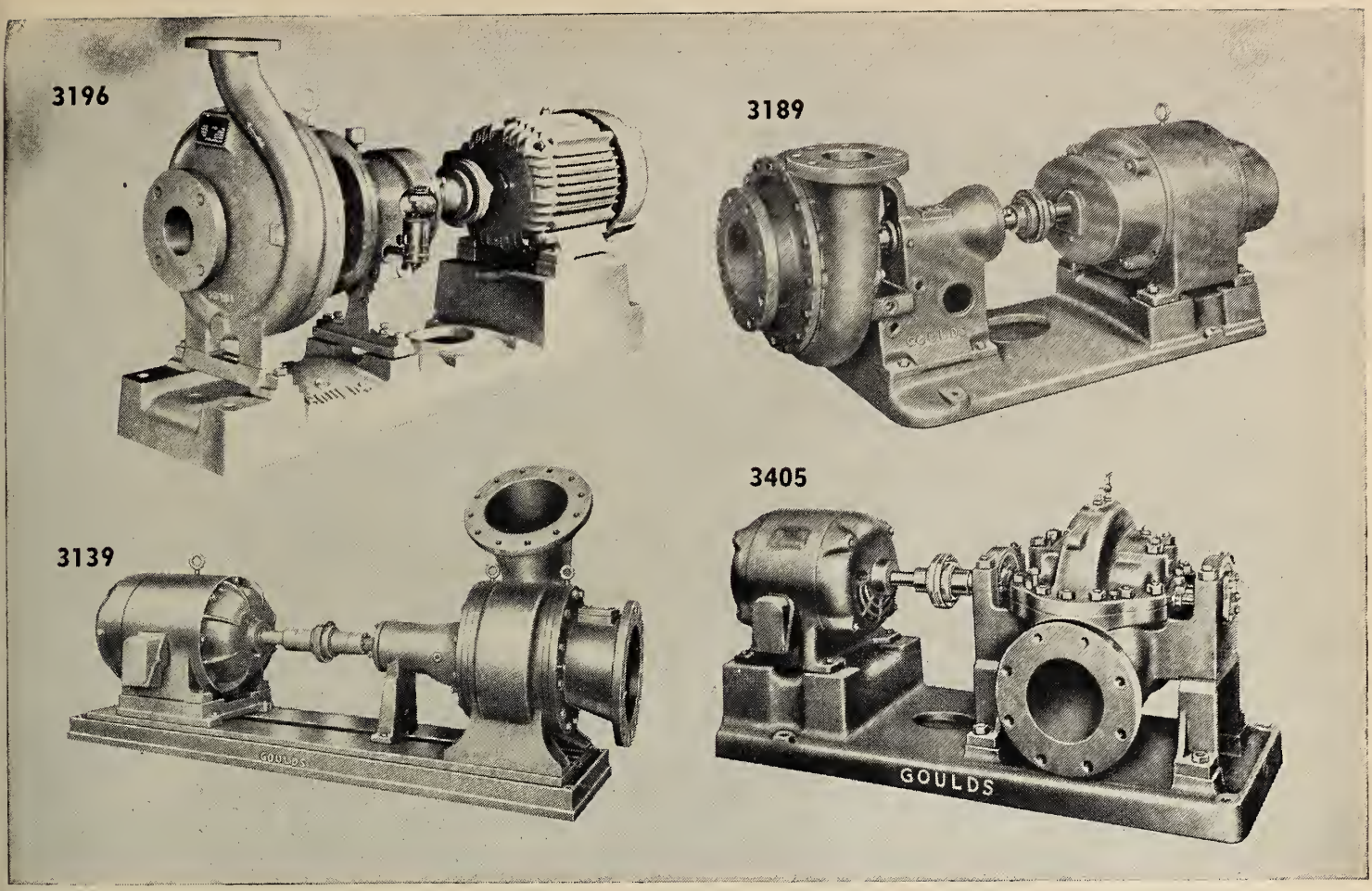

PICK A PUMP?

YOU know it's not that simple! Selection of the proper pump for your requirements demands prudent picking. **BUT...***if* one of the pumps on this page *was* suited to your requirements, you could certainly pick it with assurance of important benefits. These are four examples from the renowned range of pumps developed by an esteemed firm—Goulds Pumps Inc., a company with 114 years' experience in pump design—and now *manufactured and serviced in Canada* by MLW-Goulds Division of our company, which has its own proud background of experience. A growing number of Canadian industries have already begun to avail themselves of the outstanding pumps offered since the formation of MLW-Goulds, attesting to the evident quality of our product.

The specific models shown here *may* or *may not* be suitable to your particular requirements, but in either case they'll give you some small idea of what you can get in breadth of range and in design advantages from MLW-Goulds.

MODEL 3196–An outstanding line of AVS standard centrifugal chemical pumps developed by Goulds Pumps Inc., the American Voluntary Standards leaders. The 3196 has been in service over two years in major North American chemical plants. This line, in addition to 7 standard pumps, includes eleven bonus sizes of the same dimensions to best suit every requirement from 5 to 775 USGPM with heads up to 450′ and accommodating temperatures from −350° to +500°F. Back pull-out design plus precision aligners make maintenance and inspection a rapid one-trade operation. Completely manufactured in Canada, these pumps are stocked in ductile iron, 316 stainless steel and Gould-A-Loy 20 and can be supplied in any other machinable alloy. Bulletin 725.1

MODEL 3139–One of several lines of heavy duty process pumps which meet the many severe operating requirements encountered in the process and allied industries where either corrosive or non-corrosive liquids are handled. Specially adapted for pumping fluids with fibrous, granular or other type of solids in suspension, whether abrasive or non-abrasive, and thick liquids of all types such as paper stock, starches, slimes, slurries, etc. Capacities to 9500 GPM. Bulletin 725.5

MODEL 3189–A line of centrifugal pumps for a variety of applications in industry. Particularly suited for handling slurries, light paper stocks, and other liquids with solids in suspension. Comprising 13 sizes, the 3189 line is built in three groups, providing a high degree of standardizing and interchangeability of parts within each group. Capacities ranging up to 3000 GPM. Bulletin 720.4

MODEL 3405–This line of double suction pumps comes in 35 different sizes—140 different combinations. Three shaft and rotating parts assemblies take care of the 35 pump sizes. Extremely compact with very short bearing span which makes this pump 50% shorter than comparable units—saves floor space...makes the pump easier to handle and work on. Capacities: 100-6400 GPM. Bulletin 721.6

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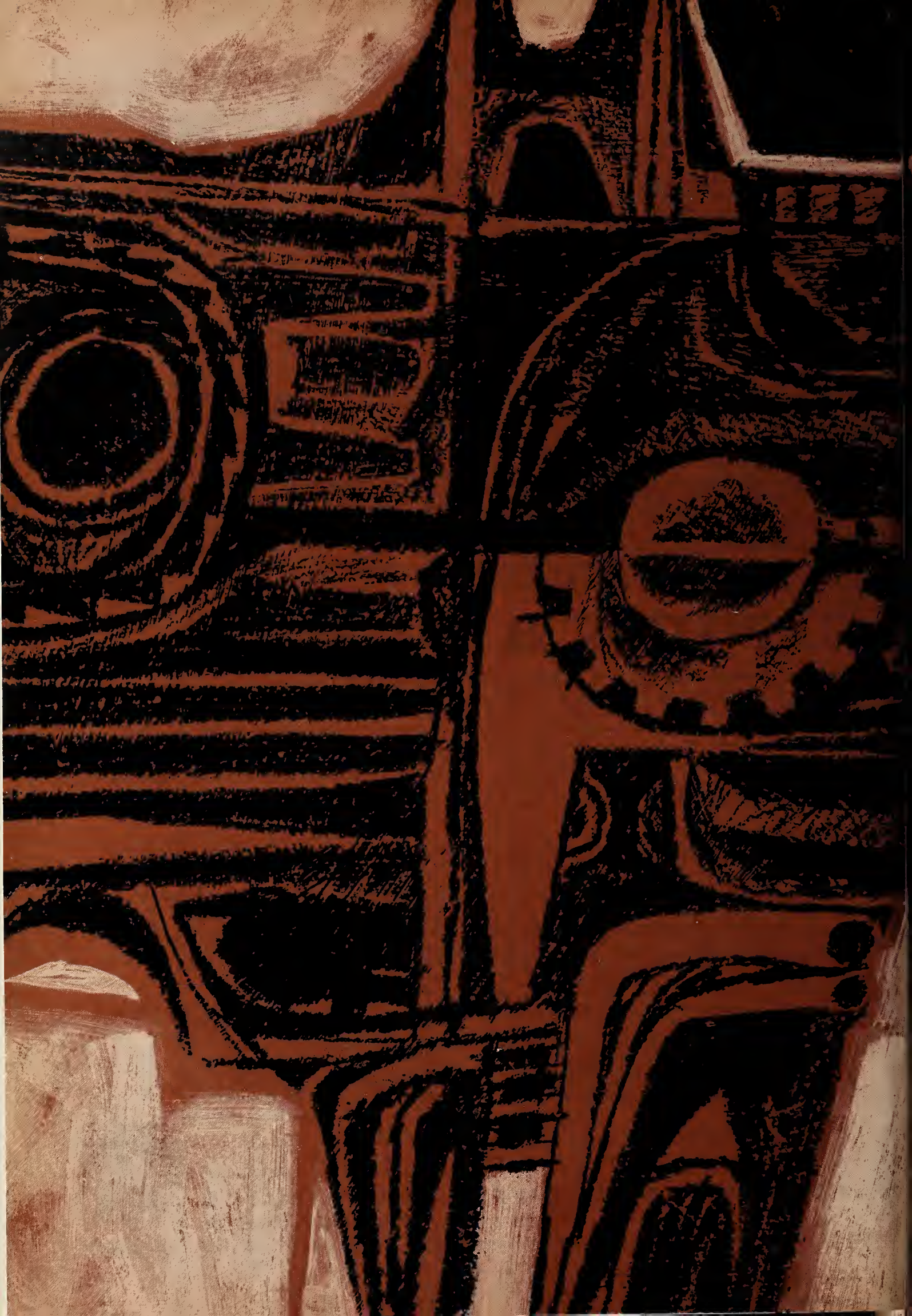

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Canadian Engineering

Victor St. Clair Blackett, M.E.I.C., was honored by the Institute April 26 for his long and selfless years of work on behalf of Moncton Branch. Mr. Blackett has served as Moncton Branch Secretary-Treasurer for 37 years. President Lawton (right) is shown presenting to Mr. Blackett an illuminated certificate during a Regional Information and Co-Ordination Centre meeting for Region IX held in Moncton. The certificate reads: An appreciation to Victor St. Clair Blackett. The President and Council of the Engineering Institute of Canada wish to record their sincere appreciation of your devoted service and the part you have played in the development of The Institute during the 37 years which you have served as Secretary-Treasurer of the Moncton Branch. 1926-1963.

New Chemical Lab Opened At N.S.T.C.

New Laboratory facilities for the training of under-graduate and graduate chemical engineering students in physical chemistry, analytical methods and materials science have been opened at the Nova Scotia Technical College. The facilities were opened formally by Nova Scotia Premier R. L. Stanfield who is Chairman of the Board of Governors.

The new arrangement permits the integration of work formerly done on several floors of three buildings into a single unit on one floor. The physical chemistry, balance room and analytical chemistry laboratories are at one end together with ancillary rooms for special instruments, and the specialized facilities for research on solids are at the other end of the same floor. These comprise rooms for microscopic work, inorganic materials preparation, precision electrical and magnetic measurements, X-ray studies and fluorescence of solids, a high temperature laboratory with special furnaces for sintering, heat treating and annealing ceramic and inorganic materials as well as special equipment for work on electronic ceramics. Several offices for graduate students and full-time research workers are also provided.

These new premises are the first stage of a reorganization of the Department of Chemical Engineering into new quarters. This step will permit greater emphasis on the most recent research methods, and will modernize its facilities for teaching the principles of chemical engineering by means of the latest mathematical and scientific methods.

New High Temperature Laboratory at the Nova Scotia Technical College.
(Maurice Crosby Photo)

Guide To Design Criteria Available Free To Members

A limited number of the publication, Guide To Design Criteria For Metal Compression Members, published in 1960 by the Column Research Council now are available at no cost to Members of the Engineering Institute of Canada. Members wishing a copy may write to Headquarters, 2050 Mansfield Street, Montreal 2, Que. These Guides will be distributed on a first-come, first-served basis until the present stock of them is exhausted.

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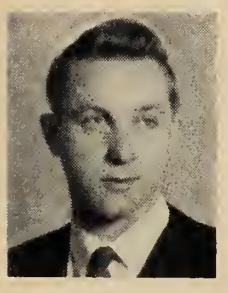
Personals



K. M. Hibbert

K. G. LaBerge

K. M. Hibbert has been named District Sales Manager for the Quebec region, Industrial-Medical Division of Liquid Carbonic Canadian Corp. He will have headquarters in Montreal.

Keith G. LaBerge has been appointed Vice President, Cellulose Operations for Rayonier Canada Limited. Mr. LaBerge, a 1936 graduate in Mechanical Engineering from the University of Saskatchewan, has been associated with the pulp and paper industry in Canada for many years.

J. C. Henshaw has been appointed General Manager of the Cochrane and Swartwout Divisions of Crane Canada Limited. Mr. Henshaw, a graduate Chemical Engineer from the University of Toronto, has specialized in industrial and municipal water treatment since 1953.

J. C. Henshaw

J. C. Klope

Joseph C. Klope has been appointed Sales Manager of Pfaudler Permutit Canada Ltd. Mr. Klope has been with the company for eleven years, and his present appointment is backed by practical experience as Superintendent of Fabrication and Pfaudler's design and development department.

J. G. Musgrave has been appointed general manager of Sperry Gyroscope Ottawa Limited. Mr. Musgrove, who was educated at Cambridge University, has been with the company since 1951. In 1957 he was appointed works manager, the position he held until his recent appointment.

Colonel W. G. Swan, (Toronto '06), a Vancouver Life Member of the E.I.C., president of based Swan, Wooster Engineering Company, has opened an eastern division of the organization in the city of St. Catharines, Ont. The eastern offices will specialize in the civil and structural consulting fields and will also co-ordinate electrical and mechanical services when required.

A. K. Douglass has been named President of Holman Bros. (Canada) Limited. Mr. Douglass was formerly General Manager.

A. K. Douglass

H. R. Stenson

H. R. Stenson, Domtar Chemical Ltd., Canada Creosoting Division, Montreal was elected 1963 President of the Canadian Institute of Timber Construction.

B. Leslie Peter has been elected Chairman of the Board and Managing Director of Alpha Aracon Radio Electronics Limited. He has been a Director of the company for the past year. Mr. Peter had been with Tung Sol Electric Inc. since 1957 serving in a succession of management posts. He established that company's Canadian Division in 1959.

B. L. Peter

A. F. Knowles

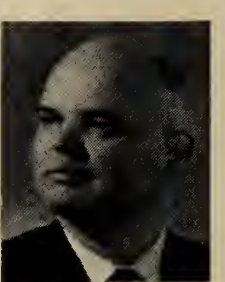
A. Frank Knowles has been appointed Treasurer of the Shawinigan Engineering Company Limited. Mr. Knowles was formerly associated with the Shawinigan Water and Power Company.

M. Dalcourt

M. A. Elson

Marcel Dalcourt has been appointed Zone Sales Manager for Onan Electric Generating Equipment and Industrial Engines in Eastern Canada. Onan Electric is a division of Studebaker Corporation of Minneapolis. Mr. Dalcourt has been actively engaged in the electric generating plant industry in Canada for more than 10 years.

Mel A. Elson has been appointed a member consultant with Johnson, Anderson, Bruce, Consulting Engineers, Port Credit, and Winnipeg. Mr. Elson, formerly Deputy Minister of Highways of the Province of Ontario and past president of Russell Construction Limited, brings to his new position 30 years experience in civil engineering and marine construction.



A. P. Earle
M.E.I.C.

J. S. Kennedy,
M.E.I.C.

Arthur P. Earle, M.E.I.C. (McGill '49) has been appointed assistant chief engineer at Dominion Textiles Company Limited. For the past 14 years, Mr. Earle has been engaged in the hydro-electric field in Quebec.

J. Stuart Kennedy, M.E.I.C. (Queen's '53) has been appointed Executive Assistant, Sales, at the Head Office in Montreal of the Canada Cement Company, Limited.

G. Y. Sebastyan, M.E.I.C. (Michigan '53) has been given the degree of Doctor of Philosophy by the University of Michigan.

(Continued on page 76)

MESSAGE FROM THE PRESIDENT

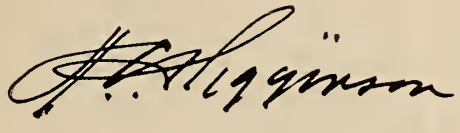
IN recent years many of us have tended to overlook the part that intellectual freedom of the individual is essential if he is to make his maximum contribution to our world. If we consider only our own profession, for a few minutes of reflection, we will be enabled to see a multitude of outstanding achievements, all of which are the product of the unfettered minds of great engineers. It is their example and leadership which inspired others to complete the development of the vast structure of engineering knowledge which is our inheritance.

THE common characteristic of these great engineers was their desire to better the lot of mankind by using their free-ranging engineering minds. This quality with the freedom from regimentation, the freedom to share knowledge, and the freedom to dissent, has established the engineering profession as unique in its contribution to our way of life. The same quality and freedoms are essential if engineering is to carry its tradition into the future.

EVERY member of the Engineering Institute of Canada utilizes the heritage of his professional forebearers. By so doing he must accept the personal responsibilities of preserving and adding to this fund of knowledge and experience. Voluntary participation in the activities of the Institute enable him to do this, since the Institute itself is founded under the same philosophy of service to mankind, independence of thought, and the free exchange of technical information that has made our profession great.

THE Engineering Institute of Canada has a brilliant past and looks forward to a future of even greater accomplishment and contribution. To achieve this future it must continue the essential functions of a voluntary, learned technical society, freely co-operating with sister technical societies in Canada and abroad, and working in the atmosphere of harmony and mutual respect with the Provincial registering bodies of Engineers, all in the interest of Canada and Canadian Engineers.

AS your president, and with the support of our members, I would dedicate my effort to these ideals.



T. C. HIGGINSON, President

for storing feed

Ten steel ingredient bins, each with a capacity of 60 tons, were designed and fabricated in Winnipeg by Manitoba Bridge to specifications laid down by the consulting engineers.

the simple and the complex...

Both are shown in this round-up of contracts from D.B. plateshops across the country. Large fabricators build up experience and take many complex jobs in their stride but every once in a while a problem comes along. When this happens new techniques are developed. This is a big responsibility for failures in the field not only cost a fortune, they can be dangerous.

When you buy welded fabrications be very sure of your supplier's ability. The Platework Division of Dominion Bridge maintain well equipped shops from coast to coast* and their total experience is unmatched in Canada.

*In Winnipeg: Manitoba Bridge & Engineering Works.

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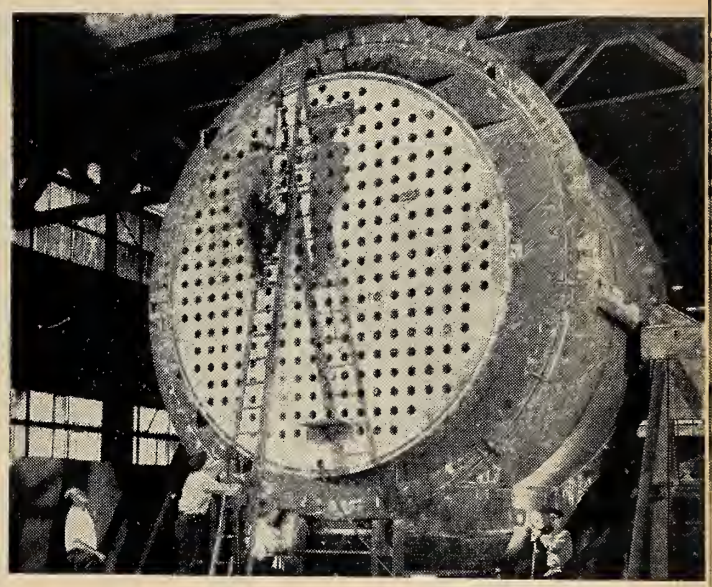
PLATEWORK DIVISION
DOMINION BRIDGE

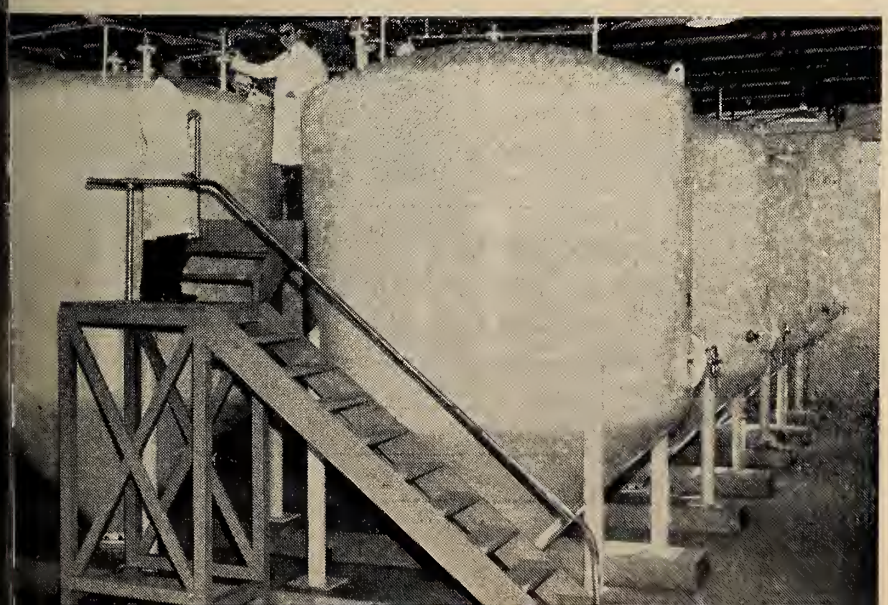
for chemical processing

One of five catalytic reformer reactor shells being made in Montreal from 1-¾ inch monel clad chrome-nickel steel. Special welding techniques were necessary to provide a satisfactory result.



for nuclear power

This is the calandria for A.E.C.L.'s new Candu reactor as it appeared during fabrication at the Dominion Bridge plant in Montreal. It is one of the most precise fabrications ever undertaken by the Company.



for making wine

These eight 5,000-gallon fermentation tanks were made by Dominion Bridge in Vancouver on very short delivery to meet the customer's needs. The material is mild steel lined with epoxy resin.

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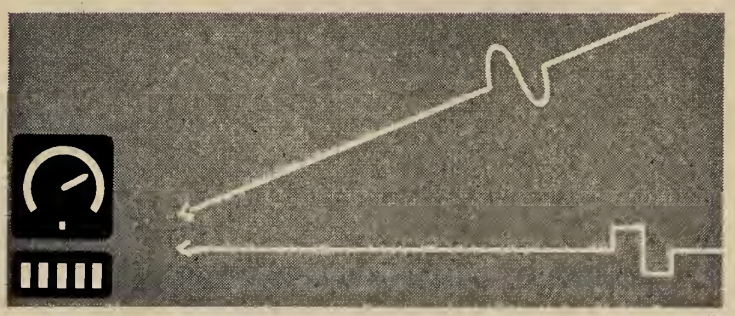

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Engineering Information Service

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PROCEEDINGS OF THE RESOURCES FOR TOMORROW CONFERENCE, Vol. 3, National Resources, Ottawa, $5.

RESOURCES FOR TOMORROW, Supplementary Volume, $1.

GUIDE TO BENEFIT-COST ANALYSIS, W. R. D. Sewell, John Davies, A. D. Scott and D. W. Ross, Department of Northern Affairs and National Resources, Ottawa, $.75.

PROCEEDINGS OF THE FIFTH JAPAN CONGRESS ON TESTING MATERIALS, The Japan Society for Testing Materials.

ENGINEERING THERMODYNAMICS, An Introduction. E. F. Pickerill. Abridged Callendar Steam Tables, Btu, and Chu Versions, by the late H. L. Callendar, $.30 each.

AUTOMATIC CONTROL HANDBOOK, G. A. T. Burdett, Advisory Editor, $21.75.

1962 STEAM ENTHALPY-ENTROPY, MacMillan, Toronto, $.20.

ADVANCES IN SPACE TECHNOLOGY, Edited by J. L. Nayler, $11.25.

THE PROFESSIONAL SCIENTIST, A study of American Chemists, Anseim L. Strauss and Lee Rainwater, $6.

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VECTOR ANALYSIS INCLUDING THE DYNAMICS OF A RIGID BODY G. D. Smith, Oxford University Press, Toronto, $4.50.

PHYSIQUE NUCLEAIRE ET PHYSIQUE MESIQUE T. H. Kahan, Armand Colin, Paris, 1963, 5,70F.

THERMONUCLEAR POWER T. S. Green, George Newnes Ltd. London, $11.25.

MARINE AUXILIARY MACHINERY H. Hillier, George Newnes Ltd., London, $8.75.

MULTIBAY FRAMES A. Kleinlogel and A. Haselbach, Frederick Ungar Publishing Co., Ntw York, $18.50.

SPECTROCHEMICAL ABSTRACTS, Vol. VIII, 1958-1961 E. H. S. Van Someren, Higher & Watts Ltd., London.

GENIE CHIMIQUE, TOME II Rene Gibert, Eyrolles, Paris, 38,00F.

CONCEPTS IN MANAGEMENT SCIENCE Donald J. Clough, Prentice Hall, Toronto.

CSA STANDARD B70-1963, CAST IRON SOIL PIPE & FITTINGS Canadian Standards Assoc., Ottawa, $1.

CSA B137-1963 POLYETHYLENE PIPE FOR COLD WATER SERVICES Canadian Standards Assoc., Ottawa, $1.50.

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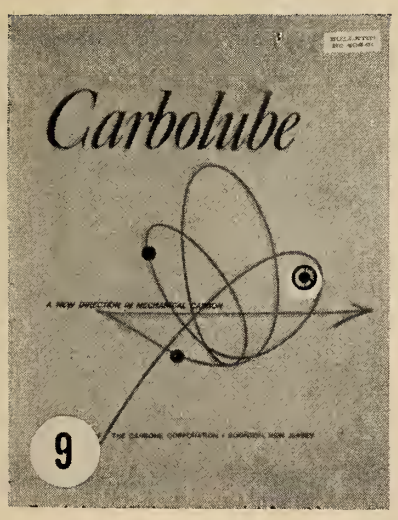

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SITUATIONS WANTED

CIVIL ENGINEER — A.M.E.I.C., P.Eng. (Que.), B.Sc. Eng. 1959. Experience in heavy construction, planning and cost estimating with some experience in design. Desires responsible position in municipality or manufacturing in Maritime Provinces. File No. 428-C.

ELECTRICAL ENGINEER — 1950 graduate. Administrative plant engineering experience in high and low tension electrics, process instrumentation and mechanical services as related to metallurgical and petro-chemical plants. Located in Montreal. Desires to relocate preferably to Ontario. File No. 5962-E.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., A.M.I.Mech.E. Married, age 35. Broad experience in engineering design, drafting supervision, liaison and production of electro-mechanical and mechanical units associated with the electronics industry. Seeks engineering administrative position where capacity for work, integrity and record of success can be utilised. Montreal area. File No. 324-M.

ELECTRICAL ENGINEER — M.E.I.C., B.Sc.E.E. University of Manitoba 1955. Desires position where he can gradually venture into engineering economics. Occupations such as city planning engineer, market survey engineer, safety engineer, could better utilize his talents than the responsibilities demanded of technical engineers. Some experience in power utility and transformer manufacture. Location open. File No. 412-E.

CIVIL AND HYDRAULIC ENGINEER — M.E.I.C., A.M.A.S.C.E. Experience includes detailed hydraulic design, engineering hydrology, feasibility and water resources studies for hydro-electric developments in Eastern Canada (8 years); previously in the irrigation and flood control fields in India (2 years). Canadian citizen with Master's in Hydraulic Engineering. B.Sc. (Civil Eng.) and B.A. (Honours in maths) degrees. Seeks career position with consultants in Western Canada, U.S.A. or international engineering organizations working in underdeveloped countries. Interests include company finance, travel and literary writing. Married, 3 children. File No. 496-C.

CIVIL ENGINEER — A.M.E.I.C., P.Eng. (Que.). Laval University, 1962. Age 23. Single. Fully bilingual. Followed 12 months training in mining company, with major stages in construction, maintenance and industrial engineering. Desires position in construction, field or office. Location open. File No. 495-C.

CIVIL ENGINEER — A.M.E.I.C., P.Eng., Alberta. Age 27, married. 1½ years experience with general contractor on hydro-development project; one-half year's experience in estimating department. Desires position with a general contractor or a consulting firm. Will relocate anywhere in Canada or U.S.A. File No. 494-C.

STRUCTURAL ENGINEER — M.E.I.C., P.Eng. 6 years in supervisory and management position. Completely familiar with all phases of design, specifications and job supervision. Desires position with progressive engineering or architectural firm offering prospects for participation in company. Complete resume on request. File No. 493-Str.

ELECTRICAL ENGINEER — A.M.E.I.C., P.Eng. (Alta.). Age 26, single. 4 years commercial and institutional building design experience. Desires responsible and challenging position with consulting engineering or architectural firm. Location open. Resume on request. File No. 492-E.

MECHANICAL ENGINEER — M.E.I.C., P.Eng. (Ont.), B. Eng. (McGill 1949). Age 39. Experienced in design, maintenance, and supervision in paper mill. Last 5 years as mechanical superintendent of pulp mill, responsible for maintenance, alterations and installations. Desires responsible position in production or plant engineering. File No. 491-M.

CIVIL ENGINEER — M.E.I.C., P.Eng., Ont. Age 39, married, no children. 6 years field experience in construction of heavy industrial plants; 6 years in a pulp and paper mill as design engineer; 1 year as structural design engineer with internationally known consulting engineering firm. Available immediately. File No. 490-C.

BRITISH GRADUATE MECHANICAL ENGINEER — First Class Honours. 2½ years broad industrial apprenticeship in heavy engineering. 1 year designing in nuclear industry, heat transfer, fluids, stress. Arriving Canada July 1963. Seeks design or development job. File No. 488-M.

CIVIL ENGINEER — A.M.E.I.C., B.Eng. (McGill) 1962. Seeks employment in the field of structures or foundations. Preferred location Montreal area, but other locations seriously considered. File No. 486-C.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., B.Sc.(M.E.). Athlone Fellowship. Age 31, married. 10 years experience in mechanical, hydraulic, pneumatic equipment design, development and fabrication. Looking for work in this field or related sales and service. Some knowledge of French. Present location Montreal; would relocate. File No. 487-M.

CIVIL ENGINEER — A.M.E.I.C., B.Sc. (Alberta '61). Age 24, married. Athlone Fellow, D.I.C. Hydro-Power and River Structures (Diploma of Imperial College, London, 1962). Presently engaged in hydraulics research at the University of Aberdeen, Scotland. M.Sc. expected October 1963. Desires position with Engineering firm specializing in hydraulics work. Available December 1963. Will locate anywhere. File No. 489-C.

BRITISH MECHANICAL ENGINEER — B.Sc. Eng. Married. 11 years nuclear design. Arriving Canada Aug./Sept. 1963. Desires design position, preferably nuclear or process. Previous Canadian experience. File No. 485-M.

SITUATIONS VACANT

CIVIL

CIVIL OR STRUCTURAL ENGINEER — required by structural steel fabricator—Montreal. Applicant must be French, good family background and be interested in sales. Working knowledge of English advisable. Please give full particulars and complete experience. Do not apply unless you are prepared to put in maximum effort. Salary dependent upon results. File No. 431-V.

SOILS ENGINEER. Masters degree in soil mechanics or at least 3 years experience in site investigations, laboratory testing and report writing. Location Toronto. Reply, stating full particulars, to File No. 429-V.

SENIOR SOILS ENGINEER — required by Toronto Branch of large firm of foundation specialists. Must have M.Sc. degree and/or at least 5 years experience in all facets of soil mechanics and foundation engineering, and be capable of taking complete charge of consulting section of the firm. Reply, stating full particulars, to File No. 428-V.

GRADUATE CIVIL ENGINEERS — Applications will be received from qualified engineers for the following vacancies which exist in the Department of Highways, Newfoundland:—1. Resident Engineers to design and supervise highway construction projects which include bridges, grading and paving. Salary range $5,060 to $8,360, depending upon experience and qualifications. — 2. Planning and Design Engineer to head up a new section in the Department. Salary $8,500 per annum. — 3. Construction Engineer to be responsible for overall supervision of all phases of construction carried on under contract to the Department. Salary $9,000 per annum. — 4. Maintenance Engineer to direct and supervise maintenance and reconstruction of roads and bridges as carried out by the Departmental forces. Salary $9,000 per annum. — Applicants must posses a degree in Engineering from a recognized university. Applications in writing giving full particulars of academic qualifications, age, marital status, experience, should be submitted to the Deputy Minister, Department of Highways, Confederation Building, St. John's, Newfoundland. File No. 440-V.

MECHANICAL ENGINEER

Located on the outskirts of Edmonton, The Canadian Chemical Company, Limited is a major producer of petrochemicals, cellulose acetate flake and synthetic fibres.

A graduate Mechanical Engineer, eligible for registration with the Association of Professional Engineers of Alberta, with up to five years experience in the Petrochemical or related industries, is required immediately for Plant and Project Engineering employment in the General Engineering Department.

Salary commensurate with experience and qualifications. Excellent Company benefits. Travel assistance granted.

Interested applicants are requested to outline their education, experience, salary expected, date of availability, references, etc., when submitting a resume to:

Personnel Department,
CANADIAN CHEMICAL COMPANY, LIMITED
P.O. Box 99,
Edmonton, Alberta.

SITUATIONS VACANT

ELECTRICAL

FIELD SALES-SERVICE ENGINEERS — P.Eng. (E.E.) — 2 to 5 years engineering experience, not necessarily in the instrumentation field, wanted by internationally known instrumentation manufacturer for sales, service and application of electronic instrumentation and systems for diversified industrial processes and research projects. Must be free to travel during the week. One—bilingual, location Montreal. One—location Toronto. Please give qualifications and personal resume. J. M. Jackson, Vice President, Leeds & Northrup, Canada, Ltd., 61 Industry St., Toronto 15, Ontario. File No. 427-V.

ELECTRICAL ENGINEER — Required for National Harbours Board, Montreal. Must be a graduate from a recognized university or equivalent. Experience: A minimum of 2 years practical field experience on Sub-Station and Distribution design. Good opportunity for advancement. Bilingualism an asset. Applications containing resume of experience to be forwarded to Chief of Personnel, National Harbours Board, Montreal Harbour, 357 Common Street, Montreal 1, Que. File No. 433-V.

MECHANICAL

MECHANICAL ENGINEER — Required for large Ontario manufacturer of a variety of automotive products and mechanical handling equipment. Should have related experience, and be capable of supervising junior engineers, designers and draftsmen. Position offers an imaginative engineer wide scope, responsibility and excellent opportunity. Salary open, good employee benefits and working conditions. All replies held in strict confidence. Written applications should contain comprehensive experience resume, personal history and present salary, and be sent to File No. 430-V.

MECHANICAL ENGINEER — with 3 to 5 years experience on design of plumbing, heating and air conditioning. Preferably a younger person who would eventually become a partner. General Consulting firm — Ottawa. Reply in confidence to File No. 424-V.

INDUSTRIAL ENGINEER. Responsible position in production management available to graduate engineer. Unusual opportunity to work closely with owners in established internationally known medium size metal working plant expanding managerial staff to keep up with continuing business growth. Position will require interest and demonstrated ability in usual aspects of industrial management; production control, time, motion study, worker training, plant and personnel management. Industrious application in this key position will result in rewarding position. Reply in confidence and with full particulars to File No. 436-V.

MISCELLANEOUS

SOUTH AMERICA — SMELTER ENGINEER — B.S. Degree in Metallurgical, Mechanical or Civil Engineering and background in mechanical and structural design, combustion and other thermal processes, gas flow, thermodynamics and pyrometallurgy. Fluent knowledge of English and working knowledge of Spanish. — Requires 6 or 8 years experience in engineering, at least 5 of which should have been in a pyrometallurgical industry, (preferably copper smelting) and some supervisory experience. — Qualifications for advancement in the organization essential. — Excellent opportunity, large copper company, central Chilean area. — Employment on contract basis in multiples of two years. Home leave vacation of two months at the end of two year contract. Transportation both ways and salary while travelling paid by Company. Provision also made to transport household effects. — In reply give complete details and references to File No. 420-V.

MANAGEMENT - ENGINEERING CONSULTANT. Preferably Canadian University engineering graduate, approximately age 30, with Industrial engineering background, experienced in plant layout and location, methods and standards, inventory and production control and management control reporting. Salary according to qualifications. Good opportunity for advancement with expanding company. — James G. Harding & Associates, 111 Lawton Blvd., Suite 101, Toronto 7, Ontario. File No. 422-V.

TECHNICAL SALES — A leading manufacturer and fabricator of vulcanized fibre and laminated plastics seeks a graduate engineer interested in technical sales work. Applicant should have 3 to 4 years experience, preferably in the electrical or related fields. Salary, expenses and incentive for candidate looking for permanent and rewarding future. Reply to manager, National Fibre Co. of Canada Limited, 107 Atlantic Avenue, Toronto 3, Ontario. File No. 423-V.

RESEARCH ASSISTANT — Required by the Department of Agricultural Engineering, University of Manitoba. Duties are to commence September 1st, 1963. and include development and supervision of a research program in Farm Structures and related Agricultural Engineering problems. It is desired that applicants be well trained in electrification to devise control devices and instrumentation associated with mechanization and automation of modern farmstead operations. Some teaching of classes to undergraduate Agriculture students will also be required. Candidates must be engineers with an M.Sc. degree and eligible for membership in the Association of Professional Engineers, Province of Manitoba. A farm background is desirable. Salary is open and subject to negotiation dependent upon qualifications. Salary requirements should be stated with application. Applications providing details of qualifications, experience, list of publications, personal information, a recent photograph, and the names of three references should be submitted to The Head, Agricultural Engineering Department, University of Manitoba. Winnipeg 19, Manitoba. File No. 426-V.

SPERRY

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THIS IS A UNIQUE OPPORTUNITY to fully utilize your present knowledge — to expand that knowledge and broaden your scope and experience.

Expansion and diversification of product lines have made available positions at supervisory, senior, and intermediate levels, working on highly interesting projects.

These projects involve the application of radar, gyros, servo systems, digital circuitry, logic, switching and analogue circuitry on both a system and a detailed basis.

A university degree in electrical engineering or engineering physics, 3 to 10 years' experience in the electronics field, together with a strong desire to create and learn are the major prerequisites.

You are invited to discuss these positions with us. Please forward your resume, or telephone for information.

Industrial Relations Manager

SPERRY GYROSCOPE COMPANY OF CANADA, LTD.

P.O. Box 710 Montreal 3, Que.

ENGINEERING OPPORTUNITY — Excellent opportunity open for position of Chief Engineer at an integrated steel and pipe manufacturing operation in Western Canada. The position offers an imaginative engineer wide scope, responsibility and excellent potential. The company is looking for a qualified engineer with experience in steel mill operations and capable of assuming responsibility for the overall maintenance program. In addition, the successful applicant will participate in a new product development program, including lay-out, design and supervision of construction, installation and "break-in" of additional production facilities. All replies held in strict confidence. Please mail comprehensive experience resume, including present salary, to: Personnel Director, Interprovincial Steel and Pipe Corporation Ltd., P.O. Box 1670, Regina, Sask.

SALES ENGINEER — A Professional Engineer, preferably a graduate in Civil Engineering, is required as a Sales Representative for the Montreal area by a manufacturer of prestressed and precast concrete. Applicants must be bilingual. Experience should include at least one of the following: Experience in industrial building industry as a construction supervisor; or Engineering sales experience, preferably in construction; or Architectural design experience in an architectural or consulting engineering company. Resumes are invited in confidence. Apply File No. 409-V.

EXPERIENCED SENIOR DRAUGHTSMAN for steel and pipe manufacturing company at Regina. Please enclose experience resume and state present salary. Reply to: Interprovincial Steel & Pipe Corporation Ltd., Box 1670, Regina, Sask. File No. 432-V.

TEACHING

EXPERIENCED ENGINEER — required as assistant professor of engineering, Acadia University, beginning salary $6,000. Apply President Watson Kirkconnell, Wolfville, Nova Scotia. File No. 437-V.

UNIVERSITY OF SASKATCHEWAN, Saskatoon. Staff position in Civil Engineering. Applications are invited for a teaching position to teach undergraduate and graduate classes and to direct research in plain and structural concrete. M.Sc. or Ph.D. degree required with preference to be given to Ph.D. Minimum salaries: Assistant Professor — $7,000; Associate Professor — $9,500; Professor — $12,500. Appointment will depend on training and experience. Applications with full particulars should be sent to Head, Department of Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan. File No. 435-V.

UNIVERSITY OF ALBERTA — FACULTY OF AGRICULTURE. Applications are invited for the position of Assistant Professor in the Department of Agricultural Engineering, University of Alberta, at a starting salary of $8,500 per annum with excellent prospects for advancement. It is preferred that duties commence September 1, 1963. Duties include undergraduate teaching, development of a Work Study program with application to practical agricultural problems, and some extension work. It is preferred that candidates have training in Operations Research techniques and that they be familiar with modern computational methods. Preference will be given to candidates with an Industrial Engineering degree, or equivalent, who possess a farm background. Applications providing details of qualifications and experience, list of publications, personal information, a recent photograph, and the names of three referees should be in the hands of the undersigned by July 15th, 1963. — Chairman, Department of Agricultural Engineering, University of Alberta, Edmonton, Alberta.

THE UNIVERSITY OF MANITOBA. Applications will be received for the position of Head of the Department of Civil Engineering. Qualifications required are Ph.D. and experience in research. Duties will commence September 1st, 1963. Write to J. Hoogstraten, Vice-President — Development, University of Manitoba, Winnipeg 19, Manitoba. File No. 425-V.

CITY OF EDMUNDSTON, N.B.

ASSISTANT CITY ENGINEER

QUALIFICATIONS:

Civil or Professional Engineer with two or three years experience in Civil Engineering.

DUTIES:

Under the direction of the City Engineer, to be responsible for the design and construction of all municipal services, e.g., water, sewers, roads, and sidewalks. This work includes capital programming, capital budgeting, estimates, contracts, inspection, project design, specifications, etc.; and to act as the City principal adviser on all engineering matters, and assist superintendents in maintenance operations related to municipal services.

LANGUAGE REQUIREMENTS:

Fully bilingual.

Starting salary range $5,780 - $6,400. All applications should contain a complete resume of education, age and experience, and should be addressed to

Louis R. Hébert, City Clerk,
City of Edmundston,
Edmundston, N.B.

THE UNIVERSITY OF MANITOBA. Applications will be received for the position of Dean of Engineering. Qualifications required are Ph.D. and experience in research in Civil, Mechanical or Electrical Engineering. Duties will commence September 1st, 1963. Write to J. Hoogstraten, Vice-President — Development, University of Manitoba, Winnipeg 19, Manitoba. File No. 425-V.

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to take charge of their Drilling, Pressure Grouting and Diaphragm construction activities which are carried out in association with SOCIETE DES SONDAGES INJECTIONS ET FORAGES (ENTERPRISES P. BACHY). The successful applicant will:—

1. Have had a sound training and extensive field experience covering all aspects of Drilling and Pressure Grouting work.
2. Have been in direct control of work on site.
3. Be conversant with all the latest techniques of colloidal and chemical grouting.
4. Have prepared technical proposals and tenders.
5. Have conducted high level negotiations with clients at all stages of contract work.

In addition, a thorough knowledge of French would be a considerable advantage.

A salary commensurate with the responsibilities of this key position will be by negotiation. A car will be provided together with the usual benefits.

Applications in writing to:—

Personnel Officer,

SIMON-CARVES LIMITED,

Cheadle Heath, Stockport, Cheshire, England,

quoting Ref. SC.40/5.

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DATE IN CIRCULATION — 20th of month.

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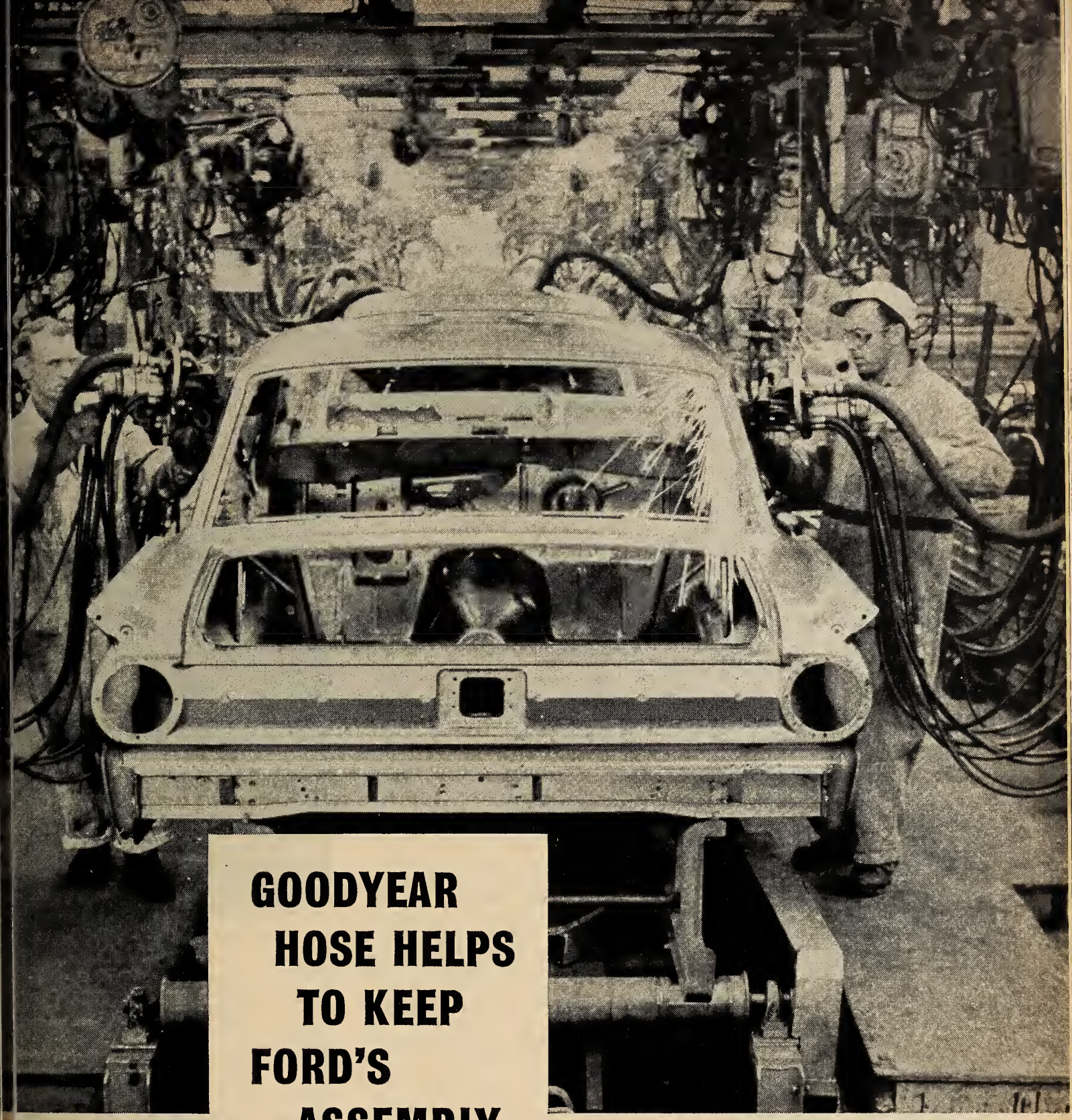

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Body Building is but one of many departments where Ortac Hose is used.

At Ford of Canada's huge assembly plant at Oakville, Ontario, over 3,000 tools . . . pneumatic nut-runners, screwdrivers, portable welding guns etc. . . . are used each working day to produce The Ford Family of Fine Cars. Over 14 miles of Goodyear Ortac Hose are used on Ford's air consuming tools. Ortac Hose is really 5 hoses in 1. It will handle air, water, chemicals, oils or gasolines. It simplifies buying and eliminates need for a large hose inventory. □ Goodyear Technical Service is always ready to match industries' needs with rubber products engineered to provide efficient operation at lowest possible cost. For information contact your nearest Goodyear Branch or Head Sales Office, Bowmanville, Ontario.

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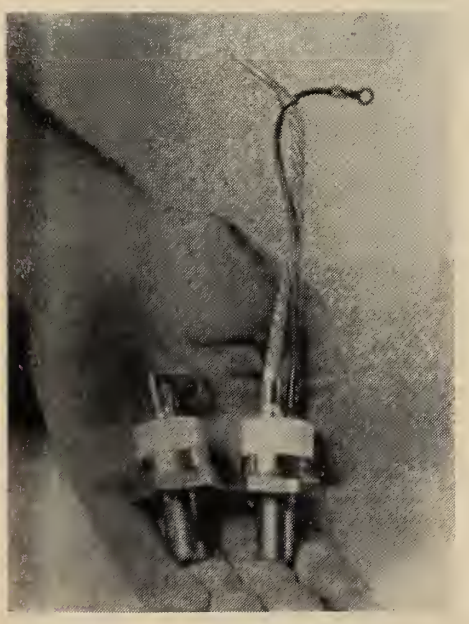
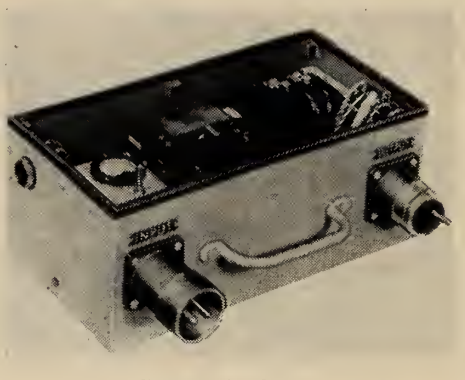
Industrial Briefs

BLACK & DECKER MANUFACTURING CO., Ltd., has added a heavy-duty hammer-drill to its industrial line of portable electric tools. This new tool, weighing only 9¾ lbs., is both a hammer and a drill. A simple turn of its collar mechanism changes the action from direct-drilling to percussion-drilling. As a drill, it will take twist drill bits, and hole saws. As a hammer, it will percussion-drill in concrete, porcelain, brick, tile and similar materials, and may be used for the installation of ¼-inch through ½-inch bolt sizes, flush, stud, tie wire, rod hanger, lead plugs and other types of expansion shells and anchors. By combining two uses in one drill, the heavy-duty hammer-drill is a versatile and time-saving device for electricians, plumbers, and other installation mechanics.

THE 30-AMPERE NPN SILICON power transistors, featuring low saturation resistance and high gain, are available from Canadian Westinghouse. These transistors, the highest-power devices of their type, are ideally suited for applications such as heavy-duty amplifiers, inverters and regulators. Available in series 2N1830 and 2N2130, these transistors can be supplied in voltage ratings from 50 to 200 volts. Typical saturation resistance of the devices is only 0.035 ohms, and a minimum gain of 10 at 25 amperes collector current. An unusually high steady-state power dissipation of 250 watts, and a peak power capability of 6000 watts are two other features of the transistors.

NPN Silicon Transistors





Lectronic Sentry

THE "LECTRONIC SENTRY" a safety device manufactured by Joy Manufacturing Company (Canada) Ltd., is now available in a completely transistorized, compact version. The "Lectronic Sentry" protects against ground faults and short circuits on DC off-track mining machines and trailing cable. A continuous monitoring signal between transmitting and receiving elements is interrupted when trouble occurs, shutting off power to the machine and its cable.

A NEW RANGE of impact-type crushers designed to reduce the high consumption of wearing parts which usually result when crushing such abrasive materials as gravel, quartz and whinstone, is available from Fraser & Chalmers (Canada) Ltd., Montreal. The Gravelpactor is fitted with reversible rotor so that, with a centrally-placed feed chute, it will operate when driven in either direction. It is claimed that by systematic reversal of rotation, it is possible to balance the wear between the two sets of breaker blocks and the two faces of each beater The designers say that, with the exception of the two bottom blocks, all the breaker blocks are reversible. Unlike a conventional hammermill, the Gravelpactor is not fitted with cage bars; it runs in closed circuit with a screen. This, together with the large clearance blocks combine to reduce wear considerably on the replaceable parts.

KLOCKNER - MOELLER CANADA LTD., manufacturers of industrial electric motor control have announced the development of their present Vancouver sales office into a fully-integrated factory-branch operation. Engineering design and assembly of "bell-M" industrial motor control centres, panels and starters will be undertaken in addition to sales and warehousing. This branch which will serve all of British Columbia and the Prairie Provinces, is the fifth for the company which has its head office and factory in Granby, Que.

A SUBMINIATURE ELECTROMETER TUBE, with low noise amplification of extremely weak signals in the order of 5×10^{-14} amperes is available from Raytheon Canada Limited. The CK587 draws only 0.0075 watt total under typical operating conditions. The new pentode is only one inch long with a .230-inch by .290-inch cross-section. Its small size contributes to an improved capability to withstand abnormal mechanical environments.

Raytheon CK587 Pentode

The partnership of Stadler, Hurter & Company, Consulting Engineers, Montreal has changed its name to Hurter, Todd & Meyer, Consulting Engineers. The partnership in the firm consists of Messrs. A. T. Hurter, M.E.I.C., A. M. Hurter, M.E.I.C., W. L. Todd, M.E.I.C. and K. R. Meyer, M.E.I.C. The partnership owns Stadler Hurter International Ltd., Montreal, whose name will remain unchanged and which will continue to handle all engineering work abroad.

(Continued on page 80)

Developments

Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.

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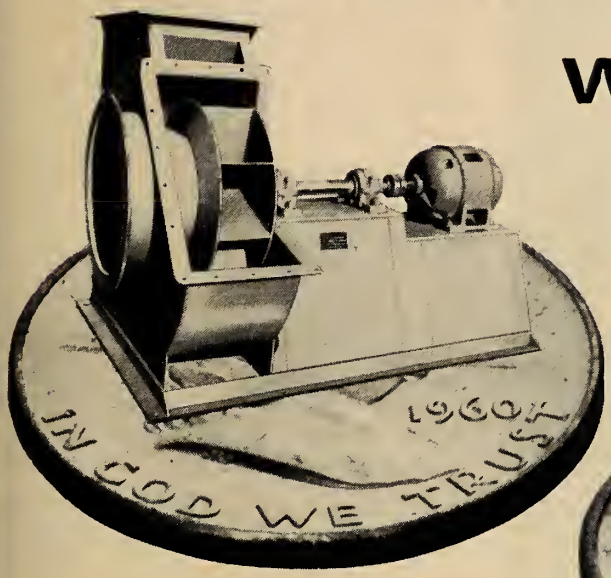

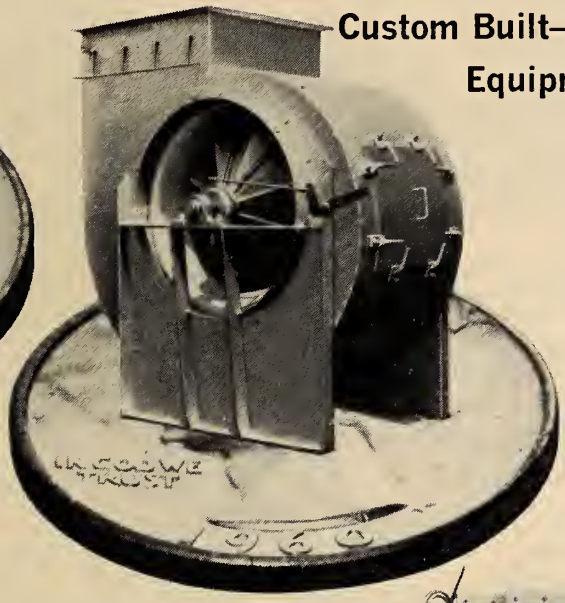

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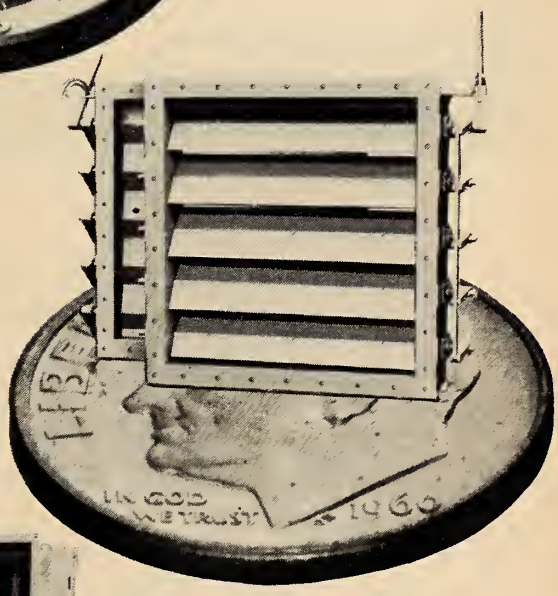

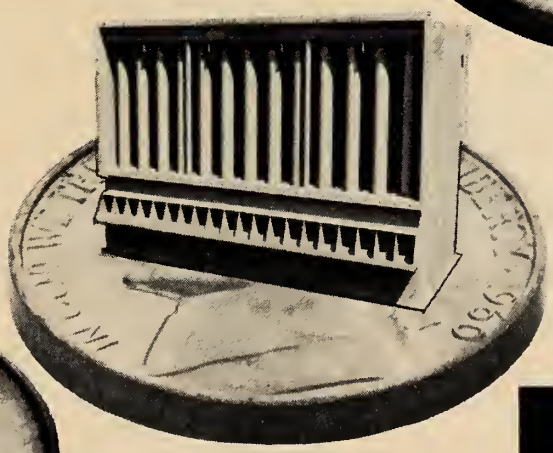

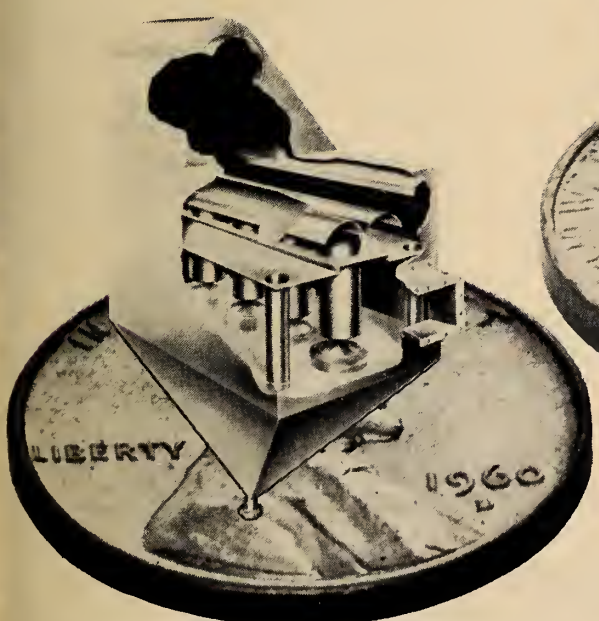

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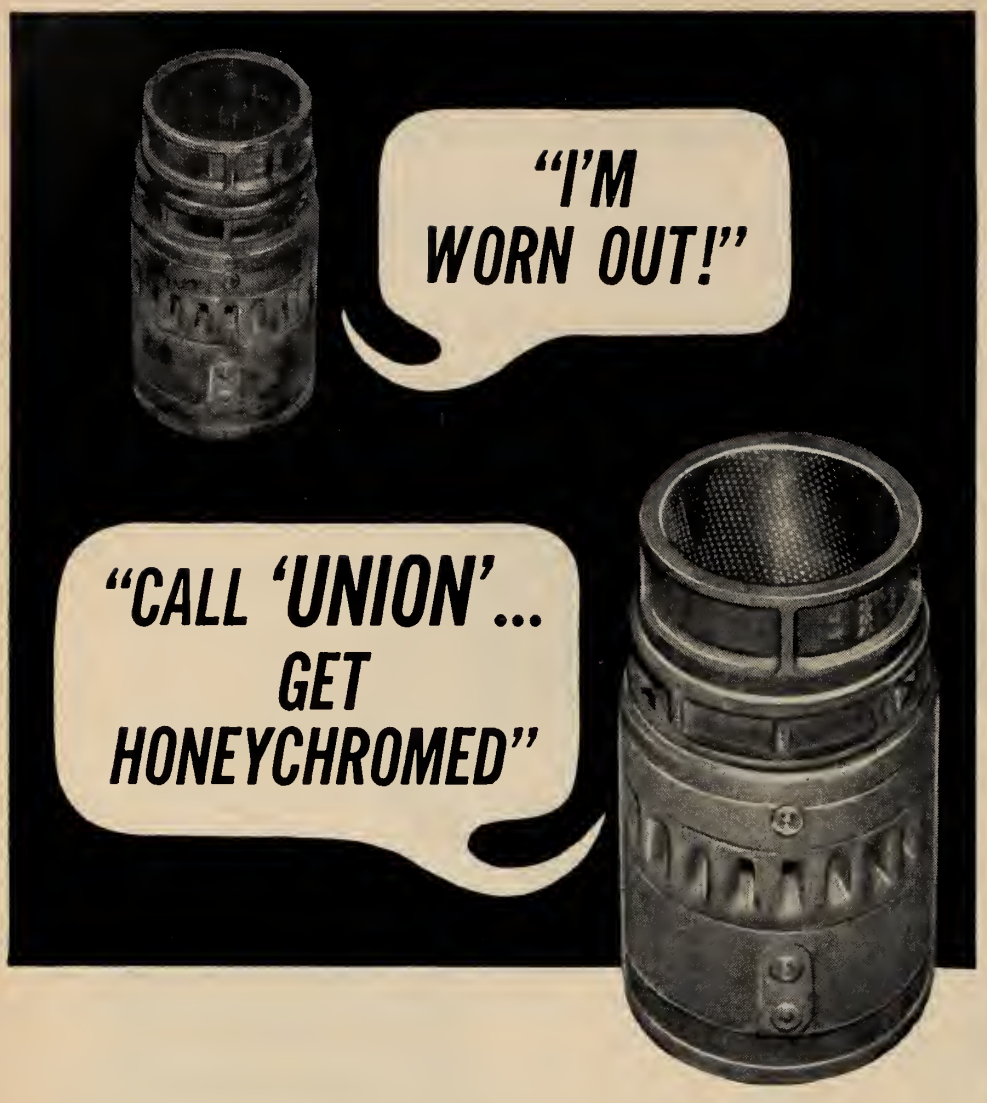

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Branch News

(Continued from page 50)

MOOSE JAW SECTION
M. C. Butterfield

James Connell of International Business Machines in Regina, spoke to the Branch at their April 17 meeting. The title of his talk was "Automation and Application of Computers to Industry". The new executive was elected at this meeting. They are: President, Jim Tomlinson; Vice-Presidents, Gordon Skorbonach, John McGuffin and Alex Gorkoff; Secretary, Ron Graham.

NORTH SHORE LOWER ST. LAWRENCE
K. R. Kilburn

The Branch held its Annual Meeting for the installation of the 1963 Branch Executive at the time of the visit of President Lawton, on March 13 in Sept-Iles.

Mr. Lawton addressed the members on the organization and activities of the EIC. He later attended a cocktail party, dinner and dance to meet the members, their wives and friends, and addressed them informally on his visit to Russia. While in the Branch area, Mr. Lawton toured the terminal facilities of the Iron Ore Company of Canada in Sept-Iles and the Quebec Cartier Mining Company in Port Cartier.

PETERBOROUGH
J. M. Hubicki

In his talk to the Branch on March 8, President F. L. Lawton warned that engineers are in danger of becoming convenient tools of government unless they resist the rise of socialism.

He mentioned medicare as an example of how a profession could be involved in a scheme in which the government's basic interest was not the welfare of the people, but the acquisition of political power.

Mr. Lawton, who spent three weeks in 1960 on a professional tour of Russia and Poland, recognized there the "soulless sameness and aura of uniformity" that exists in countries behind the Iron Curtain. Canadian engineers may think that dissenting is the job of politicians, but all engineers will be penalized if they fail to dissent whenever necessary. Democracy can change imperceptibly to socialism unless we are continuously wary. The voluntary concept was the motivating power behind all the finest things in history. It was this concept, Mr. Lawton said, allied with team effort, which was keeping the West in the forefront of research. President Lawton urged engineers to never forget to nourish the basic freedom they enjoy in the profession today which typifies the voluntary concept. Only in that way could the engineer retain the freedom necessary to best serve his community.

VANCOUVER ISLAND

J. Devlin

Vancouver Island members enjoyed a busy and interesting month starting with a well-attended luncheon meeting March 1 when John Harding, Traffic Engineer, Good Roads Department, delivered an address on the subject of traffic control.

On the evening of March 20, C. Y. Spratt, Member T.A.P.P.I. addressed a joint EIC-APE meeting. His subject, "Corrosion, Its Causes and Cure", was well received and generated an active question period.

The highlight for the period under review centered on the visit of our President on March 27. Following an executive luncheon meeting, Mr. Lawton visited the Tri-Service College, Royal Roads, and called on the Commandant, thereafter meeting informally with the Engineering faculty and students. A well-attended dinner in honor of Mr. and Mrs. Lawton was held in the evening at which the address of the of the President ended a short visit and a busy day.

WINNIPEG

Foster W. New

B. J. Holsgrove, Head of Process Engineering, Propulsion at Canadian Armament Research and Development, was the guest speaker at a dinner meeting of the Branch held at the Pembina Hotel on March 18.

Mr. Holsgrove gave a resume of the history of rocketry, illustrating that rocketry was an ancient art, the practice of which had waxed and waned through the centuries. Because of the tremendous advance of the art in the last two decades, no one individual can claim intimate knowledge of the complete field. Therefore, present-day roeketry is the result of co-operation of many individuals. Mr. Holsgrove stated that he would confine his discussions to the processing of the propulsion unit.

The unique position of the Defence Research Branch is the envy of scientists in other parts of the Western world and CARDE as a DRB agency benefits from this position. Company process engineering research fell behind because of the costs of research and the fact that primary effort had to be toward production. CARDE filled this void and has developed processing methods so that time is reduced from six to approximately one hour. For a period, CARDE unfortunately became involved in production to the detriment of research. Therefore, CARDE is very pleased that Canadian Bristol Aero Jet is taking over production thus enabling CARDE to resume the prime role of research. Mr. Holsgrove then described some of the details of the five distinct processing areas: rocket engine preparation; fuel binder preparation; oxidizer preparation; propellant mixing and casting; curing. The complete processing procedure was described by a movie while the speaker explained the specific operations being shown. A question period followed.

FOR CONTRACT DIAMOND DRILLING

With expert, experienced crews operating from strategically located branches, Boyles Bros. are equipped to offer you a complete service in core and blast hole drilling, soil sampling, foundation testing and grouting. Based on over 67 years of experience, Boyles Bros. have developed equipment, techniques and procedures to penetrate every known formation with the greatest possible speed and economy.

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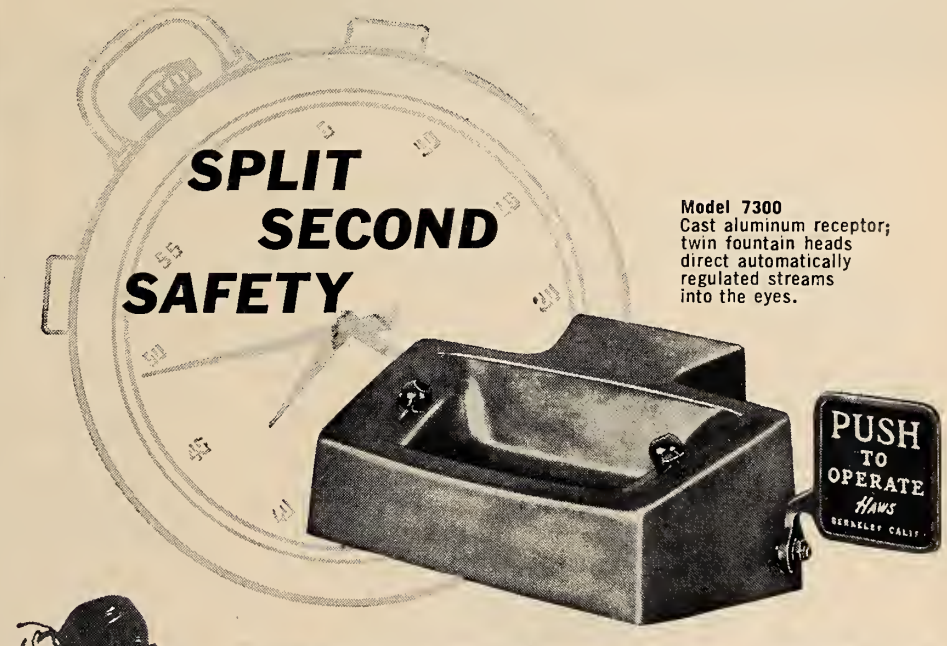
SPLIT SECOND SAFETY

Model 7300
Cast aluminum receptor; twin fountain heads direct automatically regulated streams into the eyes.



EMERGENCY EYE-WASH

Sensitive eye tissue can be destroyed in moments. Contamination from industrial caustics and chemicals requires instant first aid . . . and a HAWS Emergency Eye-Wash Fountain can mean the difference between temporary irritation and permanent injury! Write for your free HAWS catalog.

Since 1909 HAWS **EYE-WASH FOUNTAINS**
A product of HAWS DRINKING FAUCET COMPANY

MONTREAL, QUEBEC
R. G. K. WARD, LTD.
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P.O. Box 84, Sta. K

Are you starting a business... expanding... modernizing ?

Then perhaps you require financing. The Industrial Development Bank helps finance most types of small and medium-size Canadian businesses for a variety of purposes.

If required financing for your business is not available elsewhere on reasonable terms and conditions, you are invited to visit an IDB office or write to one for a booklet.

idb

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Branches:
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THE E.I.C.

- Has more than 24,000 voluntary members
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- Is officially established on 12 university campuses
- Sponsors conferences on engineering education
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If you would like more information about membership, tear out and mail this Coupon

The General Secretary, MEMBERSHIP
The Engineering Institute of Canada,
2050 Mansfield Street, Montreal 2, Que.

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.....

Position .....

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MINIMUM MAINTENANCE...
MAXIMUM EFFICIENCY

JENKINS 200 psi BRONZE GATE VALVES
for Tough Industrial Service Lines

These Jenkins Bronze Gate Valves are specially built for trouble-free service under the most demanding conditions. Refineries, dye houses, chemicals, foods, pulp and paper, rubber—all these and other industries have learned by experience that Jenkins 200 psi Bronze Gate Valves save maintenance, reduce down-time, give unsurpassed performance. Jenkins Bros. Limited, Lachine, Que.

Spindle has extended thread engagement to reduce wear. Bevelled shoulder permits repacking under pressure when wide open.

Pipe Ends and Union Ring have sturdy, flat-faced, V-shaped lugs, permit application of wrenches without chewing off corners.

Monel Seat Rings, expanded into body, are hardened to provide exceptional resistance to erosion, corrosion and wear.

Stringently tested. Each valve is subjected to 500 psi hydrostatic shell and 350 psi seat tests.

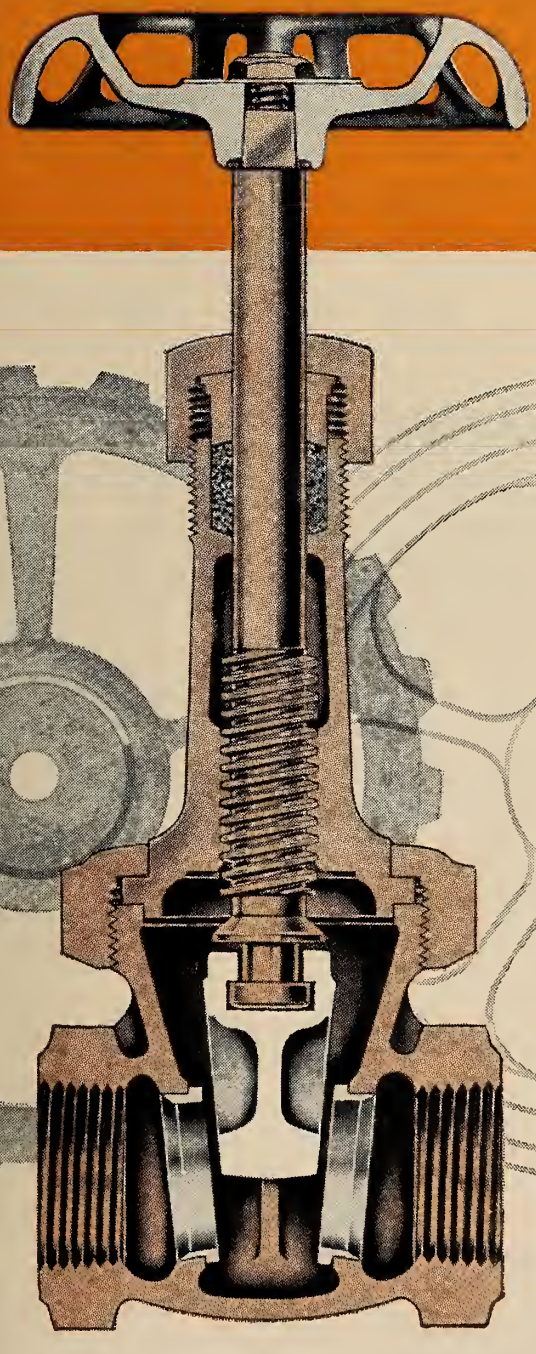


FIG. 270-U with solid bronze wedge
for economical service under normal conditions.

FIG. 270-UN with solid nickel alloy wedge
for trouble-free valve operation where rapid wear and corrosion are factors.

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
TRADE JENKINS MARK
Jenkins Bros

Personals

(Continued from page 58)

A. U. Westvind, M.E.I.C.

J. B. Kinney, M.E.I.C.

Allan U. Westvind, M.E.I.C. (Chalmers '38) has been appointed director of sales of the Swedish firm, KMW. Mr. Westvind has been president and general manager of SF Products Canada Ltd. since 1954. KMW is a manufacturer of pulp and paper machinery, water turbines and marine equipment with headquarters in Karlstad, Switzerland.

James B. Kinney, M.E.I.C. (Syracuse '19) has been named Director of Project Development at James F. MacLaren Limited, Consulting Engineers. Mr. Kinney recently retired as Viee-President and Managing Director of Wallace & Tiernan Limited. Mr. Kinney's activities will be responsible for the development of the firm's practice with particular emphasis on industrial projects and foreign work.

A. V. Phillips

R. Bisson

Raymond Bisson has been appointed Executive Assistant, Sales, at the Head Office in Montreal of the Canada Cement Company, Limited.

A. V. Phillips has been appointed General Manager of Crane Piping Limited, Hamilton. Mr. Phillips has had extensive experience in steel and alloy fabrication.

Three senior appointments in the Electric Typewriter Division of International Business Machines Company Limited have been announced. They are: **P. S. Morine,** from ET Manager, Montreal office, to ET Sales Manager; **P. M. Bingham,** from Product Manager, AMET Division, to Assistant ET Sales Manager; **T. E. McNulty,** from Branch Manager, Kitchener, to Sales Manager AMET Division.

Hyman Rozovsky, consulting engineer and specialist in industrial environment, has been made a member of the American Academy of Industrial Hygiene. Mr. Rozovsky, a graduate of Queen's University in Mining and Metallurgical Engineering, is one of 15 Canadians to receive membership in this society. He has 30 years experience in mining engineering, industrial hygiene engineering, consulting and lecturing.

J. S. Forsyth

H. Rozovsky

J. S. Forsyth has been appointed to the eastern region sales staff of I-T-E Circuit Breaker (Canada) Limited. Mr. Forsyth will be located in Ottawa.

Frank Whitfield has been appointed sales manager for Quebec for Monarch Construction (Quebec) Limited. Mr. Whitfield will be in charge of house and lot sales for the company.

R. E. J. Layton, M.E.I.C. (McGill '47) has been elected President of T. Pringle & Son Limited, Industrial Consultants in Montreal. Mr. Layton has been associated with the company since 1947.

DESIGN . . . Field Engineering . . . FABRICATION . . . ERECTION

By the Canadian Bridge Works

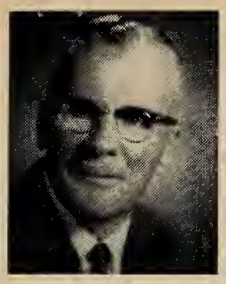
Construction of the Montreal-to-Vancouver section of this Microwave Tower System is well under way. It connects with the Montreal-to-Moncton portion built previously by this company. Our field engineering and foundation structures (Montreal to Winnipeg) were finished during last Winter's sub-zero temperatures. The project is scheduled for completion by next fall.

DOSCO

DOMINION STEEL AND COAL CORPORATION, LIMITED

CANADIAN BRIDGE WORKS . . . WALKERVILLE, ONTARIO

O. Lundquist



G. C. Aykroyd

Olle Lundquist has been appointed sales manager of Atlas Copco's mining equipment division. Mr. Lundquist, who graduated from the Royal Institute of Technology, Stockholm, in 1956, has had mining experience at Steep Rock, Boliden and Karuna mines, and has worked as an exploration engineer with Lamco in Liberia. Mr. Lundquist joined Atlas Copco in 1958, and in 1960 became head of the field services department of the Mining Division.

G. Cecil Aykroyd has been appointed regional engineer, Province of Ontario, Canadian Institute of Steel Construction. Prior to joining CISC, Mr. Aykroyd had been a consultant to architects on structural design. Before that, he had been chief engineer with Disher Steel Construction Co. Ltd.

Dr. D. W. R. McKinley, M.E.I.C. (Toronto '34) associate director of the Radio and Electrical Engineering Division, National Research Council since 1960, has been appointed Director of the Division succeeding Dr. B. G. Ballard, recently appointed President of the Council.

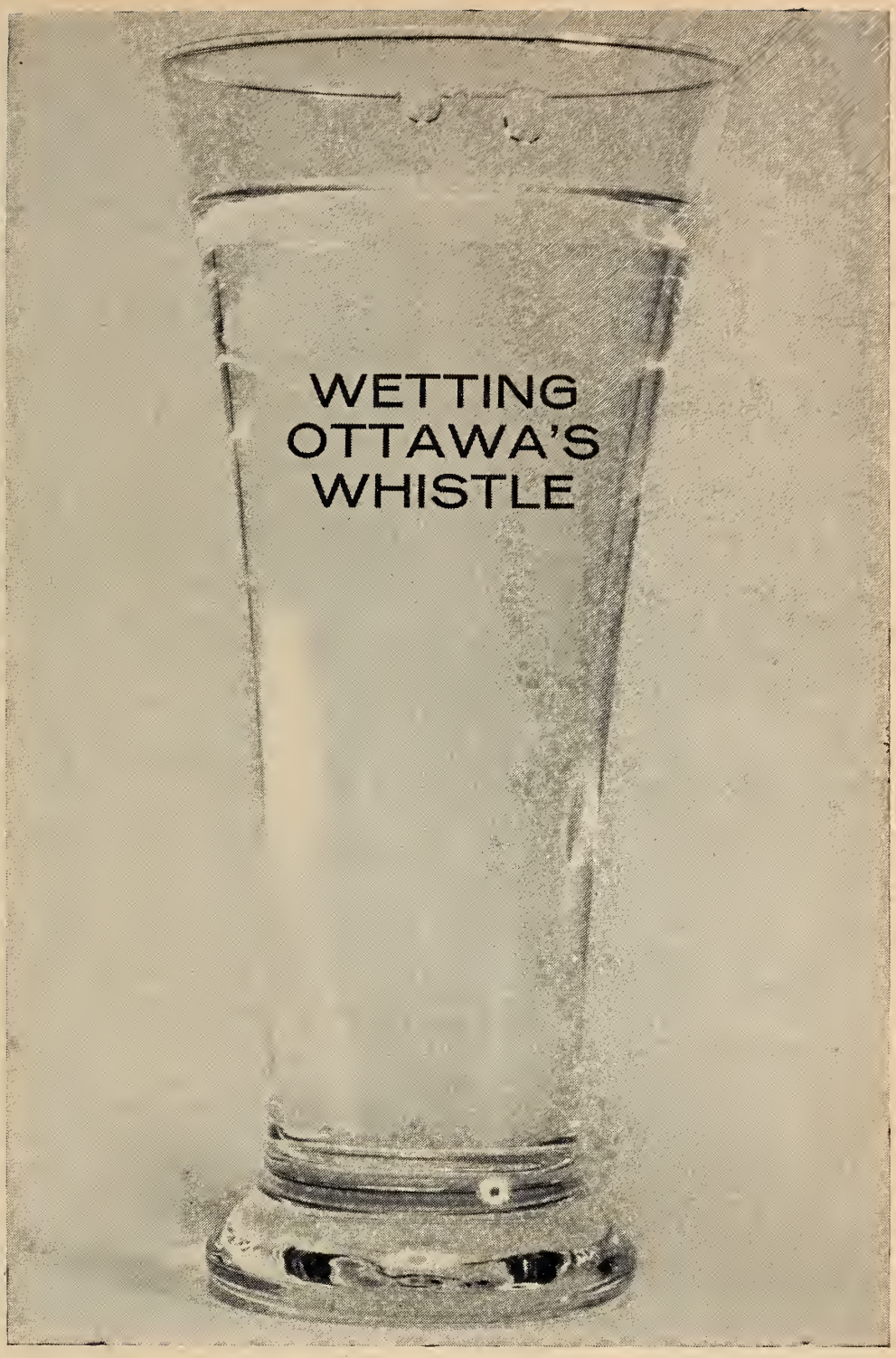
Professor L. P. Bonneau, M.E.I.C. (Laval '42) has been appointed for a three year term in the National Research Council by the Governor General in Council. Professor Bonneau is Vice-Rector and Professor of Applied Thermodynamics at Laval University.

W. G. Baldwin has been appointed Branch Manager, Montreal Office, Engineered Products, of the American-Standard Products (Canada) Limited. Mr. Baldwin joined the company as Sales Engineer in 1950. In 1960, he was transferred to Ottawa as Branch Manager, the position he held until this appointment.

G. Y. Sebastyan, M.E.I.C. (Michigan '53), Head of the Engineering Design Section, Construction Branch, Air Services, Department, Ottawa, has obtained the degree of Doctor of Philosophy (Civil Engineering) from the University of Michigan.

Obituaries

J. B. Baird, M.E.I.C. (McGill '08)
E. Grummit, Life M.E.I.C.
G. M. Warren, M.E.I.C. (McGill '26)
A. R. Whittier, Life M.E.I.C. (Queen's '20)



42,000,000 gallons a day, electrically pumped from $5,000,000 Britannia Water Purification and Pumping Station, keep much of Ottawa from going dry. During failure of the public mains three 1575 b.h.p Paxman diesels would still pump the full daily capacity *and* provide the plant's lighting and power load. Millions of Paxman horsepower are standing by like this to protect vital services and processes all over the world.

there's no stopping with **PAXMAN** *diesel alternator sets*

Paxman diesels are backed by a world-wide service which brings you men and spares whenever and wherever you need them — and fast!
100-395 kVA standard range available from stock. Sets built to customers' requirements from 100-1500 kVA with medium/high speed diesel engines; also dual fuel engined sets from 1000 kVA.

DAVEY, PAXMAN & CO LTD COLCHESTER ENGLAND A Member of the RUSTON Group

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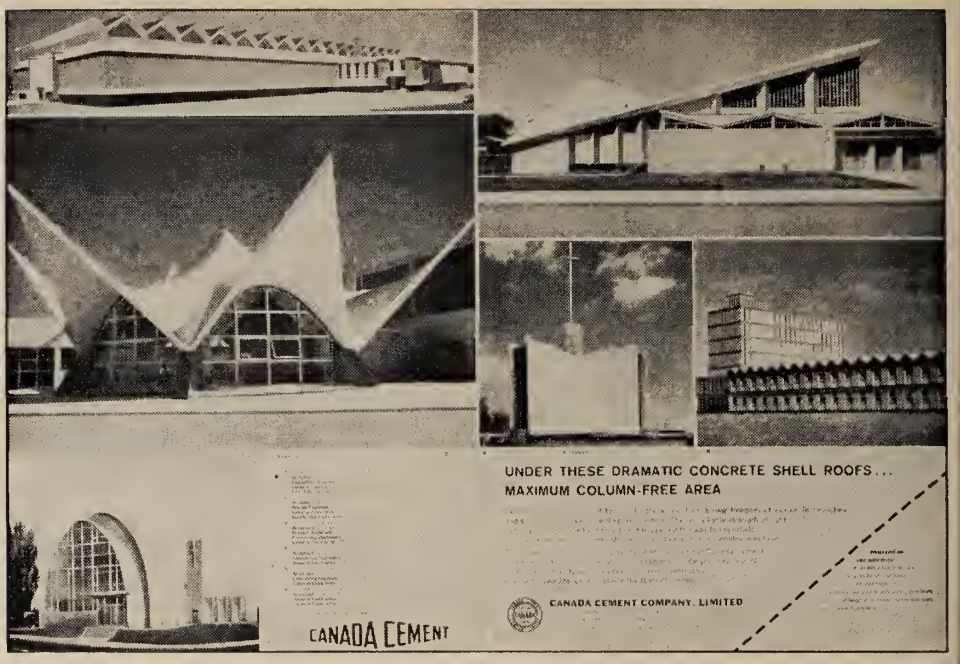
DISTRIBUTORS: NEWFOUNDLAND: Steers Ltd., St. John's · NOVA SCOTIA: Atlantic Bridge Co. Ltd., Lunenburg · EASTERN ONTARIO: Ruston & Hornsby Ltd., Toronto · QUEBEC & NEW BRUNSWICK: Ruston & Hornsby Ltd., Montreal · WESTERN ONTARIO (LAKEHEAD): W. H. Marr (Twin City) Ltd., 915, Memorial Avenue, P.O. Box 810, Port Arthur, Ontario MANITOBA & SASKATCHEWAN: Webb Scott Equipment Ltd., 947, Notre Dame Avenue, Winnipeg, 3, Manitoba · ALBERTA: Gorman's Ltd., Edmonton · BRITISH COLUMBIA: Ruston & Hornsby Ltd., Vancouver.

EIC CERTIFICATE OF ADVERTISING MERIT

Six eye-catching photographs demonstrating the beauty and utility of concrete shell roofs provided the impact for Canada Cement Company Limited's award-winning advertisement in the March issue of the Engineering Journal. Shown are three churches, two schools and an arena built with concrete shell roofs, which the advertisement says permits "Maximum Column-Free Area." Text of the ad, which is a double-page black-and-white bleed, is kept to a minimum.

The advertising manager of Canada Cement Company Limited is John V. Tittley. The ad was prepared by Cockfield Brown Limited, Montreal, Bert Churchill, Account Executive.



Each month a different panel of fifty Journal readers from across Canada is asked to nominate an award-winning ad from the viewpoints of ACCURACY – INFORMATION – ATTRACTION. Winners and their advertising agencies receive a framed Certificate of Advertising Merit.

COMING EVENTS

American Society of Agricultural Engineers. 56th Annual Meeting. Miami Beach, Fla. June 23-26.

American Society for Testing Materials, Atlantic City, June 23-28.

American Society of Heating, Refrigerating and Air Conditioning Engineers. 70th Annual Meeting. Milwaukee, Wis. June 24-26.

Institute of Electrical and Electronics Engineers, Inc. Symposium on Space Telecommunications. Boulder, Colo. July 9-11.

The American Institute of Electrical Engineers, American Society of Mechanical Engineers. 1963 International Conference and Exhibit on Aerospace Support. Washington, D.C. August 4-9. Mr. E. Halas, General Manager of Exhibits, P.O. Box 6635, Washington 9, D.C.

American Society of Civil Engineers. 12th Hydraulics Division Conference. University Park, Pa. August 7-9.

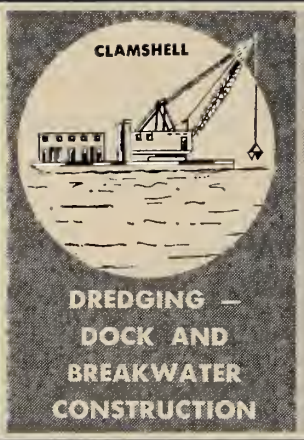
American Society of Mechanical Engineers. American Institute of Chemical Engineers. Sixth Heat Transfer Conference and Exhibit. Boston, Mass. August 11-14.

Engineering Foundation of the United Engineering Trustees, Inc. Engineering Foundation Research Conference on Comminution. Proctor Academy, Andover, N.H. August 12-19.

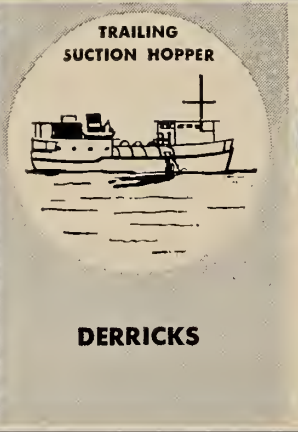
Fifth Biennial Gas Dynamics Symposium. Physico-Chemical Diagnostics of Plasmas. Northwestern University, Evanston, Ill. August 14-16.

The International Federation of Automatic Control (IFAC). Second International Congress on Automatic Control. Basle, Switzerland. August 27 - September 4. Secretary, Associate Committee on Automatic Control, National Research Council, Ottawa.

"GETTING DOWN TO THE JOB" – with J. P. PORTER

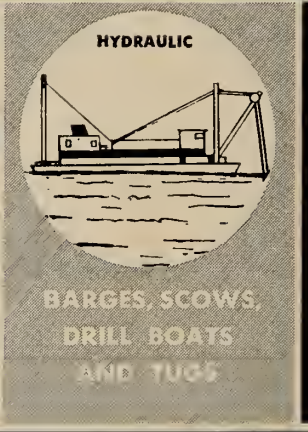


DREDGING – DOCK AND BREAKWATER CONSTRUCTION



DERRICKS

HYDRAULIC, DIPPER AND CLAMSHELL DREDGES



BARGES, SCOWS, DRILL BOATS AND TUGS

DREDGING AND MARINE CONSTRUCTION
"THE RIGHT TYPE OF EQUIPMENT FOR ANY DREDGING JOB"
THE J. P. PORTER COMPANY LIMITED
HEAD OFFICE: 806 DOMINION SQUARE BLDG., MONTREAL • TEL. UNiversity 6-8516
PLANT AND MACHINE SHOP: DARTMOUTH, N.S. BRANCH OFFICES: HAMILTON AND FORT WILLIAM

ONE OF A KIND

OR HUNDREDS

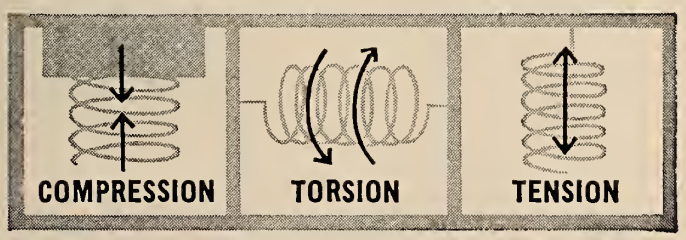
...hot coiled springs are our business

When you have a spring problem, in machine design or replacement, you can count on Ontario Steel Products to come up with the answer.

We will coil hot wound springs to your specifications in bar diameters from $\frac{3}{8}$″ to $1\frac{7}{8}$″ — inside spring diameters from $\frac{3}{4}$″ to 10″ — in free lengths up to 30″ — all to ASTM standards or closer tolerances if required.

You can specify bar size, shape and alloy needs — or discuss your requirements with our engineers.

Springs Shot Peened for longer life.



OSP

Phone or write:

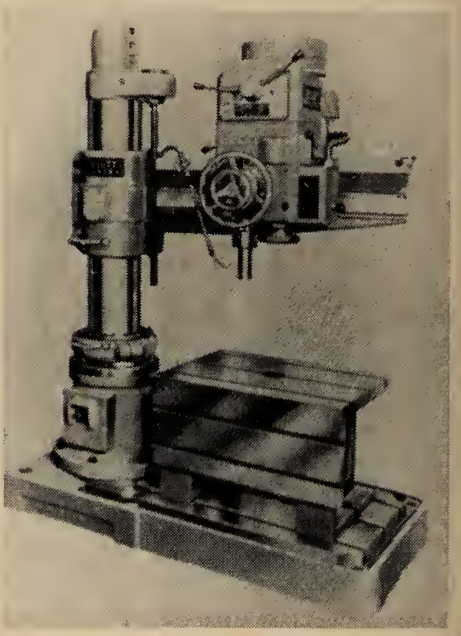
COIL SPRING DIVISION
ONTARIO STEEL PRODUCTS COMPANY LIMITED
OSHAWA, ONTARIO
33 Scott Street, Toronto
407 McGill St., Montreal

Engineering Briefs

(Continued from page 68)

HIGH EFFICIENCY and high output are characteristics of the new Series 45M balanced van hydraulic motor for mobile applications available from Vickers Incorporated, Division of Sperry Rand Corporation. A unique "dual-plate" design contributes to the unit's high overall efficiency of 85%. The series is offered in three models with nominal torque ratings of 100 p.s.i.: 110, 130 and 155 in. lbs. Maximum rated pressure is 2500 p.s.i. at 3000 r.p.m. All models are capable of a maximum speed of 4000 r.p.m. at reduced pressure, under normal operating conditions. The unit also can be operated as a pump for hydrostatic braking purposes.

CANADIAN INGERSOLL-RAND CO. LIMITED has introduced two new heavy--duty electric belt sanders. The B2 three-inch belt sander can be used wherever heavy-duty sanding must be fast, uniform and without ripples. An anti-gouge back rest prevents gouging caused by lifting the front end and digging into stock with the rear pulley. The B2 features a specially designed drive mechanism which manintains the original tracking and sanding belts run true and last longer and a quick-change lever-action belt-changer having a speed of 1300 sfpm and a loaded speed of 1060 sfpm. The B4 offers the same features as the B2, but with a 1 hp. motor and a four-inch belt for faster work on wider surfaces. The B4 is especially applicable for board flat surfaces such as doors, floors and truck panels. The B4 is 12¼ inches long, 6½ inches high, and 6⅜ inches wide, and weight 13¼ lbs.



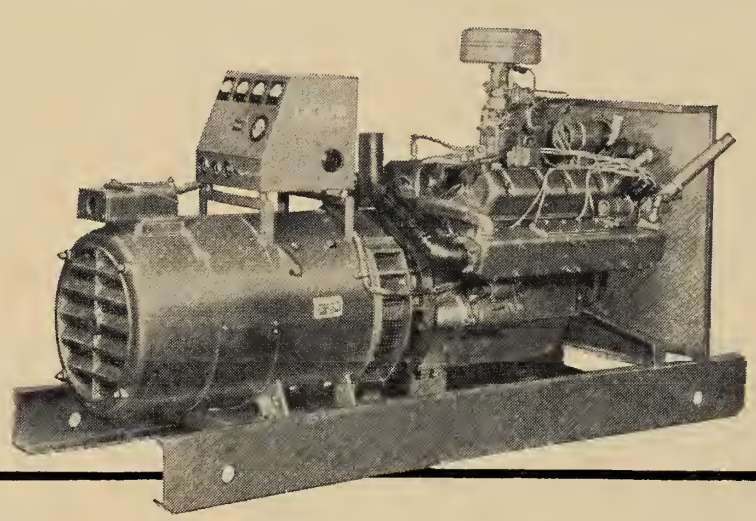
Elliot Radial Drilling Machine

THE ELLIOT MODEL DC4 Radial Drilling Machine featuring nine geared speeds from 73 to 1065 r.p.m. optional speed range from 110 to 1610 r.p.m. and three rates of power feed, is available from Elliot Machine Tools, a division of B. Elliot (Canada) Ltd. To ensure permanent and positive location against the lower slideway, a heavy spindle head is designed on a roller track with a heavy spring tensioning arrangement.

Dominion Model 410

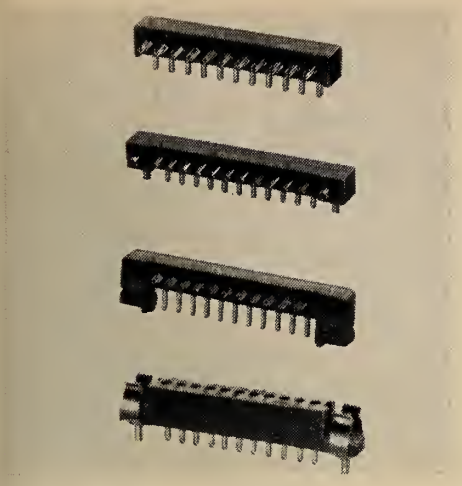
DOMINION ENGINEERING Co. Ltd. has introduced the Model 410 excavator (crane and shovel), a heavy-duty machine, Canadian-designed and manufactured. The Model 410 features graduated air controls, maximum stability with wide rugged crawlers in five options, four counterpoint options, independent boom hoist, air controlled swing brake. Its weight as a backhoe, 62,450 lbs.; boom centre to centre of pins, 24 ft.; maximum length of boom and jib as a crane, 150 ft.

when you compare performance and price you'll buy a CCW generating set!



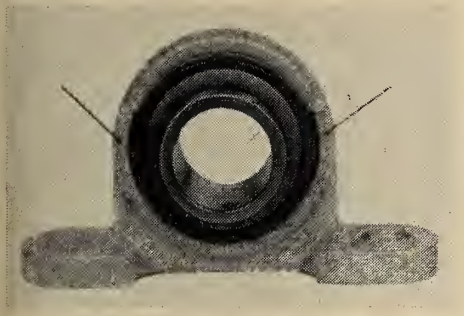
Whether your need is for primary, emergency or stand-by power there's a dependable, ready-for-action C.C.W. Generating Set to exactly fill the bill. ☐ Built in Canada by Canadian Curtiss-Wright Limited, C.C.W. Generating Sets are designed for heavy duty service in any application. These complete, compact, single unit, electric power plants have an enviable record for maximum economy and dependability. Gasoline driven models range from 1.5 to 170 KW., with diesel driven from 2 to 200 KW. All models—C.S.A. approved. ☐ Write for complete information today, indicating your needs—we'll do the rest!

CANADIAN CURTISS-WRIGHT LIMITED
Industrial Division
Box 275, 518 Evans Avenue, Toronto 14, Ontario.
TORONTO • MONTREAL • MIDLAND
WINNIPEG • EDMONTON



Printed Circuit Connectors

A NEW SERIES of 11, 17 and 23-pin subminiature printed circuit plugs, receptacles and adapters for interconnecting wiring and P.C. boards in high reliability military equipment has been introduced by Raytheon Company. The plugs are polarized to prevent cross-matching while knurled finger grip areas on the plugs facilitate safe and easy removal of printed circuit boards. All connectors are spaced for standard .100 grids.



Sealmaster Pillow Block Unit

THE SEALMASTER BEARING DIVISION, Stephens-Adamson Mfg. Co. has announced the availability of the malleable housed "LP" pillow block unit manufactured with loading slots for bearing insert replacement. The "LP" bearing, a precision unit that is self-aligning, permanently sealed and pre-lubricated, may be reused due to the loading slots in the housing.

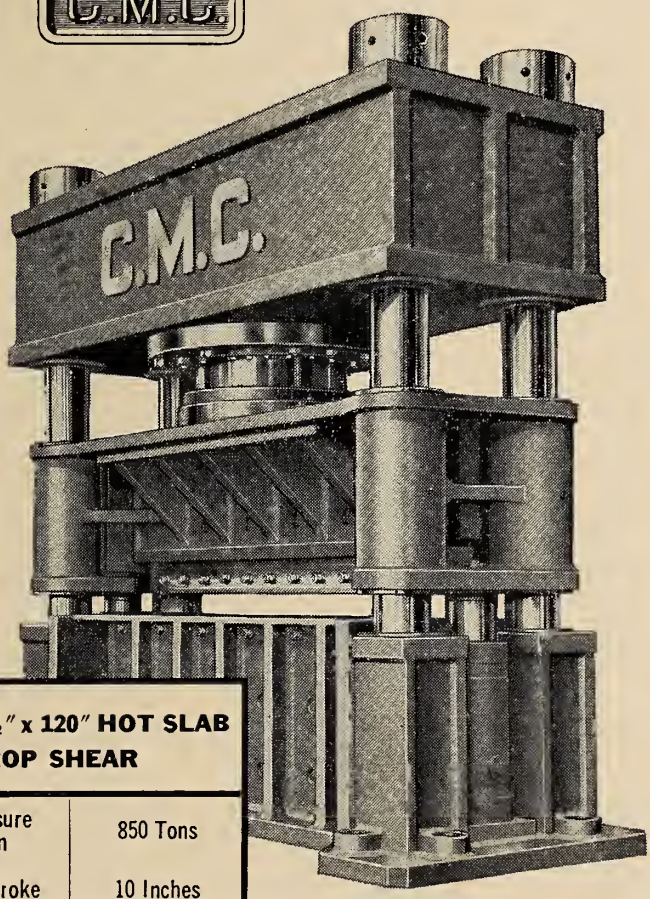
PORTABLE THERMOELECTRIC GENERATORS, which convert propane or natural gas directly into electricity, are available from Minnesota Mining and Manufacturing of Canada Limited, London, Ont. The generators, available in four stock sizes, with outputs of 2, 4, 8 and 15 watts, weigh only six lbs. and 29 lbs. Because they have no moving parts, the generators are inherently maintenance-free. They are silent and produce an output the moment they heat up. These generators provide power in remote areas or for emergency systems as a direct power source, to replace batteries or to recharge battery systems. Other uses include power supplies for pipeline cathodic protection devices, offshore lighting and telemetering devices, radio transceivers and mobile equipment.

CANADIAN WESTINGHOUSE has announced the availability of a new seven-pin miniature tube for use in UHF oscillator applications. Supplied in three versions: the 2DX4 rated at 2.4 volts and 600 ma; the 3DX4 rated at 3.2 volts and 450 ma; and the 6DX4 rated at 6.3 volts and 200 ma. The 1¾-inch tube features a strap frame grid construction resulting in a higher transconductance and better transconductance-to-plate current ratio. A large cathode and lower heater-power results in a lower cathode temperature. The use of a specially selected cathode alloy, retards the development of interference, sublimation and slump for long life performance.

PLUG VALVE OPERATORS have been added to the Viceroy line of products made in Canada by Fluid Power Limited, Toronto. Under air, oil and water, these plug valve operators may be employed at operating pressures of 10 to 150 p.s.i. Valve sizes range from one to 12 inches with two to six inch bore cylinders available cushioned or non-cushioned. Standard stroke is eight inches in length. Operator comprises cylinder with clevis and pin, mounting gasket and attachment for pipe and stem mounting bracket with adaptors available for round, square keyed or flattened valve stems.

(Continued on page 89)

Designed and Built-to-Order by C.M.C.



C.M.C. 2½" x 120" HOT SLAB CROP SHEAR	
Shear Pressure Maximum	850 Tons
Maximum Stroke	10 Inches
Slab Capacity	2½ In. x 120 In.
Maximum Hydraulic Pressure	1500 PSI
Height over all	15 Feet 6 Inches
Length over all	15 Feet
Width over all	5 Feet 10 Inches
Approximate Weight	85 Tons

Consult us without obligation

The C.M.C. Special Purpose Machine Division is ready to assist *your* company on any special machinery problem. We have complete facilities plus broad experience in designing and building machines for special applications. Our engineers are at your service. Working alone or in close co-operation with your engineering department, they will develop the machine best-suited for your job.

CANADA MACHINERY CORPORATION LTD.

GALT, ONTARIO, CANADA

AAF makes a good air filter

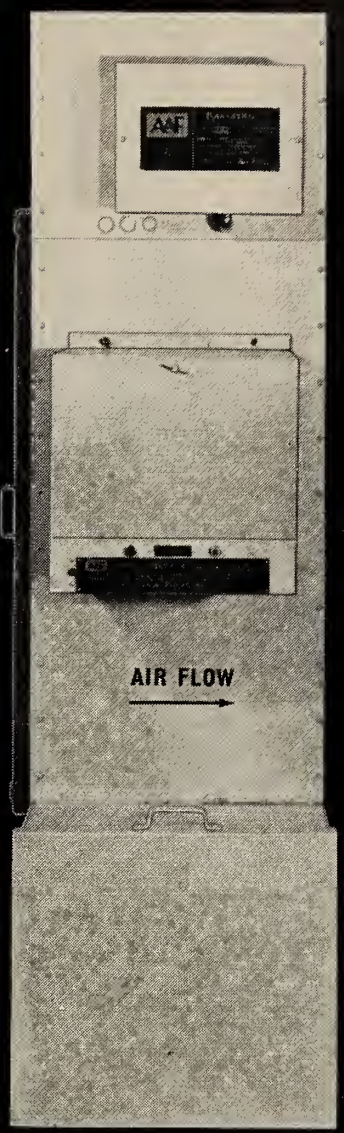
1957 ROLLOTRON

New Rollotron cuts space requirements in half!

. . . better. . . . . again!

40 in.

1959 ROLLOTRON



20 in.

NEW ROLLOTRON

■ ROLLOTRON is the one air filter that offers
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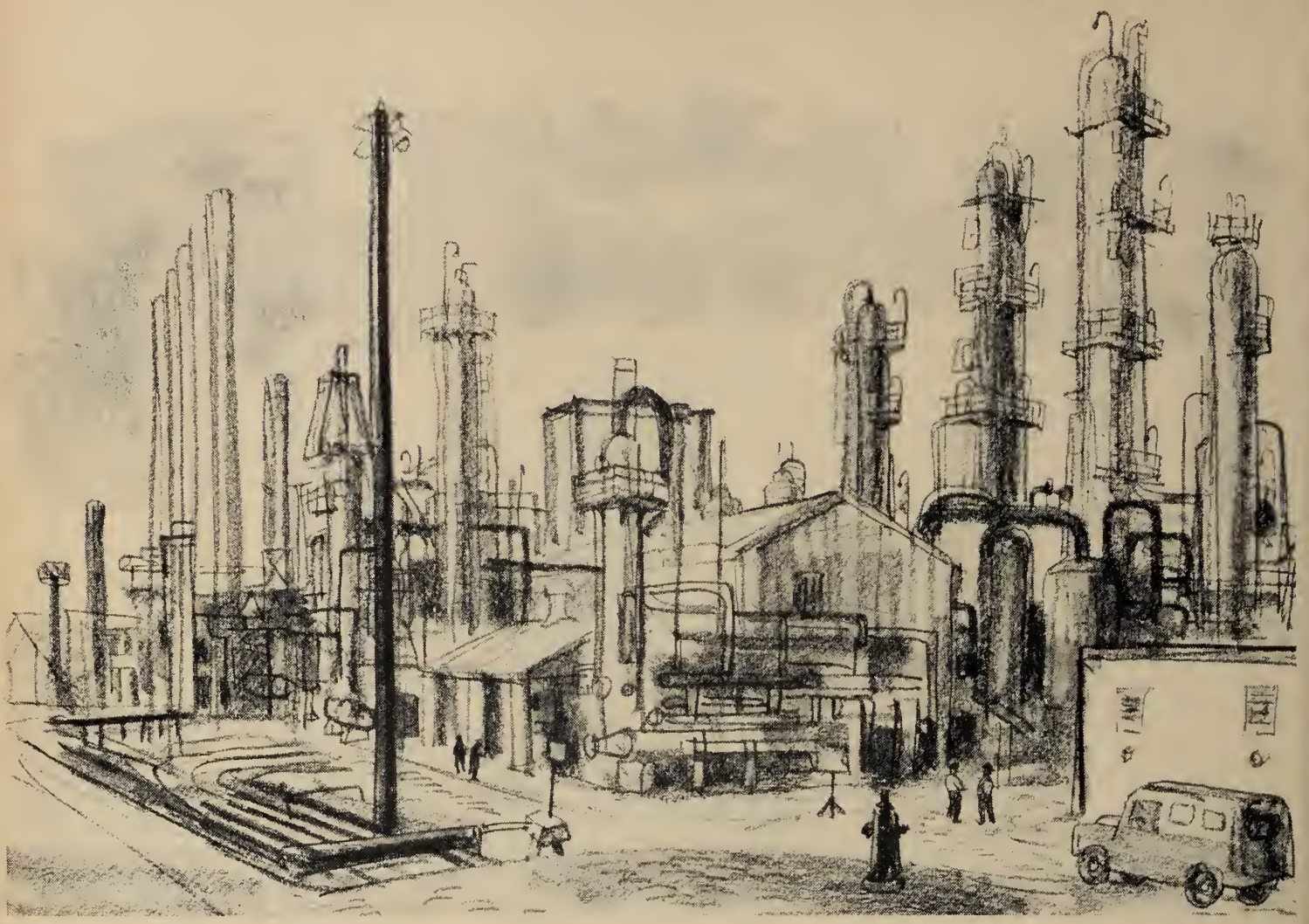

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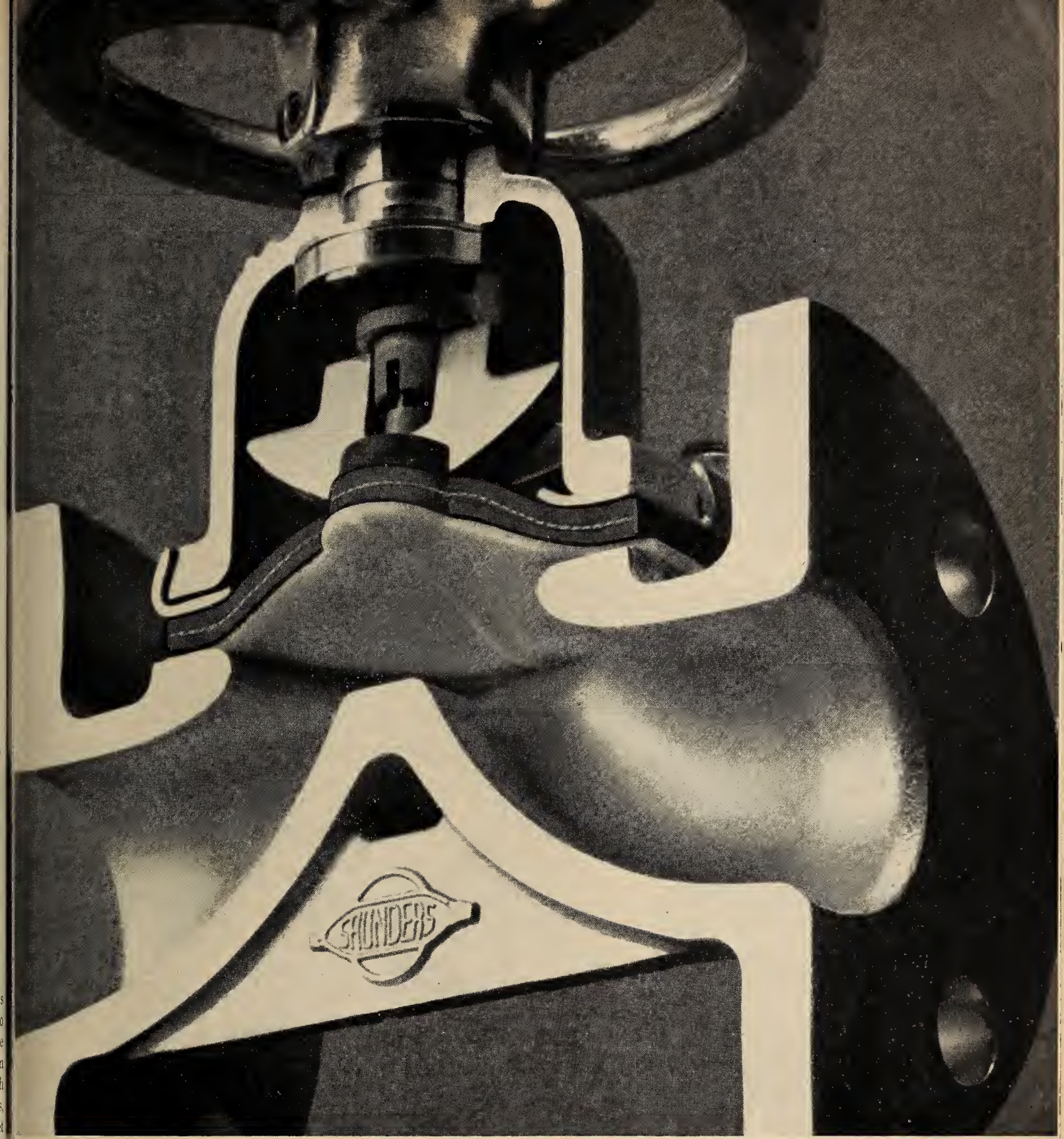

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(Continued from page 81)

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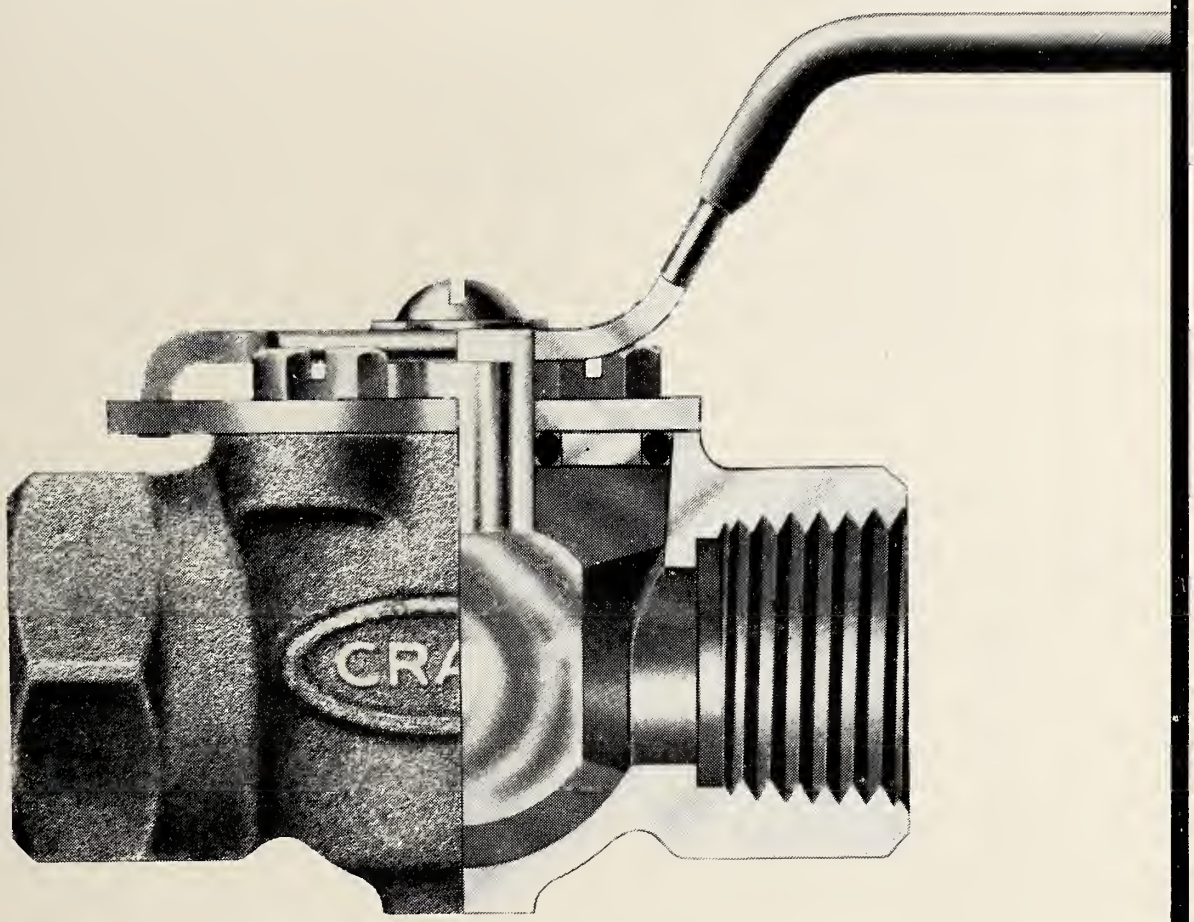

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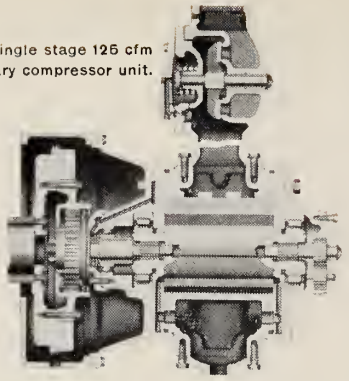

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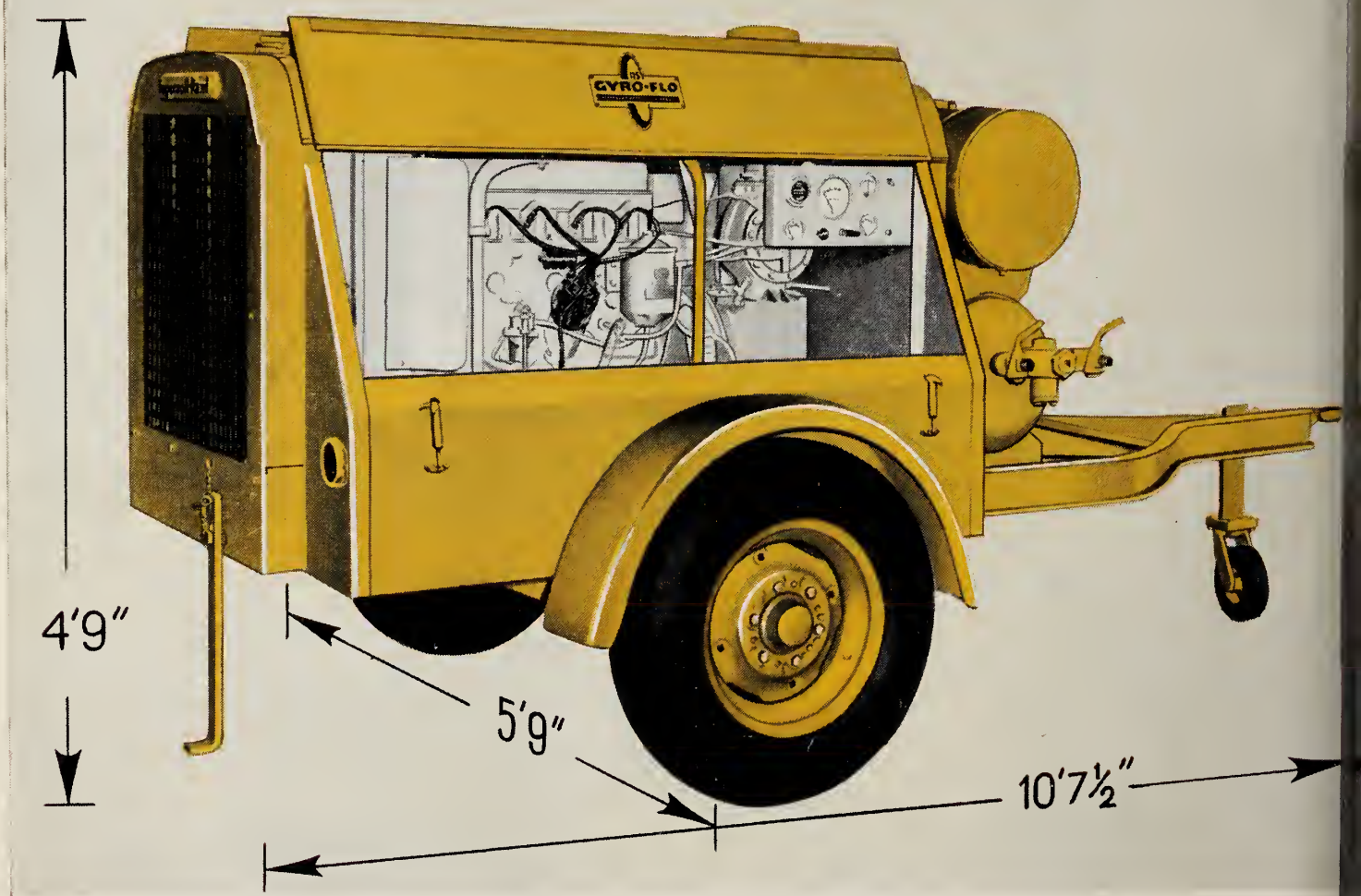

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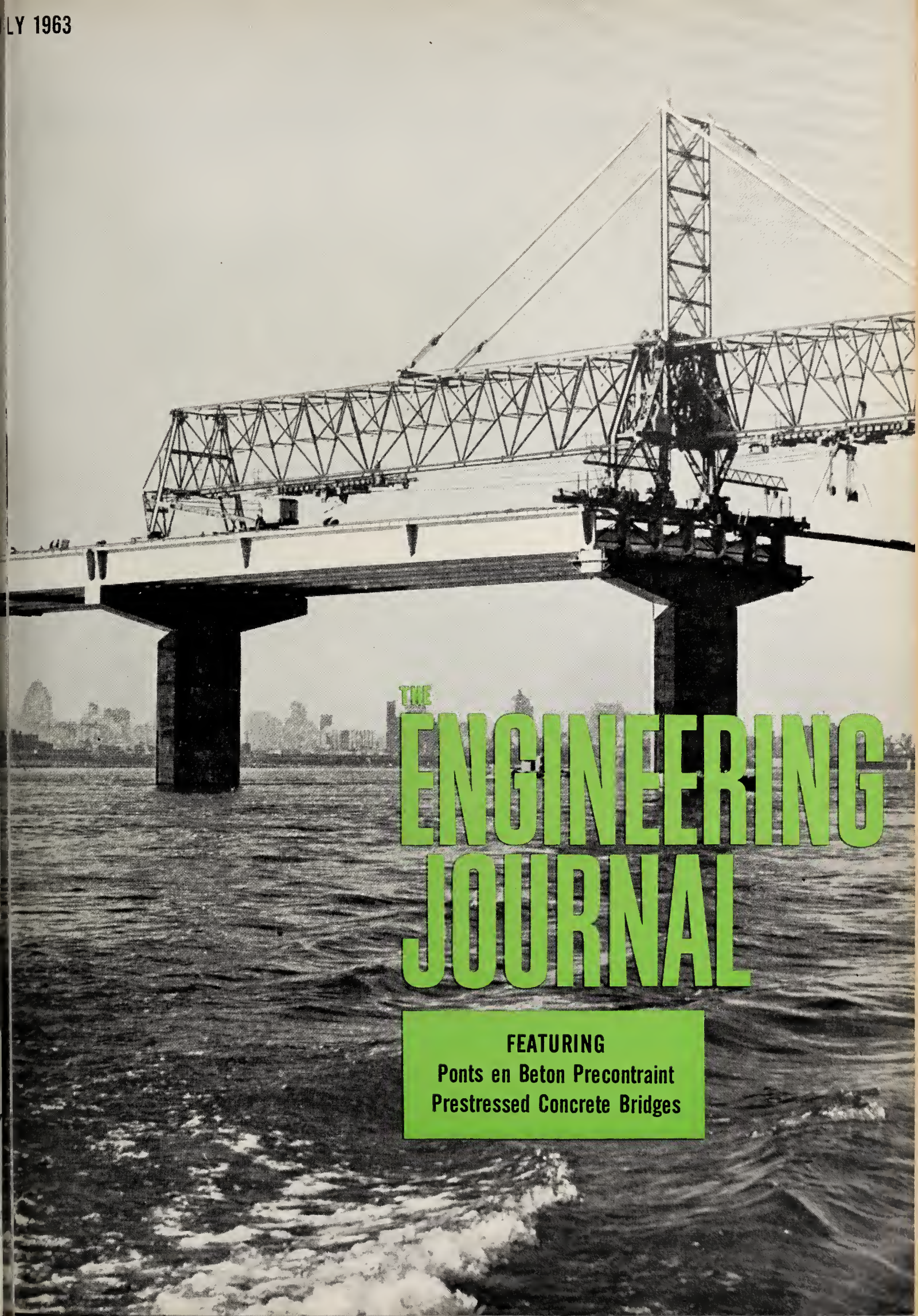


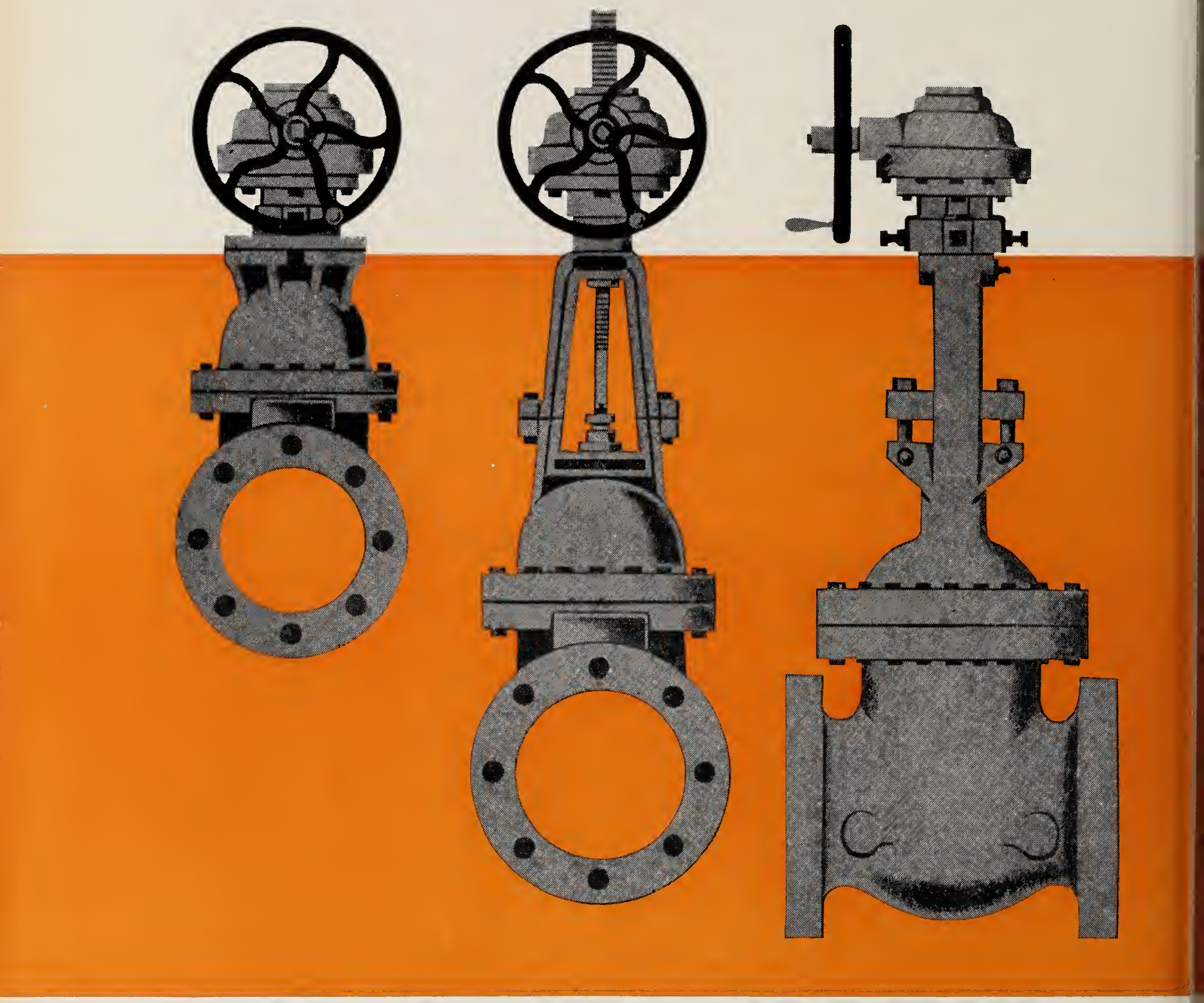
THE ENGINEERING JOURNAL

FEATURING

Ponts en Beton Precontraint

Prestressed Concrete Bridges

In less than thirty minutes you can "power up" you
Crane valves with a CONVERTO-GEAR OPERATO*



You can assemble and install a Converto-Gear* kit in the field in under thirty minutes. Compare this with the 8 to 10 man-hours needed for alternative installations.

Then compare prices: Crane Converto-Gear* Operators are substantially less expensive than any other alternative geared unit.

Now look at ease of operation. This new performer will function smoothly under all ambient conditions —is virtually immune to thermal or mechanical shock. The unit is totally enclosed, weatherproof and permanently lubricated for virtually a maintenance-free life. Its spiral-cut bevel gears are carburized st forgings—have a 4.11 to 1 ratio. Three sets of b bearings yield a mechanical efficiency of over 95%.

Converto-Gear* Operators come in two basic styl "N" provides a vertical hand-wheel—"P" has a ho zontal wheel. Either will fit outside screw and yo valves (with either ball-bearing or split yokes) a non-rising stem valves.

Get the whole story from your local industrial pro uct wholesaler, or Crane Supply. If you prefer, wr P.O. Box 70, Montreal, P.Q.

**Crane Co., Trademark*

CRANE

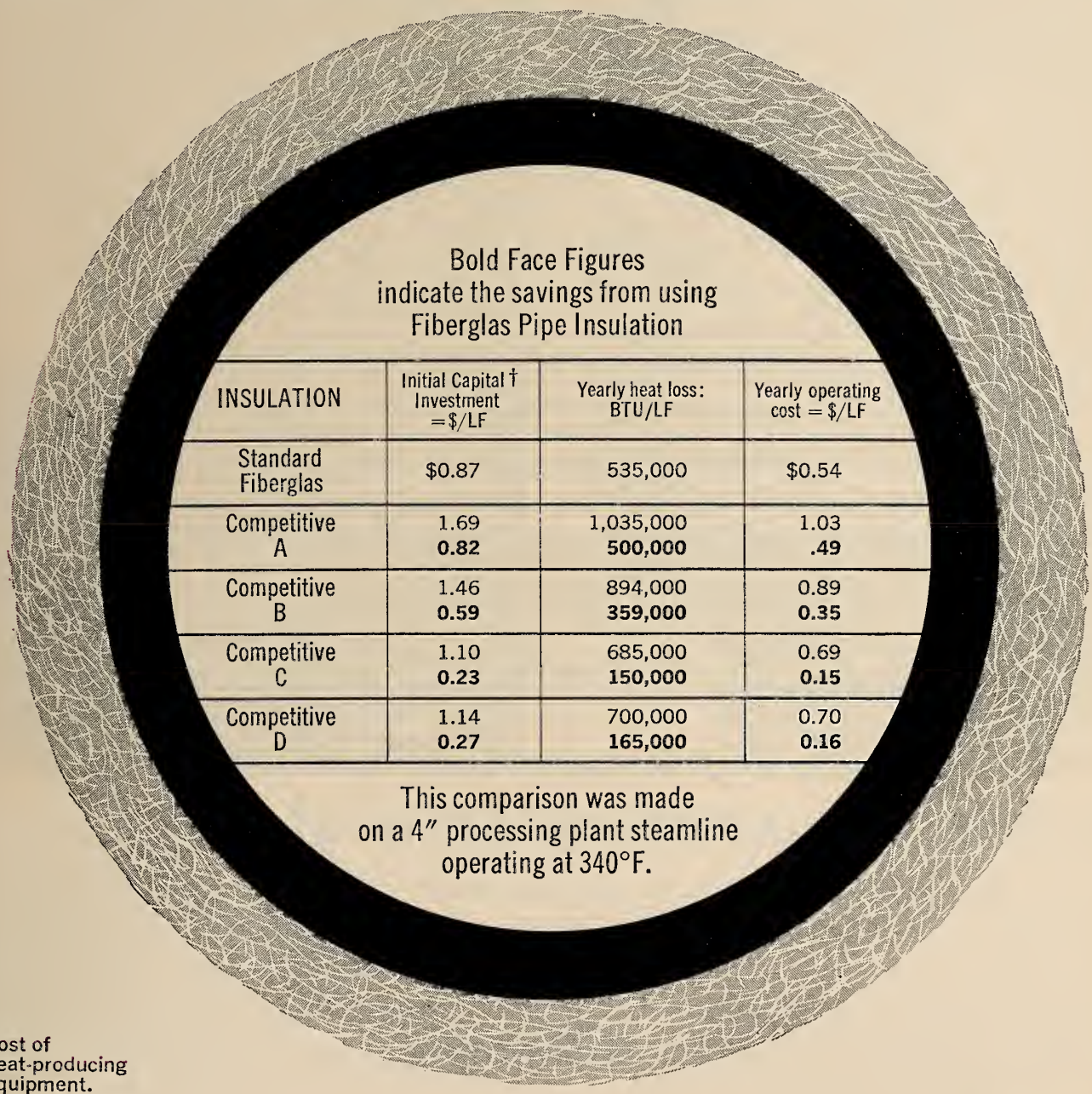
SEE HOW FIBERGLAS PIPE INSULATION SAVES YOU MORE DOLLARS!

The chart below compares the costs of Initial Capital Investment, Yearly Heat Loss and Yearly Operating Costs per lineal foot of Fiberglas* Pipe Insulation, and equal thicknesses of 4 competitive insulating materials. It demonstrates clearly that Fiberglas insulation costs considerably *less* to install and maintain than the other insulations.

This is the kind of information supplied through Dividend Engineering—a service developed by Fiberglas. It is a fast and reliable method of pinpointing insulation specifications that can project significant savings in initial and operating costs at the planning stage.

Dividend Engineering is a proven Fiberglas service using an estimating system based on thermo-economic data accumulated over 20 years in thousands of industrial and commercial buildings.

*T.M. Reg'd



Bold Face Figures
indicate the savings from using
Fiberglas Pipe Insulation

INSULATION	Initial Capital † Investment = $/LF	Yearly heat loss: BTU/LF	Yearly operating cost = $/LF
Standard Fiberglas	$0.87	535,000	$0.54
Competitive A	1.69 **0.82**	1,035,000 **500,000**	1.03 **.49**
Competitive B	1.46 **0.59**	894,000 **359,000**	0.89 **0.35**
Competitive C	1.10 **0.23**	685,000 **150,000**	0.69 **0.15**
Competitive D	1.14 **0.27**	700,000 **165,000**	0.70 **0.16**

This comparison was made
on a 4″ processing plant steamline
operating at 340°F.

† Cost of heat-producing equipment.

SPECIFY THIS FULL FAMILY OF FIBERGLAS PRODUCTS

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- Pipe Insulations
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The law of supplying demand

At Hydro-Quebec, it reads: Keep ahead. The current proofs are Carillon and Manic 2. In 1964, Carillon will add 2,500 million KWH per year to the power supply demanded by the homes, farms and industries of Quebec. By the end of 1965 Manicouagan 2 will be in production with 680,000 H.P. That's power to grow on. Carillon's generators are powered by fourteen automatic Kaplan Turbines of 60,000 H.P. each; Manic 2 is getting eight 170,000 H.P. Francis Turbines. That will make 2.2 million H.P. for Hydro-Quebec—with hydraulic turbines—designed, engineered, built and installed by Dominion Engineering.

Hydraulic Power

DOMINION ENGINEERING

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THE
ENGINEERING JOURNAL
July 1963 - Vol. 46, No. 7

PUBLISHED MONTHLY BY THE ENGINEERING INSTITUTE OF CANADA

2050 Mansfield St., Montreal 2, Que., Canada

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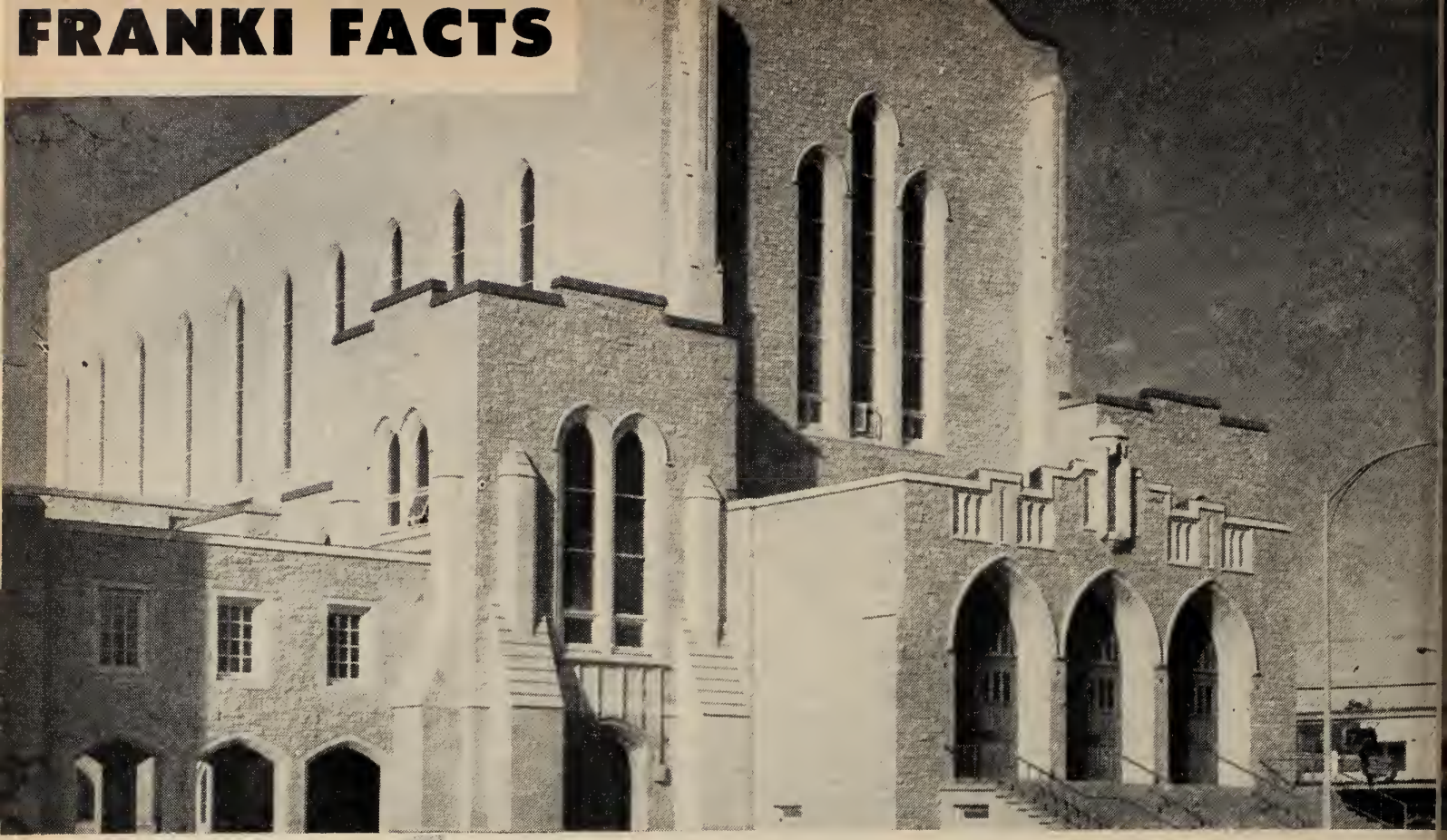


CLIENT:
Roman Catholic Archdiocese of Edmonton

STRUCTURE:
St. Joseph's Cathedral

ARCHITECT:
Henri S. Labelle, Montreal

CONTRACTOR:
Christensen and MacDonald Ltd., Edmonton

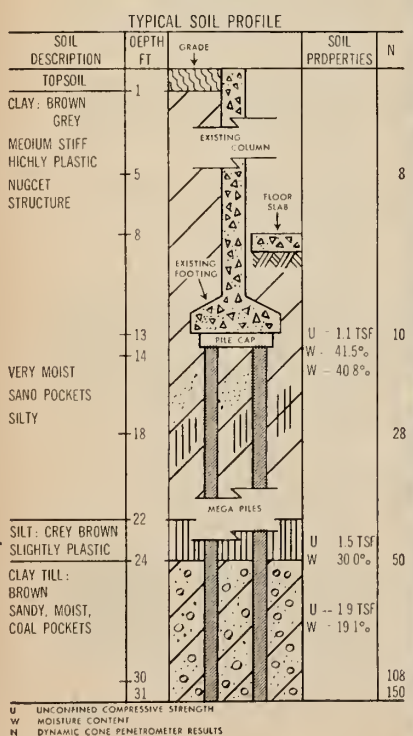
SOILS CONSULTANT:
R. M. Hardy and Associates Ltd., Edmonton

NUMBER OF FRANKI UNITS:
265 Mega Piles
78 Pipe Piles

WORKING LOADS:
20 Tons to 50 Tons

AVERAGE DEPTH OF PILES:
31' - 0" below outside grade

TYPICAL SOIL PROFILE



U UNCONFINED COMPRESSIVE STRENGTH
W MOISTURE CONTENT
N DYNAMIC CONE PENETROMETER RESULTS

CATHEDRAL GIVEN NEW FOUNDATION WITHOUT INTERRUPTION TO SERVICES

Problem:

In 1924, the Archdiocese of Edmonton began construction on a new cathedral, the episcopal seat for a large area of central Alberta. After the basement was completed, the project was interrupted by the depression and World War II. The work was not taken up again until 1960, when the original foundation footings and basement walls were underpinned.

In the intervening years, the existing work had been observed to move under load with changes in sub-soil moisture content and the first foundations were found to be inadequate to support the large superimposed loads intended with the construction of the cathedral superstructure.

The problem then was to stabilize the existing work and provide additional capacity for new loads by lowering the foundations to a soil bearing layer of sufficient strength.

Solution:

Soils information was augmented by dynamic cone penetration tests to assess the in situ resistance of the soil below footing level and determine absolute refusal for piles. The glacial till layer was known to exist at 24 feet, but maximum resistance in this soil was not reached until 31 feet, or 7 feet below the till surface. This soft condition in the upper till was due to past weathering and subsequent access by water.

Franki designed a new foundation on 6", 8" and 10" "Mega" Piles to underpin the original structure. In preparing the layout, careful consideration was given to a balanced design as related to existing and future loads.

The Mega Piles were installed by cutting trap doors in the floor system, excavating beneath the footing and jacking the piles in short lengths to refusal depth where they were held under working load until all settlement had taken place. The lack of reaction for jacking, in some cases, necessitated the reliance on arching action in the structure and some calculated available loads were exceeded by as much as 70%.

After preloading, the piles were wedged beneath the footings to take up the existing load. The wedging was then concreted into a cap. Excavated soil had to be stored inside the cathedral and the entire project, carried on over a period of 7 months, was done without interruption to divine services.

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Literature - This series of job highlights, as well as other descriptive literature, will be sent to you upon request to Franki of Canada Ltd., 187 Graham Blvd., Montreal 16, P.Q.

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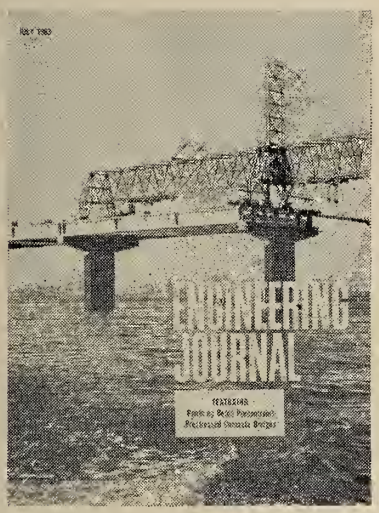

COVER ILLUSTRATION

There has been a considerable increase during recent years in the use of prestressed concrete in bridge construction. This is particularly so in the Province of Quebec. The lead paper in this issue of the Journal deals with this subject, and the cover photograph shows Montreal's Champlain bridge under construction.

In his paper, **"Prestressed Concrete Bridges in the Province of Quebec," René Martineau,** consulting engineer of Bourgeois & Martineau, Montreal, describes first, in a very general way, the development of prestressed concrete mentioning several reasons which justifies the use of this material in the beginning. Then follows a description of several bridges constructed since 1937, grouping them according to types of superstructures: simple beam bridges, cantilever beam bridges and continuous beam bridges. Next, some aspects of prestressed concerete are considered, in accordance with the existing construction codes. The fact that this technique of building is only at its beginning is emphasized by the author in the conclusion. He states that prefabrication is a satisfactory method for carrying out work, but that standardization pushed too far could, at the present time, restrict the creative imagination of bridge builders.

The experimental approach in the field of analysis of structures serves two potential areas: One basic task is to confirm or reject the validity of newly advanced theories and in particular to define their limitations. The second field of activity is to investigate the stress, deformation and failure characteristics of a particular, possibly a unique structure solely because theoretical means are not available to achieve this end. **Joseph Schwaighofer,** Professor, Department of Civil Engineering, University of Toronto, in his paper, **"The Analysis of Structures by Aid of Models,"** states that model studies may be divided into two groups: studies in which homogeneous and isotropic model materials are used which follow Hooke's law within the testing range, and model studies which consider the linear and the non-linear elastic as well as the plastic behaviour of the structure and employ therefore identical materials for prototype and model. In particular, in studies of the second group model analysis is not a mere counterpart of theoretical methods, but goes far beyond the theoretical approach in fully incorporating the physical characteristics of the structure.

George Ford, M.E.I.C., Head of the Department of Mechanical Engineering, University of Alberta, states in his paper, **"The Danger of Specialization,"** that many changes are taking place in modern engineering curricula not only in course content, but in the depth of treatment as well. Material which a few short years ago was considered only at the graduate level, is already basic to an undergraduate program. Emphasis is being placed on scientific principles and more sophisticated attacks on engineering problems. Great care must be exercised in the selection of courses in an engineering program so as to provide a base from which the orderly process of education may continue after the engineer leaves the university. Such a program can only be constituted by emphasizing the basic engineering science course at the expense of courses which give specific knowledge in a narrow field. The retention of these specialized courses can only lead to early obsolescence.

Observations made during the Second Commonwealth Study Conference held in May and June, 1962, confirmed that the method, mode and manner of individual living has undergone drastic change. What was far from obvious was the realization that the nature of man has not changed. It is suggested that in dealing with people, perhaps we have become so overcome by change that we have through neglect, "hidden under a bushel" some of the unchanging "lights" of human nature. The purpose of **G. R. McMeekin's** paper, **"Under a Bushel,"** is to remind engineering personnel of some of the simple, well-known lights of human nature, the appreciation of which can enhance man's dealings with man.

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PERMATURN VALVES

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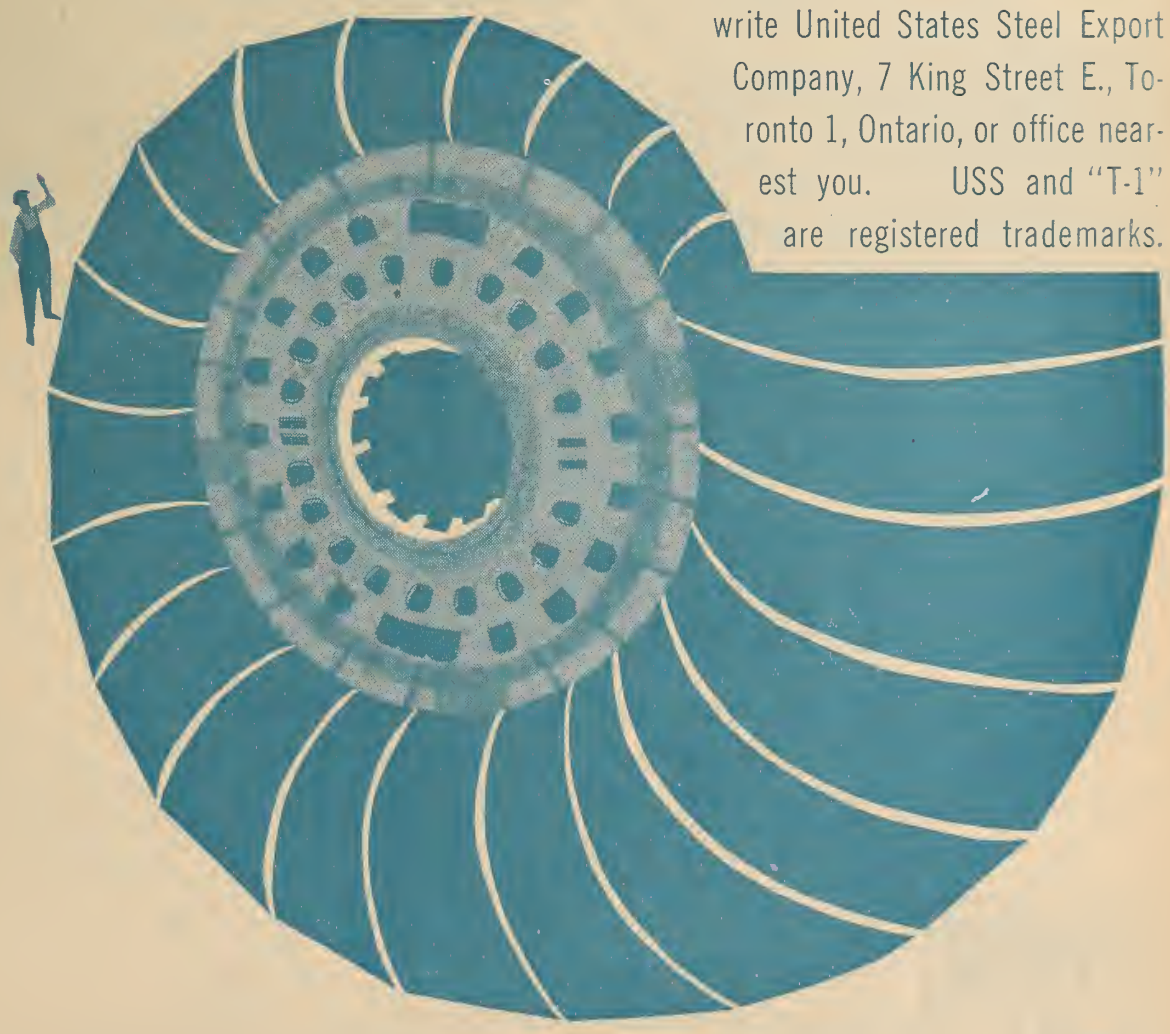

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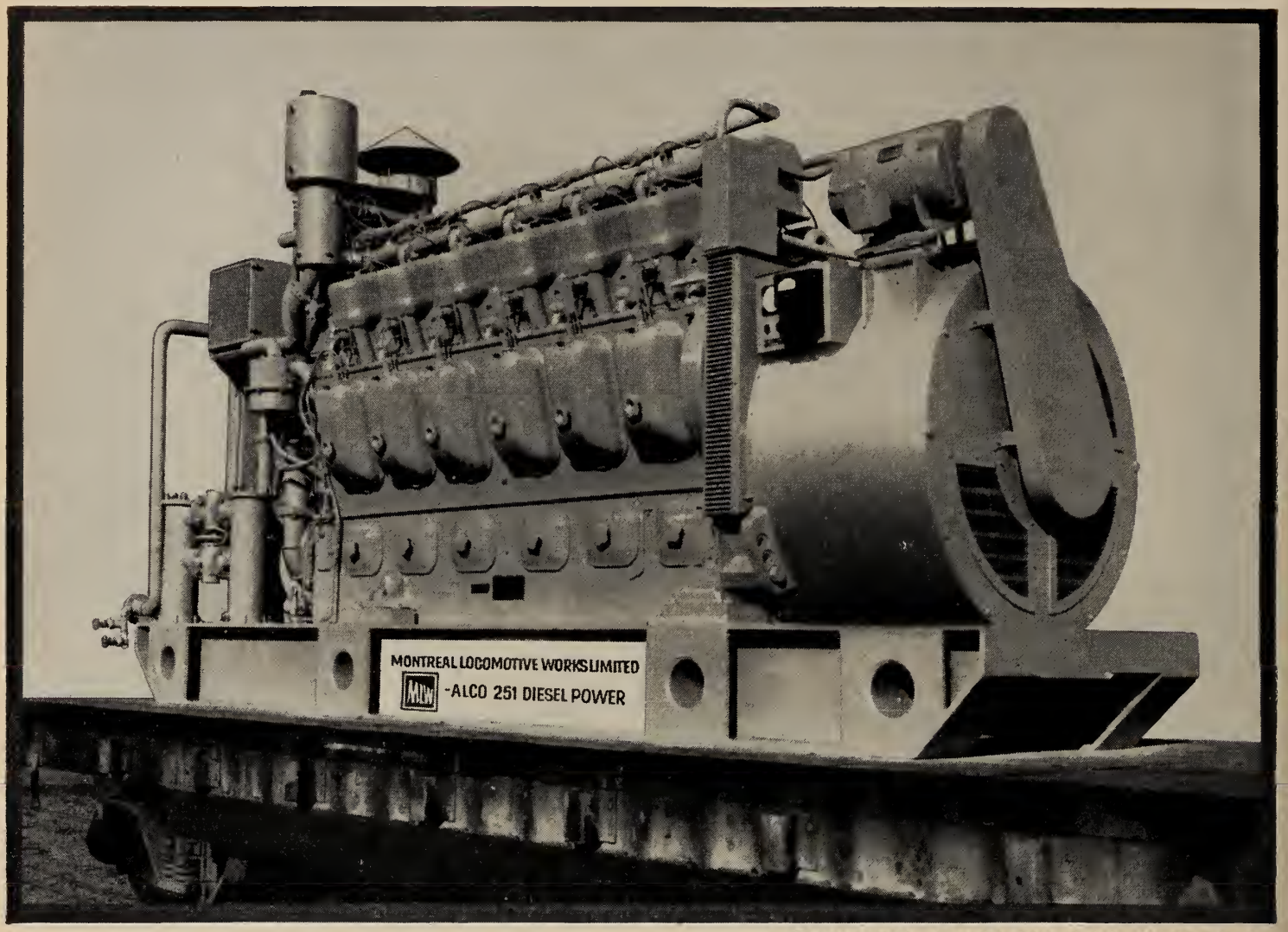

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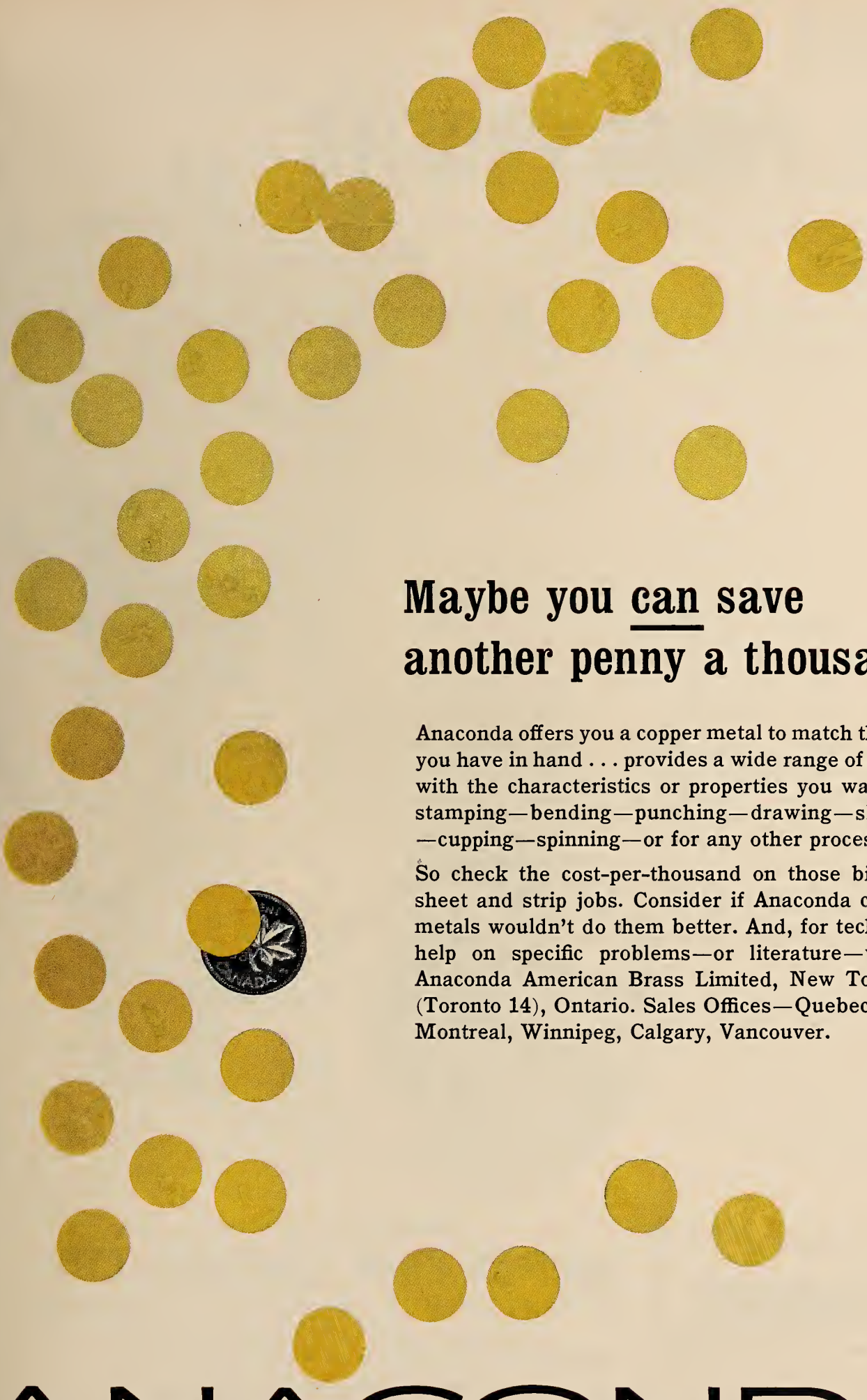

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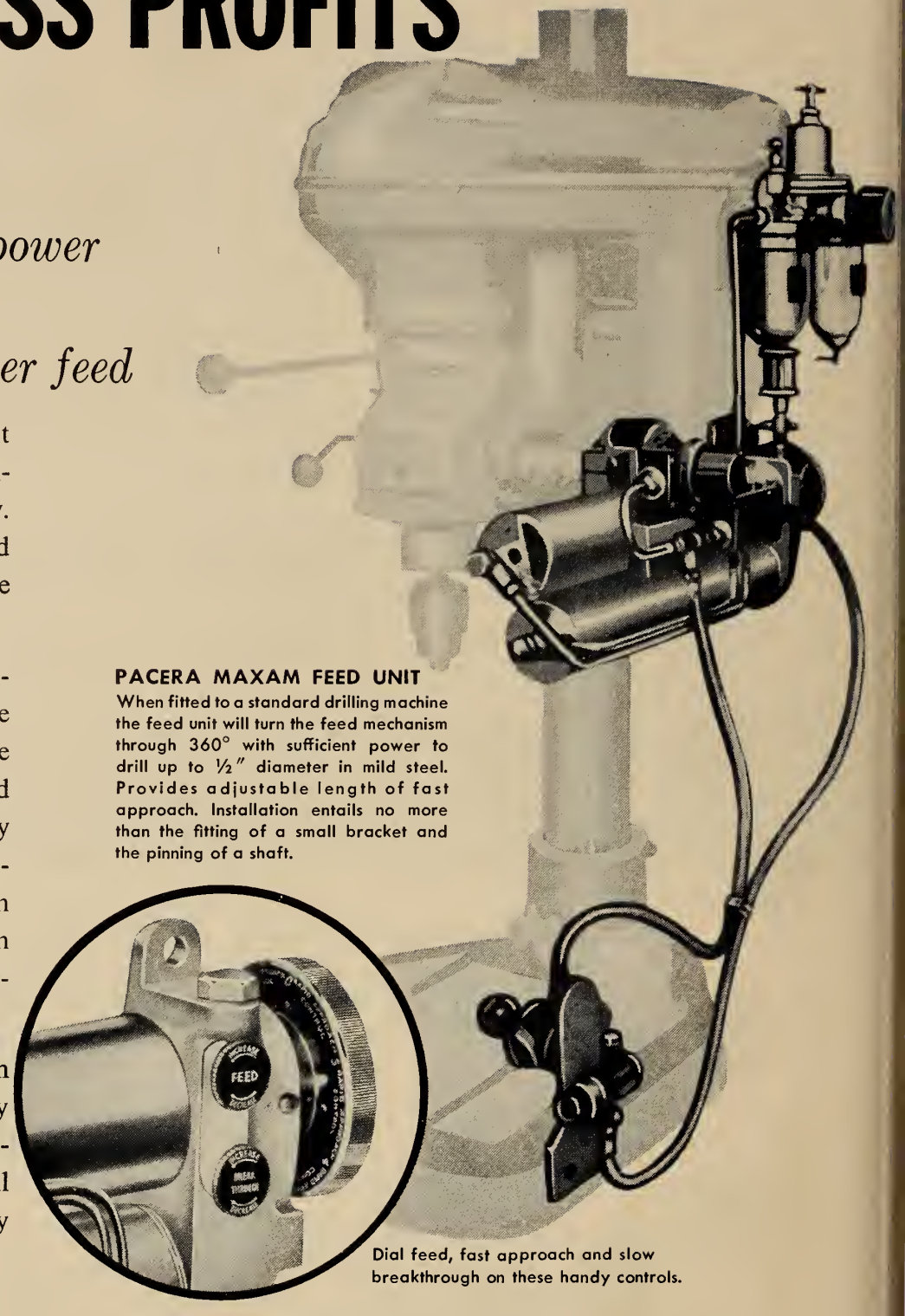

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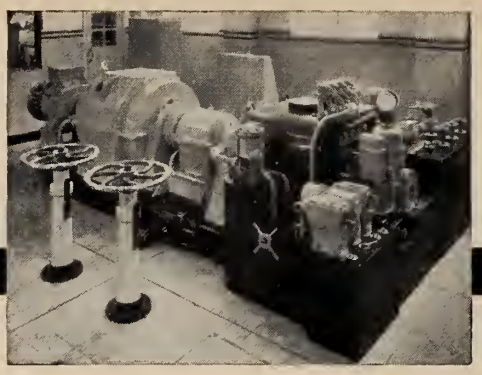
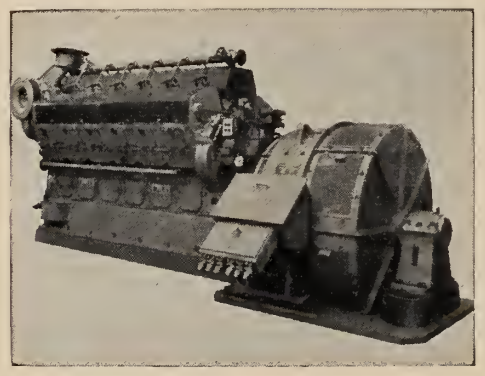
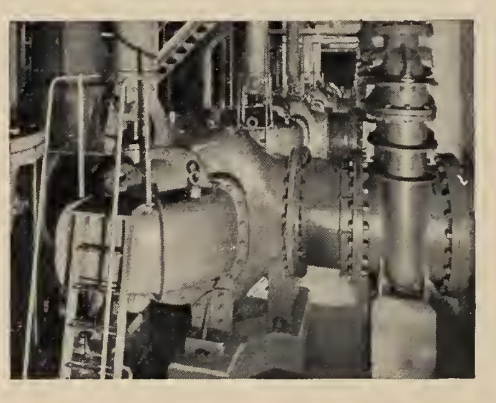


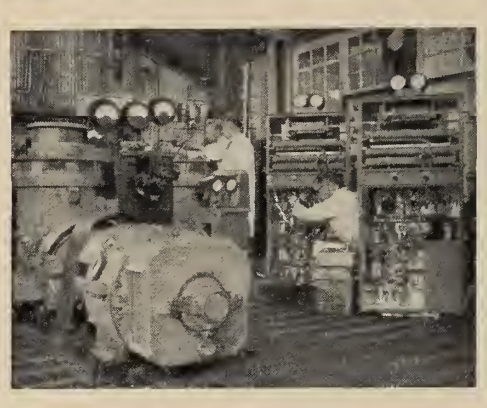
Steam Turbines



Diesel Engines



Pumps



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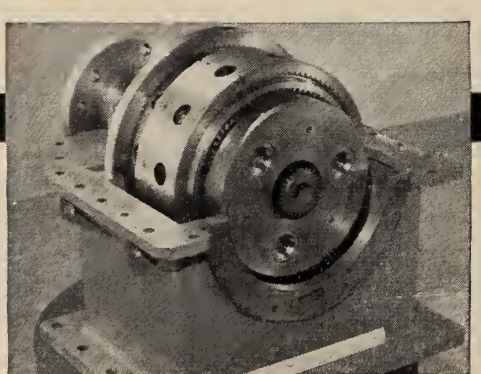

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Unfortunately, this is not always being done. Recent studies have shown that an unprecedented number of imported products are being specified when generally similar products comparable in function, design and price *are* available from Canadian manufacturers.

You, as a Professional Engineer, have a great responsibility in the development of plans and specifications for the various projects in our Province. Your assistance is urgently needed to ensure that a greater percentage of the materials used in these projects are Made-in-Canada products.

At the first Manufacturing Opportunities Show recently held in Toronto, thousands of imported components were displayed. It was clearly demonstrated that many of these could be made equally well in Canada and at competitive prices. In the few months since, thousands of dollars in orders have been placed for their engineering and manufacture in Canada, many in Ontario.

The Government of Ontario does not recommend the elimination of imports. It does suggest that when a Canadian product is comparable in quality and price to one that is imported, your decision should be to specify the Canadian product.

MANUFACTURING OPPORTUNITIES

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PONTS EN BETON PRECONTRAINT dans la Province de Québec

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I—INTRODUCTION

Le béton précontraint a connu, dans la Province de Québec, durant ces dernières années un essor considérable. Cet essor n'est d'ailleurs que le reflet de la popularité croissante de ce matériau dans le monde entier.

En effet, la première structure précontrainte dans la Province de Québec, et même au Canada, le stadium de baseball de Sherbrooke,[1] ne fut terminée qu'en 1953, c'est-à-dire, il y a à peine dix ans. A cette époque, l'on vit apparaître également la première usine de produits préfabriqués, précontraints par fils adhérents. Cette usine, née un peu trop tôt, dut fermer ses portes à cause du faible marché de ces temps héroïques. Mais aujourd'hui, l'on compte au moins trois usines produisant à pleine capacité surtout pour l'industrie du bâtiment.

Les premiers ponts furent construits en 1958, soit il y a à peine cinq ans. Ces ponts bien modestes faisaient parties des voies étagées servant d'approches à l'extrémité sud du pont Jacques-Cartier. Ils furent suivis par quelques viaducs du Ministère de la Voirie et de l'Office de l'Autoroute Montréal-Laurentides. Mais, c'est en 1959 que le béton précontraint conquiert vraiment ses titres de noblesse en s'avérant, à la suite d'un concours, la solution la plus économique pour la superstructure du pont Champlain sur le St-Laurent, à Montréal.

Aujourd'hui, l'on peut compter certes au-delà de trente ponts et viaducs en béton précontraint, dans la Province et ce n'est que le début d'une progression qui sera sans doute très rapide.

La plupart des articles parus sur le sujet, depuis dix ans, décrivent les avantages du béton précontraint: élimination des efforts de tension, plus grande efficacité de la section, etc. Les raisons qui font que l'on utilise le béton précontraint sont quelques fois bien différentes. Ainsi, le stade de Sherbrooke était destiné à remplacer un stadium en bois qui avait brûlé. Or à cette époque, les restrictions d'après guerre sur l'acier d'armature et de structure existaient encore, mais elles ne s'appliquaient pas au fil à haute résistance qui était alors produit pour le renforcissement des câbles de lignes de transmission ou autres usages du genre. De même, les ponts aux approches du pont Jacques-Cartier avaient été conçus en acier de charpente, avec dalle de béton combinée. Les culées étaient déjà construites en fonction de ce système de charpente. A cause de délais de livraison trop long, l'on songeat au béton précontraint comme seule variante possible.

Par la suite, l'on craignait que le coût du béton précontraint ne fut trop élevé. Aussi, malgré les avantages théoriques qu'on lui reconnaissait, n'était-il accepté que sous forme de variantes à des projets tablis d'une autre façon. Ce fut le cas d'un assez grand nombre de bâtiments. Ce fut également le cas des ponts Champlain et Senneville.

Enfin, aujourd'hui, l'on peut dire que le béton précontraint est reconnu

partout dans la Province. Il n'y a plus nécessité de prouver à chaque fois ses mérites, et l'on peut voir maintenant plusieurs projets où l'utilisation de ce matériau a été décidée lors de l'étude préliminaire. De plus, un plus grand nombre d'entrepreneurs sont déjà familiers avec ses caractéristiques, ce qui permet de conserver, à un projet en béton précontraint, le caractère compétitif que nous rechercherons toujours.

II—TYPES D'OUVRAGES

Avant d'examiner un peu en détail certains types de ponts, il convient de bien distinguer la technique de la précontrainte de la technique de la préfabrication. La technique de la préfabrication est une technique d'exécution seulement. Son but est de réduire le coût des structures en les décomposant en éléments que l'on cherchera à standardiser. Ceci produira une réduction sensible du coût des coffrages ainsi qu'une réduction de frais de main-d'oeuvre et d'opération par la rationalisation des tâches.

La technique de la précontrainte s'est associée à la technique de la préfabrication en permettant la production d'éléments plus légers, donc plus maniables. La préfabrication permet de plus, un contrôle plus facile de l'exécution alors même que la précontrainte exige un contrôle d'une qualité jusque là inconnue sur les chantiers, en général.

C'est pourquoi, certains croient que le béton précontraint ne peut être réalisé qu'en le préfabriquant, alors que cette technique est beaucoup plus vaste. Avec l'augmentation des moyens de contrôle sur les chantiers, l'on verra certainement de plus en plus d'application de la précontrainte à des structures coulées en place.

Les différents types de ponts réalisés dans la Province de Québec

Fig. 1. Viaducs aux approches sud du pont Jacques Cartier. Erection d'une poutre.

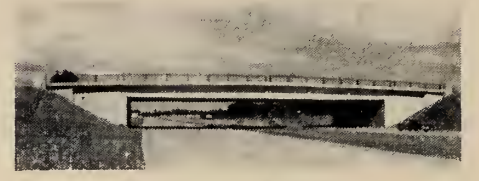


Fig. 2. Viaduc de la rue Dudemaine. Autoroute Montréal-Laurentides.

peuvent se classer en trois catégories suivant le type de tablier, soient: poutres simples, poutres cantilever, poutres continues.

a) Ponts à poutres simples.

Le système à poutres simples est simple à tous points de vues: calcul, fabrication, érection. De là sa grande utilisation.

Les premiers ponts, les viaducs d'approche du pont Jacques-Cartier construits en 1957, (Fig. 1) comportent un grand nombre de poutres parallèles, très rapprochées. Les semelles supérieures des poutres en T ne laissaient entre elles qu'un intervalle de 2½ po. Cet espace fut rempli sur coffrage permanent et par la suite on coula une dalle de béton d'une épaisseur variable de 4 à 7 po. Cette dalle agit monolithiquement avec les poutres et permet d'obtenir les courbures transversales et longitudinales désirées. De plus, dans ce cas, la dalle sert à distribuer les charges, car il n'y a pas d'entretoises.

Ces cinq petits ouvrages comportaient au total 98 poutres variant en longueur de 41 pi. à 65 pi. Ces poutres, d'un poids de 13 T pour les plus longues, furent préfabriquées à l'usine d'un enterpreneur spécialiste en préfabrication.

L'on se rendit vite compte qu'il y a avantage à espacer les poutres un peu plus. Cependant, au viaduc de la rue Dudemaine, (Fig. 2 et 3) construit à la fin de 1958, il y avait limitation de hauteur, car il fallait respecter un profil établi. Les poutres, d'une longueur cette fois de 139 pi., étaient espacées à 4 pi. 8 po. et la semelle supérieure faisait 4 pi. L'intervalle de 8 po. fut rempli, encore sur coffrage permanent, et le tout fut recouvert d'une dalle variant en épaisseur de 4 à 7 po. L'on crut bon d'ajouter des entretoises à cause de la hauteur des poutres et surtout pour absorber les moments transversaux causés par les trottoirs en porte-à-faux. Les 14 poutres de ce viaduc furent coulées en hiver, sur le sol, à environ 300 pi. des culées. Elles furent transportées et érigées, chacune à l'aide de quatre grues. Ce viaduc détenait en 1959, le record de portées de ponts au Canada. Les américains en ont parlé comme étant "a hot record in a cold climate".[2]

Puis ce fut le pont Champlain avec ses 50 travées de 175 pi. Cette fois, tous les records étaient battus! La construction de ce pont commença à l'automne 1959 pour se terminer à l'automne 1961. Là les poutres, d'une hauteur de 10'0 sont espacées à 12 pi. 2½ po. La distribution des charges vives se fait à l'aide de deux

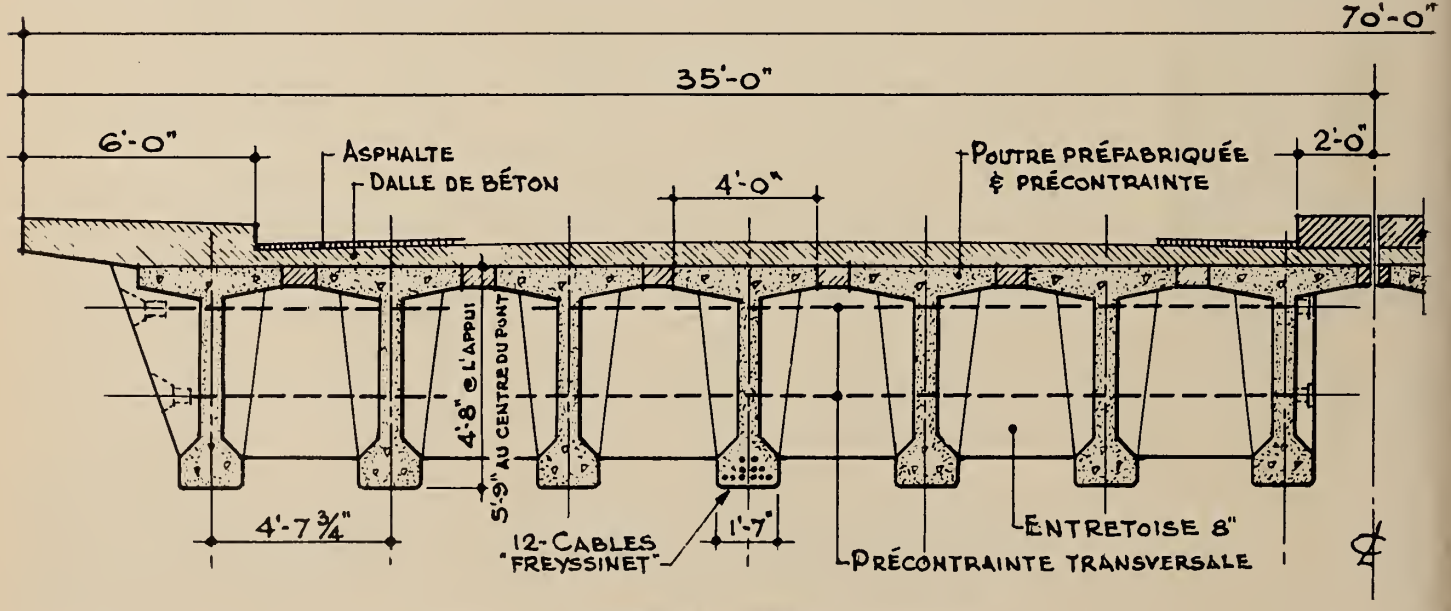


Fig. 3. Viaduc Dudemaine. Coupe en travers du tablier.

Fig. 5. Pont Champlain. Section III. Vue du pont.

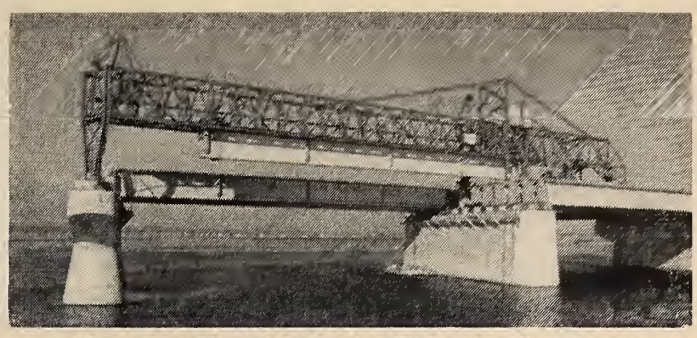


Fig. 6. Pont Champlain. Section III. Erection d'une poutre.

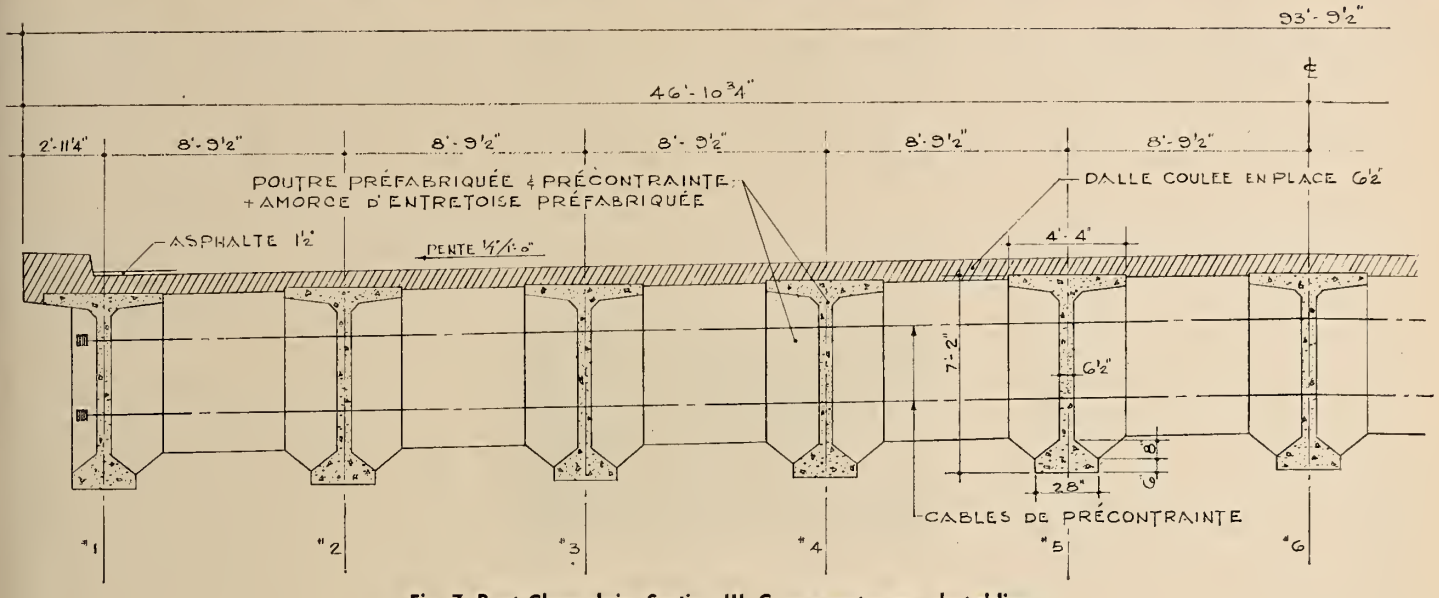


Fig. 7. Pont Champlain. Section III. Coupe en travers du tablier.

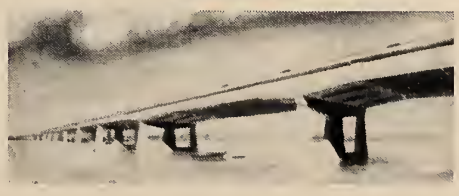
entretoises d'une profondeur de 9 pi. Les poutres sont en forme de T avec semelle supérieure d'une largeur de 6 pi. Il n'y a pas de dalle coulée à la grandeur sous le tablier, mas seul l'intervalle entre les semelles des poutres est rempli. Semelles et dalles sont précontraintes transversalement par des câbles enfilés dans des trous réservés par des gaines dans les semelles et les hourdis.

L'intérêt de ce projet, outre ses dimensions, fut la rationalisation très poussée des opérations. Comme le professeur Boris Hesketh a déjà fait une description détaillée de ce projet,[3] qu'il suffise de mentionner que ces poutres pesaient chacune 180 tonnes et qu'elles furent fabriquées et érigées au rythme de 3 par jour. L'érection se fit à l'aide d'un pont de lancement très perfectionné qui pouvait se déplacer longitudinalement et transversalement. (Fig. 4 voir page frontispice.)

La section 3 du pont Champlain, (Fig. 5) située entre Montréal et l'Ile des Soeurs sur le St-Laurent, comportait elle, 12 travées de 128 pi. Encore une fois, les poutres sont préfabriquées sur un terrain adjacent, transportées par des chariots sur rail, et érigées à l'aide d'un pont de lancement plus rudimentaire, (Fig. 6) étant donné la plus faible importance de l'ouvrage. Les poutres, 11 par travée, ont une hauteur de 7'2" et sont placées à l'espacement économique soit 8'9½" en l'occurence. Les poutres sont reliées par des entretoises calculées pour assurer la distribution des charges vives en tenant compte des rigidités longitudinales et transversales du tablier.[5] Dans ce cas, la dalle est en béton armé coulé au-dessus des poutres. (Fig. 7).

Le pont de la route Trans-Canada sur la rivière Outaouais, entre Senneville et l'Ile aux Tourtes, actuellement en construction, comportera 28 travées simples de 160 pieds de longueur. La tablier de 90'0 de largeur est supporté dans chaque travée par 8 poutres de 9'3" espacées à 11'9". Seul l'intervalle de 5'9" entre les poutres est rempli de béton et la dalle est précontrainte transversalement. Les poutres sont reliées par trois entretoises intermédiaires. Se pont aura une longueur totale de 6364 pi. entre culées, dont 5873 pi. en béton précontraint. (Fig. 8 et 9).

Fig. 8. Pont Senneville—Ile aux Tourtes. Perspective.



Les ponts énumérés sont tous précontraints à l'aide de câbles ancrés, de même que plusieurs autres qu'il serait trop long d'énumérer ici. Il convient cependant de mentionner le pont sur la rivière des Anglais à Howick. C'est le premier pont construit avec des poutres précontraintes par fils adhérents. Ce pont comporte trois travées de 60'0, et sa largeur est de 36'8". En section, le tablier est formé de 9 poutres en T, du type standard "Single Tee". L'âme est rectangulaire, d'une profondeur de 3'0. La largeur de la semelle est de 4'3". Les poutres sont placées côte à côte, sans intervalle, et supportent une dalle de béton coulée en place de 5 po. d'épaisseur. Ce pont fut complété en décembre 1962.

b) Ponts cantilever

Lorsque nous pouvons construire au moins trois travées, comme c'est le cas de la plupart des viaducs au-dessus des autoroutes, il peut y avoir avantage à utiliser un système de poutres cantilever. Ce système permet de réduire les moments en travée par rapport à un système de poutres simples, d'où réduction de la hauteur de poutre. Les tabliers des ponts construits à date selon ce système, sont tous à poutres parallèles reliés par des entretoises, avec dalle de béton armé superposée ou coulée entre les

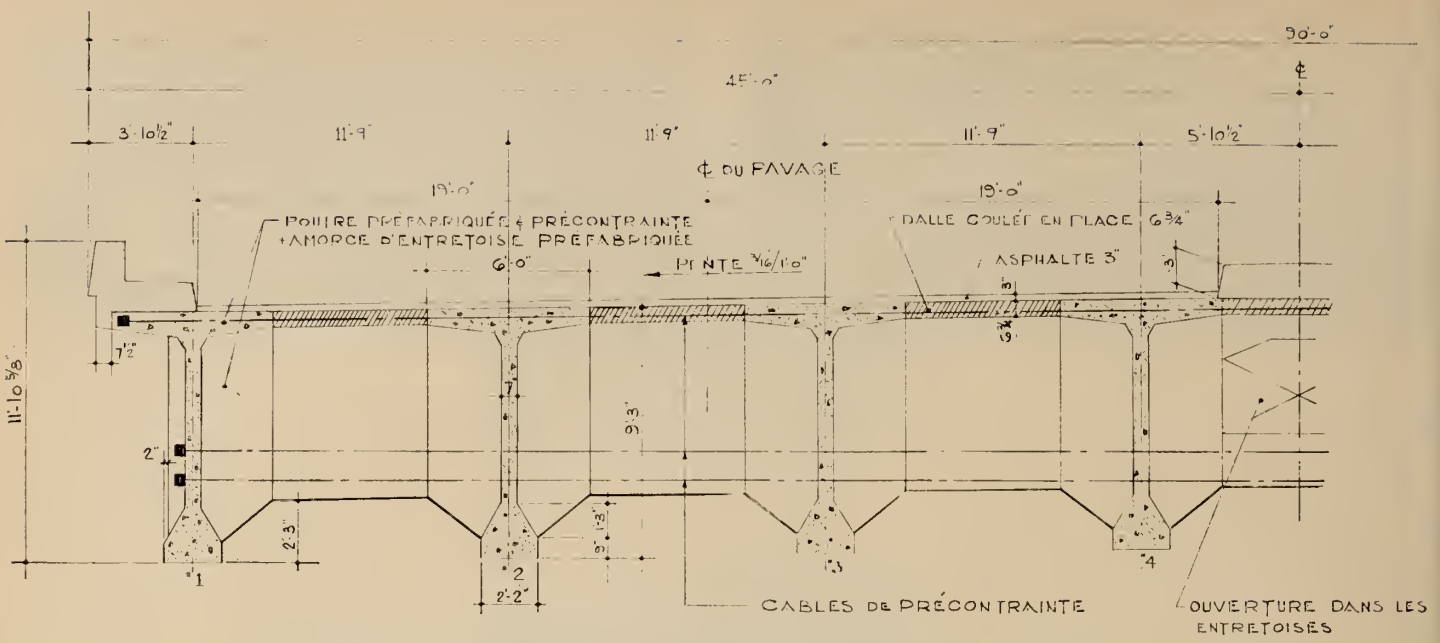


Fig. 9. Pont Senneville—Ile aux Tourtes. Coupe du tablier—des portées de 160 pi.

semelles des poutres et précontrainte transversale. Nous préférons cette dernière méthode car elle permet de compenser tous les moments négatifs par la précontrainte des poutres. Dans le cas d'une dalle de béton armé coulée au-dessus des poutres, il faut renforcer cette dalle au-dessus des appuis par des aciers ordinaires ou par des câbles de précontrainte supplémentaires.

Deux viaducs cantilever furent construits sur l'Autoroute Montréal-Laurentides, en 1958. Le viaduc de la rue de Martigny (Fig. 10 et 11) à St-Jérôme comporte une travée centrale de 85'0 et deux travées latérales de 71'0. Les poutres des travées latérales projettent en porte-à-faux dans la travée centrale sur une distance de 14'6", pour supporter les poutres centrales, simples, de 56'6" de portée. Les poutres sont en forme de T, avec semelle supérieure de 2 pi. 6 po. Elles sont espacées à 5'3". Sur les piliers, la hauteur des poutres est de 4'0, mais elle n'est que de 2'8" dans la travée centrale et au centre des travées latérales. Ce qui fait un rapport d'élancement pour la travée centrale de 1 sur 31.

Fig. 10. Viaduc de Martigny—Autoroute Montréal-Laurentides.

Fig. 11. Viaduc de Martigny—Câbles de précontrainte transversale de la dalle.

Cinq viaducs à système cantilever furent également construits sur la route Trans-Canada, (Fig. 13) en 1962. Dans ce cas, le terre-plein central de l'autoroute était plus étroit que celui de l'Autoroute Montréal-Laurentides. La travée centrale des viaducs était de 51'6" et les travées latérales de 84'6". Ce fut alors les poutres de la travée centrale qui projetaient dans les travées latérales sur une distance de 11'0. Ce qui permettait, pour la préfabrication, des poutres de longueurs égales, et aussi de hauteur constante. Ces viaducs, ainsi que plusieurs autres construits sur la route Trans-Canada, suivant un principe semblable, utilisaient des poutres préfabriquées sur les lieux avec câbles de précontrainte ancrés.

L'avantage du système cantilever est surtout appréciable dans le cas de grandes portées. Ainsi, le pont Senneville, Ile aux Tourtes, (Fig. 8) dont nous avons parlé, et qui comporte déjà 28 travées simples de 160'0, comporte également deux

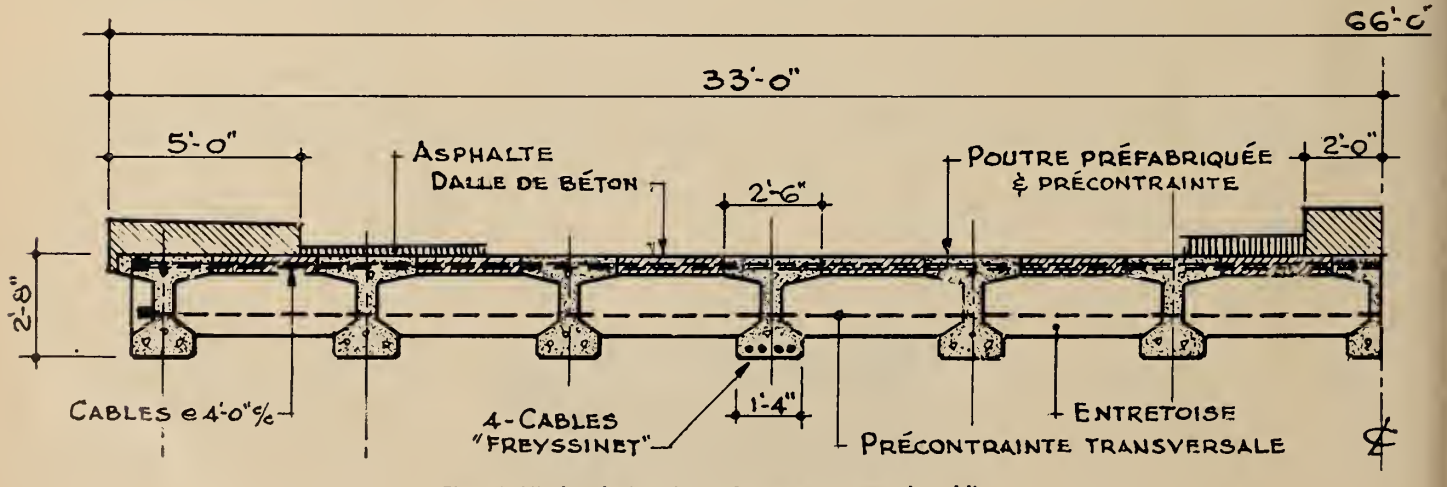


Fig. 12. Viaduc de Martigny. Coupe en travers du tablier.

groupes de trois travées chacune. Ces travées sont de 211 pi., 265 pi., 211 pi. pour chaque groupe. Pour un des groupes, ces travées sont motivées par le passage d'un chenail, et pour l'autre groupe, par la présence d'une faille dans le roc.

Les travées latérales projettent dans la travée centrale sur une distance de 54 pi. pour porter des poutres simples de 157 pi. centre à centre des appuis. Le système adopté permet d'utiliser et pour la travée simple centrale, et pour les travées latérales, des poutres préfabriquées de longueur et de profil identiques aux poutres des travées simples. Pour ce, l'on a prévu la construction en place de poutres caissons (Fig. 14) de 108'0 soit 54'0 de chaque côté des piliers principaux. Ces poutres caissons peuvent recevoir d'abord, les poutres des travées latérales. Puis, par enfilage de câbles de précontrainte, matage du joint entre ces poutres latérales et les poutres caissons, et précontrainte des eâbles de continuité, les poutres latérales préfabriquées deviennent solidaires des caissons coulés en place.

Les poutres de la travée centrale ont une profondeur de 9'3" pour une portée totale entre piles de 265'0 soit un rapport d'élancement de 1 sur 29. Ceci pour des poutres toujours espacées à 11'9". Sur les piles, les poutres caissons ont une profondeur de 12'8".

Nous pensons que ces travées seront les plus grandes portées franchies entre piles, de tous les ponts au Canada.

c) Ponts continus

Il n'y a pas eu beaucoup de ponts à poutres continues précontraintes, à

Fig. 13. Viaduc sur le route Trans-Canada.

date, au Canada. Evidemment, le calcul est plus compliqué, mais il y a surtout les difficultés techniques. Pour les ponts coulés en place, la longueur des câbles à tendre est limitée par la friction. Pour les ponts préfabriqués, il y a certaines complications à rétablir la continuité. De plus, dans ce cas, il faut prévoir un système d'éléments qui permette de tirer avantage de la continuité pour les charges mortes aussi bien pour les charges vives. Par exemple, des poutres simples, préfabriquées, posées de piliers en piliers, et rendues continues par la suite, ne sont continues que pour les charges vives. Et, dans les grands ponts, les charges vives ne représentent souvent qu'une faible partie de la charge totale.

Nous connaissons deux ponts continus précontraints dans la Province de Québec. Le premier est un viaduc passant au-dessus de l'Autoroute Montréal-Laurentides, près de St-Jérôme. (Fig. 15). C'est je crois, le premier pont continu précontraint au Canada. Il fut construit en 1958. Ce viaduc a une longueur de 261 pi. et une largeur de 50 pi. Il comporte trois travées de 81 pi., 95 pi. et 81 pi. Ce viaduc fut entièrement coulé en place. Le tablier comporte 7 poutres reetangulaires de 12 po. x 42 po. La hauteur augmente à 60 po. aux appuis intermédiaires. La précontrainte fut réalisée par des câbles d'une longueur de 258 pi. relevés aux appuis intermédiaires et ancrés aux extrémités. L'élongation totale de ces câbles, lors de la précontraine était de 18 po. Notons que les appuis mobiles de ces poutres sont des pendules en béton fretté.

L'autre pont continu est un pont sur la rivière Châteauguay, reliant l'Ile St-Bernard à la côte St-Joseph. (Fig. 17). Le pont comporte trois travées de 96'6", 120'0, 96'6". Le tablier se compose de cinq poutres longitudinales espacées à 6'0. La semelle supérieure des poutres est de 2'6" et la dalle coulée entre les poutres sur coffrages perdus en amiante, est précontrainte transversalement.

Chaque poutre de 313'0 fut divisée en quatre sections identiques deux à deux pour fin de préfabrication. Les poutres A, des travées de rive, d'une longueur de 76'6", et les poutres B de la travée centrale projetant en porte-à-faux dans la travée de rive sur une distance de 25 pi. Les poutres B ont une longueur de 85 pi.

L'érection se fit à l'aide d'un pilier temporaire au centre de la travée centrale. Les poutres B furent érigées d'abord, prenant appui sur les piliers permanents et sur le pilier central temporaire. Puis les poutres A furent érigées prenant appui sur les culées et sur les extrémités en porte-à-faux des poutres B. (Fig. 19). On enfila des câbles de continuité entre les poutres A et B, et au centre entre les poutres B. Les joints furent coulés et l'on fit la précontrainte de ces câbles, réalisant ainsi la continuité du tablier. Le pilier temporaire fut alors enlevé. Les poutres ont une hauteur de 3'2" en travée. Elles augmentent à 4'8"

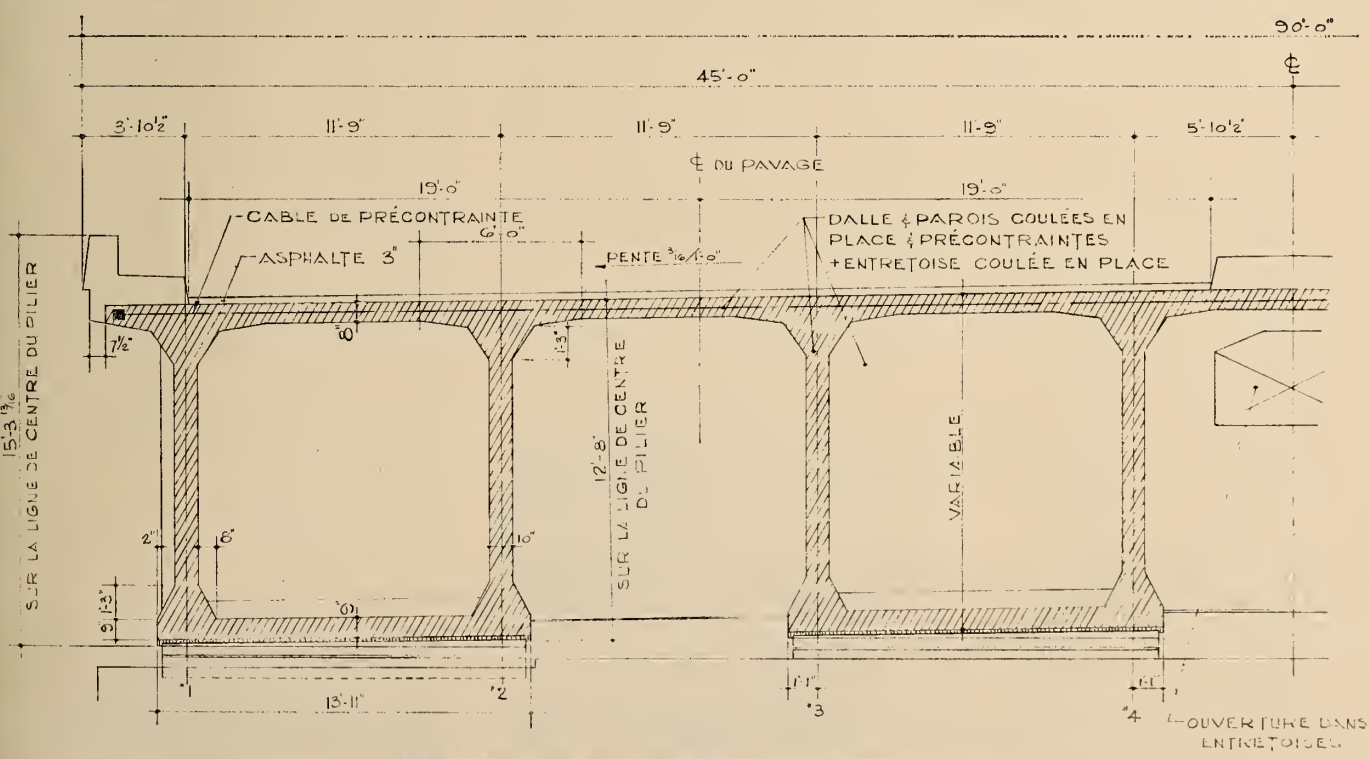


Fig. 14. Pont Senneville. Coupe en travers des poutres caissons.

aux appuis. Le rapport d'élancement de la travée centrale est donc de 1 sur 38.

III—QUELQUES PROBLEMES PARTICULIERS

a) Dalles de ponts à poutres préfabriquées

Comme nous l'avons vu dans la description des ouvrages, les dalles peuvent être: 1° Coulées au-dessus des poutres et armées d'acier doux. (Fig. 3 et 7). 2° Coulées entre les semelles des poutres et précontraintes transversalement à l'aide de câbles enfilés dans des trous réservés à l'avance dans la semelle supérieure des poutres. (Fig. 9, 12, 14). 3° Les dalles peuvent aussi être précontraintes transversalement en plaçant des câbles sur le dessus des poutres. (Fig. 18). Dans ce cas, nous aurions, par exemple, une dalle d'une épaisseur de 4 po. sur les poutres et de 6 à 7 po. entre les poutres.

La première solution nous donne la plus grande augmentation de section module de la section combinée par rapport à la poutre seule. Cette augmentation est cependant annulée par l'augmentation de poids mort. Elle exigera une quantité plus grande de béton et d'acier. Cependant, sa simplicité la rend tout de même économique pour les ponts courts. Il est à noter que, si la semelle supérieure des poutres est assez large, l'on peut faire des économies sensibles d'acier d'armature dans la dalle, en tenant compte des goussets fournis par cette semelle.

La deuxième solution est la plus économique au point de vue quantités. Cependant elle est difficile d'application pour les ponts à fort biais. Dans ce cas, nous pouvons recourir à la troisième solution.

Le calcul des dalles précontraintes transversalement se fait en considérant qu'à la rupture les dalles à goussets agissent comme des arcs, et les câbles, comme tirants.[4]

Fig. 15. Viaduc du chemin de la Rivière du Nord. Autoroute Montréal-Laurentides.

b) Distribution des moments

Pour les ponts larges, il y a intérêt à considérer les tabliers comme un tout et à tenir compte de la rigidité transversale de ce tout par rapport à la rigidité longitudinale.[5,6] Le résultat sera différent des résultats obtenus par les formules de l'AASHO.[7] Ainsi les poutres de rives seront plus chargées. Pour un pont à 6 voies où la charge de camions est prédominante, cette méthode nous permettra de constater que les efforts maximums seront produits lorsque 4 voies seront chargées, et alors, nous serons justifiés d'appliquer le facteur de réduction de charge vive de 0.75 admis par les codes pour ce cas. Cette économie est plus appréciable dans le cas de ponts en béton précontraint, car le dimensionnement des poutres se fait en fonction des surcharges seulement et non du poids propre de poutres et surcharges.

c) Appareils d'appuis

Les ponts construits dans la province, au début, comportaient pour la plupart des appareils constitués de plaques glissantes en acier. Depuis Champlain, les appuis sont, dans la majorité des cas, constitués de plaques de néoprène frettées, de dimensions en plan variables suivant les charges, et d'épaisseur variable suivant les mouvements prévus et les rotations. Les mouvements prévus comprendront: les efforts du retrait, du freinage des charges vives, de la température et du vent.

Il est à noter que le code de l'AASHO exige pour les ponts en acier une variation de température de −30°F à +120°F. Pour les ponts en béton, pour un climat froid, ce code permet de considérer une augmentation de 35°F et une chute de 45°F, par rapport à une température normale de pose de 60°F. Cette distinction entre ponts d'acier et de béton n'est pas faite ici à cause de l'absence de code pour les ponts en béton.

Nous croyons que cette distinction s'applique également ici, en majorant cependant le nombre de degrés de chute suivant la région. Il y aurait certes lieu d'entreprendre une série d'observations sur différents ponts en béton, pour vérifier cet avancé.

d) Déflection

Le code ACI-ASCE[8] mentionne que le module d'élasticité du béton peut varier de 25% par rapport à une certaine formule empirique, où le module est fonction de la résistance du béton. Ceci vaut pour le module sous charges instantanées. Pour les charges permanentes, le code américain dit que l'augmentation des déformations et par conséquent la diminution du module d'élasticité, varie de 100 pour cent à 300 pour cent suivant les conditions d'humidité, etc. L'on peut voir que le calcul des flèches devient plutôt problématique. Et pourtant il nous faut prévoir ces flèches, car elles sont importantes en béton précontraint, où nous avons la plupart du temps, de fortes charges permanentes (la force de précontrainte étant elle-même une charge permanente) appliquées sur des éléments de faible inertie relativement à leur portée.

Notre propre observation est que la diminution du module d'élasticité est beaucoup plus près du 300 pour cent que de l'autre limite. Comme les facteurs locaux affectent le retrait et le fluage du béton, nous croyons que les entreprises de béton préparé, devraient s'intéresser à cette question afin de fournir au projeteur, un peu plus de renseignements sur le sujet.

e) Facteur d'impact

Le code canadien CSA-S6-1952,[9] fait pour les ponts en acier, exige un

Fig. 16. Viaduc du chemin de la Rivière du Nord. Coupe en travers du tablier.

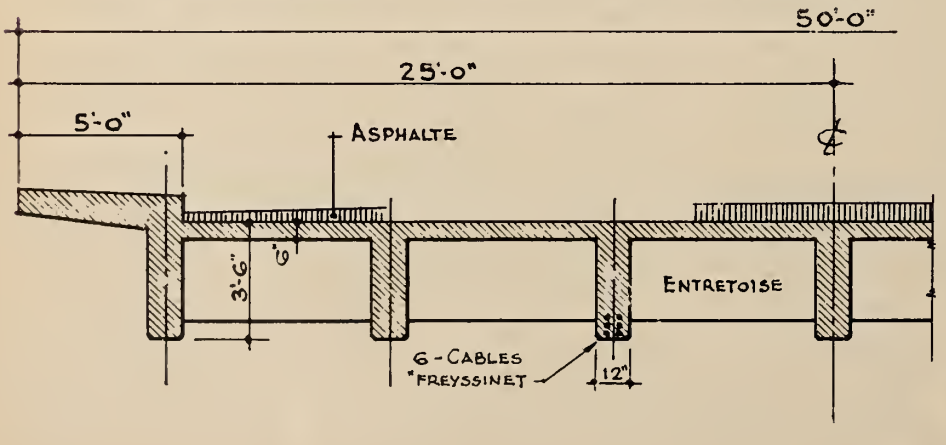


Fig. 17. Pont de l'Ile St-Bernard.

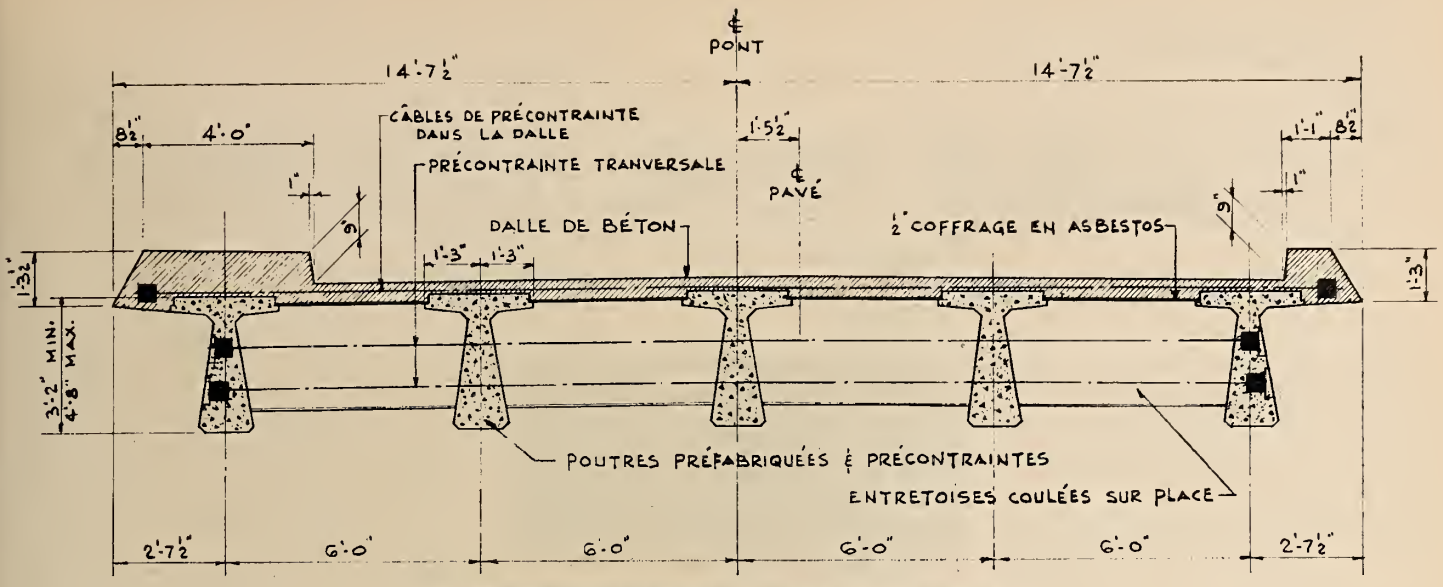


Fig. 18. Pont de l'Ile St-Bernard. Coupe en travers du tablier.

facteur d'impact de 30% pour tous les cas. En l'absence d'autre réglementation, l'on nous demandera de conserver ce facteur pour les ponts en béton armé ou en béton précontraint.

Le code de l'AASHO, pour sa part, tient compte de la portée des poutres, dans la détermination du facteur d'impact et le code français[10] tient compte, et de la portée, et du poids propre.

Ainsi, pour un pont en béton précontraint de 160 pi. de portée, nous aurions, comme facteur d'impact, suivant CSA: 30%, suivant AASHO 17.5% et suivant le code français: 8.8%. Nous surtaxons donc nos ponts, car nous appliquons, d'autre part, les mêmes facteurs de charges que l'AASHO par rapport à la rupture.

f) Injections

Les câbles de précontrainte ancrés aux extrémités (post-tendus) doivent être injectés à l'aide d'un coulis de ciment comportant un agent d'expansion. Ceci, non seulement pour les protéger de la corrosion, surtout parce que le moment de rupture d'un élément à câbles bien injectés est d'environ 25% plus grand que celui d'un élément non injecté. Cependant, ces injections sont difficiles à réaliser en hiver à cause du double chauffage qu'elles exigeront.

CONCLUSIONS

Nous avons dû négliger de décrire plusieurs ponts construits ou en voie de construction. Nous nous en excusons, mais nous voyons là la preuve que ce matériau n'est plus tout à fait nouveau. Plusieurs ingénieurs et entrepreneurs sont maintenant au courant de son utilisation, et aucun projet de pont ne saurait être étudié maintenant sans considérer le béton précontraint comme solution au même titre que l'acier de charpente ou le béton armé.

Ce matériau fournira, aux problèmes de construction des ponts, des solutions neuves, élégantes, audacieuses même, tout en demeurant économiques. Cette technique n'en est qu'à ses débuts et elle ne progressera qu'en autant que nous continuerons à l'explorer et à la perfectionner. Nous aurons besoin d'une plus grande connaissance des matériaux: béton et aciers. Nous devrons chercher à améliorer encore les moyens de contrôle sur les chantiers. Quant aux méthodes d'exécution, la porte est ouverte à l'imagination des entrepreneurs. La préfabrication continuera d'être une aide précieuse à la réalisation des ouvrages. Les usines, de leur côté, chercheront à standardiser leur production. Ce qui est bien. Il appartiendra cependant à l'ingénieur de voir si le produit standardisé constitue la meilleure solution à un problème donné. C'est pourquoi nous ne pouvons accepter qu'un organisme gouvernemental, par exemple, adopte de son côté des produits standards pour ses projets. Il y aurait alors, nous croyons, restreinte à l'application de l'imagination créatrice des constructeurs de ponts. Et cette restreinte se refléterait rapidement dans les oeuvres. Les possibilités du béton précontraint sont trop grandes et trop peu explorées à date pour se permettre de les restreindre ainsi dans des cadres trop rigides.

Fig. 19. Pont de l'Ile St-Bernard. Erection des poutres d'une travée latérale.

A cause de la nouveauté du matériau, il est normal que l'ingénieur, étudiant un projet en béton précontraint, rencontre des difficultés d'interprétation des codes. Nous avons essayé d'en souligner quelques-unes. Nous déplorons particulièrement l'absence de normes pour les ponts en béton armé ou en béton précontraint. Ce qui nous conduit à appliquer à ces matériaux, des normes conçues pour la charpente métallique. Ce qui nous empêche quelquefois de profiter de certains avantages inhérents du béton.

Pour finir, nous voulons rappeler que le choix d'une solution à un problème de construction d'un pont doit se faire en tenant compte simultanément des facteurs statiques et esthétiques. Un pont est une oeuvre d'art en même temps qu'une oeuvre utilitaire. Ces deux aspects ne font qu'un et ne sauraient être dissociés.

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EIC-63-CIV-15

THE ANALYSIS OF STRUCTURES BY AID OF MODELS

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SOME OF THE WORLD'S foremost structures of the past two decades were designed relying materially on the results of model studies. Outstanding examples include: the Pirelli building in Milan; the large shell of the Palace de Defence in Paris; the gigantic dome of the exhibition pavilion in Brno; the Christ The King monument in Lisbon.

The introduction and the ever-increasing utilization of reinforceed and prestressed concrete as construction materials paved the way for new concepts in structural engineering. The essential feature of reinforced concrete construction—from the structural point of view—is, that the entire structure is load carrying and load distributing, and not as in the majority of steel and timber structures a skeleton of members. Two and three-dimensional structural elements (for example plates and shells) gained acceptance and occupy now a dominant position in reinforced concrete design. This is reflected in the numerous theoretical investigations which were carried out to determine the stress distribution and deflection

FIG. 1c: Stress trajectories of the wall.

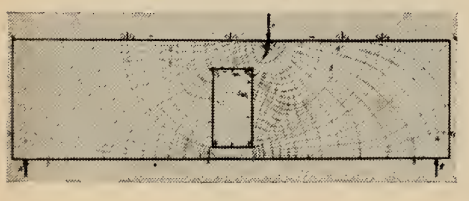
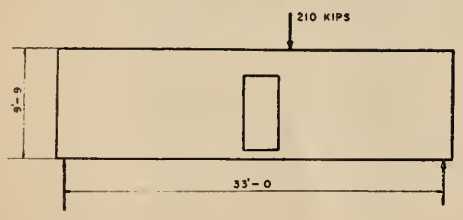


FIG. 1b: Isochromatic fringe pattern of the photoelastic model of the wall

FIG. 1a: Reinforced concrete wall with door opening (Zeller)



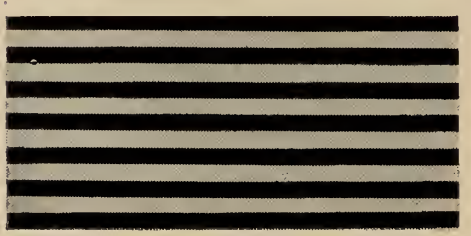


FIG. 2a: Grid used for the Moiré method

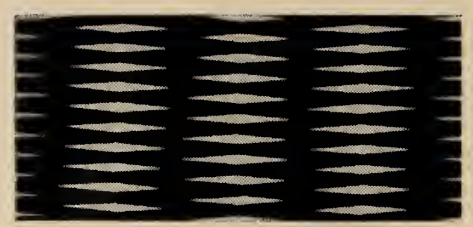


FIG. 2b: Two identical straight grids forming Moiré fringes

characteristics of these elements. Most of these studies are based on either the classical theories or on energy considerations. Unavoidably all theoretical methods of analysis must resort to certain idealizations, i.e., such concepts as homogenuity, isotropy and Hooke's law are introduced. In addition, there are usually simplifications necessary concerning the loading and supporting conditions (knife edge supports for example) of the structure. Undoubtedly these idealizations which facilitate the solution of a problem will, to a smaller or larger extent, distort the result of the very analysis. In many instances even greatly idealized problems harbour nearly unsurmountable mathematical difficulties, even when computor facilities are available. It is for this reason that structural model studies became recognized as valuable and economical if not indispensable tools in the analysis of highly complex structural systems. Modern building codes in a number of countries recognize the merits of experimental methods. "In Portugal the design of a structure can be made from model studies without the need to confirm it theoretically."[1] The German code DIN 1050 states: "Model studies and photoelastic studies may in certain cases, with the permission of the proper authorities, fully or partially replace the analytical approach." Model studies are not covered by our National Building Code. The fundamental idea on which model analysis rests is the fact that there exist certain well defined relationships between a prototype and its scaled-down model[2]. The functional dependence of stress, strain, deformation, acceleration and velocity characteristics between model and prototype can be established by (a) a step by step reasoning process and (b) by applying the principles of dimensional analysis. In case of structural model studies the stresses in and the deformation of the prototype are of primary interest. For a structural model which is geometric similar to the prototype, the following relationships hold:

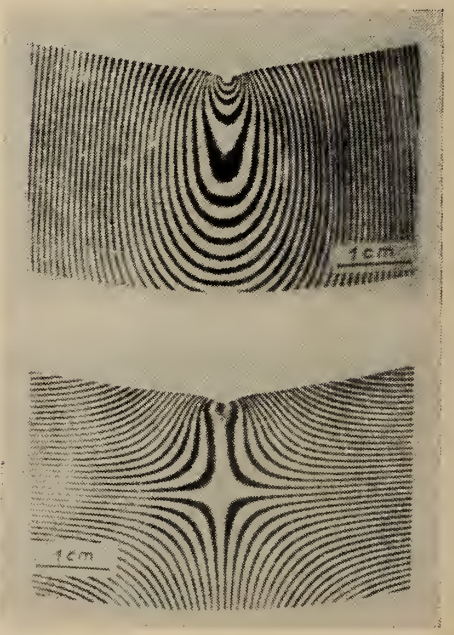
$$\sigma_p = \sigma_m \frac{P_p}{P_m}; \qquad \delta_p = \delta_m \frac{P_p E_m}{P_m E_p n}$$

whereby σ = stress, δ = deflection, E = modulus of elasticity, P = load and n = scale factor. The subscript "p" refers to the prototype, the subscript "m" refers to the model.

ADVANCE IN STRESS ANALYSIS METHODS

Minute high precision strain gauges, mainly of the electrical re-

FIG. 3: Moiré fringes of a deformed bar obtained with horizontally and vertically oriented master grids (Dantu)



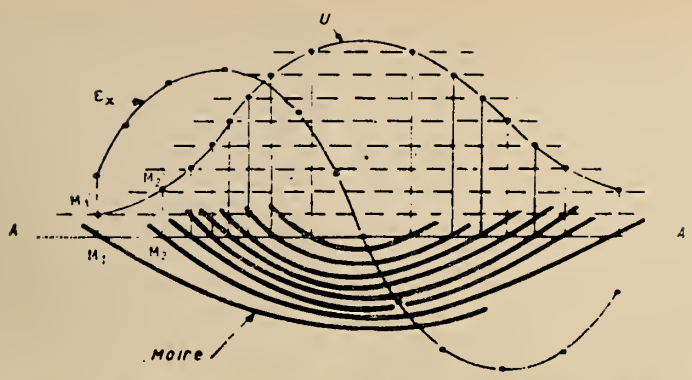


FIG. 4: Method for the determination of strain from Moiré fringes (Dantu)

sistance type, became available during the past 10 years which gave experimental stress analysis a tremendous impetus. It is now possible to determine linear strains over a gauge length of only 1/64 inch while modern strain rosettes occupy an area no larger than 0.1 square inches. Bonding and strain recording techniques were also greatly improved. New strain measuring devices based on the photoelastic principle were developed.[3, 4] Progress was also made in the field of photoelasticity, mainly through the development of new castable plastics which exhibit excellent bifringency, little edge effect and which can be cast to any shape thus reducing the amount of tedious machine work. In the area of grid methods the Moiré principle was successfully utilized for the determination of bending stresses in plates. All these achievements resulted in better, more accurate and less time-consuming experimental techniques. Reliable and reproducible strain measurements can be made on a model with an accuracy of about 1 to 2%, which by far exceeds the requirement in structural engineering. This accuracy is not impaired in the process of converting the model results to the prototype.

MODEL MATERIAL AND MODEL SEALERS

The majority of structural model studies are conducted using homogeneous and isotropic model materials which follow Hookes law. Preferred model materials are such plastics as Plexiglass, castable epoxy resins but also metals such as aluminum, brass and occasionally steel. An advantage of low modulus material is that adequate strains and displacements can be produced by relatively light loads which is both convenient and economical. Plastic materials are preferred for their ease of machining and also because complicated models can be made by gluing together of component parts. These models are in most cases geometric similar to the actual structure which facilitates conversion of the model results to the prototype. In general, model studies of this type describe the elastic behaviour of a structure and are therefore supplementing theoretical studies in the realm of "theory of elasticity". However, the prediction of the failure load and the failure mode of a structure necessitates consideration of both the elastic and the plastic range of the material. Except for structures consisting of one dimensional elements (beams, columns, frames) very few theoretical solutions are available which are capable of describing satisfactorily the behaviour of two and three-dimensional problems beyond the elastic limit. It should be noted that in theoretical studies of plasticity idealized and simplified stress-strain curves are employed. In experimental work the material properties of the structure are to be reproduced as closely as possible by those of the model over the whole range of loading up to collapse condition. As a rule this agreement in behaviour between model and future structure is judged by comparing their stress-strain diagrams. Knowledge of the stresses in the structure will no longer be the sole goal of a study, but the concurrent phenomena of crack formation, deflection and yielding of the reinforcement become equally important. In general, it will be possible to employ a model/prototype scale of about 1:10. The desirable thickness of the model will occasionally place a lower limit on the scale factor. Shell membranes for example should not be less than about ½ in. thick. When using concrete as model material the various aggregates are reduced in size in accordance with the adopted scale. This leads to micro-concrete. Considerable care has to be exercised in deciding upon the proper reinforcing wires. Some investigations consider it satisfactory to employ reinforced mortar instead of micro-concrete. Other investigators prefer plaster of paris models which display low resistance against tensile stresses. This drawback is particularly serious in cases where a crack can occur in the model, which might not be easily visible, but has a large influence on the state of stress. All these model materials show accen-

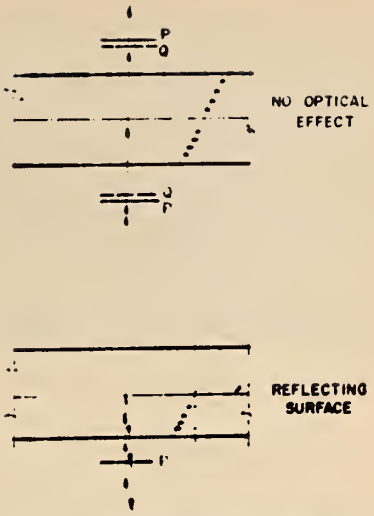


FIG. 5: Two-dimensional photoelastic approach to the bending problem of plates

FIG. 6: Device for measuring the curvature of a laterally loaded plate

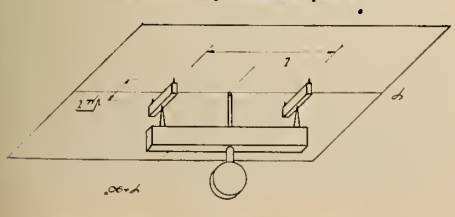


FIG. 7: Utilization of the Moiré principle for bending problems (Ligtenberg)

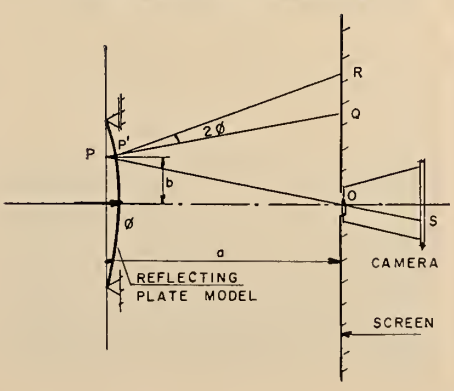
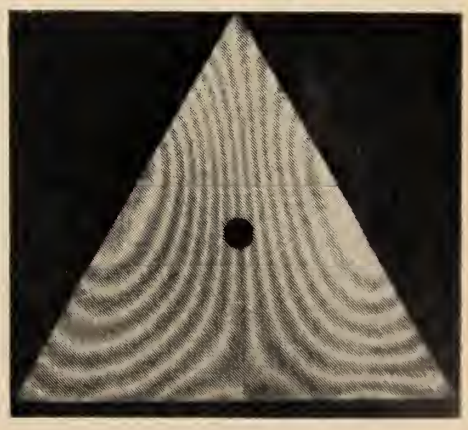


FIG. 8: Moiré fringes of a uniformly loaded triangular plate (Ligtenberg)



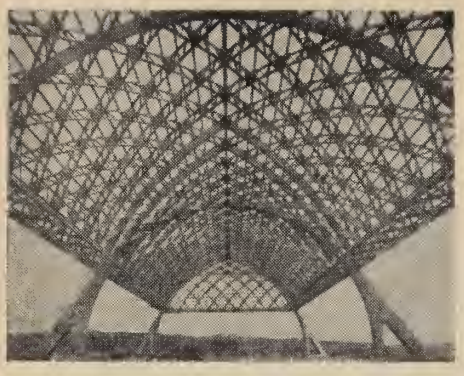


FIG. 9: Reinforced concrete skeleton of Nervi's hangar

tuated creep, but by aid of proper calibration and testing programs the influence of creep can be accounted for. The mechanical properties of plaster of paris can be varied by adding an appropriate amount of filler material with the result that models can be built in which the various parts of the models have different moduli of elasticity. Poisson's ratio of plaster of paris is about the same as that of concrete. A summary of experimental methods pertaining to various structural elements is given in Table I.

PLATES LOAD IN THEIR PLANS

Plates or deep beams with cut-outs supporting heavy loads are frequently encountered (Fig. 1a). To design and properly reinforce these members, not only the boundary stresses but also stress trajectories should be available. The photoelastic method is most suitable for this task. The isochromatic fringe pattern (Fig. 1b) indicates directly the boundary stresses whereas the stress trajectories can be obtained with ease from the isoclinics (Fig. 1c). If displacements in the plastic range are desired, the so-called Moiré method[5] can be used to advantage. It is applicable for measuring strains equal to or larger than 200 microinches/inch and consequently forms the bridge between photoelasticity and strain gauge methods which cover the field of small strains, and the grid methods which take care of very large strains. The Moiré method is of purely geometric nature and is therefore not subject to errors due to nonlinearity of the material nor limited by the creep phenomenon. If two identical grids which consist of parallel straight lines (Fig. 2a) are superimposed on one another in such a manner that these two grids form a small angle with each other, Moiré fringes appear (Fig. 2b). This phenomenon is utilized for studying displacements. A linear or a cross-grid is photographically imprinted on the plane surface of a metal, for example, which is then subjected to deformation. By superimposing now a second non-deformed grid Moiré fringes are obtained (Fig. 3). These fringes are no longer as in the case of two identical undeformed grids straight but curved. It can be shown that the Moiré fringes represent contour lines of the displacement function. By cutting this fictitious surface perpendicular to the plane

GROUP I	GROUP II
Model material: homogeneous, isotropic, follow Hooke's law	Model and full-scale structure use material with similar δ–ϵ curve

TYPE OF STRUCTURE	EXPERIMENTAL METHODS
One Dimensional: Beams, frames	Adequately covered by theory. For special cases strain gauge and photoelastic methods.
Two Dimensional: 1. Plates loaded in middle plane 2. Plates loaded perpendicular to middle plane	Theoretical approach often difficult and time consuming. Photoelastic method Moiré method, deflection and curvature methods.
Three Dimensional: Shells, folded plates, domes, etc.	2 and 3-d photoelasticity strain gauge method curvature method deflection methods.

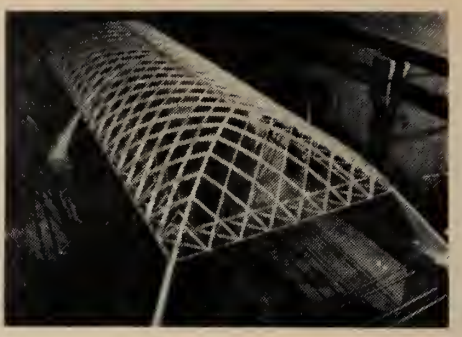


FIG. 10: Celluloid model of the hangar

of the grid (Fig. 4) the variation of the deformation along a line AA is obtained. Graphical differentiation leads to the strain. By extending this concept and utilizing square grids the strains ϵ_x, ϵ_y and γ_{xy} can be directly obtained. Usually grids with 200 lines per inch are quite satisfactory.

LATERALLY LOADED PLATES

Bending problems of plates which involve skewed slabs, slabs with cut-outs or irregularly supported plates are still only scarcely if at all covered by theory. However, these are the types of plates which are constantly encountered in actual design practice. Several experimental methods are used: Strain gauge techniques are somewhat tedious and allow only point per point exploration of the plate. The ordinary two-dimensional photoelastic approach fails, because the optical effect due to tensile and compressive stress cancel each other out (Fig. 5a). To overcome this difficulty it was suggested to insert into the plate a reflecting middle surface (Fig. 5b). This approach displays the same shortcomings which the photoelastic surface layer method characterizes.[6] The Extended Frozen Stress method[7] has also been utilized for the solution of plate problems. This is a special three-dimensional photoelastic method whereby stress freezing is carried out at 130°F. thus retaining a low Poisson's ratio. For this reason model and prototype should have about the same Poisson's ratio. Another approach to the bending problem of plates is to measure the curvature and to utilize the relationship between curvatures and moments:

$$M\phi = D(K\phi + \mu K\phi + 90°)$$

This curvature method (Fig. 6) is particularly useful for obtaining influence surfaces of moments and shear forces. In the writer's opinion the most powerful experimental method for the determination of moments in laterally loaded plates is the Moiré method in the version of Lightenberg[8]. The basic principle is demonstrated in Fig. 7. The model is ob-

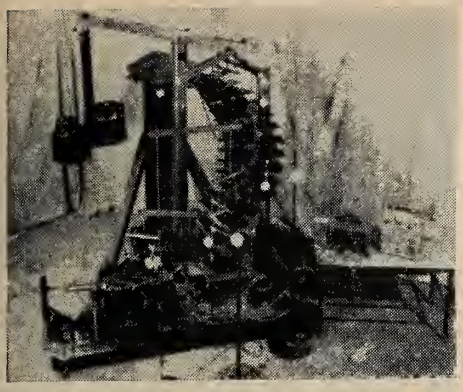


FIG. 11: Model of spiral stair and loading device (model study by the Author)

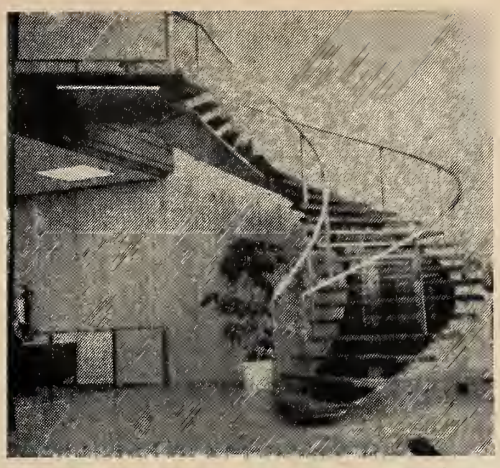


FIG. 12: Stainless steel stair in the Canadian Imperial Bank of Commerce Building in Montreal (Yolles & Assoc., Struct. Eng.)

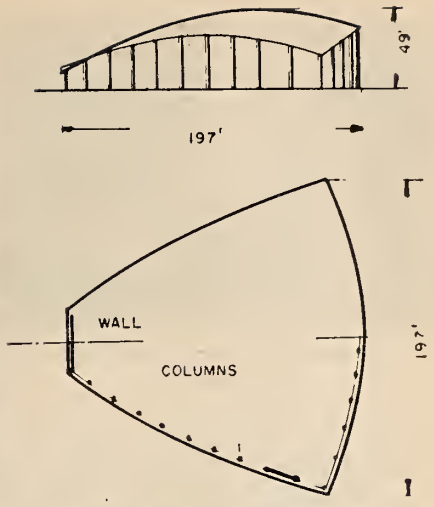
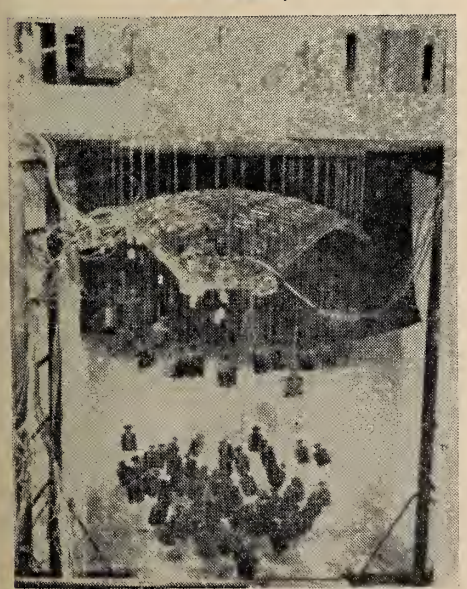


FIG. 13: Plan and elevation of the shell for the Auditorium of Hamburg University

served with the help of a camera. At point S on the ground glass of the camera the images of a point P of the slab and the refleeted image of a point Q of the screen are superimposed. After loading the plate the image of a different point of the screen, namely point R will be reflected onto point S. The distancee QR can be used to determine the angle ϕ. By proper selection of the grid spacing Moiré fringes are created by superimposing on one negative the two images of the screen which are reflected by the unloaded and the loaded model. A Moiré fringe in this case is a line joining all points where QR has a certain constant value (contour lines of QR). If the shape of the screen is such that QR is a linear function of "a" and "ϕ" then the Moiré fringes are at the same time contour lines of the slope of the slab. Graphical differentiation leads to the second derivatives and therefore to the moments. The accuracy is about 5%. Model materials are brass, plexiglass or lucite. The main disadvantage of the method is that the shear forces cannot be obtained with sufficient accuracy. Typical Moiré fringes for a uniformly loaded triangular plate are shown in Fig. 8.

FIG. 14: Model of the shell (Hergenoeder and Ruesch)



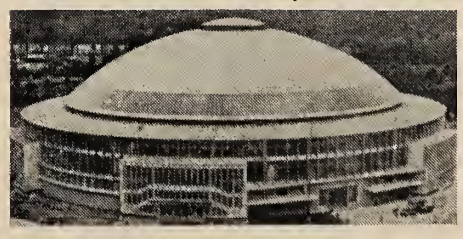
Three dimensional problem

Countless experimental possibilities are available for analyzing three-dimensional structures. The amount of work (experimental and/or theoretical) grows with the complexity of the problem. In the majority of cases the stresses on the surface of the structure are desired. A model study which is fascinating due to its simplicity was carried out in the late 1930's. It concerns the famous hangars which Nervi built for the Italian airforce (Figs. 9 and 10). The hangars were erected between 1937 and 1940 and were made of reinforced concrete. The analysis i.e., the determination of the forces in the members was materially based on strain measurements by aid of Huggenberger extensometers.

During the past year the writer conducted a model study for a stair. The helicoidal laminated shell was 1¼ in. thick and made from stainless steel bars. The model built from steel to quarter scale was investigated for static and dynamic loads. In the course of the study it was found necessary to increase the end restraints in order to maintain dead and live load deflections within prescribed limits. Twenty concentrated loads of equal magnitude were applied along the centreline of the stair. Model and loading frame are shown in Fig. 11. The full scale stair (Fig. 12) was built of stainless steel and forms an attractive addition to the new Canadian Imperial Bank of Commerce Building in Montreal.

Experimental methods for the determination of the stress distribution

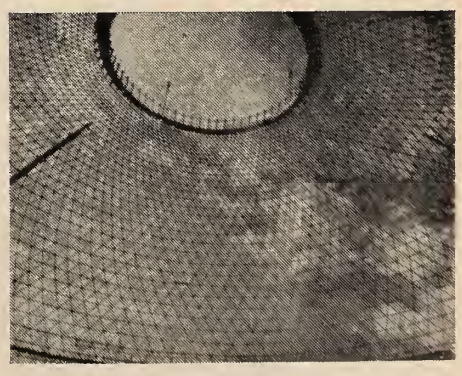
FIG. 15: View of exhibition pavilion in Brno



in shells are in great demand, at the present time. Unfortunately, attempts to utilize the Moiré method in the study of curved surfaees were not yet suecessful. A few shells were studied using three-dimensional photoelasticity. In spite of their shortcomings, strain gauge techniques are most frequently employed in the analysis of shells. A typical example is shown in Figs. 13 and 14. The shell is formed by part of a sphere with a radius of about 200 ft. and a thickness of 5 in. The boundaries of the shell follow the lines of a spherical trapezoid. The structure rests on hinged pillars which in the model are replaced by suspended bars of 2 mm. diameter to avoid horizontal reactions. The model scale factor is 1/60. Two models were constructed. The first model was used to determine the normal forces and the moments due to dead load and prestressing; the second model served for the determination of the buckling load. The effect due to weight and snow load was simulated by a number of weights. The strains were measured by resistance gauges attached to top and bottom surface of the shell. The edge beams of the shell were prestressed by aid of two 2 mm. wires. The wires were greased and stressed from both sides to reduce friction.

Occasionally construction or erection problems are solved by aid of

FIG. 16: View from the inside of the shell made from tubes



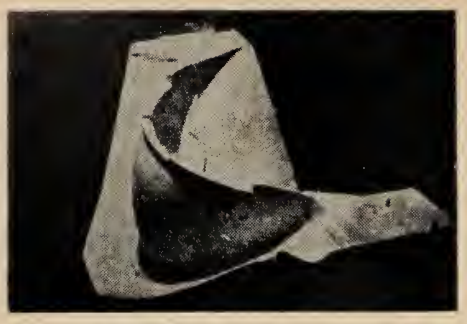


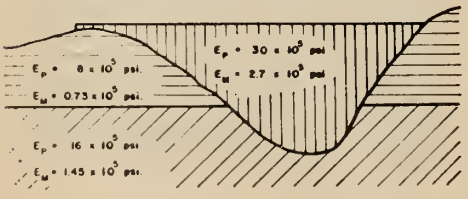
FIG. 19: Plaster of paris model of Bouca dam (Rocha)

models. The deflections to be expected during the lifting operations of a spherical shell-like structure which is made of tubes was established experimentally. The dome shown in Fig. 15 has a span of about 280 ft. and is made from a grid of tubes (Fig. 16). The theoretical analysis of the shell was based on the membrane theory, local and overall buckling was also studied analytically; however the stresses and deflections during the erection were studied by aid of the model shown in Fig. 17.

Studies using non-homogenous model materials

As previously indicated, the elastic constants of plaster of paris can be changed by adding various amounts of so-called fillers. Advantage of this possibility is frequently taken in studies of concrete dams which rest on layers of rock of varying density. A schematic of a study in which plaster of paris with three different elastic moduli was used is shown in Fig. 18. A great deal of attention is paid in several countries to experimental studies of large hydro-electric power dams. Analytical studies and preliminary model investigations using homogeneous model materials are conducted side by side. The shape of the model is constantly modified till an optimum form is reached. The final study concerning the behaviour of the dam is carried out on a model made from plaster of paris or micro-concrete. For these models scale factors of 1:50 to 1:100 are common. Strains are measured by aid of resistance type gauges, deformations by aid of dial gauges. Figure 19 shows a typical example, namely the Bouca dam (which is about 200 ft. high)

FIG. 18: Schematic of a dam with layers of different moduli of elasticity



prior installation of the gauges and the loading device. Loads are usually applied by a series of hydraulic jacks or calibrated springs. Another example of a gigantic model study is the Pirelli building in Milan. At the time of its construction in 1956 the Pirelli building was Europe's first real skyscraper and at the same time the world's highest building executed in reinforced concrete. It has 31 storeys and a total height of 372 ft. In this building the concept of the classical orthogonal structure consisting of a system of columns and floors was abandoned in favour of a monolithic unit. The structure (Fig. 20) consists essentially of two shafts at the ends of the building and two plane structures which form a sort of tree. Because of the uniqueness of the structure a three-storey high model (33 ft.) was constructed of reinforced concrete, instrumented and thoroughly studied. Figure 21 shows the model.

CONCLUSIONS

The few examples which were cited in this paper document the use-

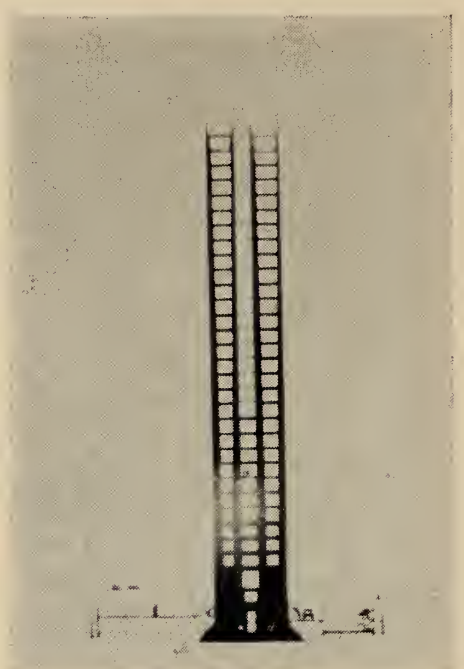


FIG. 20: Horizontal and vertical sections of the Pirelli building

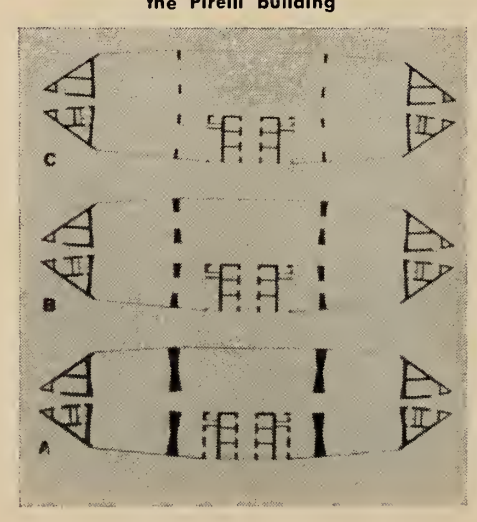


FIG. 17: Model study of the expected deformation of the shell during lifting operation (Lederer)

fulness and the scope of structural model studies. They also indicate the widespread use of experimental studies in particular on major projects for which approximate solutions based on a simplified structural system are inadequate and where economical design results in substantial savings.

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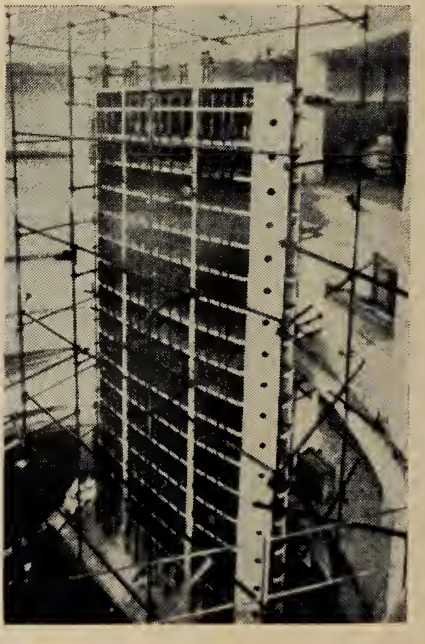
FIG. 21: Three storey high model of the Pirelli building (I.S.M.E.S. Bergamo)



EIC—63—EDUC—2

THE DANGER OF SPECIALIZATION

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THERE IS LITTLE doubt in the minds of many engineering educators today that the engineering program at our universities is undergoing a marked change. To some it appears to be revolutionary in character. I prefer to think of it as a more or less orderly evolution brought about as a reaction to the unanswered needs of our society. The many changes taking place encompass not only course content but also depth of treatment and manner of presentation. Emphasis is being placed on scientific principles and more sophisticated attacks on engineering problems. Material which a few years ago was considered only at the graduate level is already basic to an undergraduate program. This change in emphasis is placing a burden not only on the university and its students but, I believe, on industry as well. The time has come when both must share in the training of the engineer.

Not too many years ago, well within our own memories, the graduating engineer had specific or specialized training in a number of areas. He was reasonably well trained in draughting; he knew his way through many design handbooks and had worked out projects in machine design and like professional subjects. This specific or specialized training met the immediate needs of industry. The graduating student was just about ready to go into productive work when he left the university. The events of World War II, the cold war which has followed, and the space race have brought an end to this and have driven the last nails into the coffin of the handbook engineer. It is now very apparent that in the limited time available, we cannot give the student the basic engineering science courses so necessary in our complex world and also provide the specialized training in order that he be immediately useful to industry. More than ever we must look to industry to provide a large amount of on the job training.

Educators are charged with the task of producing competent young men who will be able to keep abreast of the varied and demanding changes of this rapidly expanding profession. It is, to my mind, impossible to turn out graduates with specific training in specialized areas and still hope to upgrade the scientific background of the student to meet the standards demanded today. Industry as well as the university realizes that the student with specific training in the "how" type of course is in grave danger of becoming the unimaginative empiricist of tomorrow. And in the words of President J. H. Davis[1] of Stevens Institute of Technology "Empiricism is exactly the element in engineering which we have been striving, through proper education, to lessen."

To understand better how this transformation has evolved, let us consider for a moment the birth and growth of engineering. We like to think that engineering, as we know it, started about 350 years ago. This may surprise some, but prior to that mankind knew a few principles, was fairly ingenious, but did not understand or try to analyze his problem. The idea of cause and effect was alien to him. Galileo (1564-1642) is considered by many as being the first engineer in the modern sense. He embodied all the ideals of our present engineering leaders; he not only developed new ideas and theories but he put them to work on projects to benefit mankind.

Some 150 years later, 1795, the famous school in France, Ecole Polytechnique, was established by Monge. He decided that a four year training was the best preparation for a young man going into engineering and laid down the basic system used in most universities today, the lecture laboratory system. He also required a student to study two years of mathematics, physics and chemistry and then spend two years at the professional school of Mines or Roads and Bridges. With this start, France for nearly 60 years was undoubtedly the leader in engineering. This position was slowly relinquished to Germany, then to Britain and with the advent of the nuclear and space age it now rests in the United States.

In the early days of engineering there were considered to be two classes of engineers, the military and the civil. Those civil engineers concerned with machines came to be called mechanical engineers, and as new science and skills developed they became specialists in the new art. The key development was the invention of the steam engine which made available large quantities of cheap dependable power. This stimulated the development of labor-saving devices

of all kinds. These in turn required more and better materials, more precise machine tools, more efficient fuels, more emphasis on factory planning and so forth. Thus mechanical engineering was established. During the same period parallel developments were taking place in the electric power field. These formed the basis for electrical engineering which soon branched out into the fields of electronics and communications. The developments in pure chemistry and in the processing of raw materials together with the demand for synthetic products on a large scale give rise to chemical engineering. Today we have a vast number of specialized branches.

During the late 19th century and the early part of the 20th century considerable progress was made in formulating scientific principles and relating them to practice. It became possible to begin to eliminate empirical methods and replace them with the broader concepts of science. This process still continues. The rate at which we are acquiring knowledge is tremendous. In the last 50 years there has been more engineering and development than in the previous 150. We have a whole army of engineers and scientists in research and development. In fact 80% of all the scientists and engineers who ever lived are alive today.

Undoubtedly in the pioneering days there was a good case for specialization. Engineering then was of necessity almost entirely empirical; and learning what could be done and how it could be done was more important than what could be done in the future. Knowledge in one field was not related to other fields. There was little or no research, and the gap between science and practice was very wide. Engineering then was more an art than a science.

There is still art in engineering but it is more the art of application of scientific principles. Empiricism remains in many areas but is greatly reduced in amount and value. Research is the order of the day, and the gap between science and application has narrowed. Good engineering practice cannot function without a firm foundation in mathematics, and the physical and engineering sciences. Any reasonable four year undergraduate engineering program is far too short to give a depth of treatment in these fundamental sciences and expect specialization as well.

Now I should like to point out what I mean by "fundamental sciences". As a minimum I would consider the following as necessary to a well founded mechanical engineering program. With minor changes the list is equally applicable to the other branches.

1. Mathematics: at least through partial differential equations, vector analysis, numerical analysis and computer techniques.
2. Chemistry: organic, inorganic and physical.
3. Physics: electricity, magnetism, sound, light, wave propagation and as much modern physics as possible.
4. Mechanics: statics, dynamics, vibrations and strength of materials.
5. Fluid Mechanics.
6. Thermodynamics: basic and applied.
7. Heat transfer: steady state and transient with application to design problems.
8. Metallurgy.
9. Electrical Engineering: circuits, principles of electronics, and automatic control.
10. Drawing and Machine Design: concentration in drawing should be on visualization and sketching, emphasis in machine design on imagination, ingenuity and the application of mechanics to design.
11. Materials and their processing.
12. Economics and Human Relations.

The last topic is included because some business sense is mandatory and the ability to think qualitatively as well as quantitatively is essential.

It is clear that the time required to obtain a good grounding in these fundamentals leaves little time in a normal program to specialize to any degree. The specialized courses to which I refer include work or material that can best be obtained by reading a design handbook or two, when actually working in the field. They are not and should not be considered an integral part of the undergraduate engineering education. Once industry gains a graduate who has been schooled in the fundamentals of his profession, it is in a far more able and practical position to handle his instruction in specialized areas than is the university. Engineering schools must devote their time and energies to the problem of getting the student to think and reason in the basic engineering sciences. If they are successful they will have done an invaluable service for industry and the student by producing a competent engineer.

It is apparent from what has been said that the selection of courses for an engineering curriculum is most important. A measure of a good curriculum has been given by Cambel[2] with his proposed dimensionless educational parameter which he defined as the ratio of "Useful life of acquired knowledge" to "Time needed to acquire knowledge". Each of us knows from personal experience that the time needed to learn is great. On the other hand, unless the courses of the curriculum are chosen wisely, the useful life of acquired knowledge is relatively small. For a well trained person this ratio should be much greater than unity. This can only be obtained by enlarging the numerator because there is little that can be done to decrease the denominator. The numerator will be increased by placing emphasis on the basic engineering sciences. This will produce a base from which the orderly process of education may continue after the engineer leaves the university.

Lest I be misunderstood, I must say now that I do not advocate a program of applied science in the narrow sense. I believe that most of the senior courses should have as their ultimate objective, not only analysis and synthesis, but engineering design as well. We must never forget that although the engineer uses scientific methods, his motivations and those of the pure and applied scientist are radically different. Therefore to the plea for an emphasis on a basic engineering science foundation for an engineering curriculum, I add the plea that the engineering student be given an appreciation of his profession by providing suitable laboratory and design opportunity while in school.

In conclusion may I underscore the main themes of this paper. First, if engineering as a program is to continue to grow and flourish by providing the student with a basis from which he may enjoy a long knowledgeable life then the basic engineering science courses must be emphasized at the expense of courses which give specific knowledge in a narrow field. The danger of retaining these specialized courses is early obsolescence.

Second, since these specialized courses are to be removed from the curriculum, industry itself must take on the professional training of the engineer. The student who leaves the university with his first degree is ready to learn, he is the "Freshman Engineer".

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UNDER A BUSHEL

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"FORGET FOR THE TIME being the techniques of industry and concentrate upon people, their families and communities who service the whole industrial machine." This was the charge given during his opening address by His Royal Highness, The Duke of Edinburgh to his Second Commonwealth Study Conference made up of 300 representatives from the 35 countries and territories that form the British Commonwealth, encompassing one-quarter of the world's land mass and one-quarter of the world's population. This Conference which began in Montreal and finished 25 days and 2,000 miles later in Vancouver had as its theme the study of The Human Consequences of the Changing Industrial Environment in the Commonwealth and Empire. This relative handful of people were to use Canada as a laboratory to observe first hand, and by report, the effect of technological change upon people.

Attendance at this Conference was an experience in observing and talking to people engaged in the business of making a living — whether they were managers, industrial employees, railroaders, farmers, educationalists, town planners, bankers, unionists, government employees, engineers or any one of many others. It was also an experience in living and studying with a group of people from other parts of the Commonwealth representing economies which vary from the cradle of the industrial revolution, to the "emerging" countries of Africa. It was an experience that provided a focal point after the Conference was over for reflection about people generally. It was the total of these experiences that provided the impetus for this paper.

The overall theme of the Conference was in reality observing the effects of technological development, or progress on people as exhibited in the change in their way of living in Canada. The effect of change was the focus of everything we did, or saw, or heard.

Change and the evidences of it are well known to all Canadians. My experience differs only in that I took 25 days last spring to study it and muse upon it with engineers, businessmen, labour leaders and others from all parts of the Commonwealth.

The detail to support the evidences of change was myriad and cannot be even slightly recounted in a paper of this nature. We heard of, and observed, vast change in transport industry, including railroading and air transport. Startling statistics supported the evidences of change — such as that the first aircraft used by Trans-Canada Airlines required 70,000 engineering manhours for design while the DC-8 jet required a whopping 7,000,000 manhours for design — a 10,000% increase.

We observed some of the results of change in man's place of living in Canada — the decline in the rural population and the burgeoning urban population that has evolved for us "metropolitan man", living in areas where growth feeds upon growth.

We were told of the change in agriculture — in this particular instance in the wheat farming province of Saskatchewan where evidence of change could be expressed in terms of farming as a way of life, giving way to farming as a business.

Change in the methods and modes of education were amply set out to the members of the Conference where in the period of about a generation the little red school house has given way to the yellow school bus.

As a matter of fact, change has become so much an order of the day that we have had to revise such things as the age-old axiom of "what goes up, must come down", to "what goes up comes down, unless it goes into orbit". As engineers much of our work has to do with innovation and creativity which is a forerunner to, if not a part of change.

I cite this sweeping panorama of change to give perspective to the area of my more specific remarks. And in a setting such as this it would come as no surprise to any one if the theme of what I have to say further was to question whether we as engineers are keeping up to, and abreast of these changes. This could well be the subject of an address and a very fitting one.

However, I am not going to question whether engineers are keeping up to these changes. And please don't imply from this that I am a passive defender of the status quo, and against research, and progress, and change. Quite the contrary, I firmly believe that man is an adventurer and must, and will, continue to probe the unknown and seek to broaden his knowledge.

On this occasion I would like to look back and pose the question whether we are using what we already know. After talking with people, and listening to people, and living with people of varying origins and backgrounds for the period of the Conference, and while relating this to my own experiences, I began to wonder in the weeks following the Conference, if we weren't so caught up in the aura of change that we are forgetting some of the important things that do not change. Continuing reflection in terms of our Conference commission to talk to and study people, and the effect of change upon them, I became convinced that there is something very basic about people that hadn't changed in my day — or your day — or the days of our fathers and our grandfathers. I refer to human nature. Human behavior has changed, and human attitudes have changed but I submit the nature of man — complex as it may be, has not changed. The various facets of human nature express themselves in terms of needs and wants which determine to a large part human behavior. The degree and order of importance of these needs do certainly change, but not man's basic nature. For example, perhaps the most basic fundamental of human nature is self-preservation. We in this country have developed a way of life wherein we know we are not going to starve to death or be fallen upon by warring tribes or wild animals, so this fundamental assumes less importance as such, but it still exhibits itself as our seeking of security for ourselves and our families. So the basic fundamental of human nature "to preserve self" is very much a part of man today even though its

order of importance or the degree of its expression is not the same as in the case of our forefathers who were wresting this land from the Indians and the wilderness. But put us hypothetically back into the same early situation and you would observe a rapid return to real prominence of this facet of man's nature. Thus I maintain that man's basic nature has not changed.

The relationship between these fundamentals of human nature and management is so obvious that I only pause to remind you that management has been defined in many ways but broadly each definition never omits the human funetion. A recently observed reference described management, as we are using the term today, "as being more concerned with people than things."

Let me pause further to quote a biblical reference which provides the topic of this paper: "Neither do men light a candle and put it under a bushel, but on a candlestick; and it giveth light unto all that are in the house". I don't intend to use this as a text for a sermon, but rather to illustrate the points I wish to make in regard to man's human nature and the understanding of it. We acknowledge that management is more concerned with people than with things and yet I feel that we can get so caught up with change in the technological race that has marked the mid-years of the 20th century, that we may well forget these "lights" of human nature that have been burning for centuries — and in forgetting, thereby put them under a bushel. What I do wish though is to remind you that amid all the change there are things that are unchanging — things like the many facets of man's nature.

I use the word "remind" advisedly as this basic human nature that is part of every man is known to you. It is not something new. Not only do you know these basic fundamentals because you have heard them — you have also observed them in others, and what is most important you know them because they are a part of you. Your basic human nature is no different from the man next to you — or the man who works for you — or the man for whom you work. Any differences are in degree and order of importance of the exhibition of the needs or wants based on these facets of human nature — not on any particular differences in basic human nature.

I would like to look at some of these basic facets of human nature — these candles that have been burning since time began and which can shed light on human understanding — if we don't hide them under a bushel.

PEOPLE WANT RECOGNITION

I. The child that "shows off" when visitors are calling — the teenager who puts the Hollywood muffler on his car and races it at high speed and takes off from stop lights with screeching tires — the beatnick who slouches around with his beard and off-beat talk — the workman who you can count on to turn in twice as many suggestions each month as the rest of the crew combined. These are all differing behaviorial expressions of man's basic requirement to gain attention — to be recognized. Some people seek attention and recognition in the work situation by constantly drawing attention to themselves by being a part of the limelight — by having an opinion on everything and making sure it is heard. Other people seek their attention and recognition in a much more modest way by very thoroughly and very consistently doing the job expected of them. But neither wants to be taken for granted. Wanting recognition is a perfectly normal human trait that has not been changed in a thousand years and not likely to change in another thousand. You want it and need it and so do I. The teenaged hot rodder who exhibits his need for recognition in a socially unacceptable manner must be disciplined and controlled but the basic trait of wanting recognition is perfectly normal — and most instances perfectly healthy. There was quite a well known industrial relations film that made the rounds several years ago, the title of which was, "The Boss Didn't Say Good Morning". Its theme is a very simple example of recognition; or the lack of it. Here is a person who could not afford to give a subordinate the recognition of acknowledging he even existed by making a simple saluation like "good morning". I don't have to tell you from this example and from seeing such a boss in action, what this does for their rating on "the supervisor's hit parade". A simple example you say. I agree, but no simpler than the recognition that one of the basic fundamentals of human nature is that people want and need attention and recognition. It is one of these candles that should be put on a candlestick where it can be used to give light to human understanding — it should not be hidden under a bushel.

II. Another unchanging human characteristic that is closely akin to wanting attention and recognition is the trait of needing praise and build up. In other words, we need to have an outward and tangible expression now and again of recognition. This again, is a perfectly normal and natural facet of human nature. Of course, one of the most natural and highly appreciated forms of praise and build up is a good word from the boss along with a salary increase. Both being told we are doing a good job and the increase in salary are tangible evidences of recognition in the form of praise. One without the other does not necessarily fulfill as well the need for praise and build up. The important thing is that praise and build up are needed by people. They cannot be used as "a phoney" to cover up shortcomings—but in the proper atmosphere wonders can be wrought by the use of well intentioned and well deserved praise. Before anyone says to himself "here is another of these 'do gooders' who thinks people should be continuously patted on the head," let me remind you that I said well deserved and well intentioned praise. Ill intentioned or phoney build up is probably worse than never giving a man any praise. What I am saying is that you respond to praise, and so do I, and so does everyone else. The fact some need more than others is only a matter of degree. This need was well illustrated to me during the Conference where an organizational change was described in which an employee was transferred from the supervision of one boss to another due to a number of personality "clashes." Some months later the original boss told the new one that despite their problems, the transferred employee possessed and exhibited the best technical qualifications of anyone he ever had working for him in this capacity. Later this compliment got back to the employee and evoked the comment, "If he only had told me that—even once, it would have made such a difference in our relationships." Recognition in the form of praise was warranted but recognition wasn't given. So it is a fact of this unchanging human nature that people want tangible recognition in the form of praise and build up every now and again. This is another of the candles that should be put on a candlestick where it can give light of understanding in man's relationship with man—it should not be hidden under a bushel.

III. Another facet of human nature that is again rather closely allied to the two previous ones mentioned, if not a part of them, is that each man maintains a mental image of himself that can probably be best described as his dignity. And it is human nature to want our dignity respected. In our total make-up we all have strengths and weaknesses. Our weaknesses or our inadequacies are the things we

don't like to dwell upon—rather it is our strengths that are the things that are important to us. Our strengths generally represent what we like to do and provide the incentive or the motive power in much of our activities, including our work. We respond to our strengths and the recognition of them—and likewise we are not proud of our inadequacies. We would like to keep them hidden. In my own youth I still find a good example of this. As a young lad in the Y.M.C.A. I was a junior leader and in carrying out the varied program of the Y, I found that I was quite average in leading my group in most aspects. However, in one, distance running, I excelled, but in parallel bar and ladder work I was just the opposite. Of course, as is human nature, I tried to avoid the latter—my arms were never my strength and if I could chin myself five times I did well. It always used to burn me when some big hulk in the group who couldn't run half a block, would venture the opinion that I wasn't very good at demonstrating how to go hand over hand on the suspended ladder. There is a facet of human nature here that we can well capitalize on—we can and should find peoples' strengths and emphasize those and likewise we should de-emphasize the points of weakness. This is as sound a way as I know to respect a man's dignity. This is not to say that where weakness is a deterrent to a man's progress it should not be worked on—but it should not overshadow the strengths that provide the man's major worth and his motive power. It is human nature to want our dignity respected and to the degree this facet of human nature can be respected and satisfied, we have another candle that should be on a candlestick where it can give light to human understanding—not hidden under a bushel.

IV. I have already mentioned earlier, by way of example, the fundamental of human nature which I described as people wanting security. Security has in some people's vocabulary become to be looked on as a dirty word. The connotation has been attached that it means being lazy, non-progressive, or sitting in a cosy rut. I don't agree with this interpretation—I look upon security as the desire of a person to provide for himself and his family those things that are considered first of all necessary, and then those things that are desirable, to living. We may exhibit our desires for security in many different ways but this does not escape the fact that it is a fundamental part of you and me and everyone else. As mentioned, people in some parts of the world exhibit security in form of self-preservation, that is, getting enough food for themselves and their families, to stay alive. To some people security is best achieved by staying in the cosy rut and not "rocking the boat"—but to some people security is achieved by venturing into the unknown, by risking everything with the hope of eventually providing themselves with a large slice of security, in the form of more of this world's goods. I interpret that the seeking of security is a basic trait of human nature even though it exhibits itself in varying degrees in different people. But the recognition of it is like a candle that should be in a candlestick where it can give light to our dealings man with man—not hidden under a bushel.

V. Another unchanging facet of human nature that we should keep before us is that, "people want to know". They want to know what is going on—they want to know the why of things. This is not idle curiosity—this is part of each of us and we are never going to dismiss it by saying, as I suspect is said in many instances —"it's none of their damn business". I shouldn't like this interpreted unrealistically that I am in favour of divulging willy-nilly to all employees all corporate business, including plans for the future. Please don't whitewash this facet of human nature this way. I would remind you that in much of the management literature in recent years stress has been laid on the message of the importance of communications. Some writers and speakers have even gone so far as to say that one of the most important functions of management today is communications—and even more commonplace are the case studies of problem situations that have as their end point the conclusion "poor communication". I don't care what position a person holds in business, in industry, in government or whatever; they want to know. They want to know the what and the why of their daily work. They want to know the what and the why of their company and how it affects them. How often have you heard someone mutter as he was redoing some work, "well, why didn't he say so in the first place". What they were saying was, why didn't you tell me more about it at the time of assignment. In other words, I want to know —and I need to know.

Let me tell you of a project in my own Company where one of our superintendents suggested the answer to rising maintenance costs on fork lift trucks would be to develop a training program. We were rather apprehensive that if "the why" of the course was given as reducing maintenance costs we might run into the reaction "why should I care if maintenance costs are high—it's not my machine and you want me to get the lead out". We considered that we might use only the "safety angle" since this was a secondary objective of the course. However, we soon took the view that the drivers should be given all the information in regard to why they were brought into this driver training course, even though many had been operating a lift truck for 10 years. The interest and the response was intense and wonderful. Many said they never really considered maintenance costs any particular concern of theirs until the Company told them of their share of the responsibility for such costs. These jobs took on new meaning for many of the fellows —even the expert drivers. They had information. The net effect was a lowering of maintenance costs by 60% during the first year after the course. A very large proportion of this improvement was attributed to the fact that the drivers were given facts and information. They were no longer doing a job "in the dark".

Again wants represented by this facet of human nature are a matter of degree. The president wants and needs to know more about a lot of different things than the workman on the job, but the difference is in degree and does invalidate the trait of human nature that people want to know. It is basic human nature to want to be "in the know"—if recognized as such it can be turned to great advantage to our dealings one with another. This too is a light that should not be under the bushel.

VI. Another trait of human nature of which we should be reminded is that people like to belong—they want to be part of something. From the very beginnings of man we have lived together in families and tribes. We marry, join lodges, unions, clubs and professional associations. Man is a social animal and likes to belong to things and be a part of things. There is also in this facet of human nature, a variation in degree of its importance and its expression—but it does not alter the fact that man likes to belong —to be a part of things. I believe that, in addition to the many off-the-job groups to which people belong, it is a fact that people also like to belong to work groups, to a shop crew, a plant crew, an office group. There is a great opportunity for management to capitalize on this need of belonging so that employees do, in fact, feel they do belong to company or firm for which they work. I don't intend to develop this any further as it could well be a study in itself—

but there are many ways to both accomplish and to turn to advantage this human characteristic of wanting to belong. It shouldn't be put under a bushel and lost to sight.

VII. Another facet of human nature that is elosely akin to the foregoing—this being that people like to participate. We ean also legitimately draw attention to, and consider, the result of partieipation which is pride of accomplishment. Again the degrec to whieh this basic facet of human nature evidences itself varies in people, and although this may dominate few, it interests most. This, I feel, is quite an important facet of human nature exhibitcd in the needs and wants of professional pcople. People generally respond to being a part of things in the sense that they participate to some degree in the formulation of plans for action and the action itself, whether it be an on-the-job situation of making a contribution on how to lay a pipe from point A to point B, or how to repair a piece of equipment, or how to design a building, or how to keep costs down, or whether to invest $10 million in a new plant —or in the off-the-job situation of laying new linoleum in the kitchen, or building a sail boat or planning a garden, or running a financial campaign for the church. People like to have a hand in things and they like to share in the accomplishment of a job well done.

To illustrate, I often recall the story told me by a friend who used to work at a Cominco mining operation located in rugged country several miles inland from the B.C. coast just north of Prince Rupert. The foreman of the surface crew had a job that presented a variety of work problems, not the least of which was caused by the heavy snowfall in the area—where the concentrator was built underground and the surface buildings were built on stilts to keep above the 12-15 feet of fallen snow. One late winter day there had been a breakdown in the concentrator and although temporary arrangements were made to keep the mill operating, they needed to replace a heavy pieee of equipment. The replacement was under 15 feet of snow in an equipment yard marked only by long painted stakes that had been driven there the previous fall. That morning the foreman's first words after the usual "good morning" were, "Well, they've got us beat this time" and then proceeded, on being questioned by the crew to tell of the problem. Soon the group was buzzing—and the upshot of the matter was that by noon the equipment was in the mill and the foreman had spent no more time in detail work supervision than any other day. Although the crew had really worked hard on this job, the story concludes they were proud as peacocks about what they had done. I gathered also that this was not an unusual occurence with this crew, but rather the standard pattern. My friend told me at the time he couldn't quite figure out whether the foreman was lazy or smart—but after he was made a supervisor himself, he figured he might have been both, but he was certainly a student of human nature.

It was utterly fantastic the jobs this man would get done by allowing participation by the crew. The crew felt that their opinion counted for something with the result they were a part of everything they did, and pride of accomplishment resulted from practically every job. These fundamentals of human nature are as candles on a candlestick that can give light to the man management function—if they are not hidden under the bushel.

The enumeration of other facets and fundamentals of human nature could be continued, but I feel these are sufficient and important reminders of the unchanging fundamentals of human nature.

I would like to quote from an article appearing in the National Industrial Conference Board publication, "The Management Record" of September, 1962: . . . "We were recently consulted by the head of one of our installations about a salary administration problem. This man was concerned beeause he was losing some of his best people to other companies. He felt he had to pay more to keep them.

"After we had talked to him we interviewed a number of the people. Not surprisingly, we learned the problem wasn't money. It was the way he was managing. The men felt they were being treated like eogs in a machine—not given sufficient responsibility, or recognition, or information. A reservoir of resentment had been building up and it had reaehed a point where the best people were leaving. For the manager, it was obviously easier—and perhaps more natural—to pin the blame on inadequate salaries than to recognize the need for improving his managerial skills."

If I might be allowed to speculate on this ineident, I would be willing to make an even money bet that three of the things that are important to this manager in his job, are responsibility, recognition and requiring suffieient information. And yet, how easy to forget that these also apply to others and figuratively to hide these "lights" under a bushel in his dealings with others.

I realize that I have treated rather cursorily these basie fundamentals of human nature, because it has not been my intention to prove these to you—you already know them. The situation can be likened to the man in E. Stanley Jones' book, "The Way", who stood resolutely looking to the east and asked for proof that the sunset was beautiful? Such proof was not available from others but the man was invited to turn and look at the western sky and prove to himself that the sunset was beautiful. I maintain these fundamentals of human nature expressed as man's needs and wants are already know to all of us. You know them because they are a part of you, of your family, of your friends —and they are part of the people you work for and the people who work for you. Not long ago I read where an economist was defined as one who tells management things which they already know, in words which they can't understand. I have been trying to set out some fundamentals of human nature that you already know, in words that you do understand. Things like:

1. People need recognition
2. People need praise and build up
3. People nced their dignity respected
4. People need security
5. People want to know
6. People like to belong
7. People like to be part of things —to participate
8. People need a pride of accomplishment.

These are some of the basic fundamentals of human nature expressed as the needs and wants of people. From the point of view of managing people we must remember that these needs when satisfied, mean high motivation—when left unsatisfied they mean low motivation.

In conclusion, I would like to recall a part of the prologue of the Duke of Edinburgh's Study Conference whieh referred to change in terms of "What have we to fear from change, when change has been the very law of our growth", I say we have nothing to fear, providing we don't get so caught up in change that we forget those things that are unehanging. Change *IS* the very law of our growth for had not man been blessed with the ability to ehange and progress by bending nature to serve his interests, we might still be living in caves, at the merey of wind and weather, scratching the earth with a stick and the helpless victims of famine and disease. Change is a very wonderful thing, but amid it all, let us not forget important things that are unchanging.

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Discussion

THE ANALYSIS OF STRUCTURES BY AID OF MODELS

Joseph Schwaighofer
Assistant Professor
Department of Civil Engineering
University of Toronto

The Engineering Journal, July, 1963
page 22

Discussed in this is Joseph Schwaighofer's paper, "THE ANALYSIS OF STRUCTURES BY AID OF MODELS".

Following the above is a discussion of George Ford's paper, "THE DANGERS OF SPECIALIZATION".

Discussion by
Dr. J. A. N. Lee

I should like to reinforce some of Professor Schwaighofer's statements and to amplify others. Professor Schwaighofer has pointed out that certain codes other than the Canadian allow the substitution of model studies for analytical investigations, and that certain classical structures have been completed on the basis of laboratory model studies. However, it would be unwise to give random permission for this alternative to be followed except to qualified practitioners. Improper scaling, faulty conditions of support and the use of the wrong materials can lead to erroneous results which could lead to unfortunate consequences. In scaling down prototype structures, the researcher invariably find that the scale factors cause any desired quantity to be almost immeasurable and that only by the use of micro research techniques can any results be of any use. Known inaccuracies in measurement can often mask otherwise important results. In addition, at these miniature scales any discrepancies can cause remarkable effects which may not be expected. A one-inch chamfer on the prototype when scaled down may be the cause of a serious stress raiser.

Professor Schwaighofer has pointed out that in using micro concrete the resistance to bond fracture is larger than required and that this can be remedied by the use of fewer bars. However replacing the concrete by plaster of paris has the opposite effect. Due to the high rate of setting, there is a definite expansion of the material rather than a shrinkage as in concrete. Consequently, using plain bars there is negligible bond resistance and so remedial measures are necessary to increase the bond. This is normally achieved by using threaded rod instead of plain bars.

While Professor Schwaighofer has introduced the use of plaster of paris as an alternative to concrete, several disadvantages are apparent. Primarily the stress strain curve of plaster is only non-linear when the material is kept wet. Very minor changes in humidity can cause larger changes in strength which are difficult to control except in special testing rooms. Using a fine crystalline plaster and heat to eliminate all traces of moisture, the plaster has the property of a perfectly linear stress-strain curve to failure without any plastic region prior to rupture.

This particular property can be used to advantage in determining the maximum stress occurring in a structure. Using control beams at the same temperature and consistency, a model can be loaded to destruction. At the instant of failure the load can be related to the maximum stress at the point at which the first crack started. It is then known that under elastic conditions the stress at all other points does not exceed this known maximum stress. If necessary this area may be reinforced in another model and the test repeated.

An advantage of plaster that has not been pointed out, is that the material is capable of being worked after casting, using an ordinary band saw, the model can be cut to shape or chiselled without causing any side effects detrimental to the experiment.

In addition to Professor Schwaighofer's remarks I should like to point out that it is not always necessary to scale structures to test their performance. Certain specialized effects may be investigated in comparable circumstances rather than in the actual situation.

Professor Schwaighofer is to be complimented on a thorough documentation of model techniques and concise explanation of the method used. I should be prepared to support any move to include the use of model analysis as alternatives to analytical investigations in our design codes.

Discussion by
Norbert Seethaler
Consulting Engineer, Toronto

The task to cover the topic of structural model analysis in a single paper is rather difficult. It necessitates the writer to concentrate either on a few specific areas or to give a broad survey of the subject, whereby many new developments in the field can only be mentioned. In this connection the author's view on "stress freezing" problems in three-dimensional photoelasticity would be welcome.

The photoelastic layer method which is briefly covered in the paper is fairly widely used as a design and development tool in mechanical and aeronautical engineering. Hampering its use in pure and scientific research is the insufficient sensitivity of the very thin plastic layer as well as the so-called thickness and stiffening effects.

In general, one can distinguish between two types of model studies:

(a) The pure scientific research in which emphasis is placed on a comprehensive and accurate description of the phenomenon;

(b) studies which concentrate on procuring only those data which are vital for the design and the development of a particular engineering product.

This later path is the one most frequently chosen in the fields of mechanical and aeronautical engineering. Models as tools for design and analysis are not yet used too frequently in civil engineering except on large engineering projects (dams) and in connection with mass fabricated structural members, because of supposedly high costs of model work.

The writer believes that by proper selection of the model material, by careful planning of the study and by exploring all available theoretical aspects, model studies are economically feasible even for small structures. I expect that with the ever increasing complexity of structural shapes and improvements in techniques, model studies will be employed in civil engineering to the same extent they are presently used in other fields.

A concrete stair case at the Colonnade in Toronto may serve as an example for using a model in the design of a small but complex structure. This study was conducted in co-operation with Dr. Schwaighofer.

Photograph of the completed Stair

Author's Reply

Dr. Lee added in his discussion valuable material concerning micro-concrete and plaster of paris. I also agree fully with Professor Lee that improper experimentation may lead to serious errors and that therefore only qualified investigators should be entrusted with model studies.

Mr. Seethaler elaborated on the topic of model analysis from the standpoint of the practizing consultant and argued—based on personal experience—that experimental studies are economically feasible even for small structures. A few words about "Stress freezing" in three-dimensional photoelasticity: In 1936, Dr. G. Oppel subjected a Trolon plastic bloc to elevated temperature (about 240°F) and impressed into the plastic a steel sphere. The plastic was allowed to cool slowly down to room temperature whereupon the constant load was removed from the sphere. Upon unloading photoelastic fringes were retained in the plastic which represent lines of constant difference in stress. Oppel's method spread rapidly around the globe and is in English-speaking countries referred to as the "Frozen Stress Method". In three dimensional problems in which the stress distribution is materially depended on Poisson's ratio, stress freezing should be accomplished at only slightly elevated temperature—at around 130 degrees Fahrenheit for Araldite epoxies for example—because Poisson's ratio of the plastic is then around 0.37 which is much closer to Poisson's ratio of the prototype ($\mu_{steel} = 0.30$, $\mu_{alu} = 0.33$). This latter method is called: "The Extended Frozen Stress Method" and was developed by the author.

(Continued on page 56)

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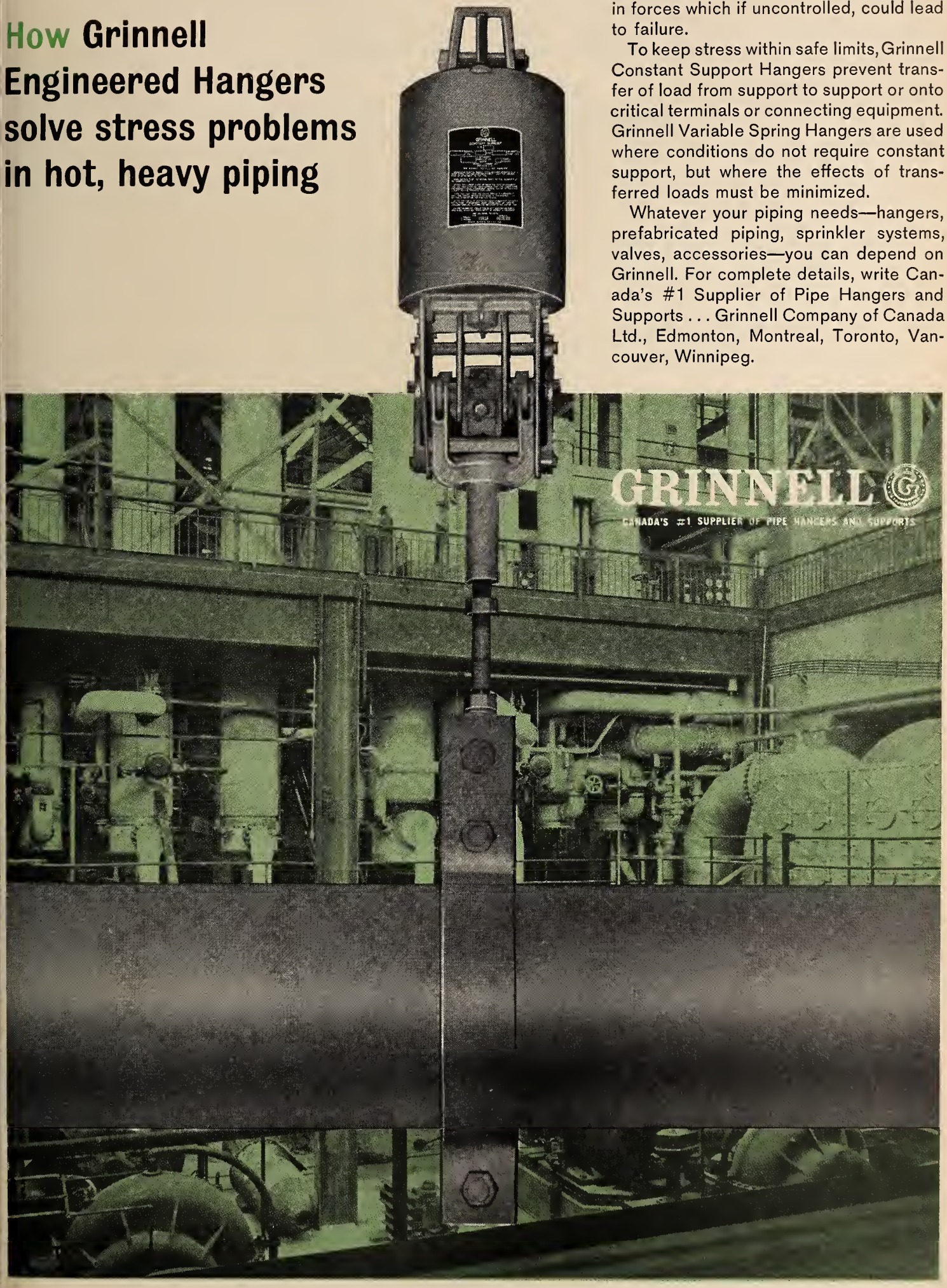

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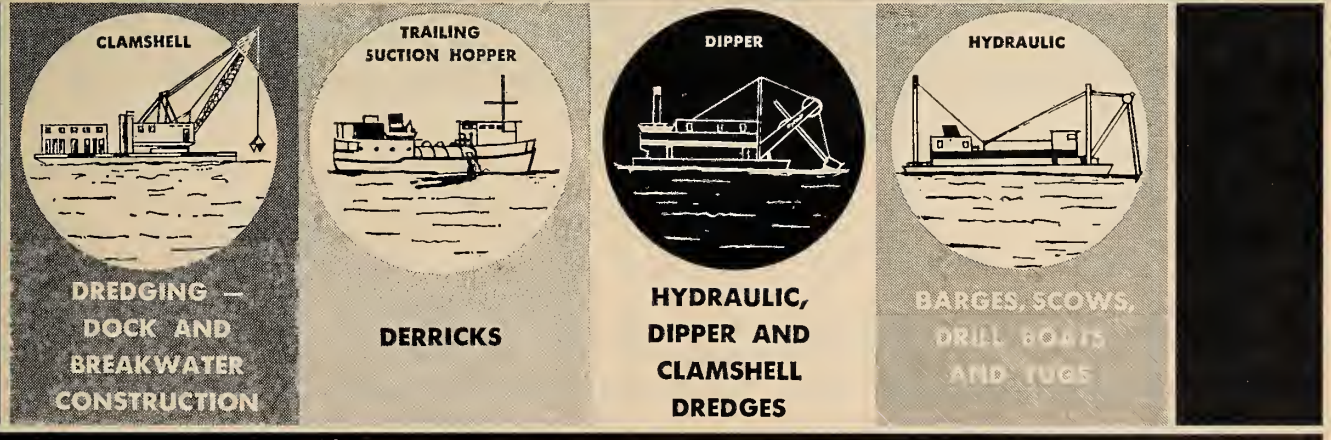

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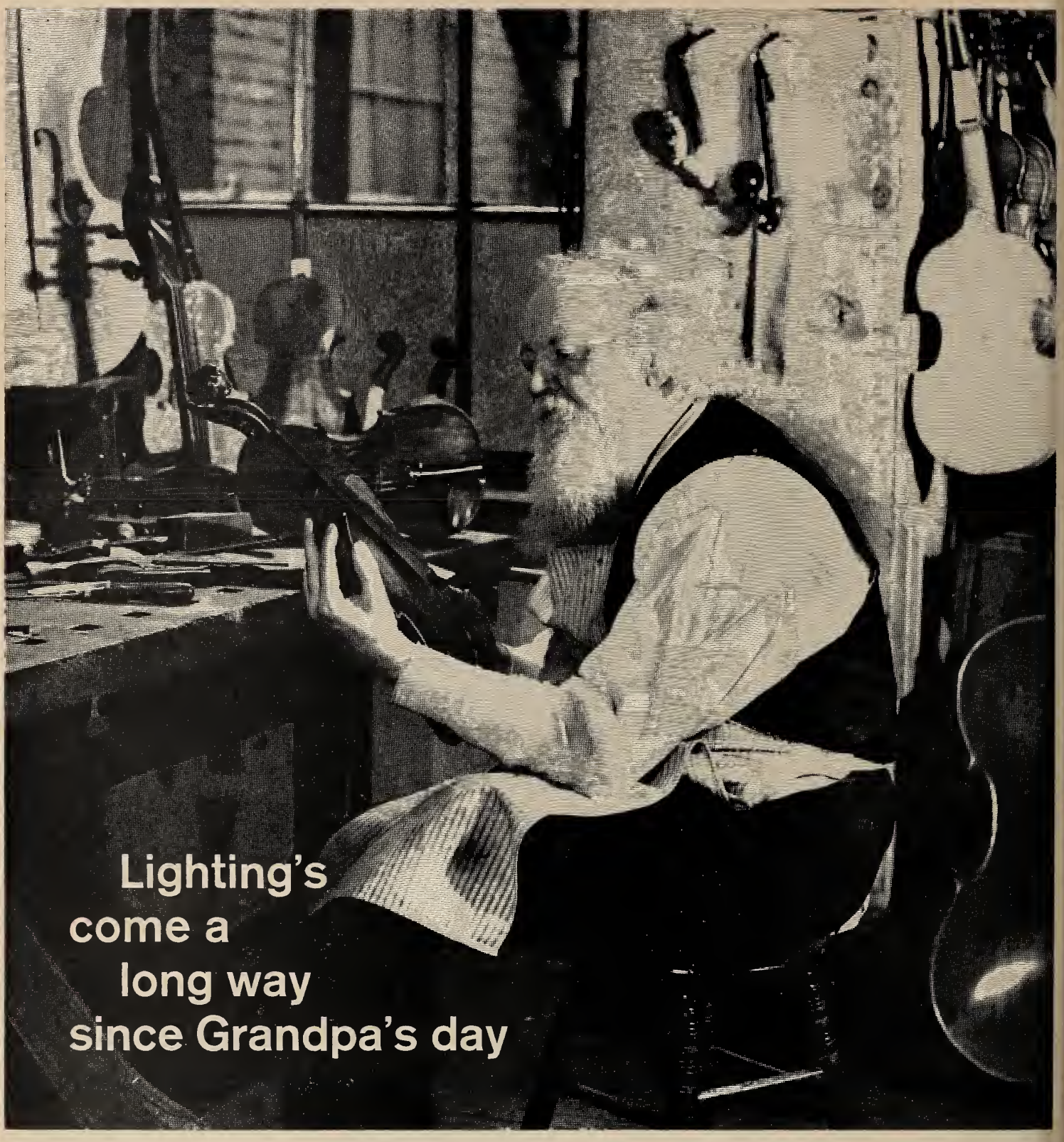

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For complete product information, call your nearby AAF representative, or write direct for Bulletin 248. Address: American Air Filter of Canada Ltd., 400 Stinson Blvd., Montreal 9, Quebec.

6221

**Paper Mill*

AAF CANADA

American Air Filter OF Canada LTD.

400 Stinson Blvd., Montreal 9

Branch News

BAIE COMEAU
G. W. Scott

On Thursday, April 25, A. L. Dempster, of the Aluminum Company of Canada, Montreal, presented a talk entitled, "Recent Developments in Bulk Handling". Mr. Dempster emphasized the degree to which Canada's economy was dependent on the export of bulk materials to world markets, and the extent to which competition stimulated the search to reduce handling costs. The speaker then dealt with some recent developments in the field of ore reclamations, earth moving, plant handling and shipping. Mr. Dempster's talk was illustrated by slides which showed a specialized piece of excavating or handling plant. These were briefly described. In covering the various aspects of his subject, Mr. Dempster referred to recently built installations at Montreal Harbour, Port Cartier, Port Alfred, Seven Islands and Kitimat. Of special interest to this Branch were the raw material handling installations at Port Alfred and Kitimat which correspond with those associated with the local aluminum smelter installation completed in 1958. Mr. Dempster was thanked by R. W. Savage.

One to two hours of documentary films, mostly those produced by the National Film Board, covering recent developments in science, engineering and industry, have been shown on Saturday mornings since the end of March. This series continued to the beginning of June.

CORNWALL
G. Peter Schwarzkopf

A. Thorley, General Manager, Warnock Hersey Soil Investigators, was the guest speaker at a recent meeting of the Branch. Slides and photographs of soil investigation from Montreal to the Northwest Territories accompanied the talk. A question period followed. The speaker was thanked by Branch Chairman, K. Barnhart.

EDMONTON
R. J. Allman

The Branch's meeting in March had as its keynote speaker, G. G. Chrysanthou, Sewer Construction and Drainage Engineer for the City of Edmonton. Mr. Chrysanthou's topic was "Relief Sewer Construction." He mentioned that various methods of tunnelling for interceptor relief sewers in Edmonton had been tried since the start of the project and that the method now in use is the poured-in-place technique. The type and shape of the present tunnels is a variation of the Boston Arehcrib method. Mr. Chrysanthou described the geology of the strata underlying Edmonton and outlined the six major tunnelling operations that comprise the construction of interceptor sewers by the tunneling method. These are: setting up the shaft site; shaft sinking; undercutting; tunnelling; placing of the concrete liner; building of manholes and chambers. Mr. Chrysanthou explained that there was still an extensive tunnelling program ahead for Edmonton, and even though his department was satisfied with the methods and performance of the tunnelling crews, they were constantly trying to improve certain phases of the operation. The talk was illustrated with slides.

In April, Dr. J. Gordon Parr, Department of Mining and Metallurgy, University of Alberta, and partner in the firm of Hanson-Parr Engineering Ltd., presented a very interesting talk entitled, "Why I Almost Didn't Join the Engineering Institute of Canada." Dr. Parr discussed the purposes and aims of technical societies and their relationship with each other. A lively discussion period followed the talk, and there was no doubt that those who attended this meeting were left with a much better idea of their role in a technical society.

KAMLOOPS
J. W. Nelson

On Friday, April 26, a joint meeting of the Branch and the APEBC was held at the Aquatic Club in Kelowna, B.C. E. C. Roper, recently appointed Director of the B.C. Institute of Technology in Burnaby, spoke of the great need for education and training for employment. In a recent year, 70% of the unemployed had only grade eight education. It was this lack of formal education which made it difficult to find employment. In spite of this obvious need, it is most likely that of every 100 students now in elementary school, only 33 will complete high school, and only 9 will attend university.

On the labor market as well, there are diminishing employment opportunities for the untrained. Technological advances have decreased the need for unskilled and semi-skilled workers. Mr. Roper pointed out the great need for technological training. Only 4% of the students in Canada now receive this training. Consequently, five out of every six technicians hired are from Europe where technical schools have been established for many years.

A Royal Commission in 1961 led the way to a "crash program" by the Federal Government. The construction of the B.C. Institute of Technology will be paid for by Federal and Provincial Governments. The Institute, to be completed in December of this year, will accommodate 1500 students. The curriculum will include programs in engineering and architectural technology; forestry; hotel; motel and restaurant administration; medical technology; mining; merchandising and business training. Tuition will be $150. per year, and financial assistance will be provided for needy students.

KITCHENER
W. L. Bulmer

The Branch's Annual Ladies' Night was held April 26 at the Crystal Ballroom at the Walper House Hotel. A buffet dinner was served followed by a dance. Forty-two couples attended.

ST. MAURICE VALLEY
Raymond Felx

Dr. O. L. Mordell, Dean of the Faculty of Engineering, McGill University, was the guest speaker at the Branch's May 29 meeting. He spoke on the university's Martlet Program. In keeping with the variety of research interests and the activities of its staff, McGill University has undertaken recently the development of a high altitude research laboratory on the southeast shore of the Island of Barbados. In this age of space technology, the necessity of gathering experimental data from the atmosphere and beyond has become extermely important. Although rockets can provide the means of sending research probes into space, they are extremely costly, and the need for less expensive high altitude probes has become accentuated.

The enginering staff at McGill received the encouragement and support necessary to establish a research station where a 16-inch gun facility, together with range instrumentation and telemetering equipment, has been completed to an extent which has permitted the system to be tried in the recent firing of the Martlet I missiles to heights of 80,000 ft. The tests showed the overall feasibility of the project and paved the way for full-scale scientific probes in the future.

This meeting was the Branch's Annual Meeting, and the following reports were presented: report of the secretary, D. Irving; report of the treasurer, J. D. Whiteley; report of the membership committee, J. Carson; report of the program committee, R. Ouellette; report of the publicity committee, R. Felx; report of the chairman, W. Ingram; and the report of the nominating committee, W. A. Pangborn.

The Branch is presently organizing a joint technical conference with the Eastern Townships Branch to be held in Three Rivers, September 27 and 28, 1963. The program will include six papers, and plant visits. A dinner and dance are scheduled for September 27.

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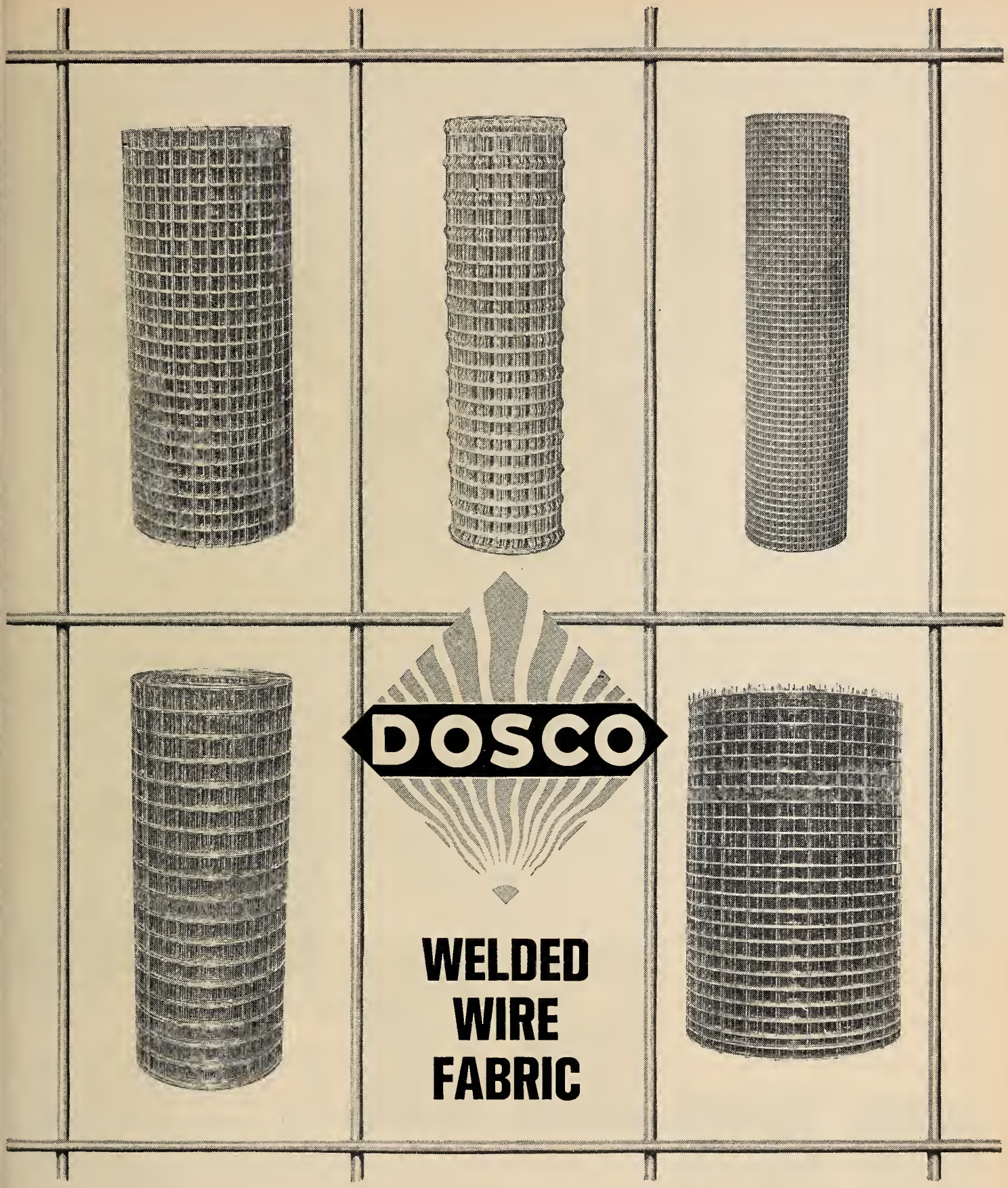

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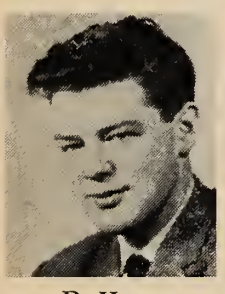
Personals

L. W. Pillar, M.E.I.C.

R. C. McMordie, M.E.I.C.

Leslie W. Pillar, M.E.I.C. (Kings Coll. '25), has been elected President of the Toronto consulting engineering firm of Ewbank, Tupper & Associates Ltd. Formerly executive vice-president and director of the firm, Mr. Pillar will succeed Dr. Kenneth F. Tupper, Hon. M.E.I.C., who has resigned his position as President and Director. Mr. Pillar's experience includes major highway and public works projects, industrial development, water supply and sewage schemes in Ontaio, Quebec, Newfoundland and Western Canada, and such diversified projects as the T.T.C. Subway, the new 300-ton Shearleg crane for Toronto harbour, and a complete study and report on the harbour of Kingston, Jamaica. Mr. Pillar was Director of Planning and Works for the City of Ottawa, and Technical Advisor to the Ottawa Joint Planning Board.

R. S. McMordie, M.E.I.C. (U.B.C. '50), has been appointed Municipal Division Manager for Southern Alberta and the Interior of British Columbia. Mr. McMordie joined Haddin, Davis & Brown as Resident Engineer in 1956 and was responsible for the supervision of installation of services for more than 5000 residential units. He later became Senior Design Engineer in the Municipal division of the company.

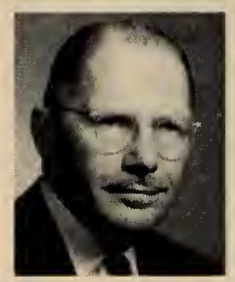


D. Hayes

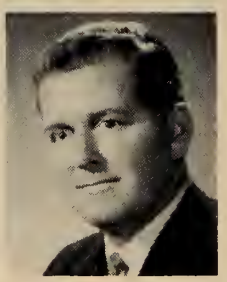
R. Playfair

Ray Playfair has been appointed Vice-President of Rousseau Controls Ltd., Montreal. Mr. Playfair joined the company in 1959 after 10 years' experience in the control field with one of Canada's leading machinery manufacturers.

David Hayes has been appointed senior technologist at Canadian Refractories Limited's research laboratories at Marelan, Que. Mr. Hayes graduated with a M.Sc. degree in ceramics from the University of Leeds where he worked for two years in post-graduate research in this field prior to joining the company. His duties with CRL will include fundamental research on sintering phenomena.



R. T. Morgan, M.E.I.C.



R. A. Gilmour, M.E.I.C.

Ralph T. Morgan, M.E.I.C. (McGill '35), has been appointed chief engineer for Canadian International Paper Company. He served in the Trois-Rivieres and Dalhousie mills from 1935 to 1954, when he returned to Montreal as assistant to the chief engineer.

R. A. Gilmour, M.E.I.C. (Manitoba '50), has been appointed marketing manager for pneumatic, hydraulic and Westoflex products for the Canadian Westinghouse Air Brake Division. Mr. Gilmour was formerly product manager for the company's Distribution Apparatus Division at London, Ont.

A. O. Wolff

H. T. Fargey

A. Olaf Wolff has been appointed Vice-President, Research and Development, and **Harold T. Fargey,** Vice-President, Sales with The Consolidated Mining and Smelting Company of Canada Limited. Mr. Wolff was formerly Director of Research and Development and Mr. Fargey was General Sales Manager. Both men have been with the company for more than 20 years and have served in various capacities at the company's operations in Western Canada and at the Head Office in Montreal.

W. D. Drummond

S. M. Young

W. Duncan Drummond, Chief Engineer, Product Engineering Department, Hamilton Works, International Harvester Company of Canada, Limited has been promoted to the position of Manager of Engineering. **Stephen M. Young,** Vice-President, Engineering has become Manager of Engineering, Farm Equipment Division of the company, in Chicago.

Albert Vernac has been appointed Product Manager for Fabricated Reinforcing Steel at Canada Iron Foundries, Limited, Structural Division. Mr. Vernac has been active in the construction field for the past 13 years, both in the structural and the reinforced concrete business.

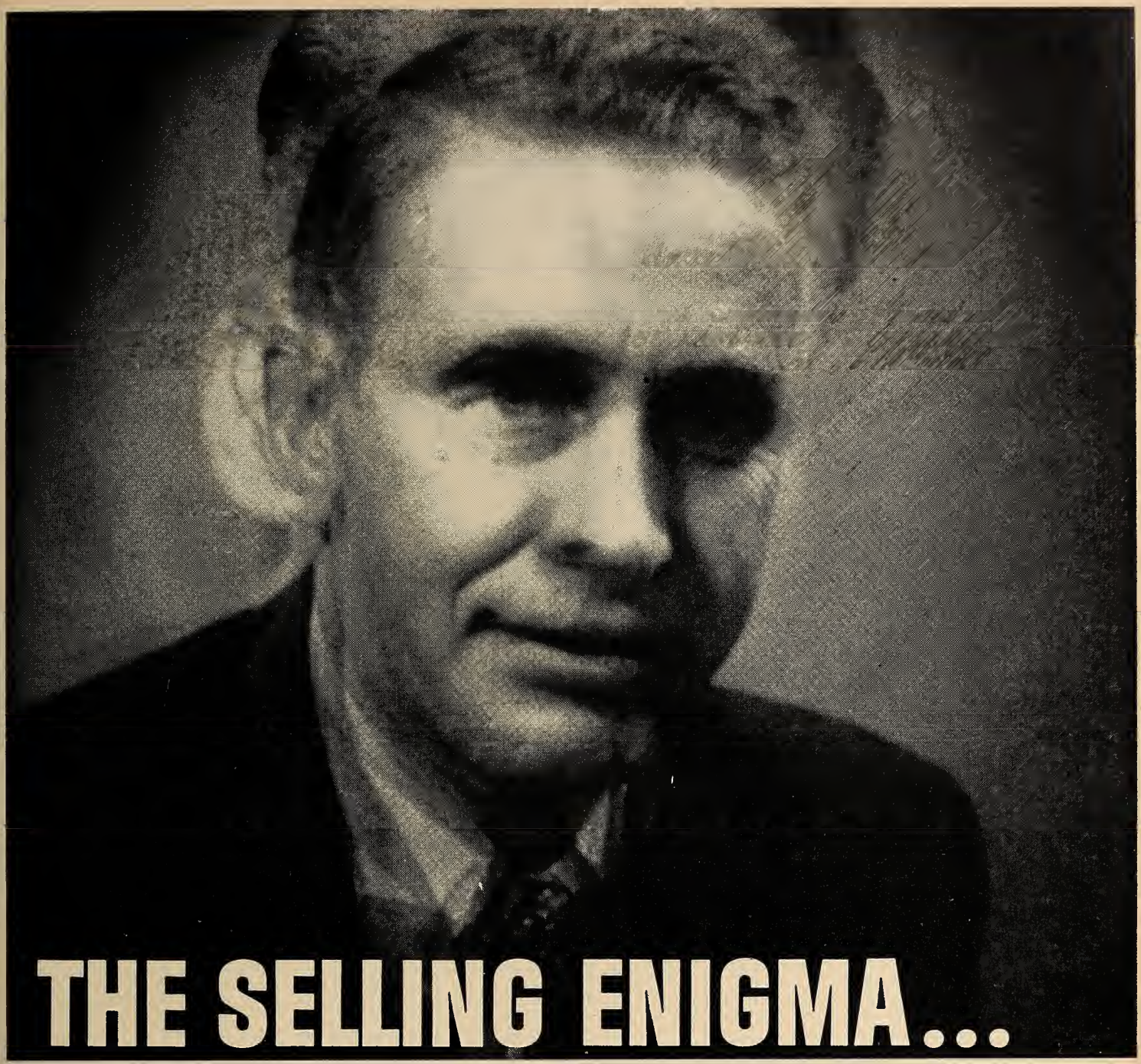
J. S. Dewar, M.E.I.C.

A. Vernac

John S. Dewar, M.E.I.C. (Queen's '41), has been elected executive vice-president of Union Carbide Canada Limited. Mr. Dewar was formerly vice-president of the company. He joined the company in 1943 as a chemical sales engineer. He was appointed vice-president, operations, and a director of the company in 1959.

Arnold J. Kibrick, M.E.I.C. (McGill '61), has been appointed District Sales Manager—Equipment Sales Quebec Region for the Electronic Tube Section of the Canadian General Electric Company. Mr. Kibrick's headquarters will be in Montreal. Prior to joining the company, Mr. Kibrick held important positions in semiconductor sales and quality control systems engineering.

(Continued on page 68)



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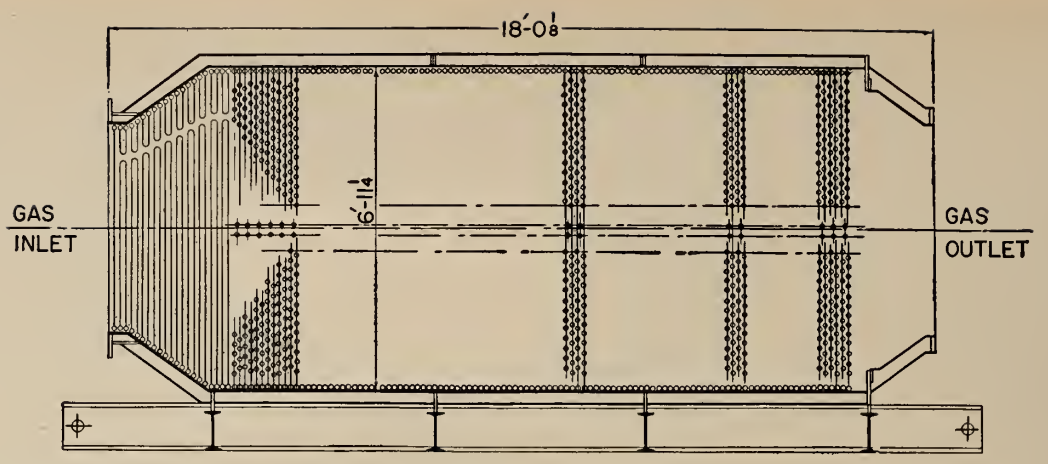

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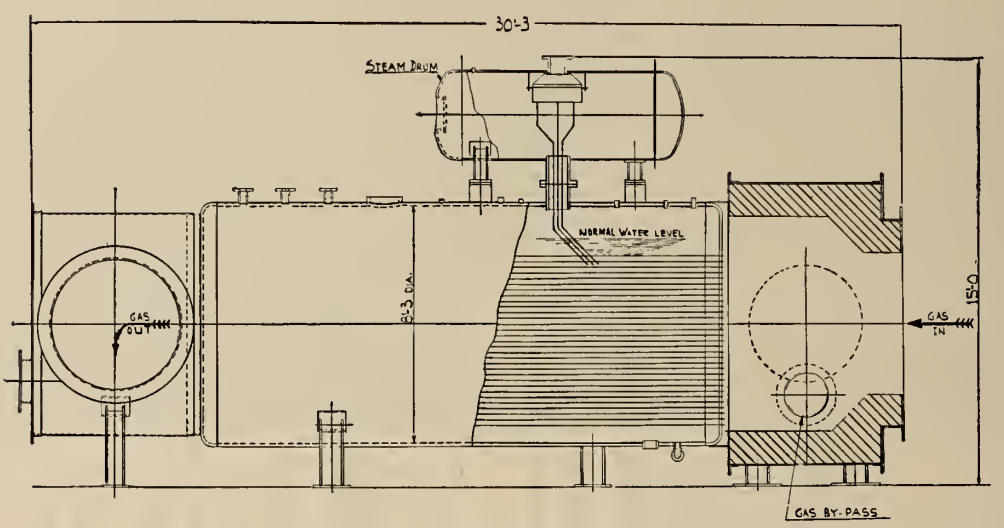
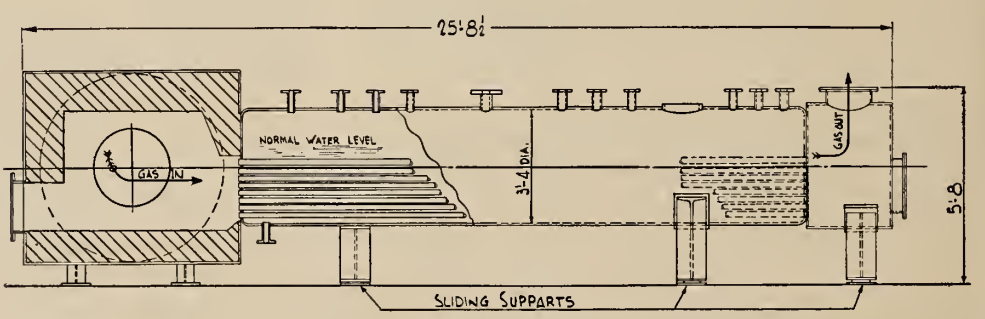


Application: Reduce temperature of discharging SO_2 in the production of sulphuric acid.

Specification

Gas in 2000°F
Gas out 780°F
Steam generated 53,000 pph. max.
Heating surface (fireside) 6,800 sq. ft.

Recovered heat warms building and operates air movers through turbines.



Application: Reduce temperature of discharging SO_2 in the production of sulphuric acid.

Specification

Gas in 2000°F
Gas out 711°F
Steam generated 6,260 pph.
Heating surface (fireside) 630 sq. ft.

Recovered heat warms building and operates water evaporator unit.

waste heat recovery boilers

The three diagrams facing this page are representative of types of waste heat recovery boilers produced by Dominion Bridge for use in Canada and abroad.

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Standard firetube boilers from 15 to 500 h.p.
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SITUATIONS WANTED

CIVIL ENGINEER — Engineer Officer, A.M.E.I.C., P.Eng. (Ont., Yukon), R.M.C., U. of T., B.Sc., 1959. Age 28, married, 2 children. Instructor road/airfield design and construction, heavy earthmoving equipment, soils, surveying. 2 years Northwest Highway System, estimating, planning, scheduling, supervising, on-the-site engineering of bridge, major culvert, road relocation (designing also) projects. Desires position engineering firm. Location British Columbia, Ontario, Alberta. File No. 479-C.

CIVIL ENGINEER—S.E.I.C., B.Eng., McGill '63. 3 years experience in municipal engineering and surveying, and 2 years in road construction. Resume on request. File No. 525-C.

CIVIL ENGINEER—1958 grad., 28 years of age, married., 4 years experience outside plant engineering, 1 year's experience as project engineer on building apartment construction. Require position involving general civil engineering. Sales or personnel as well as technical openings most welcome. Experience has been in general application engineering. File No. 521-C.

CIVIL ENGINEER — A.M.E.I.C., P.Eng. (Que.). Age 27, single. B.Sc. University of Sherbrooke 1959. Experienced in reinforced concrete design and supervision. Desires position with consulting engineering firm or general contractor. Prefer Eastern Townships and Quebec areas. Available on short notice. Complete resume upon request. File No. 520-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. Age 55, single. 28 years experience, includes 12 years structural design and supervision of commercial and industrial buildings (reinforced concrete, steel & wood); 8 years bridge design and supervision experience (steel & reinforced concrete); 8 years railway and highway design, layout, supervision, maintenance, estimate and administrative work. Will consider any location. File No. 525-C.

CIVIL AND HYDRAULIC ENGINEER — M.E.I.C., A.M.A.S.C.E. Experience includes detailed hydraulic design, engineering hydrology, feasibility and water resources studies for hydro-electric developments in Eastern Canada (8 years); previously in the irrigation and flood control fields in India (2 years). Canadian citizen with Master's in Hydraulic Engineering. B.Sc. (Civil Eng.) and B.A. (Honours in maths) degrees. Seeks career position with consultants in Western Canada, U.S.A. or international engineering organizations working in underdeveloped countries. Interests include company finance, travel and literary writing. Married, 3 children. File No. 496-C.

ELECTRICAL ENGINEER — Transmission and Distribution Department Head. 17 years diversified utility company experience, desires change to management of small company or municipal utility commission or district or divisional manager of larger operation. Anywhere on two months notice. File No. 523-E.

MECHANICAL DEVELOPMENT ENGINEER — M.E.I.C., P.Eng., B.Eng., M.Sc. Mechanical. Age 28, married. Presently in responsible supervisory position. 4 years outstanding industrial experience on diversified projects and manufacturing methods. Specific experience in thermoplastics and man-made fibres. Several publications. Excellent education and training. Desires relocation to a parallel position anywhere. Resume on request. File No. 293-M.

PROFESSIONAL ENGINEER — M.E.I.C., P.Eng. (Ont.), B.Sc. (E.E.) 1950. Age 42. 13 years experience in municipal and utility engineering. Seeks responsible position in engineering and administration where a challenge exists with advancement as a reward. Would consider industry or public service. File No. 524-E.

PROFESSIONAL ENGINEER — P.Eng. (Ont.) B.Eng. (Elect) N.S.T.C. 1959. Age 30. 4 years diversified experience in industrial and commercial design. Seeks responsible position in electrical engineering in design of power distribution, supervision, production in industry, or consulting field. Montreal area. File No. 522-E.

SITUATIONS VACANT

CIVIL

The CITY OF MELVILLE, Saskatchewan, requires the services of a qualified City Engineer. The applicant should have a Bachelor's Degree from a recognized College of Engineering and be a member of the Professional Association in the Province in which he resides; he should also have experience in Municipal Engineering. The successful applicant should have a good knowledge of construction and maintenance of streets, sidewalks, parks, buildings, etc., the supervision of public works, water works and sanitation departments and the necessary drawing of blue prints and surveying for local improvements. Group Medical Insurance and Pension Plan available to all City employees. All applications should be in the hands of the undersigned by August 5th, 1963, giving age, marital status, experience and salary expected.—Durward Carlton, City Clerk, City of Melville, Melville, Saskatchewan. File No. 455-V.

ELECTRICAL

ELECTRICAL ENGINEER. Recent graduate (or up to two to three years experience), who is interested in a career in Latin America, is required for a Canadian Electric and Power Company located in Bolivia. Duties would involve operation, maintenance and construction of distribution, transmission and hydro-electric production facilities. There are good opportunities for eventual advancement to senior administrative level. Reply to File No. 376-V.

ELECTRICAL ENGINEER — required for Electrical Engineering Department of a public utility company in Alberta. Duties to cover planning and design of electrical distribution systems, economic studies and advising operating staff on technical problems. Recent graduate will be trained. Written application should include resume of qualifications, experience, personal history and salary expected. File No. 447-V.

ELECTRICAL ENGINEER wanted for Research Project. Position of particular interest to a young engineer desiring to join a new and rapidly expanding organization, where working conditions and job opportunities are good. Some experience in transformer design is desirable. Salary commensurate with experience. Personal data to File No. 448-V.

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MECHANICAL

MECHANICAL ENGINEER — with 3 to 5 years experience on design of plumbing, heating and air conditioning. Preferably a younger person who would eventually become a partner. General Consulting firm — Ottawa. Reply in confidence to File No. 424-V.

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MECHANICAL

SENIOR DESIGN ENGINEER — Mechanical engineer required by an engineering firm in Montreal. A minimum of 10 years experience in design and modification with particular emphasis on pressure vessels, feed heating plants, pumps, filters and a variety of load bearing fabrications. Excellent opportunity for advancement. Please reply in confidence to File No. 456-V.

PROJECT ENGINEERS — Mechanical engineers required by a Montreal engineering organization engaged in development and investigational projects. The nature of the projects are extremely diversified and cover all aspects of machinery, components, accessory and associated system development. Industrial experience in design or testing would be most desirable. Please reply in confidence to File No. 458-V.

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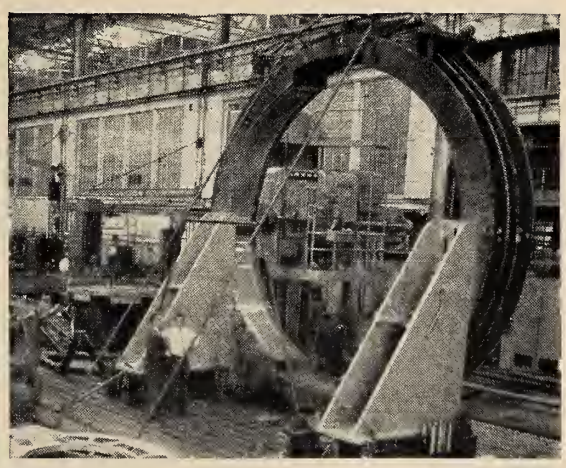

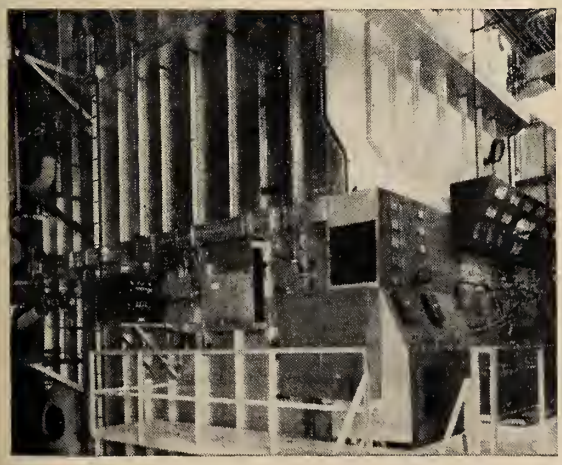

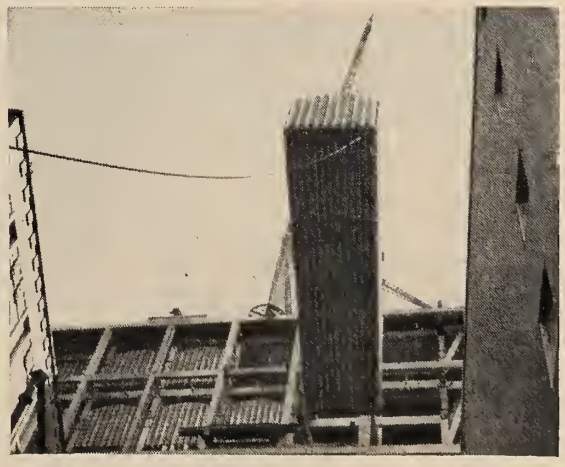

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BASIC OSCILLATIONS, Irving M. Gottlieb, Rider, New York, $4.50.

WORKED EXAMPLES IN THE THEORY OF STRUCTURES, Volume I, Volume II, N. P. Roberts and P. G. Ridley, MacDonald, London, Vol. I, 35s; Vol. II, 40s.

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BASIC PROBLEMS IN ENGINEERING DRAWING, Volume I, John T. Dygdon, Robert O. Loving and Joseph E. Halicki, Holt, Rinehart & Winston, $3.75.

THE WORLD ALMANAC, 1963, Edited by Harry Hansen, New York World-Telegram, $1.65.

ANNUAL REPORT FOR 1961 OF THE EUROPEAN FEDERATION OF CHEMICAL ENGINEERING & ITS MEMBER SOCIETIES, Frankfurt, 1962, DM 25.

CSA STANDARD, C22.2 No. 24, 1963, TEMPERATURE-INDICATING AND REGULATING EQUIPMENT Canadian Standards Assoc., Ottawa, $2.50.

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METALLURGICAL ABSTRACTS ON LIGHT METALS AND ALLOYS 1956-60, Vol. I The Light Metal Educational Foundation, Incorporated, Osaka, Japan.

REPORT OF THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES, December 31, 1961 Queen's Printer, Halifax, N.S.

THEORY OF FLOW AND FRACTURE OF SOLIDS A. Nadai, McGraw-Hill Company, Toronto, $14.50.

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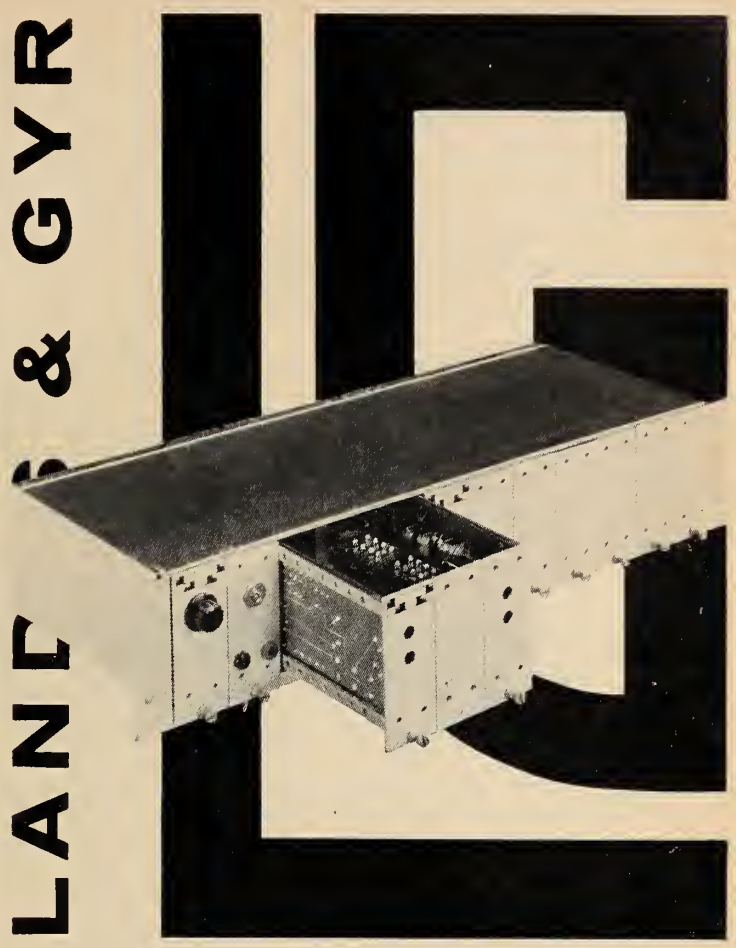

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Discussion

(Continued from page 36)

THE DANGER OF SPECIALIZATION

George Ford, M.E.I.C.
Head, Department of Mechanical Engineering
University of Alberta
The Engineering Journal, July, 1963 page

Discussion by R. E. Chant, M.E.I.C.

In the last 10 to 15 years engineering education in the United States has, in turn, emphasized the humanities, the sciences and the teaching of design. At present their main concern is over the decline of the popularity of the engineer and the apparent decline of the role he is playing in modern developments. The emphasis has been so severe that in many cases the changes have been in the form of revolutions.

Prof. Ford reviewed the arguments for increasing the science content of our curricula, mentioned the importance of engineering design and has pointed out that industry must take on a portion of the training, but he has not provided any of the details at to how. This omission is disappointing for I believe the Engineering Departments at the University of Alberta have given considerable thought to the problem during the last year.

The value of increasing the science content or the content of the engineering fundamentals in engineering curricula is the most evident method of avoiding obsolescence. Proceeding from this point of agreement with Prof. Ford, I wish to discuss the possibility of urging the high schools to make a greater contribution in the science field, to emphasize the importance of design, to comment on industrial training and to remark on the development of the art of communication.

Accepting that an increase of the content of the engineering fundamentals is mandatory, is not without its dangers. It exposes the educator to the overcrowded curricula to which many have succumbed at the expense of education. Not only are the students too involved in their regular courses to seek out other academic pursuits but lecturers are forced to use training and drilling methods rather than guided discovery methods.

In engineering education there is some type of an exponential relationship between the prerequisites and the introduction of fundamental subjects into the courses. At the present time one restriction is the mathematics upon which the effective teaching of so many other courses depend, yet we are often unable to complete this mathematical training until the penultimate year. It is unfortunate that there is no direct method in the accepted pattern of Canadian education to extend adequate teaching of the mathematics and other basic sciences back into the high schools, but there are ways and means of improving the situation. Funds have been found for summer institutes for university teachers, industrial firms are sponsoring methods of acquainting high school teachers with the application of science to industry and there are a variety of civic bodies trying to keep the youth of Canada busy. Why not support the starving science clubs, start summer seminars on engineering and science and thus acquaint the youth with the importance of technology to the future development of Canada?

Prof. Ford does not define what he means by the term "engineering design", indeed it cannot be defined in a few brief sentences, but in its broadest sense it is the analysis of a need and the resources available to fulfill the need followed by the synthesis of the resources to give the optimal solution. It requires an open mind capable of imaginative and creative thinking backed by good judgment. The problem of how to teach engineering design effectively is far more involved than the teaching of fundamental subjects, and I think we as engineering educators have not been making use of our design ability to arrive at an optimal solution.

The proponents of engineering design would have an engineering curriculum consisting of a basic core of design subjects filled in with sciences. This approach cannot be rationally supported but a course must contain sufficient design content to recognize and foster design talents, then if they can be released to a thinking creative environment in industry a very worthwhile task will have been performed. May I then support the plea for additional "professional training" by industry and suggest that this training should be planned to keep the young graduate thinking.

In concluding may I remark on one important omission in our discussions on engineering education and this is the development of methods of logical thinking. It can be argued that any science or engineering course is an exercise in logic, but logic based on the manipulation of a very special language, that is specialization. To avoid this form of specialization there is a need for the inclusion of subjects that will improve our ability to communicate, improve our ability at developing logical arguments, both written and oral, and improve our English for a start.

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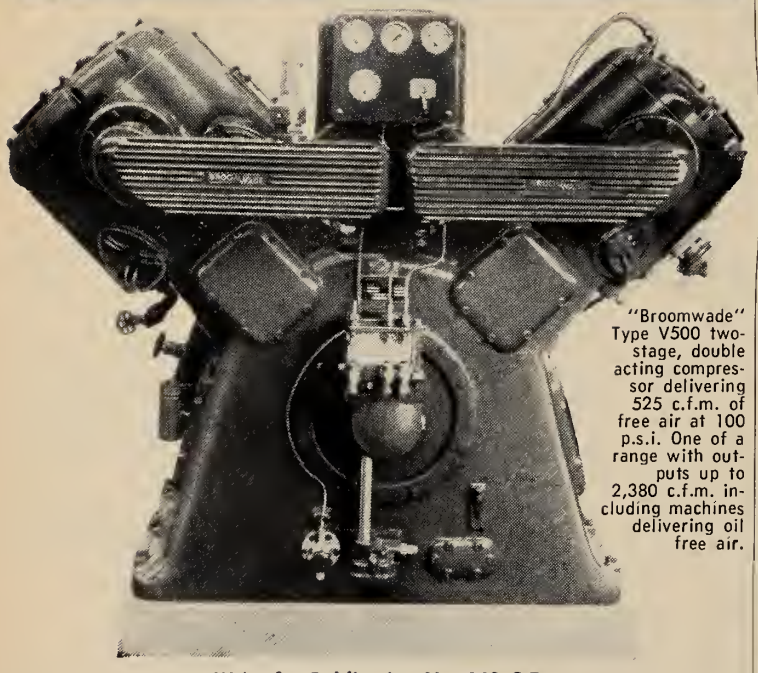

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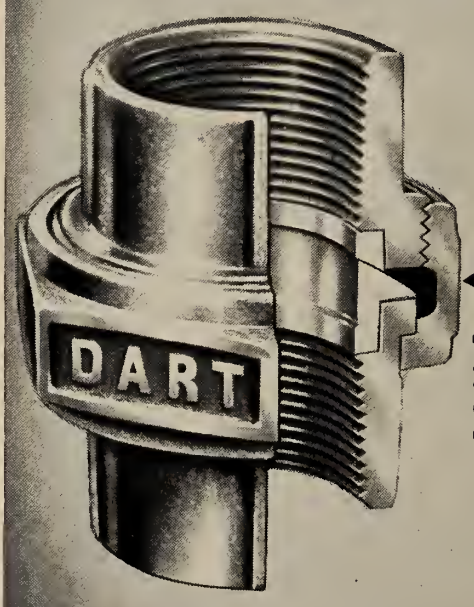

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Discussion by

J. B. Mantle, M.E.I.C.

Head, Department of Mechanical Engineering, University of Saskatchewan.

I want to compliment Dr. Ford for putting on paper his thoughts about the dangers of specialization in engineering education. Many of his ideas I agree with and heartily applaud. However, some of his points I am not so sure of and I will comment about these.

An inference that the reader may gain from the paper is that one way to avoid specialization is to bring old post-graduate level courses into the undergraduate curriculum. My own thoughts about producing a less specialized graduate is to allow more time for thorough digestion of fundamentals. In respect to the Mechanical curriculum, in particular, this would mean putting a greater proportion of the course time on such things as "basic mathematics", "engineering application of mathematics", "fundamentals of fluid flow", "materials science", "mechanics of solids" and so on. Except possibly for the basic mathematics these have not normally been considered to be postgraduate classes. I think it would be a mistake to attempt to bring such post-graduate classes as "the theory of elasticity" or "theory of plates and shells" into an undergraduate program. I notice that Dr. Ford's list of topics does not include such subjects but early in the paper he does suggest that graduate level classes are being brought in.

I think, too, that we can go so far overboard with theoretical classes in an undergraduate program that industry and the engineering profession will not be interested in our graduate. Things could get to the stage where all that our man is good for is going on for post-graduate work. Let me cite the case of a large electrical company in this country that is finding the electrical graduates of some Universities so theoretical that they are more interested in hiring mechanicals than electricals for the engineering jobs that they have to do. I would also point out that if we go too far in "theorizing" our students they will have difficulty in becoming registered as Professional Engineers. Now I do think that the professional associations have got to be prepared to recognize the "engineering scientist" but they do have reason on their side if the country is going to be flooded with them.

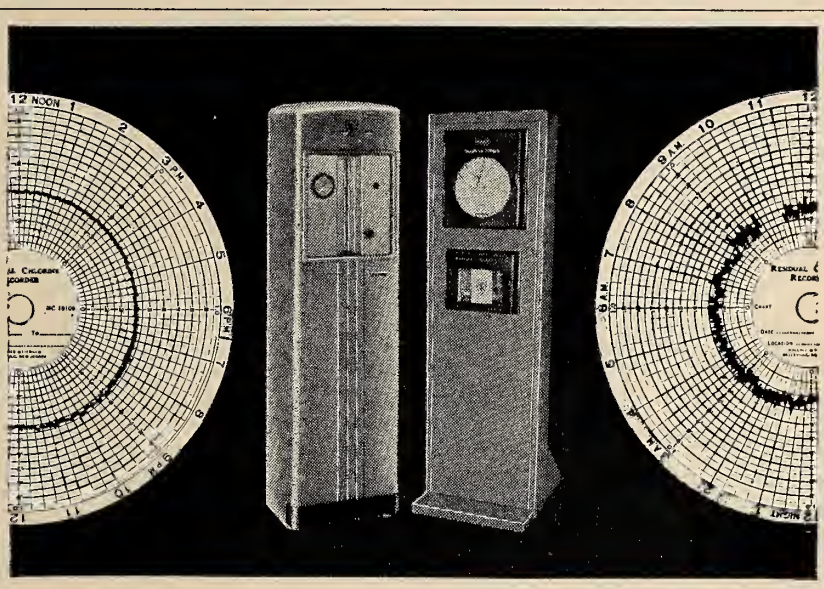
At the University of Saskatchewan we are using the two stream idea and, while there are many disadvantages, I am convinced that we are turning out two very useful types of engineer. The regular courses have been "fundamentalized" to a fair extent but we have not gone as far in this as I believe have most Canadian universities and the product is liked by industry. Our high level stream "the engineer-scientist", I venture to say, has more fundamental science training than most Canadian engineering courses. This man appears to be very much in demand for advanced design and research work but I doubt if Canada could make good use of very many men of this type.

In closing, I want to urge that in redesigning our undergraduate curricula we do not overdo it to the extent that we produce men who are not useful to Canadian industry nor acceptable to the profession.

Author's Reply

I can only reply to some of the questions raised by Prof. Chant. In upgrading our curriculum in Mechanical Engineering at Alberta we replaced many of the routine professional courses with science oriented engineering courses. For instance Shop was dropped entirely and emphasis placed on Metallurgy; Heat Transfer was included at the expense of Heating, Ventilating and Air Conditioning; and Machine Design was modified to include Continuum Mechanics and its application to design. I agree with Prof. Chant that a definition of "engineering design" is difficult and perhaps that is why I avoided the issue in the paper. The most important comment made by Prof. Chant was his reference to the development of methods of logical thinking. Computer programming, which is now included in almost all engineering curricula, is an excellent exercise in logical thinking. This, together with design oriented problems, will give the student some training in logical thinking.

In reply to Prof. Mantle may I say that I did not intend to suggest that old post-graduate level courses be brought into the undergraduate curriculum. Far from it, I was suggesting that the treatment of such courses as Engineering Mechanics be upgraded using methods which a few years ago were only treated at the graduate level. Courses covering the Theory of Elasticity, and Plates and shells, should be left for the graduate program. I have to disagree with Prof. Mantle's suggestion that in upgrading the curriculum we could produce a graduate of little use to Canadian industry and who might not be acceptable to the Profession. My contention is that the upgrading of our curriculum will produce graduates who are more qualified to be engineers and are less likely to be relegated to the position of a high class technician. In this way our future graduates will be more useful to industry and will be very acceptable to the profession.



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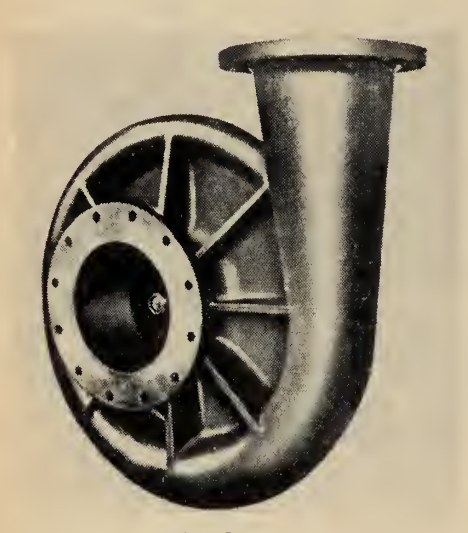
Engineering Briefs

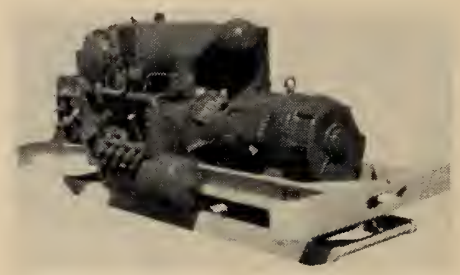
A SERIES OF CANADIAN-MADE miniature and sub-miniature RF inductors and chokes are available from Essex Electronics of Canada Ltd., Trenton, Ont. The Wee-Ductor line of subminiature inductors are available in 76 values from 0.1 microhenrys to 180,000 microhenrys. They are epoxy-encapsulated and incorporate shielding for minimum coupling in modern closely-packed circuitry. Wee-Ductors meet all the requirements of MIL-C-15305B, Grade 1. They measure 0.375 in. long by 0.157 in. diameter. The weight is 0.5 grams. The RF chokes are similarly designed for reliability in a minimum of space. With inductances ranging from 0.1 microhenrys to 10,000 microhenrys, Essex RF chokes are available in three sizes, ranging from .90 in. long by .31 in. diameter to 0.44 in. long by 0.88 in. diameter.



Joy Model G Compressor.

AVAILABLE FROM JOY MANUFACTURING COMPANY (CANADA) LIMITED, the Joy Model "G" single stage centrifugal compressor is designed for modern sewage treatment. A new bulletin containing installation photographs and charts is available from the company at Box 120, Galt, Ont.

A UNIQUE CENTRALIZED PUSH-BUTTON CONTROL SYSTEM, designed by the C. D. Howe Company and being manufactured by Mackey Automation and Controls Limited, is nearing completion for the National Harbours Board's Montreal Elevator Four. Designed for all grain handling equipment in the elevator, the control panel has on its front side, a colored flow diagram incorporating over 2,000 push-buttons and 8,000 pilot lights. The complexity of the panel itself is apparent from the fact that over 40,000 connections are required in the system.



Atlas Copco's Twin-Air Compressor.

ATLAS COPCO CANADA LTD. has announced the availability of a skid-mounted rotary screw compressor. The "Twin-Air" compressors, available in two sizes delivering 365 cfm and 620 cfm at 100 psi, are powered by direct-coupled electric motors, the PR365E-SK and PR620E-SK. The two-stage rotary screw principle provides a surge-free air supply. There is no metal-to-metal contact between rotors and housing thereby eliminating overhauls and reducing maintenance costs to a minimum. The machines offer continuous, heavy-duty services in all climates.

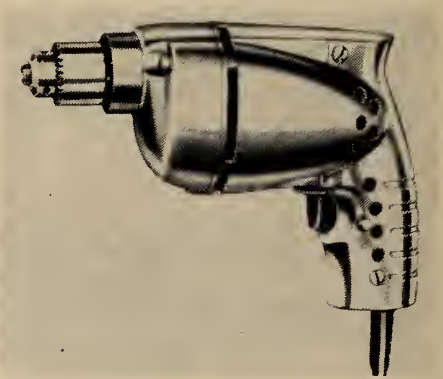
A BATTERY ACTUATED Cannon circular chart drive that will operate from four to six months on one standard D-size battery has been introduced by Canadian Meter Company Limited, Milton, Ont. The Model 301, specifically designed for installation in remote areas, features self-starting mechanism and dust-proof construction. Standard mounting dimensions permit interchangeability with conventional chart drives.

THE STEEL COMPANY OF CANADA LIMITED is now a producer of square, rectangular and round continuous-welded hot formed hollow structural steel tubing. Stelco tubing is particularly efficient in torsion and compression because the materials in the sections is ideally distributed for loads of this type. It is currently offered at one strength level with mechanical properties similar to A.S.T.M. A-36, and is well suited for welded applications. This tubing is manufactured on a mill which continuously welds and forms hot strip into a variety of round, square and rectangular sections, with a surface finish equivalent to other hot rolled structural shapes.

Developments

Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.

TONE-CRAFT Paint and Varnish Co. Ltd., Toronto, has announced the availability of Corroless, a new development in priming systems which provides rust protection and stabilization for iron and steel surfaces. Corroless, by finding ferric oxides of unstable character in the rust and causing them to become a new, inert film having a natural bond with the iron or steel, provides a continual protection against rust. Corroless dries rapidly; is harmless in that it contains no lead; withstands tropical conditions; possesses a high degree of resistance to water, seawater, crude oil; will not lose its rust-stabilizing qualities even at high temperatures; has adhesive power which further develops with aging, and is augmented by an increasing resistance against solvents.



Ingersoll-Rand's Electric Drill.

CANADIAN INGERSOLL-RAND CO. LIMITED has announced the availability of a new series of electric drills for automotive, industrial and construction use. The series consists of 20 drills produced in ¼-inch, ⅜-inch, ½-inch, ⅝-inch, ¾-inch and 1-inch sizes, having universal AC-DC 25/60 cycle motors and available in 115 or 230 volt models.

SEVEN MODELS of a utility heavy-duty buffer, one of the Reuland line of metalworking equipment, is available from Matthew Moody Division, Canadian Bowl-Mor Company Ltd., Montreal. The buffer features a totally-enclosed dust-proof motor with extra large ball bearings, endbells particularly designed for buffer and polishing service, instant starting and overload capacity. The height of the pedestal-type buffer from the floor to the center of the shaft is 37½ inches. The seven models range from 1HP to 3HP with speeds of 1,800 and 3,600 rpm. They are available in single phase 110/220 volt, to three phase 208, 380, 220/440 or 550 volt motors, all CSA approved.

(Continued on page 62)

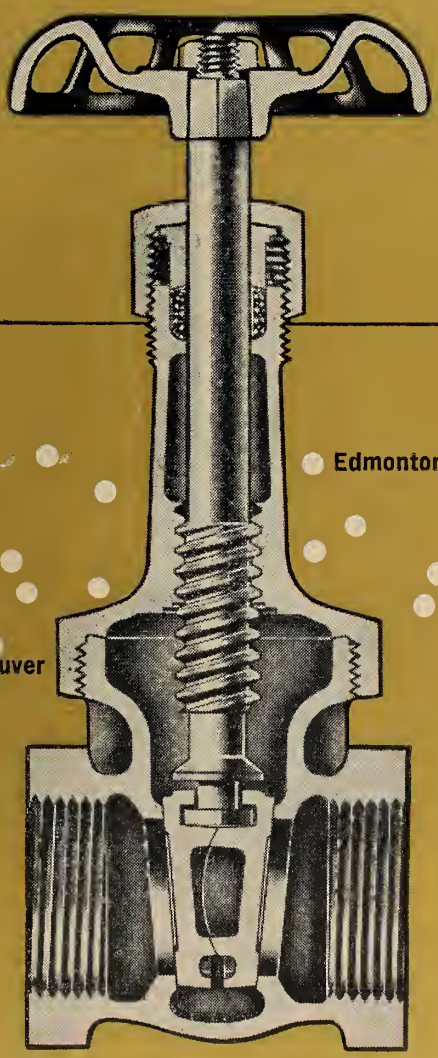
Efficiency Experts

Jenkins Bronze Gate and Swing Check Valves Teamed for Extra Service and Economy

In industrial plants from coast to coast, these 125 lb. Jenkins Bronze Gate and Check Valves provide the solid combination that makes for efficient, economical control of liquids and gases. Their special features, and the skilled craftsmanship which created them, assure the high performance and low-cost operation that modern industry demands. Jenkins Bros. Limited, Lachine, Que.

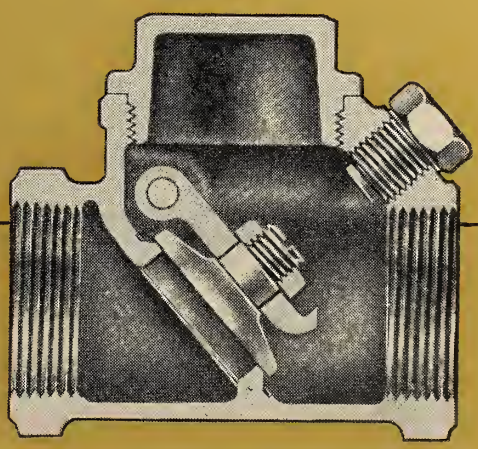
BRONZE GATE
FIG. 470

1 TRAVELLING SPINDLE has full thread engagement with the bonnet to reduce wear and assure long, trouble-free service.
2 DEEP STUFFING BOX holds more packing to prevent leaks, and assure friction-free spindle operation.
3 EXCEPTIONALLY HUSKY ONE-PIECE BONNET is of high tensile bronze. Can be removed easily and repeatedly without distortion.
4 DOUBLE DISC is the ball and socket bearing type. Ready adjustment to seats insures tightness without excessive closing effort.



BRONZE CHECK
FIG. 92

1 SEAT and DISC. Special feature permits easy regrinding without removing valve from line.
2 DISC and HANGER assembly accurately positioned in valve body by two removable side plugs. This provides exact seating of disc to body seat.
3 SEAT, DISC and HANGER—at 40° from vertical—effect tight closure at minimum pressure.
4 LIBERALLY PROPORTIONED BODY of high tensile bronze is extra strong.



JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
TRADE JENKINS MARK
Jenkins Bros

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

NO JOB IS TOO OFFBEAT FOR HORTON!

By summer, an offbeat, offshore lighthouse will climb high out of the St. Lawrence River at the mouth of the Saguenay. A lighthouse sunk in 38 feet of water!

Horton fabricated the steel-plate sections of this lighthouse crib to the most exacting specifications. Working with the general contractor Louis

Donolo Inc., and to a rigid Department of Transport time schedule, Horton completed the construction of the crib steelwork right on time.

Here is 475 tons of proof — no steel plate fabrication job is too tough — or unconventional — for Horton engineers to handle. If you have a steel plate problem — bring it to Horton!

631

HORTON SHAPES NEW HORIZONS

HORTON STEEL

WORKS, LIMITED

25 ADELAIDE STREET WEST, TORONTO, ONTARIO

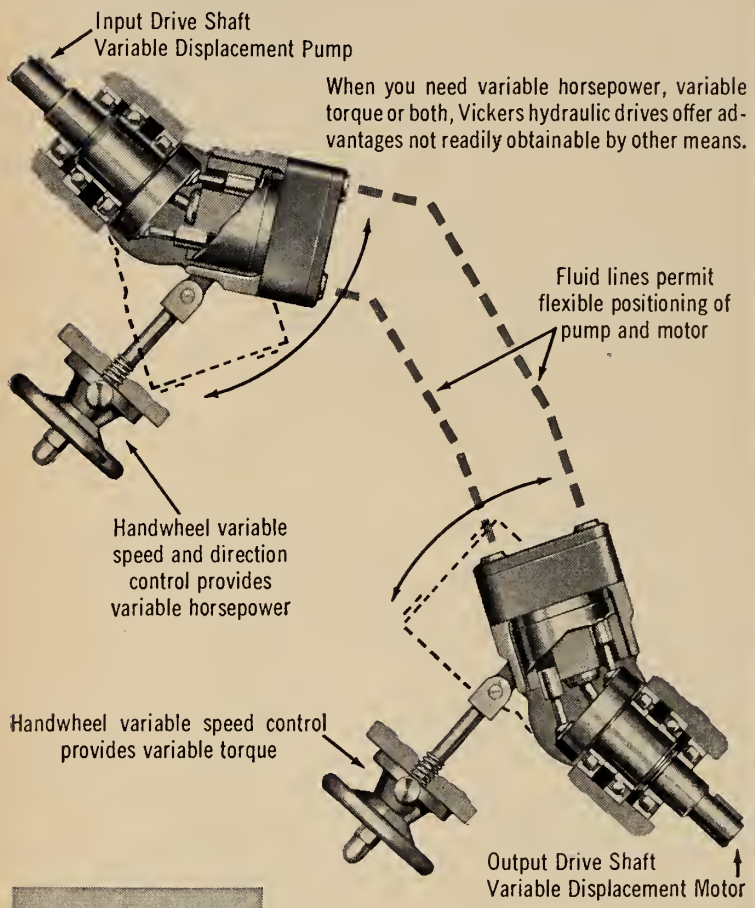
Plants and Offices throughout Canada

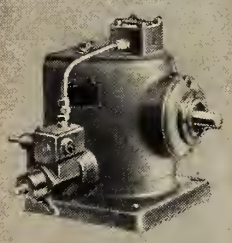
50 YEARS HELPING TO DEVELOP CANADA

WITH TANKS AND STEEL PLATE WORK FOR ANY INDUSTRIAL ASPECT... IN CARBON STEEL, SPECIAL METALS OR COMPOSITES

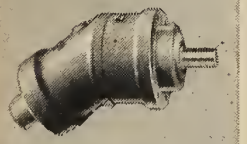
The power transmission characteristics that *your* job requires are available with . . .

VICKERS® HYDRAULIC TRANSMISSIONS





Variable displacement piston type pump or motor



Fixed displacement piston type motor for constant torque variable speed applications

- INFINITELY VARIABLE SPEED
- HIGH HORSEPOWER TO WEIGHT RATIO CHARACTERISTICS
- FULL TORQUE LOADS STARTING FROM ZERO RPM
- SMOOTH, STEPLESS ACCELERATION AND DECELERATION
- INSTANTANEOUS SPEED CHANGE
- QUICK REVERSING
- WIDE SELECTION OF SPEED AND POWER CHARACTERISTICS
- MANUAL OR AUTOMATIC CONTROL OF DIRECTION, SPEED AND TORQUE
- COMPLETELY ENCLOSED AND SELF LUBRICATED
- SUITABLE FOR USE IN EXPLOSIVE ENVIRONMENTS
- ALL COMPONENTS TIME PROVEN BY YEARS OF OPERATING EXPERIENCE

There are many more advantages. Write for Catalog 5001 for complete information.

1618

VICKERS-SPERRY of Canada Ltd.
Division of Vickers Incorporated
SPERRY RAND CORPORATION
TORONTO 18—92 Advance Rd.
VANCOUVER 9—1637 W. 5th Ave. • MONTREAL 16—750 Lucerne Rd.
VICKERS OFFERS WORLD-WIDE FACILITIES—SALES AND SERVICE

Engineering Briefs

(Continued from page 58)

THE HEAVY OIL PREHEATER ADJUSTMENT TESTER, for determining the best preheat temperature for No. 6 or "Bunker C" fuel oils is available from Testing Machines International of Canada Ltd., Montreal. This tester gives the best atomization and determines the specific viscosity of the fuel oil by a calibrated plunger and piston which sinks through a test sample contained in a small cylinder. The speed and distance by which the plunger sinks is inversely proportioned to the actual viscosity. The device is equipped with a timer constructed of a sealed "reference" tube containing a quantity of calibrated oil and a steel ball. On the side of the stem of the plunger is engraved the temperature scale for the four different types of atomizers. It is only necessary for the boiler operator to note the correct preheat temperature on the stem and correctly set his preheater for maximum efficiency and minimum smoke production.

CANADA FOUNDRIES & FORGINGS, Limited's James Smart plant has announced the availability of the new Smart's Chinook Series DD Oil-fired forced air furnaces. These furnaces, offered in five models, in all the popular ratings, feature compact and rigid casing size which makes the furnace easy to get into a basement. The furnace creates draft which overcomes poor chimney conditions. The output is 82,000 to 135,000 BTU.

(Continued on page 75)

"CINCH" ANCHORS

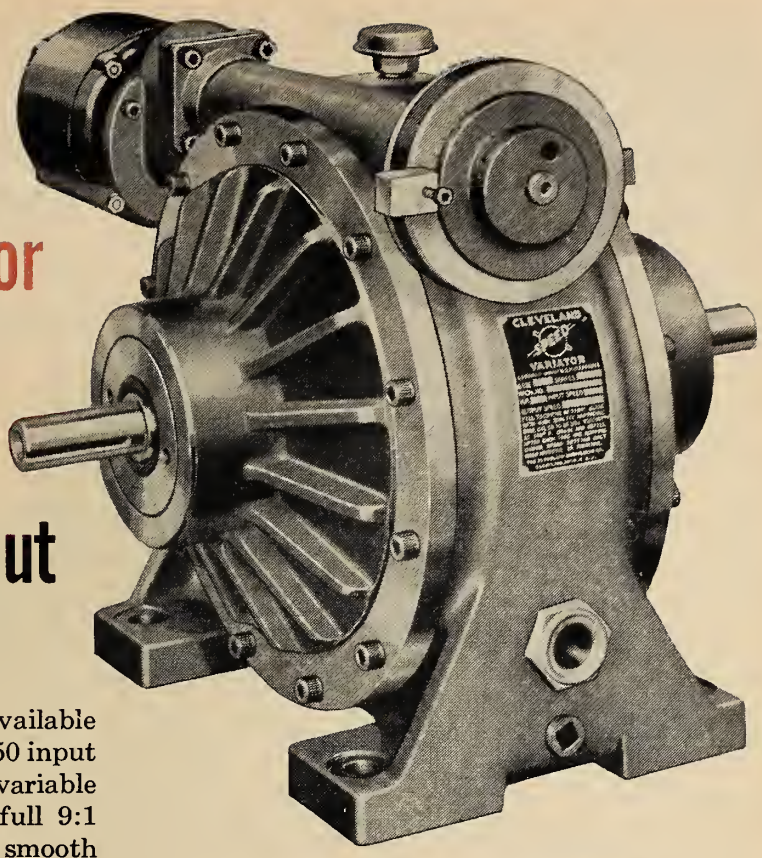
"STRONGER THAN THE BOLT"

The completely reliable expansion Anchor manufactured solely in Canada. For Bolts 3/16" to 3" diameter. Data book and stress tables sent on request.

CANADIAN CINCH ANCHORING SYSTEMS LIMITED

2095 Madison Avenue, Montreal

Cleveland Speed Variator is the Best Answer to *Precision Control* of Variable Speed Output



Advanced-designed Cleveland Speed Variators—available in 18 models ranging from fractional to 16 hp at 1750 input RPM—accurately provides dependable, infinitely variable speed control. They give stepless speed over a full 9:1 range—from ⅓ to 3 times input speed. Instant smooth change of output speed can be adjusted by either manual, automatic or remote control. Precise adjustments are always made with accurate adherence to settings.

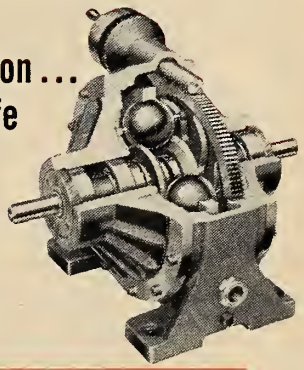
Thousands of Variators are in daily use on such varied industrial equipment as cigarette-making machines, textile machinery, metalworking machinery, pharmaceutical equipment, transfer tables, conveyors and experimental and testing equipment of many types.

Check these major Variator advantages:

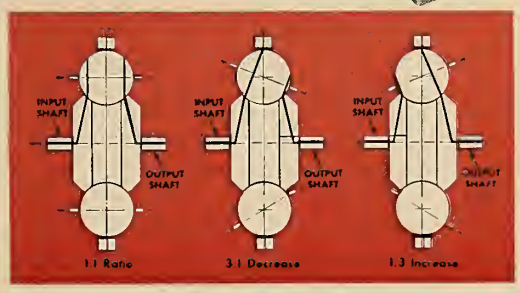
- An extremely compact unit with input and output shafts in line and rotating in the same direction
- Almost any input speed up to 1800 RPM can be used —either clockwise or counterclockwise rotation
- Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant output torque over a 6:1 range
- Speeds infinitely variable over entire range of adjustment
- No slippage—positive torque response mechanism adjusts in direct proportion to the loads encountered
- Long life and minimum maintenance due to absence of belts or complicated linkages
- Ample bearing support for overhung pulleys on both input and output shafts

Write today for free Bulletin K-200 containing detailed description, photographs, sectional drawings, rating tables and specifications.

Simple in Operation... Built for Long Life



The Variator is an extremely compact unit with input and output shafts in line, rotating in the same direction. It incorporates ample bearing support to carry overhung pulleys.



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with the drive discs. Relative shaft speeds are adjusted by changing position of axles on which the balls rotate.

PEACOCK BROTHERS LIMITED

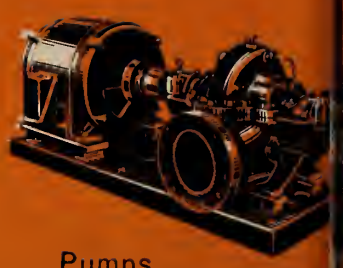
P. O. Box 1040 • Montreal 3, Quebec

Offices from coast to coast

CLEVELAND SPEED VARIATOR

CA-C ENGINEERING IS ON THE MOVE

Motors



Pumps

Texrope Drives

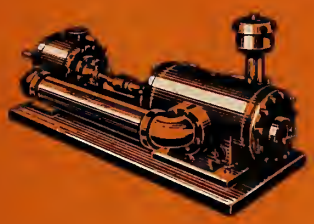
Centrifugal blow

Hydraulic Turbines

Condensers

High voltage con

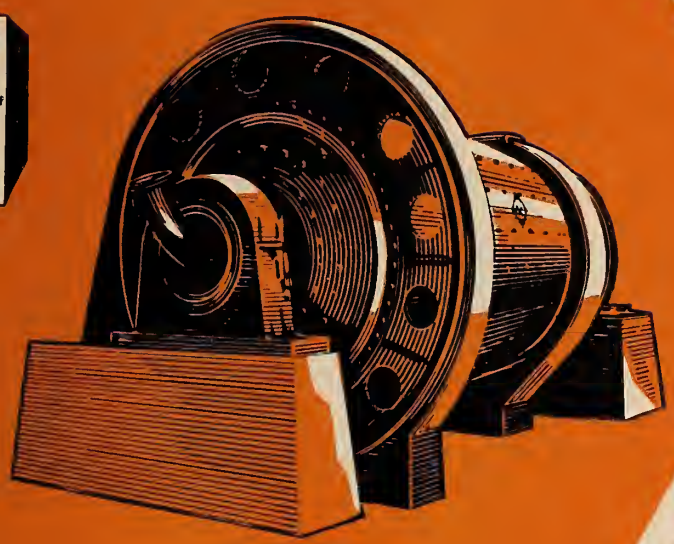
Low voltage control



Crushers

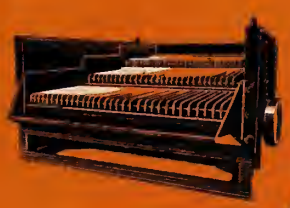
Rotary compressors

witchgear



lves

Grinding Mills



Screens

Rotary Kilns

MADE IN CANADA

...have you checked us lately?

There are new products, new functional designs, new refinements on proven ideas in Canadian Allis-Chalmers products these days. CA-C engineering is on the move . . . making good products better. Check the unusual diversity of the Allis-Chalmers line, as illustrated, then get our *latest* product facts before you specify.

62CI

CANADIAN
ALLIS-CHALMERS

SPUN ROCK

BLANKETS
and
PIPE INSULATION
for Canadian industry

Has all the features expected of a good thermal insulation, plus these

IMPORTANT EXTRAS:

- **Long, resilient, stable fibres; no binder**
- **Non-corrosive to any metal**
- **Withstands continued vibration**
- **Maximum thermal efficiency at temperatures as high as 1200° F.**
- **Made from rock, by electric furnace process.**
- **Conforms to Commercial Standards CS-117-49**

Technical infarmatian and samples available.

SPUN ROCK WOOLS LIMITED

SPUN ROCK WOOL · HEAT COLD SOUND · INSULATION

Thorold Ontario

0001

COMING EVENTS

American Society of Civil Engineers. 12th Hydraulics Division Conference. University Park, Pa. Aug. 7-9.

American Society of Mechanical Engineers, American Institute of Chemical Engineers. Sixth Heat Transfer Conference and Exhibit. Boston, Mass. Aug. 11-14.

American Institute of Aeronautics and Astronautics. Guidance and Navigation Conference. Cambridge, Mass. Aug. 12-14.

Fifth Biennial Gas Dynamics Symposium, Physico-Chemical Diagnostics of Plasmas. Northwestern University, Evanston, Ill. Aug. 14-16.

Ninth Cryogenic Engincering Conference. Boulder, Colo. Aug. 19-21.

Institute of Electrical and Electronics Engineers, Inc. Western Electronic Show and Convention. San Francisco. Aug. 20-23.

The Institution of Mechanical Engineers, The American Society for Testing and Materials, The American Society of Mechanical Engincers. Joints International Conference on Creep. New York. Aug. 25-29.

University of Melbourne. Tewksbury Symposium on Fracture. C. J. Osborn, Organizing Secretary, Tewksbury Symposium on Fracture, University of Melbourne, Parkville, N.2, Victoria. Aug. 26-30.

International Federation of Automatic Control (IFAC). Second International Congress on Automatic Control. Basle, Switzerland. Aug. 27-Sept. 4.

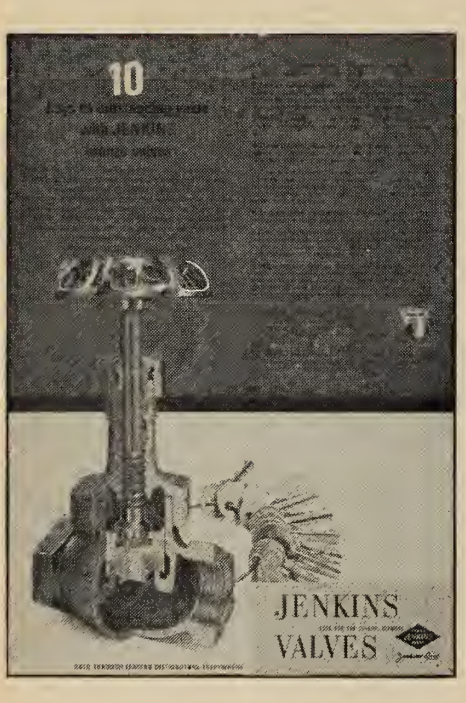
The Chemical Institute of Canada. Sixth Western Regional Conference. Trail, B.C. Sept. 12-14.

The Institution of Electrical Engineers. International Telemetering Conference. London, England. Allan P. Gruer, Sandia Corporation, 7530, P.O. Box 5800, Sandia Base, Albuquerque, New Mexico. Sept. 23-27.

American Welding Society. National Fall Meeting. Boston, Mass. Sept. 30-Oct. 3.

EIC

EIC CERTIFICATE OF ADVERTISING MERIT



An advertisement telling of "10 keys to outstanding value with JENKINS bronze valves" caught the attention of a decisive number of the Engineering Journal's advertisement jury in the April issue. The ad showed a cut-away bronze valve, beside which lay a key ring with 10 keys. Text occupied the upper half of the single-page advertisement. Set black on orange the text contained a short preamble and a concise listing of 10 advantages of Jenkins valves.

The advertising manager of Jenkins Bros. Limited is G. J. Palmer. The advertising agency is Stanfield, Johnson & Hill Ltd., B.A.C. Quill, account executive.

Each month a different panel of 50 Journal readers from aeross Canada is asked to nominate an award-winning ad from the viewpoints of ACCURACY — INFORMATION — ATTRACTION. Winners and their advertising agencies receive a framed Certificate of Advertising Merit.

MOVING?

Please Notify the Journal's Circulation Department

2050 Mansfield St., Montreal, P.Q.

AUTHORS WANTED

The 1964 meeting of the EIC will be held in Banff Alta., from May 27 to May 29. Present plans call for the presentation of some 35 papers during the technical sessions.

Engineers wishing to prepare a technical paper for presentation at the Banff meeting are invited to contact C. G. Kingsmill, Manager of Technical Services, The Engineering Institute of Canada, 2050 Mansfield Street, Montreal 2, Que. Mr. Kingsmill will be pleased to discuss any proposed papers, and can supply specific advice on the preparation of a manuscript.

A wide range of topics is expected. Papers probably will be grouped for presentation according to the divisions of the Institute's Committee on Technical Operations, as follows:

Bridge and Structural; Chemical; Civil; Communications; Electronics and Automation; Electrical; Engineering Education; Geotechnical; Hydro-Electric; Management; Mechanical; Mining and Metallurgical Oil and Natural Gas; Research; Thermal; Welding.

THERMAL POWER DIVISION FALL MEETING

Hovey Manor Sept. 24—25, 1963

A combind meeting with the Thermal Power Section of the Canadian Electrical Association will be held at the Hovey Manor, North Hatley, Quebec on Sept. 24 & 25, 1963.

Plant visits will be made to the Sherbrooke works of Combustion Engineering-Superheater Ltd., and the Tracy Generating Station of the Shawinigan Water & Power Company.

FOR FURTHER DETAILS CONTACT:

Mr. C. G. Kingsmill,
Manager of Technical Operations,
Engineering Institute of Canada,
2050 Mansfield Street, Montreal 2, Quebec

17th CANADIAN SOIL MECHANICS CONFERENCE
(Geotechnical Engineering Division Conference — EIC)
Ottawa — September 12, 1963

The Geotechnical Engineering Division of the Institute's Committee on Technical Operations is sponsoring the Annual Soil Mechanics Conference. This is being held this year as a one-day meeting at Carleton University, Ottawa. The theme will be "Safety Factors in Soil Engineering".

The Conference has been planned to follow immediately after the NRC-ASTM Symposium on Laboratory Shear Testing of Soils which is being held at the National Research Council in Ottawa, September 9 to 11.

Persons wishing to attend are requested to make their own hotel reservations.

Preprints of the papers will be supplied at the time of registration. Advance registration will be possible during the preceding ASTM Symposium schedule.

TENTATIVE PROGRAM

Morning Session

1. "Some Slope Failures in Heavily-Overconsolidated Clay" by J. D. Scott.
2. "An Introduction to the Use of Electronic Computers for Slip Circle Analysis of Slope" by J. Kilgour.
3. "Some Slope Failures caused by Groundwater" by V. Milligan.

Afternoon Session

4. "Safety Factor in Pavement Design" by G. Y. Sebastien.
5. "A Laboratory Study of Local Bearing Capacity Failure Criteria for Remolded Clay" by J. C. Osler and G. M. Peck.
6. "Earth Flows at the Beattie Mine" by W. Eden.

Lunch

Cafeteria—Carleton University

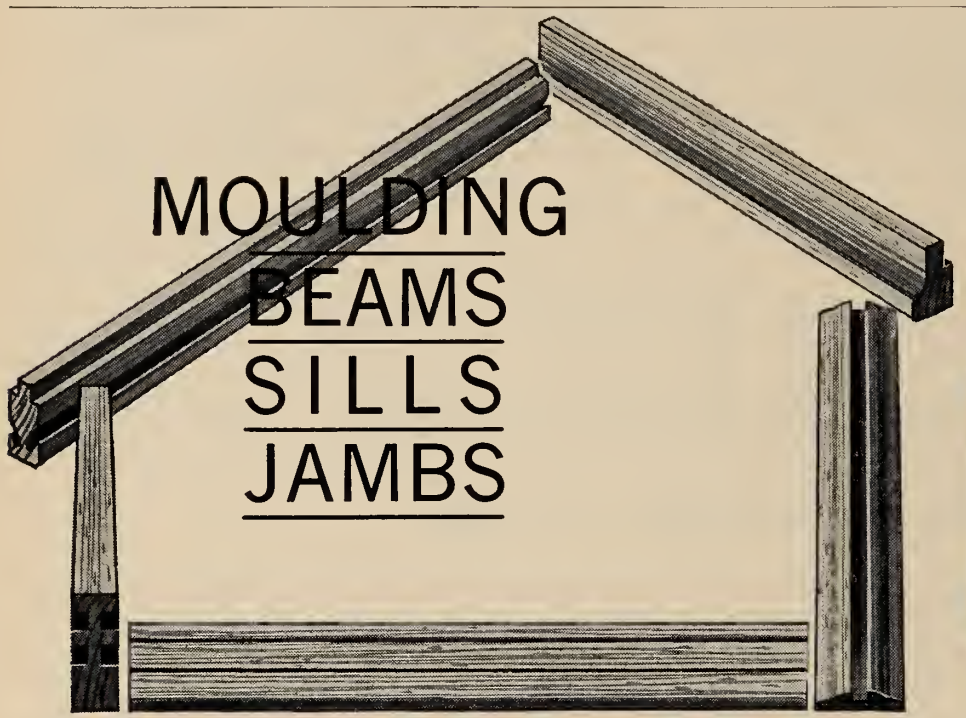
Personals

(Continued from page 46)

Dr. J. B. Mawdsley, M.E.I.C. (McGill '21), retiring Dean of the College of Engineering, University of Saskatchewan, will be granted the title of Dean Emeritus, and will continue as director of the Institute for Northern Studies. Dr. Mawdsley, appointed dean of engineering in July, 1961, had been prior to that, head of the Department of Geology at the University since 1929. In 1961 he was elected president of the Canadian Institute of Mining and Metallurgy. He is known as a brilliant educator and a distinguished engineer.

Donald D. McDonald has been appointed Earthmoving Representative of Caterpillar Americas Co. Mr. McDonald's territory includes the provinces of Saskatchewan, Manitoba and Ontario. Mr. McDonald, a civil engineering graduate from the University of Louisville, Ky., has spent the past three years in sales development departments at the company's headquarters in Peoria, Ill. He will now be involved in earthmoving analyses, contractor seminars and related activities.

Maurice Bourget, M.E.I.C. (Ecole Poly. '32), Liberal MP for Levis, Que. from 1940 to 1962, has been appointed to the Senate and named Speaker of the Upper Chamber.



MOULDING
BEAMS
SILLS
JAMBS

Accurately engineered to ensure perfection in building

Builders and architects will appreciate the care with which Canbar Wood Tank Company produce engineered wood products for the building trade. One of Canada's most modern woodworking plants, with over 80 years experience, is ready to go to work for you to process car-load and truck-load milling in transit, to your specifications.

Canbar Wood Tank Company can supply you with special shapes — round, rectangular, oval, half-round, elliptical or any shape to suit your requirements, including finger joint in up to 6-inch thick material. Our plant is best suited to handle quantity millwork.

Let our engineered wood product division assist you with your technical requirements.

NATIONAL WOOD TANK INSTITUTE

CANBAR WOOD TANK COMPANY
A DIVISION OF
CANADA BARRELS & KEGS LIMITED
WATERLOO, ONT. CANADA

R. E. Penfold

W. R. Rowbotham

Ronald E. Penfold has assumed responsibility for over-all direction of International Harvester's Engineering Department, Hamilton Works. He was recently appointed Chief Engineer. Mr. Penfold, a University of Toronto graduate, joined Harvester as a Design Engineer in 1946. He became Chief Product Engineer in 1953. **W. R. Rowbotham** has been appointed Chief Product Engineer with operational head responsibility for the company's spreader, windrower, hay equipment and combine design. Mr. Rowbotham, a Mechanical Engineering graduate from the University of Saskatchewan, joined the company as a Design Engineer in 1946, and became a Product Engineer in 1951.

H. R. Larkin

P. Demers

Pierre Demers was elected President of the Corporation of Professional Engineers of Quebec at their 44th Annual General Meeting held recently in Quebec City. **Paul-Emile Drouin,** hydraulics engineer at Hydro-Quebec, was elected Vice-President, and **Desmond Hallissey,** consulting engineer in Quebec City, Honorary Secretary-Treasuer.

Howard R. Larkin has been appointed to the Heating and Commercial Products Division of the S. A. Armstrong Limited, Toronto. Mr. Larkin has been a member of the industrial sales staff for more than six years. He will now direct heating and commercial sales operations throughout southern Ontario. He will be located in Toronto.

William A. Middleton has been appointed chief engineer of Arthur G. McKee & Company of Canada Ltd. Mr. Middleton, a mechanical engineering graduate from the University of Toronto, has had broad experience in engineering and administrative work. Mr. Middleton has held engineering positions with W. S. Atkins & Associates Ltd., Salem Brozius (Canada) Ltd., Massey Ferguson Limited and the John Inglis Company.

Personals

L. Olsson

S. R. Lindgren

Lars Olsson has been appointed president and Stig **R. Lindgren** has been appointed vice-president of SF Products Canada Ltd. Mr. Olsson joined the company in 1950. He has worked as project engineer in the company's Montreal office and was, at the time of his appointment, manager of the Vancouver office. Mr. Lindgren has been with SF since 1954 and until recently was project engineer at the Montreal office.

Robert Bailey has been appointed head of the traffic engineering department of Damas and Smith Limited, Toronto and Winnipeg based consulting engineers. Mr. Bailey, a Civil Engineering graduate from the University of Alberta, was Traffic Superintendent for the City of Calgary prior to accepting his new position.

R. E. Devine has been appointed engineering manager for the Canadian Westinghouse Distribution Apparatus Division, London, Ont. Mr. Devine joined Westinghouse in 1951 and has held supervisory engineering posts in instrument and distribution transformer departments.

Roland F. Charron has been elected to the Board of Directors of Rosco Metal Products Limited. Mr. Charron is Manager of the Montreal Branch of the company, Sales Manager for the Eastern Region, and is also a Director of Rosco Erectors Ltd.

R. F. Charron

R. E. Devine

Donald D. Kershaw has been appointed Coach Service Engineer at General Motors Diesel Limited, London, Ont. Mr. Kershaw joined the company in 1962. He had been employed since 1948 with the Toronto Transit Commission where he was Senior Technical Assistant in the Engineering Department.

G. Clayton Arthey, M.E.I.C. (Queen's '34) has been appointed General Manager of Canadian Helium Limited. This company, formed in 1962 to extract and market helium from British American Oil's Saskatchewan discoveries, is jointly owned by B-A, British Oxygen of London, and l'Air Liquide of Paris. Mr. Arthey, who has served 25 years with l'Air Liquide's subsidiary in this country, Canadian Liquid Air, has been manager of that company's Atlantic Region since 1945.

Delbert M. Bressett has been appointed superintendent of equipment of Canadian National Railways' Toronto Area. Mr. Bressett had been an engineer in the research and development branch for more than a year in Montreal.

Obituaries

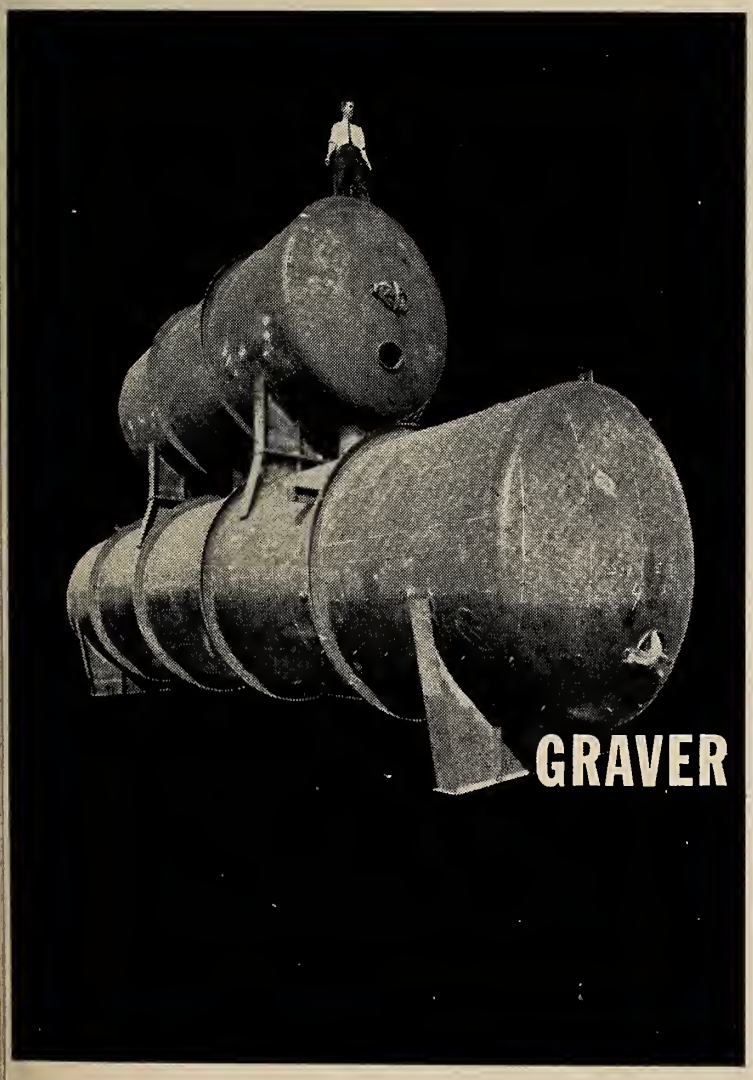
Bent, Edgar D., M.E.I.C. (Acadia '28)

Cutliffe, L. J., M.E.I.C. (N.S.T.C. '56)

McGaan, W. H., M.E.I.C.

Sharp, H. A., S.E.I.C.

Taylor, K. D., M.E.I.C. (Toronto '49)



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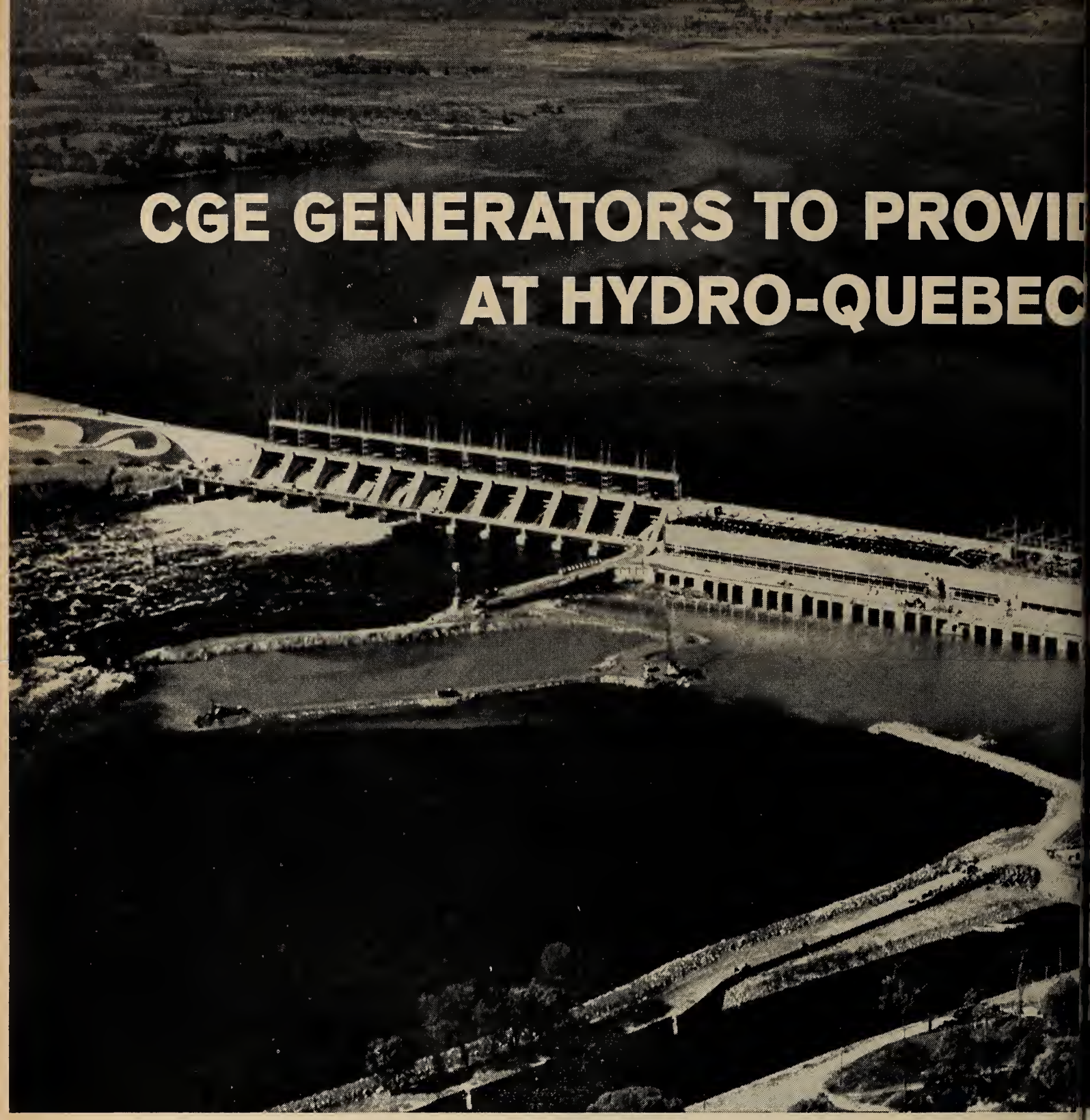

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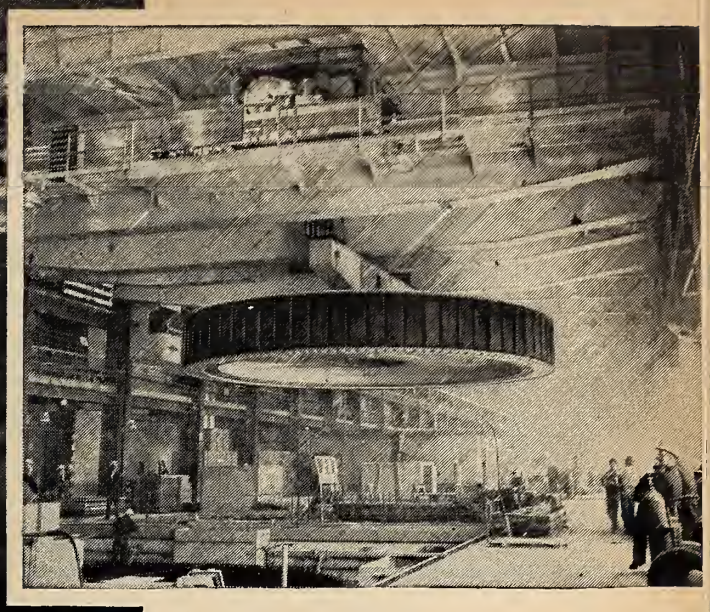
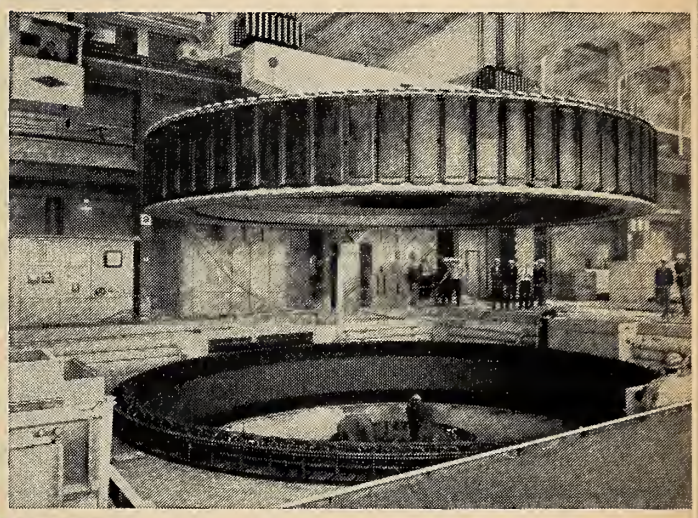
AT HYDRO-QUEBEC

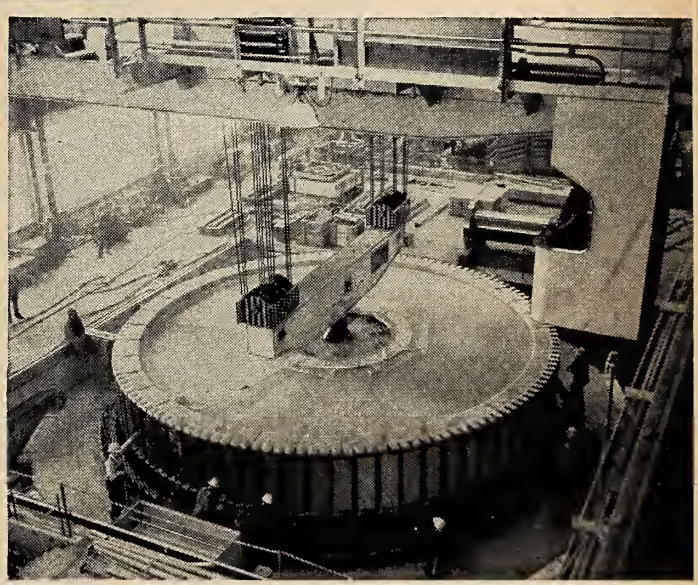
● Located on the Ottawa River, some 50 miles upstream from Montreal, Hyd Quebec's Carillon Generating Station will, when completed in 1964, feed most its power into the Montreal load area.

Canadian General Electric is supplying a total of 14 Hydro-electric generat each rated 46,750 KW (55,000KVA). When all generators have been i stalled, Carillon's rating will be 654,000 KW. Plans call for this station eventua to produce two and one-half billion KWH per year.

4,000 KW
ARILLON STATION







This sequence of photos shows a 160-ton rotor, being installed in one of the Carillon Station generators.

anadian General Electric is proud to be sociated with Hydro-Quebec in the build- g of this mighty powerhouse. We invite ur inquiries through your nearest CGE les office or Apparatus Department, terborough, Ontario.

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(Continued from page 62)

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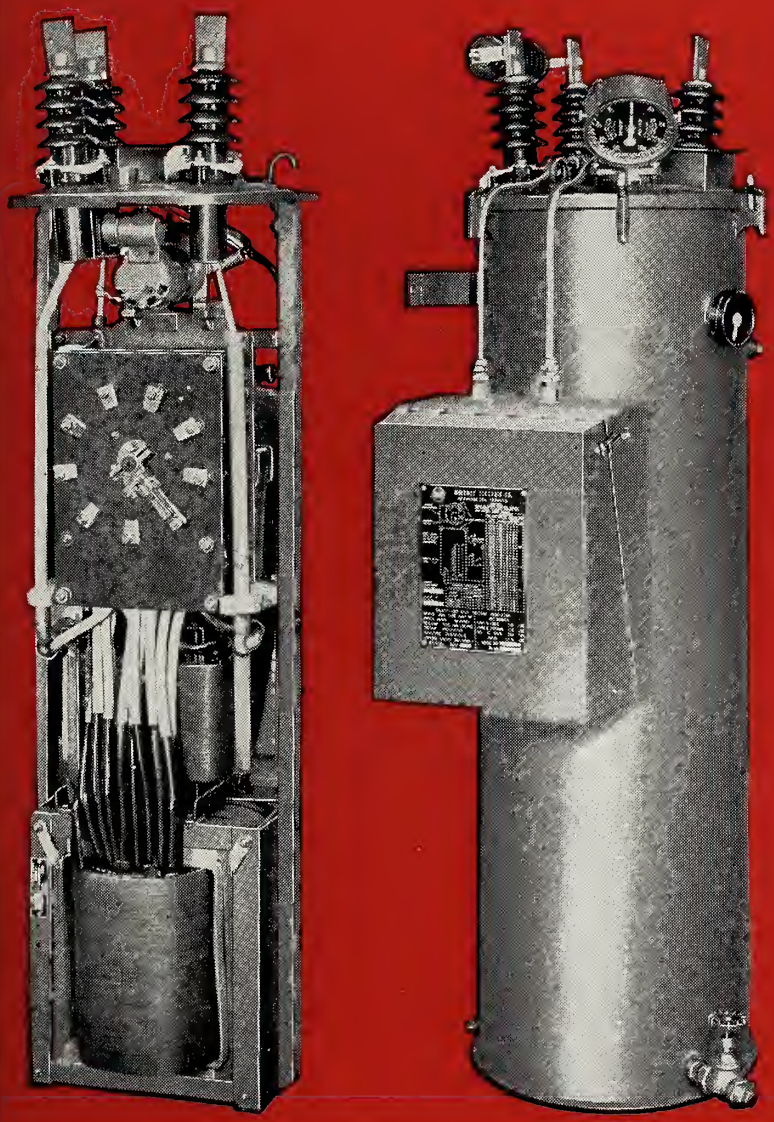

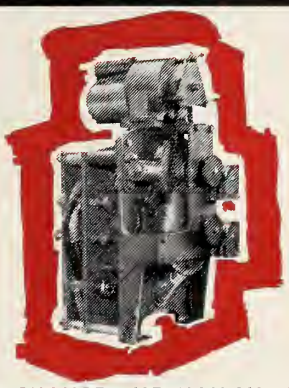

LOAD TAP CHANGER MECHANISM—The heart of this mechanism is the switching assembly, consisting of a tap selector switch and a reversing switch. The selector switch consists of two moving contacts and two sets of stationary contacts mounted in a circular arrangement on an insulating panel. Each tap in the regulating winding is connected to a stud which serves as a common mount for two stationary contacts. The moving contacts are insulated from each other and each is connected to one end of the switching reactor. The position of the tap selector switch determines the magnitude of the regulating voltage.

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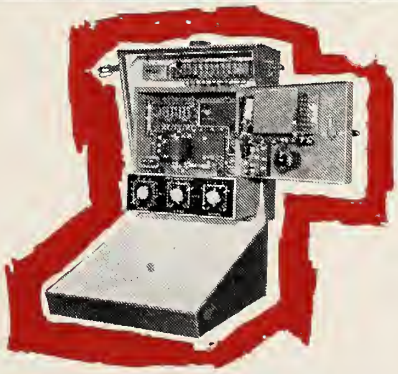

AUTOMATIC CONTROLS—Control equipment is housed in a weatherproof steel control cabinet. The front section is hinged to the rear section at the bottom so that when it is lowered it may be used for a meter shelf. The control cabinet is bolted to a bracket welded to the regulator tank. It may be removed and mounted on the pole near ground level if desired. This may be done by extending the conduit and control leads or an adapter kit using multi-conductor cable is available if desired.

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GULATORS ARE AVAILABLE IN VOLTAGES AND CURRENT RATINGS
: 2,500—5,000—7,620—13,800 AND 14,400 VOLTS...25 THROUGH 668
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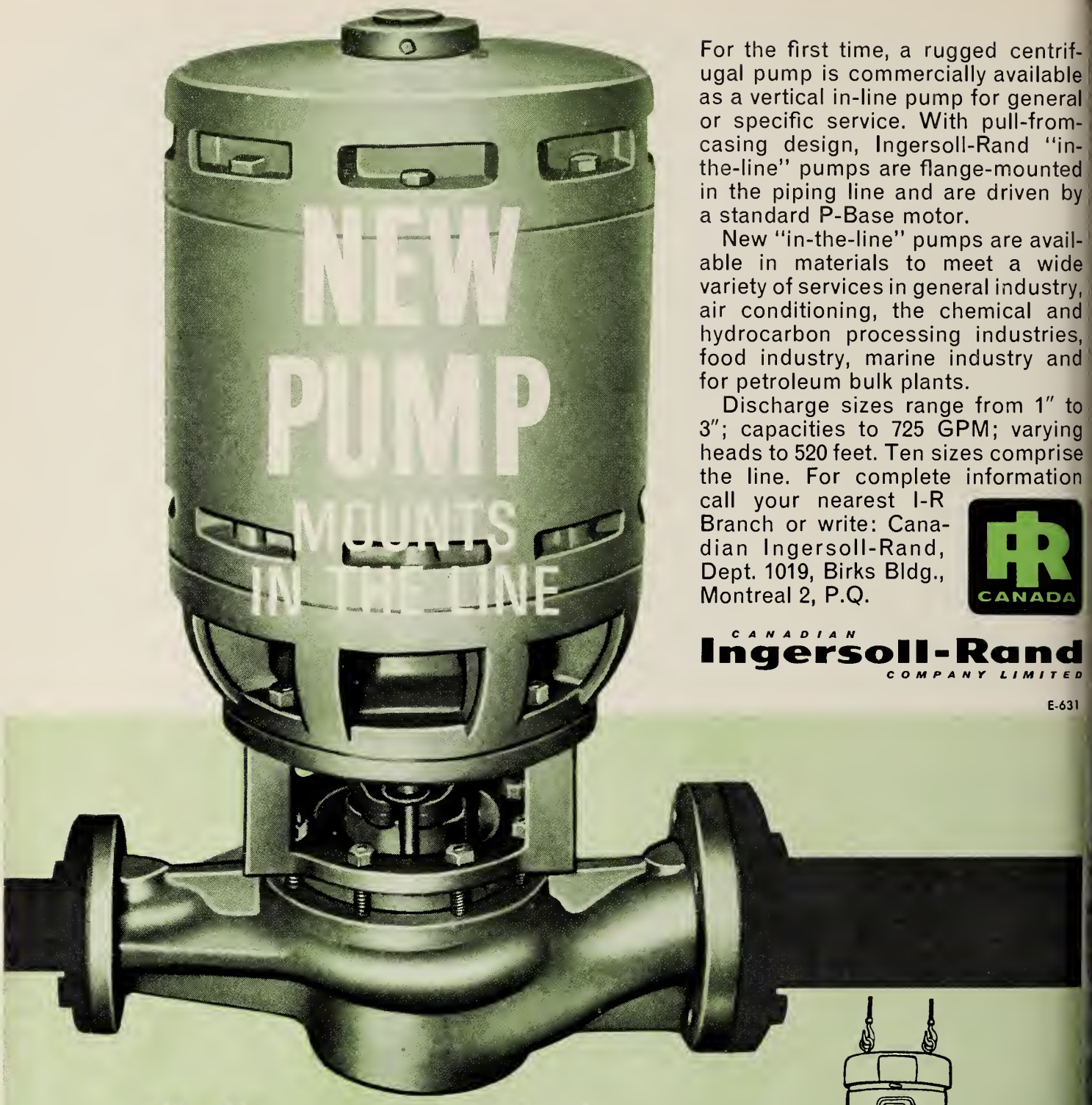

For the first time, a rugged centrifugal pump is commercially available as a vertical in-line pump for general or specific service. With pull-from-casing design, Ingersoll-Rand "in-the-line" pumps are flange-mounted in the piping line and are driven by a standard P-Base motor.

New "in-the-line" pumps are available in materials to meet a wide variety of services in general industry, air conditioning, the chemical and hydrocarbon processing industries, food industry, marine industry and for petroleum bulk plants.

Discharge sizes range from 1″ to 3″; capacities to 725 GPM; varying heads to 520 feet. Ten sizes comprise the line. For complete information call your nearest I-R Branch or write: Canadian Ingersoll-Rand, Dept. 1019, Birks Bldg., Montreal 2, P.Q.

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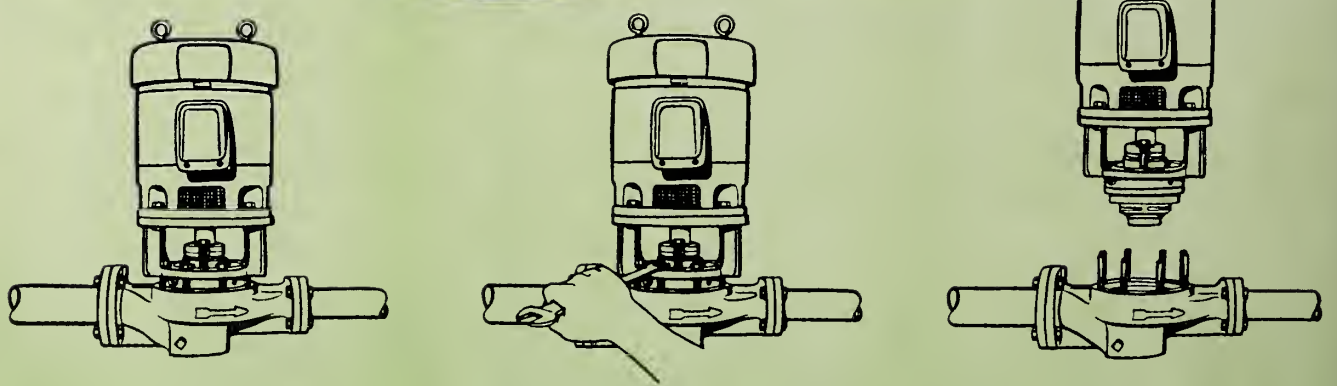

The new pump mounts directly in the piping system. No foundation, floor space or special fittings required.

The pull out design requires only the removal of a few hex. head nuts for inspection and easy maintenance.

Complete rotating element removed for inspection without disturbing or breaking flanged pipe connections.

Canadian Ingersoll-Rand Co. Limited. *Head Office:* Montreal, *Plant:* Sherbrooke, Que., *Branches:* Moncton, Montreal, Sept Iles, Ottawa, Toronto, Kirkland Lake, Sudbury, Winnipeg, Calgary, Vancouver

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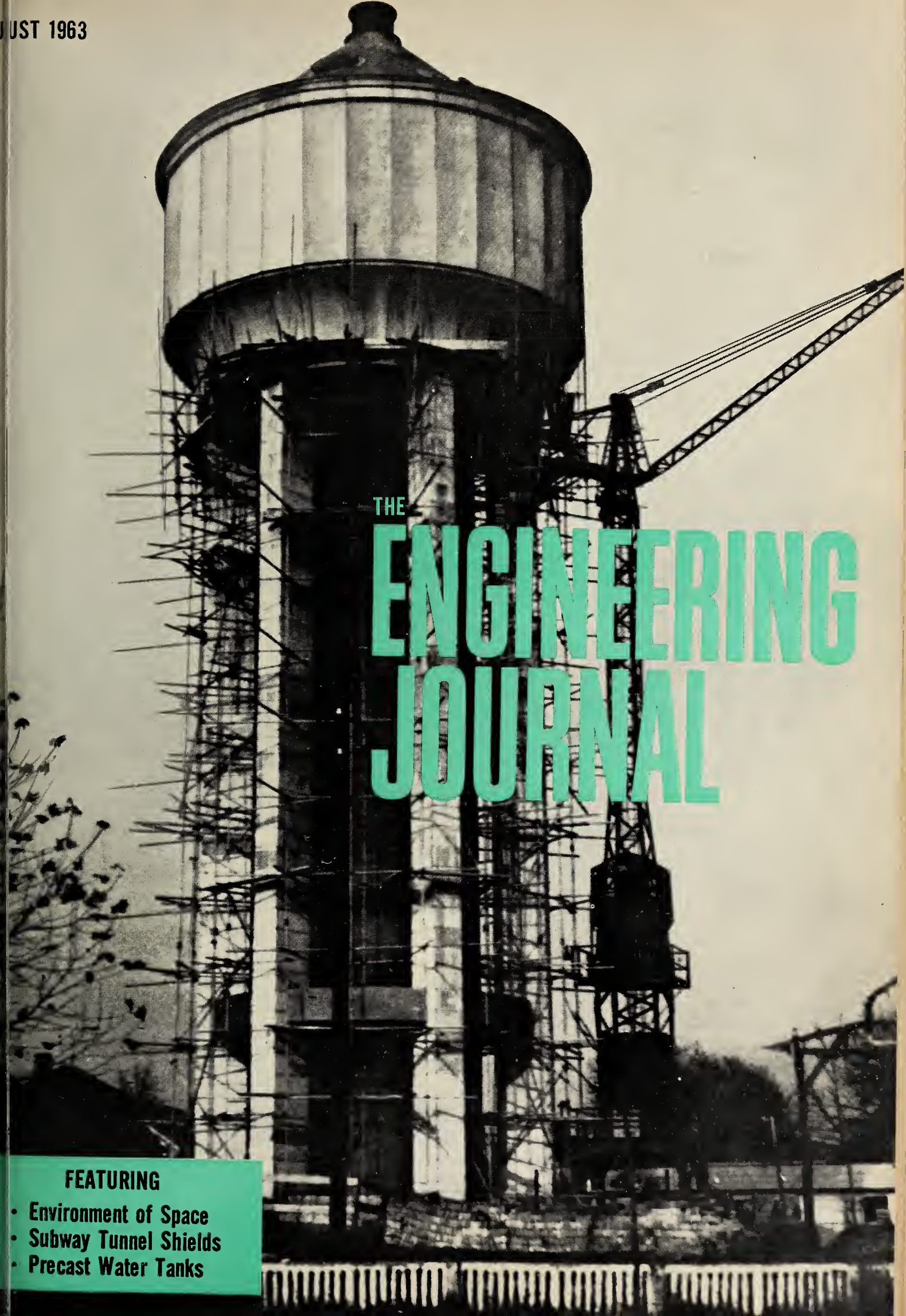

THE ENGINEERING JOURNAL

FEATURING

- Environment of Space
- Subway Tunnel Shields
- Precast Water Tanks

any way you want to look at it

McAVITY's new C-500-61 waterworks valve installs in any horizontal or vertical position... and exceeds all pertinent A.W.W.A. specifications in the process. (size 16″ to 30″ inclusive)

Meet the most versatile performer in the waterworks field. McAvity's new C-500-61 valve can be installed in **any** inclination. The only things you have to alter are the bolt-on by-pass and the Converto-Gear operator. (That Converto-Gear Operator is a real whiz itself. Spiral bevel gears of carburized alloy steel offer 95% operating efficiency. It is a completely self-contained unit, totally enclosed and permanently lubricated.)

The C-500-61 waterworks valve has bronze wedge shoes within the tongue-and-groove gate guides to carry the weight of the wedge throughout its entire length o travel. There is solid bronze to bronze contact betwee wedge and tracks throughout the full movement.

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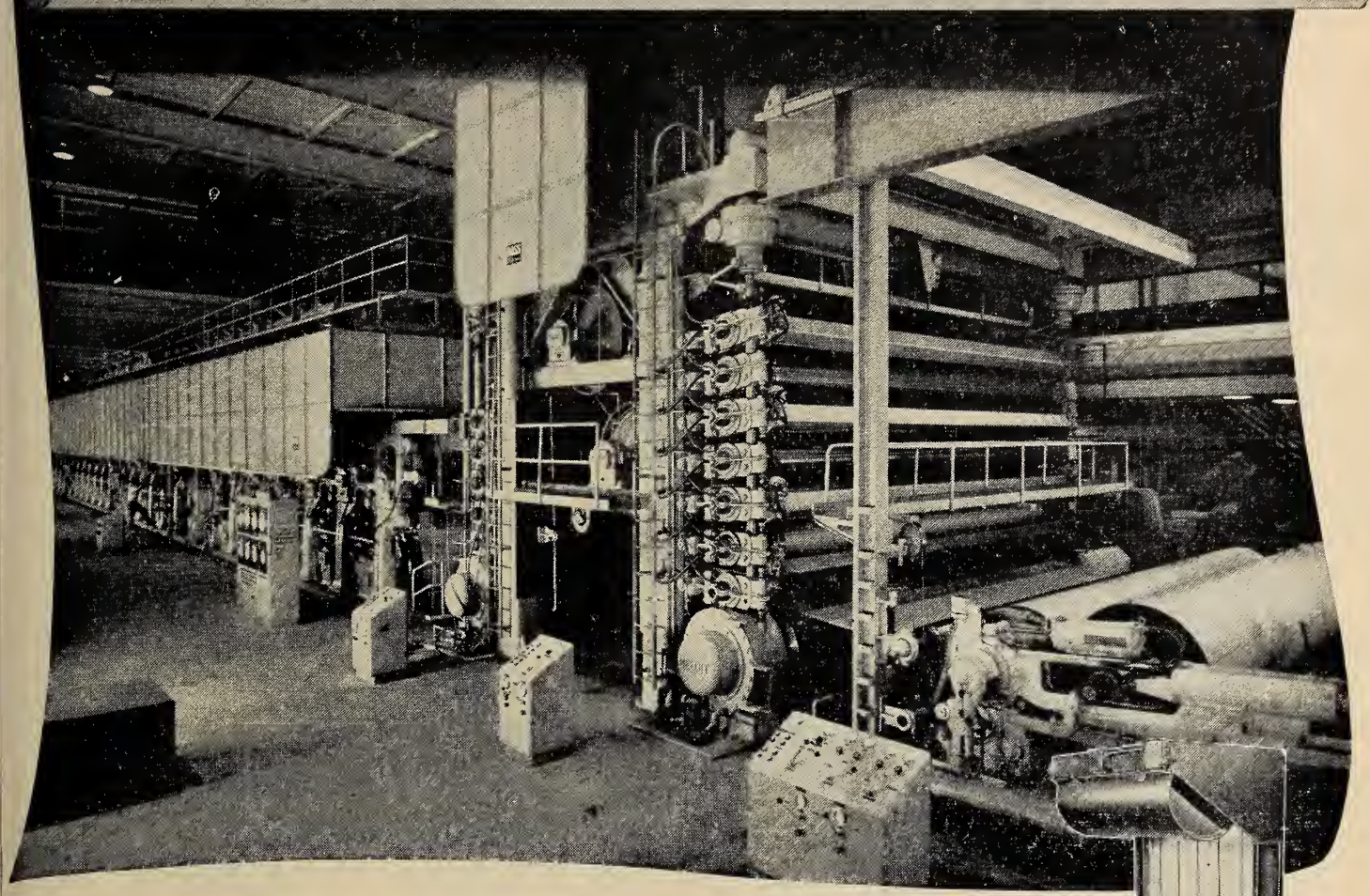

...WITH BETTER AIR

AAF Roll-O-Matic filters keep air clean at Crown Zellerbach's Antioch plant

Here is the No. 1 paper machine at Crown Zellerbach's new plant in Antioch, California. An important but unseen ally in the production of better paper is the air around this machine and throughout the plant. It is *clean* – free of the dust, dirt and impurities that could impair paper quality.

The air is kept clean by AAF Roll-O-Matic air filters – the filter that automatically replenishes its media while it cleans the air. And maintenance amounts to nothing more than occasional replacement of Roll-O-Mat media – an operation as simple as changing the film in a camera. Many months of uninterrupted service can be expected from each roll of media. For complete product information on the Roll-O-Matic, call your local AAF representative or write direct for Bulletin 248. American Air Filter of Canada, Ltd., 400 Stinson Blvd., Montreal 9.

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THE
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August 1963 - Vol. 46, No. 8

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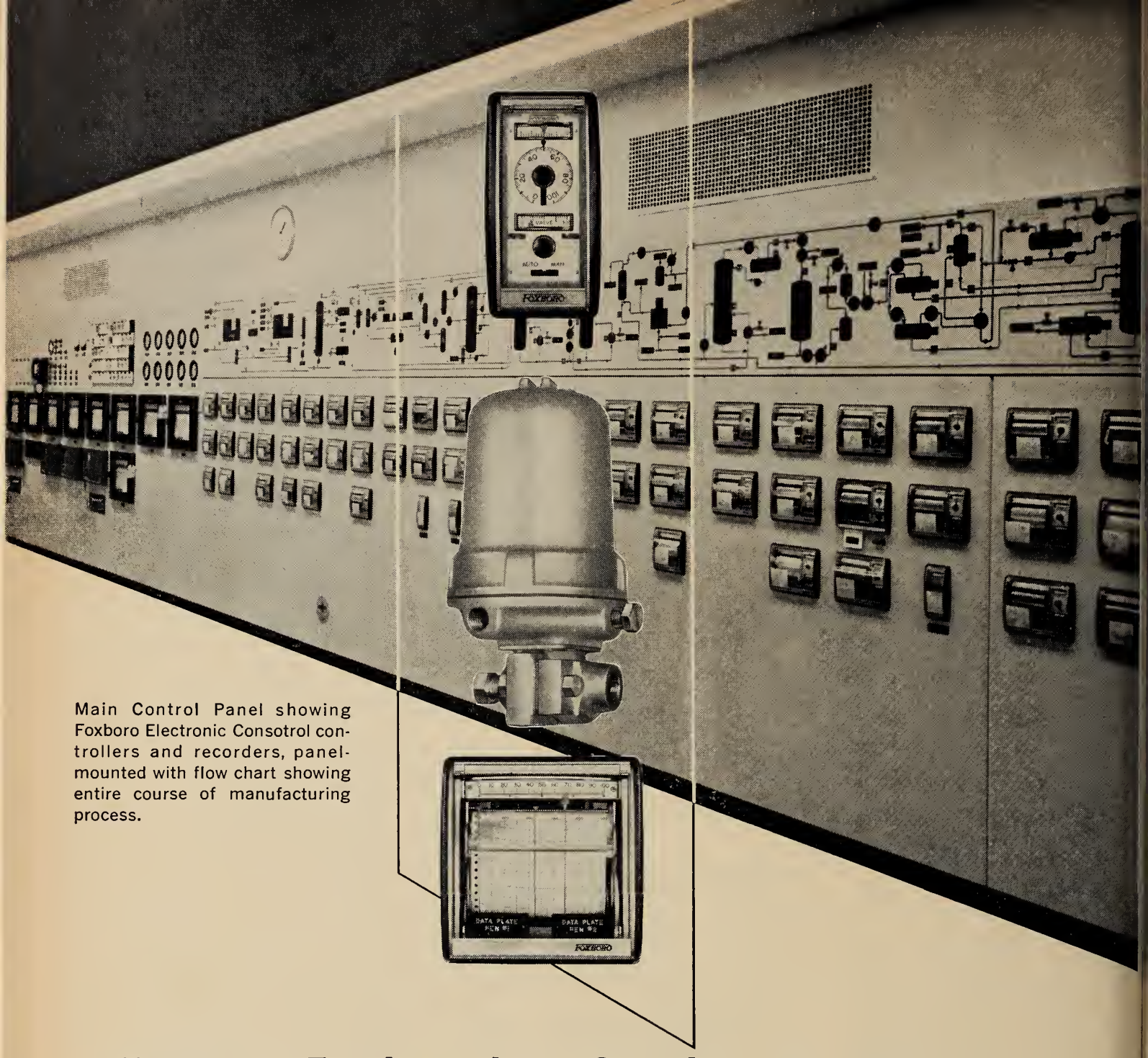

Main Control Panel showing Foxboro Electronic Consotrol controllers and recorders, panel-mounted with flow chart showing entire course of manufacturing process.

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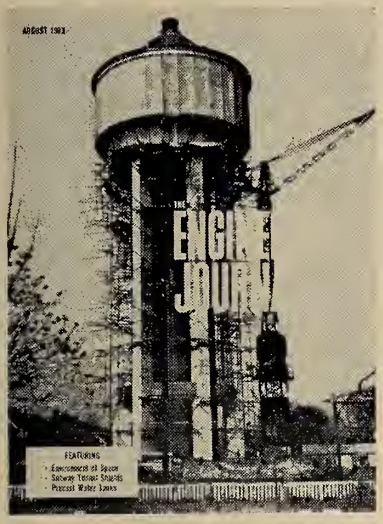

COVER ILLUSTRATION

Nandor Hussar's interesting paper on a simplified method of constructing precast and prestressed water tanks suggested this month's cover illustration. Shown is a fully precast water tank under construction. The tank inside is prestressed according to the system described in Mr. Hussar's paper.

The requirements for extreme reliability of equipment used in space missions are discussed in **F. D. Ward's** paper, **The Environment of Space, its Simulation and the Testing of the Canadian 'Topside Sounder Satellite'.** Environments associated with space vehicles are described as well as methods of simulation and testing and equipment used. Results of actual tests are described and finally examples of design remedies found to be necessary as a result of environmental testing are discussed.

University Avenue Subway, in Toronto, Ont., is the first stage of the Bloor-Danforth-University Subway. One mile of this subway is constructed entirely in tunnel, apart from the two small areas for the mezzanines of the two stations, which are constructed by the cut-and-cover method. The tunnels, 16 ft. internal diameter for the running tunnels and 24 ft. internal diameter for the station tunnels, are shield driven. In the paper, **The Toronto Subway Tunnel Shields, T. M. Noskiewicz** and **J. V. Bartlett** of W. S. Atkins & Associates, and Mott, Hay and Anderson, the Toronto Transit Commission's joint consulting engineers for the project, describe the background of the use of shields for driving tunnels. They present also the details and circumstances of the design and construction of the shields. Some of the more interesting problems encountered are examined in detail.

The principles of prestressing have been applied to the design and construction of circular structures for at least 20 years, says **Nandor Hussar** in his paper **Precast and Prestressed Water Tanks—A Simplified Construction Method.** Mr. Hussar, project engineer with Miron Company Ltd. in Montreal, is a native of Hungary and received his degree in civil engineering from the Technical University of Budapest. During his professional career he has concentrated on construction work, particularly with concrete. In his paper he outlines several methods of constructing precast and prestressed water tanks.

ERRATA

Due to a publisher's error an unrevised version of "A Yardstick for Evaluatating Costs of Electrical Energy in British Columbia" by J. F. Muir and E. Ruus was published in the January, 1963, issue of the Engineering Journal. The authors had submitted a revised version which contained several modifications, but they were not published. We sincerely regret the embarassment caused to the authors, and the inconvenience caused to the many readers who expressed interest in this paper. Any reader wishing a proper, revised copy of this paper, may obtain it free of charge by writing to the Editorial Department of the Engineering Journal.

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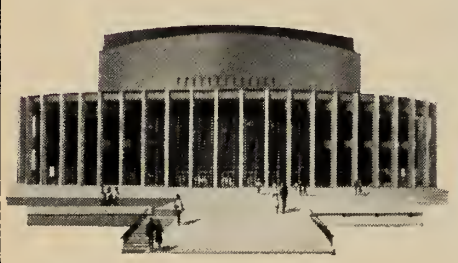
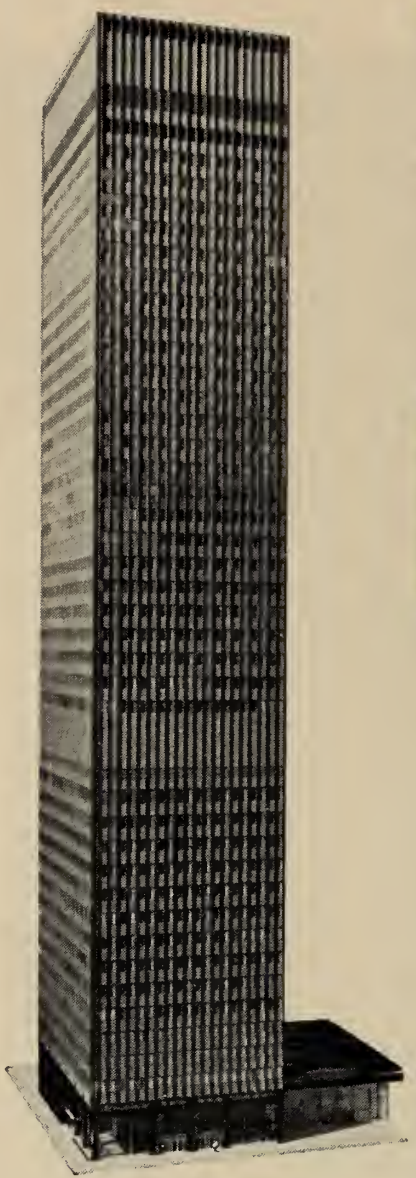


La Grande Salle de La Place des Arts. Installation: 3 DK10-10 35,000 PPH Steam Boilers. Consulting Engineers — Mech: and Elec: McDougall & Friedman, Montreal.



Canadian Imperial Bank of Commerce Building. Installation: 3 DK10-7 29,000 PPH Steam Boilers. Consulting Engineers — Mech: G. Granek & Associates, Toronto.

Standard Life Assurance Company Building. Installation: 2 TJW, 10 x 10^6 BTU/HR High Temperature Water Generators. Consulting Engineers — Mech: Wiggs, Walford, Frost and Lindsay, Montreal.

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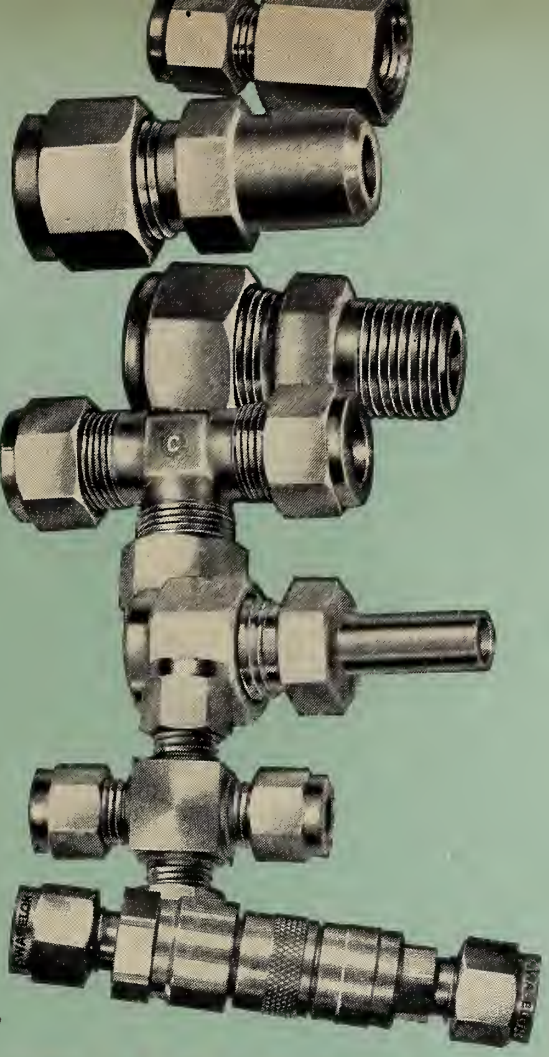

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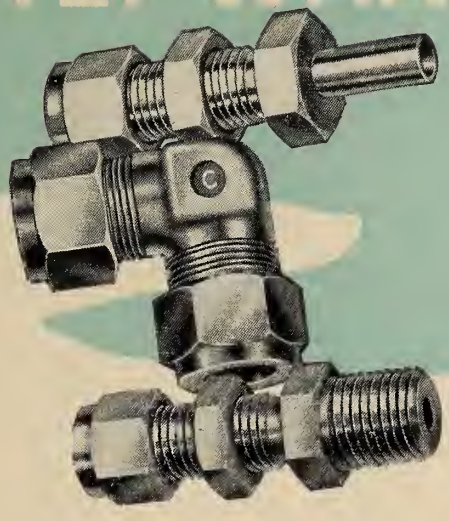

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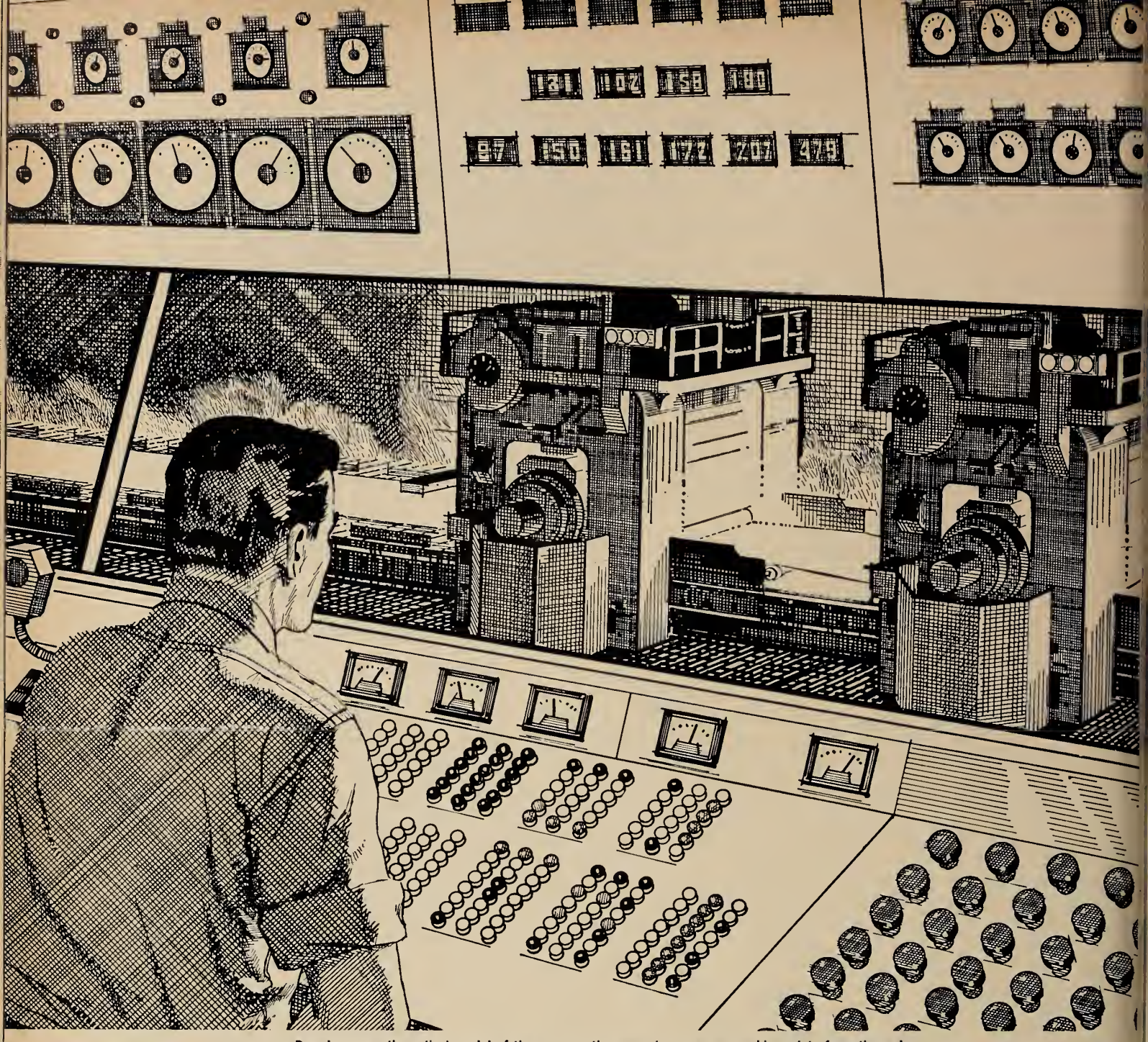

Based on a mathematical model of the process, the computer program combines data from the order sheet and sensors, then automatically makes all adjustments through the mill drive and control system.

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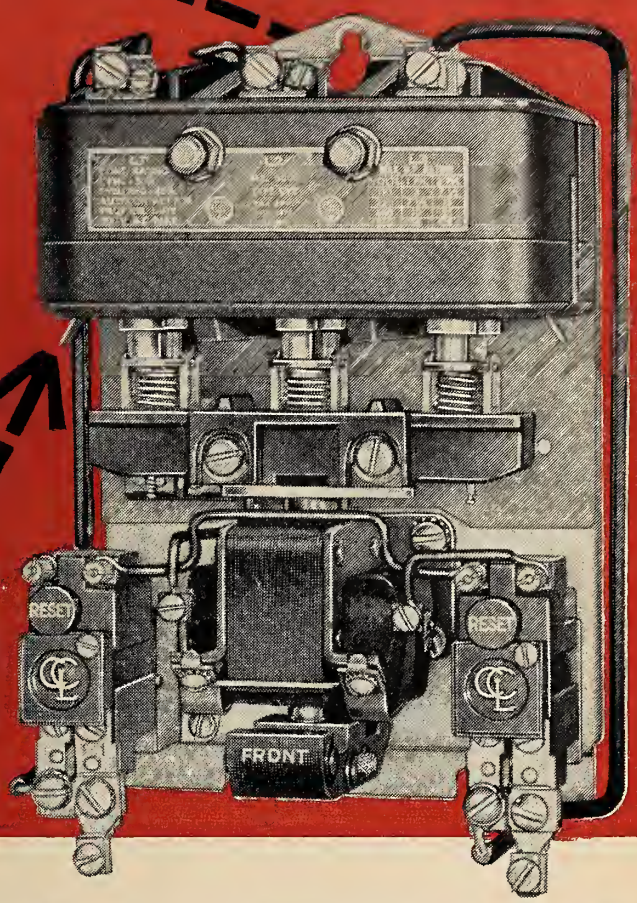
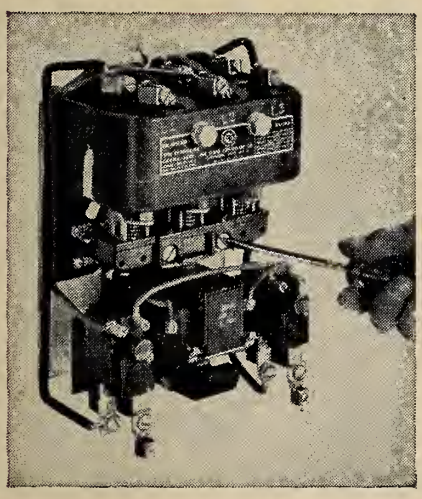


with C.C.L. Type "CY" STARTERS



C.C.L. Type "CY" Starters are in the forefront in quality of construction, ease of installation and maintenance. With all the screw heads and points of service right up front, *unobstructed* inspection of contacts and all parts can be quickly made. This simplicity of design coupled with the industry's most effective arc quenching means *big* money saving when productivity depends upon quick maintenance for electrical equipment.

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FUSION OF BOX BEAM AND PANEL COMPONENTS

A distinctive roof design was achieved in Edmonton's St. Andrews United Church through the fusion of two basic plywood components: the box beam and the stressed skin panel. Uniting these forms allowed construction of an attractive roof system which possesses the desired acoustical qualities. The use of plywood components also contributed to the reasonable cost of the completed structure.

Box beams for the church roof were prefabricated and arrived at the site with panel flanges bolted in place. After erection of beams, rafters were added and plywood panels nailed to top and bottom of these joining members. The roof is thereby comprised of stressed skin panels on long slopes, with box beams on short slopes. Beams are 5 feet wide and 40 to 60 feet in length, serving as full width supports and finished surfaces as well.

This modern roof system exemplifies the manner in which plywood component forms can be combined to achieve original total designs. Information on many more plywood uses, for structural and aesthetic purposes, can be obtained from your Association field man.

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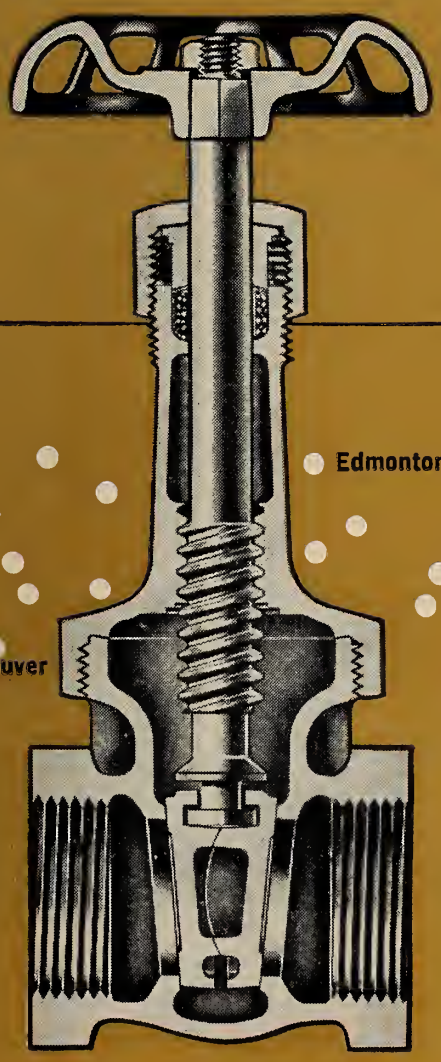
BRONZE GATE
FIG. 470

1 TRAVELLING SPINDLE has full thread engagement with the bonnet to reduce wear and assure long, trouble-free service.
2 DEEP STUFFING BOX holds more packing to prevent leaks, and assure friction-free spindle operation.
3 EXCEPTIONALLY HUSKY ONE-PIECE BONNET is of high tensile bronze. Can be removed easily and repeatedly without distortion.
4 DOUBLE DISC is the ball and socket bearing type. Ready adjustment to seats insures tightness without excessive closing effort.



BRONZE CHECK
FIG. 92

1 SEAT and DISC. Special feature permits easy regrinding without removing valve from line.
2 DISC and HANGER assembly accurately positioned in valve body by two removable side plugs. This provides exact seating of disc to body seat.
3 SEAT, DISC and HANGER—at 40° from vertical—effect tight closure at minimum pressure.
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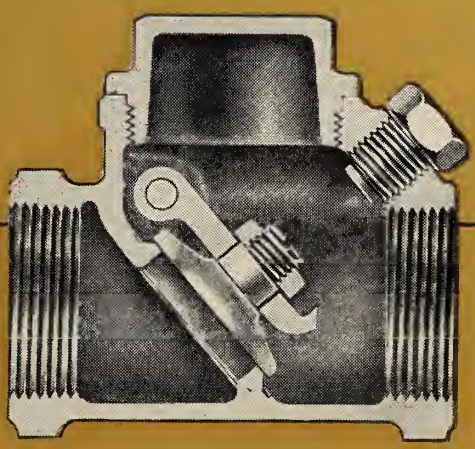

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Item 17. 89 tons—162 tons: Inkster, Michigan. Inkster Raad. Contractor: Darin & Armstrang, Inc. Fabricator: Unit Steel Corp.

Item 18. 97 tons—97 tons: Romulus, Michigan. Wayne Raad. Cantractor: L. A. Davidson. Fabricator: Unit Steel Carp.

Item 19. 220 tons—220 tons: Inkster, Michigan. Ecarse Raad. Contractar: Darin & Armstrang, Inc. Fabricatar: Calumet Structural Steel Fabricators.

Item 20. 94 tons—89 tons: Taylar Center, Michigan. Beech-Daly Road. Contractar: Darin & Armstrong, Inc. Fabricator: Unit Steel Corp.

Item 21. 80 tons—80 tons: Ramulus, Michigan. Middlebelt Road. Contractar: L. A. Davidson. Fabricator: Unit Steel Carp.

Item 32. 167 tons—167 tons: Romulus, Michigan. Shaak Raad. Contractar: L. A. Davidson. Fabricatar: Unit Steel Carp.

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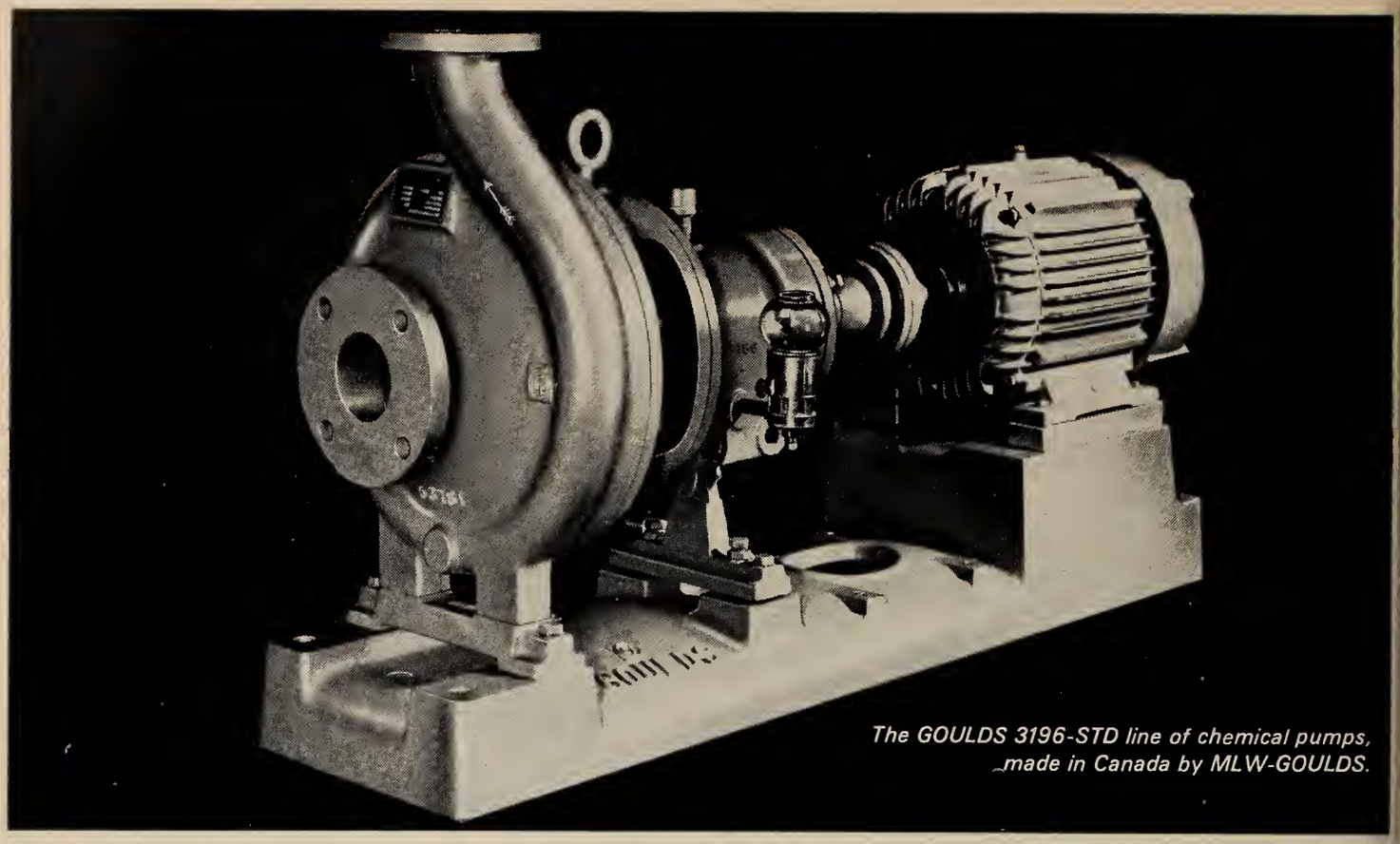

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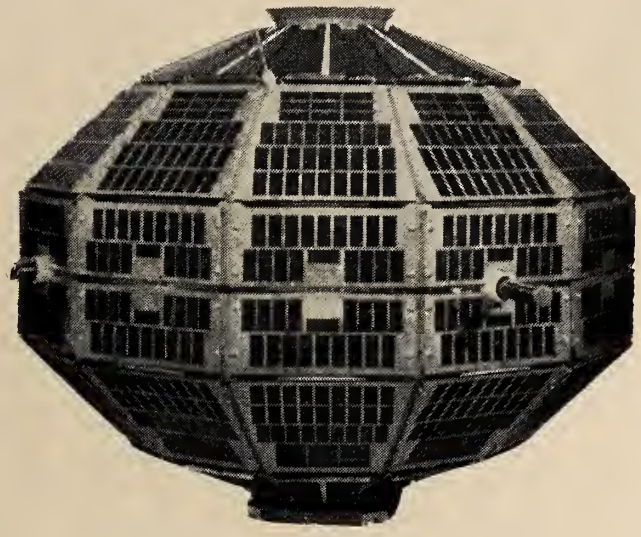

THE ENVIRONMENT OF SPACE— Its Simulation and the Testing of the Canadian "Topside Sounder" Satellite

F. D. Ward,
CARDE

THE INCREASING importance of environmental testing has been particularly accentuated by the present interest in space-science. By environmental testing I mean the subjection, in the laboratory, of a component or assembly to a near as possible simulation of the operational environment.

The extreme cost of launching a small body into orbit round the earth, or on a more extended journey, justifies the expenditure of much time and money to ensure reliability. With most terrestrial technologies, a failure, though lamentable, can usually be diagnosed by examination, and the knowledge thereby gained be used to improve subsequent models. The cause of a failure in a space vehicle is almost invariably a matter for conjecture. If the satellite, after separation, sends no signals back to earth, then a post-mortem must be held in the absence of a body.

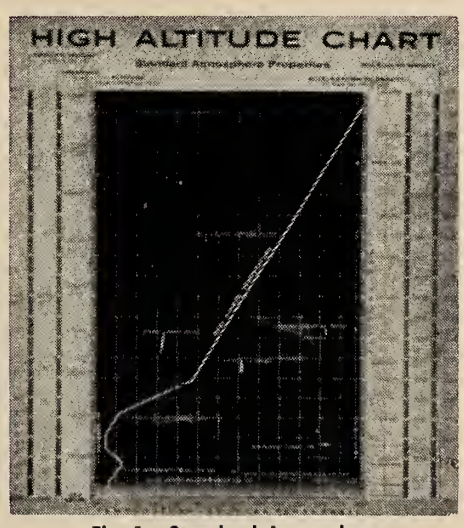

Fig. 1.—Standard Atmosphere

What is so unusual about this space-flight environment? It consists of two main phases, those of launch and free flight. During the launch phase the payload is accelerated to the required velocity on top of a rocket or series of staged rockets. Following this, it speeds smoothly on its way, perhaps to orbit the earth as a satellite.

During launch, the payload will be subjected to acceleration in the direction of flight, of increasing magnitude, either smoothly or in steps, up to a maximum when all the propellant is burned. At the same time aerodynamic heating will be raising the temperature of the external skin of the nose cone in which the payload is carried. Superimposed on these effects will be that of vibration, of a type peculiar to rocket combustion processes. We can say that the launch phase is characterized by man-made environment, but when combustion is complete and the payload has left the atmosphere, the environment is solely that of space. This is apart from the fact that the payload will be travelling

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Estimate of Potential Damage To a 3 Metre Spherical Vehicle

Impact Frequency	*Particle Mass (gm.)*	*Pen. of Aluminum (cm.)*
Once per day	6.3×10^{-6}	0.1
Once per 60 dys.	5.6×10^{-4}	0.5
Once per 35 yrs.	8.0×10^{-2}	3.0

From Whipple F.L. (1958)

Fig. 2.—Probability of Particle Penetration

at say, 25,000 ft./sec., but velocity as such is not a factor which need be considered. Thus any payload must possess firstly an ability to withstand without damage a few minutes of violent vibration and acceleration, and secondly a long-term ability to operate in a spatial environment.

The vibrations which emanate from a rocket engine are of the type known as random, or "White Noise", the vibrational spectrum up to very high frequencies being filled with vibrations of a completely random nature. These vibrations can be transmitted either acoustically or structurally, and can be very disruptive in effect. It can be appreciated that while common sinusoidal vibration applied to a structure can induce resonant motion in different parts at different frequencies, random vibration could excite resonance in many components at the same time.

The effect of continuous acceleration is not so severe; the effect of say a 20g acceleration in making each pound weigh an apparent 20 lb. is easily provided for in the design of the structure.

We will assume that the payload, having survived the launch conditions, is orbiting the earth at an altitude of 150 miles. Fig. 1 (ref. 1) illustrates the variation of various atmospheric properties with altitude. It is seen that at 150 miles, or 800,000 ft. the pressure is 5.7 x 10^{-8} mm mercury, and temperature 1000°F. Air temperature at this degree of rarefaction, that is at a pressure of one ten thousand millionth of a standard atmosphere, has little practical significance, being only a measure of molecular vibration. The satellite would certainly not pick up this temperature. Much more important is the thermal effect of radiation as, unless in the shadow of the earth, it would be in the full glare of the sun unshielded by any appreciable atmosphere. It would be in general receiving heat from the sun and the earth, and be itself radiating heat to space. In the region of the earth's orbit, the intensity of total solar radiation is of the order of 440 B. Th. U./hr./ft^2, while at 150 mile altitude the earth is giving some 70 B. Th. U./hr./ft.^{2}. Both are regarded as black bodies, radiating at 6,000°K and 280°K respectively. The steady temperature attained, neglecting any heat generated internally, would depend upon the ratio of absorptivity to emissivity of the satellite's surface. The latter figure can be ascertained by laboratory measurement, and thus the temperature of the satellite may be calculated. As a point of interest, a body with an absorptivity-emissivity ratio of unity, would acquire a temperature of 320°K, which is quite reasonable.

The extremely low pressure may have undesirable effects upon some of the electronic packages, while any moving parts which depend upon lubricated joints may be in serious trouble due to evaporation of the lubricant. Plastics may lose strength by sublimation, and even metals, it is said, can be adversely affected by some wave lengths of solar radiation.

Most of us are aware that a body in space is subject to a condition known as weightlessness. This is of course of misnomer, what is meant is that a condition of "free fall" exists, this condition being assumed immediately by any space vehicle once the power is terminated. The only acceleration then will be as dictated by gravity, and in a virtual vacuum the vehicle with its contents and occupants, will accelerate in the gravitational field. There would then be nothing to prevent unrestrained objects from floating freely within the confines of the vehicle. A man would experience a sensation of having no weight, precisely as he does instantaneously when accelerating downward in an express elevator. This condition is one of the most intriguing aspects of space travel, which unfortunately cannot be reproduced in the laboratory for any appreciable period.

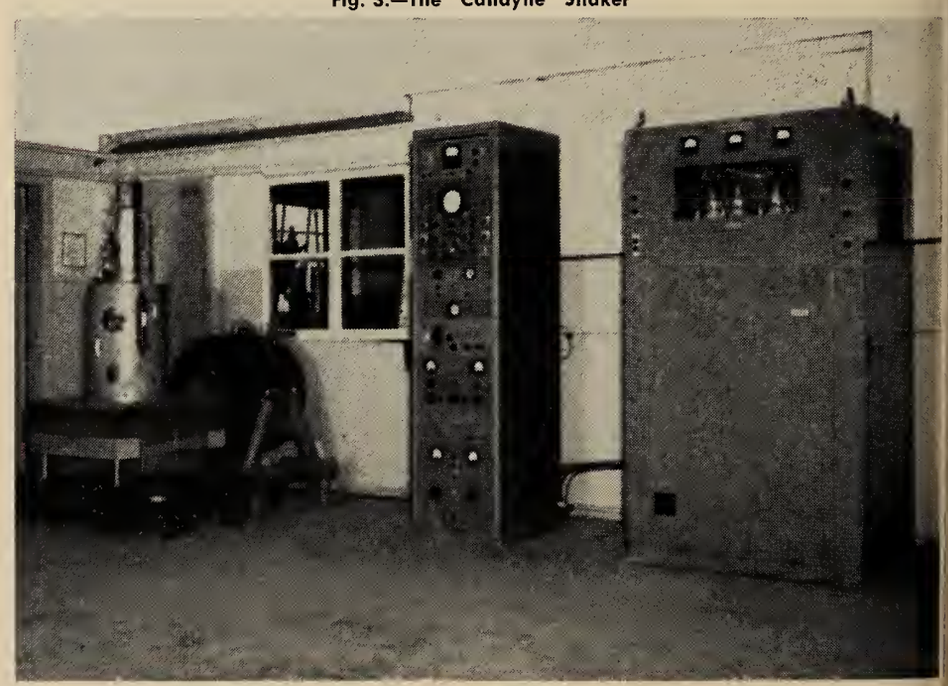
A satellite, it must be realized, is also in free fall. Its velocity round the earth is such that its acceleration towards the earth, that is V^2/r in the usual terminology, equals the acceleration due to gravity. Like a point on the rim of a rotating wheel, it accelerates continuously towards the axis. In practice it is slowly retarded by the attenuated atmosphere, resulting in a continuously decreasing radius of rotation until aerodynamic heating in the dense atmosphere causes its destruction.

This free fall effect is, I think, the only facet of the environment of space which can be favorable to man. It does mean that mechanical operations can be performed with quite low power, in that the item to be moved does not have to be supported. For instance a thin radio antenna can be extended for an unsupported distance which would be quite impracticable under terrestrial conditions.

Another problem is that of meteoric impact. So-called space appears to be littered with particles of matter known as meteorites, ranging in size from about one micron upwards. Luckily the larger the particle, the less frequent its occurrence. Velocities of these particles entering the earth's atmosphere will be upwards of 35,000 ft/sec. There is an obvious danger of penetration of the skin of a spacecraft.

Figure 2 is a table showing the probability of penetration of a three-metre diameter spherical vehicle in the neighbourhood of the earth. (Ref. 2). It would appear that a vehicle

Fig. 3.—The "Calidyne" Shaker



N.A.S.A. Vibration Test Schedule

(a) Sinusoidal, in 3 Phases

Sweep c.p.s.	*Condition*	*Duration*
5-15	¼ in double amplitude	5 mins.
15-45	3 g	"
45-116	4.05 in sec. max. (3-7.5 g)	"
116-3000	7.5 g.	"

(b) Random, in 3 Phases

c.p.s.	*Spectral Density g^2/c.p.s.*
20-80	0.04
80-1300	0.04-0.07

Fig. 4.—NASA Vibration-test Schedule

with a 1 mm skin is going to be punctured daily. If the density of a particle of mass 6.3 x 10^{-6} gm is 0.05 gm/cm^3 (Ref. 3) its diameter will be 0.1 mm. Obviously, even the hole made by such a small particle would be undesirable in the hull of a spacecraft.

Incidentally, the Echo 1 navigational-aid satellite has been circling the earth since December, 1960. Even if punctured, there would be no force to cause this thin-metallic "balloon" to deflate, but it would be interesting to know the extent of the damage.

We will now consider how the various environments can be reproduced on earth, so that our equipment when flown will have a good chance of survival. Firstly there is the condition of continuous acceleration. This is not very difficult, but if the spacecraft is large it would require a bulky, and expensive, installation. In essence, the vehicle or equipment is mounted on a horizontally rotating arm in an attitude so that the resultant of centrifugal acceleration and gravity acts in the required direction. If the arm is long enough then all parts of the object will experience approximately the same acceleration. It will be appreciated that while the arm is rotating, it is difficult to see what is going on, and the feeding of services to and from the test specimen requires complicated slip rings and rotating hydraulic couplings or a radio link.

For large payloads, and particularly if one wishes to apply acceleration suddenly or cause a high rate of change of acceleration, the rocket sled appears to be the only answer. This equipment requires a mile or two of level railroad track, along whose surface slides a rocket-driven sled which carries the apparatus under test.

The universally-used tool for producing vibration is the electro-magnetic shaker, which is essentially a moving-coil loudspeaker. Oscillations are produced electronically and fed into an amplifier from which the armature is driven. The power required is considerable; the example shown in Fig. 3 is capable of shaking masses up to 170 lb. over a range of 5-3000 cycles per second, and maximum acceleration from 10 g to 30 g depending upon the frequency. The amplifier has a maximum output of 10 KW. This apparatus generates vibrations of sinusoidal form; it becomes considerably more complex if random motion is required. In brief, the completely random nature of a vacuum tube discharge, after tailoring to fit the specifications, would be used to feed the amplifier.

Apart from the questions of free-fall and meteoric impact, it is a reasonably simple matter to reproduce the environment of space. What is needed is a chamber, with means of heating or cooling the walls, capable of attaining a high vacuum. No new technology is needed to give a pressure of the order of 10^{-6} mm mercury, or about 500,000 ft. Lower pressures can be attained at higher cost.

Sunlight can be reproduced in a number of ways, by arc or vapour discharge lamps, but there is a tendency now to favour a common carbon-arc lamp. The spectrum from this is a close simulation to that of sunlight.

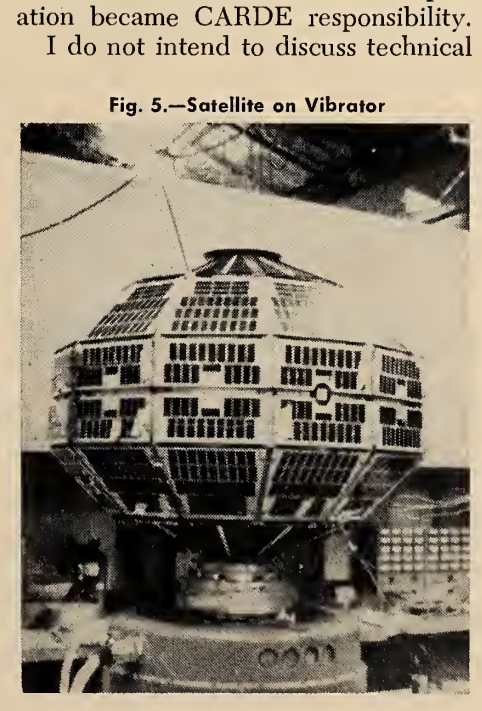
Part II

I have attempted to present the philosophy which is the basis of environmental testing. We will now consider its application to the Canadian "Topside Sounder" Satellite.

While CARDE played no part in the design or construction of the satellite, it was called in to undertake some aspects of the environmental test work. It is DRB policy to centralize environmental facilities in one establishment and thus while new equipment had to be acquired to test the satellite, the installation and operation became CARDE responsibility.

I do not intend to discuss technical details of the satellite except so far as they affect the testing aspect. It was designed to describe a polar orbit at an altitude of 150 miles and to transmit signals which by reflection and correlation with ground based measurements, would measure the depth of the ionosphere. Other apparatus would be carried to record cosmic radiation intensity. Four units were made. No. 1 was a structural model, used principally for vibrational and temperature checks. No. 2 was a fully instrumented prototype required to survive full operational and environmental tests while Nos. 3 and 4 are actual vehicles.

Fig. 5.—Satellite on Vibrator



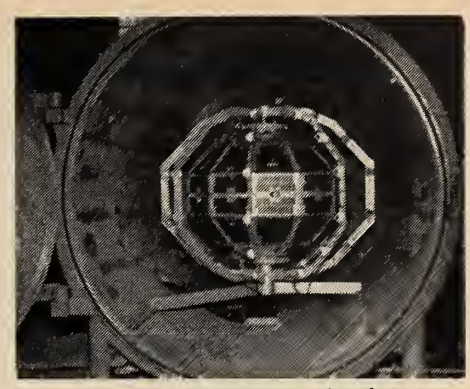


Fig. 6.—CARDE Vacuum Chamber

The satellite is intended to have a working life of one year and it is fitted with solar cells to charge the batteries. Thus an environmental test, incorporating simulated sunlight in addition to checking the resistance of the electronics to thermal radiation will also confirm operation of the solar cell system.

The environmental test program was divided into two main phases:

(a) Vibration test, both sinusoidal and random, the object being to check the resistance of both structural and electronic components to vibrations during launch.

(b) Thermo-vacuum, including sunlight, to represent operational conditions.

It is a NASA stipulation that all spacecraft launched by their facilities must have survived a vibration program approved by themselves. This includes a period of random vibration which, as was mentioned earlier in this paper, simulates rocket motor noise.

Unfortunately, CARDE has no facilities to provide random vibration nor was it permissible to indulge in the large expenditure necessary to make this addition. Consequently, all the vibration testing of complete satellites was performed by NASA, at Goddard Space Flight Centre. In parallel with this situation it should be pointed out that at this time Goddard had no facilities for providing simulated sunlight in a vacuum chamber, while CARDE through the

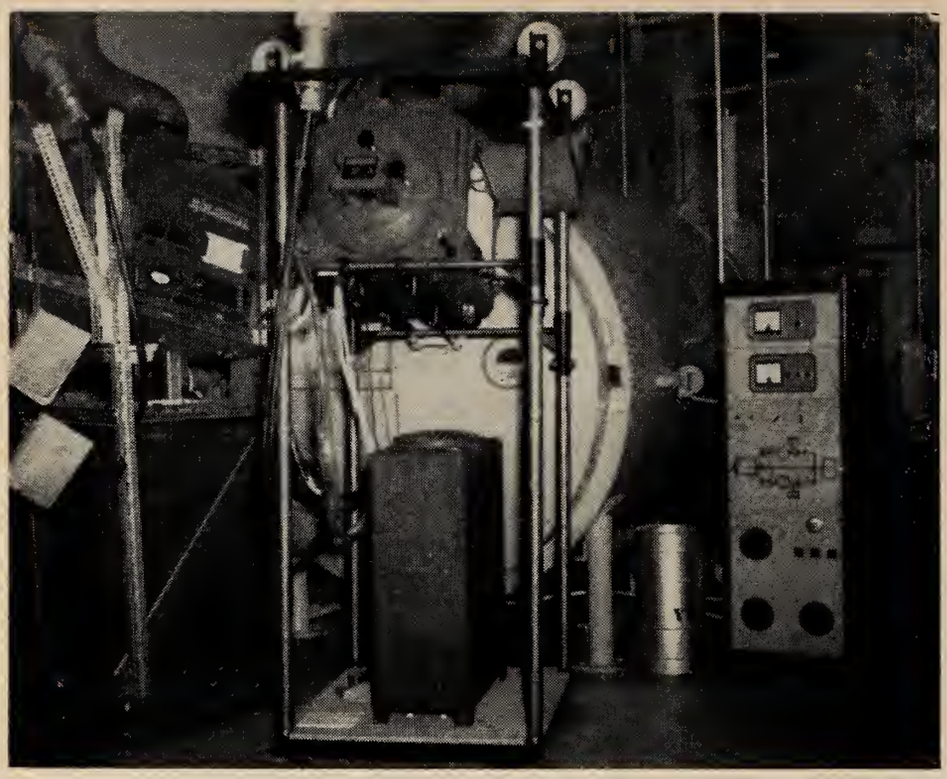


Fig. 7.—Carbon-arc Lamps

foresight of DRTE, was so equipped.

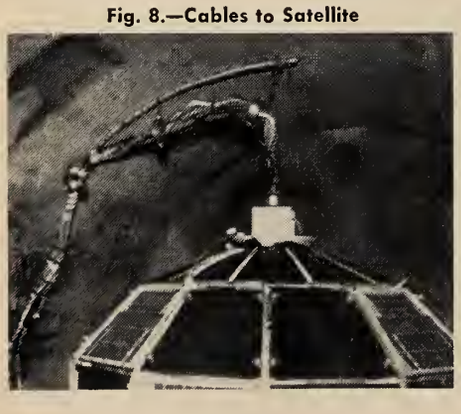
Figure 4 shows the vibration test schedule, as specified by NASA. It is seen that the period of test is quite short, perhaps surprisingly so to anyone familiar with aircraft or armament vibrational specifications. It should be remembered that the satellite experiences vibrations for the period of launch only.

Figure 5 shows the satellite mounted on the vibrator at Goddard Space Flight Centre.

Initially, vibration tests were made with the structural model of the satellite, when the testing was justified in that a bad resonance occurred at one point. Modifications were made which were incorporated into the prototype and the actual satellite, after which no further trouble was experienced under vibration.

Subsequent vibration tests of complete satellites were simplified by virtue of the fact that the electronics were not required to operate during vibration, but were required to be undamaged by vibration. Thus instrumentation was reduced to a set of eight accelerometers to record vibration at various points.

Fig. 8.—Cables to Satellite



Thermo-vacuum testing was a much longer and more complicated process. It involved subjecting the satellite to extremes of heat, cold, high vacuum and simulated sunlight for long continuous periods and with electronics operating.

The vacuum chamber acquired for the purpose is shown in Fig. 6. It was supplied as a complete unit by Consolidated Vacuum Corporation of Rochester, N.Y. It has a working section 6 ft. diameter by 8 ft. long, with walls which may be held at any temperature between −40 and +200°F. Internal pressure may be reduced to the order of 10^{-5} mm mercury by means of a large roughing pump and a pair of oil diffusion pumps. Normally, the chamber can attain 10^{-5} mm in about three hours, while after some 24 hours of continuous operation the pressure will approach 10^{-6} mm. The latter represents about 700,000 ft. or 130 miles which reproduces fairly well the satellite altitude.

Sunlight is simulated by a pair of large carbon-arc lamps, each of 10 kilowatt rating (Fig. 7). The lamps are arranged to shine through the ports of the chamber; one lamp at a time is employed, it being necessary to use them alternately as the carbons need to be renewed at hourly intervals. The distance from the arc to the satellite was calculated to give an intensity of "one sun".

Rotation of the satellite is achieved mechanically. It sits upon a rotating platform which by bevel gears is caused to oscillate five revolutions in each direction, taking two minutes for a complete cycle. The drive shaft runs through a sealed bearing in the rear wall of the chamber to a reversible DC motor.

This oscillating motion, while obviously not a true representation of a continuously rotating satellite, simplifies considerably the problem of conducting information. It was found that, provided no sharp bends were used, the various leads could be bunched together and permitted to twist with the oscillation. Troubles were experienced at first with fatiguing wires, but the final arrangement shown in Fig. 8 was quite successful. It will be seen that the cables are supported by the inner races of ball races, the outer races being suspended from the chamber walls.

Apart from the various monitoring cables to record functioning of the electronics, we were required to record temperatures at 29 specified points, there were 18 points in and on the satellite and 11 on the chamber wall. Initially, experiments were made with thermocouples but there were disadvantages to such a system.

Firstly, a thermocouple circuit needs metallic connectors throughout which complicates the provision of selector-switches and recorders. Secondly, it was found to be extremely difficult to register an accurate chamber wall temperature with a thermocouple. The bead, which must of course be electrically insulated, makes a poor thermal contact with the wall. Under high vacuum, the effect of radiant heat was observed to give large errors.

After much experimentation it was decided to use "Stikon" temperature sensors, which are of the resistance thermometer type. The thermal contact between the grid and the wall, through a thin paper film, is superior to the thermocouple and they were found to be comparatively insensitive to radiation effects.

Given accurate matching of lead wire resistances, it was possible to connect a large number of gauges to a central distributor switch and to indicate temperatures by means of a digital voltmeter to an accuracy of the order of 1°F.

This system was used initially, but

Fig. 9.—Cascade of Relays

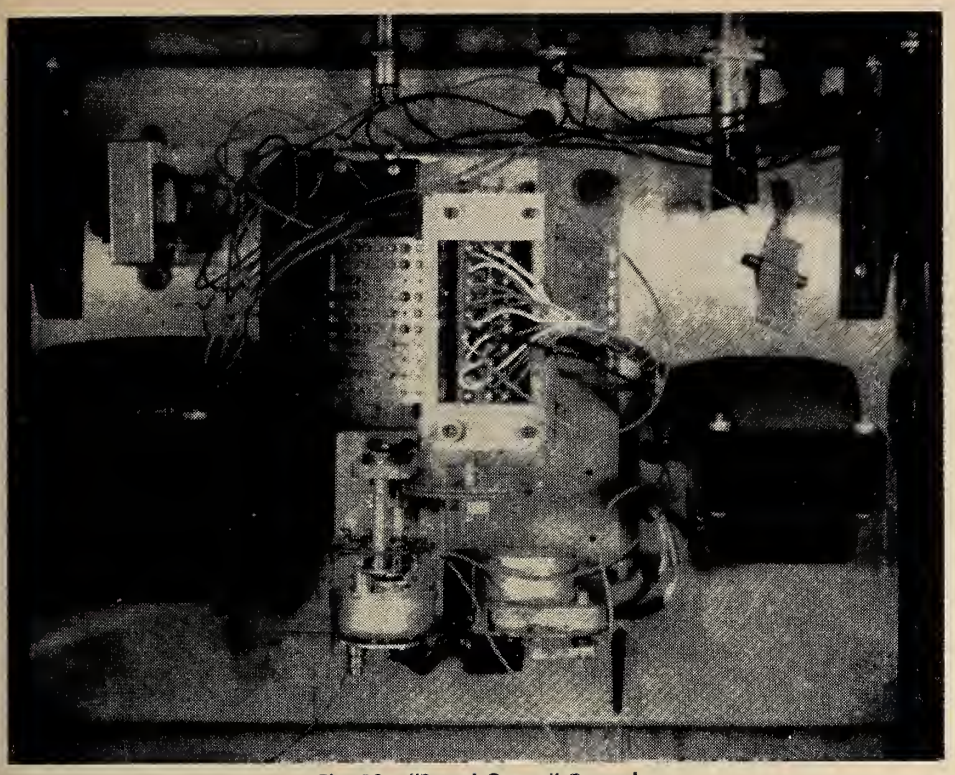


Fig. 10.—"Barrel Organ" Control

to avoid the tedious task of writing down say 30 temperatures as quickly at possible, repeated at 10 minute intervals, the development of a recording system was commenced. There did not appear to be anything on the market which exactly fitted our requirements. A normal sequential switching system could not be guaranteed to give contact of reproducibly low resistance, nor could it be made to "ring the changes" in say, reading No. 1 every five minutes and No. 3 every 15 minutes.

Figures 9 and 10 show the method as finally evolved. It can best be called the "Barrel-organ" system. Thirty-two lead-ins are cascaded by means of multiple-contact relays to the input of a print-out voltmeter. The first relay selects 16 of 32, the second selects eight out of 16, and so on by permuting five on-off switches it is possible to select any one channel out of 32.

This permutation was achieved by a rotating drum on which pins operate the relays via micro-switches. The drum is rotated intermittently by a ratchet-motor, at a frequency of one oscillation per second.

The drum is divided into 60 positions which permit two complete sweeps of the 29 temperatures in one minute. Thus printed results were obtained, for practical purposes in duplicate. The operator when requiring a reading would press a button to energize a hold-in relay which would cause one revolution of the drum. As he was usually concerned with means of roughly similar temperatures, he would average mechanically a group of voltages before conversion to temperature.

The relays were found to possess consistent contact resistance of the order of .005 ohm; when the relay board was enclosed in a dust-proof cover and the contacts cleaned daily with alcohol this did not vary appreciably during the course of a seven-day test. Compared with a total circuit resistance of about 100 ohm this variation was insignificant. Thermo-vacuum tests were performed on the structural model, to determine surface heating effects, on the prototype and on the two flight models. The latter benefited from lessons learned on the previous tests. Figure 11 which is reproduced from a DRTE test report summarizes the thermo-vacuum tests performed on the satellite which is now in orbit. In the chamber for one week, under high vacuum, it experienced two days at high temperature, one day of solar simulation and one day at low temperature. During the low temperature test, malfunction was detected in one package (a converter). Later it was conceded that it would be acceptable to test separately a replacement unit and to install it in the satellite without further test on the complete assembly.

That, in brief, is what we did to the satellite in an attempt to disclose its weaknesses. On the way in which it resisted these attempts and the way in which it has performed its specified duty since it was launched in September 1962, I think DRTE are to be congratulated.

Fig. 11.—Summary of Thermo-vacuum Tests

Environmental Conditions Experienced by the S-27-3 Spacecraft During the Thermal-Vacuum Test Period

Test Condition	*Start of Test Condition*	*End of Test Condition*	*Maximum Chamber Pressure (mm. of Hg)*	*Minimum Chamber Pressure (mm. of Hg)*
Pump down	1600 hrs. May 29	0010 hrs. May 30	760	1.0×10^{-4}
Transient Period Leading to High Temperature Test Equilibrium Conditions	0010 hrs. May 30	2215 hrs. May 30	(1) 1.0×10^{-3}	7.1×10^{-5}
HIGH TEMPERATURE TEST Equilibrium Temperature 108°F ±5°	2215 hrs. May 30	2215 hrs. June 1	7.1×10^{-5}	2.6×10^{-5}
Transient Period Leading to Solar Simulation Test Conditions— Chamber Walls Cooling	2215 hrs. June 1	0915 hrs. June 2	2.8×10^{-5}	2.2×10^{-5}
SOLAR SIMULATION TEST— Chamber Walls Cold, Carbon Arc Illumination	0915 hrs. June 2	0215 hrs. June 3	2.2×10^{-5}	2.0×10^{-5}
Transient Period Leading to Low Temperature Test Equilibrium conditions	0125 hrs. June 3	1830 hrs. June	2.1×10^{-5}	8.6×10^{-6}
LOW TEMPERATURE TEST— Equilibrium Temperature 28°F ±4°	1830 hrs. June 3	1830 hrs. June 4	8.6×10^{-6}	2.8×10^{-6}
Transient Period Leading to Room Temperature and Pressure Conditions	1830 hrs. June 4	0900 hrs. June 5	760	2.8×10^{-6}

NOTE—(1) Pressure rose to the value 1.0×10^{-3} for a short period due to a momentary power failure.

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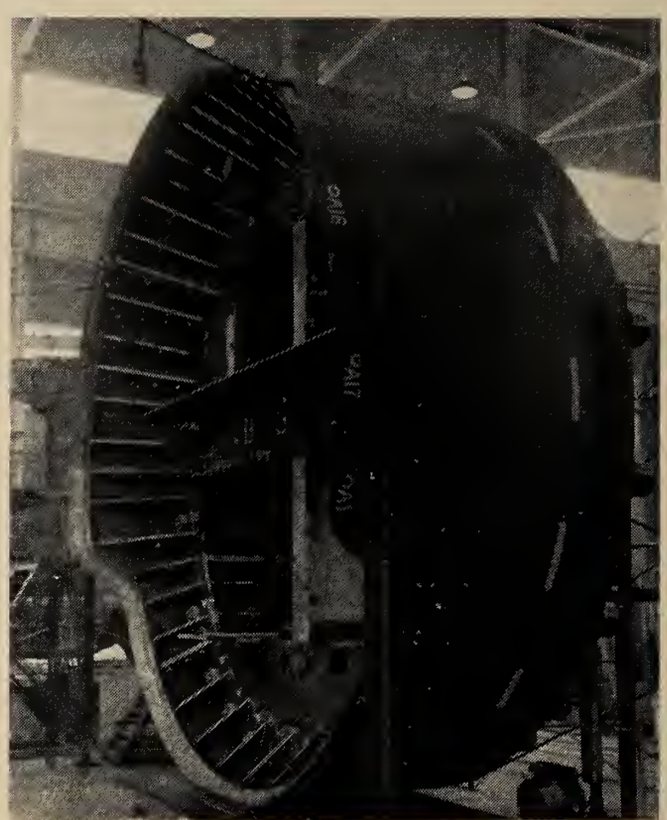
TORONTO SUBWAY TUNNEL SHIELDS

T. M. Noskiewicz, M.E.I.C.

and

J. V. Bartlett

of Messrs. W. S. Atkins & Associates, and Mott, Hay and Anderson, the Toronto Transit Commission's joint consulting engineers for the project.



UNIVERSITY AVENUE Subway, recently completed in Toronto, is the first stage of the Bloor-Danforth-University Subway. One mile of this University Avenue Subway was constructed entirely in tunnel, apart from the two small areas for the mezzanines of the two stations, which were constructed by the cut-and-cover method.

The tunnels, 16 ft, internal diameter for the running tunnels and 24 ft. internal diameter for the station tunnels, were shield driven. In this paper the background of the use of shields for driving tunnels is briefly set out. The details and circumstances of the design and construction of the Toronto Subway shields are described. Some of the more interesting problems encountered are examined in detail.

Shield Driven Tunnels

Obviously, tunnelling in soft ground consists of excavation, and the erection of permanent lining material to support the ground. In ground which is sufficiently self supporting this is still done in the simplest possible manner, but as ground conditions deteriorate, it becomes necessary to take special measures. As its name implies, a shield is basically a casing between the ground and the working chamber.

In England, in 1818, Marc Isambard Brunel registered a detailed patent for a "casing or cell intended to be forced forward before the timbering which is generally employed to secure the work", and as in so many other engineering fields, it is hardly too much to say that his vision covers every subsequent development

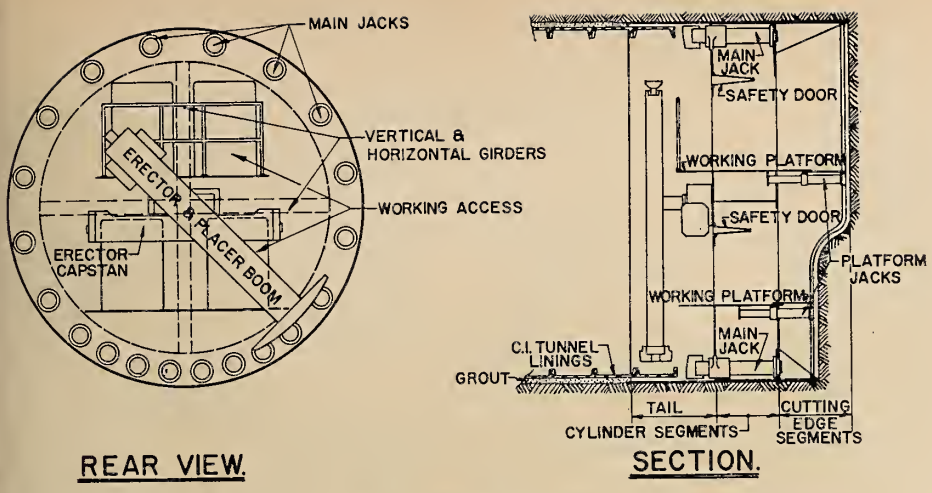


Fig. 1. Diagram of shield.

in tunnel shields. James Henry Greathead advanced Brunel's work when, in 1869, for the construction of the Tower Subway in London, he introduced a much improved type of shield and successfully used a cast iron lining in conjunction with it. To this day, tunnel shields are often referred to as Greathead shields.

Since then, the development of the shield has been geared to the advance of mechanieal engineering, especially the metallurgical, electrical and hydraulic branches.

Today the shield normally consists of a steel cylinder extending from the cutting edge at the leading end, to a tail overlapping the tunnel lining at the trailing edge. Fig. 1 is a diagram of a shield. There is a diaphragm plate pierced for working access, and stiffened by vertical and horizontal girders, which are conveniently placed to divide the face into different working levels and widths.

Around the periphery are mounted the hydraulic jacks which propel the shield forward off the completed tunnel linings.

Further refinements provided when suitable consist of:—

(a) Moveable working platforms
(b) Adjustable face shores
(c) Safety doors
(d) Mechanical erectors for placing segmental tunnel lining.

The University Avenue Subway

The first section of the Toronto Subway was by cut-and-cover methods close to the surface.

However, one mile of the new University Ave. Section, including two stations has been constructed in tunnel for the following reasons:—

(a) The alignment passes close to hospitals and other important buildings where noise and disturbance must be kept to a minimum.
(b) It was possible to pass under the Provincial Parliament Buildings without elaborate underpinning which would otherwise have been necessary.
(c) The grading of the track required that cut and cover work would have reached a difficult and uneconomical depth at some points.
(d) The strata at depth included various water-bearing sands and silts best dealt with by compressed air shield-driven tunnelling.
(e) Interference with surface traffie was negligible.

The Feasibility Study of 1956 also established that a circular cast-iron tunnel lining was to be used, in view of the variable ground and water conditions, and that the tunnels should be shield-driven. Having decided to tunnel, the Toronto Transit Commission arranged for their consulting engineers to design the shields, and for a contract for their construction to be awarded in advance of the general structural contract. This was necessary to save time and to enable the structural contract to start on schedule, but it carried the additional advantage that on completion of the structural contract, the Commission would own shields of the right diameter should additional tunnels be required at a later date.

Four shields were required to drive 16 ft. internal diameter running tunnels in four separate drives. Each of the running tunnel shields is 17 ft. 6 in. outside diameter and weighs about 70 tons. This shield is shown in Fig. No. 2 being assembled in the shop and undergoing final tests.

Two larger shields were used to drive 24 ft. internal diameter station tunnels. Each of the station tunnel shields is 25 ft. 9 in. outside diameter and weighs approximately 130 tons.

The Design of the Shields

The following factors affected the design of the shield:—

(a) The shields had to be capable of dealing with treacherous ground conditions. This, together with the presence of some large boulders effectively precluded any fully mechanised "digger" type.
(b) The tunnels were to pass under important roads, services and buildings. The shields must therefore be conservative in design to the extent that the fullest ground support must be provided at all times, and even in the event of failure of the compressed air, there should be no major influx of ground into the tunnel.
(c) A shield is essentially a tool. Different contractors like different tools. The shields should therefore be versatile so far as detailed working arrangements are concerned. The area behind the shields should be left as clear as possible for the contractor's plant, and working access to the face should be as open as possible (bearing in mind the safety requirements of the last paragraph).
(d) The shields had to be suitable for construction of 24 in. wide rings of segmental cast iron tunnel linings, 16 ft. internal diameter for the running tunnels, and 24 ft. internal diameter for stations.
(e) All components had to be small enough to pass through air-locks for erection in compressed air.

There follows a description of the various shield components as designed, with comments:—

The Steel Structure

We would like to skate over this part of the design as quickly as possible. All specialists like to surround their art with a little black magic. But, seriously, the design of this structure demands the empirical approach. Any shield designed to meet all conditions (for instance the cutting edge striking undetected rock) would be hopelessly expensive and unwieldy. There is now a considerable body of experience of shield operation (including a fair number of failures and distortions) and the scantlings of the various members are selected largely on the basis of experience and judgement.

The essential parts of the shield

structure are the inner structure, the cutting edge and the skin.

i) The inner structure consists of cylinder segments bolted together to form the main stiffening ring, diaphragm plates and stiffening girders.

ii) The cutting edge is made up of several segments bolted together to form the cutting edge cylinder which is extended forward at the top section to form the hood.

iii) The skin is the outer shell and is made up from several curved plates, but in single lengths extending from front to rear to eliminate radial joints. The curved skin plates are bolted to the inner structure through the cylinder segments and the cutting edge segments. The rear end of the skin plates forms the tail of the shield, within which the tunnel lining is erected. As the tail is not braced or supported from the inside, it must be designed to resist all external pressures without distortion. Large shields normally have had skin plates built up of laminated and rivetted steel plates. The T.T.C. shields have segmental plates of 1½ in. single thickness full strength butt welded over the length of the tail.

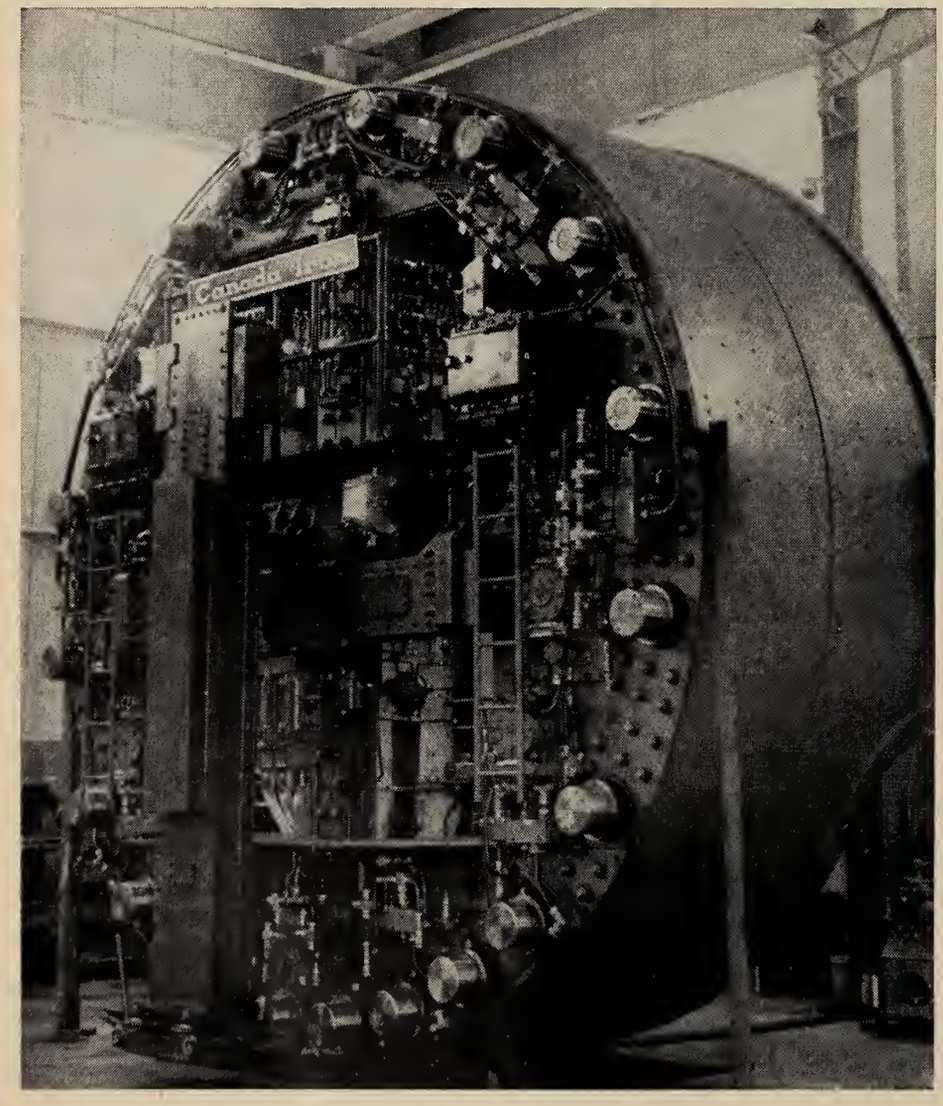
Hydraulic System

Although hydraulic power has been used extensively in tunnelling, water has been the fluid medium used almost exclusively in the past. In recent years oil hydraulic equipment has been incorporated for various auxiliary equipment but nevertheless a large shield-driven tunnel installation has necessarily included a water accumulator and its associated pump on the surface, with high-pressure water services fed through the tunnel to the shield; or alternatively the water pumping equipment has been towed behind the shield on a trailing platform as a separate assembly.

The Toronto Subway Shields are entirely self-contained, the only service brought to a shield in the tunnel being electrical power cables.

The following design influences and requirements affected the design of the hydraulic equipment:—

Fig. 2. Rear view of 16 ft. dia. tunnel shield assembled in the shop. The shield is without skin plates.



Design Influences: — Pressure medium: OIL

Reason:

(1) Low corrosion rate on equipment

(2) Easy availability of pumps, valves etc. therefore:

(3) Lower relative cost than water equipment:—Bronze, stainless steels, chrome plate etc. not necessary except as required on bearing surfaces.

Equipment requirements: —

1) Main 110 ton shove jacks for driving and manoeuvering the shield. Double acting for hydraulic retraction. Dia. 6 13/16 in. Maximum working pressure 6000 p.s.i.

2) Platform jacks (double acting) for moving the working platforms into the excavated face in front of the shield. Also used for jacking the shoring timbers against the tunnelling face.

   Dia. 5 in. maximum working pressure 1,000 p.s.i.

3) Erector capstan and operating rams for rotating the placer boom to the correct radial position for placing cast iron tunnel lining segments.

4) Placer boom and operating rams required to place cast iron segments into their correct diametrical positions in the tunnel lining.

5) Face jacks for holding up the shoring timbers against the tunnelling face. Used only on the 24 ft. dia. tunnel shields as additional face supports to platform jacks. The alternative manual mechanical jacks were adopted in preference to hydraulic rams (lower cost).

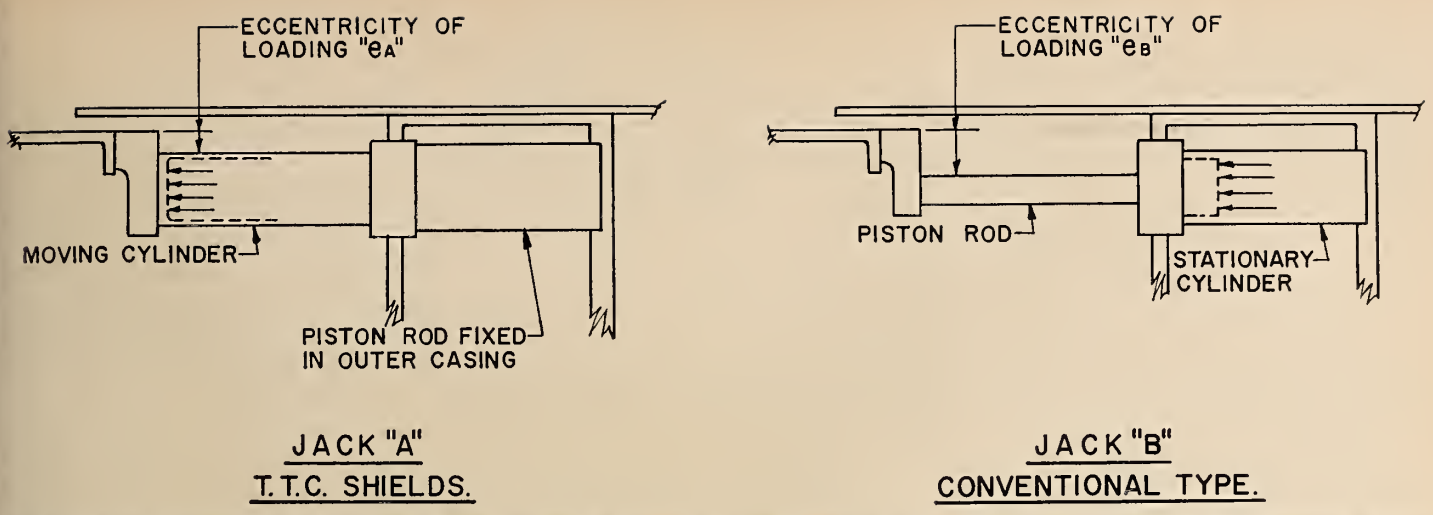
6) Motors, valves, pumps, tanks, safety devices, etc.

The system for each shield comprises:—

For each 16 ft. dia. tunnel shield 20 Main shove jacks, 6 Platform jacks, 1 Erector

For each 24 ft. dia. tunnel shield 30 Main shove jacks, 8 Platform jacks, 24 Mechanical face jacks, 1 Erector

Main shove jacks have been located around the inner periphery of the shield (Fig. 2) with larger concentration of jacks in the bottom to prevent the shield from "nosing down". This double spacing of main jacks around the top of the shields has been justified in practice. Even double-spaced, the top jacks have on the average seen less use than the bottom jacks.



JACK "A" T.T.C. SHIELDS.

JACK "B" CONVENTIONAL TYPE.

Fig. 3. Greater diameter of the working cylinder reduces the length of crank required to reach the outer diameter of the segment against which the ram is required to shove.

Main Individual Design Requirements:

(a) All equipment to be as robust as possible to withstand handling by mechanically untrained miners.

(b) To withstand tunnelling conditions of dust, wet, grout, mud etc., all moving surfaces passing through hydraulic glands to be thoroughly protected both mechanically and from dirt.

(c) To cope with inevitable breakdowns all equipment to be duplicated in such a way that driving operation of the shield can be continued.

(d) Interchangeability. Component parts of main items as well as the main items themselves to be interchangeable between shields.

(e) Ease of replacement of main items, such as shove rams, to be catered for by overall design of the item as well as their hydraulic isolation, in case of failure, from the circuits by suitable stop valves etc.

These criteria:

(a) Robustness
(b) Dirt exclusion
(c) Interchangeability
(d) Stand-by Siamesing
(e) Ease of replacement

each had considerable influence on the design of the components and the shield structure.

We would like now to explain how the above criteria influenced the design of equipment items.

1) Main shove jacks

(a) Robustness.

It is known that considerable side forces are exerted on shield jacks but as it is impossible to calculate their extent it was considered that the safest course was to design the stiffest possible jack within the dimensional limits dictated by the shield structure and interchangeability requirements.

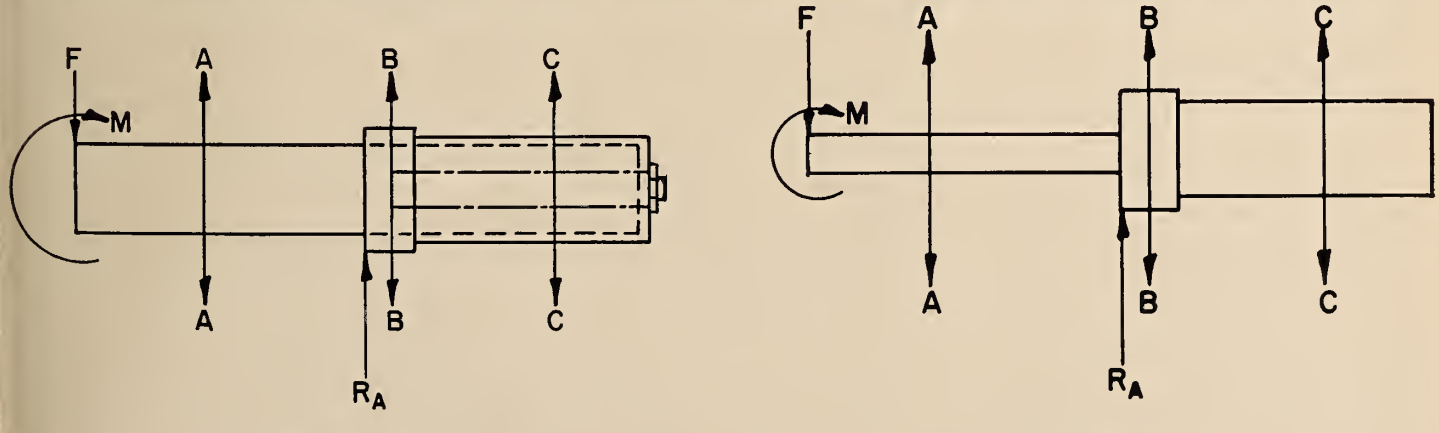
As a cylinder must be of a larger diameter than its piston rod (more so with a double acting ram) it was decided to utilise the cylinder and the pressurised column of oil within it as the moving working portion rather than the piston rod, which would have a lesser resistance to side loading.

The greater diameter of the working cylinder also reduced the length of crank required to reach the outer diameter of the segment against which the ram is preferably required to shove. This is illustrated in Fig. 3. The eccentricity of loading "e" is thus reduced which further reduces the couple and resultant side load.

Calculations for the jacks took the following form:—

(i) A comparative analysis was made of two jacks of identical bore and stroke in order to determine their relative stiffness and ability to resist side loading (Fig. 4).

Fig. 4. Comparison of two rams of identical bore and stroke to determine their relative stiffness and ability to resist side loading.



JACK "A" T. T. C. SHIELDS.

JACK "B" CONVENTIONAL TYPE.

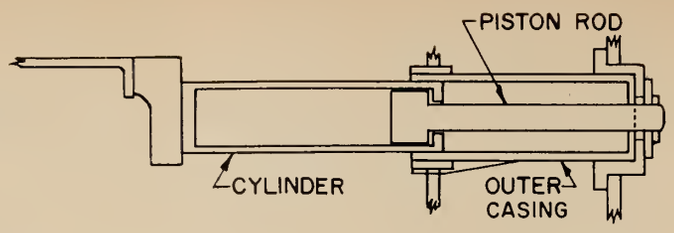


Fig. 5. Diagram of the main jack showing the principle of moving cylinder and stationary piston rod.

Jack A—As used on the T.T.C. Shields

Jack B—Conventional type

It was assumed that difference between the two jacks may only be found in difference of section at A-A. Using theory of simple bending in beams, with 1 lb. side load (F) on extended jack, the following deflections were established:—

Jack A—12.53 x 10^{-6} in. per lb. side force

Jack B—19.13 x 10^{-6} in. per lb. side force

showing a gain in resistance to deflection of approximately 35%.

(ii) On the new design of jack A, taking critical stress for EN 19 steel as 35 tons p.s.i., and basing critical bending stresses at 1% proof (limit of proportionality) it was found that Max. Reaction at R_A (shear) would be 21.6 tons. Hence maximum values for side force and end load were determined.

Side force max. load = 9.0 tons

Max. end load = 130.0 tons

The jacks were designed to use modern techniques developed for the manufacture of relatively thin wall cylinders of high tensile steel for oxygen gas cylinders rather than heavy thick walled cast steel. The cylinders were forged from EN 19 steel 1% chromium-molybdenum steel (British Standards B.S. 970-1947) of 55 long tons per sq. in. ultimate and a min. y.p. of 44 long tons per sq. in. with a heavy base to which the special articulated shoes were bolted.

The cylinders were machined externally to slide in an outer fabricated steel case (see (b) dirt exclusion) and the piston was arranged so that its head projected slightly outside the line of the end of the external case. Any expansion of the cylinder ahead of the piston could then take place without binding on the fabricated case around it. To reduce breakages of tunnel iron linings an articulated shoe was used on the ram heads. This shoe further assisted in reducing the side loads on the main rams.

(b) Dirt Exclusion.

The use of the cylinder for shoving meant that the piston and rod needed to be anchored at one end and advantage was taken of this to effect total protection by encasing it in an outer cylinder of a diameter large enough to enable the working cylinder to slide within it. This point is illustrated in Fig. 5.

(c) Siamesing.

Not applicable except that two jacks are operated by each main valve at the same time, and under (e) (ease of replacement) the two hydraulic mains to the ram are provided with stop valves for isolation. As a further safety precaution, in case only the cock in the main to the annulus side of the piston is shut down, a bursting disc was provided between the cock and ram to blow in case of intensification which would develop should pressure be supplied inadvertently to the "drive" side of the piston.

(d) Interchangeability

So far as component parts are concerned, this was catered for by close limiting of part drawings and careful inspection.

(e) Ease of Replacement

Owing to the effective stroke of the rams 27½ in. and the nearness of the rear shield bulkhead to the tunnel segments it was considered that it would be advantageous to give an early angle to the rams during their placing or withdrawal. The rams and their location in the bulkhead were therefore made eccentric, so that when the ram was withdrawn with its casing its rear end would drop down the guide ramps welded to the outside of the case and so clear the tunnel segments.

2. Platform Jacks

These rams are straightforward except that the piston rods are anchored to the bulkhead and the two hydraulic supplies to each side of the piston head are taken down the piston rod. The cylinder ends are fixed to the front faces of the moving platforms. The reason for this choice of application is that hydraulic connections to the anchored piston rod are neater and keep pipes out of the way of damage and that, by moving the cylinders instead of the rods as in conventional applications, the exposed rod is well back from the miners' working positions and out of pick range, and well protected from dirt under the floor.

A feature of interest in the hydraulic control of the platform rams is the incorporation of an intensification bleed system in the circuits.

These platform rams operate in opposition to the main shove rams and, during a shove, considerable intensification of pressure in their cylinders could develop from their being forced against the working faces by the high pressure shove rams moving the shield forward. Any excess pressure so developed over that required to hold the face timbers in position is bled automatically through check valves to a central adjustable relief valve in such a way that overpressure developed in any one or more jacks does not affect any of the others.

3. Erector Capstan and Rams

The erector assembly consists essentially of rack and pinion device which rotates the erector boom through an arc of 370°. In operation the erector is used in rotating up the cast iron segments for lining the tunnel. The final placing and keying the segments is done by a radial movement of the erector boom, powered by a placer assembly integral with the boom.

As the erector capstan is not required to be used during a main shove its rams were designed to be supplied by either of the 6000 p.s.i. main pumps; selection being made by lever operated spool valves. The criterion of standby operation is therefore satisfied.

Robustness and compactness in the design of what must be a bulky piece of equipment was maintained by keeping the operating strokes of the rams fairly short. This necessitated a high gear ratio in order to give the boom a minimum sweep of 370°. Therefore, in order to reduce the tooth loading of the necessarily small diameter pinion it was arranged for two pinions to mesh with the hydraulically operated rack and both of these to mesh with the smaller

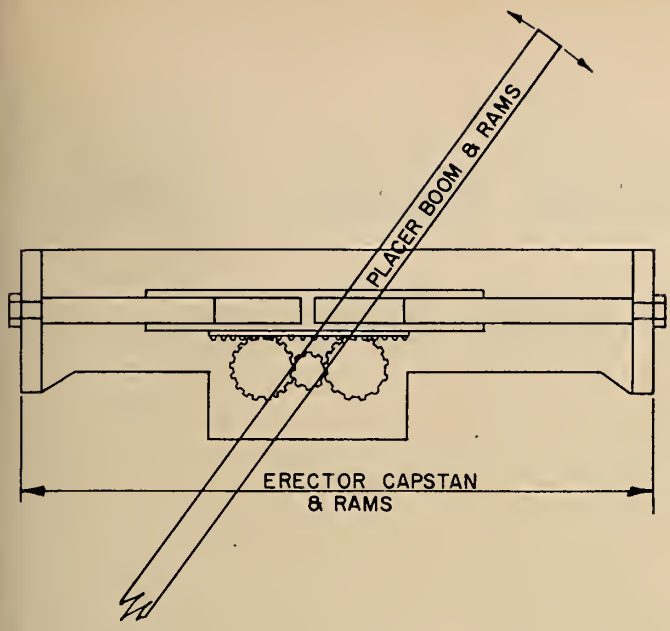


Fig. 6. Erector and placer assembly. This hydraulically operated erector is used for placing each segment into position in the tunnel linings.

pinion between them fixed to the hub of the capstan (Fig. 6.)

Two single acting rams were preferred to one double acting piston so that serviceability could be maintained easily. Internal leaks across a piston are difficult to find and, with equipment where safety is essential, a leak at the gland of a single acting ram is shown immediately.

For compactness it was arranged once again to reverse the normal order and move the cylinder and anchor the rams. The rack operating cylinder is a monolithic block bored out at each end to form two back to back cylinders provided with two glands through which the two pistons are sealed. The ends of the pistons remote from one another are anchored to the capstan case so that, by introducing hydraulic pressure into either cylinder down bores in the rams, the cylinder is made to move along the rams. The rack is bolted to the moving cylinder block by special tapered shear screws designed to distribute the shear forces equally among them.

The erector capstan case is totally enclosed to exclude dirt.

4. Placer Boom and Rams

The placer head is extended and retracted by opposed single-acting rams.

To exclude dirt this is designed as a simple box section built up of structural shapes and arranged to slide along its length over two channels bolted to a block carried by the capstan hub. The ends of the boom are arranged to receive inside it the rams of single acting jacks, the cylinder bases of which are recessed into each side of the capstan block. This design enables gland leaks to be apparent before there is likelihood of danger and at the same time enables all hydraulic surfaces to be covered from dirt and grout.

To reduce the loading on the capstan jacks the boom was counterbalanced to half the weight of a segment.

Control difficulties and Safety Devices. Erector Capstan and Placer.

Inching control valves were incorporated to enable accurate placing of the segments.

The main difficulty to be overcome on the capstan was the over-run of the load as it swung over D.C. or the similar reversal of load on the placer boom jacks as the boom moved either above or below horizontal. These problems were overcome in the design stage by incorporating into the circuits a system of automatic double reflux valves with pilot operated check valves which were originally developed by the valve makers for use on "bridging" tanks during the last war. In this application the bridge was picked up behind the tank and swung over the tank and dropped in front of it by two hydraulically operated booms.

Adjustable relief valves are incorporated in the erector capstan and placer jack circuits and set to blow at pressures just above those required to lift a segment with the boom horizontal and fully extended and with the boom vertical respectively. This arrangement takes care of any overload condition should the boom foul other equipment and also acts as travel limit safety valves.

5. Pumps and Valves

Two 20 hp. pump units serve the main shove jacks with the hydraulic assembly which operates the erector capstan, while the two 6 hp. pump units serve the platform jacks and the placer assembly. The control circuits are so arranged as to permit emergency operation of any of the services should one pump unit of either pair be temporarily out of use.

The details of the pumps are as follows:—

4½ g.p.m. at 6000 p.s.i. 20 hp. for driving main shove jacks and erector capstan.

5.5/1.1 g.p.m. at 1,000 p.s.i., 6 hp. for driving and holding the platform jacks and placer jacks.

Also driven by the motors for the 6,000 p.s.i. pumps are two small pumps delivering 2½ g.p.m. at 300 p.s.i. to provide an independent supply to the pilot valve circuits.

Normally it was arranged for one of the 1,000 p.s.i. pumps to drive the platform rams and the other pump to drive the placer jacks but, by suitable valving, either pump could drive the lot.

Conclusions

The tunnel shields used on a tunnel section of the University Ave. Subway in Toronto are described in this paper. The six shields used on this project are especially noteworthy in that they are entirely self-contained, the only service brought to a shield in the tunnel being electrical power cables. It is believed to be the first occasion on which self-contained shields of this type and size have been built. It is also believed to be the first occasion on which fully protected hydraulic equipment has been designed specifically for the arduous work and conditions encountered during tunnelling. An interesting feature of the shield jacks is that they have the cylinder as the working part instead of the piston rod. This increases the jacks' stiffness and ability to resist side loading. The use of the cylinder for shoving made it possible to protect all swept surfaces, such as piston rods, from mechanical damage and contamination by dirt, grout or other foreign matter.

ACKNOWLEDGEMENTS

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PRECAST AND PRESTRESSED WATER TANKS

— A Simplified Construction Method —

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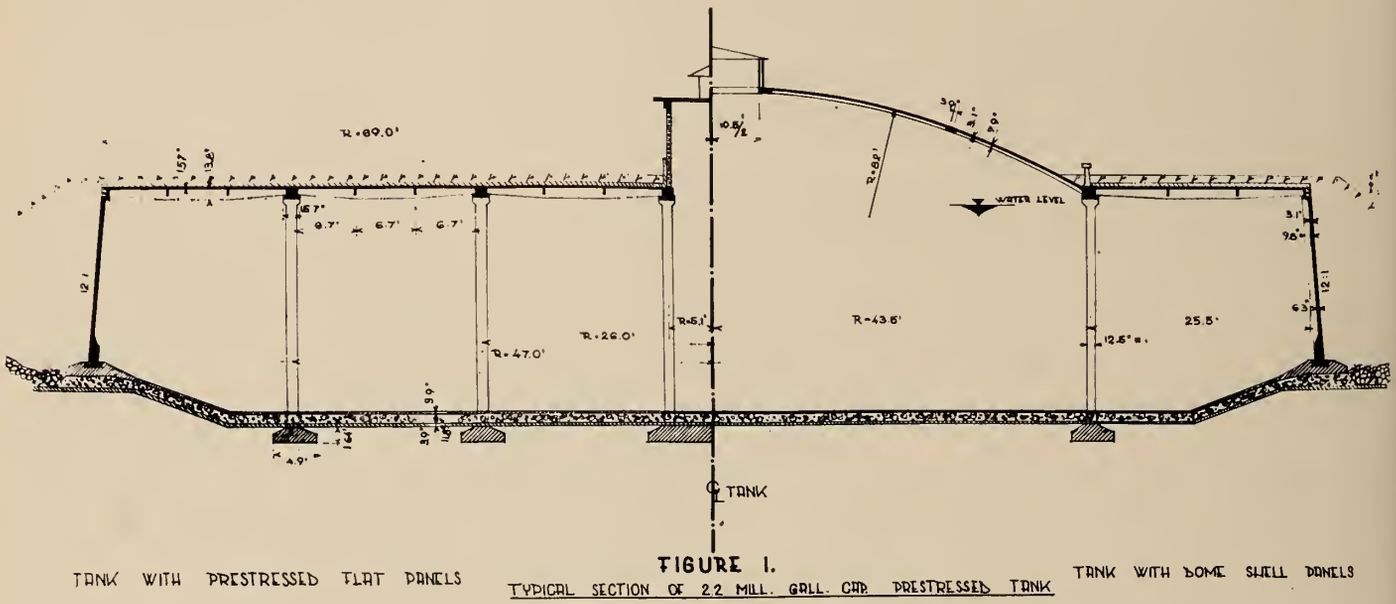
THE PRINCIPLES of prestressing have been applied to the design and construction of circular structures for at least 20 years. In both Europe and America, several methods have been used in the application of the same principles. The best-known system perhaps is the "Preload" system developed in the United States.

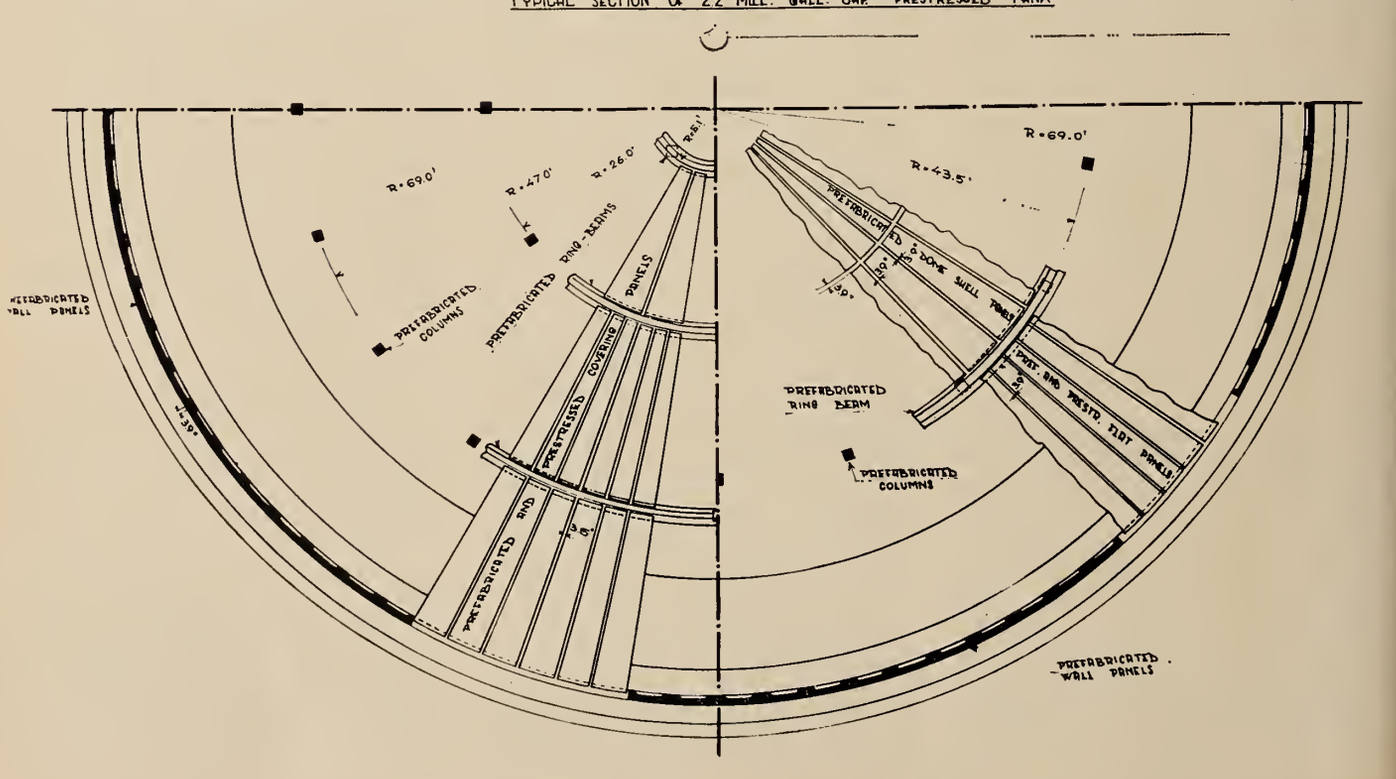
This "Preload" system applies to the concrete wall horizontal layers of prestressing wire under uniform stress.



TANK WITH PRESTRESSED FLAT PANELS

FIGURE 1.
TYPICAL SECTION OF 2.2 MILL. GALL. CAP. PRESTRESSED TANK

TANK WITH DOME SHELL PANELS



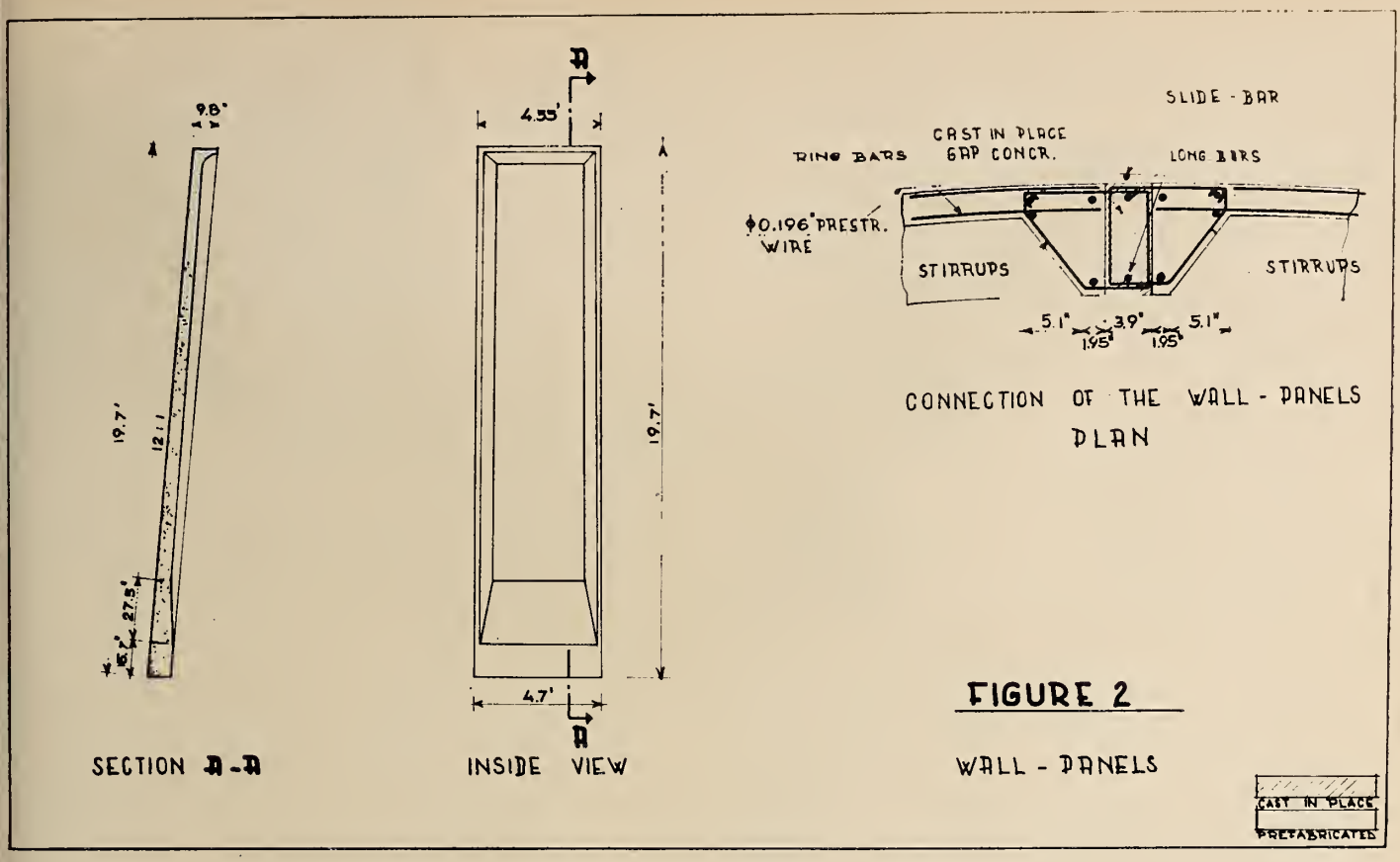


FIGURE 2

WALL - PANELS

The wire is wound up by a winding machine travelling around the outer circumference of the wall, which draws the wire through a steel die, reducing it in diameter. The wall is thus subjected to compressive stresses which will counteract subsequent tensile stresses due to the internal water pressure. To protect the wire against corrosion, a coat of gunite is applied to the external face of the wall.

The Swiss BBR system applies similar ideas for circumferential prestressing of reservoirs. There are a number of other systems in Europe all working along similar lines. In all the systems where a winding machine is used for prestressing the concrete walls are generally cast in place and the machine is applied after the concrete has cured.

A precast method, the Pritzker system, has lately found application in the United States. The walls consist of precast, prestressed barrel shells erected vertically on a circular foundation. Precast, prestressed single Tees serve for roof members spanning between the exterior wall and a central cone.

The system which will be discussed in this paper was first used in Hungary and Germany in the 1950's. The tanks built in Hungary according to this principle were mentioned among the outstanding recent structures at the fourth, last congress of the Fédération Internationale de la Précontrainte in Rome.

The system accomplishes circumferential prestressing with simple means without the use of patented winding machines and highly skilled labor. Except for the foundation, all elements are precast. This means considerable time saving at its construction.

The method is based on a principle which has been applied by makers of wooden barrels for many centuries: prestressing wire will perform the same function as the metal hoops of a barrel. The exterior wall of the tank is constructed slightly tapering toward the bottom. Prestressing wire is wound all around the walls in a predetermined pattern marked on the wall, either from a reel mounted on a truck or, in the case of small tanks, by one or two workmen. In winding on the wire no special effort is required: wire has to be only reasonably tight since no stress is required in that stage.

After the wire has been wound on it is forced down the sloping wall. There will be an elongation of the wire and corresponding stress. The bigger the slope the smaller is the distance the wire rings need to travel to achieve an elongation corresponding to a stress of 70% of the ultimate strength of the wire. There is, however, a practical limit: to prevent the wire from sliding on concrete there are vertical slide bars located around the perimeter of wall which keep the wire from touching the concrete. The practical limit is imposed by the friction coefficient between steel and steel. Usually a slope of 12 to 1 is used as a maximum; at a bigger slope the wire rings would slide back. Forcing down is implemented with the simplest tools, using hammer and clipper plates. The final calculated position of the rings is reached in several steps since the rapid build-up of localized compression would crush the thin concrete wall.

The distance the wire-rings have to travel is directly proportional to the radius of the tank. For this reason this method is not practical for the construction of tanks with capacities of several millions of gallons where diameter of the tank would be beyond practical limits.

After all wire-rings are in their predetermined position, the wall is compressed sufficiently to counteract the effect of subsequent internal pressures. Wires are then protected by a coat of gunite sprayed on the wall.

Figure 1 shows half plan and section of 2.2 mill. gallons capacity water tank constructed according to this method. Only the 4 in. thick bottom slab is poured in place. Wall panels, columns, rings beams and roof elements are all precast. Diameter of the tank is 138 ft. and height of the wall is 19.7 ft. Wall panels are tapering shells reinforced with ribs at the four sides as shown in Fig. 2. They have a thickness of 3 in. at the top and 6 in. at the bottom and are

joined with cast-in-place concrete in the gap left between two adjacent panels. Stirrups from the wall units are projecting into this gap. There are 120 wall panels for this tank each weighing 3.4 T.

The section in Fig. 1 shows two alternatives for covering the tanks: on the left side, precast, prestressed flat slabs are used with cast-in-place concrete in the radial and circumferential gaps between adjacent units. Roof slabs are supported by precast ring beams resting on precast columns.

The right side of the section shows the flat slab units combined with precast cylindrical shell sections. Shell segments are joined with cast-in-place concrete in the gaps, same way as the flat slabs. Shells are 3 in. thick and reinforced with ribs. Horizontal thrust of the dome is balanced by prestressing the bottom ring according to the principle described earlier. Fig. 3 shows the thrust ring of the dome with the sloping height increase to allow space for the prestressing wire.

The photograph taken from inside shows the same all-precast tank with

Fig. 4

flat slab roof during construction. Gaps between adajacent wall units, roof slabs and ring beams are not yet concreted. Pouring gap-concrete will follow next. Interior face of the wall will receive three layers of waterproofing sprayed on before prestressing takes place. The bottom slab will also be waterproofed. Special watertight mortar is used for the cast-in-place concrete in the joints.

This construction method is very simple, fast and relatively inexpensive. It can be done by contractors having no previous experience in building prestressed concrete reservoirs, and no patent fees are involved. It is very well suited for construction in remote areas since fabrication can be done on the job site. It is also suited for minor reservoirs, up to about 300,000 gallon capacity.

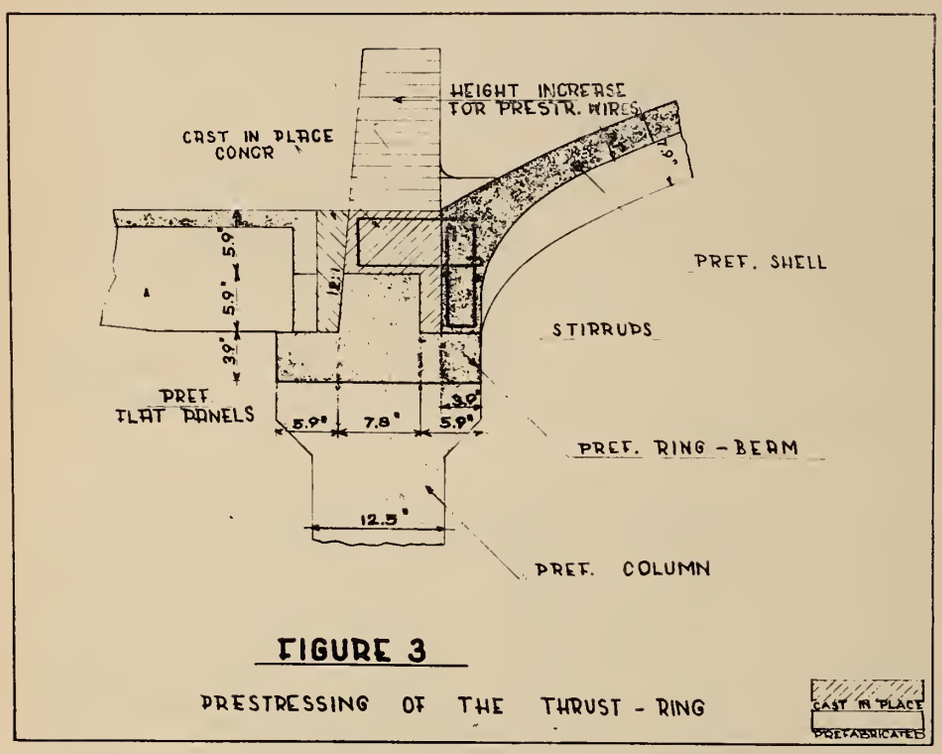


FIGURE 3

PRESTRESSING OF THE THRUST-RING

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PROGRAM

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PAPERS:

1—**Pump Storage**—D. Werminlinger (Bilingual)

2—**Coating Operation**—F. O'Flaherty (English)

3—**Transmission A Haut Voltage**—Mr. Baribeault (Francais)

4—**Water Filtration**—(Degremont Co.) (Bilingual)

5—**Earthquakes & Buildings Design**—H. S. Ward (English)

6—**Control de la Pollution Industrielle**—Dr. L. P. Roy (Francais)

PLANT VISITS:

1—**Shawinigan Water & Power—Generating Station in Shawinigan**

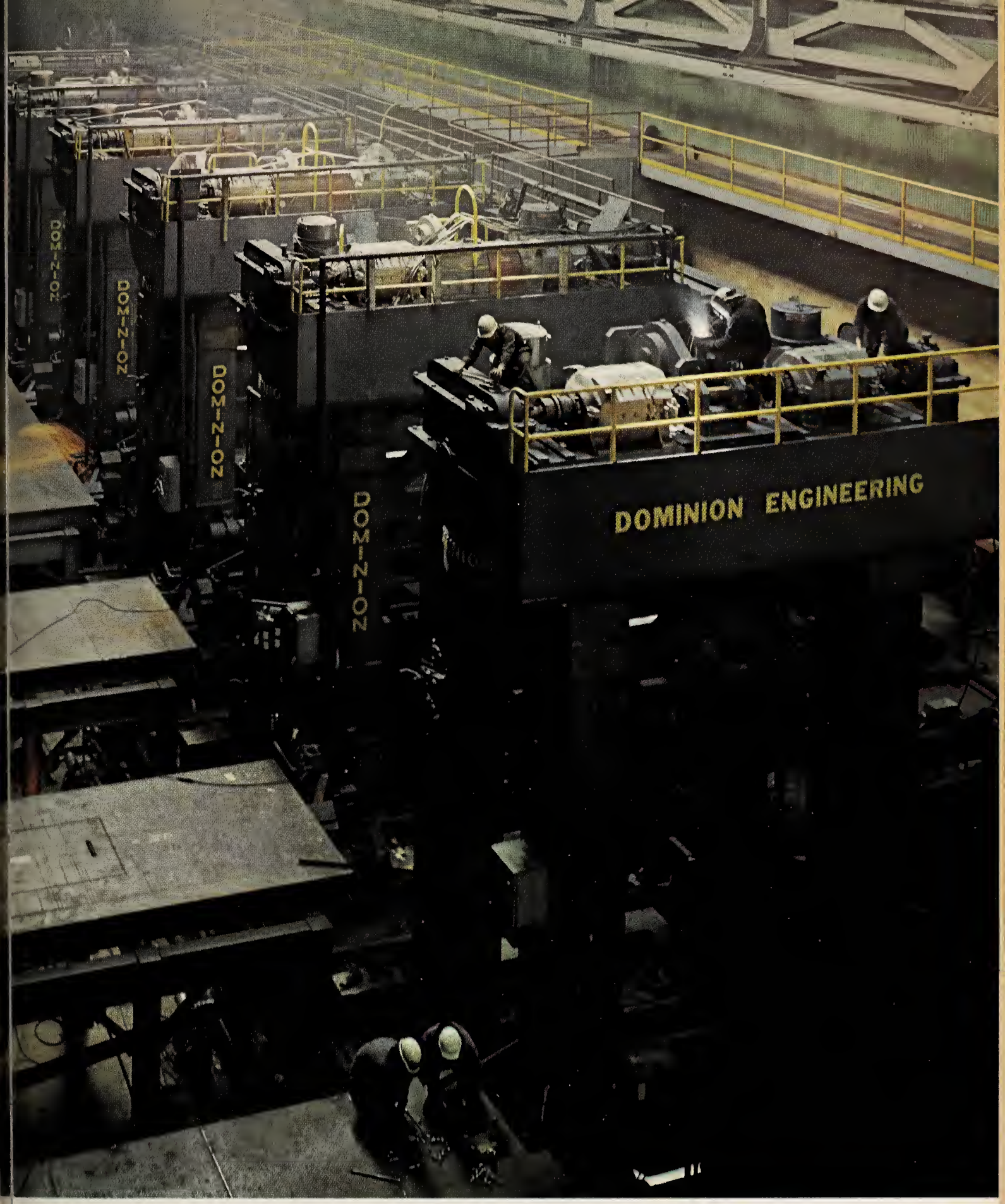
2—**Three Rivers Domtar Coating Operation**

3—**Usine de Filtration de Trois-Rivieres**

LADIES' PROGRAM:

Mixed luncheon, visit to a Shoe Manufacturing Plant, tea, fashion show, cocktails, dinner and dance.

LUNCHEON — COCKTAILS — DINNER — DANCE



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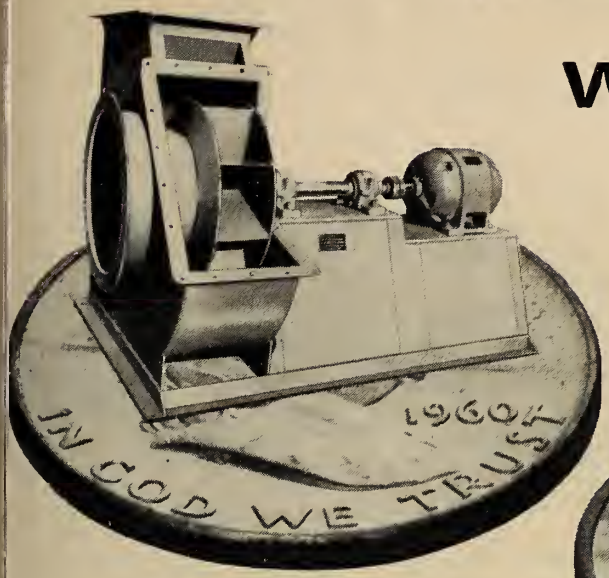

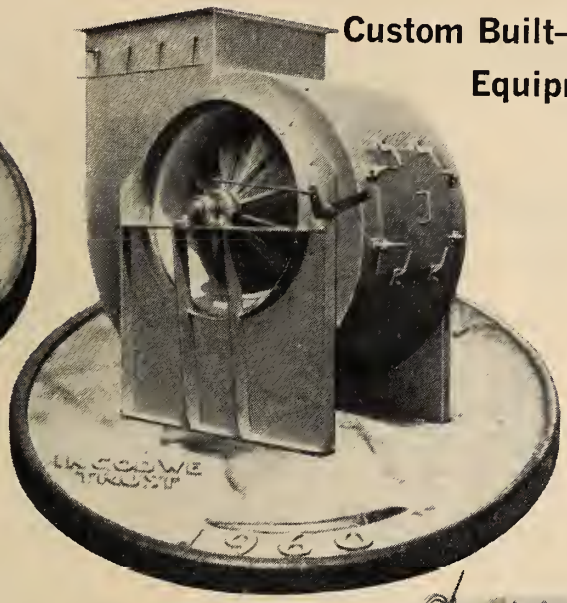

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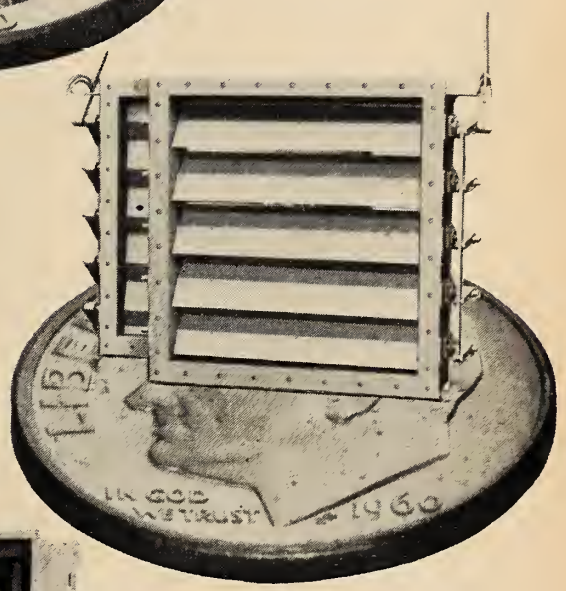

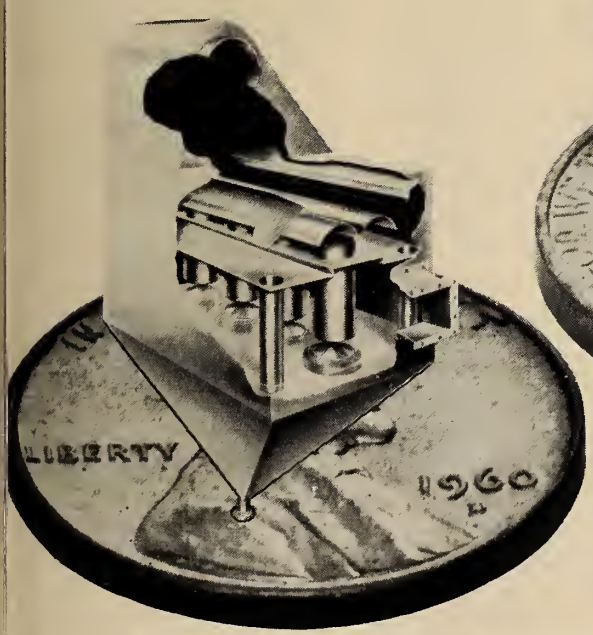

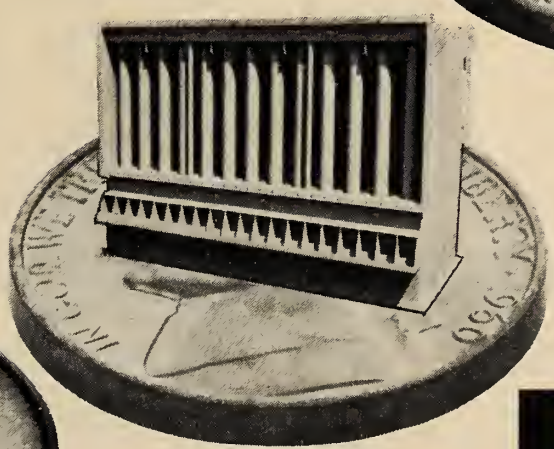

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Discussion

THE ENVIRONMENT OF SPACE— ITS SIMULATION AND TESTING OF THE CANADIAN "TOPSIDE SOUNDER" SATELLITE

F. D. Ward
Canadian Armament Research and Development Establishment
The Engineering Journal, August, 1963
page

Discussion by L. S. Davis
CARDE

This discussion is based on precautions that were taken to ensure reliability of test equipment

With reference to the test schedule of the 'Topside Sounder' satellite as discussed by Mr. Ward, it can be seen that seven days of continuous testing were required to complete the thermal/vacuum test. An additional requirement of the test specification was that in event of loss of vacuum in the space chamber three additional days of continuous testing would be required in addition to the original seven, a condition which would seriously hamper the satellite program. It was therefore imperative that all possible causes of equipment failure be under constant surveillance.

Since much of the test equipment was non-automatic in operation a system was implemented whereby at regular intervals all apparatus was readjusted and operating data was recorded. Spacing of these check intervals was such that any deviation from normal would be observed and rectified without serious effect to the space environment. In those cases where close tolerance in the space environment was required, continuous monitoring and adjustment of that equipment was necessary.

The data recorded during the interval checks was used to plot a trend chart which was helpful in predicting when changes would be required in order that the space environment meet the specification. The chart was also used as a record of events that had taken place.

It was realized that a major breakdown such as a refrigerator compressor burnout or heater element failure would disrupt the test and necessitate the extra three days of testing. However, it was possible to ensure that any minor breakdown would not interfere with the test by having standby equipment available, by having duplicate sets of fuses and jumpers on hand and last but not least by having the engineer-in-charge on each shift thoroughly schooled in the mechanics of all equipments so that instant remedial action could be taken where possible to bypass defective machinery. On one occasion the effectiveness of this procedure was shown when all refrigeration units ceased to operate. Normally this would have meant closing down the diffusion pumps with a resulting loss of vacuum. However previous experimental trials had shown that a one minute on nine minute off continuous cycle of the diffusion pump heaters would maintain safe operation of the pump oil for 45 minutes. The procedure was used while repairs were made with no detrimental effects on the space environment.

We were fortunate at CARDE in having a 12½ Kw. standby electrical generator on hand. This was connected to the mains in such a manner that in the event of a power line failure operation of the most vital equipment would be automatically maintained.

In conclusion it can be stated that reliability of equipment can be maintained at a high level by first conducting a thorough pre-test checkout, second by implementing a carefully planned inspection program and finally by ensuring that standby units are on hand. The success of the 'Topside Sounder' test program was due in large part to the use of these preventive measures.

Discussion by D. L. Bulleid
CARDE

The main object of extensive environmental testing is to ensure equipment reliability and thus safeguard not only the experimental results, which it is hoped to obtain but also the investment, which, as we shall see, can in some cases be astronomical.

Let us first consider a few costs relative to the testing of a piece of equipment such as the Topside Sounder Satellite.

The shaker at Goddard Space Flight Centre which was used in order to carry out the main vibration testing program of the completed Topside Sounder is reported to have cost $100,000. This particular shaker of course has everything that a good shaker should have such as provision for random vibration and cycling, but even so the investment is considerable. The 1500 lb. force shaker which is installed in the Environmental Laboratory at CARDE and which you saw on the screen cost some $33,000. in 1954. This shaker was used to conduct vibration tests on certain Topside Sounder components.

As Mr. Ward has indicated the Thermal Vacuum testing of Topside Sounder was carried out at CARDE. For this purpose a Thermal Vacuum chamber was purchased in 1960 for some $40,000. On top of this, let us try and consider the cost of carrying out continuous periods of thermal vacuum testing. These tests were conducted on a continuous day and night basis for two or three week periods, to a total of about 10 weeks. CARDE provided 2 men per shift to ensure continuous operation of the chamber and to take readings of temperature and vacuum and also to operate the arc lamps employed to simulate the sun. DRTE provided 2 men per shift to monitor the performance of the satellite. Thus it will be seen that this portion of the testing alone occupied 120 man weeks. This does not include set up time or development of the temperature recording system which Mr. Ward has described or any other of the necessary preparatory work.

It is hoped that the few examples given will serve to indicate the considerable cost of environmental testing, bearing in mind that the examples given are those of a relatively small scale operation. In contrast let us now consider a few costs associated with space research from which I think it will become apparent that the cost of extensive pre-flight testing is amply justified not only to ensure results but also to protect the investment. What is this investment?

The Thor Agena B rocket vehicle which was used to place the 320 lb. Topside Sounder into orbit, to be fair, is actually capable of placing 500-600 lbs. in orbit costs some $6 million each. At this price one does not want to have to say, "sorry chaps a wire broke or a component came loose; please can we have another launch vehicle". On top of even this $6 million per vehicle are range costs, transport costs and of course the cost of the satellite itself.

The cost of the moon probe program has been estimated at $20-30 billion of which about $6 billion will be spent in the next two years.

I hope that those few examples will convince the sceptics, if any, that Fred Ward and his staff are in fact spending money in order to protect investments one, two or even three orders of magnitude greater than that which they spend.

Discussion by: John Mar, MEIC, Head of Space Technology Thermal Mechanical Group
Defence Research Telecommunications Establishment
Ottawa

As Mr. Ward points out, the first phase of environment to which a spacecraft is subjected is that associated with launch. The mechanical forces, vibratory and major body accelerations, associated with booster operation primarily dictate the structural design of spacecraft. These vibration and acceleration forces occur in the lateral plane as well as in the thrust or direction of flight. Although thrust direction components are always more severe than lateral by factors of 2 or 3 in vibration and 8 to 10 in acceleration, lateral components nevertheless influence spacecraft design heavily. For instance, lateral vibration excitation of the lateral bending mode resonance of the first model of Alouette caused a structural failure to occur.

In addition to rocket motor combustion mentioned in the paper, aerodynamic forces such as boundary layer pressure fluctuations on the skin of the rocket during flight, rocket body excitation through encounters with "wind gusts" during ascent, and liquid fuel turbopump cavitation noise contribute significantly to the overall vibration level. As these latter factors are functions of flight speed and time, vibrations increase in frequency with time after lift off. Typical rates of sinusoidal vibration component frequency change are from 2 to 4 octaves per minute; a factor which is included in satellite vibration test specifications.

Time durations of the vibration environment is usually about 15 minutes during actual flight but is made much longer for design qualification testing.

(Continued on page 62)

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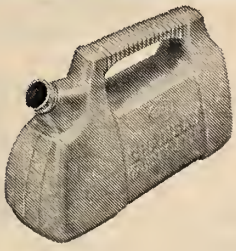

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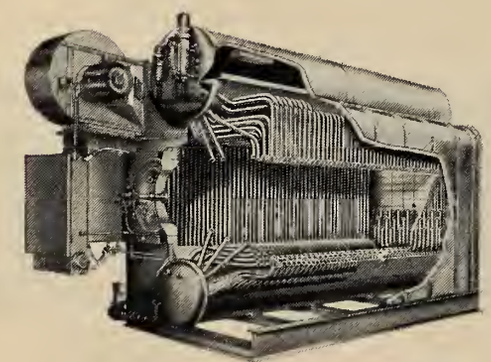

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Photomicrograph courtesy Forest Products Research Branch, Department of Forestry, Ottawa showing the innocent looking, bamboo-like tubes called hyphae, (or, in mass, mycelium) which cause wood rot. They are an air-borne form of plant life of a very low order.

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You, as a Professional Engineer, have a great responsibility in the development of plans and specifications for the various projects in our Province. Your assistance is urgently needed to ensure that a greater percentage of the materials used in these projects are Made-in-Canada products.

At the first Manufacturing Opportunities Show recently held in Toronto, thousands of imported components were displayed. It was clearly demonstrated that many of these could be made equally well in Canada and at competitive prices. In the few months since, thousands of dollars in orders have been placed for their engineering and manufacture in Canada, many in Ontario.

The Government of Ontario does not recommend the elimination of imports. It does suggest that when a Canadian product is comparable in quality and price to one that is imported, your decision should be to specify the Canadian product.

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77th
ANNUAL GENERAL MEETING

An excellent technical program, diverting social activities and a host Branch which combined charm and efficiency resulted in an excellent 77th Annual General Meeting of the Engineering Institute of Canada.

The meeting was held May 22-24 in the Chateau Frontenac, Quebec City. Dozens of members of the Quebec Branch contributed freely of their time and energy, and the results justified the effort. Particular note should be made to the contributions of the members of the Annual Meeting Committee:

Chairman, Jacques Roy; Vice-Chairman, Jean-Baptiste Delage; Secretary, Yvon Magnan; Publicity, Guy Dion; Budget, Finance and Muriel's Room, Gerry Verge; Meeting Arrangements, Bernard Michel; Hotel Arrangements, Marc Bergeron; Registration, Rene Rioux; Entertainment, Marcel Jobin, Transportation, Jacques Beauchamps.

Mme. Georges Demers and Mme. Jacques Roy were Co-conveners of a Ladies Committee which contributed a great deal to the enjoyment of the many women visitors.

EXECUTIVE COMMITTEE MEETING

Two days before the Annual Meeting was to open officially a meeting of the Executive Committee was held. President Lawton was Chairman. Those attending the meeting included President-elect Higginson, four Vice-Presidents, Chairmen of four Standing Committees, and four Councillors.

Following are the highlights of the meeting.

FINANCE COMMITTEE

G. N. Martin of Montreal, Chairman of the Finance Committee, summarized the current financial position of the Institute. He said Associate Members are somewhat behind in payment of 1963 fees. However, there is a possibilty that joint fees collected by some Associations have not yet been received by the Institute.

The sale of advertising in the Engineering Journal has improved somewhat in the past few weeks.

The new records and accounting system now is in full use at Institute Headquarters. Approximately 2,000 additional questionnaires were returned following their inclusion with the Annual General Meeting advance mailing. About two-thirds of the members now have returned the forms.

The ad hoc committee established to study special fees and arrears will report to the next meeting of the Executive Committe.

Privy Council Assistance

The Privy Council is seeking contact, through the Institute, with the Dean of engineering on certain engineering and training problems related to the design of protective construction. Recommendations are required regarding:

a. Expansion of Canadian capability in the design of protective construction;

b. An indication of those universities prepared to undertake various phases of the work;

c. How much assistance would the university require from the Emergency Measures Organization or other federal agencies;

d. What would be the best way to disseminate information and knowledge among those interested.

C.T.O. is also studying this problem.

ANNUAL MEETING OF COUNCIL

On the evening of May 20 the last meeting of the Council for 1962-63 was held. President Lawton was Chairman.

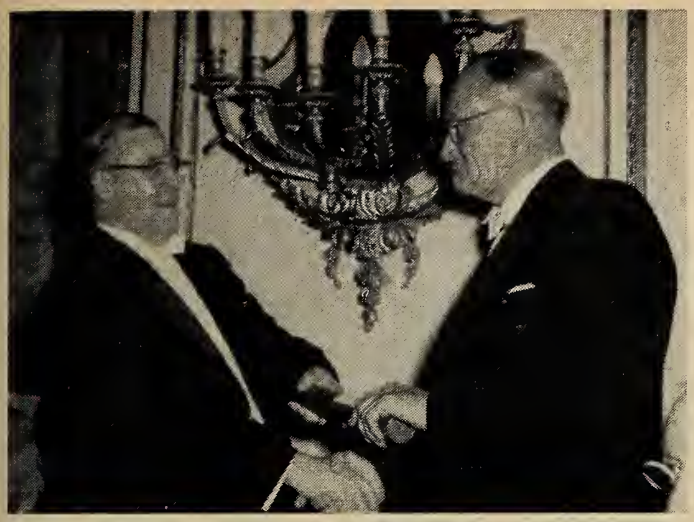
A large part of the meeting was taken up with questions of organization and communications. To provide a background for these deliberations Mr. Lawton had prepared a working paper which was distributed to Council in advance of the meeting. The working paper consisted of Mr. Lawton's observations, and his recommendations, as follows;

Since the formal acceptance of the Executive Committee in 1962 it had taken over much of the routine work from Council, thus permitting Council to devote its time to policy discussion.

It was explained that the R.I. and C.C. meetings were designed to provide a focus for the communication of information and the transmission of ideas. An analysis is being made of recommendations made at the numerous R.I. and C.C. meetings for submission to Council. There was some discussion regarding combining R.I. and C.C. meetings with Regional Technical Conferences.

During a discussion on the Institute's Information Office, Vice-President J. S. Waddington of Brockville, Ont., said he was one of those who "viewed with alarm" the disbanding of the library. He reminded the meeting that the earlier discussions about the library, and the

Mr. Lawton congratulates Mr. Higginson after presenting him with the gavel and the certificate which names Mr. Higginson as President of the E.I.C. for 1963-64.



Mr. Lawton presents the certificate to Dr. C. M. Anson of Sydney, N.S., who was elected an Honorary Member.

Dr. E. V. Buchanan of London, Ont., elected an Honorary Member, receives the certificate from Mr. Lawton.

vote, were based on the assumption that we would effect an arrangement with the N.R.C. library. As this does not now seem possible he would like the present arrangements for our Information Office to continue, and later to increase activity. The motion was carried with one dissenting vote.

Technical Conferences

C.T.O. Chairman Gooch said his committee can undoubtedly help with most Regional and Divisional Technical Conferences. If this help is to be effective, though, it is essential that C.T.O. be consulted from the beginning.

Mr. Gooch said that if all engineering Divisions of C.T.O. were to produce all the papers they were capable of producing, it would be impossible to present them at one meeting, even the Annual Meeting. The obvious solution is to hold Divisional Technical meetings and Regional Technical Conferences in various areas.

Canadian Geotechnical Journal

Background information was presented regarding this proposed new quarterly journal. Those producing the journal have asked for joint sponsorship of the publication by the E.I.C. and the N.R.C.

After interested discussion of the merits and possible disadvantages of having the Institute participate it was resolved that Council empower the General Secretary, working with the Chairman of the Publications Committee, to work out an agreement with the National Research Council to sponsor the publication of the Canadian Geotechnical Journal.

President Lawton's Closing Remarks

In closing the meeting, President Lawton expressed his most sincere thanks to the Vice-Presidents, Members of Council, Committee Chairman and all those in the Institute who have made such a constructive and valuable contribution during the past year. He attributed the progress of the Institute to the generous co-operation of everyone concerned.

Mr. Martin proposed a vote of thanks to the President for his devotion and leadership during his term of office which had added greatly to the stature of the Institute.

COMMITTEE MEETINGS

On the morning of May 21 several important committees began a series of hard-working meetings. Included were the Committee on Technical Operations and its Technical Divisions; the Committee on Branch Operations attended by Branch Officers and Councillors; and the Deans' Committee.

An informal luncheon provided a pleasant break for the committee members and served as an opportunity for many of the early guests to renew old acquaintances and make new friends.

The committee meetings continued in the afternoon. At 4:00 p.m. officers of the Institute met representatives of the local and national news media at a press conference.

An informal reception for early arrivals was held during the evening. A welcome guest was the ubiquitous Muriel.

ANNUAL GENERAL MEETING

Simultaneous translation was available. The meeting was one of the most successful ever held by the Institute and there was ample time and opportunity allowed for discussion, freely in either French or English, from the floor. The minutes of this meeting will be published in a later issue of the Engineering Journal.

At the opening luncheon delegates were welcomed by Mr. J. Roy and by Quebec City alderman Paul Mecteau who represented Mayor Wilfrid Hamel.

The afternoon saw the opening session of the annual Student Conference, and the Board of Directors' meeting of the Association of Consulting Engineers.

The technical sessions, which included 70 top-level technical papers and three panel discussions, began on the morning of May 22 and continued morning and afternoon for three days. Five technical sessions were held simultaneously each day.

Mr. Lawton presents the Julian C. Smith Medal to Dr. Hector Cimon of Quebec City, one of the two recipients of this honor during the meeting.

Edgar A. Cross of Toronto, elected Fellow of the E.I.C., receives his certificate from Mr. Lawton.

This group picture shows most of the delegates to the student conferences held during the Annual Meeting.

In the evening following another of Muriel's gatherings, an informal dinner was held. The Chairman was Mr. Georges Demers of Quebec City, Vice-President Region VIII. President Lawton dealt with "An Engineering and Science Policy for Canada" as the topic for his retirement address.

NEW COUNCIL MEETING

President-elect Higginson was Chairman at the first meeting of the new Council, held May 23.

President Higginson opened the meeting by outlining clear objectives for Council, and urged that strong efforts be made to attain them. In 1962-63, E.I.C. finances showed a depletion in reserves, and the financial operation of the Engineering Journal caused some concern. It is the duty of Council to see that these reserves are re-established. There are several ways in which this can be done:

a. By trying to increase the income from the Journal;
b. By the increase in fees authorized in 1962-63;
c. By reducing expenditures wherever possible.

Mr. Higginson paid tribute to the many accomplishments of Mr. Lawton, and he also complimented Mr. Martin for his effective efforts as chairman of the Finance Committee. The importance and effectiveness of the R.I. & C.C. ings were stressed.

Deans' Committee

It was reported that a statement on the functions and terms of reference of this committee is being prepared for Council consideration by Deans Conn, Lemieux and Hardy.

Uniform Year

Not all Branches operate with the same administrative year. As this naturally causes some confusion and is a hindrance to ideal communications, it was resolved that Council recommend to the Branches

Mr. Lawton presents the Sir John Kennedy Medal to Dr. Albert R. Decary of Quebec City.

Dr. John Bertram Stirling of Montreal receives the Julian C. Smith Medal from Mr. Lawton.

Mr. Lawton presents the certificate to Robert L. Dunsmore of Montreal who was elected a Fellow of the E.I.C.

John Murray Fleming of Port Arthur, elected a Fellow of the E.I.C., receives his certificate from Mr. Lawton.

that a uniform year be adopted for fiscal and administrative operation, and that this be the calendar year.

Annual Meeting Committee

A cordial and sincere vote of thanks was extended to the 1963 Annual Meeting Committee for the excellence of all arrangements.

AWARDS LUNCHEON

J. B. Delage, past Chairman of the Quebec Branch was Chairman of the informal Awards and Prizes luncheon. After the luncheon outstanding authors of the previous year received their awards.

At the same time the Eastern Townships Branch was presented with the George McKinstry Dick Branch Achievement Award by Past President Dick for large Branches.

Following are the medals and prizes presented, and the recipients.

Leonard Medal, R. F. Coulter. Plummer Medal, Professor R. W. Missen. Gzowski Medal, Professor A. G. Davenport. Ross Medal, C. H. R. Campling, J. A. Bennett and D. H. O'Hara. Angus Medal, Wing Commander A. B. Howell.

Sir George Nelson Award, Gaston Galibois. Ernest Marceau Prize, Michel Belanger. Phelps Johnson Prize, Gaston Lambert. John Galbraith Prize, S. W. P. Wyszkowski.

During the afternoon there were continuations of the meeting of the National Committee on Professional Development Programs, and the Annual General Meeting of the Association of Consulting Engineers.

In the evening the Association of Consulting Engineers held its Annual Dinner. A large and enthusiastic group of delegates and their wives enjoyed a dance arranged by the local committee. Included was cabaret entertainment with Monique Gaube.

ANNUAL BANQUET

The Annual Banquet and Dance were the culmination of a busy final day of meetings, and of a highly successful Annual Meeting. Committees continued their work through the day including a meeting of the Joint A.S.M.E.-E.I.C. International Council and of the Life members.

One of the highlights of the Annual Banquet, at which both outgoing President Lawton and incoming President Higginson spoke briefly, was the presentation of Honours, Honorary Memberships and Fellowships.

The Sir John Kennedy Medal was awarded to Dr. Albert R. Decary.

Julian C. Smith Medals were awarded to Hector Cimon and Dr. J. B. Stirling.

Named Honorary Members were Dr. C. M. Anson and Dr. E. V. Buchanan.

Fellows were named for the first time this year, and those so honored were: Edgar A. Cross; Dr. R. L. Dunsmore; J. M. Fleming; and A. W. F. McQueen.

TRANSACTIONS
OF THE ENGINEERING INSTITUTE OF CANADA

Forthcoming separate papers comprising "Transactions of the Engineering Institute of Canada" are:

SERIES "A" CIVIL; GEOTECHNICAL; BRIDGE & STRUCTURAL

EIC-63-BR & STR 15 "The Relationship Between Design Specifications and the Behaviour of Prestressed Concrete Beams Subjected to Combined Bending and Shear" by J. G. McGregor

EIC-63-CIV 22 "Temperature Effects in Concrete Arch Beams as Applied to the Trial Load Method" by K. Menehan and W. Stensch

EIC-63-CIV 24 "Runoff from Rainfall on Small Rural Watersheds" by D. F. Witherspoon

EIC-63-GEOTECH 11 "Strain-Time-Strength Relationships in a Marine Clay" by D. F. Coates, K. N. Burn and G. C. McRostie

SERIES "B" MECHANICAL; WELDING; THERMAL

EIC-63-MECH 26 "Connective Heat Transfer from a Helical Fin Tube in Longitudinal Flow" by R. E. Chant

SERIES "C" ELECTRICAL; COMMUNICATIONS, ELECTRONICS AND AUTOMATION; HYDROELECTRIC

EIC-63-CE & A 7 "Problemes de Genie que Posent les Aerostats aux Grandes Altitudes" by J. Baril, A. K. Laflamme, R. A. Lefebvre

EIC-63-CE & A 12 "Multi Channel Strain Analysis" by D. G. Bellow and J. S. Kennedy

SERIES "E" CHEMICAL; MINING; OIL AND NATURAL GAS

EIC-63-OIL & NAT GAS 1 "Development of Athabasca Tar Sands" by R. W. Ansley

THE ABOVE PAPERS WILL BE SENT AUTOMATICALLY TO THOSE WHO HAVE SUBSCRIBED TO THE SERIES IN WHICH THE PAPER APPEARS. OTHERS WHO DESIRE A COPY MAY ORDER IT FROM HEADQUARTERS ON THE FORM ON THE FOLLOWING PAGE.
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(See page 117)

17th CANADIAN SOIL MECHANICS CONFERENCE
(Geotechnical Engineering Division Conference — EIC)
Ottawa — September 12, 1963

The Geotechnical Engineering Division of the Institute's Committee on Technical Operations is sponsoring the Annual Soil Mechanics Conference. This is being held this year as a one-day meeting at Carleton University, Ottawa. The theme will be "Safety Factors in Soil Engineering".

The Conference has been planned to follow immediately after the NRC-ASTM Symposium on Laboratory Shear Testing of Soils which is being held at the National Research Council in Ottawa, September 9 to 11.

Persons wishing to attend are requested to make their own hotel reservations.

Preprints of the papers will be supplied at the time of registration. Advance registration will be possible during the preceding ASTM Symposium schedule.

DIVISION PAPERS

OF THE ENGINEERING INSTITUTE OF CANADA

Forthcoming separate Division Papers are:

EIC-63-CIV 23 "Iron Bacteria in Small Water Supply" by S. W. Grainge and G. E. Myers

EIC-63-CIV 25 "Minimum Cast Design of a Level Roadway Supported by Piers upon a Uniform Slope" by H. S. Heaps and D. A. Boyd

EIC-63-CIV 26 "The Effective Width of Plates Under Transverse Point Loading" by T. A. London and J. A. N. Lee

EIC-63-CIV 19 "Water Reducing Admixtures for Concrete Applications and Specifications" by T. G. Clendenning and M. T. Loughborough

EIC-63-HYDEL 6 "Sluice Gate Rating Curves by Model Testing" by R. J. Silver

EIC-63-HYDEL 11 "Forward Planning Studies involving the Economic Full Supply Level of Grand Rapids Generating Station of Manitoba Hydro" by L. A. Bateman and K. Renger

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For the benefit of engineers wishing to submit papers to the Engineering Institute of Canada, a comprehensive Guide For Authors has been prepared and is available free from EIC Headquarters.

ABSTRACTS

Transactions of the E.I.C.

EIC-63-BR & STR-15

"The Relationship Between Design Specifications and the Behavior of Prestressed Concrete Beams Subjected to Combined Bending and Shear"

J. G. MacGregor

The basis, development and use of the shear strength provisions in the new C.S.A. Code A135 for Prestressed Concrete are discussed in this paper. The first section is a brief review of the strength and behavior of beams failing in shear and theoretical relationships for inclined cracking and ultimate shear strength are derived. Following this the shear design clauses in the new C.S.A. Code are presented and this and other codes are compared to test results. Finally, two design examples are given in an appendix.

EIC-63-CIV-22

"Temperature Effects in Concrete Arch Dams as Applied to the Trial Load Method"

K. Menehan and W. Stensch, P.Eng.

This paper presents a method for determining the effects of temperature change on concrete arch dams. The method was developed in conjunction with the trial load analysis of Canadian hydro-electric projects.

For those not familiar with the trial load analysis, a brief outline is given. The paper also includes a summary of the application of the above to electronic computers.

EIC-63-CIV-24

"Runoff from Rainfall on Small Rural Watersheds"

F. Witherspoon

A graphical relation is presented which is useful in estimation of runoff volumes from small agricultural areas in Ontario. The parameters used in the relation are antecedent precipitation index, effective rainfall duration, soil cover conditions and effective rainfall depth. The mean error of estimate of runoff depth is 0.05 inches on areas up to one square mile of a medium-textured soil.

EIC-63-GEOTECH-11

"Strain-Time-Strength Relationships in a Marine Clay"

D. F. Coates, K. N. Burn

G. C. McRostie

A number of problems have recently been encountered by the authors where the variation of strain and stability of clays with the passage of time under constant stress conditions was important. One such job was of a sufficient magnitude to support a detailed laboratory testing program which is described in this paper.

The main purpose of this testing program was to determine if the strength of the particular clay deposit would decrease with time while being subjected to a constant shear stress. The strains were also examined to determine if a critical strain might exist for this clay.

Three series of triaxial tests were run using constant strain rates, constant stress, and uniform stress increments for uniform increments of time. The results were analysed conventionally and using rheological models.

EIC-63-CE & A-7

"Problemes de Genie que Posent les Aerostats aux Grandes Altitudes"

J. Baril, A. K. Laflamme

R. A. Lefebvre

L'introduction contient une brève description des recherches entreprises sur la haute atmosphère et des véhicules utilisés: l'avion, la fusée, et la combinaison nacelle-aérostat. Une nacelle typique est ensuite décrite et les problèmes que posent sa fabrication-température, pression, radiation solaire etc. . . . sont ensuite discutés. Une description de la procédure de lancement termine la conférence.

EIC-63-CE & A-12

"Multi-Channel Strain Analysis"

D. G. Bellow and J. S. Kennedy

A 100-channel digital data processor, which greatly facilitates the collection of output data from strain gauges, thermocouples or transducers, has recently been constructed at the University of Alberta. The processor consists of zero balancing units, a scanning unit, an analog-digital voltmeter, a program unit, a typewriter and a tape perforator. The tape perforator has been made compatible with the University's LPG-30 digital computer so that no intermediate steps are required between sampling of the channels and final output from the computer in cases where numerical analysis of results is required. The use of the equipment for the determination of the transverse deflection in rectangular plates subjected to uniform moments which produce large longitudinal deflections is discussed.

EIC-63-OIL & NAT GAS-1

"Development of Athabasca Tar Sands"

R. W. Ansley

Research directed to the development of the Athabasca tar sands in Northern Alberta has now reached the stage where economical commercial production appears to be feasible. One company has already received permission from the Government of Alberta to produce 31,500 barrels per day of synthetic crude and two other interests are awaiting decisions on applications to each produce 100,000 barrels per day of hydrocarbon products by the early 1970's.

A very comprehensive research and development program has been undertaken during the past seven years jointly by Cities Service Athabasca, Inc., Imperial Oil Limited, Richfield Oil Corporation and Royalite Oil Company. As a result of their work they have concluded that it is now feasible to design, construct and operate a mining-processing complex to produce 100,000 barrels per day of hydrocarbon product.

A brief history of the research program is presented and a summary of the Cities Service Athabasca group's proposal to the Government of Alberta is included.

EIC-63-MECH-26

Convective Heat Transfer from a Helical Fin Tube in Longitudinal Flow

R. E. Chant

Established procedures and data for design involving convective heat transfer are not available for other than the most elementary components and geometric configurations. A design project for heat transfer equipment of any complexity becomes a development project, often consisting of collecting suitable data as well as prototype testing.

The tests were undertaken to investigate the effect of the fin efficiency on the convective heat transfer coefficient, to attempt to establish a representative equivalent diameter and to provide additional data for longitudinal flow over a helical fin tube. The tests consisted of increasing the outside diameter of an annulus enclosing a heated helical finned tube in each of the four tests. Air was forced over the finned element and data permitting the study of the convective heat transfer and the friction losses were collected.

In the paper the data are correlated and compared to the work of others. The result represents a small segment of the very involved problem of developing a universal solution for longitudinal flow over helical finned tubes. The magnitude of obtaining a complete solution can be indicated by pointing out that a transverse fin is a helical fin with a zero pitch, and a longitudinal fin is a helical fin with an infinite pitch.

The geometric configuration of the finned element tested was such that the flow took place in the spaces between the fins as well as in the annulus beyond the tip of the fins. This led to the conclusion that the normal procedure of using the equivalent diameter derived from the annular flow area beyond the tip of the fins could not be universally used. Whereas an equivalent diameter determined from the total free cross-sectional area was satisfactory for all cases. It was further concluded that the use of the fin efficiency in determining the heat transfer coefficient facilitated the correlation of the results by the normal type of expression for flow in enclosed passages.

(Continued on page 76)

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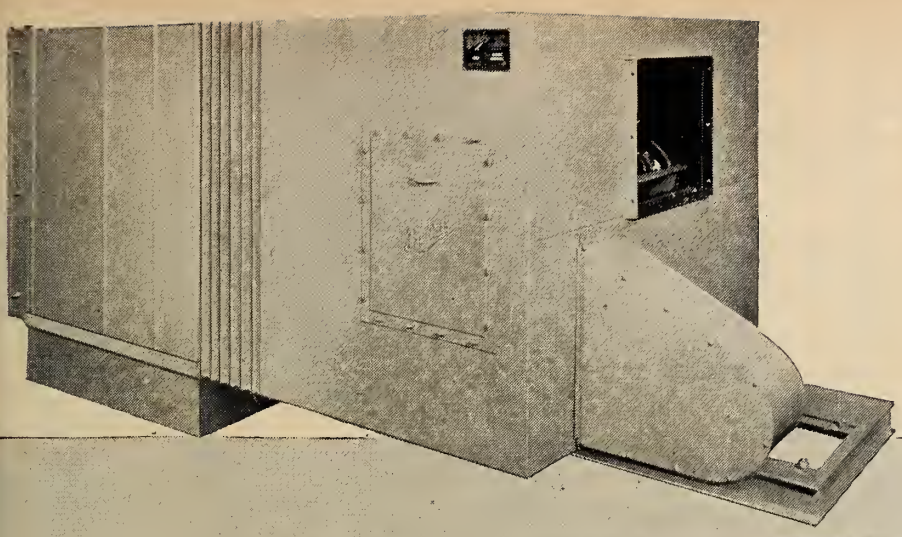

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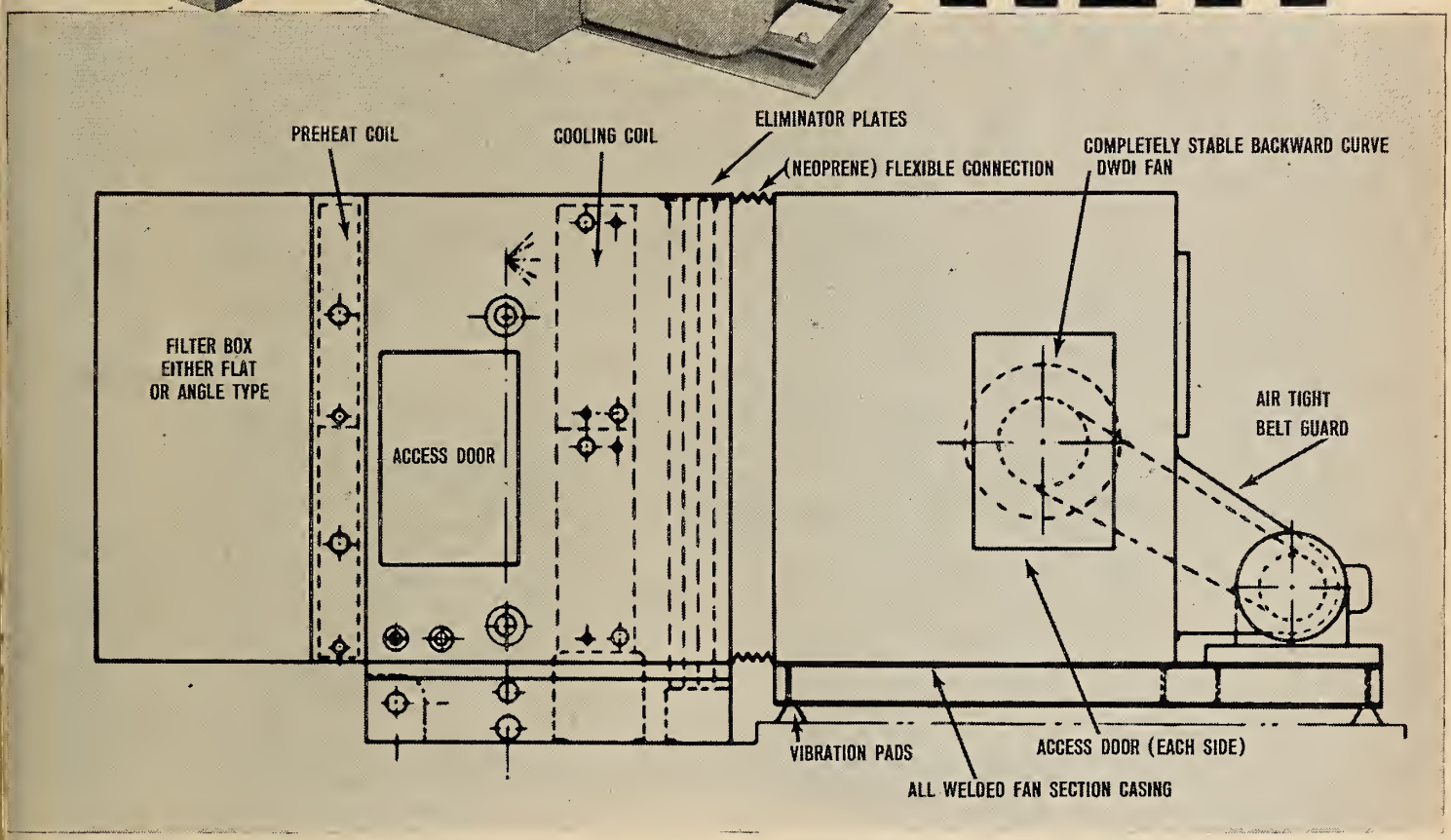

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Branch News

BELLEVILLE

J. E. Tomlinson

The final monthly meeting was held at the RCAF Station Trenton. Following a dinner, a lecture and display of equipment used in Air Force telecommunications was presented. The evening was conducted by Squadron Leader C. E. Holdway assisted by Flight Lieutenants Crawford and Grainger. S. L. Holdway outlined Canada's defence policy by reviewing the armed forces organization and especially the part played by Air Transport Command which is stationed at Trenton. ATC's concept is to maintain an emergency capability by doing useful work such as aerial photography, air search and rescue and survival training. In the telecommunications field, ATC is interested in radio, radar, in both ground and air borne systems, and data processing systems. The Air Transport system must provide a link control to all operating units across Canada during both peace and war. This is done through a national teletype system, a radar system, and many radio frequencies. Station Trenton must also maintain radar for cloud visibility, beacons for holding and landing aircraft, and radio facilities for 12 channels for the control tower, a single side band to Marville, France, as well as many mobile sets. Airborne facilities which must also be maintained include short and long range navigational systems, the intercom system within the aircraft itself, the search and weather radar systems and the identification radar system. The Yukon has one of the most elaborate and complicated electronic systems of any aircraft. It has five communications and eight navigational and identification systems. Complete records are maintained in all repair shops concerning the reliability and serviceability of these electronic facilities so that economies can be made in future designs.

The latter part of the evening was spent touring the various maintenance shops where the many communications components are repaired. In many cases, the test equipment used is more complicated than the equipment being repaired.

CORNWALL

G. Peter Schwarzkopf

W. Wilkinson, Technical Sales Representative for the Atlas Power Company of Canada, addressed the June 6 meeting of the Branch. He stressed the importance of plastics in industry in his talk, "Modern Materials for Chemical Process Equipment". As the field of plastics is comparatively new, the selection of plastics and fabrication is a delicate process and requires closer personal consultation between the parties concerned than when working with metals. Some city industries have corrosion problems, and this address proved of special interest to several local engineers, particularly those associated with pulp and paper and the handling of chemicals.

KITCHENER

W. N. Meikle

The Branch's last meeting of the year, May 29, was a plant tour through Marsland Engineering Limited of Waterloo. Members and their guests were guided by Larry Marsland and members of his staff. This relatively new plant manufactures diversified electronic products. Audio speaker of all sizes are manufactured here on automatic machinery designed and built in the plant. Television and FM tuners are another major product of the company. Mechanical revolving units, servo positioning units and anti-backlash gear trains form a large part of the mechanical production. These units are integrated into such things as strip chart recorders and plotting tables. A new environmental laboratory allows all components and assemblies to be tested under all conditions. C. G. E. Downing thanked Mr. Marsland for the tour and commented that it was enlightening to see a small Canadian company such as this, gaining recognition in a very highly technical field against competition from the best in the world. Refreshments were served after the tour.

LAKEHEAD

W. Buryniuk

H. Parsons was the guest speaker at the June 5 meeting of the Branch. He spoke on Social Engineering. At this meeting, Victor C. Hess, plant manager of Canada Malting, Port Arthur, was presented with a membership certificate in the Institute by Branch Chairman, L. E. Hardman. Mr. Hess joined Canada Malting upon graduation from the University of Alberta in 1934.

MONCTON

V. C. Blackett

On April 26, President Lawton and the General Secretary visited the Branch. In his address, Mr. Lawton outlined what might be expected if the present scheme for Confederation is adopted, and the resultant effects on the Institute and its Branches. The General Secretary described the organization of the Institute.

During the meeting, Mr. Lawton, on behalf of the Council of the Institute, presented a scroll to V. C. Blackett in recognition of his 37 years of service as Secretary-Treasurer of this Branch. A special presentation and an album of records was presented to Mr. Blackett by Branch members. Several members from the nearby Amherst Branch were present at this meeting.

The annual meeting was held May 15. Officers elected for 1963-64 were: Chairman, J. F. Callaghan; Vice-Chairman, M. J. Nickerson; Secretary-Treasurer, V. C. Blackett; Committee men, W. Cameron, A. J. Hiscock, W. Lenco, R. F. MacKenzie, P. M. Tomney, L. R. Ward; Ex-officio, Immediate Past-Chairman, L. R. Wadlyn; Branch Councillor, W. M. Steeves.

Following the dinner, the Chairman introduced R. S. Myles of Spear and Northrup, Consulting Engineers. Mr. Myles spoke of the plans and specifications for the 3819-foot, $5 million highway bridge to be built across the Miramichi River between Newcastle and Chatham, N.B. The asphalt and concrete surface of the bridge will rise to a maximum height of 129 feet above sea level and is designed to permit passage of sea going ships underneath on the river's channel. The bridge will be made up of three span-tied arch units; the center span, three anchor spans of 300 feet each, three plate girder units of 110 feet each, and one rolled beam span measuring 72 feet in length. A total of 21 reinforced concrete piers will be utilized in the construction of the bridge. An abutment will be positioned at the end of each structure. The roadway over the bridge will be 26 feet wide and additional provision has been made for a sidewalk on each side. The New Brunswick Telephone Co. plans to lay four cables under one of the sidewalks, while under the other conduits of the New Brunswick Power Commission will be installed.

MOOSE JAW

R. L. Graham

Eric Reeves of the British American Oil Company, Toronto spoke to the Branch's June 6 meeting on the "Critical Path Method of Planning Works Projects". He dealt with the origin of critical path and presented simple examples of this. He concluded by giving the members a simple problem which they were to solve using the critical path method.

NORTH SHORE LOWER ST. LAWRENCE

K. R. Kilburn

Earl Johnson, Project Engineer, Canadian Bechtel Ltd., Montreal, was the guest speaker at the Branch's May 30 meeting. The subject of his talk was Iron Ore Pelletizing. The topics he covered in his talk included the history

of the development of the pelletizing process and the theory of the principles applied in the process. He reviewed the current pelletizing methods and gave a detailed description of the Iron Ore Company of Canada's Carol Pelletizing Plant at Labrador City in south-west Labrador. He also previewed future developments in the iron ore pelletizing process.

ONTARIO AGRICULTURAL COLLEGE

Eric R. Norris

The final meeting of the Branch was held, March 23. This was the annual Ladies' Night. Awards were presented for participation in the College Royal. No business of note was discussed.

ST. MAURICE VALLEY

Raymond Felx

This Branch and the Eastern Townships Branch are organizing a Joint Regional Technical Conference to be held at the Cascade Inn, Shawinigan, Que., on September 27 and 28. The program will be bilingual and will include such topics such as pump storage, coating operations, high voltage transmission, water filtration, earthquake and building design, and industrial pollution control. The program will include plant visits, a cocktail party, mixed luncheon, and dinner and a dance. The ladies will be invited, during the afternoon technical sessions, to attend a tea at which a fashion show will be presented. The committee and the Chairman responsible for this program are: W. Ingram, Chairman; R. Felx, Publicity Chairman; J. Carson and R. Ouellette, Hotel Arrangements; J. Carson, Technical Papers; R. Ouellette and G. Kingston, Registration; J. Whyte, Finance; J. Hutton and M. Fraser, Ladies' Committee; W. Pangborn, Industry Committee.

VANCOUVER ISLAND

J. Devlin

On June 5, W. I. O'Hara, General Manager of the International Power and Engineering Consultants, Ltd., Vancouver spoke to the Branch on "Engineering the Development of Peace River Power".

CONFEDERATION REJECTED

The results of the referendum on Confederation conducted simultaneously by the Engineering Institute of Canada and in all Provinces are as follows:

ENGINEERING INSTITUTE OF CANADA

Province	Voting Members	Ballots Returned	Ballots For	Ballots Against	Ballots Rejected
Alberta and NWT	1406	641	398	243	0
B.C. and Yukon	966	451	219	223	9
Manitoba	635	227	104	121	2
New Brunswick	434	154	97	53	4
Newfoundland	157	69	42	26	1
Nova Scotia	602	190	123	66	1
Ontario	4739	1982	1039	939	4
P.E.I.	39	13	6	6	1
Quebec	4222	1633	655	966	12
Saskatchewan	956	304	186	116	2
Outside Canada	906	308	93	212	3
	15062	5972	2962	2971	39

CANADIAN COUNCIL OF PROFESSIONAL ENGINEERS

Province	Voting Members	Ballots Returned	Ballots For	Ballots Against	Ballots Rejected
Alberta	3357	1642 (48.9%)	1052 (64.1)	562	28
British Col.	2586	992 (38.4)	473 (47.7)	508	11
Manitoba	1303	405 (31.1)	169 (41.7)	203	33
New Brunswick	498	244 (49.2)	169 (69.3)	70	5
Newfoundland	188	112 (59.5)	70 (62.5)	42	0
Nova Scotia	643	246 (38.3)	178 (73.0)	68	0
Ontario	20882	8422 (40.3)	4410 (52.4)	3887	125
P.E.I. (Referendum not held)					
Quebec	10500	3174 (33.8)	1367 (43.1)	1416	391
Saskatchewan	855	245 (28.9)	188 (76.7)	57	0
Yukon	46	25 (54.4)	21 (84.0)	4	0

It should be noted that in all Provinces except Ontario, a two thirds majority of those voting is required for amendments to by-laws and since such amendments would be required in all Provinces except Manitoba in order to implement Confederation, 5 Provinces are considered to have voted against Confederation.

In addition, the Constitution of Canadian Council requires that approval be received by seven Provinces representing at least ninty percent of the membership before action can be taken on matters of policy.

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Personals

W. C. Murray Luscombe, M.E.I.C. (Queen's '41) has been appointed Construction and Planning Co-ordinator at McMaster University. In this newly-created position, Mr. Luscombe will co-ordinate the activities of the university staff, university planning groups, the Board of Governors Planning and Building Committee and the architectural and consulting engineers who will be involved in the continuing expansion of the University's facilities.

W. C. M. Luscombe
M.E.I.C.

P. E. Savage,
M.E.I.C.

Palmer E. Savage, M.E.I.C. (McGill '31) was elected President of the Canadian Institute of Steel Construction at the 33rd Annual Meeting held recently at Montebello, Que. Mr. Savage is Vice-President and Manager, Engineering and Construction Services, Dominion Bridge Company Limited, Montreal.

R. B. Carter has been appointed apparatus sales manager for the Pacific District of Canadian Westinghouse Company Limited. Mr. Carter succeeds **R. W. Lister** who has been named marketing manager for the Westinghouse Motor Division at Hamilton. **J. A. Reid,** formerly in charge of that division has been appointed industry sales manager, Montreal District. **W. Rayner** has been appointed graduate training co-ordinator, and **D. W. Prendergast** as marketing supervisor, switchgear devices.

R. C. Kane

L. A. DeRoo

L. A. DeRoo has been appointed manager, Switchgear & Control Division, Canadian Westinghouse Co. Ltd. Mr. DeRoo joined the company in 1956 and was formerly manager of manufacturing for the S & C Division. He is succeeded in the latter post by **R. C. Kane,** formerly superintendent of manufacturing engineering.

J. Pefhany,
M.E.I.C.

D. O. Robinson,
M.E.I.C.

J. Pefhany, M.E.I.C. (N.S.T.C. '51) has been appointed Chief Engineer at the Brampton, Ontario plant of Thermo Electric (Canada) Limited. Mr. Pefhany will be in charge of the engineering phases of Instrument Systems, Product Design and Development as well as the engineering of sensors and other products produced by this company.

D. O. Robinson, M.E.I.C. (Queen's '23) has been appointed Vice-President, Chief Engineer, Sales, of the Canada Cement Company, Limited.

M. P. Durrant

W. H. Pemberton

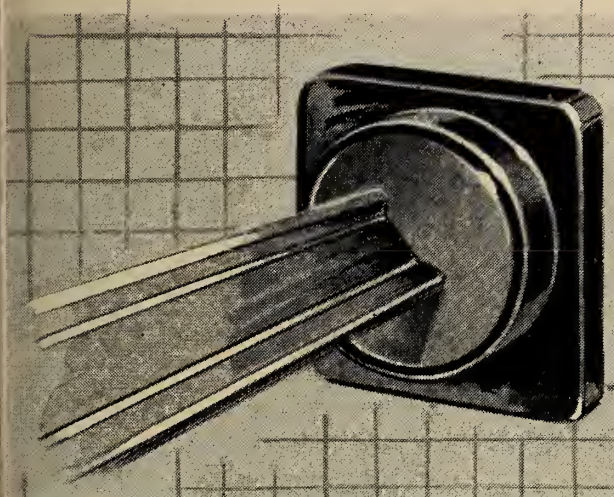
Morgan P. Durrant has been named General Manager of the Powers Regulator Company of Canada, Ltd., Downsview, Ont. Mr. Durrant, an engineering graduate from the University of Saskatchewan, was formerly associated with Trane Company of Canada, Ltd.

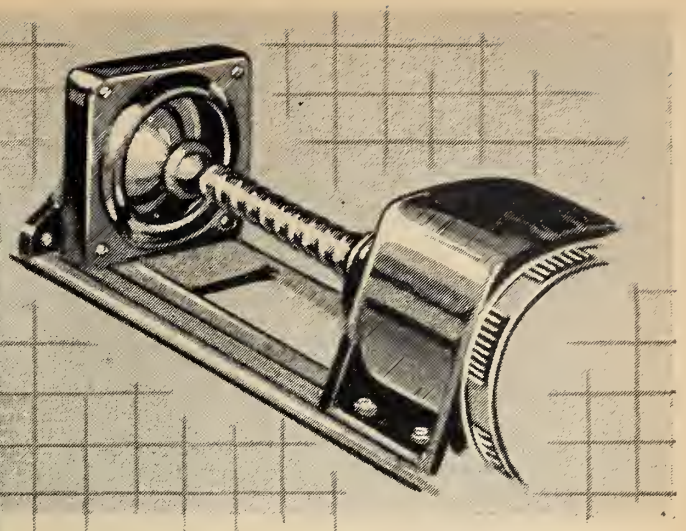
W. H. Pemberton has been appointed Product Sales Specialist for the Delta-Star Electric Division of H. K. Porter Company (Canada) Ltd. Mr. Pemberton will be responsible for customer service and field sales training.

Frank Grosvenor, M.E.I.C. (Toronto '30), senior cost standards engineer at Ontario Hydro's Toronto office, will act as chief design engineer for a phase of the study of electric power resources in Brazil being undertaken by the United Nations. Mr. Grosvenor joined Ontario Hydro in 1930. The Brazilian study is to prepare a program for the economic development of power generation and transmission facilities to meet anticipated demands for electricity over the next 15 years.

(Continued on page 66)

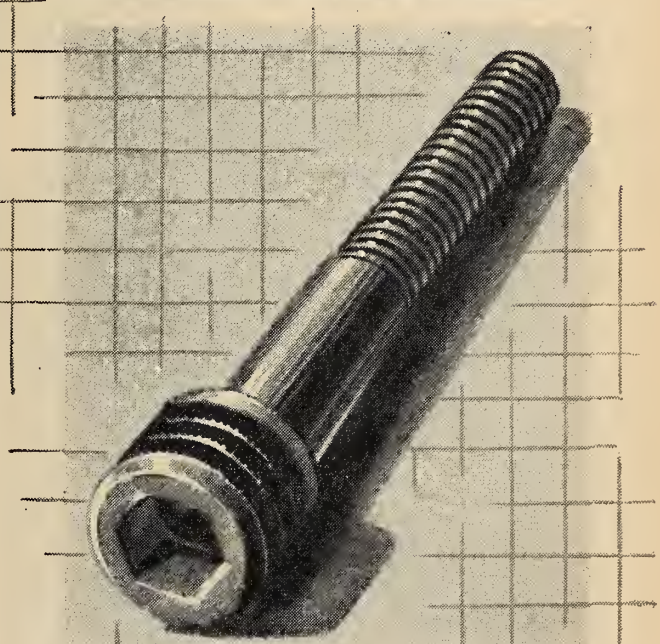
Lower cost cold extrusion dies with longer life; maraged to high hardness without distortion.

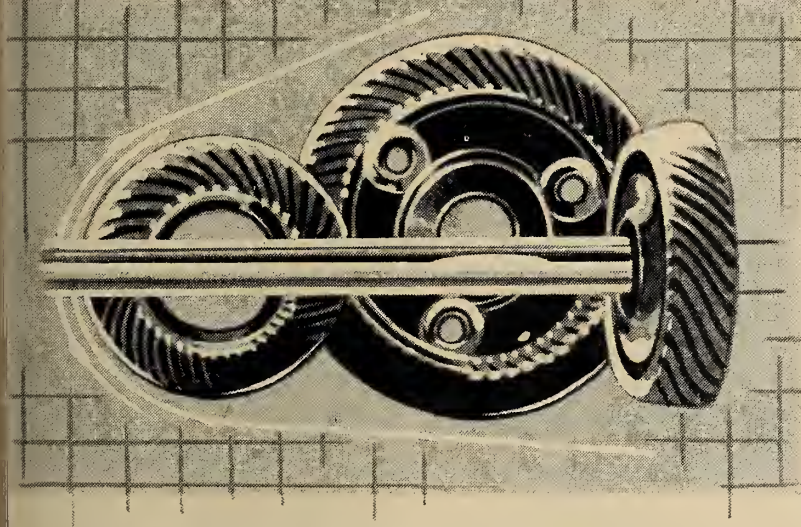




Flexible couplings, fabricated by cold forming and welding, to handle high loads at high speeds.

Fasteners that are smaller yet take greater stresses because of strength and toughness of maraged steel.





Smaller gear assemblies for big loads; no final machining after heat treatment to 25 Charpy and 50 Rc.

Now your dream designs can become realities

Use maraging nickel steels to improve an existing product... to develop bold design concepts. Pioneered by Inco, maraging steels offer you *a combination of properties unmatched by any other high strength material:* super strength, ductility, hardness and good fabricability.

Maraging nickel steels give you a tensile strength up to 275,000 p.s.i. with real toughness—Charpy V-notch impact up to 16 ft.-lbs., down to -420F. Hardness up to 52 Rockwell C. Simple heat treatment at low temperature (900F) without quench means low cost and virtually no distortion. Welds can be strengthened by local heat treatment. The machinability of maraged steels is comparable to AISI 4340. And they are the only ultra high strength steels which can be used efficiently in field welded fabrications.

Maraging steels are produced in plate, sheet, bar, forgings and castings. If you would like an informative summary of the facts on maraging nickel steels ...simply write us:

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED

55 YONGE STREET, TORONTO

for storing feed

Ten steel ingredient bins, each with a capacity of 60 tons, were designed and fabricated in Winnipeg by Manitoba Bridge to specifications laid down by the consulting engineers.

the simple and the complex...

Both are shown in this round-up of contracts from D.B. plateshops across the country. Large fabricators build up experience and take many complex jobs in their stride but every once in a while a problem comes along. When this happens new techniques are developed. This is a big responsibility for failures in the field not only cost a fortune, they can be dangerous.

When you buy welded fabrications be very sure of your supplier's ability. The Platework Division of Dominion Bridge maintain well equipped shops from coast to coast* and their total experience is unmatched in Canada.

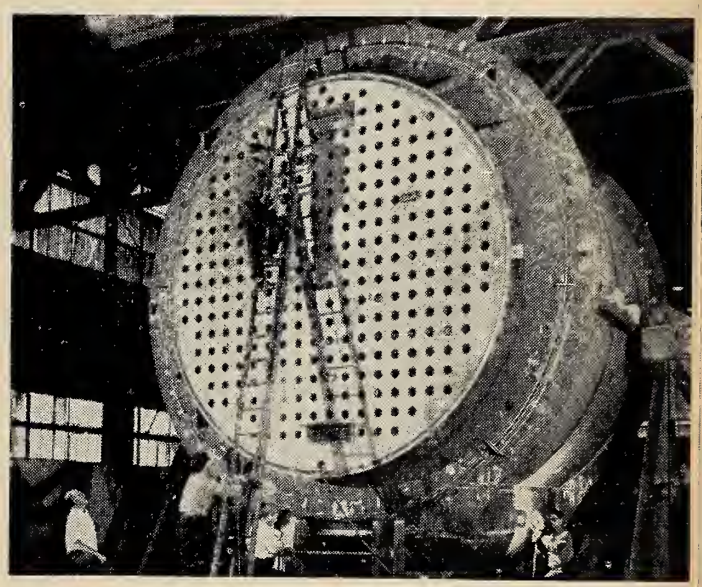
*In Winnipeg: Manitoba Bridge & Engineering Works.

130

PLATEWORK DIVISION
DOMINION BRIDGE

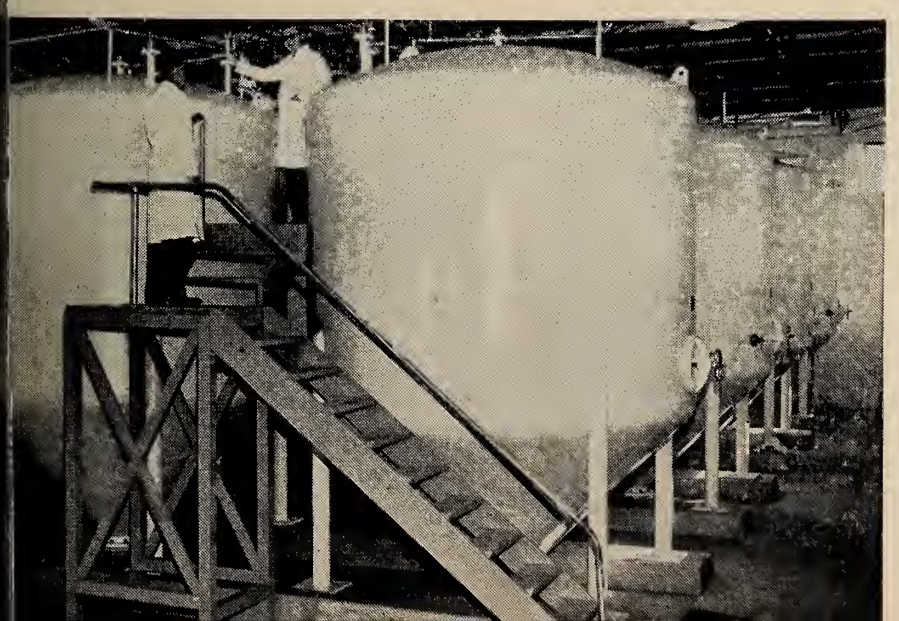
for chemical processing

One of five catalytic reformer reactor shells being made in Montreal from 1-¾ inch monel clad chrome-nickel steel. Special welding techniques were necessary to provide a satisfactory result.



for nuclear power

This is the calandria for A.E.C.L.'s new Candu reactor as it appeared during fabrication at the Dominion Bridge plant in Montreal. It is one of the most precise fabrications ever undertaken by the Company.



for making wine

These eight 5,000-gallon fermentation tanks were made by Dominion Bridge in Vancouver on very short delivery to meet the customer's needs. The material is mild steel lined with epoxy resin.

Canadian Engineering

WATERLOO HONORS TWO PROMINENT INSTITUTE MEMBERS

The University of Waterloo honored two prominent members of the E.I.C. at its Sixth Convocation, held July 6.

Dr. Albert E. Berry, Hon. M.E.I.C., and Dr. Robert F. Legget, M.E.I.C., were awarded degrees of Doctor of Science, honoris causa. Dr. Legget also delivered the Convocation address.

Dr. Berry retired recently as General Manager and Chief Engineer of the Ontario Water Resources Commission. Dr. Legget is Director of the Division of Building Research, National Research Council, Ottawa.

CALGARY BRANCH ASSISTING TWO AFRICAN STUDENTS

This academic year the Calgary Branch of the E.I.C., in co-operation with the African Students' Foundation, has sponsored two African students, Mr. Eliphelet Miano and Mr. Mahendra H. Mehta.

Mr. Miano came to the University of Alberta, Calgary, in September, 1961. He was born in 1932 in Central Kenya where his father was a teacher. His education was taken at a Methodist primary and boarding school, at a non-denominational high school at Kikuyu, and at Makere College in Uganda. His course there was leading towards a teaching career. Mr. Miano wished to train as an engineer so he left Makere College and applied for engineering training abroad. Until the opportunity to come to Canada appeared, Mr. Miano worked as an engineer apprentice on a variety of civil engineering projects, including road and railroad construction.

Mr. Mehta came to Calgary last fall as a first year engineering student. He was born in Zanzibar in 1942 and soon after his family moved to Lushoto in Tanganyika. As there were no schools in Lushoto, Mr. Mehta's early education was provided by his mother. At the age of seven he moved with his family to Arusha. Shortly after this, his father died and his mother moved the family to Tanga. There Mr. Mehta attended the Karimjee Secondary School where he received his School Certificate and Higher School Certificate with excellent marks. In addition to his studies he was assisting his mother and grand-father financially by giving private lessons to other students. He was very active in sports and was President of the Students' Union.

P D P PROGRAM AT TORONTO

Most of us in the Engineering Profession recognize a need for education beyond our normal university training. It is a well known fact that the true success in any profession depends on a continuing education in matters beyond those of our specialized technical field. The Professional Development Program (P.D.P.), sponsored by the Engineering Institute of Canada, is designed to help satisfy this need by providing a series of evening lecture courses.

The Toronto Branch of P.D.P. will provide a program consisting of three Groups of twenty lectures again this year.

Subjects to be covered by P.D.P. in 1963-64:

Group I
Speech Communications
How to Listen
Banking
Personal Investment
Physical Fitness
Criminology
Insurance
Psychology
Labour Relations
Medicare
Law
Industrial Development

Group II
Sales Merchandising
Metro Planning
Critical Path Operations
Engineering in Russia
Case Studies
Data Processing
Computer Demonstration
Federal Financing
Metro Politics and Government
Combines and Combine Laws
Mental Health
Religion
Air Traffic Control
Trade Unions

Group III
Canadian and Foreign Affairs
Case Studies
Art
Reform Institutions
Canada in World Markets
Music
Computer Applications
Personal Investment
Medicine
Conservation
Civil Defense
Religion
Astronomy
Company Finance

Each subject is presented by a recognized authority in the field.

The weekly lectures (7:30 to 9:30) are to be held this year on Monday evenings for Groups I and II beginning October 7, 1963, and on Wednesday evenings for Group III beginning October 9, 1963.

The first hours is devoted to the lecture and the remaining hour to questions and discussion.

All engineers and university graduates are eligible to participate. New members are recommended to join Group I.

Fees for each Group payable Registration night are:

E.I.C. Members — $18
Non E.I.C. Members — $20

The fees provide funds for lecturers, accommodation, and administration costs only. The program is self-supporting and non profit.

All those interested are invited to register on Monday, September 30, 1963 at the Cavalier Room of the Westbury Hotel, at 7:30 p.m.

Further information about the program may be obtained by contacting the E.I.C. Field Office, 160 Eglinton Avenue East.

TWO-DAY REFRESHER COURSE AT HALIFAX

The Halifax Branch of the Engineering Institute of Canada is sponsoring, in conjunction with the Nova Scotia Technical College, a two-day refresher course to be held September 5-6.

The program will consist of two full days of study in each of three areas of Mechanical, Electrical and Civil Engineering. A seminar will be offered on the evening of September 5. It will deal with some area of general interest, such as Engineering Education. The following topics will be covered in each of the three broad areas.

Civil Engineering—Outline of recent developments in the field of soil mechanics and foundations. This will include illustrations of new measuring techniques.

Electrical Engineering—A survey of the theory and operating principles of electrical analog computers, including demonstrations of solutions of practical engineering problems by these methods.

Mechanical Engineering—Introduction to new methods of measuring motion, strain and force. The lectures will include an introduction to methods of measuring strain, force and acceleration and will be reinforced by demonstrations of strain guages, photoelastic methods, surface coatings, vibrometers and accelerometers in the laboratory.

From Acetaldehyde to Zinc-sulphate, industry's choice for severe service . . .

GRINNELL-SAUNDERS* DIAPHRAGM VALVES

Principle of the Grinnell diaphragm valve

Instead of the typical disc, or other device, for controlling flow, Grinnell-Saunders valves incorporate a diaphragm and compressor. This diaphragm completely isolates the valve bonnet . . . and seals off fluids from contact with working parts.

Product purity is safeguarded. The valve mechanism is completely protected. Flow is unobstructed . . . streamlined. And valve closure is leak-tight, even with suspended solids in the line.

Simple, low-cost maintenance

The principle of the diaphragm valve itself cuts down maintenance requirements. Lubrication, and an occasional diaphragm change, are usually all that's needed, even in the most severe service.

Body materials

Grinnell-Saunders diaphragm valves are available in a wide range of body materials to meet virtually any requirement. You can specify cast, malleable, or ductile iron, cast or stainless steel, Durimet 20, Hastelloy A, B, C, bronze, Monel, aluminum, pvc, Saran, and Penton.

NEW . . . 48-page book on valve specifications, recommendations . . .

Operating advantages, applications, service recommendations, specifications, dimensions . . . everything you need to know about Grinnell-Saunders Diaphragm Valves is in the new Catalog SV-63. It is your complete guide to this all-inclusive line — and a must for everyone involved with valve selection, application, maintenance. A copy is yours for the asking from your Grinnell representative.

Long-lasting diaphragms

Grinnell diaphragms — many designed with sturdy backings and built-in reinforcement — reduce diaphragm replacements to a minimum. Diaphragm materials include white, natural, pure gum, and soft natural rubber, neoprene, black or white chlorinated butyl, clear Tygon, Hycar, Hypalon, G.R.S., Teflon, Kel-F, and polyethylene.

Linings

Iron body valves with flanged ends are available lined with any of the following materials: hard or soft natural rubber, neoprene, glass, lead, Penton, pvc, Saran, Heresite, or Lithcote. Other linings — and linings for valves other than iron — can be supplied on special order.

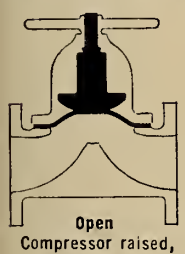
Bonnets

Handwheel and chainwheel bonnets of various types, with or without indicating stems; lever-operated bonnets, and bonnets for any make of power operator are all included in the Grinnell-Saunders line.

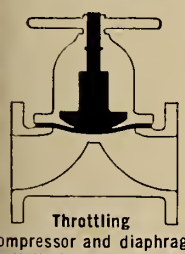
Grinnell Valve Engineering Service

Grinnell engineering service and valve stocks are available to industry throughout the U. S. and Canada. Grinnell representatives stand ready to help you any time with valve selection — and you can depend on them for a sound approach to your problems. Write your nearest Grinnell office for prompt service. Grinnell Company of Canada, Ltd., Edmonton, Montreal, Toronto, Vancouver, Winnipeg.

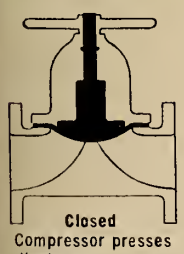
Saunders Reg. Trademark



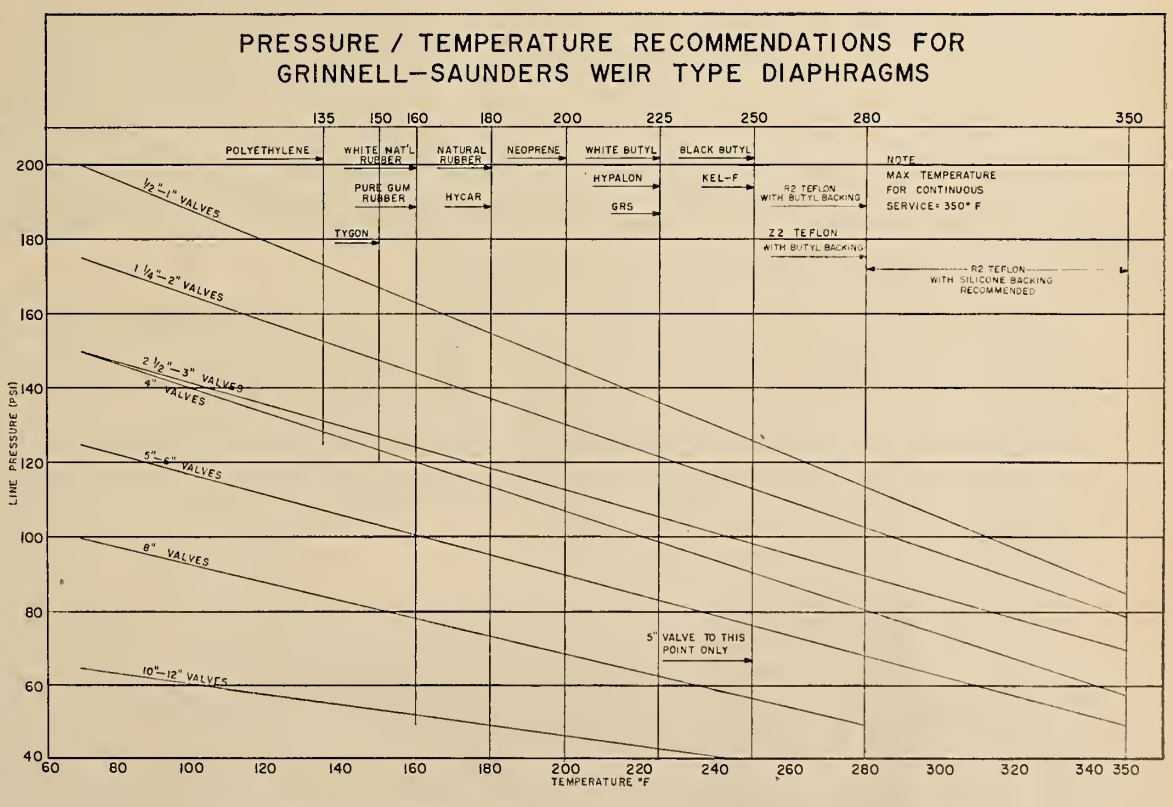
Open
Compressor raised, lifting diaphragm



Throttling
Compressor and diaphragm partially lowered

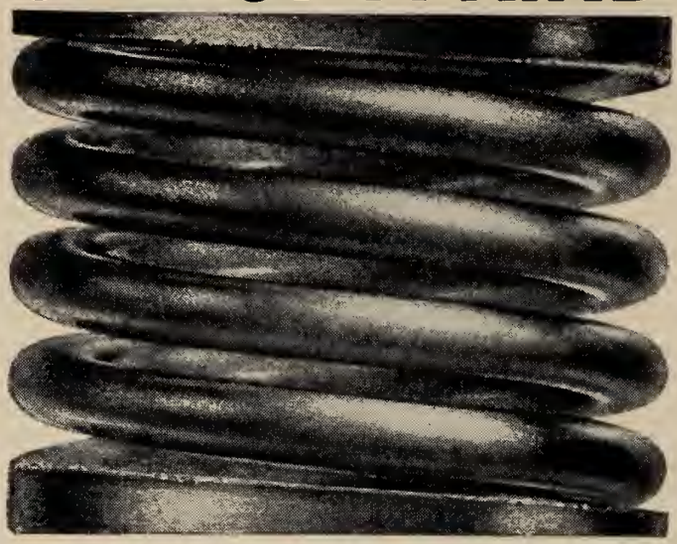


Closed
Compressor presses diaphragm tightly against weir



Full size (8½" x 11") copies of above chart available on request.

ONE OF A KIND



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When you have a spring problem, in machine design or replacement, you can count on Ontario Steel Products to come up with the answer.

We will coil hot wound springs to your specifications in bar diameters from 3/8" to 1 7/8" — inside spring diameters from 3/4" to 10" — in free lengths up to 30" — all to ASTM standards or closer tolerances if required.

You can specify bar size, shape and alloy needs — or discuss your requirements with our engineers.

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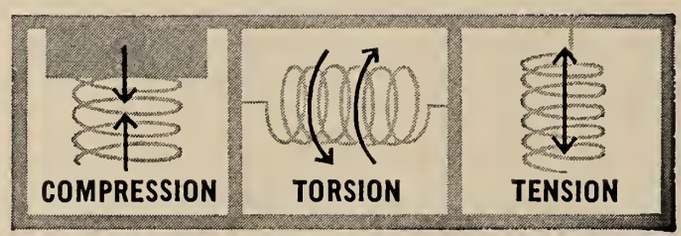

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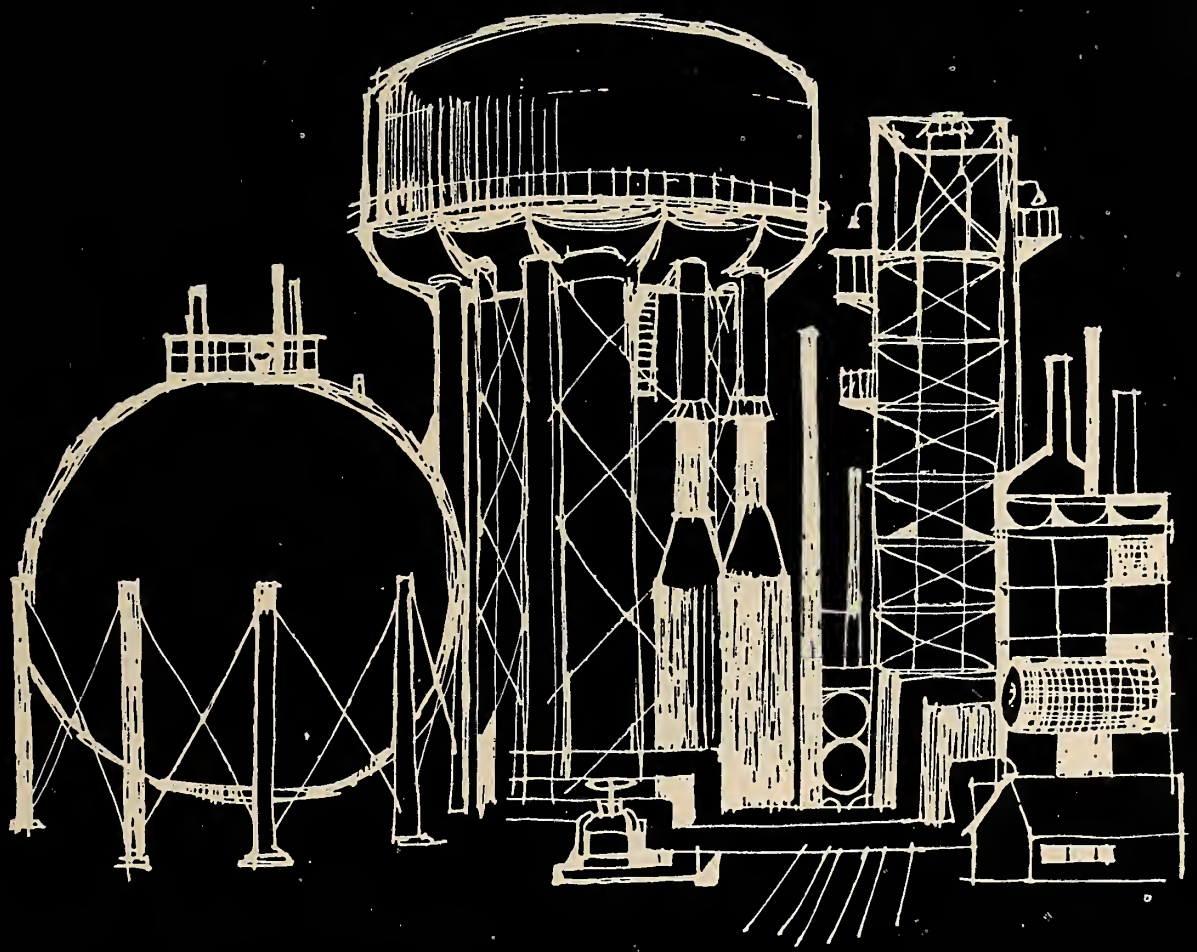

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Manufacturers of Valves and Boiler Fittings for over 100 years

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PEACOCK BROTHERS LIMITED

MONTREAL

Discussion

(Continued from page 36)

A highly transient source of severe vibration is ground reflected acoustic noise from the rocket nozzle during lift off. Typical noise levels at payload positions in the nose cones of large rockets are around 130 to 150 db (pressure reference at 0.0002 dyne/cm^2 per db). This noise level compares closely with the maximum acoustic energy that can currently be artificially obtained in the best of acoustic test chamber facilities (155 db). Such acoustic noise levels, if sustained for any appreciable period of time, will cause fatigue failures and cracking of thin skinned structures.

In the area of satellite thermal environment, Mr. Ward did not mention the earth reflected solar contribution (albedo) and free molecular flow aerodynamic heating. The earth's cloud cover, land and water masses, and polar ice caps reflect between 30 to 40% of the sun's radiation. This reflected albedo contributes several hundred Btu/hr/ft^2 additional energy to an orbiting satellite. The amount of the contribution depends on orbit altitude and increases with decreasing altitude. The transfer function relating this dependency is approximately $(1-\sqrt{2y})$ where $y = h/r$, h = orbit altitude, r = mean radius of the earth.

A typical table of heat fluxes prepared for the Canadian Alouette (Topside Sounder) is as follows[1]:—

Source	Heat Flux
Direct Solar	442 Btu/hr/ft^2
Earth's Albedo	177 "
Earth Infrared	68 "

Aerodynamic (free molecular flow) for various circular orbit altitudes "h"

h =	62	statute miles	62,700 Btu/hr/ft^2
	93	"	480 "
	124	"	59 "
	155	"	14.4 "
	217	"	2.6 "

Since Alouette's orbit altitude is greater than 217 statute miles, aerodynamic heating is negligible.

With reference to space vacuum, a few other facts and phenomena of interest might be noted. The high vacuum condition encountered by orbiting spacecraft corresponds to pressures of around 10^{-16}mm Hg. In this vacuum, certain alloys and metals with high vapour pressures such as some magnesiums, zinc, and cadmium platings evaporate or sublime at the surface. In time, these materials, as with oil and grease type lubricants, completely deplete into space. Although the sublimation of metals is slow, serious problems can result from fouling of electrical junctions and optical surfaces by the molecules leaving the metal surface.

Where strength is required, say on spaceship docking mechanisms of space platforms, space vacuum has the beneficial effect of generally increasing the fatigue and impact strengths of most metals through depletion of the surface oxide films. Surface oxides are believed to aid in propagating fatigue fractures by their wedging action in surface fissures of the metal.

The space radiation environment is extremely important in spacecraft design as it produces undesirable changes in the properties of materials with sensitive crystal lattices such as solid state components (transistors, solar cells, etc.) and plastics

with long chained molecules. The operating lifetime of solid state electronic systems in satellites is greatly shortened by radiations encountered in space.

Briefly, space radiation comprises electromagnetic radiation (ultra violets, X and gamma rays) from the sun's spectrum, protons and electrons from the solar wind, high energy cosmic rays (protons and alpha particles) from beyond the solar system, high energy particles of about 120 mev produced by solar flares, and high kinetic energy protons and electrons trapped in the Van Allen radiation belts. Aside from their affect on materials, the radiation is lethal to man.

To further illustrate Mr. Ward's comments on meteoroid hazard to spacecraft, it may be of interest to mention that the writer estimated a 15% chance that one meteoroid of sufficient size to cause shell penetration would strike Alouette during its first year in orbit.[2] The probability of impact with smaller particles which primarily cause pitting and "sandblasting" of the outer surface of Alouette is of course much greater.

To reproduce the orbit space environment on earth, with the exception of the gross effects of heat transfer simulation through removal of the convective media, is extremely difficult to do. Better simulation of the sun's spectrum through use of mercury-xenon vapour discharge lamps and other mixed spectrum sources, and introduction of artificial radiation sources in space chambers are currently undergoing active investigation in the space environmental community.

Several corrections concerning details of the Alouette satellite might be pointed out in Part II of Mr. Ward's paper. The first concerns Alouette's orbit altitude which should read 625 statute miles and not 150. At this altitude, Alouette carries out electron density distribution measurements of the ionosphere by swept frequency sounding. The remaining point concerns vibration testing. Two pieces of Alouette's electronic equipment, the 2 watt telemetry transmitter and ¼ watt beacon both of which operate from lift-off, were required to be turned on during vibration testing.

REFERENCES

[1] "Structural and Thermal Design of the Topside Sounder Satellite", H. R. Warren and J. Mar, Canadian Aeronautics and Space Journal, Vol. 8, No. 7, September 1962.

[2] "Meteoroid Impact on the Topside Sounder Satellite", J. Mar, Canadian Aeronautics and Space Journal, Vol. 8, No. 9, November 1962.

Discussion by

J. S. Brooks, RCA Victor Company, Ltd., Montreal,
Manager, Environmental Laboratory
and Project Manager (Canada)
Project Relay Communications Satellite program.

Mr. Ward has presented a balanced and interesting paper on spacecraft environmental testing. Some of the instrumentation and set-up methods used with the large vacuum chamber are ingenious and worth noting for other applications. Obviously, considerable care and planning were used in this, as in every other phase of the Alouette project. It is also obvious that this care and planning has been justified by the success of the spacecraft in orbit. I have much pleasure, therefore, in congratulating DRTE and CARDE on their remarkable achievement. Once again they have demonstrated that Canada's engineers, scientists and industry are second to none, given the opportunity to perform.

The paper refers, in general, to environmental testing of the spacecraft. There are some differences, however, when spacecraft components or payload units are considered. The test program for these units usually has three elements:

1. Development testing and component pre-conditioning
2. Prototype Qualification Tests
3. Flight Model Acceptance Tests.

Development testing during the research and design phase requires little explanation except to point out that the specification environmental levels are usually exceeded to ensure a safety margin. Component preconditioning is becoming more important in the electronics field. The process consists of "baking" component parts for periods varying from 150 to 1,000 hours, with inspection and test before and after the baking period. Only parts showing stable characteristics after bake are accepted for use in Flight Model Equipment. This is one of the many arms of the web of reliability analysis which forms the background to space electronics.

Prototype Qualification Tests, under current NASA rules, employ environmental levels much higher than the expected operational levels. Environmental tests of the more familiar type, such as transportation shock and vibration, temperature-humidity cycling, centrifugal acceleration and salt-fog exposure, are usually required also.

Flight Model Acceptance Tests are usually restricted to the more significant launch and orbital environmental parameters, but at reduced levels compared with the Prototype Qualification Tests. It is interesting to note that for Project Relay spacecraft communications equipment, electrical operation during vibration tests was required as a means of detecting suspect component parts and obscure failure modes.

My point in giving this test breakdown, is to highlight the fact that complete environmental testing of spacecraft is not yet possible in Canada, but that the full test program for spacecraft payload items is within our existing capabilities, including random vibration and thermal-vacuum tests. This was demonstrated at RCA Victor, Montreal, on Project Relay spacecraft equipment. The complete NASA environmental test specification was accomplished in-house for all the Canadian equipment. To enlarge our facilities in Canada to encompass complete spacecraft testing would require additional major equipment. The purchase, maintenance and use of such equipment is costly. An extended and extensive program of space engineering would be needed to justify the large expenditures involved on an economic basis.

FLUIDICS
SPOKEN HERE
Water treatment news

Permutit Multiport Valves

by Herbert Bowers
Service Manager
The Permutit Company

In an industry which has changed as rapidly as the fluid process industry, it is an unusual piece of equipment which can retain its leadership of design for 28 years without major alteration. Yet Permutit's Multiport Valve has done just that.

Time, and increasing thousands of units in use, only indicate that it is still one of the most advanced designs ever developed. It continues to find increasing use in pressure filters, softeners, and demineralizers.

Of course, as they become available, various new materials and corrosion-resistant linings have been added to the Multiport Valve. Better design know-how, from years of experience, has resulted in some minor changes.

Positive rotation. The most important basic feature of this valve is its positive operation. It is mechanically rotated from each functioning position to the next. It cannot skip a function. It cannot remain in any functioning position once the sequencing control indicates a change of function.

This is an important advantage over the diaphragm or piston valve which depends generally on a combination of water pressure and springloading to open or close the ports. In this type of valve, the diaphragm can easily malfunction. It can fail to open or close a port, causing the sequencing mechanism to proceed to the next function without completing the previous function.

This can be particularly serious if the incomplete function is one in which the regenerant is normally washed out of the unit. Should this occur, it is possible for the regenerant to be discharged into the system during the service portion of the cycle.

This is exactly what the Permutit Multiport Valve prevents.

Corrosion resistance. The Multiport Valve has the further advantage of being readily lined with any corrosion-resistant material required. It has low pressure loss, since all ports are carefully streamlined. Its construction is so rugged that many of the original valves are still in operation after more than 25 years of service.

If you have not yet discovered how you can put the Permutit Multiport Valve to work profitably, we will be glad to send you details on it. Write Permutit Company of Canada, Dept. EJ-83, 207 Queens Quay West, Toronto 1, Ontario.

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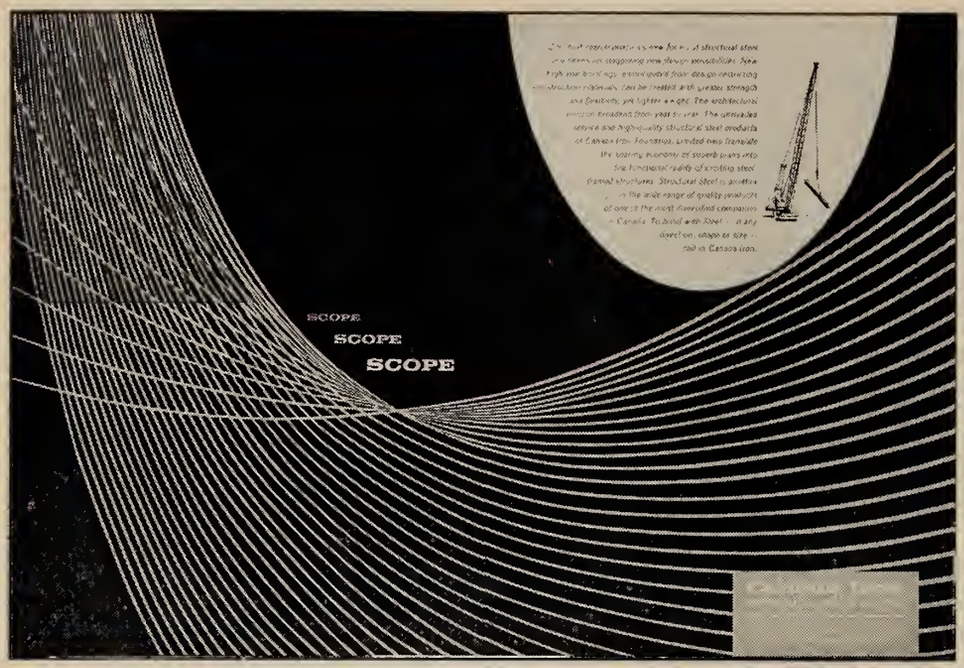
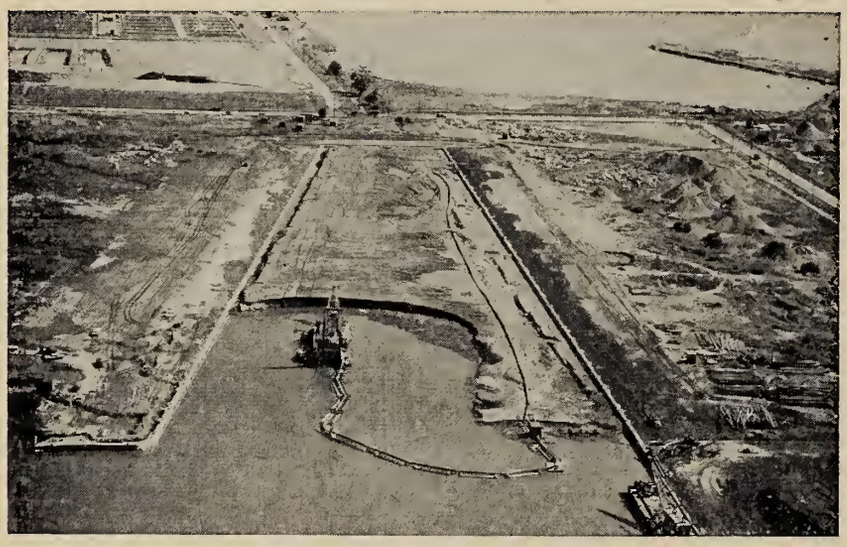


A striking design of blue webbing on a black background drew readers' attention to the scope of Canada Iron Foundries products in the award-winning advertisement in the May issue of the Engineering Journal. A copy inset, which includes a line drawing of a crane lifting an I beam, refers to Canada Iron's "constant search for new forms of structural steel" and concludes with the advice: "To build with Steel—in any direction, shape or size—call in Canada Iron."

Advertising Manager for Canada Iron Foundries is J. Pollock. Ronalds-Reynolds & Company, Montreal is the company's advertising agency. Stephen S. Brott is the account supervisor.

Each month a different panel of fifty Journal readers from across Canada is asked to nominate an award-winning ad from the viewpoints of ACCURACY—INFORMATION—ATTRACTION. Winners and their advertising agencies receive a framed Certificate of Advertising Merit.

DREDGING & MARINE CONSTRUCTION



PORTER'S 20" HYDRAULIC DREDGE "SHUNIAH" DURING REMOVAL OF 550,000 CUBIC YARDS OF SAND, SILT AND RUBBLE, FOR DEPARTMENT OF PUBLIC WORKS, CANADA, AT SHIP CHANNEL EXTENSION, TORONTO.

√ DREDGING √ DOCK AND BREAKWATER CONSTRUCTION √ DERRICKS
√ HYDRAULIC, DIPPER AND CLAMSHELL DREDGES
√ BARGES, SCOWS, DRILL BOATS AND TUGS

PLANT & MACHINE SHOP — DARTMOUTH, N.S.
BRANCH OFFICES: HAMILTON and FORT WILLIAM, ONT.

HEAD OFFICE: 806 DOMINION SQUARE BLDG., MONTREAL • TEL. UNiversity 6-8516

THE J. P. PORTER COMPANY LIMITED

COMING EVENTS

Engineering Foundation Research Conference on Urban Transportation Research. Andover, N.H. Aug. 26-30.

Chemical Institute of Canada. Physical and Organic Chemistry Divisions. Symposium on Solvation Phenomena. Calgary, Alta. Aug. 29-30.

Canadian Institute of Mining and Metallurgy, Canadian Conference on Metallurgists. Second Conference. Quebec City. Sept. 5-7.

International Association for Analogue Computation. Conference on Analogue Computation Applied to Aero-Nautics. Liege, Belgium. Sept. 9-12.

American Institute of Mining, Metallurgical and Petroleum Engineers, Inc. Society of Mining Engineers. Second Annual Fall Meeting. Salt Lake City, Utah. Sept. 11-13.

Institute of Electrical and Electronics Engineers, Inc., American Society of Mechanical Engineers, American Institute of Chemical Engineers. 11th Annual Joint Engineering Management Conference. Los Angeles. Sept. 12-13.

Fédération Européenne du Génie Chimique. IV Congrès International de la Détergence. Secretariat General du IVe Congrès International de la Détergence, 49, Square Marie-Louise Bruxelles 4. Sept. 7-12.

World Power Conference. Sectional Meeting. The Struggle Against Losses in the Field of Energy Economics. Lausanne, Switzerland. Sept. 13-17.

The Engineering Institute of Canada. St. Maurice Valley and Eastern Townships Branches. Joint Regional Technical Conference. Shawinigan, Que. Sept. 27-28.

Fédération des Chemistes et Technologistes de Yougoslavie. IV International Chemical Fair. Belgrade. Sept. 27-Oct. 6.

The 1963 Canadian Electronics Conference. Toronto, Ont. Sept. 30-Oct. 2.

The Institution of Electrical Engineers. Conference on Electronics Research and Development for Civil Aviation. The Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C. 2, England. Oct. 1-4.

Water Pollution Control Federation. Annual Meeting. Seattle, Washington. Oct. 6-10.

this is the way it goes to work: its sleeves rolled up and ready

When Cochrane makes a deaerating boiler feed system, it's *packaged*—pre-engineered, pre-assembled and ready to run. Just set the skid-mounted unit in place and connect it to your water, condensate, steam, drain and electrical systems. Odds are high that your own plant people can complete the installation with no difficulty whatsoever. Cochrane package boiler feed systems include deaerator and storage, boiler feed pumps, condensate receiver and booster pumps (where required), as well as controls and accessories. Options include continuous boiler blow-off systems and water treatment equipment.

For complete information on COCHRANE pre-engineered boiler feed systems, write to the *Engineered Products Group*, Crane Canada Limited, 1355 Martin Grove Road, Rexdale, Ontario.

ENGINEERED PRODUCTS GROUP

CRANE

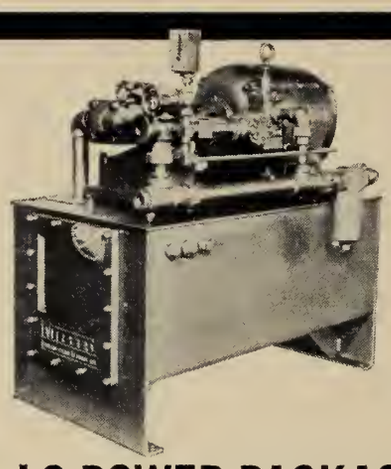
Personals

(Continued from page 54)

George F. Barrett, M.E.I.C. (McGill '47) has been appointed Manager, Structural Manufacturing at United Steel Corp. Prior to joining the company, Mr. Barrett held managerial positions in the structural division of Dominion Bridge Co. Ltd.

Robert R. Farrell has been elected to the Board of Directors of I-T-E Circuit Breaker Company, Philadelphia. Mr. Farrell, President of the company's Canadian branch is also a director of the Canadian Porcelain Company.

Peter H. Roe and **Carl J. Turkstra** were the first persons to be rewarded Doctor of Philosophy degrees by the University of Waterloo. Both Ph.D. degrees were for studies in engineering. Peter Roe came to Canada from England in 1951. He received his B.A.Sc. from the University of Toronto in 1959 and then did post-graduate study in electrical engineering at the University of Waterloo. He was a member of the University's first graduating class when he received his master's degree in 1960. Carl Turkstra, from Hamilton, took his undergraduate degree in civil engineering at Queen's University. He received his M.A.Sc. from the University of Illinois before going to Waterloo. He flew from England, where he is lecturing at London University to receive his Ph.D.



HI-LO POWER PACKAGES DELIVER TO 120 USGPM

Hydraulic power packages, developed by Vickers-Sperry for Canadian industrial applications, offer a wide selection of pressure and volume combinations to meet industrial operating conditions. These Hi-Lo units offer the following features.

* Large volume at low pressure or low volume at high pressure.
* Adjustable pressure control, remote control or automatic high-low pressure control.
* Pressures to 2400 psi.
* Micronic particle oil filtration to insure a clean, trouble-free system.
* Use with standard 1200—1800 rpm electric motors.

For more information on these Hi-Lo power units or any other components in the complete Vickers-Sperry hydraulics line, write for Catalogue 5001C or contact the application engineering office nearest you. 1488

VICKERS-SPERRY of Canada Ltd.

Division of Vickers Incorporated

SPERRY RAND CORPORATION

TORONTO 18—92 Advance Rd.

VANCOUVER 9—1637 West 5th Ave. MONTREAL 16—750 Lucerne Rd.

VICKERS OFFERS WORLD-WIDE FACILITIES—SALES AND SERVICE

K. Raht

K. E. O'Neill

Kenneth E. O'Neill has been appointed Vice-President of Trane Company of Canada, Limited. He will be responsible for the manufacturing, engineering and industrial relations divisions of the company. Formerly Assistant to the General Manager, Mr. O'Neill has held a number of engineering and sales positions in his 25 years with the company.

K. Raht, a senior research engineer with The Consolidated Mining and Smelting Company of Canada at Trail, B.C., has been elected to the American Academy of Industrial Hygiene. He is the first Canadian from the mining, metallurgical or chemical industry to have received this recognition. Mr. Raht joined Cominco in 1914.

Con Bachovzeff, M.E.I.C. (McGill '51) has been appointed Manager, Mechanical Manufacturing, at United Steel Corp. Mr. Bachovzeff has held engineering and management positions in the chemical, transportation and manufacturing industries in Canada.

H. L. Smith, M.E.I.C. (U.B.C. '44) has been appointed general manager of Manitoba Rolling Mills Division of Dominion Bridge Company Limited, Winnipeg. Mr. Smith has been associated with the Mill since 1926 and successively held the positions of superintendent, works manager, manager and assistant general manager at the company's Selkirk rolling mill.

M. G. Taylor, M.E.I.C. (N.S.T.C. '27) has been awarded an Honorary Doctor of Engineering Degree from the Nova Scotia Technical College. Mr. Taylor obtained his engineering certificate from Acadia University in 1925, his B.Sc. in Electrical Engineering at N.S.T.C., and his M. Sc. from the Massachusetts Institute of Technology.

Georges A. Boire, M.E.I.C. (McGill '49) has been appointed vice-president and general manager of Champlain Oil Products Limited. Mr. Boire has wide experience in the petroleum industry in Quebec and throughout Canada.

Peter B. Cleugh, M.E.I.C. (McGill '49) has been appointed sales manager of Manitoba Rolling Mills Division of Dominion Bridge Company Limited. Mr. Cleugh has been technical assistant to the general manager of Winnipeg Branch, and was formerly manager of personnel relations at the company's head office in Montreal. Mr. Cleugh joined the company in 1949.

(Continued on page 68)

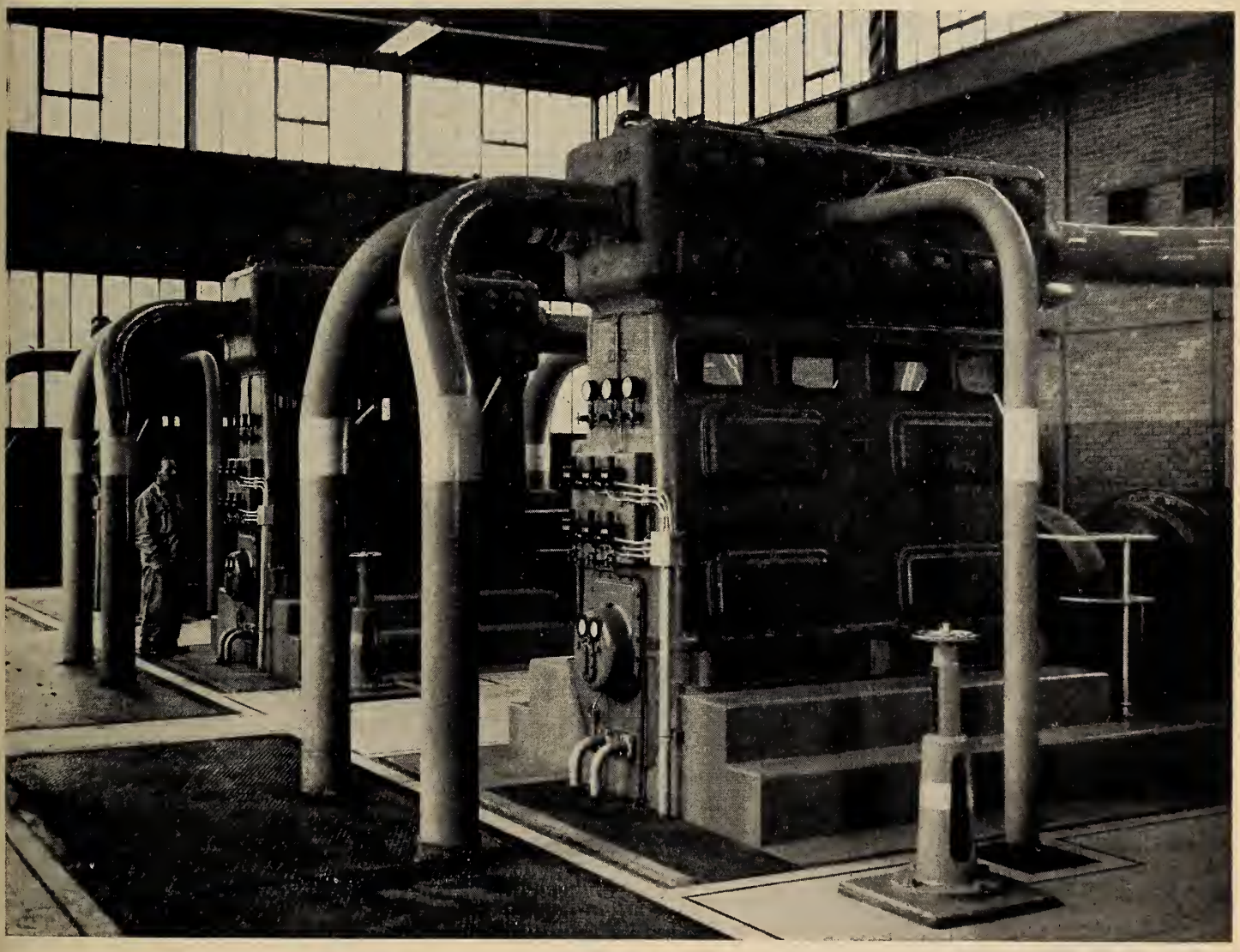
SULZER

Oxygen Compressors for Steel Works, the Chemical Industry and Cracking Plants

Delivering
50 to 6,000 Nm^3/h
Pressures
up to 200 kg/cm^2 g

Sulzer labyrinth-piston compressors deliver pure dry gas, operate without friction in the gas-swept parts and without cylinder and piston wear, dispensing with the need for liners and thus permitting intensive direct cooling. Hence they are not susceptible to fire hazards. Direct compression of dry oxygen is possible without extra wear. The heat of compression can be led off quickly and directly, without accumulating. These labyrinth-piston machines compress without friction and require little in the way of floor space and foundations; the driving motor can be coupled direct.

They are built in various types, and the series-produced standard models cover the wide performance range without gaps. The principle of standardized interchangeable components has been consistently applied, resulting in:
interchangeable parts between different compressor types—small spares inventory—prompt spare parts service.



Three Sulzer 4D225-3A compressors, compressing to 41 kg/cm^2 abs. at 480 r.p.m., delivery 2,550 m^3/h per unit.

Sulzer Brothers Limited
Winterthur, Switzerland

Sulzer Bros. (Canada) Ltd.
1310 Greene Avenue,
Suite 650 Montreal

World-wide service: **London W.C.1:** Sulzer Bros. (London) Ltd., Bainbridge Street; **Paris 7e:** Cie de Construction Mécanique Procédés Sulzer, 19, rue Cognacq-Jay; **Lisboa:** Sulzer Irmãos Lta., Apartado 2702; **Madrid:** Sulzer Hermanos S. A., Apartado 6050; **Oslo:** Sulzer Brothers, Nordisk Aksjeselskap, Ridder-voldsgate 7; **New York (6), N.Y.:** Sulzer Bros. Inc., 19 Rector Street; **Singapore 9:** Sulzer Central Office for S.E. Asia, Newton P.O. Box 8; **Mexico 1, D.F.:** Sulzer Hermanos S. A., Apartado postal 7183; **Rio de Janeiro:** Sulzer do Brasil S. A., Caixa postal 2435; **Buenos Aires (R 74):** S. A. Sulzer Hermanos S.I.L., Avenida Belgrano, Nº 865, 2º P; **Johannesburg:** Sulzer Bros. (South Africa) Ltd., P.O. Box 930; **Beirut:** Sulzer Bros. Ltd., Middle East Consulting Office, P.O.B. 5317; **Tokyo:** Sulzer Brothers (Japan) Limited, C.P.O. 147. Represented in all other countries.

863

AIRCRAFT TURBINES ARE FOR AIRCRAFT—RUSTON TURBINES ARE FOR INDUSTRY

ON-SITE POWER FOR BASE LOAD NEEDS DOWN-TO-EARTH TURBINES

Industrial power at the touch of a button! Here, eight gas turbines in a power station RUSTON-planned throughout as an integral installation.

We would never recommend a Ruston turbine for use in an aircraft. We design them for industry. We make them so big and strong that they can run up to 25,000 hours before overhaul . . . year in year out on load without stopping. We make long life, heavy duty turbines, give them low loadings, conservative ratings and high safety margins.
And in the hottest, driest and grittiest climates in the world they are acknowledged best buys for companies with the keenest costing systems. Power, light, heat, air-conditioning, drying, distillation . . . pre-engineered installations by our experts . . . a completely integrated whole . . . an operation which pays!
Ruston turbines have 15 years proven trouble-free experience . . . cumulative running hours approaching one and a half million hours . . . and unique, world wide experience of application techniques.

RUSTON

INDUSTRIAL GAS TURBINES

RUSTON & HORNSBY LTD. TORONTO, VANCOUVER & MONTREAL

Members of the RUSTON Group: Davey, Paxman & Co. Ltd., Alfred Wiseman & Co. Ltd.

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DISTRIBUTORS:
NEWFOUNDLAND: Steers Ltd., St. John's · NOVA SCOTIA: Atlantic Bridge Co. Ltd., Lunenburg · EASTERN ONTARIO: Ruston & Hornsby Ltd., Toronto · QUEBEC & NEW BRUNSWICK: Ruston & Hornsby Ltd., Montreal · WESTERN ONTARIO (LAKEHEAD): W. H. Marr (Twin City) Ltd., 915, Memorial Avenue, P.O. Box 810, Port Arthur, Ontario · MANITOBA & SASKATCHEWAN: Webb Scott Equipment Ltd., 947, Notre Dame Avenue, Winnipeg, 3, Manitoba · ALBERTA: Gorman's Ltd., Edmonton · BRITISH COLUMBIA Ruston & Hornsby Ltd., Vancouver.

Personals

(Continued from page 66)

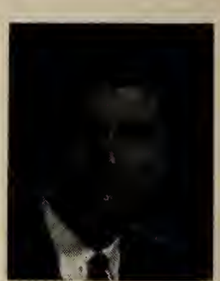
W. D. Laird
M.E.I.C.

G. Sarault,
M.E.I.C.

W. Douglas Laird, M.E.I.C. (Manitoba '40) has been appointed North American Resident Technical Representative-Compressors for Atlas Copco Canada Ltd. In this capacity, he will advise on the operation and development of air compressors in North America. Mr. Laird, who retains his present position of manager of the industrial division of the company, joined the firm in 1952.

Gilles Sarault, M.E.I.C. (McGill '34) has been elected President of the Canadian Council of Professional Engineers. Mr. Sarault is presently a consulting engineer practising in Quebec City and specializing in the electrical and mechanical fields.

E. W. R. Butler,
M.E.I.C.



A. O. Drysdale,
M.E.I.C.

E. W. R. Butler, M.E.I.C. (McGill '24) has been elected president of the Bailey Meter Company Limited. Mr. Butler joined the company in 1924. Until his appointment as assistant manager of the company in 1952, Mr. Butler served as manager for Western Canada. In 1956 he was elected vice-president and director of the company.

A. O. Drysdale, M.E.I.C. (McGill '41) has been appointed Assistant to the Vice-President and General Manager of Operations at Canada Cement Company, Limited. Mr. Drysdale, formerly Superintendent of the company's plant at Belleville, Ont., is Past-President of the Ontario Chamber of Commerce.

George S. MacDonell has been named Manager, Radio and Television Product Section of Canadian General Electric's Appliance and Television Receiver Department. Mr. MacDonell will be responsible for all phases of marketing and manufacturing in the home entertainment product section. Mr. MacDonell joined the company in 1950 after graduation from the University of Toronto.

Pierre Lambert has been appointed to the field engineering staff in the Quebec City office of The Master Builders Company, Limited. Mr. Lambert, a graduate of Ecole Polytechnique, Montreal, has had wide technical and practical experience in the construction field, having served as technical counselor to Ministers des Richesses Naturelles, Quebec Provincial Government, Quebec City.

Murray E. Malloy has been appointed District Sales Manager for the Montreal, Ottawa, Quebec City and Maritime Provinces areas of Douglas Engineering Co. Ltd., Toronto. Mr. Malloy, a graduate of Dalhousie and the Nova Scotia Technical College, was formerly associate with Canadian Westinghouse.

Gordon C. Naylor has been appointed Manager, Atlantic Region, of Canadian Liquid Air Company, Limited. His office will be in Halifax. Mr. Naylor joined Liquid Air in 1954. In his new position Mr. Naylor will be responsible for the company's activities in the Maritimes.

H. Douglass Short has been appointed Consulting Engineer for Line & Cable Accessories Limited, Newmarket, Ont. Mr. Short, an Electrical Engineering graduate from Queen's University, has had many years experience in transmission line engineering both in the low voltage and the extra high voltage field.

W. J. S. Dormer, M.E.I.C. (McGill '23) has retired from the Bell Telephone Company after forty years service. During the last six years with the company, Mr. Dormer was in charge of Outside Plant Engineering in Northeastern Territories comprising Frobisher Bay, Goose Bay, Gagnon, Wabash and the eastern coast of Hudson Bay.

F. L. W. McKim has been appointed Director of the Administration and Awards Division of the National Research Council. **Dr. H. R. Sallans** has been appointed Director of the Prairie Regional Laboratory at the NRC. **Dr. W. G. Schneider** has been named Director of the Division of Pure Chemistry.

Douglas Harold Perkins has been appointed Supervisor, Research and Development at Concrete Pipe Limited. Mr. Perkins, a graduate in Civil Engineering from the University of Toronto, has had 20 years of practical experience in various engineering capacities. For the past five years he has been managing director and chief engineer of the Canadian Concrete and Pipe Institute.

J. Charles Turcot has been appointed as Resident Representative in Quebec City for S. A. Armstrong Limited. In his new capacity, Mr. Turcot will be responsible for the sale of all products of the Armstrong Heating and Commercial Division, as well as Water Pressure Systems.

(Continued on page 72)

BOTH CASTINGS PRODUCED TO CUSTOMERS SPECIFICATIONS by "UNION"

You want a perfect match for your specs — and you want the best materials for long wear and efficient performance. Every important factor is taken into consideration when "Union" takes on a casting job. Over 50 years of experience plus the most up-to-date equipment and techniques assures that your highest standards will be met. For further details on castings, write for "Union" bulletin No. 62F1 — French Bulletin No. 62F1F, or talk to your "Union" representative.

UNION

THE UNION SCREEN PLATE COMPANY OF CANADA (LIMITED)

HEAD OFFICE: LENNOXVILLE, QUE.

3 PLANTS TO SERVE YOU — AT STRATEGIC LOCATIONS

PLANTS and SALES OFFICES: LENNOXVILLE, MONTREAL, P.Q. and BRAMPTON, ONT.

FORCE

The pounding of heavy machinery is the orchestration of industrial progress. Massive machines produce an endless variety of goods turned out with the microscopic precision that modern production techniques demand. The design and building of heavy machinery is an important function of Canada Iron Foundries, Limited. Sheet metalworking equipment, steel mill equipment, pulp and paper machinery, rubber and plastics machinery, general machinery and gear products can be supplied by Canada Iron. Finely engineered heavy machines for many fields are more items in the wide range of quality products of one of the most diversified companies in Canada. For heavy machinery, built with skill and integrity—call in Canada Iron.

Canada Iron

CREATING CAPITAL GOODS FOR THE FUTURE

DIVISIONS · Foundry · Mechanical · Pipe · Structural · Tamper · Western Bridge · Railway & Power Engineering Corporation, Limited · C.M. Lovsted & Co. (Canada) Limited

FOR CONTRACT DIAMOND DRILLING

With expert, experienced crews operating from strategically located branches, Boyles Bros. are equipped to offer you a complete service in core and blast hole drilling, soil sampling, foundation testing and grouting. Based on over 67 years of experience, Boyles Bros. have developed equipment, techniques and procedures to penetrate every known formation with the greatest possible speed and economy.

BOYLES BROS
DRILLING COMPANY LTD.
VANCOUVER, CANADA

You'll find it pays to consult those who know most about diamond drills and drilling.

Vancouver, B.C., Edmonton, Alberta, Yellowknife, N.W.T., Port Arthur, Ont., Toronto, Ont., Noranda, P.Q., Newcastle-on-Tyne / London U.K.

On guard just in case! When trouble strikes, emergency action must be *immediate*. Contamination from acids, chemicals and other industrial caustics requires first aid *now*... HAWS Decontamination Booths are your best stand-by protection against serious injury. MODEL 8600: Fiberglass decontamination booth; spray nozzles and eye/face wash activated by weight on treadle base.

HAWS **DECONTAMINATION BOOTH**
A product of HAWS DRINKING FAUCET COMPANY

Since 1909

MONTREAL, QUEBEC R. G. K. WARD, LTD. 6100 Monkland Ave.
NORTH VANCOUVER, B.C. ROBERT SOMERVILLE, LTD. 2720 Crescentview Drive
TORONTO, ONTARIO SYDNEY W. BEANEY P.O. Box 84, Sta. K

Personals

(Continued from page 69)

J. L. Hayes

L. Sadler

Leslie Sadler has been appointed Saskatchewan district manager for Lincoln Engineering Co. (Canada) Ltd. His office will be located in Saskatoon.

J. L. Hayes has been appointed Manager, Montreal Sales and Service for Leeds & Northrup, Canada, Ltd. He will be responsible for Quebec, Eastern Ontario and the Maritime Provinces. Mr. Hayes has 15 years of background in the instrumentation field, sales and service.

Dr. O. M. Solandt, Hon. M.E.I.C. (Toronto '36) has been named chairman of the board at DCF Systems Limited, Malton, Ont. Dr. Solandt, a distinguished research scientist, was the first chairman of the Defence Research Board which he helped plan. Since leaving DRB in 1956, Dr. Solandt has been in charge of research and development for the C.N.R. Dr. Solandt is a trustee of the Mitre Corporation of Boston and vice-chairman of the Board of Governors, Sir George Williams University, Montreal. He is also consultant in research to the Montreal General Hospital.

Dr. A. E. Berry, Hon. M.E.I.C. (Toronto '17) has been appointed Chief Consultant in Research and Development at Josam Products Limited, Toronto. Dr. Berry retired this April as General Manager and First Engineer of the Ontario Water Resources Commission after serving 44 years in public service.

Yvon Lafonatine, A.M.E.I.C. (Ecole Poly. '58) has been appointed plant manager, West African Explosives and Chemicals Ltd., Liberia, a division of Canadian Industries Limited. Mr. Lafonatine joined C-I-L in 1958 and previous to his recent appointment, was technical service representative, explosives, Montreal.

J. R. Mills, M.E.I.C. (N.S.T.C. '41) has been appointed Director of Voluntary Economic Planning in the Department of Finance and Economics of the Province of Nova Scotia. Mr. Mills has 22 years of experience in construction and allied work with the Foundation Group of Companies. Before resigning late in 1962, Mr. Mills was Division Manager Atlantic Provinces, and Vice-President of the Foundation Company of Canada and Executive Vice-President of Foundation Maritime Limited.

If you have your degree in engineering and experience in air conditioning or heating or ventilating or heat transfer equipment — we would like to talk to you!

CAREERS

IN PRODUCT SALES ENGINEERING ARE OPEN AT TRANE . . .

The growing demand for Trane products in each of the above fields has meant a steady acceleration in growth at Trane. For example, new production lines for the manufacture of packaged air conditioning equipment and unit ventilators were set up this year. A 20% plant expansion program is on the boards for 1964. Our field force continues to grow.

All of this means new opportunities for Product Sales Engineers. This is YOUR opportunity to join the leader.

Your location — Toronto.

Your salary — open.

Your resume will be treated in complete confidence by:

J. G. Betts,
Trane Company of Canada, Limited
401 Horner Ave., Toronto 14, Ont.

Or if you prefer, telephone Mr. Betts (in confidence) at 259-8221 and arrange an interview.

TRANE

FOR ANY AIR CONDITION

Manufacturing engineers of air conditioning, heating, ventilating and heat transfer equipment

Trane Company of Canada, Limited, 401 Horner Ave., Toronto 14, Ont.

Employment Service

THE ENGINEERING INSTITUTE OF CANADA

This service is operated for the benefit of members of the Engineering Institute of Canada and for organizations employing engineers.

SITUATIONS WANTED

Advertisements are inserted free of charge for members of all classes. Maximum length is 60 words, and repeat insertions must be separately requested in writing for each desired appearance.

SITUATIONS VACANT

Rate: Six dollars per column-half-inch per insertion.
Replies to advertisements should be addressed to the file number, Employment Service, 2050 Mansfield Street, Montreal. Interviews with the Employment Service may be arranged by calling VI 2-8121 at the above address.

SITUATIONS WANTED

CIVIL ENGINEER — B.Eng. '46. Contract and construction control for large development company. Design, construction and maintenance of services and roads for industrial, commercial and residential neighbourhoods. Desire position with municipal consultant or municipality in Ontario. File No. 535-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. (Alta. 1956). Age 31, married. 6 years' experience in all types of structural design. Responsible for structural design of many large structures in Alberta, assoc. of architectural firm. Desires challenging position with consulting firm or as construction engineer. Alberta preferred. Full resume on request. File No. 536-C.

CIVIL ENGINEER — M.E.I.C., B.Sc. (U. of Sask.) 1963. Age 22, single. 1 year's experience in heavy construction and planning. Desires a position with a general contractor, industrial or consulting firm. Will locate anywhere in Canada. File No. 538-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. (Que.), B.Sc. '54 Queen's University. Experience with large steel fabricating firm in steel design, erection equipment design, erection procedures and methods. Would prefer to locate in Ontario but would seriously consider offers from elsewhere. File No. 331-C.

CIVIL ENGINEER — A.M.E.I.C., B.Sc. B.A., P.Eng. Laval. Age 32. 5 years' experience in design and supervision of highways construction. This experience includes surveying, preparation of estimates and layout. Good experience in general construction and drainage. Thesis in prestressed concrete. Would like to work with consulting engineers or contractors. Available within one month. Will locate anywhere. Bilingual. File No. 102-C.

CIVIL ENGINEER — A.M.E.I.C., B.Sc. (Civil) U.N.B. 1962. Age 23, married. Presently employed in estimating and sales. Undergraduate experience in highways. Seeks position with consulting firm or general contractor with opportunity for advancement. File No. 543-C.

ELECTRICAL ENGINEER — M.E.I.C., P.Eng., 1961 Graduate (Power). Ambitious, age 24, married. Summer experience in power consulting. Presently employed in electronics field. Desires position offering opportunity in the electrical power field related to maintenance, consulting or construction. File No. 537-E.

MECHANICAL ENGINEER — A.M.E.I.C., P.Eng. Ontario. Married, age 28. Desires responsible position in production offering prospects for participation in small company. Prefers non-metropolitan location in Southern Ontario. File No. 539-M.

CIVIL AND HYDRAULIC ENGINEER — M.E.I.C., A.M.A.S.C.E. Experience includes detailed hydraulic design, engineering hydrology, feasibility and water resources studies for hydro-electric developments in Eastern Canada (8 years); previously in the irrigation and flood control fields in India (2 years). Canadian citizen with Master's in Hydraulic Engineering. B.Sc. (Civil Eng.) and B.A. (Honours in maths) degrees. Seeks career position with consultants in Western Canada, U.S.A. or international engineering organizations working in underdeveloped countries. Interests include company finance, travel and literary writing. Married, 3 children. File No. 496-C.

MECHANICAL ENGINEERING GRADUATE — Experienced man for maintenance and engineering department of a large manufacturing firm in East Toronto. Employee benefits include group insurance, medical, hospital and pension plan. Good opportunity for advancement. State full particulars regarding experience, personal data and salary acceptable to File No. 481-V.

MECHANICAL ENGINEER — M.E.I.C., P.Eng. (Ont.), B.Eng. McGill 1955, M.B.A. Western. Experience in metal working, petroleum, synthetic fibre, and pulp and paper industries. Have worked in engineering, manufacturing and marketing divisions of a national, medium-sized metal fabricator. Presently engaged in large company analysing new products and businesses for acquisition. Desire responsible position leading to management, preferably in manufacturing plant. File No. 540-M.

MECHANICAL ENGINEER — A.M.E.I.C., P.Eng. (Ont.), B.Sc. Age 26, married. 5 years' field experience with a leading manufacturer of industrial instrumentation. Desires a responsible and challenging position with a process industry in this or a related field. File No. 542-M.

PROFESSIONAL ENGINEER — M.E.I.C., B.Sc. (Electrical). Certificate in Business Administration. 12 years' diversified experience in plant engineering, maintenance, machine shop, production, sales and construction. Presently employed as superintendent. Seeks position as Plant Manager. Will relocate. File No. 460-E.

STRUCTURAL ENGINEER — A.M.E.I.C. P.Eng. (Que). 10 years' experience with leading industrial firms both in steel and concrete structures, design and drafting supervisions. Presently in Montreal. Desires to relocate, preferably to Ontario. File No. 541-Str.

SITUATIONS VACANT

CIVIL

CITY OF TORONTO PLANNING BOARD —PLANNER I — $7,010 to $8,123. For the Projects Division, a Civil Engineer, preferably with planning experience, and special knowledge of the transportation aspects of city planning. Duties include analysis of traffic data, evaluation and preparation of proposals, and liaison with transportation agencies. Degree in Civil Engineering, Membership in the Town Planning Institute of Canada desirable. Apply: Commissioner of Planning, City of Toronto Planning Board, 129 Adelaide Street West, Toronto 1, Ontario. File No. 473-V.

PROFESSIONAL ENGINEER to join a newly formed company offering Project Liaison Services, Job Coordination, Project Management, Construction Supervision, and Construction Consulting Services. This man is aged 30 to 39, well experienced on a variety of Industrial Commercial Construction work, and is good in Planning, Coordinating, Scheduling and Management. He is able to sell himself to clients. Participation in the company will be offered. Location is now in Montreal. Future location could be anywhere in Canada. Reply with full particulars to File No. 471-V.

ELECTRICAL

SUPERVISOR OF INDUSTRIAL ENGINEERING — required by B.C. Hydro & Power Authority. The apopintee will be required to organize and conduct a work study program of Transmission and Distribution Operation and Maintenance throughout the Authority's Operations Division. This will involve the making of detailed studies of work methods and procedures, preparation of recommendations regarding improvements, and establishment of time standards and standard cost data; would assist in training programs as required, and supervise others in related work. Applicant should have at least 5 years' experience in the field, with some background in transmission and distribution maintenance. Preference will be given to graduate electrical engineers, but equivalent training will be considered. Apply in writing only stating salary expected to: B.C. Hydro and Power Authority, Head Office Personnel Department, 970 Burrard Street, Vancouver 1, B.C. File No. 472-V.

EXPERIENCED PROCESS INSTRUMENTATION SALES & APPLICATION ENGINEER — A challenging opportunity for a graduate engineer, preferably electrical, with at least 3 to 5 years' experience in process instrumentation, application engineering and marketing. The application engineering and marketing work done by the incumbent will cover the full line of GE instrumentation, including the new GEMAC process instrumentation and control system. Location Quebec City. Interested applicants are requested to submit a complete resume of their qualifications to File No. 476-V.

APPLICATION AND SALES ENGINEER FOR METERING EQUIPMENT — Canadian General Electric requires a graduate Electrical Engineer with at least 3 to 5

SITUATIONS VACANT
ELECTRICAL

years' experience with an electrical utility or with sales experience to utilities. The position will entail travelling to visit customers and district offices, to engineer specific jobs or to present product presentations. Location Quebec City. Interested applicants are requested to submit a complete resume of their qualifications to File No. 477-V.

MECHANICAL

MECHANICAL ENGINEER — with 3 to 5 years experience on design of plumbing, heating and air conditioning. Preferably a younger person who would eventually become a partner. General Consulting firm — Ottawa. Reply in confidence to File No. 424-V.

INDUSTRIAL ENGINEER — required to organize Industrial Engineering Section at Head Office of multi-plant Company. Will be responsible for formulating Company policies and procedures in the field of industrial engineering and assisting the operating divisions in the implementation of same. Applicants should be 35-45 years of age with 7-10 years' relevant experience. A knowledge of French preferred. Reply giving a complete resume to File No. 474-V.

INDUSTRIAL ENGINEER — Required for a major non-ferrous industry located in the Province of Quebec. Work involves the coordination of production assignments, establishment of standards, verification of production schedules, etc. Applicant should be a University graduate, with sound knowledge and experience in the Industrial Engineering field. All applications will be treated in strict confidence. Please reply to File No. 478-V.

MISCELLANEOUS

TECHNICAL SERVICES ENGINEER — Major oil company with headquarters in Toronto requires a Technical Services Engineer. Applicants should be at least 25 years of age with a degree in engineering or chemistry. Industrial sales experience in petroleum products an asset. Position involves travelling throughout Ontario with headquarters in Toronto. Full range of company benefits, salary commensurate with experience. Reply with full particulars to File No. 480-V.

HOUSING RESEARCH VACANCY — The Division of Building Research, National Research Council, Ottawa, has an opening for an Engineer or Architect to carry out studies involving the application of industrial engineering techniques to the study of house building operations. This will include time and motion studies and methods analysis with a view to determining the relative efficiencies with which typical on-site building operations are conducted, the use of labour, the handling of materials, the scheduling of materials, etc. Applicants must have an honours Bachelor's degree in Engineering (Civil or Mechanical) or Architecture, with high academic standing and preferably (although this is not essential) some experience in residential construction. This is a new position which offers excellent possibilities for advancement. Initial salary will depend on qualifications. Apply giving complete details of education and experience to the Employment Officer, National Research Council, Sussex Drive, Ottawa 2, Ont. In reply please quote BR-324. File No. 479-V.

SALES ENGINEERS: With B.Sc. degree required by fully integrated major oil company, marketing department, for early assignment in Western Canada. If you believe SALES is a true engineering function, then your future professional life can fit this position. Training course given. Excellent remuneration and advancement prospects. Three to five years sales experience desirable but not a requirement. Knowledge of modern industrial equipment a definite asset. Permanent position. Full company benefits. Please give personal history and statistics. File No. 446-V.

ENGINEERS REQUIRED BY ELECTRICAL POWER UTILITY IN NOVA SCOTIA

A SENIOR CIVIL ENGINEER for Project work on hydro-electric developments and related structures. Seven to ten years experience in construction and design work is desirable.

A SENIOR MECHANICAL ENGINEER with extensive experience in the design of thermal generating plant. Activities will include the carrying out of cost and feasibility studies relative to plant size, location, etc.

AN ELECTRICAL ENGINEER for Design and Protection work as applied to electrical generating equipment, transmission substations, and other electrical plant. Applicants should have from three to seven years experience.

AN ELECTRICAL ENGINEER preferably having two to five years experience with an electrical public utility. Preference will be given to applicants having previous experience in the construction, maintenance and operation of transmission and distribution systems.

Salaries for the above positions commensurate with experience and ability. All replies will be treated with the strictest confidence. Apply in writing, stating experience and salary expected to:

Superintendent of Personnel,
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Graduates in Engineering are required to operate the WR-1 nuclear reactor that is being built at the Whiteshell Nuclear Research Establishment, Pinawa, Manitoba.

Applicants should have three or more years of industrial experience after graduation.

Succesful applicants will receive training at the Chalk River Project, Ontario.

Housing or single accommodation available at Pinawa.

Full Company benefits, including superannuation, accumulative sick leave, three weeks annual paid vacation, hospital, medical-surgical plans, and group insurance.

State full particulars of education and experience to:

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DATE IN CIRCULATION — 20th of month.

SITUATIONS WANTED — Accepted free of charge from Members of The Engineering Institute of Canada only.

ABSTRACTS

(Continued from page 48)

The heat transfer data obtained was compared to existing work and an expression representing the combined correlation is included. An expression portraying the correlation of the test data is also presented and the limitations of these expressions are outlined.

Division Papers of the E.I.C.

EIC-63-CIV-23
"Iron Bacteria in a Small Water Supply"
J. W. Grainge and G. E. Myers

Iron bacteria in a water system may result in visible growths in one or more of a variety of forms. Although the bacteria are not pathogenic, consumers complain bitterly because of the objectionable appearance of the growths, particularly the light brown filamentous forms which have often been mistaken for sewage fragments.

The bacteria can be removed from the water at the source by superchlorination followed by filtration or by complete water treatment. The growth of the bacteria in the water distribution system can be controlled somewhat by maintaining a high residual of chlorine in either the free or combined form. In a small water system the cost of such treatment may be considered to be excessive on account of the equipment and chemicals required.

The present paper relates the history of a water system in which growth of iron bacteria was controlled with copper sulfate manually fed to the water in the reservoir once per day at almost negligible cost.

The treatment has not entirely eliminated the problem because iron bacteria continue to come from the source well, but the objectionable growths in the reservoir and distribution system have been largely eliminated.

EIC-63-CIV-25
"Minimum Cost Design of a Level Roadway Supported by Piers upon a Uniform Slope"
H. S. Heaps and D. A. Boyd

A method is given to determine the most economical number and spacing of concrete piers required to support a horizontal plate girder and deck when the footings of the piers are upon ground of uniform slope.

It is shown that, for a given length of roadway and inclination of the ground below the piers, there is a particular spacing and number of piers which leads to a structure of minimum cost. The dimensions of such a structure may be readily determined by reference to three graphs. A further slight reduction in cost may be achieved if a certain number of the smallest piers are replaced by an embankment.

EIC-63-CIV-26
"The Effective Width of Plates under Transverse Point Loading"
T. A. London and J. A. N. Lee

Present day efforts to design products with adequate safety but minimum factors of safety necessitates a more detailed analysis of simple situations. Whilst the days of the 'make-it-big-enough' engineers are limited, the present engineer must still be provided with simple rules by which to design. Simple concepts however, endanger the competency of a professional engineer by his own blind faith in their applicability. Therefore, it must now be a general rule that general rules are either dangerous or over-safe.

One such concept has referred to the notion of an effective width of outstanding flanges of beams or similar components. Since the user of this idea need have no more detailed knowledge than the application of simple theories of strength of materials, the implied analogy has been applied erroneously, perhaps to a multitude of situations. Without attempting to destroy or disown the concept of an effective width, this paper develops the theory applicable to a plate loaded in tension at the centres of two opposite edges and is supported by experimental verification.

The research described herein was sponsored by the National Research Council of Canada as a portion of the project "The Effective Width of T-beams", Grant No. A1242.

EIC-63-CIV-19
"Water-Reducing Admixtures for Concrete Applications and Specifications"
T. G. Glendenning and M. T. Loughborough

Water-reducing admixtures are finding increasing use in concrete construction and a few large agencies, including Ontario Hydro, have adopted them for mass concrete. By their part in reducing cement content, water reducers have contributed to greater freedom from cracks in Ontario Hydro's dams. No major problem has arisen in their use, although false setting has been aggravated in certain instances.

Although not usually preventing the loss of slump with time that results from high concrete temperatures, retarding water reducers do extend the period during which concrete will respond to vibration. In this way they have been beneficial in the prevention of cold joints. Excessive retardation can result in greater plastic shrinkage and cause difficulties due to higher form pressures.

Specifications for water-reducing admixtures and for dispensers for concrete admixtures were developed by Ontario Hydro in 1961 in the absence of a national specification. Until such time as a national specification is produced both the admixture specification and the dispenser specification, which are suited to any central mixing plant operation, should prove of value to other large scale producers of concrete such as ready-mix suppliers.

Benefits derived either directly or indirectly from the specification have included greatly improved admixture dispensers and very favourable prices on water-reducing admixtures which, since their adoption in 1956, have made possible cement savings amounting to approximately 1/3 of a million sacks.

(Continued on page 81)

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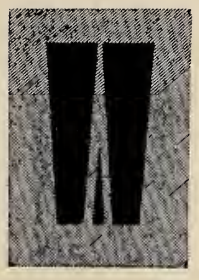

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ABSTRACTS

(Continued from page 76)

Division Papers of the E.I.C.

EIC-63-HYDEL-6

"Sluice Gate Rating Curves by Model Testing"

R. J. Silver

This paper presents the details of an hydraulic model investigation designed to establish rating curves for the deep sluice gates of the Passes Dangereuses Dam. Introductory discussion centers about the need and justification for using hydraulic models. Empirical formulas relating gate discharge to head for the deep sluice gates when operating under partial gate openings are presented and their similarity to formulas derived for similar structures is discussed. The variations in the coefficients within these empirical formulas are qualitatively discussed.

EIC-63-HYDEL-11

"Forward Planning Studies Involving the Economic Full Supply Level of Grand Rapids Generating Station of Manitoba Hydro"

L. A. Bateman and K. Renger

This paper will endeavor to outline some of the fundamental considerations underlying the choice of the Full Supply Level for the Grand Rapids Development and show the extensive nature of the work involved in reaching a conclusion in this connection. The paper deals with a simulation study of the Manitoba Hydro Integrated Hydro-Thermal System in conjunction with the Grand Rapids and Upper Nelson River Sites Developments through a period from 1967 through 1975. The paper anticipates the effects of regulation on one of the largest natural water bodies in Canada—Lake Winnipeg.

EIC

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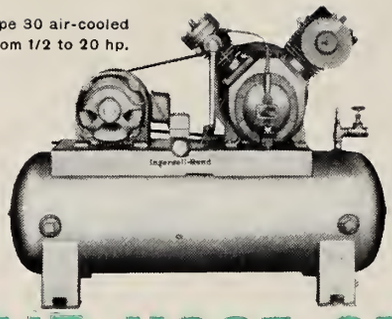

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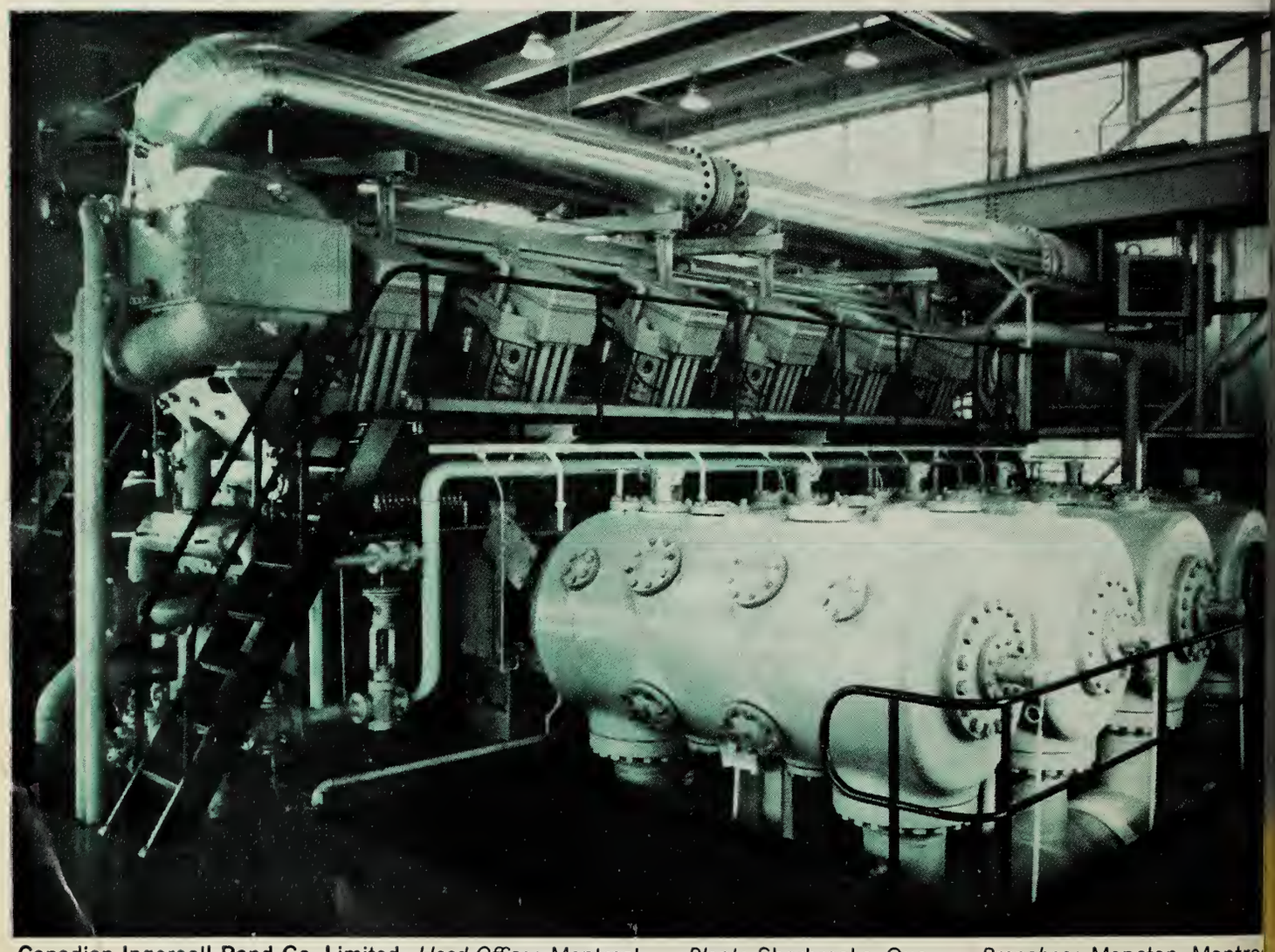

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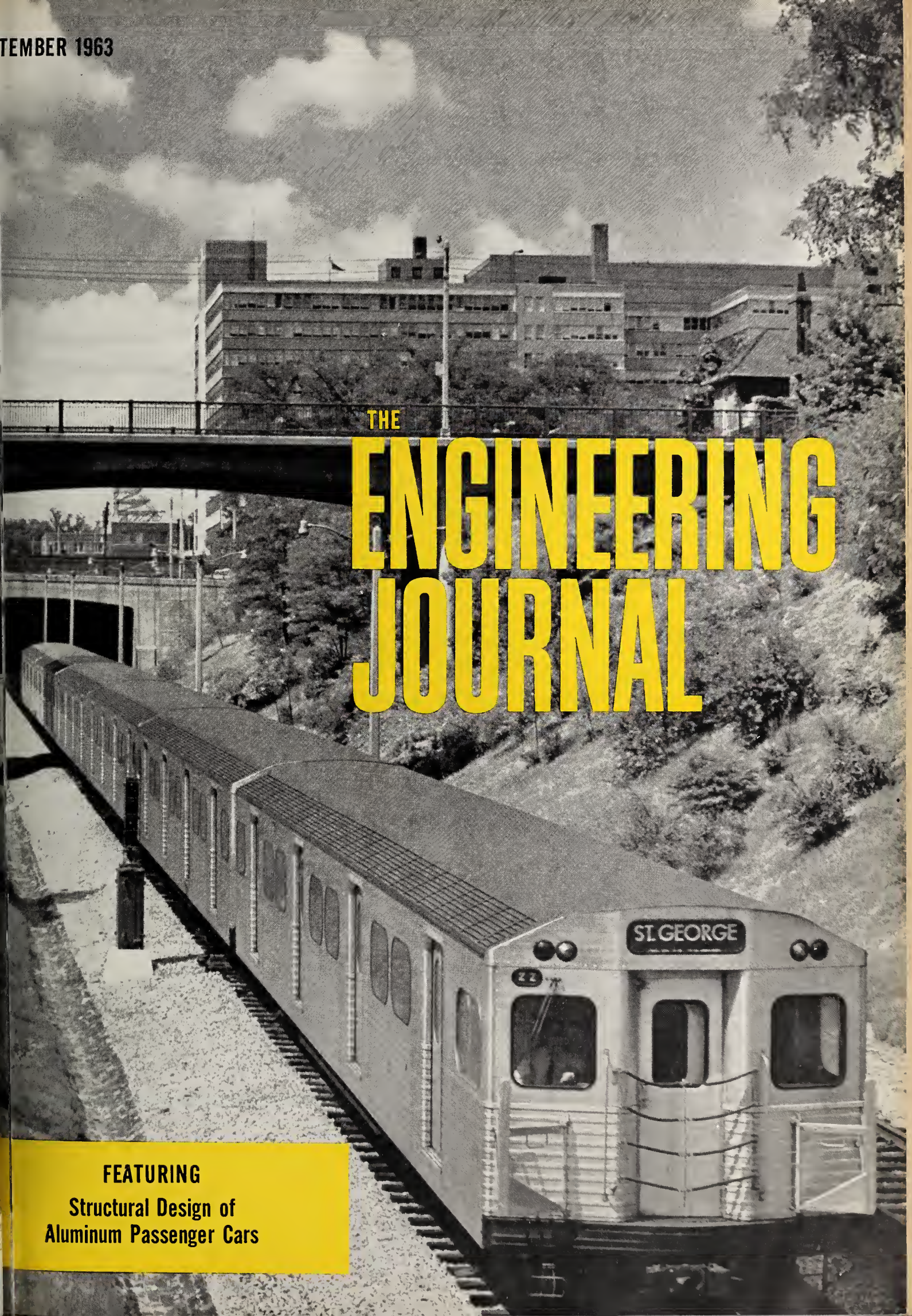

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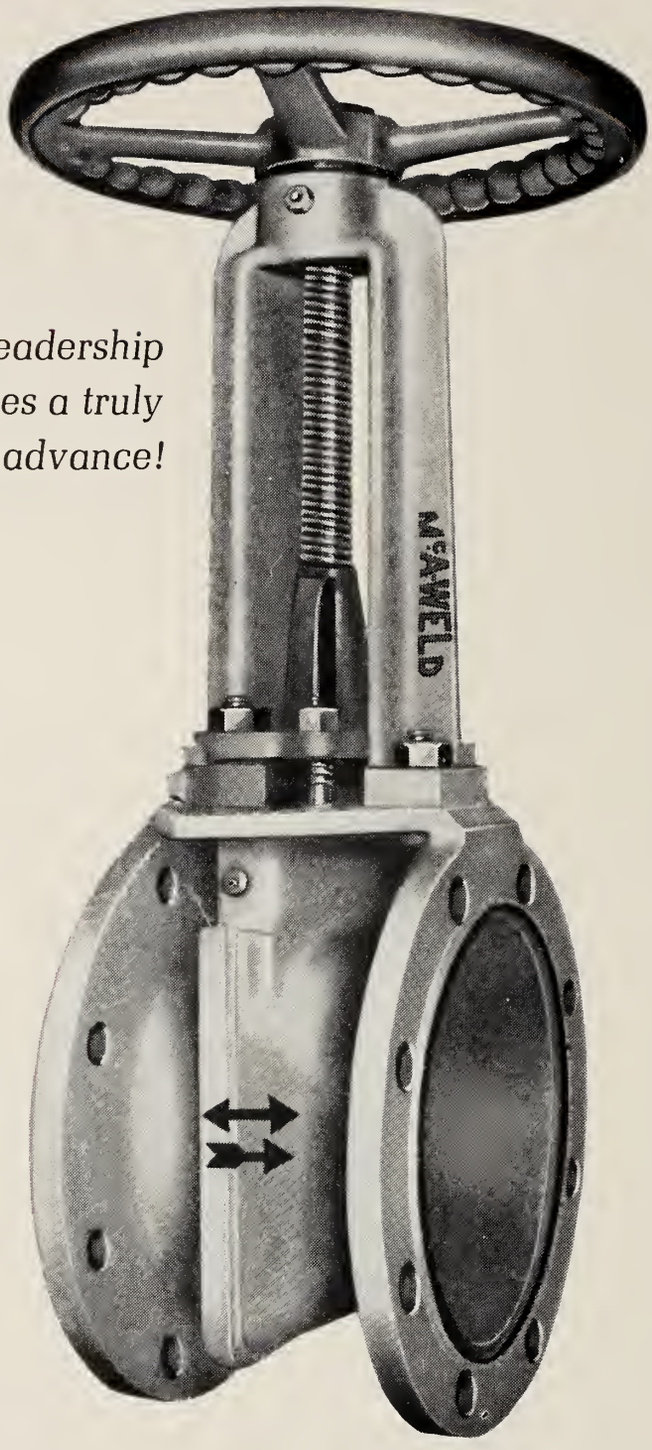

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Consulting Engineers for the Richelieu River Bridge: Lalonde & Valois. Fabrication and Erection: Canada Iron Foundries, Limited, Structural Division. Metallizing Sub-Contractor: Lagendyk and Company Limited.

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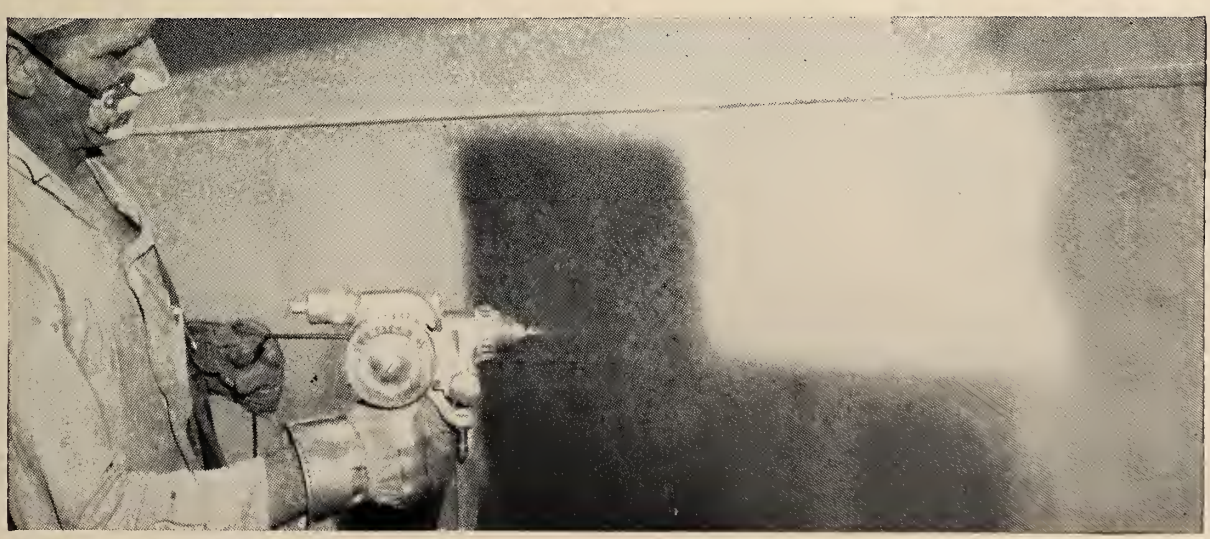

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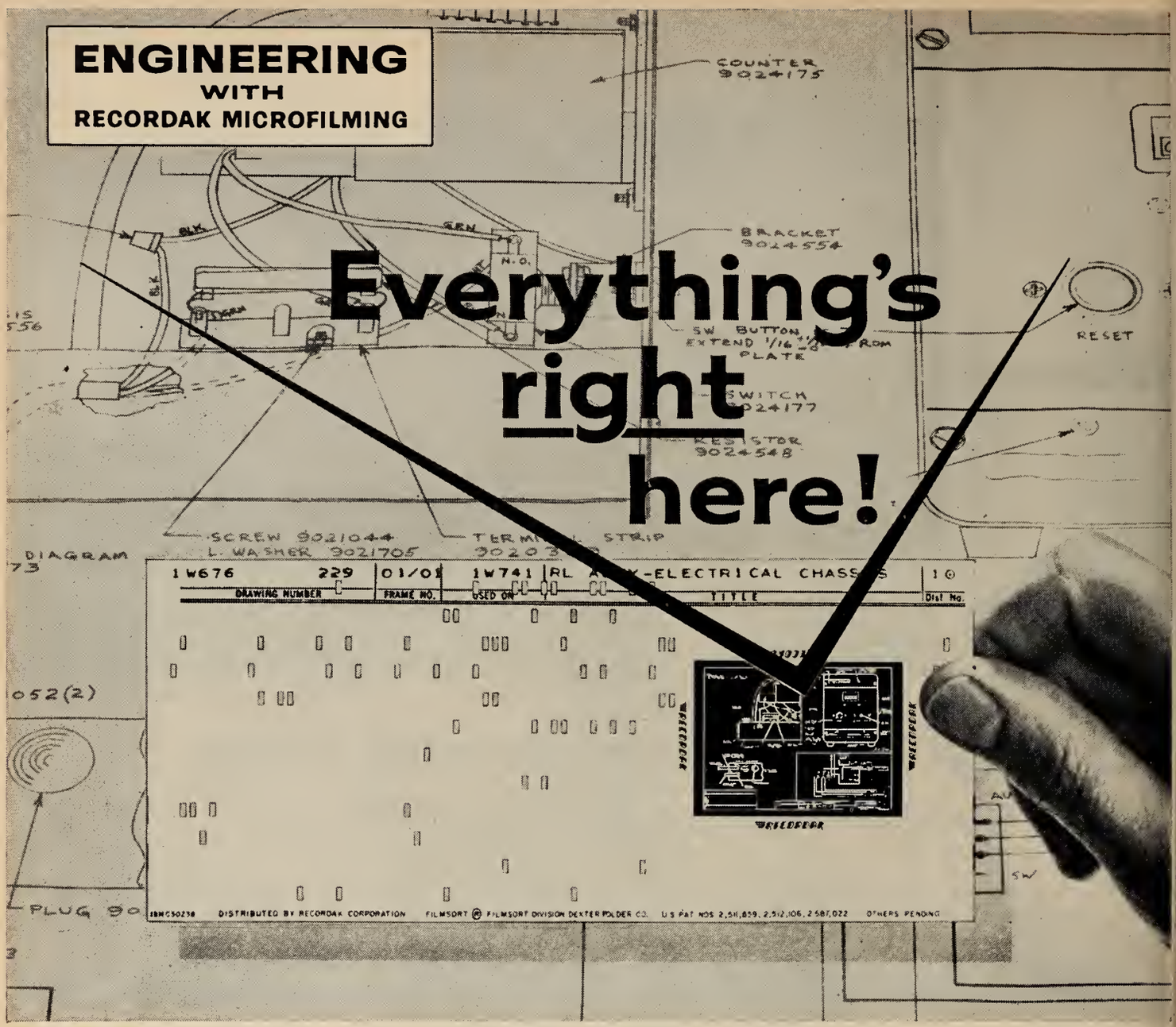

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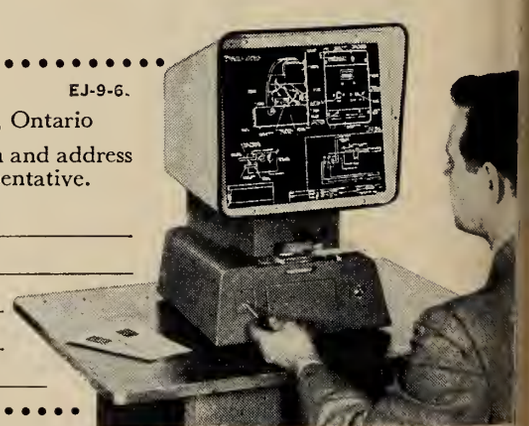

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IN THIS ISSUE

COVER ILLUSTRATION

The first paper in this month's issue of the Journal deals with the structural design of aluminum passenger cars. Illustrating this theme is our cover showing aluminum cars in operation in Toronto. (Photo courtesy the Aluminum Company of Canada).

In the first part of the paper, **Structural Design of Aluminum Passenger Cars**, by **Dr. K. Sutter**, Director, Geneva Office, Aluminium Laboratories Limited, and **M. S. Woo**, Principal Aluminum Design Engineer, Alunimum Company of Canada, Ltd., a review of past practices in designing railway passenger cars, including transit stock is presented. This review reveals the need for a calculation method whereby the most suitable designs may be determined. Several calculation methods, including one originated by Dr. Sutter, are described. The idealizations used in establishing Sutter's methods are explained and the results derived from this method are compared with test results. A unique method of construction proposed recently for design of the Amersham transit stock in London, England, necessitated a model test, the findings from which are compared with results obtained by Sutter's method. A graph for rapid determination of deflections is proposed when time limitations do not permit use of the calculation methods.

As part of a study of the strength of steel arches and culverts under earth fills, an investigation has been made at the Nova Scotia Technical College of the collapse load of curved plain and corrugated steel sheets bearing against compacted sand backfill. Field observations on underground steel structures in different soils are analysed to obtain information about the deflections and pressures on such structures and their relation to the soil properties and backfill support. In their paper, **Composite Design of Underground Steel Structures, G. G. Meyerof**, M.E.I.C., Director of the School of Graduate Studies at Nova Scotia Technical College, and **C. L. Fisher**, M.E.I.C., Chief Engineer with the Armco Drainage and Metal Products Co. of Canada, Winnipeg, propose a method of composite design of underground structures based on these laboratory and field tests. The approach is illustrated by examples from some recent applications in practice.

S. Cherry, M.E.I.C. of the Department of Civil Engineering, University of British Columbia; **H. S. Ward**, of the Building Physics Section, Division of Building Research, National Research Council, Ottawa; and **W. A. Dalgliesh**, A.M.E.I.C. of the Buildings Structures Section, NRC state in their paper, **Earthquake and Wind Loads in Building Design**, that current information on seismic activity in Canada indicates that certain regions, notably the West Coast and the St. Lawrence Valley, warrant consideration of earthquake hazard. Following a review of the dynamic behaviour of buildings during earthquakes, the seismic code requirements of various countries are compared with the National Building Code of Canada (1960). Although these comparative studies suggest that seismic regulations of the national Building Code are not unduly conservative, it is noted that the essential features of dynamic theory are more realistically reflected in some of the other codes examined. With the design procedures of the NRC as a criterion, an evaluation is made of the relative importance of wind and earthquake loadings for common types of multi-storey buildings.

The basic process of appraisal, selection and placement constitutes a major area of practice and research of the industrial or applied psychologist. One of his most significant contributions has been the development and standardization of personnel tests for selection and placement of many kinds of employees. Tests have been developed for various jobs and have shown substantial evidence of their value for their intended purposes. In his paper, **Doubtful Methods in Personnel Appraisal, Peter Moon**, P. Eng., of the Department of Psychology, Purdue University, discusses some of the concepts of psychology, and its use in the prediction of behaviour. Personality tests, projective tests and research concerning the application of these techniques are considered and the need for caution in the use of testing is emphasized.

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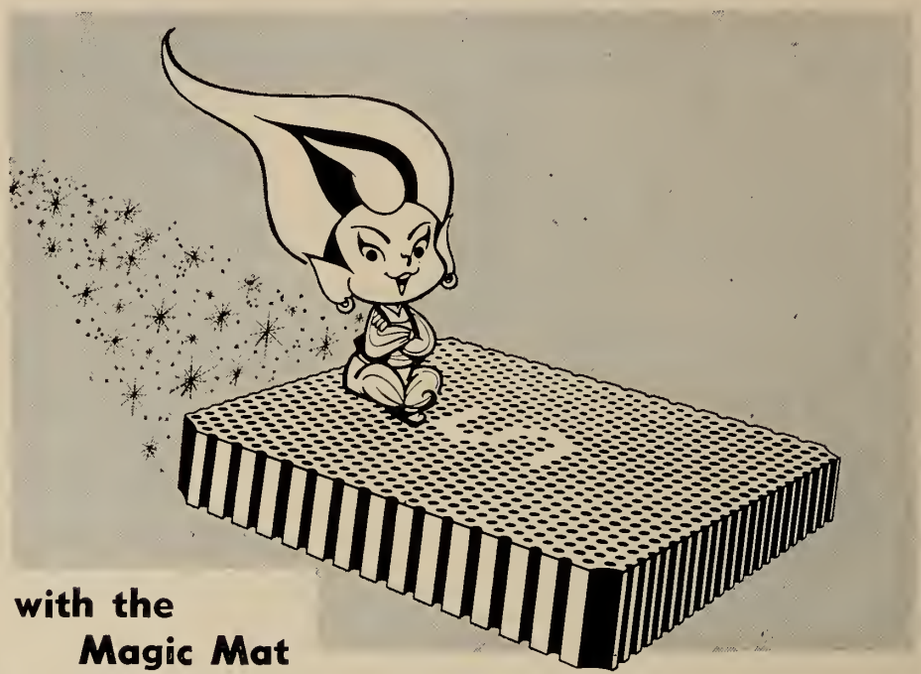

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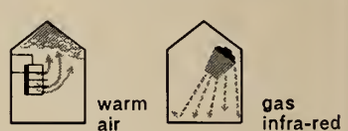

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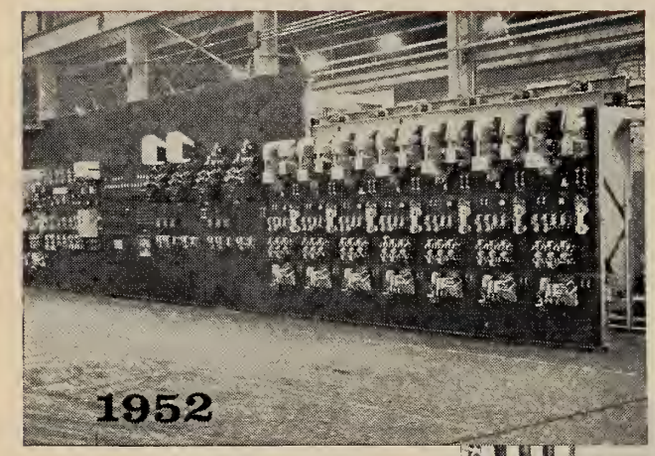

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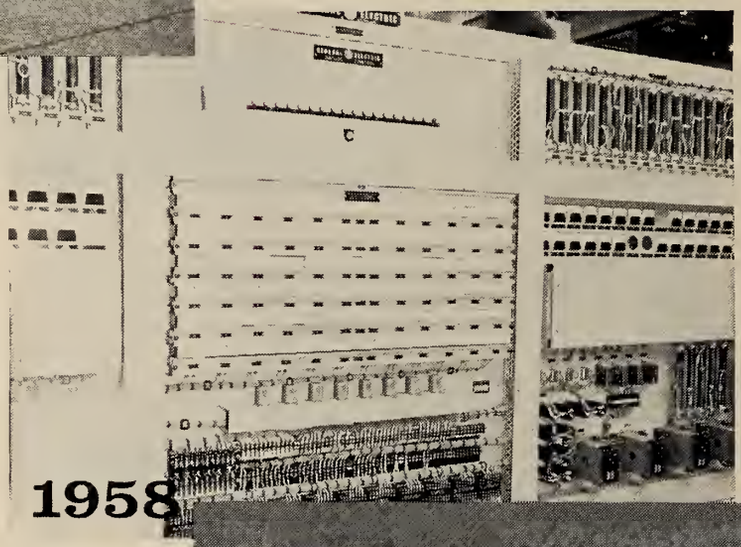

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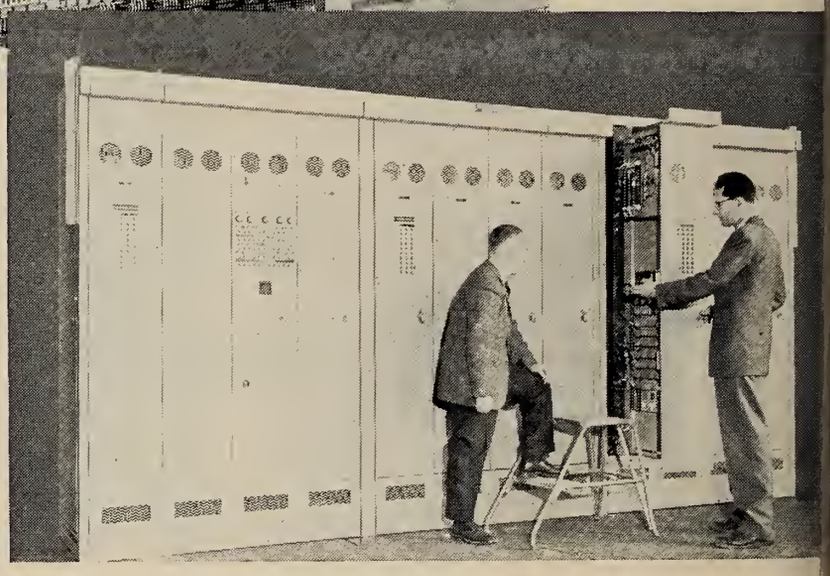

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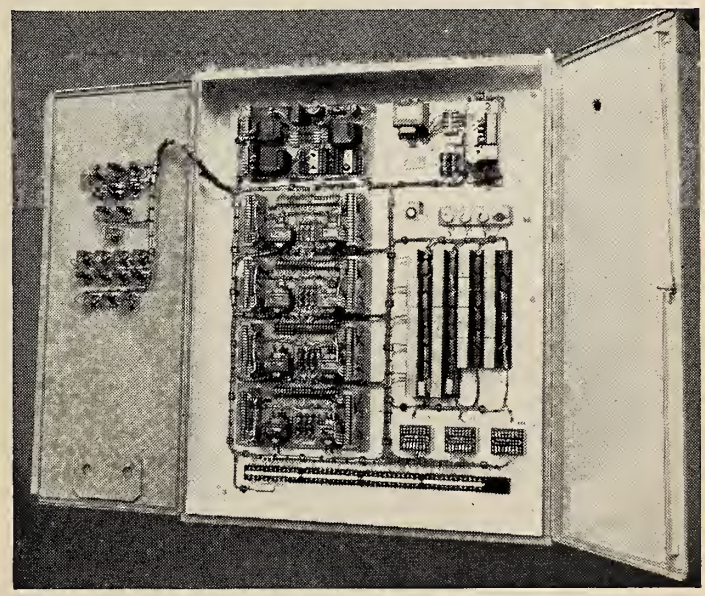

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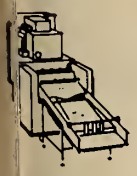

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Roman Catholic Archdiocese of Edmonton

STRUCTURE:
St. Joseph's Cathedral

ARCHITECT:
Henri S. Labelle, Montreal

CONTRACTOR:
Christensen and MacDonald Ltd., Edmonton

SOILS CONSULTANT:
R. M. Hardy and Associates Ltd., Edmonton

NUMBER OF FRANKI UNITS:
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78 Pipe Piles

WORKING LOADS:
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AVERAGE DEPTH OF PILES:
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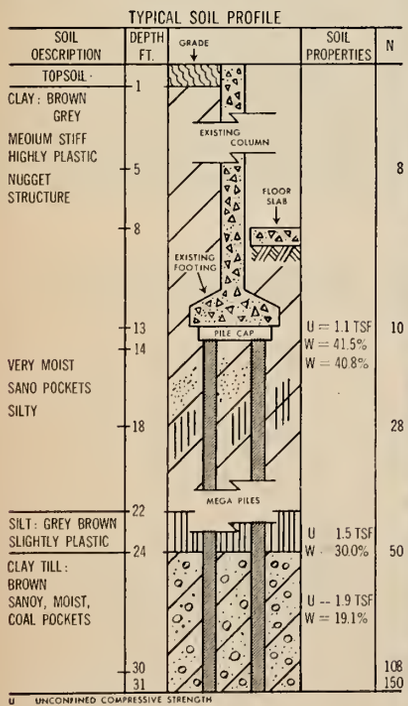

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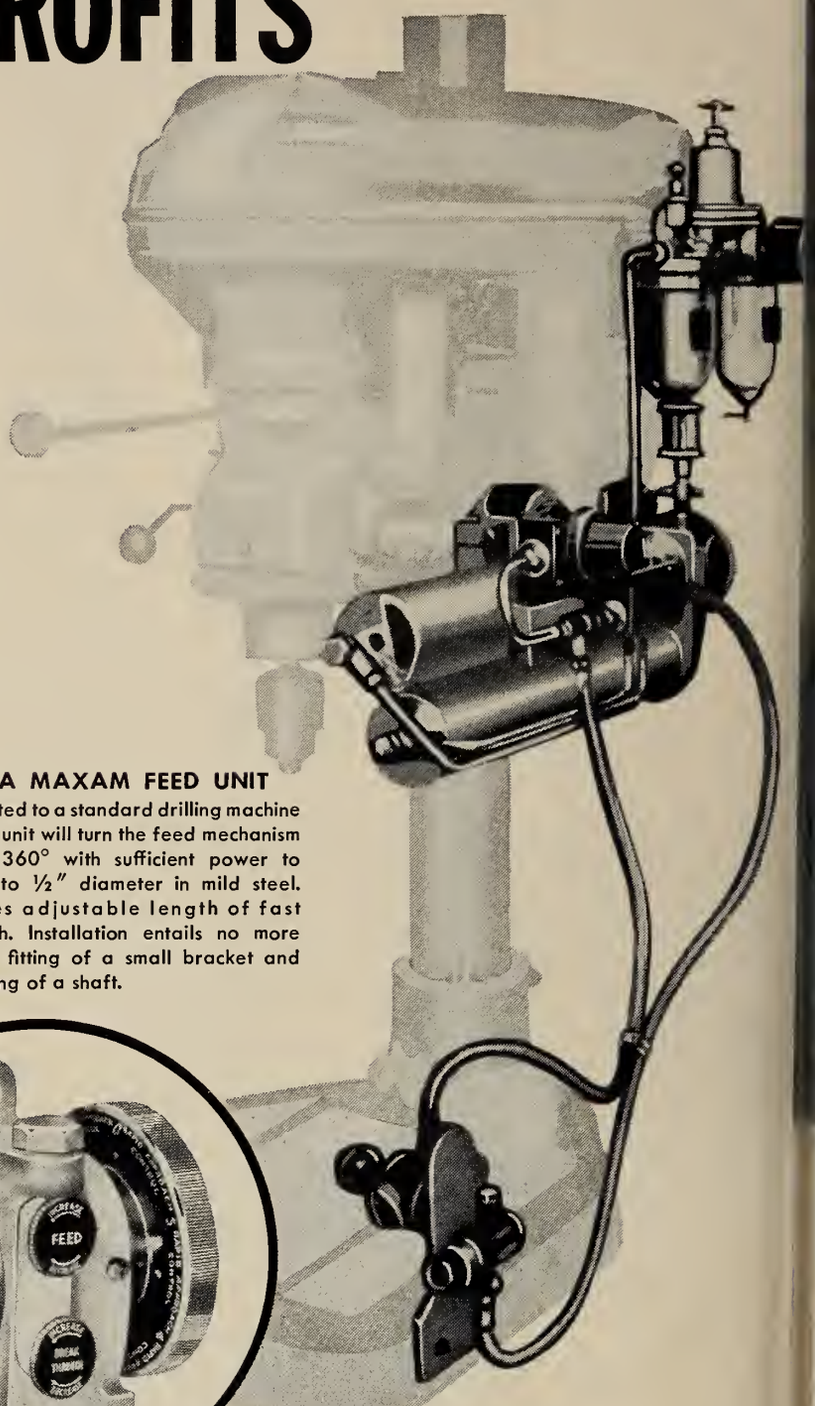

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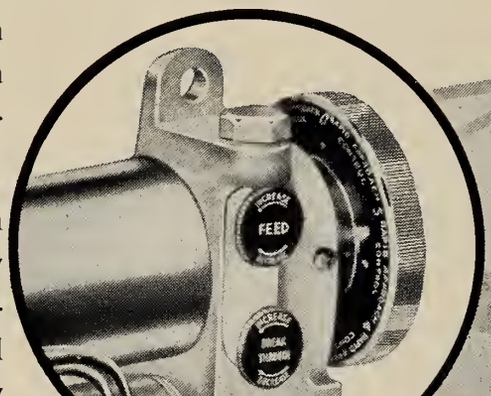

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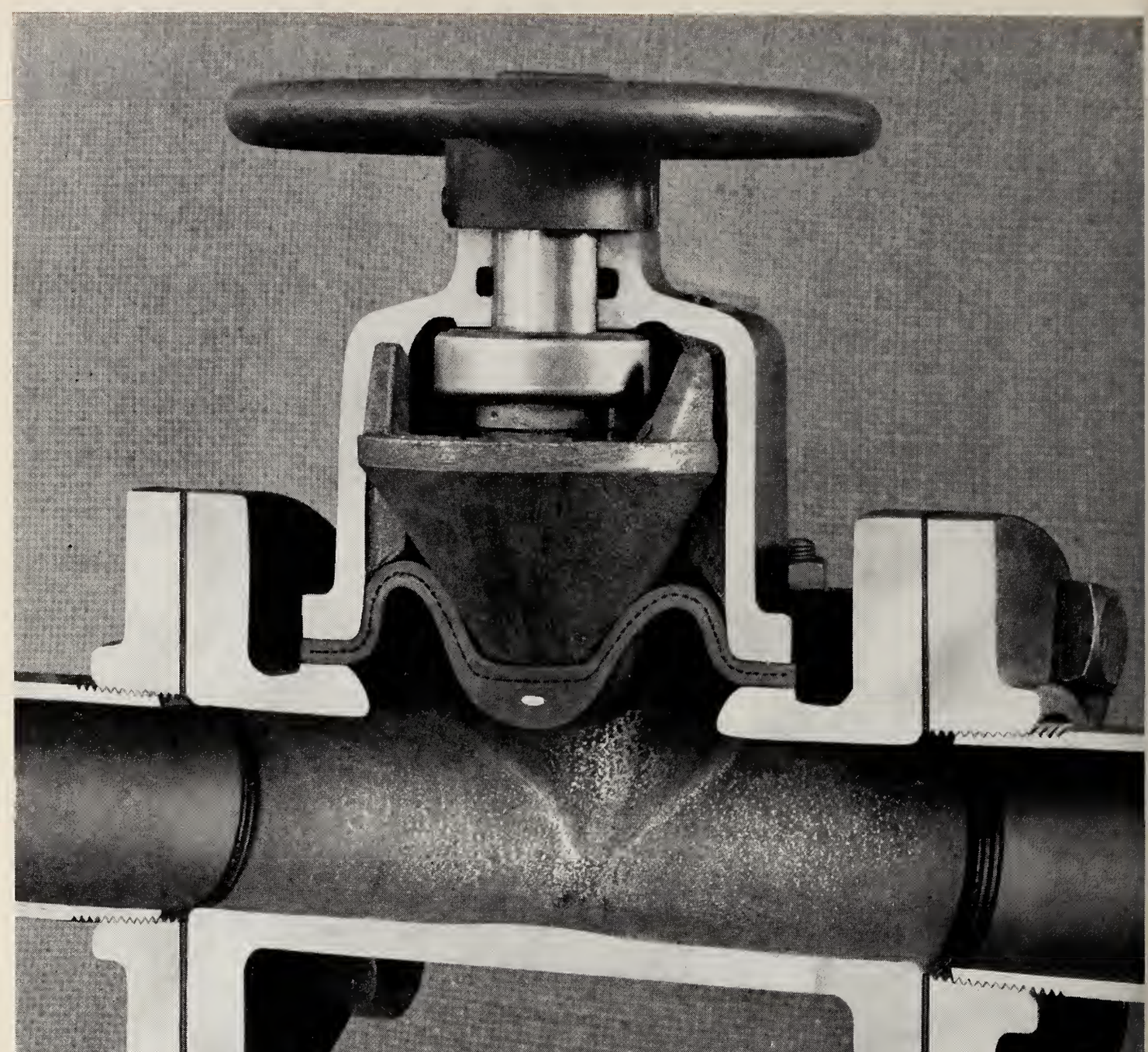

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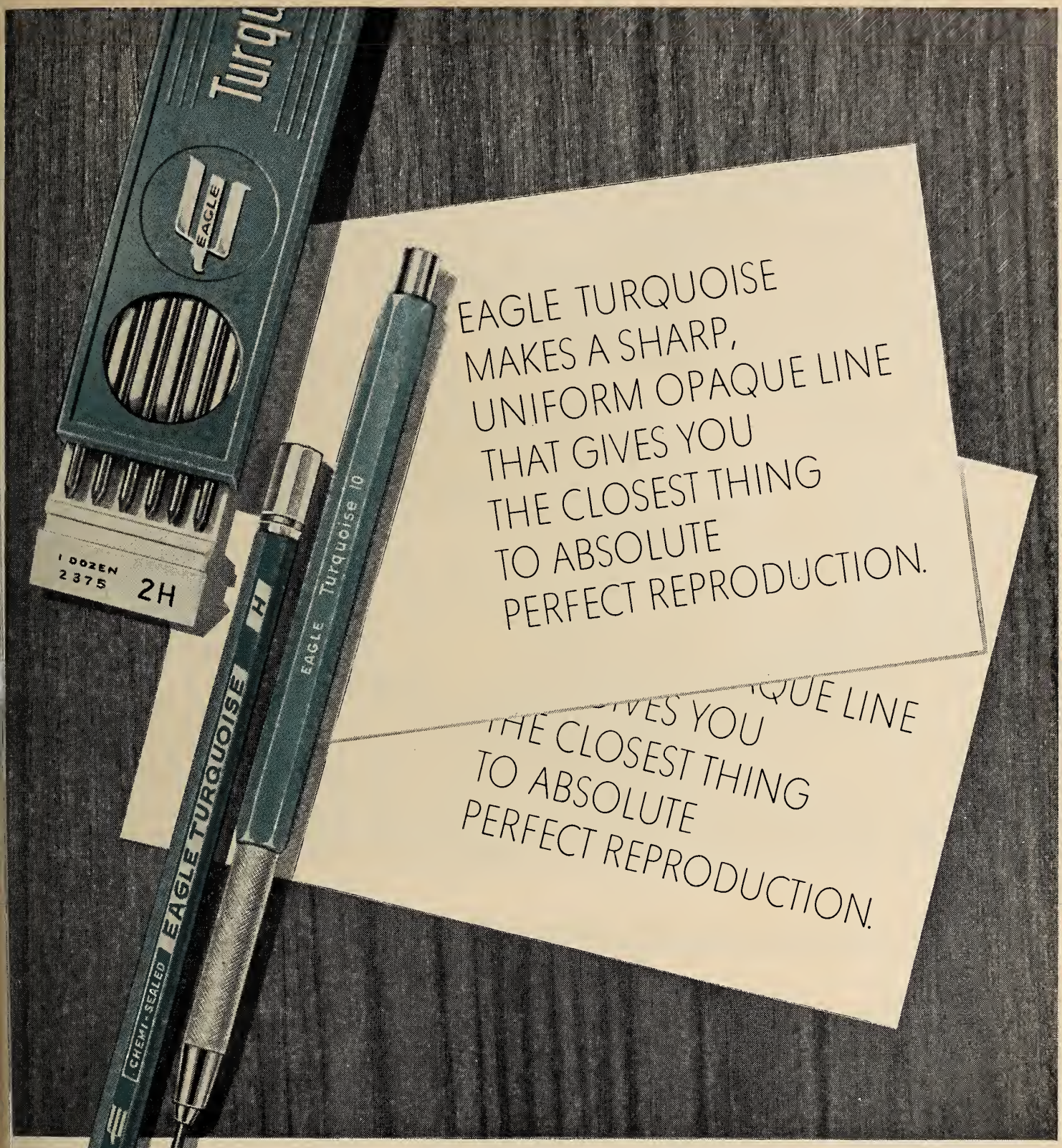

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Structural Design of Aluminum Passenger Cars

Dr. K. Sutter
Director, Geneva Office, Aluminium Laboratories Limited,* Geneva, Switzerland

M. S. Woo
Principal Aluminum Design Engineer, Aluminum Company of Canada, Ltd.,* Montreal
*Members of the Aluminium Limited Group of Companies

IN ANY engineering field, the search for newer and better materials never ends. In the superstructures and underframes of passenger cars and transit stock, steel has been used since the beginning of this century. Aluminum was first used structurally in the late 1920's and recently a trend towards accelerated adoption of the light metal can be discerned. This is not surprising as the advantages of light weight and good corrosion resistance are almost self-evident.

In the railway field, it is difficult to assess, in dollars and cents, the light weight advantage. In the urban and suburban transit fields, many authorities acknowledge that the premium for light weight is worth from $0.65 to more than $1 per pound. It has now been established that, if an aluminum car is properly designed, no difficulty exists in staying under the low limit of the premium. For this reason, the near future will see aluminum subway cars as common as aluminum semi-trailers are today.

REVIEW OF CAR DESIGN PRACTICES

Composite Designs in Timber and Steel

In the early days of the railways, the underframe and the body of passenger cars were built of timber. This mode of construction was satisfactory with the low speeds and short cars then in use. Around 1860 underframes made of steel sections were introduced, with the body remaining in timber. By about 1890 the evolution of such composite structures reached its climax. Speeds of about 50-60 m.p.h. and body lengths up to 60 ft. were achieved. However, under such conditions it was necessary to provide a tie bar arrangement underneath the steel frames as the longitudinal members were no longer strong enough to carry the vertical loads. Some of these cars can still be seen today.

All-Steel Designs

At the beginning of the present century, a fundamental change in concept of design of passenger cars was introduced in the United States. Because some serious accidents had taken place, the railway quickly became safety conscious. As a result, the timber body skeleton was replaced by a riveted steel frame and the panelling was also carried out in steel. Another safety measure was the introduction of minimum requirements for buffing loads. Presently in Europe, the buffing requirement for main lines is 200 metric tons and in the United States and Canada 400 short tons. In the case of transit stock, the commonly accepted figure is in the neighbourhood of 100 short tons.

This new design has proved its value in increased safety for passengers. Tare weight of the cars increased but was not considered a disadvantage until some years later. Also, because the all-steel bodies were stiffer than the previous composite types, the use of a tie bar arrangement then became superfluous.

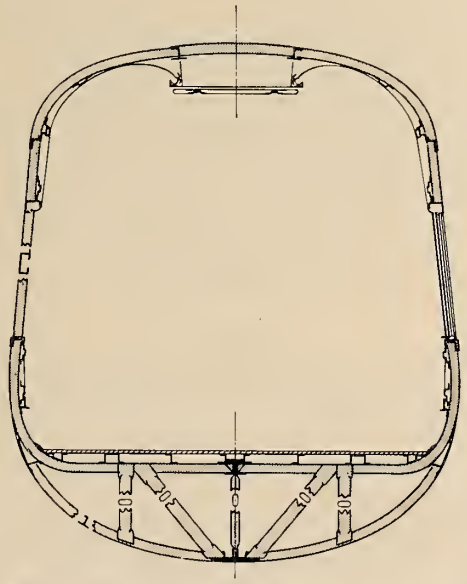


Fig. 1—Ultra-Light Weight Design in Aluminum Union Pacific Railroad ("City of San Francisco", built by Pullman-Standard)

The steel underframe was still regarded as resisting the buffing loads while the resistance to vertical loads was assigned to the superstructure.

The superstructure received little attention at the beginning of the all-steel development, because the steel body frame was so much stronger than the timber construction. Later, it was recognized that the body frame could not be structurally separated from the underframe and the side was considered to participate, partially or fully, in carrying the loads intended for the underframe. Moreover, by calculation, it was demonstrated that the addition of diagonal members in the sides increased the strength of the car and for some years such diagonals were used extensively.

The designe analysis for this type of framework—essentially a lattice—differed from the conventional structural engineering design. The longitudinals of the underframe and the body were considered as continuous rather than pinned at the panel points (where the side posts and the diagonals came in) and for this reason the design calculations for such body sides were quite involved.

Initially designers considered that the body panelling was unstressed. Later on the panels were conceded to take part of the stress and body side diagonals were eliminated. These panels were considered to develop tension diagonals in the rectangles formed by the body framework. Depending on the loadings, one or the other tension diagonals becomes active and thus, the statical system of the body framework is variable and it is difficult to develop a systematic method of calculation.

Unit Bodies

Refinements to the all-steel design began around 1930. High strength, low alloy steel came into the picture, followed by all-welded construction. Although the tare weight was substantially reduced, it was realized that even more drastic reduction was desirable.

By introducing a better distribution of the material on the floor platform (which took the place of the heavy underframe), the body sides and the body roof, together with better distribution of the material between skeleton and panelling, it was possible to make all structural mem-

bers participate in carrying both the horizontal buffing loads and the vertical live loads plus tare weight. This type of construction became known variously as unit body, stressed skin or self-supporting body design.

With this type of layout, design calculations became much more important. The car sides were regarded as load-carrying members and the panelling was assumed to act in conjunction with the structural shapes of the car sides. Thus, it became possible to treat the sides as Vierendeel girders. The variable statical system then vanished from the scene.

Some well-known methods of calculation for this type of structure will be described in the next section, after a review of the activities in aluminum passenger cars.

Aluminum Designs

The first structural use of aluminum occurred in the late 1920's and early 1930's. Several cars with aluminum superstructure and underframe were built in the U.S.A. At that time, it was feasible to replace steel by aluminum, section for section, and the weight savings achieved were quite remarkable. However, the development of light steel designs in the 1930's put an end to this method of design. It became apparent that lighter designs were essential and the Union Pacific Railroad pioneered in this field with their first series of aluminum cars built by Pullman-Standard in 1933-34.

These cars made use of what we now call ultra-light designs. The car bodies were no longer a rectangular box but an oval tube (Fig. 1). The centre sill apparently made possible this deviation from the classical cross section and, from the viewpoint of strength, this shape was undoubtedly favourable.

Unfortunately, the oval tube had serious drawbacks in the work shop. It was necessary to assemble many sections "in place", with resulting heavy manufacturing costs. Over the years, therefore, the cross section of the cars returned to the rectangular shape which facilitiates the pre-fabrication of the sides, roofs, floors and the end walls as approximately plane elements. Later experience in Europe led to the same conclusions. There, the ultra-light designs did not, however, refer so much to the general shape of the cross section as to the shape of individual elements making up the car body. European design employed relatively thin panelling with closely spaced stiffeners as is standard for aircraft. This type of design was not only expensive but it did not withstand the rough handling associated with railway or subway operations. Also, the provisions of flanges with varying width and perforations in the webs for the extra saving of weight is not economically justified in railway or subway rolling stock. For these reasons, the ultra-light designs have never achieved any real significance for railway and transit car design.

Weight Comparisons

To illustrate the weight saving possibilities of different types of design, some typical examples are listed in Table I.

MODERN METHODS OF DESIGN

From the foregoing review of design practices, it is apparent that the trend is towards a lighter car consistent with low fabrication cost. If the car is made lighter by using thinner sheets and sections, vibrations and fatigue begin to enter into the picture. So a better knowledge of the stress and deformation patterns in a car becomes essential. Several methods of calculating the stresses and deflections have been developed in the last 15 years of which three have gained acceptance: (1) Dr. Sutter's method (1947), (2) Prof. Argyris' method (1954) and (3) work being done at the University of Sheffield under Prof. Allen.

Sutter's method[1]

In the Sutter method, the three-dimensional coach is transformed into a two-dimensional system in the plane of the coach side: Fig. 2 shows the 'side' for this example. The 'side' is considered to be a truss of the Vierendeel type, the upper chord consisting of material above the windows including a portion of the roof, and the lower chord consisting of that below the windows and doors including some of the underframe. The vertical members are the pillars of the coach. The geometry of the girder is determined by the positions of the neutral axes of the chords: Fig. 2 depicts the truss consisting of the neutral axes of the sections considered. The flexibilities of the truss members are determined from the moment of inertia of the section they represent.

The foregoing idealization is considered to be more applicable in the case of a vertical load than a buffing load. The total vertical floor load for one-half of the coach is distributed along the lower chord of the truss but the buffing load is also included and applied at the lower chord.

The truss is transformed into a statically determinate primary system by cutting the upper chords and introducing unknowns at the cuts to maintain the original geometry. To accomplish this three unknowns are introduced at each cut and thus, for a typical 10-panel car, the number of unknowns is 30. The work involved in formulating the coefficients is re-

TABLE I
Weight Comparisons of Steel and Aluminum Cars of Different Type of Designs

Type of Design	European Railways* Tare weight in 1,000 lb.				U.S. Railways Tare weight in 1,000 lb.			
	Steel	Year built	Aluminum	Year built	Steel	Year built	Aluminum	Year built
Composite, steel underframe with tie bar, body frames in timber, steel panels	96	1913	—	—	132	before 1910	—	—
All metal car, riveted	101	1934	59	1954	120	1930	110	1937
All metal car, welded	89	1935	—	—	106	1940	—	—
Ultra-light design	—	—	30	1950	—	—	92**	1936
Unit body	60	1937	45	1958	106	1940	98	1940

* A linear weight adjustment to a uniform length of 22.70 meters has been made.

** This represents the average weight per 85 ft. of the "City of San Francisco" of the Union Pacific. The structural weight saving is actually more favourable than the figures indicated. Although the cars are 2½ ft. lower than the standard ones, the average weight is compiled from 4 coach type and 5 dining and sleeping cars. All other U.S. figures are based on coach type of passenger cars.

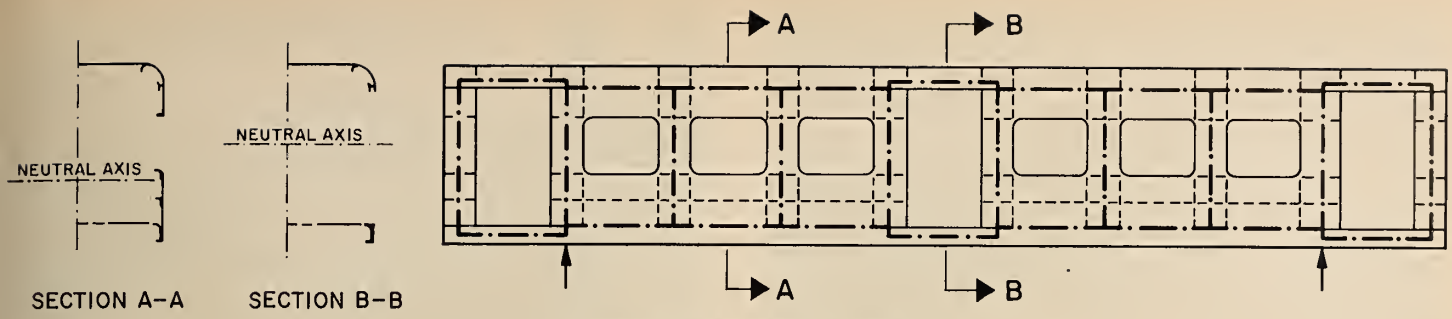


Fig. 2—Idealized Side & Neutral Axes

duced by considering only displacements of the cut faces due to bending and ignoring the secondary displacements due to direct and shear loads. The equations can be solved without the aid of an electronic computer.

The value of the unknowns, together with the loads in the primary system, yield the distribution of bending moments and direct loads throughout the truss. From the properties of the sections, stresses can be calculated in the members forming the truss.

Once the loads in the car body members have been determined, the principle of virtual displacements may be applied to obtain the desired deflections.

Argyris' method

Professor J. H. Argyris and his team at the Imperial College of Science & Technology, London developed in 1954 a more general method of analysis for three-dimensional structures. This method is used extensively in aircraft stress analysis. In 1959 A. H. Lucas of Norris Brothers Limited[2] applied this method to an integral railway coach structure. For a typical car, with 10 panels of doors and windows, about 300 unknowns would be involved. To solve such simultaneous equations the use of an electronic computor is required.

Allen's method

In England, the British Railways, the leading coach buildings, and the Aluminium Federation (formerly the Aluminium Development Associations) are jointly sponsoring with the University of Sheffield under Professor D. N. G. Allen, a research program to evolve a simple, practical and realistic method of calculation. A description of one aspect of the program has been published;[3] in this program, the coach was analyzed as a two-dimensional structure and the extent of idealization is the same as Sutter's. However, in the case displacements rather than force were chosen as basic unknowns.

Choice of Method

The choice of a method of calculation depends largely on the special requirements of an organization. From the point of view of an aluminum producer who does not fabricate cars but is, nevertheless, often involved in design problems, the relatively simple Sutter method seems to be the best choice. Prof. Argyris' method is handicapped by the number of unknowns involved and the resulting complexity of the calculations. It can quite logically be justified in aircraft structures but it is doubtful that passenger stock qualified. Judged by the published portion, Prof. Allen's method is more suitable than Dr. Sutter's in cases where the primary concern is on stress. However, the main criterion for transit stock is defleetion rather than stress and Sutter's method is simpler to use in predicting deflections.

It should not be taken that the authors are placing too little emphasis on stress. This is far from the intention but experience has shown that the principal stresses in structural members of a car are in the order of 5000 p.s.i. when the buffing load is excluded and hence are not cause for concern. There remains the matter of area of stress concentration, but a new type of car is invariably tested in the prototype stage before production begins and this problem, if it occurs, could be quite easily corrected at this stage.

Experience in Using Sutter's Method

Dr. Sutter's method has been used in Europe and the United Kingdom. A comparison of deflections calculated in this way with measured ones is instructive. An example is the case of two types of light weight coaches designed for the Indian Railways.[4] The first type is a steel suburban car in which the calculated deflection at mid-span under vertical load is 0.23 in. while the measured deflection is 0.25 in. The second is the regular railway mainline steel coach in which the calculated deflection is 0.265 in. while tests show 0.230 in.

An interesting European example is described by Bode.[5] This article includes the laconic statement that Sutter's calculation method gave good results!

MODEL TEST OF AMERSHAM CAR

In 1959, the London Transport Executive ordered from Cravens, Ltd. 464 aluminum suburban cars, known as the Amersham cars. In these cars, the exterior panelling from the waist rail to the bottom of the roof covering was eliminated by arranging the outer faces of the structural extrusions to form the exterior faces of the car.

Since this was a new type of construction it was felt that a model test prior to the prototype test was justified. Accordingly, a one-third scale model was built by Alcan Industries Limited, London* and tested at Aluminium Laboratories Limited, Banbury, Oxon*. At the maximum working load, the calculations by the Sutter method showed a deflection of 0.128 in. when the modulus of elasticity is adjusted to 9,100,000 p.s.i (the value used for a riveted structure) compared with 10,000,000 p.s.i. for the aluminum alloys used. The measured deflection was 0.14 in.

When the loading was increased to more than four times that of maximum working load or about 2½ times the maximum working load plus tare, the model was probably very near the top limit of the elastic range. The deformation can be seen in Fig. 3. The model failed when a load equivalent to 3½ times the maximum working load plus tare. Deformations can be seen in Fig. 4.

Wooden horses were placed under the model to prevent its complete disintegration after failure. When the loads were removed after the failure, appreciable springback took place but there was a permanent set of about ¼ in. After the model test, Cravens, Ltd. finalized the design. Sufficient design changes were made that the deflection under maximum working load was expected to be ¼ in.

GRAPH FOR RAPID DETERMINATION OF DEFLECTIONS

Even though some relatively simple calculation methods are now available and satisfactorily proven, the

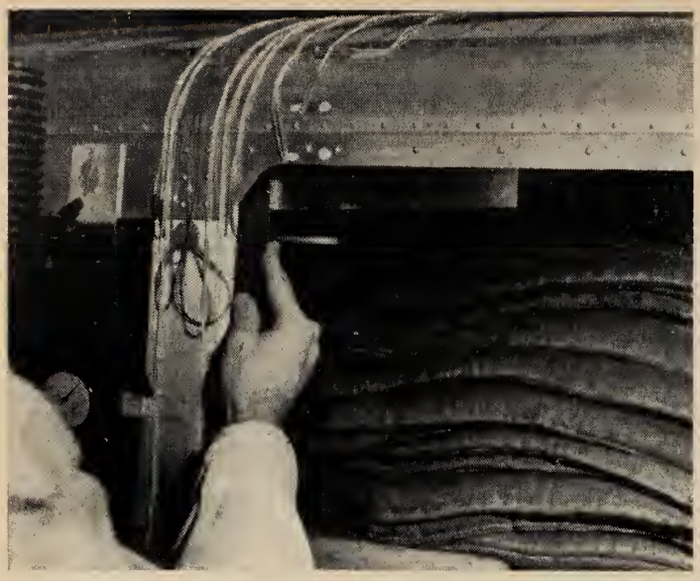


Fig. 3—Deformation of Motor Doorway of Amersham Model near the limit of elasticity.

Fig. 4—Deformation of Post of Amersham Model at Point of Failure

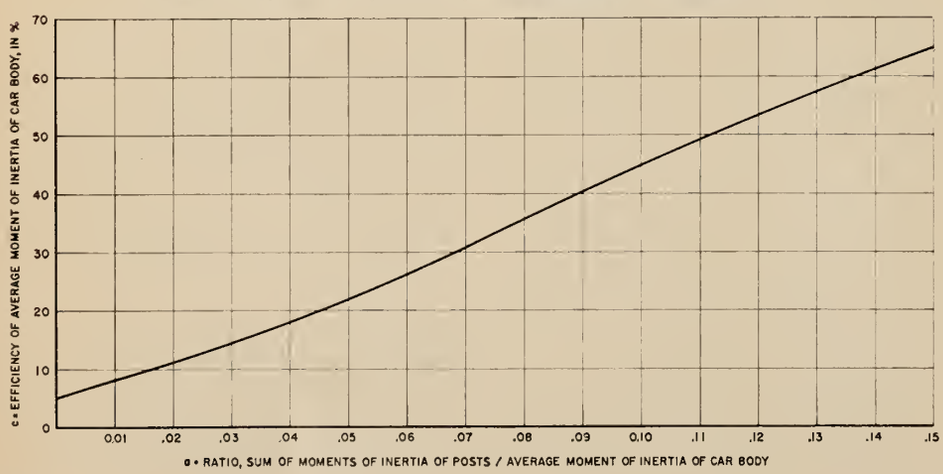
time for design of cars after tenders have been called is invariably too short to do a proper structural analysis unless a computer program has been set up and the machine is available. A graph for rapid determination of deflections, even though the deflections so obtained are rough, will be found useful. A proposed graph for this purpose is shown in Fig. 5; comments and additional information from other design engineers will be welcomed by the authors with a view to improving its accuracy.

In developing the graph an analysis of calculations carried out by the authors and of known test results revealed that deflections in subway cars can be calculated by the formula for a plate girder, provided the moment of inertia is reduced. As a criterion for the choice of the reduction factor "c", the authors suggest the ratio of the sum of the moments of inertia of all the posts to the average moment of inertia (to be known as "a"), with the average moment of inertia taken as the weighted average for the vertical cross section through a typical window opening and a typical door opening.

The weaker the posts, the less the car body behaves as a plate girder and the bigger its deflection compared to the plate girder. Experience indicates that for car bodies with "a" equal to about 0.01, the efficiency "c" is about 10%. In the case of railway mainline passenger cars with door openings at the ends and "a" equal to about 0.15, the efficiency is about 60-70%.

The fact that a connection exists between "a" and "c" should be evident. Slender posts connect the roof and the floor platforms in such a way that these two elements of the body can deflect almost independently from each other. The only elasticity requirement to be satisfied is to have the same deflection in mid span. The efficiency "c" is in this case very small. If a car body were a tube without openings, it would deflect as if the roof, the floor and the sides were part of an integral member; the efficiency "c" would be 100%. In this chart an attempt is made to indicate the variation of "c" between the extremes.

Fig. 5—Proposed Graph for Rapid Determination of Deflections



It is interesting to notice that the ratio "a" is generally larger for North American transit cars than for older European cars. This seems to indicate an encouraging trend towards an efficient structure which also combines high aesthetic appeal as a result of good design.

ACKNOWLEDGMENTS

We wish to express our thanks to Cravens, Ltd. for permission to publish data and photographs of the model tests on the Amersham stock. Also, the assistance of Messrs. J. Z. Tomaka of the Aluminum Company of Canada, Ltd., and I. H. Jenks of Aluminium Laboratories Limited, in preparing this paper is appreciated.

(*Members of the Aluminium Limited Group of Companies)

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EARTHQUAKE AND WIND LOADS IN BUILDING DESIGN

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SEISMOLOGISTS AGREE that no area is immune from the possibility of earthquake damage; but there are certain areas of recognized seismic activity for which there is a substantial probability of future strong-motion earthquakes. Two such regions in Canada are the St. Lawrence Valley and the coastal area of British Columbia. This is amply demonstrated by recent publications of the Dominion Observatory[1], which show the locations and magnitudes of the known earthquakes in these regions. (Magnitude—term used to define the instrumental measurement of an earthquake and related to the amount of energy it releases. Structural damage at the epicentre normally begins at a magnitude of about 5.6. The epicentre is the point on the earth's surface directly above the origin of an earthquake.)

Hodgson[2] has reported that, although Canada has had fewer destructive earthquakes than, say California, the magnitudes of those that have occurred are about as severe as those of California. Damage estimates of some of the more recent disturbances in Eastern Canada are as follows: Cornwall-Massena, 1944, magnitude 5.9, damage $2 million; Temiskaming, Quebec, 1935, magnitude 6.3, damage $20,000; St. Lawrence Valley, 1925, magnitude 7.0, damage $100,000. Along the Pacific Northwest, major earthquakes have been reported with epicentres in the Queen Charlotte Islands 1949, magnitude 8.0; off the British Columbia Coast 1946, magnitude 7.3; Vancouver Island 1918, magnitude 7.0 and 1957 magnitude 6.0. Fortunately, except for the Cornwall earthquake, the property damage resulting from these tremors was slight since the immediate epicentral areas were very sparsely settled. The effects of a few earthquakes in settled areas make an interesting comparison: Seattle 1949, magnitude 7.1, damage $20 millions; Long Beach, California 1933, magnitude 6.2 (less than that of Temiskaming) damage $50 million; and the great San Francisco earthquake of 1906, magnitude 8.2, damage $400 million.

Thus, although the record of damage and disaster in Canada has fortunately been relatively low, this fact should not lead one to believe that serious earthquakes are never likely to occur in our country. Centres such as Quebec, Montreal, Ottawa, Vancouver and Victoria are all in seismically active regions. Due to population increase, industrial expansion and development of urban areas, and the associated demands for taller, heavier structures and major engineering projects, the hazard from possible earthquakes has become much more acute in recent years.

What can and should be done about earthquake hazard? Attempts to answer this question have led to the development of the specialized field of earthquake engineering. Although much of the research activity has been in California and Japan, scientists and engineers in many other countries are concerned as well, with the result that, following two world conferences,[3, 4] an International Association for Earthquake Engineering has now been formed. Canada has membership in the Association, and a National Committee is being organized under the auspices of the National Research Council.

Earthquake engineering is concerned with the study of the structural stresses induced by earthquakes

and the development of design procedures suitable for structural design use. A major Canadian task, as in the past, will be to evaluate current knowledge in the field and to decide how to apply it to Canadian needs.

The purpose of this paper is to survey the present state of understanding of earthquake forces and the response of buildings to such forces. The first section deals in a fundamental way with the dynamics of buildings. This will be followed by an examination of the way certain building codes attempt to protect against earthquake damage. This will include, in particular, a discussion of the current provisions of the National Building Code of Canada.[5] Finally, a comparison will be made of the earthquake provisions and the somewhat overlapping provisions for wind loads in the National Building Code.

BEHAVIOUR OF STRUCTURES DURING EARTHQUAKES

The rational design and construction of earthquake-resistant structures requires a knowledge of the lateral forces developed in the structure by the earthquake. These forces can be evaluated theoretically by subjecting the base of a damped system of many degrees of freedom (the structure) to transient erratic motion (the earthquake) and determining the response of the system. Although amenable to mathematics, this represents a complex dynamic problem, the essential features of which will be examined here. The presentation is intended as an introduction to the subject of earthquake engineering and is based largely on the publications

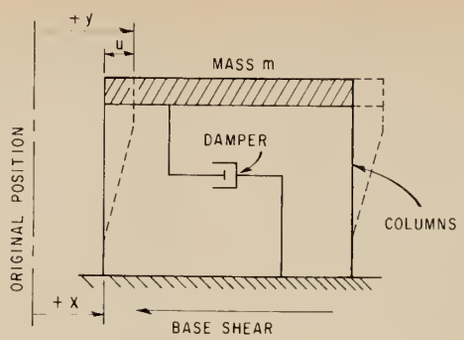


Fig. 1—Schematic representation of one-storey flexible structure.

of Housner,[6] Clough,[7] Blume and others.[8]

Single-storey Structures

Figure 1 is a schematic representation of the deformed shape assumed by an idealized one-storey structure whose rigid foundation undergoes a displacement equal to the earthquake motion, x, of the ground. Due to the flexibility of the structure and the inertia of its mass, m, the columns deform thereby permitting the mass to displace relative to the ground by the amount u = y — x, where y is the displacement of the mass from its original position. These displacements are a function of time, t, and the structure is therefore excited into motion which is opposed by the shear stiffness, k, of the columns and the inherent friction of the structure, normally referred to as the damping. For a linear elastic system the shear or lateral force, V, exerted by the columns on the mass and on the ground may be expressed as

$$V = ku \qquad (1)$$

The friction of a structure can be described satisfactorily by the condition of viscous or linear damping. Linear damping results in damping forces directly proportional and opposed to the velocity; the proportionality constant, c, is known as the damping coefficient. When motion is restricted to translation in one direction only (as represented by u), the differential equation governing the response of the flexible structure may be written as

$$c\frac{du}{dt} + ku = -\frac{md^2y}{dt^2} = -\frac{md^2(x+u)}{dt^2}$$

or $$m\ddot{u} + c\dot{u} + ku = -m\ddot{x}, \qquad (2)$$

where $\ddot{x}$ is the horizontal acceleration of the base or ground which is identical with that recorded by a strong-motion accelerometer during an earthquake.

If, as is normally encountered in building structures, the damping is small, the solution of equation (2) for the response u, at any time t, is given by the Duhamel integral[9] as

$$u(t) = \frac{T}{2\pi}\int_0^t \ddot{x}(\tau)e^{-\beta(2\pi/T)(t-\tau)} \sin\frac{2\pi}{T}(t-\tau)\,d\tau \qquad (3)$$

where T = natural undamped period of vibration of the structure

$$\times = 2\pi\sqrt{\frac{m}{k}}$$

β = fraction of critical damping

$$\frac{c}{c_c} = \frac{c}{2\sqrt{km}}$$

The critical damping c_c is the minimum value of c resulting in a non-oscillating response.

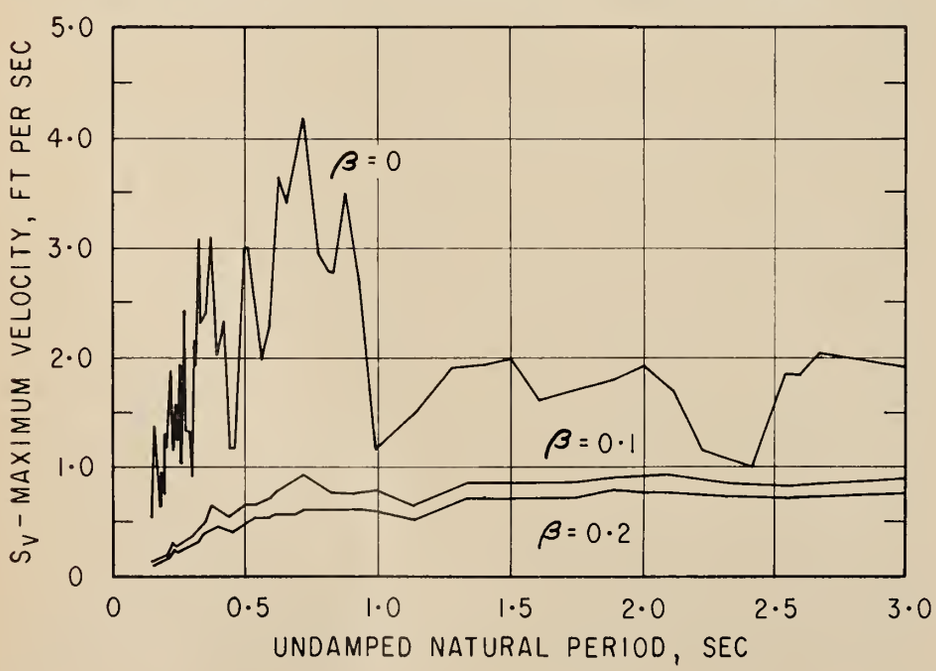
It should be noted from equation (3) that the dynamic response u of the structure is dependent on the character of the structure, defined by its natural period of vibration (a function of its stiffness and weight) and its damping, and on the character of the ground acceleration.

The character of the ground acceleration is exhibited by the integral appearing in equation (3) namely

$$S(t) = \int_0^t \ddot{x}(\tau)e^{-\beta(2\pi/T)(t-\tau)} \times \sin\frac{2\pi}{T}(t-\tau)\,d\tau \qquad (4)$$

If the displacement $u(t)$, equation (3) is differentiated, the velocity $\dot{u}(t)$ will be obtained and is found to equal $S(t)$. For a particular ground acceleration input record, and for a

Fig 2—Velocity spectrum for Taft Earthquake, July 21, 1952 (from Reference 6).



particular β and T, the integral defining $S(t)$ can be evaluated and the maximum value, S_v, observed. The plot of such maxima for a range of structural periods T yields a graph or influence line of maximum velocity response known as the velocity response spectrum. A family of such spectrum curves can be obtained corresponding to different β values.

The computation required for the evaluation of the response spectrum is extremely great and is best done by analogue or digital computers. Velocity response spectra for the Taft, California earthquake of July 21, 1952,[6] are presented in Fig. 2. The effectiveness of small amounts of damping in modifying the response is seen to be very marked.

The dynamic response of a structure to any given earthquake is directly obtainable from the velocity spectrum of that earthquake. When this spectrum is known, the maximum base shear transmitted into the structure from the ground may simply be written as

$$V_B = ku_{\max} = k\frac{T}{2\pi}S_v$$

or, alternatively

$$V_B = \left(\frac{2\pi}{T}\frac{S_v}{g}\right)W = CW \qquad (5)$$

where W denotes the weight of the structure and g is the acceleration of gravity. C, known as the seismic coefficient, is seen to depend on the period of the structure and on the spectral velocity.

Although the exact nature of future earthquake ground motions is not known, average response spectra may be predicted as shown by Housner.[6] These average spectra were developed from numerous strong-motion records of past disturbances.

Multi-storey Structures

Multi-storey structures have several characteristic or normal modes of vibration that are transiently excited by earthquakes. It is possible to describe the actual response of a structure by a superposition of its normal mode components.

By modal superposition principles,[10] the actual multi-degree of freedom structure may be represented by an equivalent set of one-mass systems. Each system responds to the earthquake excitation independently and in its own mode. Then the actual response of a linearly elastic multi-storey structure with small linear damping can be expressed as the sum of the responses of the independent modes. The spectrum concept is applicable to each mode separately. The base shear contribution made by each individual mode is therefore determined from equation (5), using for the nth normal mode its corresponding period T_n and an effective weight W_n given by

$$W_n = \frac{[\Sigma_z(\phi_{zn}w_z)]^2}{\Sigma_z\phi_{zn}{}^2w_z} \qquad (6)$$

where w_z represents the weight of the zth floor whose displacement in the nth mode is ϕ_{zn}. There are as many values of n as there are degrees of freedom. ϕ_{zn} and T_n are characteristics of the structure and can be evaluated by standard means.[8]

On the basis of the spectrum concept, the total maximum base shear, V_B, transmitted into the structure from the ground is therefore

$$V_B = \Sigma_n V_{Bn} \qquad (7)$$

where, from equation (5),

$$V_{Bn} = \left(\frac{2\pi}{T_n g}W_n\right)Sv_n.$$

It should be noted that the result represented by equation (7) is only approximate. V_B is actually greater than the true maximum base shear since the individual modal maxima are not achieved concurrently. The error arising from the superposition of the spectral maxima can be overcome, in part, by assuming that the total maximum response is given by the square root of the sum of the squares of the modal maxima.[10]

The resolution of the base shear into equivalent lateral seismic forces, F, acting on the masses at each floor level is also effected by modal superposition principles. Due to the nth mode contribution, the maximum value of this force at the zth level is

$$F_{zn} = V_{Bn}\left[\frac{\phi_{zn}w_z}{\Sigma_z\phi_{zn}w_z}\right] \qquad (8)$$

and, using response spectrum procedures, the total maximum seismic force at this level may be approximated by

$$F_z = \sum_n F_{zn} = \sum_n V_{Bn}\left[\frac{\phi_{zn}w_z}{\Sigma_z\phi_{zn}w_z}\right] \qquad (9)$$

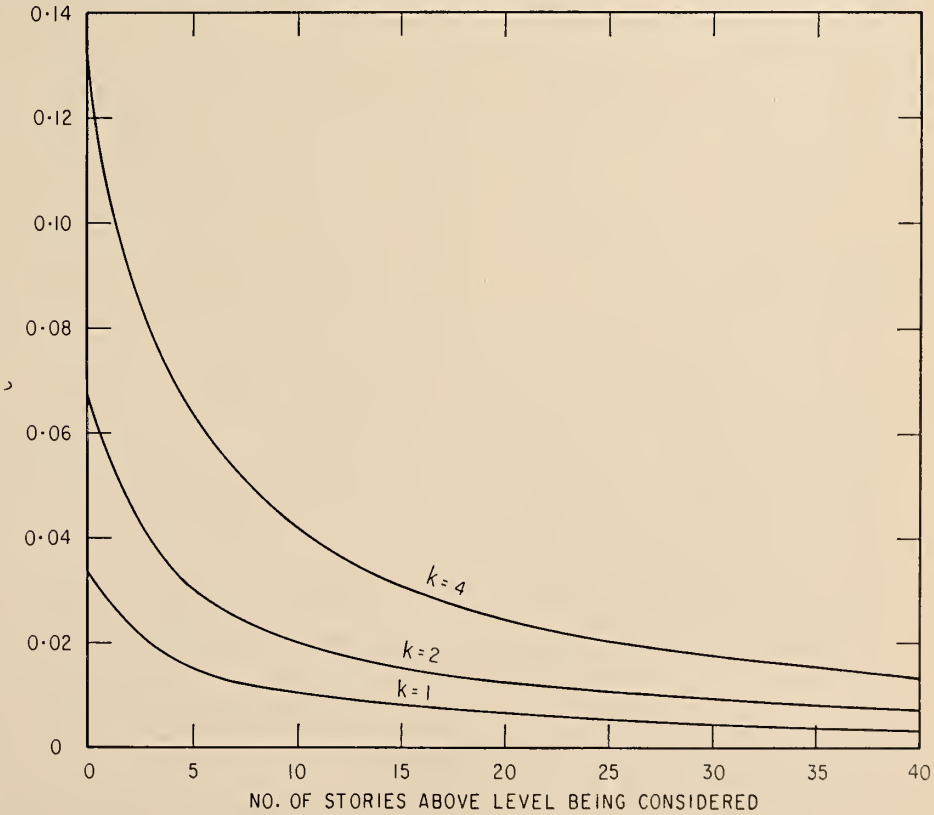
Again, F_z is greater than the true maximum value.

Influence of Inelastic Behaviour

The preceding account of structural behaviour is based on the assumption of a purely elastic response. During an earthquake, structures may undergo inelastic deformations of relatively large magnitudes before failure occurs. The energy absorbed in this plastic deformation prevents an energy build-up to the levels required for achieving maximum spectrum velocities. This has the effect of reducing the response of the system and limiting the lateral forces developed in the structure.

Recent studies[8,11,12,13] have shown quantitatively the importance of in-

Fig. 3—Values of seismic coefficient C, according to National Building Code of Canada, 1960.



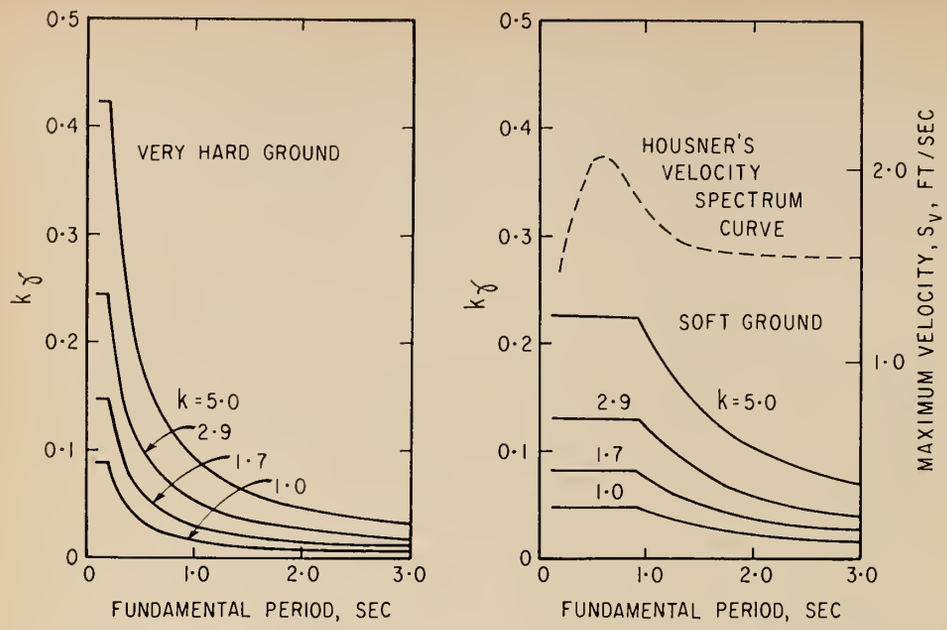


Fig 4—Typical values of seismic coefficient, Kγ, from Rumanian Code.[16] (Broken line, typical velocity spectrum for "average" earthquake.[6])

elastic deformations in limiting dynamic structural response. In this regard, the structural framing system has a significant influence on the over-all ductility and energy-absorbing capacity of the structure.

Effects of Other Factors

The theoretical principles outlined above focus attention on important parameters influencing the behaviour of structures during earthquakes. It should be recognized that additional factors may play a significant role in determining dynamic structural response. Among these are: soil conditions at the site, building and ground interaction, and alterations to earthquake motions due to interference from the structure itself (feedback). Many of these problems are complex and have not been completely investigated or are not yet fully understood.

BUILDING CODE APPROACHES TO EARTHQUAKE DESIGN

In the several countries that have earthquake load requirements in their building codes, a number of different approaches are used. The provisions of five building codes are outlined to illustrate the principal features, and to show how these provisons are related to the principles described in the preceding section. Attention will be confined to buildings, although may of the codes also consider special structures such as dams and bridges.

Canada

In the National Building Code of Canada 1960,[5] earthquake loads are dealt with in Part 4, Section 4.1.2.-15(1). The shear force, V. In the Canadian Code the symbol F is used) at any level in a structure is given by:

$$V = CW, \qquad (10)$$

where W is the total load above this level and consists of the design dead load plus the design stored load and service equipment loads. The seismic coefficient, C, is computed from:

$$C = \frac{K(0.15)}{N + 4.5} \qquad (11)$$

where N is the number of stories above the level under consideration and K is the integer 1, 2 or 4, representing the seismic risk associated with a region. Values of C for different values of N and K are plotted in Fig. 3. Values of K are obtained from a seismic regionalization map, based on information from the Department of Mines and Technical Surveys. The St. Lawrence Valley and the West Coast are regarded as regions of high seismicity, for which K has the value 4. Recently a Seismic Regionalization Committee was formed in the Department of Mines and Technical Surveys to re-appraise seismic activity in Canada.

The present Canadian Code (1960) follows closely the treatment given in the (U.S.) Uniform Building Code, 1958.[14] One difference is the provision in the Canadian Code for a complete dynamic analysis by a person competent in this field.

Japan

The Japanese code, Standards of Aseismic Civil Engineering Constructions,[15] uses a formula similar to equation (10). The chief distinction is that a high seismic coefficient is chosen, but on the other hand the allowable working stresses are also high (e.g. steel: 15.3 tons/sq. in.). Implicitly this approach considers a large earthquake, with low probability of occurrence, but still permits an economical design on account of the high working stresses.

The seismic coefficient is a function of building height, type of construction, type of foundation material and the seismicity of the region, thus

$$C = ABC_0, \quad \text{where } AB > 0.5 \qquad (12)$$

In equation (12) A is a variable which depends on the type of the construction and foundation; typical values of A are shown in Table I. These values are based on the relationship between the expected frequency content of a particular ground motion, and the frequency response of a given type of construction. For example, wood construction tends to be flexible and is not as adversely affected by a high frequency excitation as is the more rigid masonry construction; high frequency excitation is associated with the earthquake motion of hard grounds. Table I, then, indicates the possible occurrence of resonance for different types of structure-foundation conditions.

The values of B may be 1.0, 0.9 or 0.8, depending on the seismic risk of a region. C_o is the basic seismic coefficient and its value varies with building height; for buildings up to 16 metres high C_o is 0.20 and for every additional 4 metres C_o is in-

TABLE I.

Typical Values of Coefficient A in Equation (12)

Associated periods of ground motion decreasing ↑

Foundation Material	*Constructional Material*			
	Wood	*Steel*	*Reinforced Concrete*	*Masonry*
Tertiary Rock	0.6	0.6	0.8	1.0
Gravel	0.8	0.8	0.9	1.0
Alluvium	1.0	1.0	1.0	1.0
Very Soft Soil	1.5	1.0	1.0	1.0

Natural period of structure decreasing →

creased by 5%. Heights of buildings are restricted in regions with the highest seismic risk, as shown in Table II.

Rumania

The Rumanian Building Code[16] specifies that the total base shear, V_B, be calculated from:

$$V_B = \sum_n V_{Bn} = K\psi \sum_n W_n\gamma_n \quad (13)$$

where K represents the seismicity of a region. In Rumania there are four seismic zones for which the values of K are 1.0, 1.7, 2.9 and 5.0. The parameter γ is a function of the foundation soil and the period of vibration of the structure. Typical curves for the product $K\gamma$ are shown in Fig. 4, and these show a resemblance to the velocity spectrum curves obtained by Housner.[6] ψ is a damping function whose value depends on the type of construction: for steel construction $\psi = 1.6$ and for reinforced concrete $\psi = 1.2$.

When the base shear has been calculated the lateral load at the zth storey is calculated from equation (9).

U.S.S.R.

The latest Soviet Building Code[17] concerned with earthquake loads states that the total design seismic force, F_z, at the zth storey is determined from the formula:

$$F_n = \sum_n F_{zn} = K \sum \delta_n\eta_{zn}W_{zn} \quad (14)$$

where K = a regional seismic coefficient, the value of which may be 0.025, 0.05 or 0.10. A certain amount of flexibility is allowed in the use of this coefficient; if a careful survey is made within a region with a specified K value then this value can be modified if it is justified by the survey. Important struetures, sueh as power stations and government buildings, within a given region are designed on the assumption that they are in a region with a higher seismic risk.

The coefficient δ is a function of the period of free vibrations of the structure. The coefficient is plotted in Fig. 5 and again the resulting curve is seen to resemble the velocity spectrum eurve of an idealized earthquake. The coefficient η_{zn} is a function of the deformation curve resulting from free vibrations of the structure;

$$\eta_{zn} = \frac{\phi_z \sum_{j=1}^{N} W_j\phi_j}{\sum_{j=1}^{N} W_j\phi_j^2} \quad (15)$$

where N is the total number of stories.

If a complex structure is being designed the following substitution is allowed:

$$\phi_z = h_z \quad (16)$$

where h_z is the vertical distance from the base to the zth storey. This approximation can only be applied for the fundamental mode of vibration. The weight of the jth storey, W_j, is taken as the dead load plus 80 per cent of the live load. Equation (14) computes the actual load at the zth storey, not the shear force, and its use demands a dynamic analysis of the system.

TABLE II.

Height Variations in Seismic Areas in Japan

Type of Building	*Height Restriction, metres*
Steel	30
Reinforced Concrete	16
Wood	20

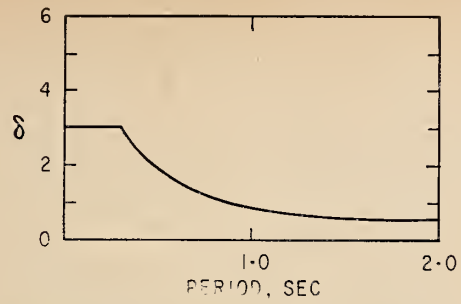


Fig. 5—Value of coefficient δ, vs period of free vibration of structure.

U.S.A.

Many of the large eities on the west coast of the U.S.A. have their own building codes, but perhaps the most significant American document is the 1961 edition of the Uniform Building Code.[14] The base shear, V_B, is calculated from

$$V_B = KEC \sum_{j=1}^{N} W_j \quad (17)$$

In equation (17) K represents the seismicity of a region, and its value can be 0.25, 0.5 or 1.0. E represents the capability of a structure to dissipate energy and its values are given in Table III. The Code requires that all buildings over 160 feet high must be constructed of completely moment-resisting frames.

The coefficient C in equation (17) is a function of the fundamental period of vibration T, thus

$$C = \frac{0.05}{\sqrt[3]{T}}, \qquad T \geq 0.1 \text{ sec.} \quad (18)$$

The base shear is distributed along the height of the structure by the following formula:

$$F_z = \frac{W_z h_z}{\sum_{j=1}^{N} W_j h_j} \cdot V_B \quad (19)$$

In this equation h_j is the height to the jth storey, and F_z is the lateral load, not the shear force, at the zth storey.

The overturning moment, M, acting on a structure is calculated from

$$M = J \sum_{i=1}^{N} S_i h_i \quad (20)$$

where J is an empirical factor that indirectly takes account of the diminishing importance of higher order modes:

$$J = \frac{0.5}{T^{2/3}} \quad (0.33 \leq J \leq 1) \quad (21)$$

Discussion of the Building Code Requirements

The building codes described in this paper express in different forms, the action of an earthquake upon a building, but they have certain features in common. All the codes contain a factor which defines the available knowledge concerning a region's seismic activity.

Each of the building codes takes into account, explicitly or otherwise, the response of a building to an earthquake. The Uniform Building Code, and Rumanian and Soviet Codes explicitly use the free periods of vibration of the structure as the parameter determining building response; this is also loosely implied in the Canadian Building Code, insofar as it is possible to relate the height of a building to its fundamental period. A plot of height versus period for a number of buildings indicates an approximate linear relation of the form $H/T = 167$,

TABLE III.

Values of Coefficient E [in Equation (17)

Type or Arrangement of Resisting Elements	*E*
Buildings with a moment-resisting space frame, capable of resisting 100% of the total lateral load	0.67
Buildings with a complete horizontal bracing system capable of resisting all lateral loads, including a moment-resisting space frame, which by itself can resist a minimum of 25% of this load	0.80
Other types of framing systems	1.00
Building with a box system; this is defined as a complete vertical load-carrying space frame while the lateral loads are resisted by shear walls	1.33
Other structures	1.50

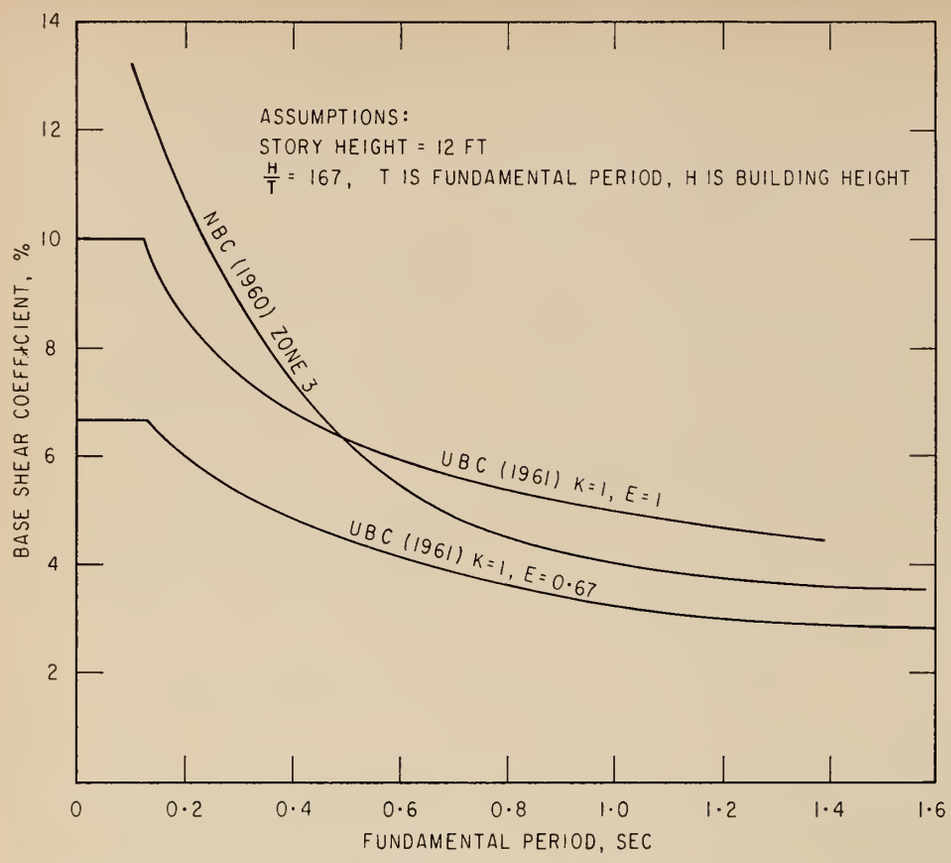


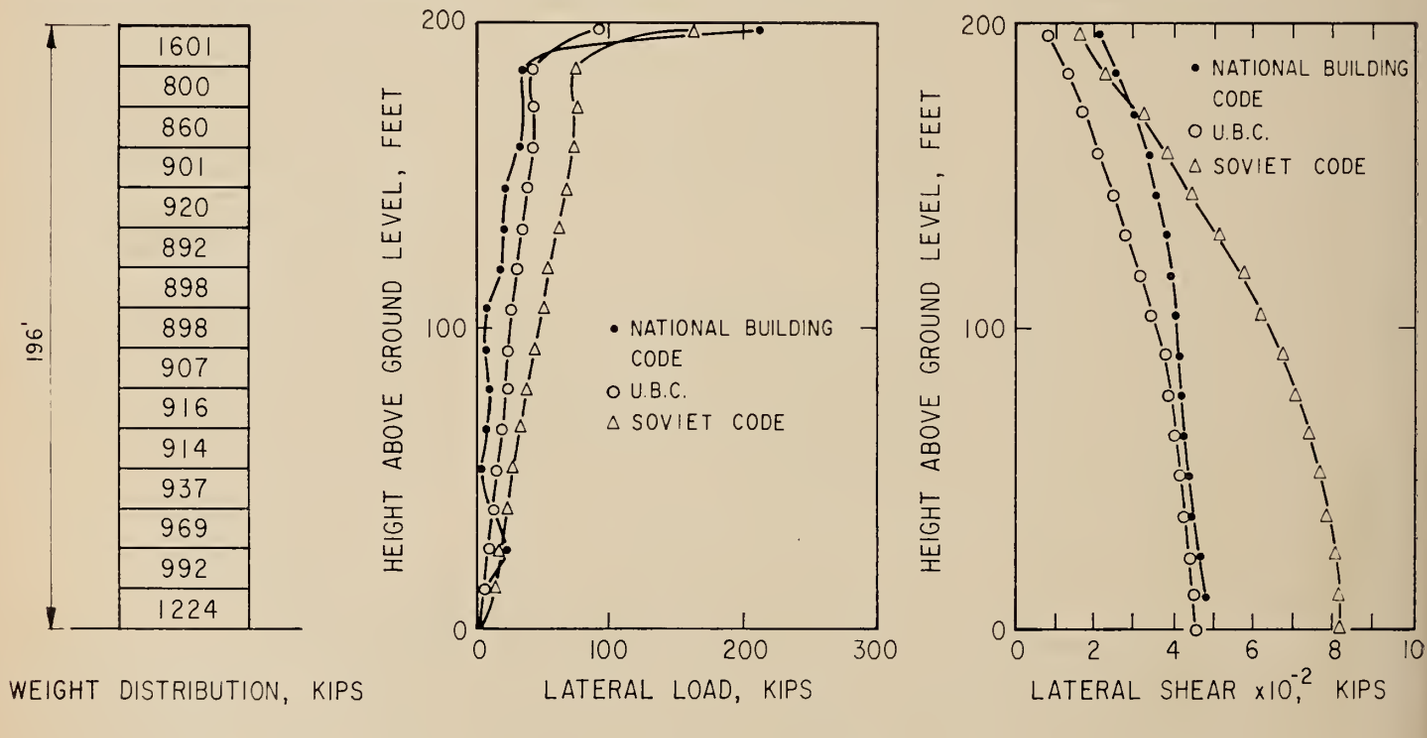
Fig. 6—Comparison of seismic coefficients of National Building Code (Canada, 1960) and Uniform Building Code (U.S., 1961).

where H is building height in feet and T is the fundamental period in seconds. This makes it possible to compare the base shear coefficients of the Canadian Code and the U.B.C. as shown in Fig. 6.

The Japanese and Rumanian codes take account of different foundation materials in earthquake design. The two variables considered in this aspect of the problem are the degree of consolidation of the foundation material and the period of vibration of the structure. An expression for the damping action of structures is formulated in the Rumanian code, and is implied in the factors C and δ of the U.B.C. and Soviet codes respectively. It is worth noting, however, that the damping values used are arbitrarily related to building types rather than being based on actual measurements.

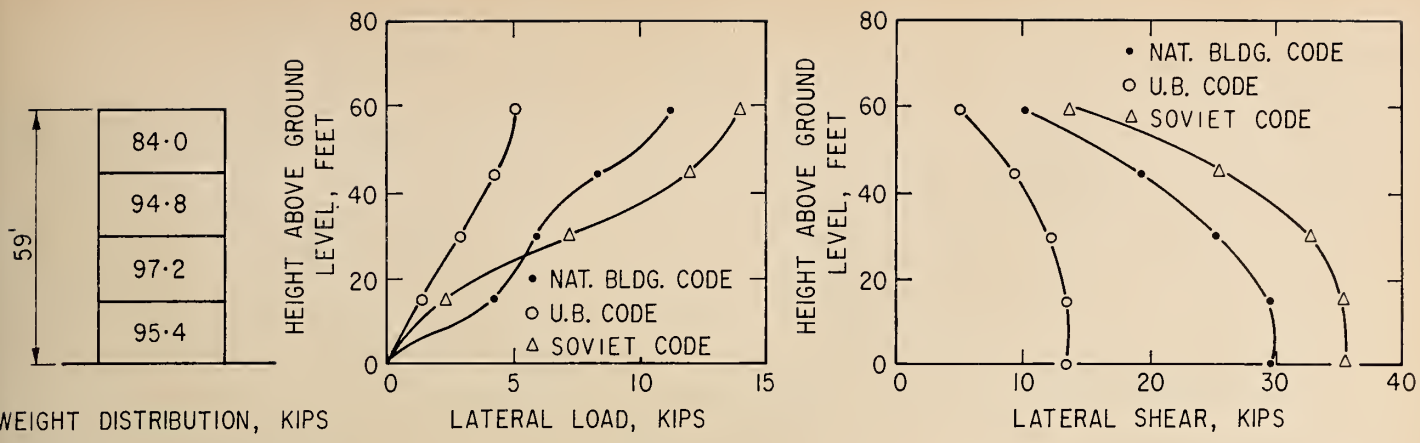
In an attempt to obtain some comparison between the National Building Code, the Uniform Building Code and the Soviet Building Code, two buildings were designed according to these different codes. The two comparative designs are shown in Figs. 7 and 8. Figure 7 illustrates the

Fig. 7—Comparison of earthquake designs for a 15-storey building (Alexander Building, San Francisco). Zone 3 assumed.



BUILDING CODE	BASE SHEAR, KIPS	EFFECTIVE SEISMIC COEFFICIENT	OVERTURNING MOMENT, KIP FT
CANADIAN 1960	475·1	3·25 %	73,193.
U.B. CODE 1961	453·9	3·20 %	26,944.
SOVIET 1957	816·8	5·76 %	112,496

TOTAL WEIGHT OF BUILDING	14,619 KIPS
FUNDAMENTAL PERIOD OF BUILDING	1·25 SEC



BUILDING CODE	BASE SHEAR, KIPS	EFFECTIVE SEISMIC COEFFICIENT	OVERTURNING MOMENT, KIP FT
CANADIAN 1960	29·71	8·0 %	1278·9
U.B. CODE 1961	13·80	3·7 %	375·2
SOVIET 1957	35·32	9·6 %	1608·6

TOTAL WEIGHT OF BUILDING	371·4 KIPS
FUNDAMENTAL PERIOD OF BUILDING	0·726 SEC

Fig. 8—Comparison of earthquake designs for a four-storey building. Zone 3 assumed.

fact that the Canadian and Uniform Building Codes give similar values for the base shear of high rise buildings; because of the J factor given in equation (21) the overturning moments as calculated by the Uniform Building Code are consistently smaller than those calculated by the other codes. The approximation of equation (16) has been used in the calculations for the Soviet code and so the values given in Figs. 7 and 8 are not fully representative of this design method. Fig. 8 illustrates the fact that the Uniform Building Code, when compared with the other two codes, favours smaller buildings with a relatively high fundamental period.

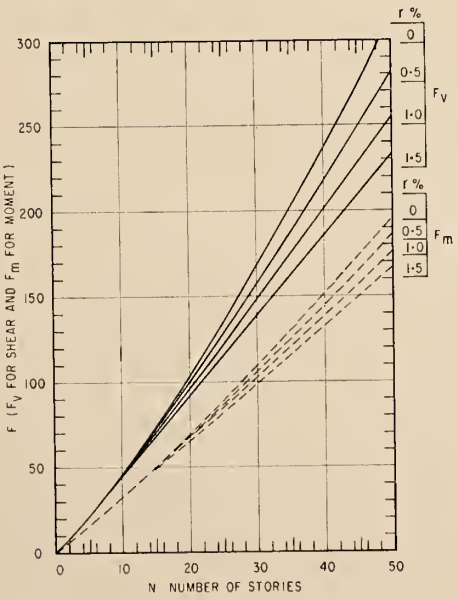
Of the three methods based on dynamic principles, the Uniform Building Code is the easiest to apply. When the fundamental period of the structure has been evaluated, the base shear and overturning moment can be calculated, utilizing equation (20) for the latter. The Rumanian and Soviet codes are based on a complete free vibrational analysis of the structure.

RELATIVE IMPORTANCE OF WIND AND EARTHQUAKE LOADING

The fact that winds, as well as earthquakes, exert lateral forces on buildings invites a comparison between the two. A detailed discussion of wind loads will not be included in this paper as a comprehensive review of wind loads has already been provided by Davenport.[19] Suffice it to say that although winds and earthquakes produce dynamic forces with distinctly different characteristics, both are approximated by static loadings in the simplified approaches usually adopted in building codes.

It is generally recognized that the two forces need not be considered simultaneously; it is therefore necessary to ascertain which of the two lateral load provisions will govern in any given design problem where both apply. A comparison of this sort, however, is valid only for one particular set of conditions and may fail to reveal the effects of certain important variables (e.g., geographic location) on the relative importance of wind and earthquake on a country-wide basis.

Fig. 9—Values of F_v and F_m used in Equations (28) and (29).



In the following discussion, the relevant variables have been arranged in a compact form to allow some general observations to be made about their effects on a wind-earthquake comparison. It is hoped that the ratios developed will aid in placing the code provisions for the two lateral forces in their proper perspective.

Basis for Comparison

For the comparison, equations for shear and moment due to wind and due to earthquake were developed using the lateral force provisions of the National Building Code (1960). The only adjustment made to the techniques laid down in the Code was to replace the wind height factors (Table 4.1.2.F) by the following:

Gust pressure at height x,

$$q_x = q_{30}\left[\frac{x}{30}\right]^{2/7}$$

where q_{30} is the basic gust pressure given in the Climate Supplement to the Code.[18]

Ratios of wind shear to earthquake shear and of wind moment to earthquake moment for a selected class of buildings which includes most of those being built today were formed from the equations for wind and earthquake loadings. The shears and moments considered in the ratios act just above the foundation and the basement slab and occur only at this point; a general indication of their variation along the height of the building will be given later.

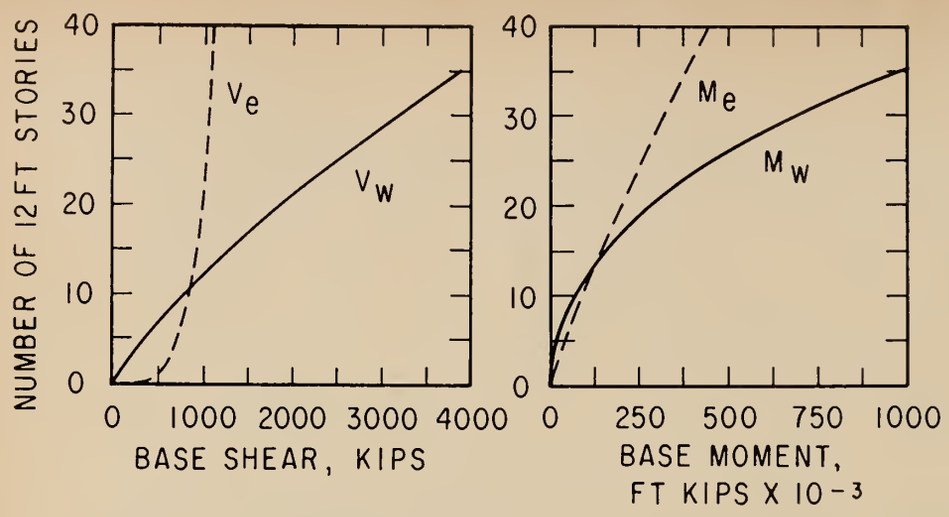


Fig. 10—Comparison of wind and earthquake designs for a common type of building in Halifax region.

The buildings considered have a uniform plan area for all stories (no setbacks), and all storey heights including the single basement storey are the same. Storey weights are either uniform or else increase uniformly from the top storey downwards. Service machinery is located in a penthouse on the roof, and the combined weight of the roof structure, penthouse and contents is twice the weight of the top storey. Only two plan dimensions are used regardless of the shape (rectangular, U-shaped, L-shaped, etc.): the over-all widths normal to the forces considered, and the mean depth, defined as the plan area divided by the width.

Ratios of Wind to Earthquake

The equations of wind shear and moment and earthquake shear and moment used to form the ratios are:

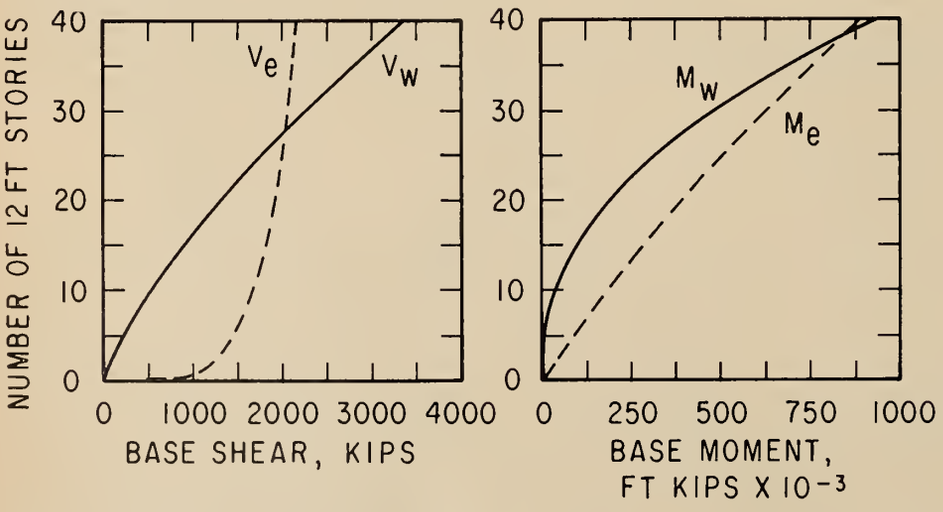
Wind shear

$$V_w = 0.294 q' h^{9/7} w N^{9/7} \qquad (22)$$

Wind moment

$$M_w = q' h^{9/7} w h [0.294 N^{9/7} + 0.166 N^{16/7}] \qquad (23)$$

Fig. 11—Comparison of wind and earthquake designs for a common type of building in Montreal region.



Earthquake shear

$$V_e = 0.15 K p_1 d w \left[\frac{4 + rN^2 + (2 - r)N}{2N + 9}\right] \qquad (24)$$

Earthquake moment

$$M_e = 0.15 K p_1 d w h \sum_{n=0}^{N} \left[\frac{4 + rn^2 + (2 - r)n}{2n + 9}\right] \qquad (25)$$

where

q' = basic gust pressure q_{30} (30 ft. ht.) multiplied by a total pressure coefficient of 1.5, p.s.f.

w = width of building as defined earlier, ft.

d = depth of building as defined earlier, ft.

h = storey height, ft.

p_1 = average unit weight of top storey, p.s.f.

r = ratio of increase in unit wt./storey: p_1

n = number of storeys down from top (n for roof = 0)

N = total number of storeys (not incl. basement)

K = seismic zone factor (1, 2 or 4)

The ratios V_w/V_e and M_w/M_e can be simplified by separating the parts of the formulae which are functions of N from the other factors as follows:

$$\text{Let } F_v(N) = \frac{0.294 N^{9/7}(2N + 9)}{0.15[4 + rN^2 + (2 - r)N} \qquad (26)$$

$$\text{and } F_m(N) = \left[\frac{0.294 N^{9/7} + 0.166 N^{16/7}}{0.15}\right] \sum_{n=0}^{N} \left[\frac{2n + 9}{4 + rn^2 + (2 - r)n}\right] \qquad (27)$$

Then the ratios are:

$$\frac{V_w}{V_e} = \frac{q' h^{9/7}}{K p_1 d} \cdot F_v(N) \qquad (28)$$

$$\frac{M_w}{M_e} = \frac{q' h^{9/7}}{K p_1 d} \cdot F_m(N) \qquad (29)$$

$F_v(N)$ and $F_m(N)$ are plotted against N for four different values of "r" in Fig. 9.

DISCUSSION

Geographic location determines the wind gust pressure q and the seismic factor K. The considerable influence that location has on the design forces can be shown by Figs. 10 and 11, where the same structure has been

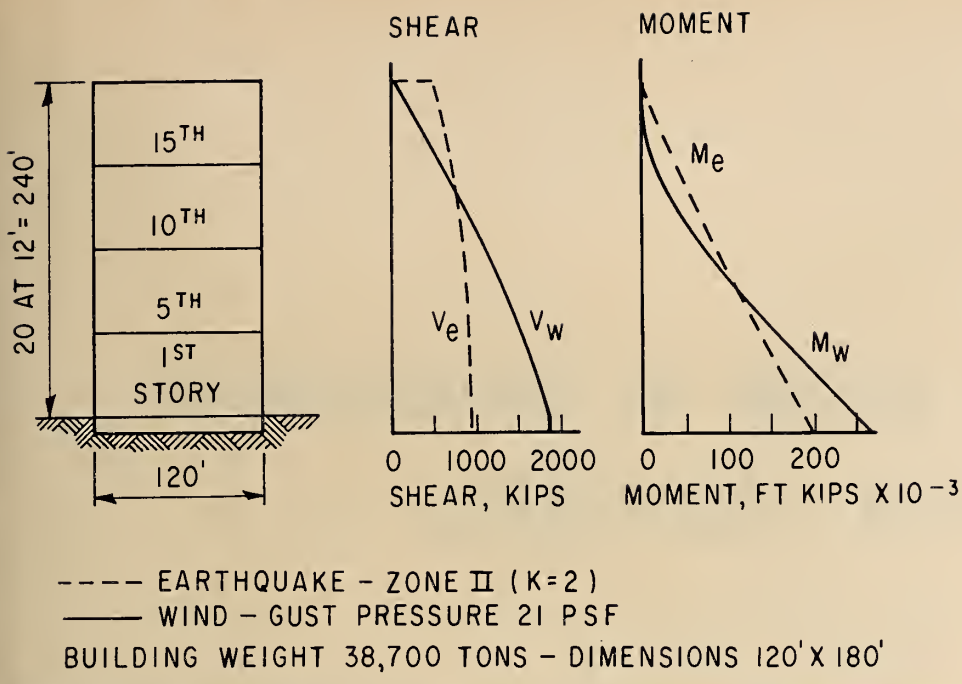


Fig. 12—Shear and moment distribution with height for a 20-storey building (comparison of wind and earthquake loads).

analyzed for two different areas, one with high wind loads and the other with a high earthquake factor. Shear and moment are plotted against building height, and although the shapes of the curves remain the same, the relations between those for wind and those for earthquake vary considerably from one region to the other.

Other factors being constant, the higher the building, the more probable it is that wind effects will exceed earthquake effects. Earthquake effects, on the other hand, exceed those due to wind for all buildings below a certain height and, as shown in Fig. 11, this critical height may well be as high as 30 storeys (360 ft.) or even more.

Weight distribution is expressed by four parameters, p_1, d, w and r. For relatively low buildings, an average storey weight, W_{avg}, can be substituted as follows:

$$\text{Ratio} = \frac{q' w h^{9/7}}{K W_{avg}} \cdot F(N) \qquad (30)$$

as Fig. 9 demonstrates that the weight distribution assumed is not critical for buildings up to 10 storeys in height. For taller buildings, the ratios are more sensitive to "r", indicating the need for a more careful assessment of the weight distribution and/or a more liberal allowance for error in the result.

Distribution of wind and earthquake forces along the height of a typical building is shown in Fig. 12. It may be observed that when earthquake governs at the base, then it governs all the way to the roof; on the other hand, even though wind may govern at the base, earthquake invariably takes over at and above some upper level of the building.

CONCLUSIONS

Evidence of seismic activity in Canada demonstrates the need for earthquake protection in certain regions.

In the light of present-day knowledge it appears that the National Building Code of Canada does not adequately account for all the variables involved in the problem of earthquake design. There are strong arguments for considering the fundamental period of vibration of a structure as a basic design parameter and also for considering the relations between type of structure and type of soil. Nevertheless for many typical structures the National Building Code specifies values of base shear that do not deviate far from the values calculated according to the regulations of other countries.

In comparison with wind, earthquake requirements govern the design of buildings lower than a certain critical height, which varies from below five to more than 30 storeys, depending on the building and its location. Wind requirements dominate for the lower part of buildings which are over this critical height, although a substantial upper part may still be governed by earthquake.

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COMPOSITE DESIGN OF UNDERGROUND STEEL STRUCTURES

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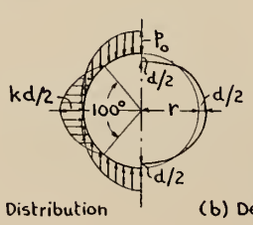
Culverts, overpasses and other underground structures built to help accommodate expanding transportation facilities create new problems of design and construction. The influences of interrelated factors on the design and construction of underground steel structures are discussed briefly in this paper on the basis of recent investigations.

IN CONNECTION with the expansion of modern transportation facilities many culverts, overpasses and other underground structures have to be built. Some of these installations are more heavily loaded and have longer spans than those built in the past and thus create new problems of design and construction. As in the case of other structures, the main requirements are adequate strength and stability, tolerable deflections, reasonable economy of construction and limited maintenance with sufficient durability during the service life. The influence of these interrelated factors on the design procedures and construction practice of underground steel structures will be briefly indicated in this paper on the basis of recent investigations.

Fig. 1. Pressure Distribution and Deflection of Flexible Pipe.



(a) Pressure Distribution (b) Deflection

Strength and Deformation of Flexible Structures

An estimate of the applied loads and supporting strength of flexible circular culverts under an earth fill can be made by the Marston-Spangler theory of loads on underground pipes.[1] In this method (Fig. 1) the vertical pressures on the culvert are assumed to be uniformly distributed over the pipe diameter at the top and over the bedding width at the bottom of the culvert. The horizontal pressure on each side of the culvert is distributed parabolically over the middle 100° of the pipe and is assumed to be directly proportional to the horizontal deflection of the pipe.

The stresses and deflections of the culvert are then determined by the elastic theory of flexure of thin pipes.

Where a uniform soil support around the culvert is obtained by good construction, the flexural stresses are small compared with the axial stresses along the circumference of the culvert, and the maximum radial deflection of a circular culvert is[1]

$$d = \frac{0.167 p_0 r^4}{EI + 0.061 k r^4} \qquad (1)$$

where
p_0 = average vertical pressure at top of culvert,
r = radius of culvert,
E = modulus of elasticity of culvert,
I = moment of inertia of culvert,
and
k = coefficient of soil reaction ("subgrade modulus").

Since the flexural rigidity EI of flexible culverts is generally small compared with the second term in the denominator, the former can safely be neglected and the maximum deflection is, approximately,

$$d = 2.7 p_0 / k \qquad (2)$$

Field experiments on corrugated steel culverts under fills of sand, silt and clay with heights exceeding the pipe diameter have shown that the vertical soil pressures vary between about 50 and 90 per cent of the overburden pressure at the top of the culvert. The horizontal soil pressures on such culverts were generally greater than the vertical pressures and sometimes exceeded the overburden pressure. It was also found that the method of backfilling and compaction, as well as the foundation conditions, affected the load on culverts. The complex loading conditions have been simplified by White[2] who assumed a uniform pressure distribution around flexible pipes with sufficient cover (height exceeding one-eighth of the pipe diameter), good backfill and a uniform foundation (Fig. 2). This soil pressure is taken as the overburden pressure plus any distributed live load at the top of the culvert. For heights of fill exceeding about 10 ft. under highway loading and exceeding about 30 ft. under railway loading the live load is negligible when the vertical pressure at the top of the culvert is, approximately,

$$p_0 = wh \qquad (3)$$

where
w = average unit weight of fill,
and
h = height of cover above culvert.

Experience with culverts has shown that their flexural rigidity governs mainly the installation stages and compaction of the backfill, and the compressive strength of the culvert governs its behaviour under the working load. Thus, the culvert can be considered as a thin compression ring provided adequate backfill is supplied. The simple ring compression theory has been used successfully to design thin-walled plain and corrugated steel structures of different shapes, sizes and depths of backfill compacted to about 95% of the standard Proctor density.[2] The compression is assumed to be the same throughout the culvert, except for any friction forces which are neglected. The corresponding soil pressure on the structure at any point is then taken to be inversely proportional to the radius at that point and is given by

$$p = p_0 r_t / r \qquad (4)$$

where
p_0 = vertical pressure at top of culvert,
r_t = radius of top of culvert,
and
r = radius of culvert at point considered.

On the basis of these approximations the distribution of the soil pressure on circular and elliptical culverts and pipe-arches is shown in Fig. 2. The pressure is a maximum near the haunches or foundation where adequate compaction of the backfill is required to ensure support without undue deformation. Further, the average axial stress in the culvert is, approximately,

$$f_a = p_0 r / A \qquad (5)$$

where
A = cross-sectional area of culvert material.

This stress must not exceed one-half of the yield stress of the culvert material or of the joint strength, whichever is least, under carefully controlled construction, while a factor of safety of 3 to 4 on this strength is customary for average backfilling practice.

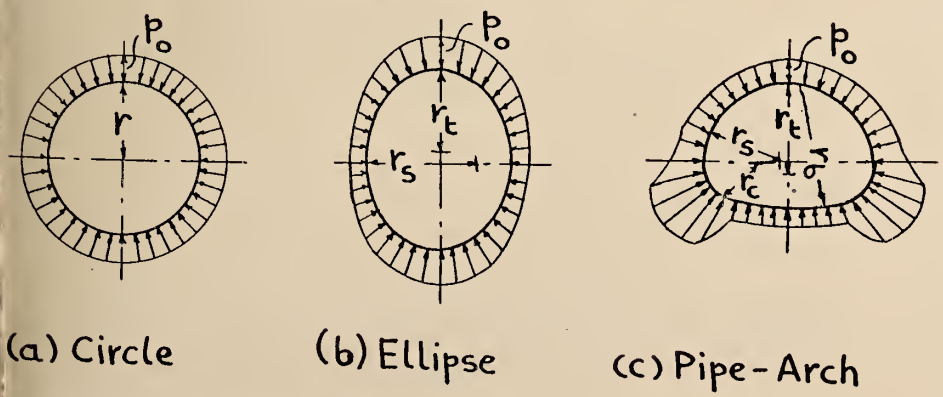
Although this approach takes some account of the method of backfilling, the actual soil properties vary within wide limits, even at a specified Proctor density. Moreover, both above methods of analysis neglect instability of culverts due to ring buckling, which was discussed by Watkins[3] on the assumption of a uniform pressure distribution around circular culverts. Since buckling may govern the strength of larger culverts and the pressure distribution around such structures is not necessarily uniform, an investigation was made at the Nova Scotia Technical College of the ultimate load of steel culvert sheets bearing against dense sand backfill. Full details of this investigation have been given elsewhere[4, 5], and the main test results and analysis are summarized below.

Model Tests on Culvert Sheets

Since underground flexible culverts frequently have their critical sections in the lower quadrants due to large soil pressures and difficulties of obtaining a uniform backfill, as indicated above, quarter-sections of a circular culvert were tested at a scale of one-eighth of full size. An axial load was applied at the end of curved plain and corrugated steel sheets and measurements were made of the strains, soil pressures and deflections of the sheets. It was found that both stresses and radial deflections increased roughly linearly with the load until failure was reached, except near the critical section where the increase was more rapid as the ultimate load was approached.

All plain sheets failed by buckling at about one-sixth of the yield stress

Fig. 2. Pressure Distribution for Flexible Culverts.



of the material, while the corrugated sheets failed generally by crushing at the yield stress of the steel. Except near the critical section, the bending stresses in the sheets were small and amounted to about one-quarter to one-half of the axial stresses at failure in the central portion of the sheets. The average radial failure strains were generally of the order of ¼ to ½% of the radius of the sheets, while the corresponding vertical strains at the upper edge were about ½ to 1% of the radius of the sheets.

While the distribution of the soil pressure on the sheets at failure was similar to that of the radial deflections, the observed coefficients of soil reaction (ratios of soil pressure to radial deflection) varied considerably around the sheets. The magnitude of this coefficient decreased as the radial deflection increased and agreed reasonably well with the values deduced from triaxial compression tests on the sand at a lateral pressure equal to the average confinement pressure of the soil. From the average observed soil pressures at failure and the original radius of the sheets the average axial stresses were estimated from eq. (5), and the calculated stresses were found to be of a similar order of magnitude as the observed maximum axial stresses.

Using the coefficient of soil reaction deduced from the loading tests, the buckling stress f_b of the sheets was estimated from the theory of elastic stability of curved plates bearing against compact soil[5] when

$$f_b = \frac{2}{A}\sqrt{\frac{kEI}{1-m^2}} \qquad (6)$$

where
A = cross-sectional area of plate,
E = modulus of elasticity of plate,
I = moment of inertia of plate,
k = coefficient of soil reaction,

and
m = Poisson's ratio of plate.

The maximum value of f_b is given by the yield stress f_y of the plate.

The estimated critical stresses compared reasonably well with the observed maximum values and also supported the observed mode of failure of the sheets. Thus, the estimates showed that the plain sheets were expected to fail by buckling at a stress of the order of one-sixth of the yield stress of the steel, while the corrugated sheets were expected to fail by crushing at the yield stress since their theoretical buckling stress was some 2 to 4 times the yield stress. The proposed analysis was also found to be supported by the results of some loading tests on small model culverts by Watkins[3] who observed buckling failure for small values of the flexural rigidity of culverts and for small values of the coefficient of soil reaction of the backfill, while for large values of these parameters failure occurred by yielding of the section.

Buckling Stability of Culverts

In conjunction with the above mentioned model tests a method has been developed[5] to estimate the critical buckling stress of underground flexible culverts. When some allowance is made for accidental eccentricities and imperfections of culverts in practice, the critical stress can conveniently be expressed by

$$f_c = \frac{f_y}{1 + f_y/f_b} \qquad (7)$$

where
f_b = buckling stress of culvert,

and
f_y = yield stress of culvert material or joints.

The buckling stress f_b is given by eq. (6) and practically independent of the radius r of the culvert, provided the ratio of r/L of the culvert exceeds 2, where L is the relative stiffness of the culvert with respect to the soil and is

$$L = \sqrt[4]{\frac{EI}{(1-m^2)k}} \qquad (8)$$

with symbols as before. Based on the analysis of field observations it has also been suggested[5] that a value of r/L of less than 2 should not be used in practice. Thus, for the important practical case of r/L≧2, eq. (7) yields

$$f_c = \frac{f_y}{1 + (f_y A/2)\sqrt{(1-m^2/kEI)}} \qquad (9)$$

This equation has been plotted in Fig. 3 for steel with E = 30,000,000 p.s.i., f_y = 40,000 p.s.i., m = 0.3 and a factor of safety of 2 to give the allowable axial stress f_a in steel structures having either 2-2/3 in. x ½ in. or 6 in. x 2 in. corrugations. For convenience of application this stress has been evaluated in terms of the ratio of t/k, where t is the thickness of the steel plate and k is the coefficient of soil reaction.

The above expressions were derived for circular culverts with a uniform soil resistance and would, therefore, apply mainly to cover heights exceeding, say, the culvert diameter. The results can, however, also approximately be used for other cases, such as flexible arches with a shallow cover, by

Fig. 3. Allowable Stress for Steel Culverts.

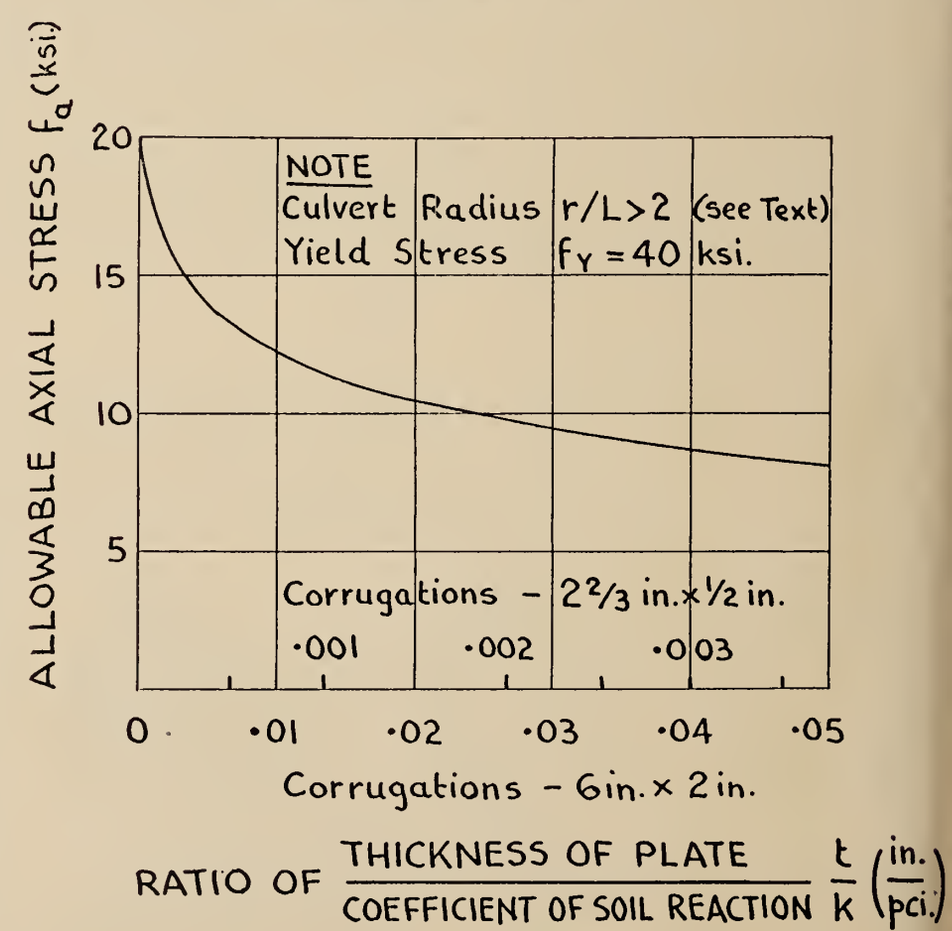


TABLE 1.

Values of Constant of Soil Reaction for Sands and Clays

Relative Density of Sand	*Constant Ks (pci)*	*Relative Consistency of Clay*	*Constant Kc (psi)*
Loose	1.5—4	Stiff	500—1000
Compact (Medium)	4—12	Very Stiff	1000—2000
Dense	Over 12	Hard	Over 2000

TABLE 2.

Deformation Properties of Fills Near Flexible Culverts Over 5 ft. Diameter

Location and Reference	*Soil Type*	*Cover Height h (ft.)*	*Culvert Dia. 2r (ft.)*	*Coeff. of Soil Reaction k (pci)*	*Modulus of Deformation E_s (psi)*	*Constant of Soil Reaction K_s (pci)*
Denver, Colo.[8]	Crushed Rock	41	15	10	1350	2.7
Ames, Iowa[7]	L. Sand-Clay	15	5	12	550	3.0
Ames, Iowa	C. Sand-Clay	15	5	26	1150	6.5
Colorado[8]	L. Silty Sand	13	10	4	350	2.3
McDowell, N.C.[7]	C. Sandy Silt	170	5½	40	2000	1.4
Lethbridge, Alta.[9]	V. Stiff Clay	99	9	55	4500	—
LaFleche, Sask.[9]	Stiff Clay	34	6	15	800	—

NOTE: C. = Compact; L. = Loose

taking the effective radius of the section and average values for the height and soil properties of the cover. In order to apply the proposed analysis to an estimate of the critical stress governing the strength of flexible culverts in practice, the relevant physical properties of the culvert and fill have to be determined. Thus, the effective flexural rigidity EI of culverts should include the influence of flexibility of any joints, which may reduce the rigidity of culverts to about one-half of that of the steel section, while for the fill conservative values of the coefficient of the soil reaction k should be chosen.

Usually the deformation properties of fills are more closely represented by a modulus of deformation E_s and Poisson's ratio m_s, and the value of E_s can readily be determined from triaxial compression tests on compacted soil samples. In that case the above equations can be adapted by using the approximate relationship[5]

$$k = \frac{E_s}{2(1 - m_s^2)r} \qquad (10)$$

or

$$k = E_s/1.5r \qquad (11)$$

since Poisson's ratio $m_s = ½$, approximately.

The coefficient of soil reaction k can also be estimated from the approximate expressions

for sands

$$k = K_s h/1.5r \qquad (12)$$

and for clays

$$k = K_c/1.5r \qquad (13)$$

where K_s and K_c are constants of horizontal soil reaction for sands and clays, respectively[6], for which typical values are given in Table 1. The values for sands apply to dry and moist materials and should be halved for submerged sands.

The above values of the deformation properties of sands were compared with the results of some field observations on flexible culverts under granular fills.[5] It was found that the deduced values of the coefficient of soil reaction k and the modulus of deformation E_s of loose fill were roughly one-half of that of compact material, and the corresponding values of the constant of soil reaction K_s were also in good agreement with those given in Table 1. From this comparison it was concluded that for an adequate support of flexible culverts of average size (up to about 5 ft. diameter) the coefficient of soil reaction k of the fill should not be less than about 20 p.c.i., and the corresponding modulus of deformation E_s should not be less than about 1000 p.s.i.

Relatively few field observations are available for larger culverts exceeding about 5 ft. diameter and these are summarized in Table 2. The deduced values of the deformation characteristics of fills of sands and silts and are of the same order of magnitude as those found for smaller culverts. The results indicate the need for good compaction of the soil in order to reach the minimum values of k and E_s suggested above, when moreover the value of E_s should increase roughly with the culvert diameter, say, about 200 p.s.i. per foot of diameter.

The observations on the two flexible culverts in clays are of particular interest in connection with the problem of ring compression and stability. The culvert at Lethbridge consists of No. 1 gauge corrugated steel with 6 in. x 2 in. corrugations and is installed in medium-plastic clay compacted to about 94% of standard Proctor density above midheight of the culvert and compact gravel-clay mixture below. The maximum deflection of the culvert is about 4.0 in. Using eq. (5) the axial stress in the culvert is estimated to be about 13,000 p.s.i. which is within the range of 12,000 to 18,000 p.s.i. based on strain gauge measurements on the culvert. Since the allowable stress according to Fig. 3 is about 14,000 p.s.i., which includes a factor of safety of 2, the culvert has a theoretical margin of safety of about 2 against failure.

TABLE 3.

Results of Field Measurements of Deflections of Large Culverts

Total No. of Culverts	*Cover Height h (ft.)*	*Culvert Diameter 2r (ft.)*	*Average Deflection d/2r (per cent)*	*Maximum Vertical Deflection d/2r (per cent)*
128	1—20	5— 9	1.7	8.8
53	1—20	10—15	2.0	10.5
20	20—75	10—15	2.5	5.8
37	20—90	5— 9	4.9	12.1
238	1—90	5—15	2.3	Total (excl. one 22% max.)

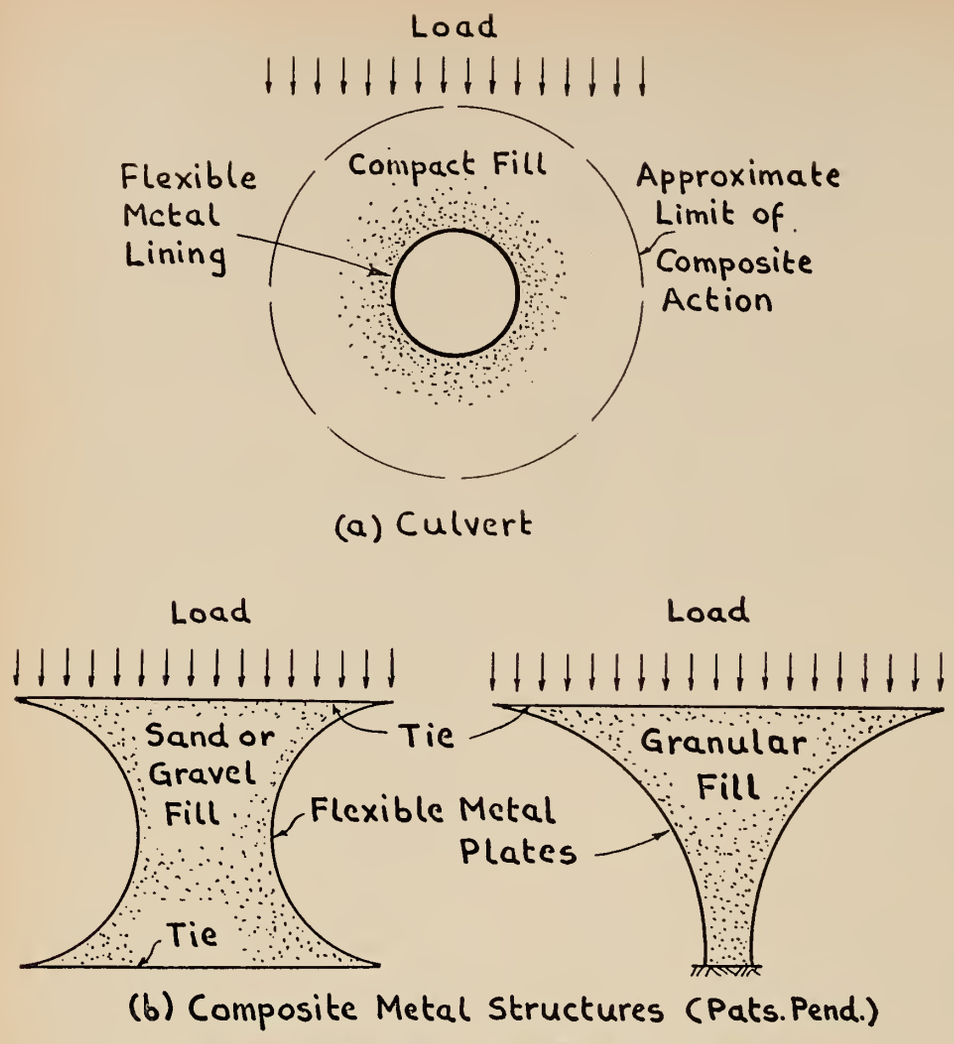


Fig. 4. Composite Action of Flexible Metal Structures.

The experimental culvert at La-Fleche consists of No. 20 gauge material with 2-2/3 in. x ½ in. corrugations installed in medium-plastic clay compacted to about 98 per cent of standard Proctor density. The maximum deflection of this culvert, which buckled in the lower quadrant, was about 5.2 in. The allowable stress (including a factor of safety of 2) is about 9,000 p.s.i., estimated as above, and the theoretical critical stress is thus about 18,000 p.s.i. It is of interest to note that the average axial stress from strain gauge measurements was in the range of 16,000 to 18,000 p.s.i. so that buckling failure of the culvert would be expected theoretically.

Measurements of deflections of numerous large-diameter corrugated steel culverts which have been in service for many years in different soils are summarized in Table 3. The observations show that the average deflection of all culverts is roughly 2½% of the culvert diameter, and a maximum deflection of about twice this value has been found satisfactory in practice. Where these deflections had been substantially exceeded, it was found that the type and degree of compaction of the backfill were the most important factors.

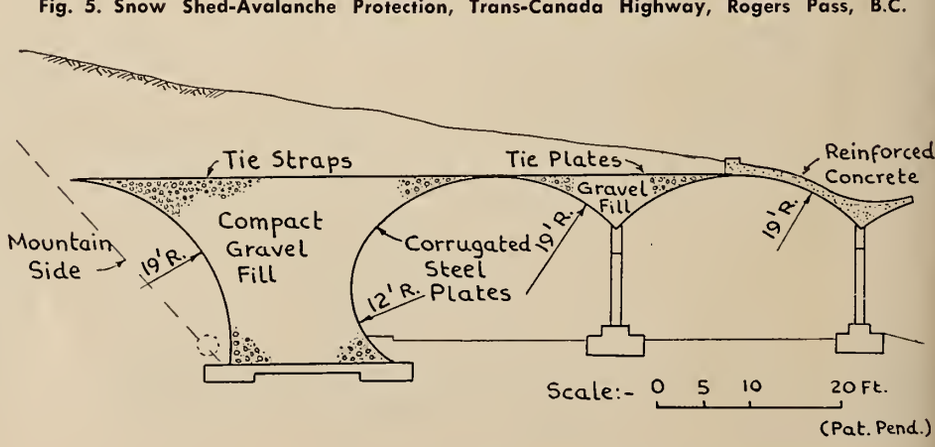
Vertical deflections exceeding about 20% of the culvert diameter usually caused the sides of the culverts to move inwards and thus reduced the lateral soil support. This type of failure was due to unsuitable backfill material or poorly compacted soil and represents deflection instability of the culvert.[3] In order to avoid such instability for which a theoretical analysis is not yet available, allowable deflections are commonly limited to 5% of the diameter and circular culverts may be ellipsed vertically by this amount before installation.

Composite Construction

The application of the methods of analysis outlined above for an estimate of the strength, stability and deflection of steel structures under earth fills may be illustrated by an example of the composite design of a culvert (see Appendix). In such structures composite action between the flexible steel lining and surrounding soil to support the applied loads is largely due to the stability of the backfill outside the metal lining. The major zone of the fill acting with the structures is within a width around the lining of about the diameter of circular culverts or the equivalent diameter of other shapes, and the average soil properties in this thick compression ring should be used in composite design (Fig. 4a). The principle of composite action can, however, also be applied to curved metal sheets bearing against granular material contained between the sheets, and such composite structures have a considerable strength compared with that of the sheets alone (Fig. 4b).

This latter type of construction has been used recently in the design of a snow shed for avalanche protection on the Trans-Canada Highway (Fig. 5). At the mountain side the composite structure consists of tied and curved corrugated steel sheets of No. 7 gauge structural plate containing compact gravel fill, and this composite section acts as a retaining wall which tends to deflect under vertical load towards the mountain. The tied corrugated steel sheets of No. 8 gauge material above the central row of columns also contain compact gravel fill and form a composite spandrel-filled arch. Using eq. (5) the axial stresses in the curved sheets are estimated to range from about 8,000 to 15,000 p.s.i. According to Fig. 3 the maximum stress would require a coefficient of soil reaction of about 60 p.c.i. which is readily supplied by the compact gravel fill.

Fig. 5. Snow Shed-Avalanche Protection, Trans-Canada Highway, Rogers Pass, B.C.



So that the composite action of flexible steel structures and the surrounding fill assumed in the proposed methods of analysis is obtained in practice, proper construction procedures are necessary. Thus, to provide a fairly uniform foundation for culverts on either soft subsoil or on rock, a bedding of compacted granular material of adequate width and thickness is required. Dense granular material is also to be preferred for the backfill and should be particularly well compacted in thin layers under the haunches and within a distance of about one diameter around the structure. The strength and deformation properties of granular fill in the composite section can be further improved by stabilizing the material with cement or chemical grout, which has been used recently in a number of cases. While silt and soft clay are usually unsuitable as backfill, properly compacted stiff clay has proved to be quite satisfactory. In general, the type of material and degree of the compaction of the backfill of underground structures should be the same as that used for well-constructed embankments.

Special construction methods can be employed to decrease the load normally acting on flexible structures by improving their composite behaviour with the surrounding soil. If a greater degree of compaction of the backfill is used at the sides of a culvert than either above or below the structure, a correspondingly greater proportion of the load of the overburden will be transferred from above the culvert to the soil at the sides of the structure. Further, yielding joints embodying rocker-type high strength steel bolts have been used experimentally to reduce the load in some corrugated metal structures. While further research is needed on these types of construction, differential compaction and yielding joints would encourage the backfill near underground structures to carry more of the overburden and could thus lead to more economical composite structures in practice.

CONCLUSIONS

Analysis of the results of field observations and model tests on flexible steel culverts under earth fills shows that the strength and deformation of such structures depends on the composite action between the metal lining and surrounding soil. For small values of the flexural rigidity of the culvert and small values of the coefficient of soil reaction structural failure occurs by buckling of the lining, while for large values of these characteristics failure occurs by yielding of the section.

A design chart and simple equations are presented to estimate the allowable stress in underground steel structures in practice. While further field observations should be made on large diameter structures installed under various soil conditions, it may be concluded from the present data that the proposed method of analysis is reasonable. Various construction problems of underground steel structures in fills have been outlined and illustrated by examples of composite design, and special construction methods have been indicated to improve composite action.

ACKNOWLEDGEMENT

The Authors are indebted to G. B. Williams, Asst. Deputy Minister of Public Works, and G. N. Munro, Chief Engineer of Prairie Farm Rehabilitation Administration, for permission to use unpublished data of structures, and for many helpful discussions with their staffs and with H. L. White of Armco Drainage and Metal Products, Inc.

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APPENDIX

Example of Design of Culvert

A 20 ft. diameter culvert is to be installed under a 40 ft. high fill of compact sand weighing 110 lb. per cu. ft. Find the required thickness of 6 in. x 2 in. corrugated steel sheets if the maximum deflection of the culvert is to be limited to 2 per cent of the diameter.

The average vertical pressure at the top of the culvert is, from eq. (3),

$$p_0 = wh = 110 \times 40/144 = 30.5 \text{ psi.}$$

Thus for a maximum deflection of 2 per cent of the culvert diameter, or

$$d = 2 \times 20 \times 12/100 = 4.8 \text{ in.,}$$

the required coefficient of soil reaction is, from eq. (2),

$$k = 2.7p_0/d = 2.7 \times 30.5/4.8 = 17.2 \text{ pci}$$

Hence use the minimum recommended value of k = 20 pci.

Assuming an allowable axial stress f_a = 10,000 psi in the steel, the cross-sectional area is, from eq. (5),

$$A = p_0 r/f_a = 30.5 \times 10 \times 12/10{,}000 = 0.366 \text{ sq. in.}$$

Hence trying No. 1 gauge material (A = 0.343 sq. in.) and a coefficient of soil reaction k = 20 pci., the relative stiffness of culvert to soil is, from eq. (8),

$$L = \sqrt[4]{\frac{EI}{(1 - m^2)k}}$$

Since for the steel section E = 30,000,000 psi, I = 0.166 in.^{4} and m = 0.3,

$$L = \sqrt[4]{\frac{30{,}000{,}000 \times 0.166}{(1 - 0.3^2)20}} = 22.9 \text{ in.}$$

Thus the ratio of r/L = 10x12/22.9 = 5.2, which is acceptable since it exceeds the minimum recommended value of 2.

Further for No. 1 gauge material (t = 0.276 in.) the ratio of t/k = 0.276/20 = 0.014 for which Fig. 3 gives an allowable stress f_a = 11,500 psi. Thus the required cross-sectional area is, from eq. (5) above,

$$A = 30.5 \times 10 \times 12/11{,}500 = 0.318 \text{ sq. in.}$$

and therefore No. 3 gauge material (A = 0.305 sq. in.) can be used. (For No. 3 gauge material t = 0.245 in. so that t/k = 0.245/20 = 0.012 and, from Fig. 3, f_a = 11,800 psi, which allows A = 0.31 sq. in. as provided).

Finally, the maximum deflection of the culvert is, from eq. (2) above,

$$d = 2.7 \times 30.5/20 = 4.1 \text{ in.}$$

Alternatively, the compaction of the sand could be increased to give a coefficient of soil reaction k = 40 pci., when No. 5 gauge material can be used (A = 0.267 sq. in. and t = 0.215 in.). Then t/k = 0.0054 and, from Fig. 3, f_a = 13,500 psi, for which the required A = 0.27 sq. in. Further, the corresponding maximum deflection d = 2.1 in. Thus the greater soil compaction would reduce the culvert material required by about 15 per cent, and the choice between the alternatives depends on economic considerations.

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DOUBTFUL METHODS in PERSONNEL APPRAISAL

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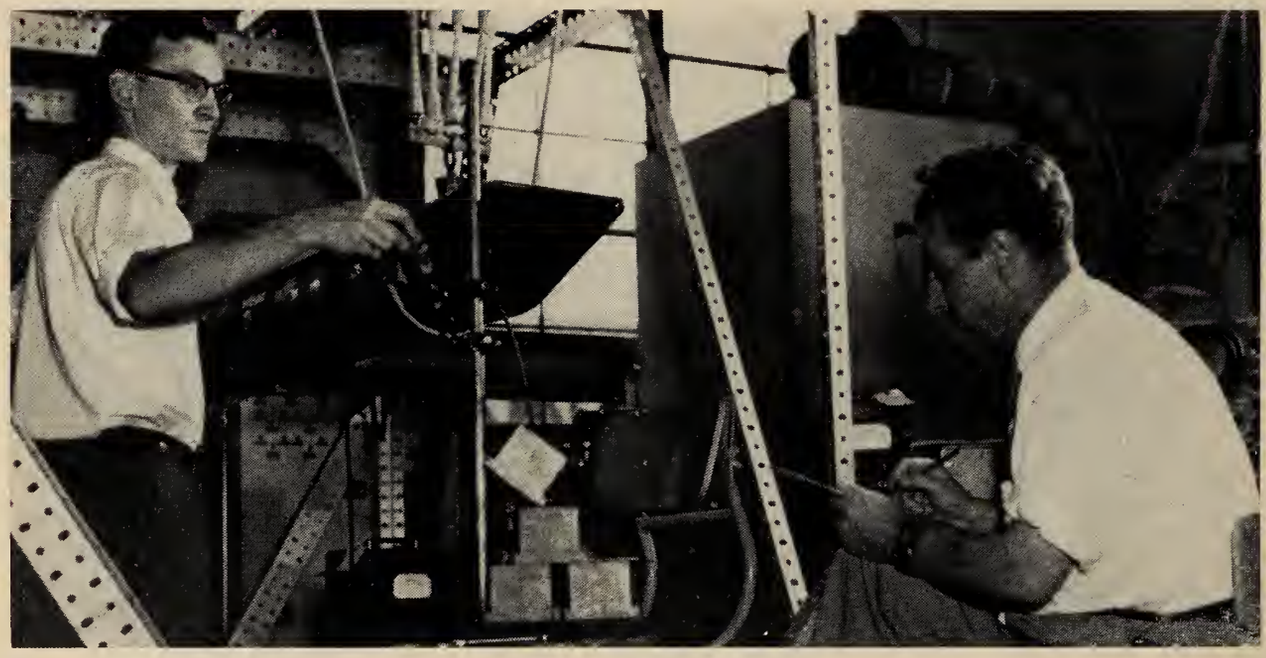

THE PAST three decades have witnessed many developments in industrial psychology. The industrialist psychologist's techniques have made possible better methods of personnel selection and placement, leading to lowered costs, higher efficiency and greater job satisfaction. In training, human factors and consumer research, the industrial psychologist has made a special contribution. His methods are based on a solid foundation of psychometric measurement.

During the past few years, a new trend has appeared. Consulting psychologists have found themselves in greater demand by management to evaluate men in high positions. Executive assessment is now in vogue and a new type of psychologist has entered the field—the clinically trained psychologist, bringing with him the diagnostic instruments used in the clinic. Traditionally the clinical psychologist has worked among the mentally sick. His techniques are not based to any great extent on the science of psychology in the measurement sense[22] but more on the intuition and on the concepts of abnormal psychology. Scientific procedure is rather different.

RELIABILITY AND VALIDITY

Two highly important concepts in psychological testing are *reliability* and *validity*. Reliability is defined as "the degree to which a test measures consistently whatever it does measure". If the thickness of a piece of metal is measured with a micrometer, one expects a second measurement to yield the same result. Exactly the same is expected of a psychological test. It must show substantially the same results when used on two different occasions. In psychometric measurement, a test must give high reliability before any reliance can be placed on the scores obtained from it. Validity. In a broad sense, validity refers to the extent to which the test is capable of achieving the purposes it is intended to serve. In other words, the test has validity only if it is capable of measuring that psychological property it is intended to measure. For example, a test purporting to measure "mechanical ability" must actually measure it otherwise the test lacks validity for that purpose.

It is possible for a test to be highly reliable without having any validity for a given purpose. If an intelligence test were used on a group of labourers in order to predict job success, it might measure intelligence with high reliability yet correlate zero with measures of job success. Thus, to be of practical value, a test must show both high reliability and also satisfactory validity. A test showing low reliability is unlikely to yield satisfactory validity. These facts should be borne in mind.

THE USE OF PSYCHOLOGICAL TESTS AND STATISTICAL PREDICTION

Psychological tests have been used for many purposes including the measurement of various kinds of intelligence, interests, achievement, "personality" and for the diagnosis of mental disturbances. In industry, tests are widely used for predicting job success.

A competent lathe operator requires certain basic skills. He needs good eyesight, finger dexterity, mechanical aptitude and ability to read blueprints. These abilities can be measured. A common procedure is to test a group of employees with one or more appropriate tests. Measures of job performance are obtained, such as quantity of production, quality of production or supervisory ratings. The test scores are correlated with these measures of performance, known as the "criterion". The correlation coefficient thus obtained is a measure of the association between test scores and the criterion. This coefficient, known as the validity coefficient, varies between +1 and −1. Either +1 or −1 indicates complete dependence of one characteristic upon the other, the sign showing the association as direct or inverse. The absence of any relationship is denoted by a validity coefficient of .00 or thereabouts.

Let us consider the case of 50 foremen tested with a mental ability test. Their supervisors have rated them in terms of job performance. Figure 1 shows ratings plotted against test scores. In this example the validity coefficient is .60.

In all correlational analysis, it is necessary to apply statistical tests to ascertain the probability of the observed relationship happening by chance. In the above case, there is less than one chance in 1000 of this being so. Examination of Fig. 1 shows that those men rated higher than average also tend to score high on the test. Results like this can often be useful in selecting new men. However, before placing complete faith in the test, it is prudent to "cross-validate" by testing a second group. If the test is doing its job, the validity coefficient derived from ratings and test scores of the second group should approximate closely to the original. By cross-validating in this manner, personnel decisions can be made with greater confidence. If it is not done, there always exists the danger of applying results which have derived from a chance relationship. *This* precaution should be observed in *all* personnel research to guard against false conclusions.

PERSONALITY TESTS AND THEIR SHORTCOMINGS

Job performance is affected by various personality factors and a person's failure is as likely to stem from personality defects as from lack of ability. For years, psychologists have worked on research in personality and on the development of tests to measure personality traits. The results have so far been disappointing and personality measurement is considered the weak spot in psychological techniques.

Personality is not easily defined. There are about 50 different definitions available. Each one is lacking in some respect. A simple definition is "a unique pattern of traits". In considering a man's personality, it must be remembered that there are differences between the man as he really is and the man as others see him.[17] Certain common elements will be present but the two views can never coincide.

One of the reasons for the failure of personality tests to be of much value in predicting job success lies in their construction. They often take the form of pencil-and-paper tests and the subject is required to respond to multiple-choice questions relating to behaviour, likes and dislikes, attitudes and beliefs or he is asked to evaluate himself. His responses are scored on the basis of such traits as "introversion", "extroversion", "dominance" and "sociability". Many such tests are easy to fake and this limits their value to a great extent. It is therefore well to remember that the personality test can only reveal that part of a subject's personality which he thinks he knows or cares to reveal, and also that the name of a test is no guarantee of its ability to measure that which it claims to measure.

It may reasonably be concluded that pencil-and-paper personality tests have a low or negligible value in selection. A US Navy research psychologist has written:

> If there were no personality measures available, the practical contribution of psychologists to the problem of selection and classification in the Armed Services would be reduced by an insignificant amount. This statement should not be construed as casting aspersions on the use of these tests in the clinic. That is where they belong . . . it just does not seem to matter much what combinations and amounts of personality traits an individual may have as long as he is healthy enough to stay out of an institution or is not too obnoxious to others.[16]

PROJECTIVE TECHNIQUES

Projective tests are unstructured tests and the subject or patient is given a minimum of instructions. For example, in taking the Rorschach Inkblot Test, the examiner hands the patient a card and asks him what he sees. He can respond however he wishes and this removal of restraints from the patient's behaviour, it is claimed, enables him to reveal his "personality". The projective techniques attempt to uncover hidden motivations and feelings which would not normally be revealed. Traditionally the projective tests are the tools of the psychiatrist, the clinical psychologist and the psychoanalyst for use in diagnosing and treating mental ailments.

Many different projective tests have been developed for clinical use. Two of the most widely used are the Rorschach and the Thematic Apperception Test (TAT). The TAT consists of a provocative series of pictures. The

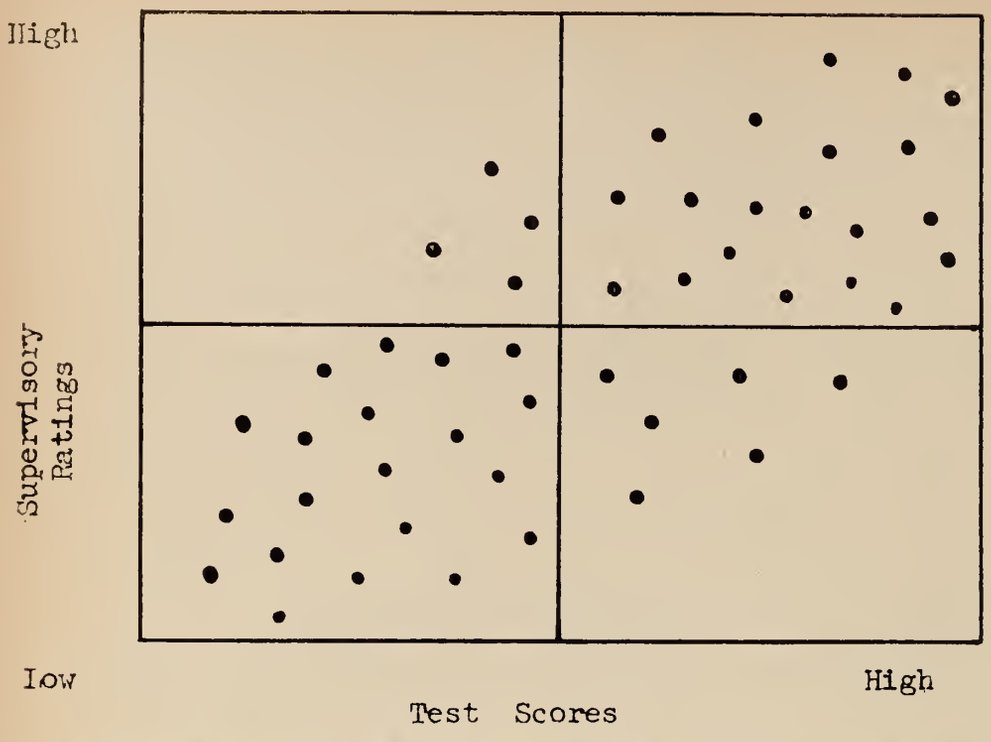

Figure 1. Scatterplot showing the relationship between Supervisory Ratings and Test Scores of 50 Foremen, r = .60.

person being tested is shown each picture in turn and asked to compose a story about the situation and the people in them, also the thoughts and feelings of the latter. All responses are recorded by the tester, who makes inferences about the subject's personality and adjustment from the stories he tells. The TAT has also been quite widely used in consumer research.[5]

The Swiss psychiatrist Rorschach was the first to use inkblots for the diagnosis of the condition of mental patients following earlier research on imagination by others.[1] He believed that abnormal people had characteristic ways of seeing things, depending on the nature of their emotional problems. Since the test was first introduced, elaborate scoring procedures have been developed.

According to the patient's responses to the inkblots on the cards, interpretations are made in terms of his personality. Much work has been done in developing the test and in training analysts to use it.[20] Over the years, however, there has been a tendency for the Rorschach to become a cult like psychoanalysis and in the opinion of its advocates, the test is immune to ordinary standards of reliability and validity, as it is concerned with the "whole personality".

The test is said to have many applications. One writer[20] has detailed the Rorschach's "rich possibilities" as follows:

> . . . to discover the pattern of a person's character in a short time, for counseling higher officials in industry . . . in accident prevention, for vocational counseling . . . in child guidance, for the selection of army officers, for marriage guidance, for research and for psychiatric diagnosis.

In addition, the manual of the test[14] claims that from the Rorschach record it is possible to deduce the subject's mental approach to problems, his creative capacities, an estimate of his intellect, maturity, special talents and also that the test detects anxieties, phobias and sex disturbances, severe disorders and serves as a guide for treatment. From these claims it might be concluded that the Rorschach is indeed a wonderful instrument.

THE APPRAISAL INTERVIEW

For many organizations, the interview is the most important part of the selection procedure. It is here that decisions are made in the light of all available evidence to hire or reject an applicant.

In his book, "Uses and Abuses of Psychology," Eysenck[9] discusses the wartime activities of the Office of Strategic Services (O.S.S.) in the USA and those of the War Office Selection Boards (W.O.S.B.) in England. The O.S.S., responsible for the selection of persons for duties requiring high morale, intelligence and courage, used psychologists in a screening procedure consisting of observations of candidates, "depth" and "stress" interviews, objective tests and ratings as the candidates underwent difficult tasks designed to reveal their mental and moral qualities. Follow-ups of the personnel tended to show that prediction of success was better than chance. Eysenck points out however that the same success in prediction might quite well have been achieved by using only objective test scores. (An objective test is one that can be scored routinely by simple rules requiring a minimum of judgment. For example, an arithmetic test requires no interpretation of test scores; the answers are either right or wrong)

The procedures of the W.O.S.B. were similar, with emphasis on the interview. Officers, psychiatrists and psychologists selected officer-candidates for an expanding army. The new methods were an improvement on older methods, such as inquiring into a man's pedigree, but success at Officers' Training Units was predicted *better* by an intelligence (objective) test than by the whole of the W.O.S.B. procedure.

Towards the end of World War II, the American Veterans Administration (V.A.), expecting large numbers of returning servicemen with neuroses and other mental ailments, prepared special hospitals for their treatment. Staffing became a problem for the V.A. and for the universities on account of the large numbers of applicants for training as clinical psychologists. A selection procedure modelled on that of the O.S.S. and composed of interviews, projective tests and objective tests was developed. The assessment staff was composed of well-qualified psychologists. They believed that the best predictors of success in the training program would result from the interviews, next the projective tests and lastly the objective tests and the candidates' past academic achievement. As it happened they were quite wrong. The best predictors were the objective tests and the scholastic records and the worst were the projective tests and the interviews. The O.S.S. approach emerged as a failure, as the more impressions and information were gained by the assessment staff, the less accurate were the predictions. Kelly and Fiske[13], referring to the V.A. Training Program in Clinical Psychology tell us that one objective test predicted success as well as any of the clinical judgments made in the entire assessment program. This evidence reminds us of the fallibility of the human as as interviewer. These authors re-emphasize the need to determine the validity of any tool used in personnel selection or in personality diagnosis and state that errors in judgment can be minimized by plac-

ing greater reliance on measures of demonstrated reliability and validity.

For those who place their faith in clinical procedures, the above findings must be disturbing. One might well ask "if clinical psychologists are unable to predict success in clinical training with projective tests and other nostrums, how can they be expected to do better in appraising technical, scientific and executive personnel?"

As a technique for assessing personality, the interview tends to be both unreliable and invalid. Some interviewers are better than others and the interview has certain unique advantages. It provides indications of traits such as "social acceptability", "fluency" etc.,[23] but it must be borne in mind that the interview is merely another tool in the selection process that should demonstrate satisfactory reliability and validity.

THE "BLOT" IN INDUSTRY

To-day, the Rorschach is widely used by clinically-oriented psychologists operating in the field of executive appraisal and selection. At this point it is appropriate to inquire whether the projective techniques and the Rorschach in particular have any predictive power with respect to success or failure where personality plays an important role. Let us examine some of the evidence.

Kurtz[15] describes a study in which 42 highly successful and 38 unsatisfactory insurance sales managers were tested with the Rorschach. A special scoring key for the test was developed by Rorschach experts from the responses of the managers to the blots. The key indicated the presence of 32 "signs" which correctly classified 79 of the 80 managers. To be able to select high-level personnel with near 100% accuracy would delight any company president and it was not immediately clear to those present that further studies were necessary before using the Rorschach blots for selection purposes. Fortunately a scientific attitude prevailed and the scoring key was cross-validated on a new group of 41 managers, half of which were high-rated and the others low. Again the testing was done by the experts, but this time the scoring key *completely failed* to classify correctly with respect to managerial success.

This study seems typical of attempts to predict job success with the Rorschach. At the same time it emphasizes the need to check the findings by cross-validation in the interests of scientific procedure and for the benefit of the company paying for the research. Kurtz believes this to be a fair trial of a scoring system. It failed to work. As he points out, there are people who regard the Rorschach as a cure-all. They fail to consider it as merely another test whose validity should be demonstrated rather than assumed.

For further evidence of the failure of the "blot" in selection, we have the reports of Professor Guilford[11] of the University of Southern California. He states that the Rorschach has on occasion failed even to discriminate between psychopaths, psychoneurotics and schizophrenics. Where validation studies has been done, Guilford tells us that it has completely failed to predict vocational success.

In an article on the use of the Rorschach in the study of personality and occupations, Roe and Mierzwa[19] consider the use of this test in industry and particularly in executive appraisal. They express exasperation by the lack of evidence presented by those who praise the utility of the Rorschach for that purpose, and tell us that neither the individual nor the various forms of the group Rorschach have proved better than other techniques when used alone for screening or selection purposes.

Roe[18] has also carried out studies of normal people (defined as neither abnormal nor subnormal not suffering from mental disorder or mental deficiency).[7] In her studies of successful scientists, she found a number of these men to be rather severely neurotic. This was rather startling, especially when they are vocationally successful and adequately adjusted socially and maritally. The point she emphasizes is that the difficulties caused by severe disturbance have been successfully coped with. Some of the scientists gave the types of responses to the Rorschach test that mental patients often give but evidence of maladjustment in their daily lives is the exception rather than the rule. Dr. Roe believes that psychologists have not studied sufficiently those persons who overcome their problems. We must therefore remember that a person who shows a so-called "abnormal" response on a projective test should not be classified as abnormal without strong supporting evidence.

In addition to the above evidence, the opinions of certain leading psychologists are quoted. Eysenck[8] has written:

> To many cautious psychologists the test (Rorschach) appears as one whose reliability is known to be low, whose validity has never been established with regard to the claims made in its favour and whose subjective nature does not attract the scientific worker.

Cattell[4] of the University of Illinois, well-known for years of research in personality refers to the Rorschach as follows:

> It remains a mixture of ill-defined intentions analogous to a patent medicine.

And in the Annual Review of Psycology for the year 1958, Jensen[12] writes:

> . . . the standard projective techniques have been a failure . . . in personality research . . . The Rorschach in particular has been worthless as a research instrument. After more than thirty years of research, the vast bulk of Rorschach studies are still attempts to show some kind of validity for this test. In view of this poor showing, the hopes and claims that continue to be professed by the adherents of these methods are indeed cause for wonder.

And yet — there are still people in high places who really believe that a man's potential for advancement in industry can be estimated from his responses to a set of inkblots!

CAVEAT EMPTOR

Heads of business and industry are forced to be realistic when they buy a commodity. They naturally expect evidence of its value before purchasing, but in matters of psychological measurement many executives are quite naive and fall prey to the peddler of expensive "selection and appraisal" programs. While sincerely wishing to improve organizational efficiency by using scientific methods of personnel selection, the businessman often has no way of differentiating between effective research and completely unvalidated and unscientific methods. Only too often, the evidence offered regarding the effectiveness or validity of a procedure is in the form of verbal or written testimonials[10]. Argument and anecdotal accounts are frequently presented instead of facts.

Intelligent people can quite easily be deceived if they are presented with a flattering report on their own fine qualities revealed by a "test", which when properly evaluated can be shown completely worthless. Stagner[21] of Wayne State University, at a conference of personnel managers, administered a "personality" test. He then handed out a fake analysis made up of items from dream books and astrology charts with a few critical comments to make it appear more plausible. Each manager received an identical analysis and was asked to rate the accuracy of it. Ninety percent of them considered it to be

"amazingly accurate". When they were requested to compare their own analysis with the others a tremendous uproar resulted as they realized that they were the victims of a hoax. The same experiment showed similar results with other groups. Stagner suggests that consultants might profit by bringing this study to the attention of their clients and that the facts disclosed should be given wider publicity in industry. It is unfortunate that reports like this are frequently to be found in journals with a limited circulation.

Certain psychologists, it seems, are aware of the misleading of businessmen. Dunnette and Kirchner[6] have illustrated a number of methods designed to lead the unwary to erroneous conclusions. Their article deals with a fairly well-known test, the Activity Vector Analysis, published by Walter V. Clarke and Associates. Its distribution is restricted to those who have completed a three-week course at a cost of $1500. The Fifth Mental Measurements Yearbook[3] contains reviews of this test. One of the reviewers, Brent Baxter, has seen "little evidence on which to recommend its use". The other, George K. Bennett, President, The Psychological Corporation, New York, writes:

> Over the past forty years a great number of self-descriptive inventories have been constructed and tried out. This reviewer is unable to recall a well-established instance of useful validity for this class of questionnaire against a criterion of occupational success. The Activity Vector Analysis is simply another such inventory, and, from a technical standpoint, a poorly constructed one. The mumbo jumbo of allegedly sophisticated statistical procedures is no substitute for demonstrated validity . . . Subsequent to the preparation of the paragraphs above, three additional . . . reports by Merenda and Clarke were received . . . and transmitted to the reviewer. These have been read with care, and in the reviewer's opinion conform to the pattern of incomplete, statistically pretentious, and misleading accounts previously described.

Finally in connexion with appraisal and selection procedures we have the words of one of the grandfathers of industrial psychology[24]. Of the latest trends in consulting, he has said:

> Particularly striking are the current activities of . . . psychologists in the large-scale promotion of presumably miraculous methods for the appraisal and development of executive personnel . . . there is very little firm evidence as to the validity of tests and other psychological tools widely used in the appraisal and selection of management personnel . . . There is practically no evidence that there is a "typical" set of desirable traits which are uniform for all management positions or that on the other hand, tests used to measure such a presumed set of traits have validity in the diverse situations in which they are used . . . There is real possibility that considerable damage can be done to the individual and also to the organization by the use of nostrums for the identification of management potential. This is particularly the case when conventional tests are replaced by procedures under which the candidate is shown an inkblot and the examiner proceeds . . . to help or harm him by interpreting remarks such as cat, insides of person, branches, sweet peas, sunset and crab in terms of introversion-extroversion, adjustment, inferiority and insecurity. The danger becomes compounded when the judgment made on the basis of such tests are supplemented or even replaced by those derived from stress interviews, the silent treatment, and psychological interpretation of comments made in the course of non-directed interviews conducted, in some instances, by inadequately prepared psychologists operating as experts in management selection.

The selection and appraisal of personnel is a vitally important and difficult task. Simplified procedures are not easily come by, if at all. Management is right in exploring new methods for solutions to their problems, but caution is necessary. It is dangerous and imprudent to pin one's faith to personnel procedures that have no scientific basis such as many of the personality tests and projective techniques. In the case of the "blot", it might not be quite true to say that those who use the Rorschach are mistaken in their beliefs, but it is quite correct to state that *no scientific evidence has been produced to justify its use in the selection and appraisal of high-level personnel.* Also, there appears to be no evidence that those who use the concepts of abnormal psychology are more consistent or better equipped to predict job success than those trained in applied psychology.

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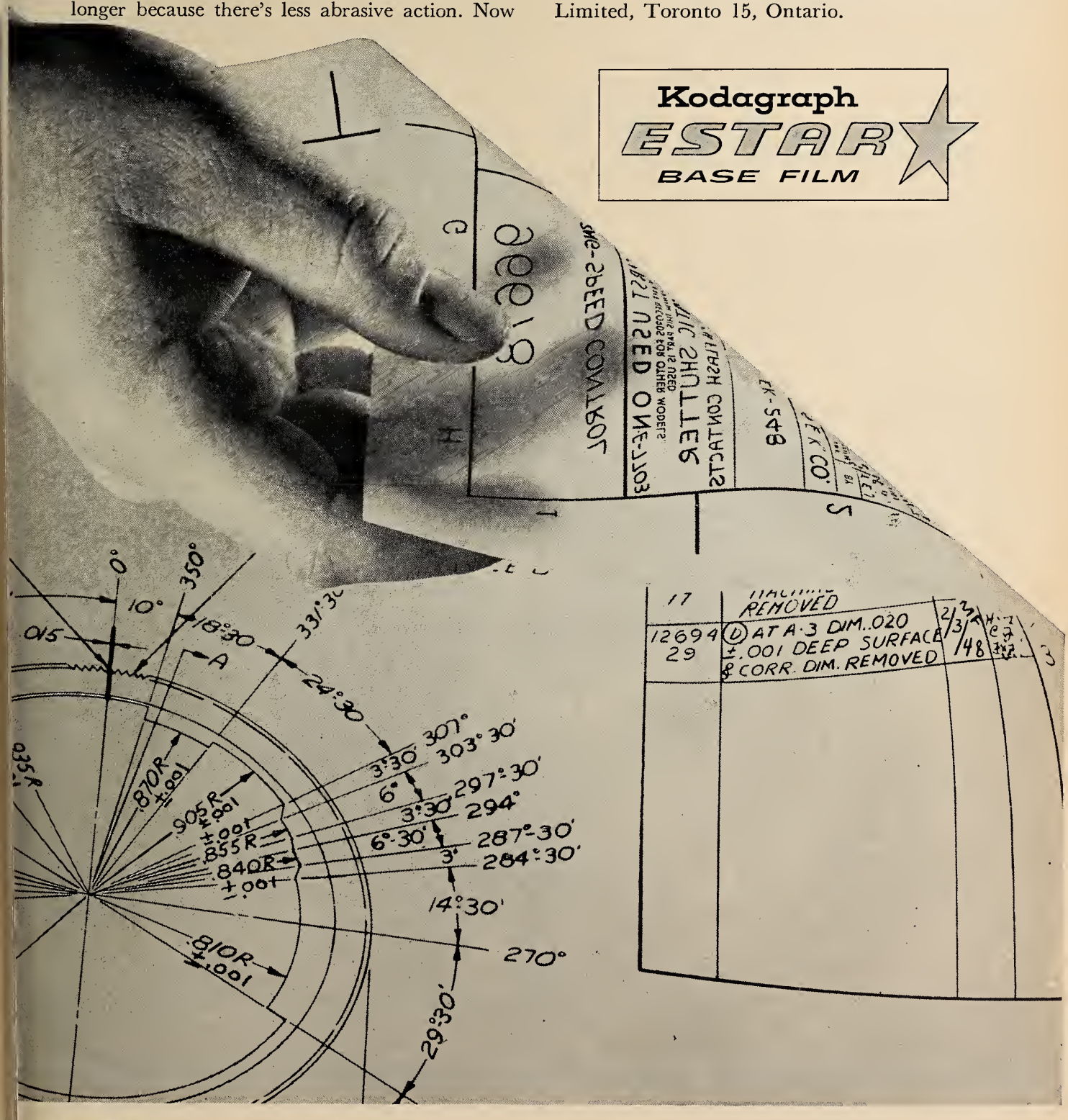

Discussion

EARTHQUAKE AND WIND LOADS IN BUILDING DESIGN

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The Engineering Journal, September, 1963, page 27

Discussion by R. E. David

Messrs. Cherry, Ward and Dalgliesh have presented a very interesting contribution to the new science of earthquake engineering, which is still in its infancy because of the extreme complexity of sudden seismic vibrations which seem to emanate from all directions. Up to last year, too few strong motion seismographs existed. Therefore, scientists and engineers lacked very important data concerning the amplitude of the vibrations to which a structure had been subjected.

The authors are, unfortunately, right in reminding the structural engineer of the ever-present danger. Hundreds of millions of dollars have been spent for all types of structures designed without the necessary precautions against earthquakes in the seismic zones of Canada.

The authors have provided a useful guide to the structural engineer who is at a loss, most of the time, when trying to select the right formula for evaluating earthquake loads. Single-storey structures are studied; so are multi-storey structures, which are more susceptible to the vibratory effects. It would have been of interest if the authors had elaborated on the difference of behaviour between 80 ft. and 300 ft. buildings.

Because the formulas given in this paper include a damping co-efficient, it is felt that it should be explained in detail. Damping results from a number of causes such as: friction between the foundations and supporting soil, friction between building components. A more detailed study of this subject would have provided precious information to the designer.

It should be noted that the formulas specified in different codes deal only with the horizontal component of the seismic wave and not the vertical component. The horizontal component tends to overturn the building and, consequently, increases the vertical load on the columns. Nevertheless, vertical components of the wave are very seldom considered due to the fact that buildings are always well proportioned to resist vertical loads. Facts have proved that vertical stresses are often greater than expected.

The earthquake which occurred in Acapulco in 1957 did very little damage. But the second earthquake of the equivalent magnitude which occurred in May, 1962, produced intense vertical vibrations with resulting serious damage.

The authors have also mentioned briefly that there is a definite relationship between the soil conditions and the extent of the damages. This fact has been emphasized recently following close studies of disaster areas. Therefore, structural engineers are advised to investigate the soil conditions in seismic zones. The study of soil conditions has given birth to a new science, "soil mechanics applied to earthquake regions", which differs from "soil mechanics based on static tests."

Although we can assume that earthquake damage to certain materials is cumulative, it has been found that column failures were mainly responsible for the damages. For this reason dynamic formulas are much more realistic than the static formulas provided by the different building codes. The static formulas might be misleading because the designer might forget that he is facing a dynamic problem.

The study and comparison of the different codes and the derived examples, as presented by the authors, are very informative. They show the discrepancy between the different concepts which lead to the determination of the formulas.

Author's reply:

The authors are grateful for the pertinent discussion of Monsieur R. E. David.

He is correct in pointing out that one of the major difficulties of an engineer faced with the design of a structure to withstand an earthquake is the lack of data regarding the amplitudes and periods of vibration to which typical structures can be subjected. This is mainly because relatively few strong-motion seismographs have been placed in structures that are within known earthquake zones. The United States of America in 1932, and Japan in 1951 inaugurated strong-motion seismograph programs: a similar program is being initiated in Canada this year. The design engineers and owners of important structures within the earthquake zones of Canada could actively assist this program by installing strong-motion seismographs in their buildings.

At the present time there is very little information available concerning the damping forces introduced during the vibration of buildings. In theoretical calculations viscous damping is usually assumed, but this is probably an oversimplification. Other damping mechanisms have been investigated,[1] but this information generally applies to small structural elements rather than large structures.

Observation has shown that soil conditions are an important factor in earthquake design. A certain amount of fundamental work has been published[2,3,4] on the vibration of foundations, but again the engineer is confronted with a lack of quantitative information regarding the behaviour of actual foundations.

These three factors are the major imponderables in earthquake engineering. Some building codes do attempt to allow for them in utilizing the scanty information now available, but these details will almost certainly be revised folowing further engineering studies of earthquakes. In the meantime the existing provisions of the National Building Code of Canada provide a good first-order measure of protection.

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COMPOSITE DESIGN OF UNDERGROUND STEEL STRUCTURES

G. G. Meyerhof, M.E.I.C.
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The Engineering Journal, September, 1963, page 36

Discussion by

J. L. Jasper, M.E.I.C.
Soil Mechanics Engineer, P.F.R.A.
Canada Agriculture

The authors are to be commended on their comprehensive paper on the design of underground steel structures, which points out the composite action between a flexible steel lining and the surrounding soil. The paper is particularly timely in that today's trends are towards larger structures, more heavily loaded than in the past. It is imperative to realize that the performance of a flexible steel conduit will depend mainly or entirely on the characteristics and behaviour of the adjacent backfill.

It is hoped that the comments which follow will supplement the contribution made by the authors.

It was difficult, at first, to realize the units of some of the terms of the equations presented. For example, the moment of inertia "I" of the conduit material must be in terms of "in.^{3}", i.e. "in.^{4} per in." of horizontal projection, and the cross-sectional area "A" is similarly in terms of "sq. in.

(Continued on page 88)

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EXECUTIVE COMMITTEE MEETING IN MONTREAL

A meeting of the Executive Committee of Council was held in Montreal on Friday, July 26, President Higginson was Chairman. Following are highlights of the meeting.

Journal Policy

R. A. Phillips, Chairman of the Publications Committee, explained that in the past the editorial content of the Engineering Journal had been dictated largely by an obligation to publish Annual General Meeting papers in it. These would normally fill most issues of the Journal, and would leave little room for other technical papers. Now, with the publication of the Transactions Series and the Division Papers a way has been developed to publish, at a much earlier date than previously had been possible, both Annual General Meeting and other technical papers of merit.

The result has been that restrictions of the technical content of the Journal have been eased. This has provided an opportunity to make the Journal increasingly current and more newsworthy.

Membership Certificates

It was decided that, effective immediately, membership certificates will be issued to corporate members only on request and payment in advance of $3 per certificate. Certificates will be mailed directly to the members concerned.

Branch Rebates

Approved was a Finance Committee recommendation that a payment of 50 per cent of Branch rebates should be sent to all Branches in August. Rebates will be calculated on the basis of the increased fees.

Fees For New Members

According to the Institute's By-laws 24, newly-elected members are billed a proportion of the annual fee based on the unexpired portion of the year, calculated from the beginning of the month in which the election takes place. As this procedure involves considerable clerical work including extra difficulties when provincial agreements are involved, a more simplified procedure was proposed.

It was resolved that effective January 1, 1964, a newly-elected member will, on election, pay the full fee for the year in which he is elected. At the discretion of the Executive Committee new members elected late in the year may have the fee credited to the following year.

Confederation

President Higgingson noted that all present had received the report of the voting on Confederation. The proposal had been defeated by a narrow margin in the E.I.C. It had also been rejected by the Corporation of Professional Engineers of Quebec and by the Association of Professional Engineers of Newfoundland, Manitoba, Alberta and British Columbia.

Tabled was a letter from the Executive Secretary of the Canadian Council of Professional Engineers which stated that in view of the results of the referendum and the requirements of C.C.P.E. it was agreed that the Canadian Council has no mandate to proceed with the implementation of the Confederation proposal.

A special meeting of Canadian Council will be held in the latter part of October to establish the future policy of Council in relation to this problem.

President Higginson said he intends to meet with the President and Executive Secretary of C.C.P.E. prior to the C.C.P.E. special meeting in October.

Canadian Geotechnical Journal

The General Secretary reported that as all formalities had been completed, arrangements were being made for the publication, in the near future, of the new Canadian Geotechnical Journal, sponsored by the National Research Council and the E.I.C.

Branches

At the request of the Branch, it was resolved that the Nipissing and Upper Ottawa Branch be transferred to Region III from Region V.

Approval in principle was given to petitions that the Estevan, Moose Jaw, Regina, Saskatoon and Yorkton Sections be given Branch status from January, 1964.

It was further resolved that the present Prince Albert Section become a section of the Saskatoon Branch. If the Swift Current Section does not wish to apply for Branch status, it will become a section of the Moose Jaw Branch.

Student Reception

The General Secretary reported that the Corporation of Professional Engineers of Quebec and the Engineering Institute of Canada had co-sponsored a reception in Montreal for engineering students from the Ecole des Travaux Publics de Paris.

Engineers' Wives Association

Vice-President J. S. Waddington reported that, as Chairman of a Special Committee, he had attended a meeting of the representatives of Engineers' Wives Association held during the E.I.C. Annual Meeting in May. The representatives at the meeting expressed their satisfaction with the assistance being given them by the E.I.C. They said the wives groups prefer to remain loosely knit with no definite affiliation as part of a national committee. Mr. Waddington, therefore, recommended that the Institute continue its support as in the past.

Economic Council of Canada

The General Secretary reported that, in accordance with the President's instructions, he had written to the Prime Minister of Canada urging the appointment of at least one engineer with appropriate qualifications as a member of the Economic Council, and offering the full support of the E.I.C. in the work of the Council. A reply was received thanking the E.I.C. for its suggestion and offer of help, but stating that no action could be taken until the proposed legislation had been passed by Parliament.

Minister of Industry

It was agreed that the President should write to the Hon. C. M. Drury, newly-appointed Minister of Industry, congratulating him on his appointment and offering him the support of the Institute as appropriate.

Agreements With U.K. Institutions

It was reported that the present agreements with Sister Societies in the United Kingdom are not working out to the full satisfaction of all parties. The President was empowered to continue these negotiations to reach a mutually satisfactory agreement of co-operation.

Other Societies

An "Inquiry into Professional Education for Town and Regional Planning" has been organized and is being conducted by Professor John Willis of Toronto. The Institute, having been invited to comment about this aspect of education from its own point of view, was to ask Mr. Harry Beaton of Montreal to prepare a statement on behalf of the E.I.C.

The President authorized to appoint delegates to:

A conference on National Highways Policy for Canada sponsored by the Canadian Construction Association:

A Conference on Building Standards for the Handicapped being sponsored by the Associate Committee on the National Building Code, N.R.C.:

A Conference on Automation and Social Change sponsored by the Government of Ontario.

(Continued on page 70)

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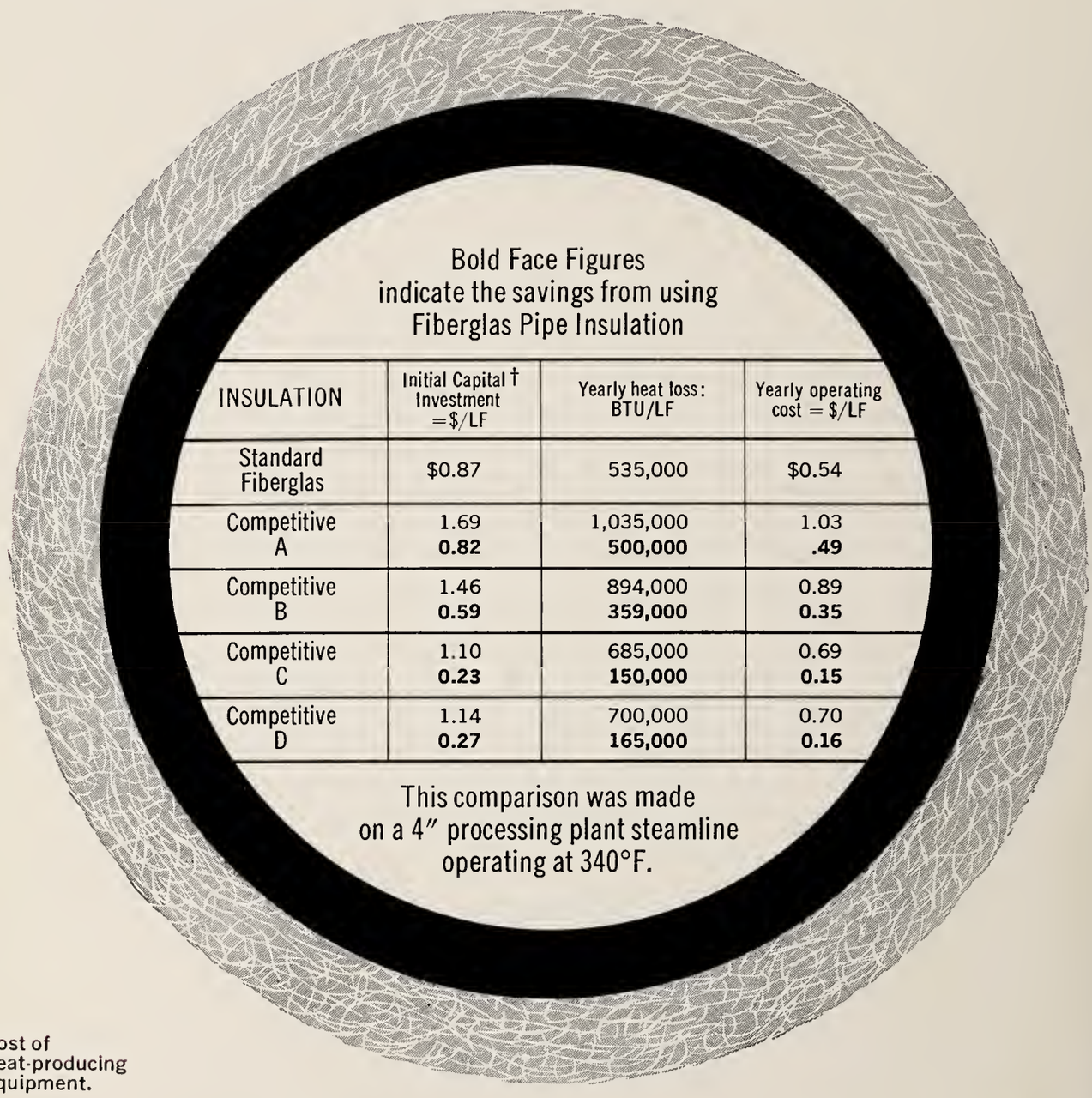

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Competitive C	1.10 **0.23**	685,000 **150,000**	0.69 **0.15**
Competitive D	1.14 **0.27**	700,000 **165,000**	0.70 **0.16**

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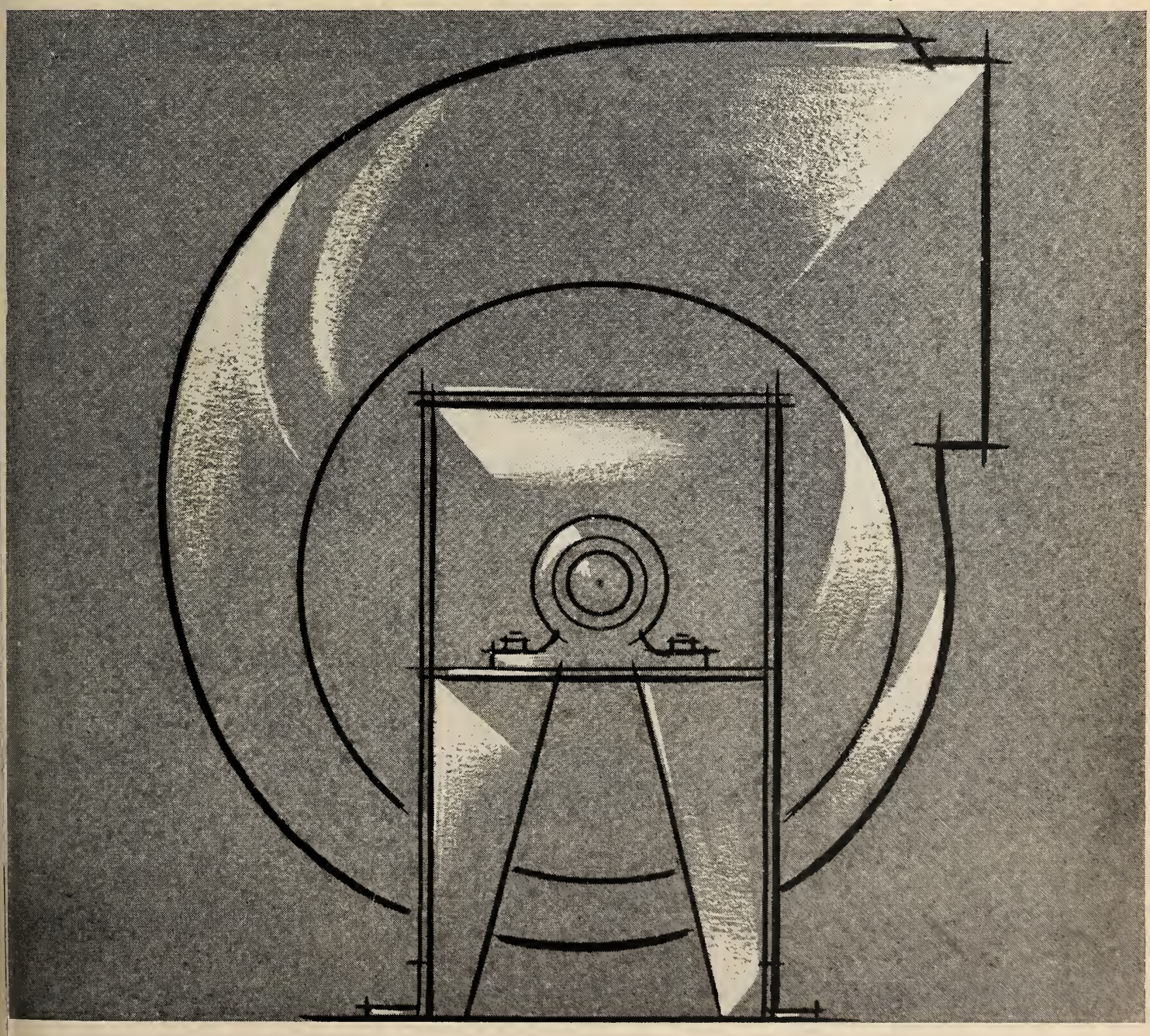


Annual General Meeting

1963

Minutes of the Seventy-Seventh Annual General Meeting of The Engineering Institute of Canada held on Wednesday, May 22, 1963, at the Chateau Frontenac Hotel, Quebec City, between the hours of 9:00 a.m. and 11:15 a.m., presided over by the President, F. L. Lawton, Montreal, Quebec.

QUORUM, CALL TO ORDER AND NOTICE OF MEETING

The President established that a quorum of members in good standing was present. He called the Seventy-Seventh Annual General Meeting of The Engineering Institute of Canada to order at 9:00 a.m. The General Secretary read the official notice of meeting which (in accordance with Section 52 of the By-Laws) was mailed to all corporate members twenty-one days before the date of the meeting.

President Lawton said it was his happy privilege to welcome the members to the Seventy-Seventh Annual General Meeting of the Institute in the historic city of Quebec. He was sure that the somewhat wet aspect of the great outdoors would not dampen their spirits because the welcome of fellow engineers in Quebec would more than make up for it. He looked forward to a useful and profitable time in this meeting and in the sessions to follow.

CONFIRMATION OF MINUTES

It was moved by Mr. J. V. Palmer, seconded by Mr. W. M. Steeves, and carried unanimously, that the minutes of the Seventy-Sixth Annual General Meeting of the Institute held in Montreal, Quebec, on Tuesday, June 12, 1962, be taken as read and adopted.

PRESIDENT'S OPENING REMARKS

Membres de l'Institut Canadien des Ingénieurs, distingués invités, mesdames et messieurs—

Je suis très heureux de vous souhaiter une chaleureuse bienvenue à la 77 ième réunion annuelle générale de notre Institut Canadien des Ingénieurs. Je suis heureux parce qu'elle est chez vous, dans cette ancienne ville fondée par Champlain.

Chez vous! Ca me rappelle beaucoup de choses. Par exemple, Jean Bourdon qui était probablement le premier ingénieur au Canada. Chez vous, parce que les ancêtres de la plupart de ceux qui participent à la réunion ce matin tirent leur origine de la rive gauche de la Manche.

Chez moi, également. Mes ancêtres tirent leur origine de la rive droite de la Manche. Chez moi, parce que j'ai été très chanceux. Chez moi, parce que j'ai trouvé chez vous le choix de mon coeur, ma femme.

Chez nous, parce que notre famille est canadienne et bilingue. Chez nous, parce que mon espoir est que tous les ingénieurs, membres de l'Institut Canadien des Ingénieurs, soient Canadiens—seulement Canadiens—au sein de l'Institut, chez nous.

ANNUAL REPORT OF COUNCIL FOR 1962

The President stated that the Annual Report of Council for the year 1962 is incorporated in the Annual Report for 1962 which was circulated to the membership in the April, 1963, issue of The Engineering Journal.

It was moved by Mr. R. H. Stevenson, seconded by Mr. T. Dobie, and carried unanimously, that the Annual Report of Council for the year 1962 be accepted.

Report of Finance Committee

Mr. G. N. Martin, Chairman of the Finance Committee, stated that the report for the 1962 period was published in the April issue of The Engineering Journal and the main highlight is the increase in the Institute's fees. The report unfortunately does not show the effect of this increase which will not become apparent until the coming year. The Committee is taking advantage of this increase to provide more funds for the improvement of the technical operations of the Institute.

It was moved by Mr. G. N. Martin, seconded by Mr. A. B. Connelly, and carried unanimously, that the Report of the Finance Committee for 1962 be adopted.

Report of Official Auditors and Treasurer's Report

The Treasurer, Mr. A. W. Howard, stated that these reports and statistics for the twelve months to 31st December 1962 were circulated to all members who would therefore be aware that there had been changes in financial policy.

It was then moved by Mr. Howard, seconded by Mr. J. T. Fisher, and carried unanimously, that the Treasurer's Report and Report of the Official Auditors be adopted, and that Peat, Marwick, Mitchell & Company of 901 Victoria Square, Montreal, be appointed Official Auditors to the Institute for the year ending December 31, 1963.

Report of Committee on Branch Operations

Reviewing the Report of the Committee on Branch Operations as printed in the April issue of The Engineering Journal, Mr. R. H. Stevenson said that in 1962 the Branch Model By-Laws were completed and forwarded to Council with the recommendation that they be approved. This approval was given and they were sent out to Branches. Several Branches suggested amendments which in turn were considered and appropriate action recommended to Council.

Last year the Committee reviewed the schedule of Branch Rebates and it was decided no revision was required. However, in view of the increased membership fees, the Committee considered this matter should be considered again and a sub-committee on the subject set-up. This sub-committee is still studying the matter but it is anticipated that its task will shortly be completed.

The Committee felt that consideration should be given to means of ensuring that Branch Operation Manuals are kept up-to-date. Accordingly a Special Committee was appointed to review them and incorporate any necessary changes.

It has been recommended to Council that Branches should be encouraged to adopt a uniform operating year.

Mr. Stevenson went on to express the Committee's regret at the loss of its former Chairman, Mr. E. D. Gray-Donald, who had played an important part in

E.I.C. affairs for many years. However, he expressed the Committee's gratification that Mr. Gray-Donald is now a member of Headquarters staff in the capacity of Deputy General Secretary.

It was then moved by Mr. Stevenson, seconded by Mr. E. A. Cross, and carried unanimously, that the Report of the Committee on Branch Operations for 1962 be accepted.

Report of Committee on Membership

Commenting that this Report had already appeared in The Engineering Journal, Mr. J. T. Fisher, Chairman of the Committee on Membership, said that the highlight of the year's activities was that membership of The Engineering Institute of Canada, as at December 1962, totalled over 24,000.

It was then moved by Mr. Fisher, seconded by Mr. C. M. Boissoneault, and carried unanimously, that the Report of the Committee on Membership be accepted.

Report of the Committee on Technical Operations

Mr. P. W. Gooch gave a résumé of the Committee's Report which appeared in the April issue of the Journal. He drew attention to the list of Divisional Chairmen of C.T.O. who constitute the Committee itself, as printed in the Journal, and expressed gratitude for their assistance during the year.

As regards this year's Annual Meeting, it was pleasing to be in a position to be reasonably selective in deciding upon the papers to be included in the program. It is hoped that a still wider selection will be forthcoming in future years resulting in improved quality.

Mr. Gooch stated that, even with five simultaneous sessions, there was considerable difficulty in accommodating this year's technical program. Furthermore, there are drawbacks in having too many simultaneous sessions because it then becomes difficult for members to attend all those they wish. The Committee felt that future policy should be to confine the Annual General Meeting program to a relatively small number of papers and set up annual meetings for the individual technical divisions of C.T.O.

The objective of 25% of technical papers being in the French language was not attained but 15%-20% was achieved.

During the year under review a plan for re-organization of C.T.O. was presented to Council. This involved the appointment of representatives of each Branch and Region to C.T.O. and of a Vice-Chairman of the Committee to undertake the necessary liaison work this involved. Mr. W. A. H. Filer has been appointed to this position and is making good progress in putting the change into operation.

The Research and Welding Divisions developed during the year and it is hoped that their part in the program will be increased in future years.

The Oil and Natural Gas Division was formed during the year and Mr. A. D. Short, its Chairman, is organizing his Committee and laying plans for the coming year.

A procedure for divisional annual reviews is to be worked out.

It was then moved by Mr. P. W. Gooch, seconded by Mr. C. E. Frost, and carried unanimously, that the Report of the Committee on Technical Operations for 1962 be accepted.

Report of Publications Committee

Mr. R. A. Phillips, Chairman of the Publications Committee, stated that the Report of his Committee for 1962 appeared in the April issue of The Engineering Journal. However, he wished to demonstrate what the Editor, Staff and Publications Committee are attempting to accomplish by the radical change in policy which has taken place in the last few months. Until December last year approved papers were published either in the "Journal" or in "Transactions". 75% of the technical content of the Journal was from papers presented at the previous Annual Meeting or before and authors complained of the delay. Readers complained that too many articles were out of date and many were technically specialized. Transactions were published quarterly and each volume covered a wide variety of interests. The number of papers worthy of publication is growing.

To meet these needs within the financial capacity of the Institute, to enhance the repuation of its publications, and thus to stimulate the preparation of more papers, a new plan for publications was put into force. There are now three media of publication:

The Engineering Journal
Transactions
Divisional Papers

Papers in the Journal will be short, of wide interest and as current as possible. The Journal has been changed in appearance and layout.

Transaction papers, approved by the Editorial Review Board, will be published individually. Abstracts of these will appear in the Journal promptly under an item headed "New Papers Available". There are five Series of Transactions and members can either subscribe annually to the Series of their choice (at a cost of $3.00) or obtain individual papers (at a cost of 50 cents).

To handle more papers the review procedures were overhauled as described in "Guide to Authors", copies of which are obtainable from Headquarters on request. More reviewers are needed and anyone who feels able to undertake this assignment is requested to contact the Technical Services Manager at Headquarters.

It was then moved by Mr. Phillips, seconded by Mr. G. F. C. Bennett, and carried unanimously, that the Report of the Publications Committee for 1962 be accepted.

Report of Other Committees, Representatives and Branches

The General Secretary then read the Report of the Life Members Committee, which was not received in time for publication in the April issue of the Journal, as follows:—

During the past year the Life Members Committee held three meetings, and in addition the Committe sponsored an impromptu luncheon meeting of all Life Members who attended the Annual Meeting in June.

At this last meeting the work of the Committee was discussed and their actions were given approval by those present. The meeting was declared a success and the suggestion made that one be held each year on the occasion of the Annual General Meeting.

We again assisted the Institute in bringing Student delegates to the Annual General Meeting and subscribed money so that the value of the Students' Prizes could be doubled.

We also assisted financially in filming the Seventy-Fifth Anniversary Show produced by the Montreal Branch.

The Financial States for the year is as follows:—

Balance—December 31st, 1961		$7,340.00
Revenue		
Contributions	$1,491.75	
Interest	207.63	
		1,699.38
		9,039.38
Expenditures		
Contribution to Student Prizes Twenty at $50.00	$1,000.00	
1962 Student Activities	500.00	
Filming of Seventy-Fifth Anniversary Show	750.00	
Purchase of Typewriter	105.47	
Miscellaneous	30.46	
	$2,385.93	
Rebate	56.22	$2,329.71
Balance—December 31st, 1962		$6,709.67

At the beginning of 1962 there were 749 Life Members. During the year we lost 41 members through deaths, which left our total as 708 at the end of the year.

C. Kirkland McLeod, *Chairman*
J. A. Freeland, *Secretary*

The President stated that reports of the other Committees, the Representatives, and the Branches were incorporated in the Annual Report for 1962 which was circulated to the membership in the April, 1963, issue of The Engineering Journal.

It was moved by Professor H. D. Lash, seconded by Mr. H. A. Mullins, and carried unanimously, that the Reports of the other Committees, the Representatives, and the Branches for 1962 be accepted.

Nominating Committee, 1963

The General Secretary drew attention to the list of Branch Representatives on the Nominating Committee attached to the Agenda of the meeting and stated that the Chairman of the Committee for 1963 is Mr. D. M. Jenkins of London, Ontario.

HONOURS, AWARDS AND MEDALS

The President reported that the Council of the Institute had unanimously voted that certain honours, awards and medals be bestowed by the Institute in 1962, as follows:—

SIR JOHN KENNEDY MEDAL
Dr. Albert R. Décary

JULIAN C. SMITH MEDALS
Hector Cimon
Dr. J. B. Stirling

HONORARY MEMBERS
Dr. C. M. Anson
Dr. E. V. Buchanan

FELLOWS
Edgar A. Cross
Dr. R. L. Dunsmore
J. M. Fleming
A. W. F. McQueen

LEONARD MEDAL
R. F. Coulter

PLUMMER MEDAL
Professor R. W. Missen

GZOWSKI MEDAL
Professor A. G. Davenport

ROSS MEDAL
C. H. R. Campling, J. A. Bennett, D. H. O'Hara — Co-Authors

ANGUS MEDAL
Wing Commander A. B. Howell

DUGGAN MEDAL AND PRIZE
No Award

SIR GEORGE NELSON AWARD
Gaston Galibois

MARTIN MURPHY PRIZE
No Award

ERNEST MARCEAU PRIZE
Michel Belanger

PHELPS JOHNSON PRIZE
Gaston Lambert

JOHN GALBRAITH PRIZE
S. W. P. Wyszkowski

H. N. RUTTAN PRIZE
No Award

THE GEORGE McKINSTRY DICK BRANCH ACHIEVEMENT AWARD

For Large Branches: Eastern Townships Branch
For Small Branches: No Award

REPORT ON ELECTION OF NEW OFFICERS

The President reported that a new President and the appropriate number of Vice-Presidents and Councillors were elected in accordance with the By-Laws, as follows:—

PRESIDENT—
T. C. Higginson, Saint John, New Brunswick

VICE-PRESIDENTS taking office in May, 1963
Region I: W. A. Smith, Calgary, Alta. (until 1965)
Region III: W. B. Ibbotson, Sudbury, Ont. (until 1965)
Region VI: C. E. Frost, Montreal, Que. (until 1965)

COUNCILLORS taking office in May, 1963*

Branches		
	Region I	
Central B.C.	P. Tassie	(until 1965)
Edmonton	B. A. Ellis	(until 1965)
Kootenay	R. F. Bailey	(until 1965)
Vancouver	R. H. Carswell	(until 1965)
	Region II	
Saskatchewan	K. Allcock	(until 1965)
	Region III	
Sudbury	R. P. Crawford	(until 1965)
	Region IV	
Border Cities	R. H. Darke	(until 1965)
London	D. J. Matthews	(until 1965)
Toronto	D. R. Abbey	(until 1966)
	Region V	
Belleville	W. L. Canniff	(until 1965)
Brockville	F. F. Walsh	(until 1965)
Chalk River	R. D. Page	(until 1965)
Kingston	W. B. Rice	(until 1965)
Nipissing & Upper Ottawa	A. B. Hayman	(until 1965)
Ottawa	A. B. Connelly	(until 1966)
Port Hope	J. L. Sylvester	(until 1965)
	Region VI	
Montreal	G. M. Boissonneault	(until 1966)
	S. W. Pappius	(until 1966)
	Region VII	
Eastern Townships	J. C. Davidson	(until 1965)
St. Marice Valley	W. A. Pangborn	(until 1965)
	Region VIII	
North Shore Lower St. Lawrence	R. W. Kirkland	(until 1965)
	Region IX	
Halifax	D. E. Rudolph	(until 1965)
Northern Nova Scotia	F. C. Morrison	(until 1965)
Saint John	P. W. Hastings	(until 1965)
	Region X	
Corner Brook	K. Bulins	(until 1965)
Newfoundland	G. A. Myers	(until 1965)
Prince Edward Island	D. I. D. Rozman	(until 1965)

*This does *not* include present Councillors who have been appointed for a further term.

Representatives

American Society of Mechanical Engineers: R. W. Sproule.

Association of Professional Engineers of Alberta: J. F. Langston.

Association of Professional Engineers of Manitoba: B. Chappell.

Corporation of Professional Engineers of Quebec: G. W. Joly.

Association of Professional Engineers of Nova Scotia: W. A. MacDonald.

Association of Professional Engineers of New Brunswick: J. J. Donahue.

The President introduced Mr. T. C. Higginson of Saint John, New Brunswick, the Institute's President for 1963-64.

Mr. Higginson expressed his appreciation of the honour invested by the members of the Institute in himself and the Vice-Presidents, Councillors and Committee members who would work with him. He believed he could speak for them all in saying that they were very much aware of the responsibility entrusted to them. In all deliberations the over-riding consideration would be the interest and welfare of the individual member.

OTHER BUSINESS

Mr. Martin made a statement concerning the questionnaire sent out to members in which they were requested to state the particular disciplines in which they were interested and to give other information which would assist the operations of the Committee on Technical Operations, the Publications Committee, the Finance Committee and Headquarters. He was happy to report that over 66% of the membership have now replied. He appealed to any members who had not returned completed questionnaires to do so forthwith.

CONFEDERATION

The President reported as follows:—

Work in connection with the proposal set forth in the Final Report of the Engineers Confederation Commission has demanded a great amount of time on the part of many members. Following a meeting on June 9, 1962, between representatives of the Canadian Council of Professional Engineers (CCPE) and of the Institute, when it became apparent that no compromise on differences of viewpoint could be achieved, both groups

agreed to recommend to their Councils that a ballot on the issue be taken, the EIC representatives doing so on the understanding that the Councils of the eleven constituent Associations and Corporation of CCPE each balloted their members on an identical question and at the same time as the EIC. Council of EIC accepted this recommendation at its meeting of June 10.

This same meeting of Council authorized a Special Committee be constituted to draft a recommendation which Council, if it accepted it, would send out with the ballot to EIC members. It also authorized this Committee to secure a legal opinion on the proposal from the Institute's legal counsel, which should also accompany the ballot.

This was done and the results laid before Council on December 14, 1962. Council approved the documents in general, except for editorial changes and some rearrangement of material. It authorized the Executive Committee to send out revised documents to members of Council for final comments when the Executive Committee was satisfied the instruction of Council of December 14 had been effected. Members of Council were allowed three weeks from date of mailing in which to submit their comments, after which the Special Committee would collate these comments before preparing the final form of these documents.

Meantime, late in 1962, CCPE advised that all eleven Associations and the Corporation would proceed to ballot their members on the above understanding.

On March 2, 1963, the CCPE President, Vice-President and Executive Secretary met with the EIC President, one Vice-President and the General Secretary to review outstanding matters. After careful consideration and extended discussion, agreement was reached on:—

(a) The basic question for the ballot.
(b) A subsidiary question which one or more Associations must ask, because of their Bye-Laws, relative to the fee increase involved in an affirmative answer to (a).
(c) The estimated date at which the ballot might be sent out. This was placed at May 31, 1963, give or take a few days.

On April 19, the Executive Committee approved the documents and set up the necessary Committee to be responsible for the conduct and counting of the ballot to be mailed May 31, 1963.

Mr. E. A. Cross said that during his term as a Vice-President of the Institute he found that only a small percentage of the membership appeared to have read the Report of the Confederation Commission. He urged all members to study this Report before completing the ballot.

VOTE OF THANKS

On behalf of the members Dr. B. G. Ballard said that during recent years there has been an expansion of the technical operations which has necessitated changes in the operation of the Institute, changes which make it possible to bring to members a better technical program and which make its publications more effective.

During the past few months, and even years, it has been necessary to adjust the technical program to meet the changing needs of members, and to expand into fields not previously covered. To bring new material to the members there was a change in publications policy. The growing number of members and their wide geographical distribution necessitated a change in organization. All these things have demanded the attention of the President, the Council and staff of the Institute, to whom he paid tribute.

He moved a hearty vote of thanks to the President for the manner in which he met this challenge, to the Vice-Presidents likewise, and to the Headquarters staff who carried out their duties so capably under difficult circumstances.

Mr. Lawton expressed his thanks on behalf of all those included and added his appreciation of Dr. Ballard's own co-operation.

The motion was seconded by Dr. John Green and carried unanimously.

NEW VICE-PRESIDENTS

The General Secretary asked Mr. W. A. Smith of Calgary, Mr. W. B. Ibbotson of Sudbury, and Mr. C. E. Frost of Montreal, to rise and be recognized.

MOTION OF ADJOURNMENT

It was moved by Mr. J. J. Rowan, seconded by Dr. G. McK. Dick, and carried that the Seventy-Seventh Annual General Meeting of The Engineering Institute of Canada be adjourned.

The meeting adjourned at 11:15 a.m.

F. L. LAWTON, M.E.I.C.
President

GARNET T. PAGE, M.E.I.C.
General Secretary

PLAN TO ATTEND

78th Annual Meeting

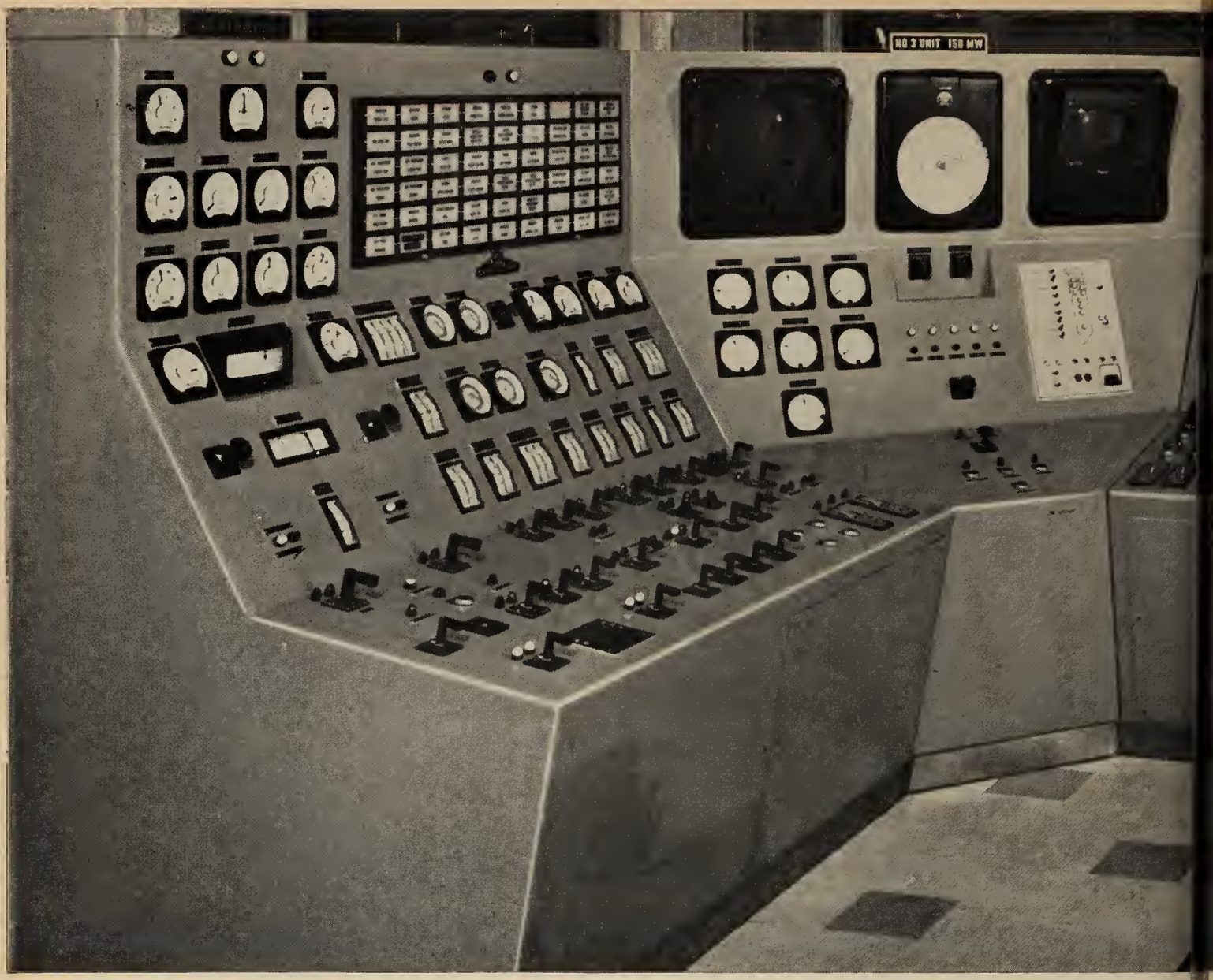
of the

ENGINEERING INSTITUTE OF CANADA

BANFF SPRINGS, BANFF, ALTA.

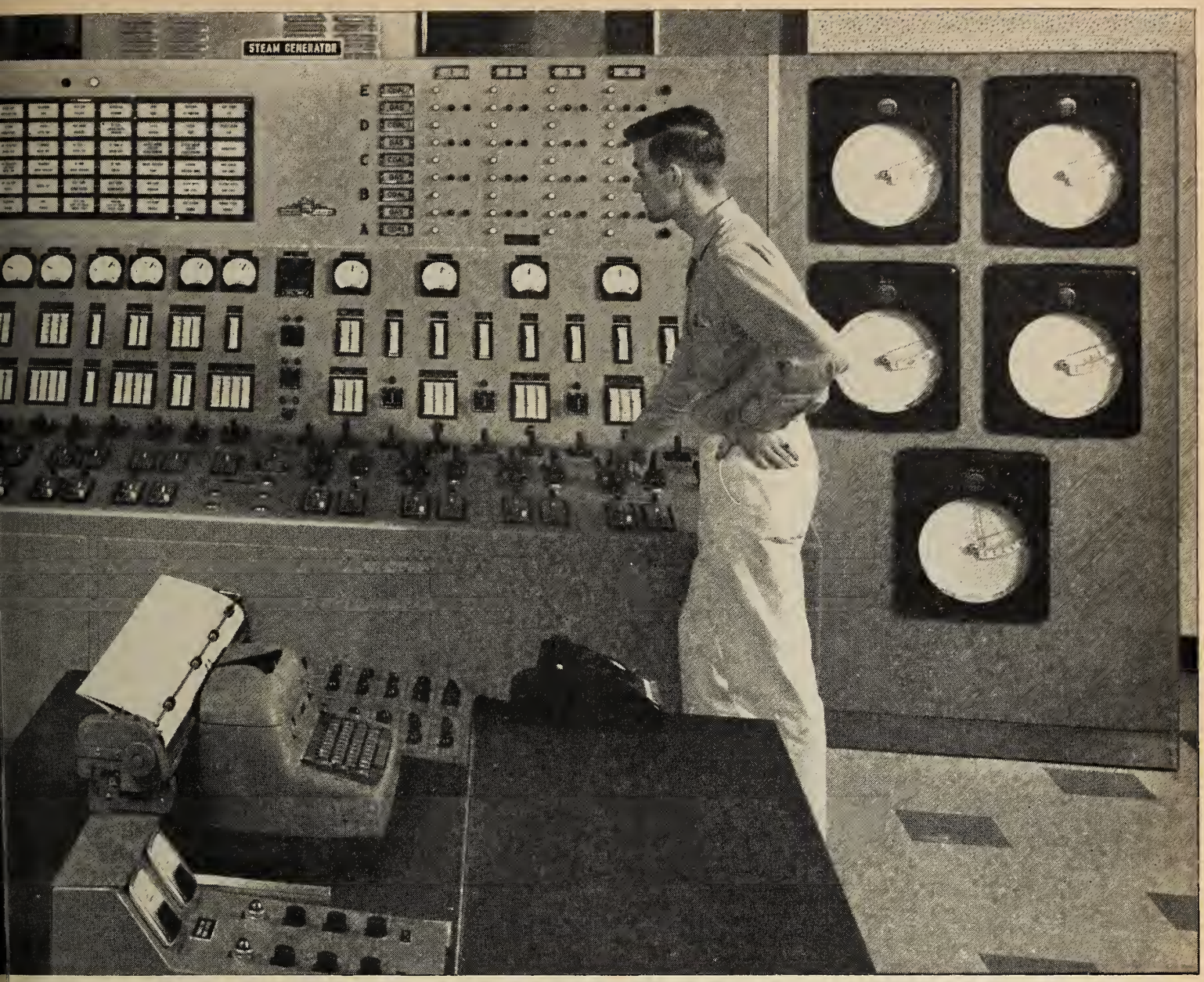
MAY 27-29

1964



Bailey 720 Electronic Controls at Calgary Power Ltd., Wabamun

First solid-state electronic boiler control operating in a Canadian utility



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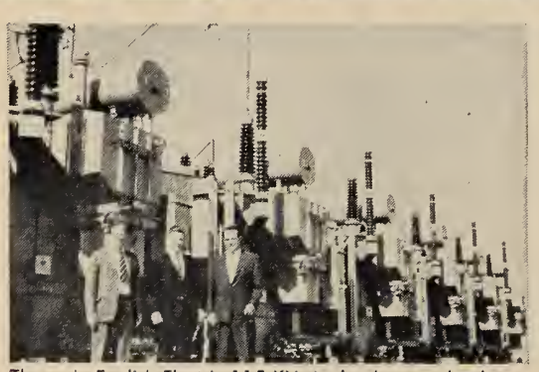

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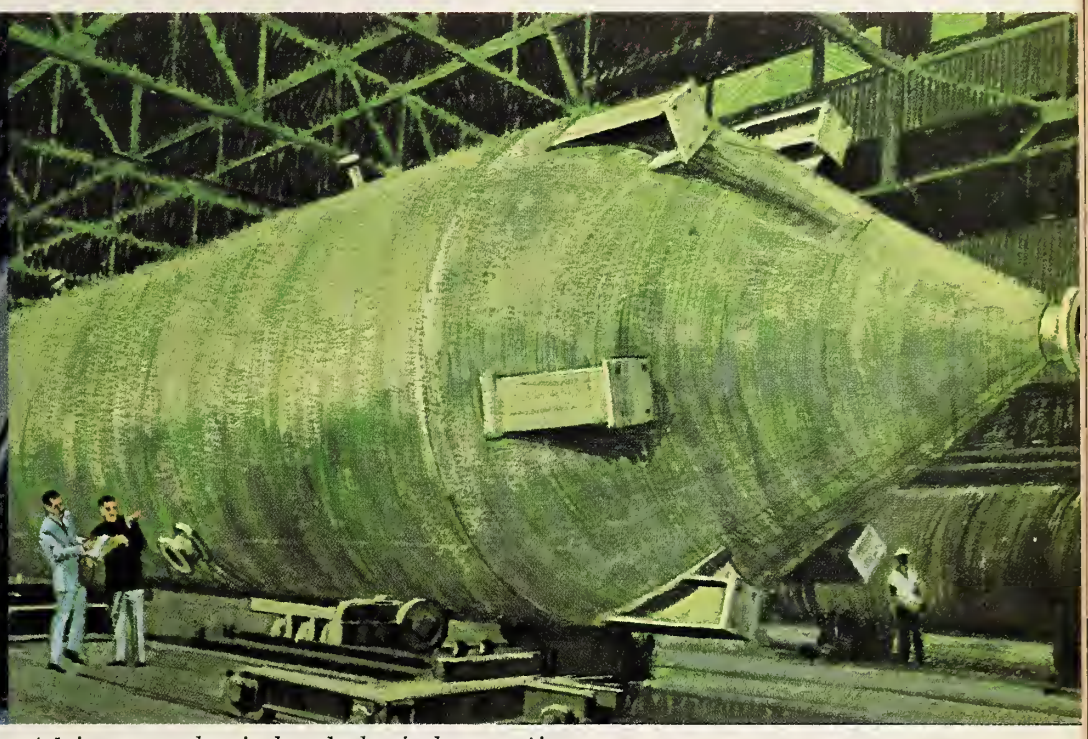

Advice on mechanical and physical properties

Foundry practice

An as-welded 9% nickel steel tank for liquefied gases is pressurized with liquid nitrogen at -320°F to discover its resistance to internal pressure. The tank burst at 2300 psi, after it had withstood loads approaching 6 times the allowable room-temperature design stress. This series of cryogenic tests resulted in as-welded 9% nickel steel being accepted by ASME; code case 1308 (Special Ruling).

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THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED

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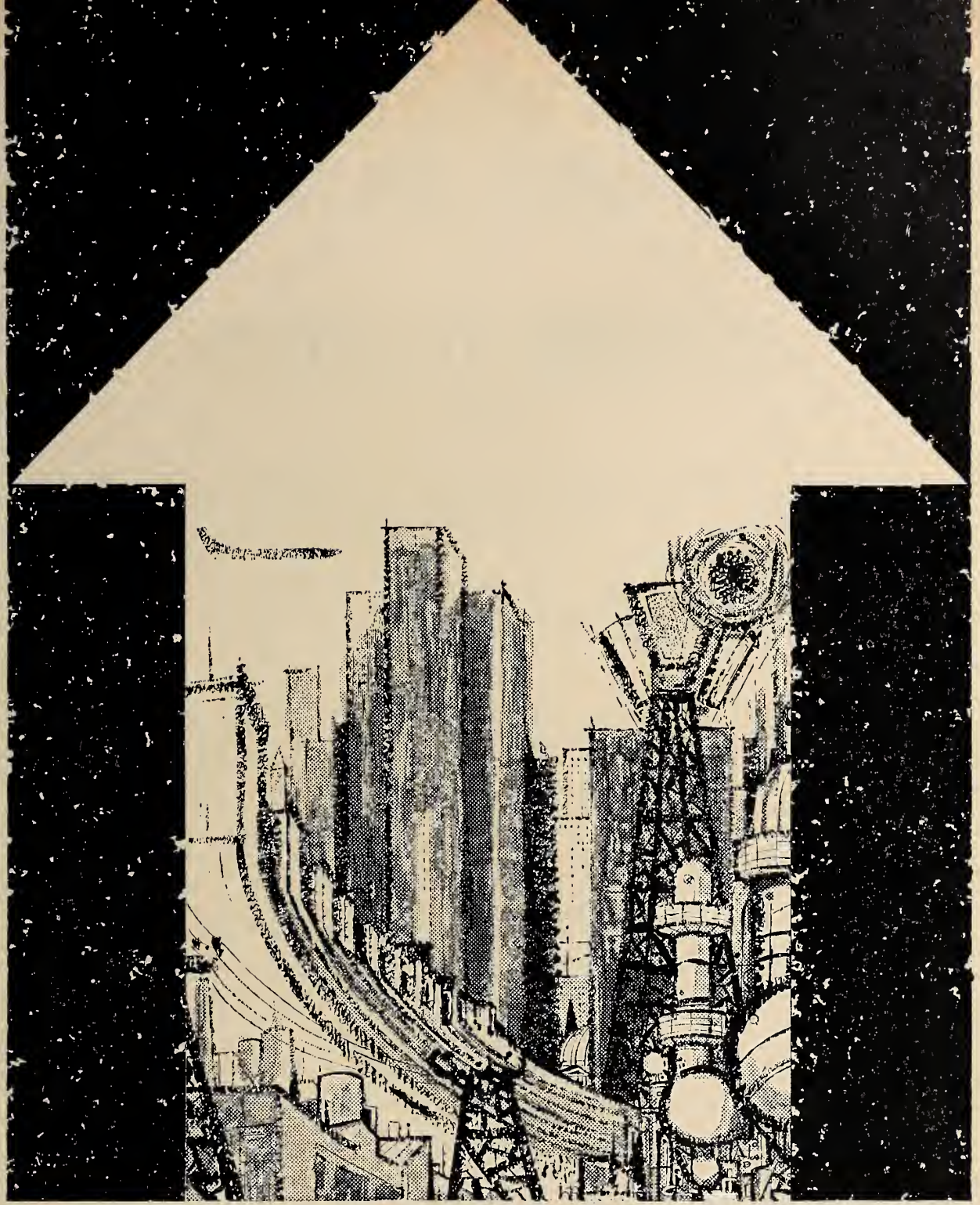
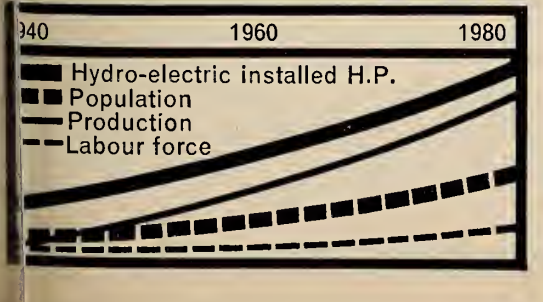


GROWING OUR WAY

uébec is on the move, upward. Growth rate of this ynamic province is steadily increasing in all the portant indices, and the surface is barely scratched. ou can share in this aggressive growth pattern by cating your new plant in Québec's surging free terprise climate. Natural resources are rich and undant. Developed facilities are numerous and accessible. Installed, low-cost hydro-electric power will reach almost 20,000,000 H.P. in two years; the labour force will exceed 3,000,000 by 1980, with excellent technical training facilities. Québec is at the hub of the world's trading lanes by sea and air. Government is stable, and future development plans are well and soundly charted. There's a place for you in the picture.



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PAPERS FOR 1964 ANNUAL GENERAL MEETING
BANFF, ALBERTA, MAY 27-28-29

●

INVITATION TO AUTHORS

●

Members are invited to submit engineering papers to be included in the technical program. Papers will be gladly accepted in English or French. The first step should be submission of the Title and a brief description of the paper to the appropriate Division Chairman.

FOLLOWING ARE THE NAMES AND ADDRESSES OF THE CHAIRMEN OF THE 15 DIVISIONS OF THE COMMITTEE ON TECHNICAL OPERATIONS:—

BRIDGE & STRUCTURAL
Professor B. A. Hesketh, M.E.I.C.,
Ecole Polytechnique,
2500 Marie-Guyard Avenue,
Montreal 26, Quebec.

***CHEMICAL ENGINEERING**
To be appointed.

CIVIL ENGINEERING
Dean Michel Normandin, M.E.I.C.,
Department of Engineering,
University of Sherbrooke,
Sherbrooke, Quebec.

***COMMUNICATIONS, ELECTRONICS & AUTOMATION**
To be appointed.

ELECTRICAL ENGINEERING
Mr. J. A. Girdwood, M.E.I.C.,
Chief Engineer,
Wagner Leland Division,
Sangamo Company, Limited,
Guelph, Ontario.

ENGINEERING EDUCATION
Mr. J. Hoogstraten, M.E.I.C.,
Vice-President of Development,
University of Manitoba,
Winnipeg, Manitoba.

GEOTECHNICAL ENGINEERING
Mr. G. C. McRostie, M.E.I.C.,
Consulting Engineer,
393 Bell Street,
Ottawa 4, Ontario.

HYDRO-ELECTRICAL
Mr. L. M. Hovey, M.E.I.C.,
Consulting Engineer,
Manitoba Hydro Electric Board,
P.O. Box 815,
Winnipeg, Manitoba.

***MANAGEMENT ENGINEERING**
To be appointed.

MECHANICAL ENGINEERING
Mr. S. W. Pappius, M.E.I.C.,
Manager, Platework Division,
Dominion Bridge Company, Ltd.,
P.O. Box 280,
Montreal, Quebec.

MINING & METALLURGICAL
Dr. R. P. Charbonnier, M.E.I.C.,
Senior Scientific Officer,
Department of Mines and Technical Surveys,
Fuels & Mining Practice Division,
562 Booth Street,
Ottawa, Ontario.

OIL & NATURAL GAS
Mr. A. F. D. Short, M.E.I.C.,
Engineering & Economics Department,
Royalite Oil Company, Limited,
Royalite Building,
Calgary, Alberta.

RESEARCH
Dean D. M. Myers, M.E.I.C.,
Faculty of Applied Science,
University of British Columbia,
Vancouver, B.C.

THERMAL POWER
Mr. D. L. Harris, M.E.I.C.,
Chief Engineer,
Mechanical Services and Thermal Division,
Shawinigan Engineering Co. Ltd.,
620 Dorchester Blvd., West,
Montreal 2, Quebec.

WELDING
Mr. R. M. Gooderham, M.E.I.C.,
Director,
Canadian Welding Bureau,
1393 Yonge Street,
Toronto, Ontario.

After tentative acceptance of a paper, the Author will be required to prepare an abstract of about 200 words by November 1st, and complete manuscript by January 31st.
Engineers are urged to consider the importance of contributing to the technical program of the Institute, not only at Annual General Meetings, but also at Divisional, Regional and Branch Conferences.

HEADQUARTERS WILL BE GLAD TO RENDER WHATEVER ASSISTANCE IS NEEDED. PLEASE CORRESPOND DIRECTLY WITH MR. C. G. KINGSMILL, MANAGER OF TECHNICAL SERVICES

***Please contact Manager of Technical Services until a Chairman has been appointed.**

turning point

where profits are made—or lost!

Metal turning can be tricky. Composition, temper, machinability rating, mechanical and physical properties must all be considered when turning out a better product—at a profit.

When you have any question about matching the alloy to the job, perhaps Anaconda can give you the answer.

Anaconda makes rod in many alloys for almost unlimited applications. Anaconda's Technical Department will help you select one for a single property or a combination of properties to provide a top quality product at lower cost.

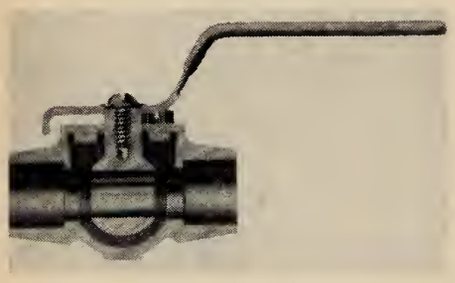
Write for Publication B-3, "Machining Copper and Copper Alloys" or Publication B-14, "Anaconda Rods for Screw Machine Products" to Anaconda American Brass Limited, New Toronto (Toronto 14), Ontario. Sales Offices—Quebec City, Montreal, Winnipeg, Calgary, Vancouver.

C-6322

ANACONDA

Engineering Briefs

ABART ENGINEERING LIMITED, Toronto, Canadian distributors for the Johnson-March Corporation's Triangle Division has announced the availability of the Triangle Infra Red oven. This custom designed oven can be built for use with infra red bulbs, infra red quartz tubes or infra red strip heaters. The ovens may be portable or permanent, conveyorized or batch type. They require no heat up period. Portions of the oven can be turned off for shorter parts or slower conveyor speeds. Panels and channels are available for 2 to 12 lamps, in 6, 8 and 12-inch centers, and wired for 110V, 220V or 440V. The ovens can reduce moisture content from 100% to zero or any desired content. They will dry paper, cloth, plastics, ceramics or motors; will toast wheat germ, keep food warm; will skin dry moulds, or preheat a casting for welding.



Gem Ball Valve

CRANE CANADA LIMITED'S Industrial Products Group has announced the new "GEM" Ball Valve adaptable to a wide variety of installations on both hot and cold water lines. GEM Ball Valves, available in ½-inch and ¾-inch sizes, feature a one-piece chrome-plated ball and stem encased in Buna-N rubber. The self-cleaning tight seal requires little servicing.

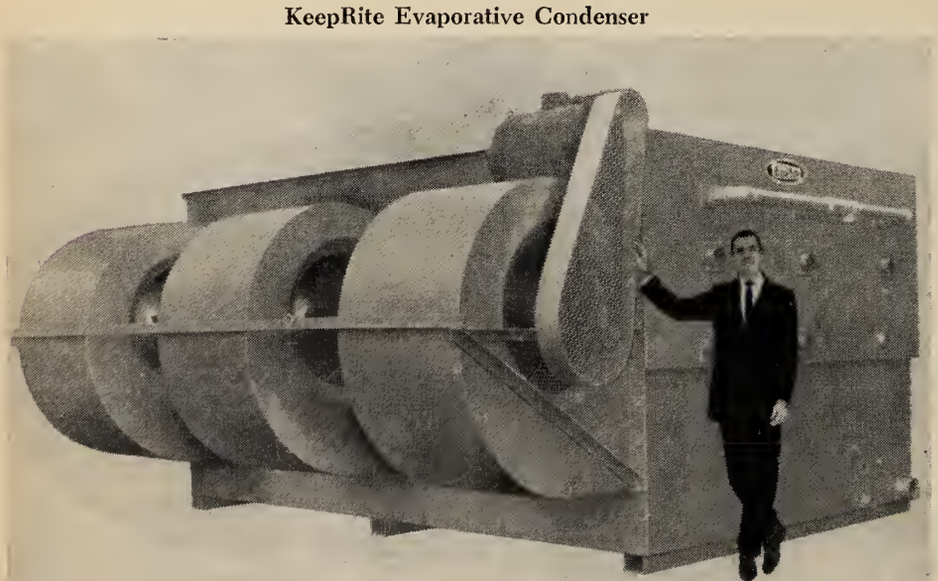
CANADIAN WESTINGHOUSE CO. LTD. has announced the availability of the DS-3 totally-enclosed dry type transformers, designed specifically for heavy industrial use. Typical applications include take-off of lighting loads from power circuits and stepping-down of voltages for ventilating fans, portable tools, pumps and compressors, machine tools, electric furnaces and rectifiers. These transformers may also be used for stepping-up a low voltage for special applications Class H. silicone insulation which allows a 150 degrees C. temperature rise is incorporated to obtain a combination of high overload capacity, long service life and compact assembly.

THE MODEL U-1 ANTENNA COUPLER, designed and manufactured by Sinclair Radio Laboratories is a three cavity, highly selective, tunable passive filter conforming to the basic military requirements. When used in conjunction with a receiver, it improves the front end selectivity and provides up to 60 db isolation at frequency separations of ± 1%. The U-1 coupler is designed to be used separately in a single channel system or as one channel in a multicoupler. A special variable coupling device incorporated in the output cavity permits several channels to be connected to the same antenna with no matching problems.

Engineering Briefs

Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.

KeepRite Evaporative Condenser



ALPHA FAN DIVISION of Joy Manufacturing Company (Canada) Ltd., has announced the availability of the new Axial Flow propeller fan for use in industrial, commercial and institutional ventilating applications. The rotor is a four bladed clover-leaf type designed for maximum efficiency at medium static pressures.

Axial-Flow Fan.

THE INTERNATIONAL NICKEL COMPANY of Canada has announced three new booklets available by writing to the company at 55 Yonge Street, Toronto. The first of these booklets, "Welding Materials" contains a listing of materials produced by the Huntington Alloy Products Division of the company for the welding of nickel alloys, cast irons and many combinations of dissimilar metals and alloys. The second, a 16-page fully illustrated booklet gives detailed information on the applications of decorative nickel plated coatings. A 31-page brochure, "Nickel Containing Materials in the Railroad Industry," presents a comprehensive examination of the wide use of nickel alloy steels and other nickel alloys in the construction of railway equipment.

ONE OF THE LARGEST industrial-type evaporative condensers ever built in Canada is available from KeepRite Products Limited, Brantford, Ont. This 250 ton capacity unit, one of a completely new line of condensers offered by this company, has over two miles of prime surface tubing in the condenser coil. Other features include the 8-gauge galvanized steel casings, all-welded construction, easy accessibility to all components through access doors and a choice of centrifugal or propeller fans. The KeepRite evaporative condensers range in size from 100 to 250 tons capacity.

(Continued on page 72)

EL-:

. . . nothing can take it like NEOPRENE hose

NEOPRENE–ANOTHER RELIABLE ELASTOMER

DU PONT CANADA

Pont of Canada Limited, Room AEJ-941, P.O. Box 660, Montreal 3, P.Q.

(Continued from page 50)

Pictures Wanted for History of Canadian Trucks

The Automotive Transport Association of Ontario plans to publish, during Canada's Centennial Year, a pictorial history of the development of truck use.

Relatively little now is available concerning the early history and use of trucks in Canada, and the Association is anxious to secure photos of early trucks and tractor-trailer equipment operated in this country.

Pictures loaned to the Association which are considered suitable for the historical record, will be copied and returned together with an extra print. Truck owners and allied trades are being asked to help develop the collection of "old timers".

Copies of old advertising (prior to 1926), whether for local or highway services, are also required urgently. Material in the form of stories, articles or press releases on the early days of truck use will also be welcome.

The Association guarantees the return, in good order, of all material loaned to it.

Persons or organizations having such material, or knowing of its whereabouts, are asked to contact: J. O. Goodman, General Manager, The Automotive Transport Association of Ontario, 439 Queen's Quay W., Toronto 2-B.

SPUN ROCK

BLANKETS
and
PIPE INSULATION
for Canadian industry

Has all the features expected of a good thermal insulation, plus these

IMPORTANT EXTRAS:

- **Long, resilient, stable fibres; no binder**
- **Non-corrosive to any metal**
- **Withstands continued vibration**
- **Maximum thermal efficiency at temperatures as high as 1200° F.**
- **Made from rock, by electric furnace process.**
- **Conforms to Commercial Standards CS-117-49**

Technical information and samples available.

SPUN ROCK WOOLS LIMITED

SPUN ROCK WOOL · HEAT COLD SOUND · INSULATION

Thorold Ontario

0001

Courses in Materials Handling in Montreal

Evening courses in materials handling are being offered this fall by the extension department of McGill University and l'Ecole Polytechnique de Universite de Montreal. The courses, which will consist of 15 two-hour lectures, are sponsored by the Montreal Chapter of the American Material Handling Society.

At McGill three courses—Material Handling—General, Material Handling in Manufacturing, and Material Handling—Warehousing—start Oct. 7. Material Handling-Analytical Techniques starts Oct. 10.

At l'Ecole Polytechnique the course in Manutention des Materiaux—Principes et Techniques starts Oct. 17 while the course in Entreposage starts Nov. 11. All six courses will be held between 8:00 p.m. and 10:00 p.m.

All the courses are practically oriented and are open also to non-members of the Society. While no university credits are given, certificates will be awarded. The cost for the courses is $35 at McGill and $30 at l'Ecole Polytechnique.

Those wishing further information may contact Roy Fontaine at 877-5423 Montreal or in care of the Society, P.O. Box 50, Valois, Que.

Waterloo Program to Include Post-Grads

Beginning this fall and winter the University of Waterloo will extend its co-operative engineering program to include post-graduate courses for engineers now in industry. The co-operative study plan will enable engineers to attend university classes on a part-time basis for either higher degree or for updating courses.

In Waterloo's co-operative engineering program students spend alternate four-month semesters at university for academic studies and in industry for practical experience. The university operates 12 months a year with one group of students on campus while another group is working in industry. More than 300 Canadian companies now participate in the program by employing and providing supervised training for Waterloo's 1,000 engineering students.

The present program of alternate semesters will be modified for graduate students to minimize disruptions to home life and employment. Two basic schedules, full time and part time, will be available.

A full-time student will spend four days a week during each four-month semester while half-time students will attend classes two days a week.

Engineers' Ball At Niagara Falls

The Tenth Annual Professional Engineers' Ball will be held this year at the Sheraton Brock Hotel in Niagara Falls on Friday, October 18.

The Ball is sponsored by the Niagara Chapter EIC-APEO. Mart Kenney and his orchestra will provide the dance music, and there will be intermission entertainment.

The program will begin with cocktails at 6:00 p.m. followed by a buffet dinner at 7:00 p.m. and dancing at 9:00 p.m. Tickets will be $12 per couple.

France Exhibit During October

Canadian engineers and technical men will have an opportunity to see and study the latest achievements of French engineering at the "France in Canada" Exhibition at Montreal's Show Mart, October 11 to 27.

The engineering and technical section of the exhibition, largest ever organized outside France, will include exhibits of the latest French developments in such fields as electricity and electronics, scientific and medical research, aeronautical and space industries, atomic energy, steel industry, transportation and city planning.

The industrial displays, organized by the French Government, will form a major part of the exhibition which is designed to interest Canadian professional and industrial groups and organizations in French engineering and technical services.

Mechanical industries will be represented by a wide range of equipment and machine tools, from woodworking and textile machinery to compressors, pumps and presses. Public works equipment, hoisting and handling machinery will be shown as well as agricultural equipment. Also exhibited in the mechanical engineering section will be optical and precision instruments.

A total of 8,000 square feet will be taken up by electric and electronics equipment and components, of which the highlight will be a giant 735,000-volt circuit breaker. Chemicals will be represented by a collective display put on by the Union of Chemical and Pharmaceutical Industries, in which the latest petrochemical techniques will be stressed. An entire section will be reserved for water purification and treatment.

Exhibition organizers envisage the show not only as a means of increasing the export of French equipment, capital and know-how to Canada, but also as a way of establishing contacts with Canadian industrialists and engineers in view of arranging for the manufacture of French products under licence in Canada. To this end, some 50 technical conferences and meetings will be held, some in Montreal, some in Toronto, to which thousands of Canadian engineers are being invited.

come and tour technological france—in montreal!

visit the french exhibition in montreal show mart, oct. 11-27

Engineering . . . science . . . industry . . . commerce—these are the keynotes of "The France of Today", largest French exhibition ever held in Montreal. Here, in a setting happily rounded out by displays of France's latest consumer goods, you'll see the stimulating new developments that have made French technology famous around the world. Come and "study in France"—there's no ocean to cross!

- Electricity & Electronics
- Scientific & Medical Research
- Aeronautical & Space Industries
- Atomic Energy
- Mechanics
- Steel Industry
- Transportation
- City Planning

Plus many sections of special interest to ladies: fashions, jewellery, gourmet foods, Paris café, etc.

Technical Lectures & Tours
Every morning except Sunday, from 9 to 12.30, special lectures and guided tours will take place. These are reserved for authorized persons holding a special invitation. (See coupon.)

Please detach and mail this coupon

French Trade Commissioner in Montreal,
2060 Mackay Street, Montreal, Que.

I wish to be invited to the technical lectures and tours, on the subject(s) marked hereafter by a cross.

☐ Mechanical Construction ☐ Chemical Industry ☐ Research
☐ Electrical and Electronic Construction ☐ Steel Industry ☐ Scientific Research
☐ Atomic Energy ☐ Aeronautical Construction ☐ Construction and Buildings
☐ Public Works ☐ Transport

NAME_____

POSITION_____

COMPANY'S NAME AND ADDRESS_____

Engineering Briefs

(Continued from page 68)

ELECTRONIC WATCHMEN LIMITED has designed and manufactured a new A/C standard control panel which contains all the basic elements of a central station air conditioning system in a complete pre-wired package, in system capacities up to 60 hp. The air control centres eliminate field installation of disconnect switches, or magnetic starters. The panels contain an electronic anti-short cycle device.

THE POLYKEN PROBE TACK TESTER available from Testing Machines International of Canada Ltd., measures the degree of tackiness of pressure sensitive adhesives, printing inks, paints and elastomers. It provides a means of bringing the flat surface of a probe into contact with the test sample at controlled speeds and controlled dead weight contact pressures. The contact dwell time can be selected and controlled. The subsequent breaking of the adhesive bond thus formed is also done at a controlled speed. The maximum force recorded when the probe loses contact with the test sample is taken as the measure of tackiness. The entire test is programmed to operate automatically.

THE AIR BRAKE DIVISION of Canadian Westinghouse has announced the availability of "Super Spool" pneumatic directional control valves for a wide range of industrial applications. Spools are made of a lightweight aluminum, hollowed for minimum inertia for high speed operation and designed to provide full air flow with a minimum of travel. Sealing surfaces are hard-anodized, polished and buffed to an 8 micro-inch finish. All standard operator, model, spool and size combinations are available for 2, 3, and 4-way operation to J.I.C. and A.S.A. standards.

CANADIAN GENERAL ELECTRIC COMPANY has announced a new semiconductor device called an integrated reference amplifier which performs the same circuit functions as a separate transistor and zener diode. A new method of defining temperature coefficient has been developed in conjunction with the integrated reference amplifiers. Temperature co-efficients as low as + or − 0.001%C, over the entire temperature range are possible. Ten models of the new silicon integrated reference amplifiers are available.

RAYTHEON CANADA LTD. has announced a sharp-cutoff, heater-cathode subminiature pentode. The CK5636 is a dual-control tube for use as a converter, modulator, phantastron or gating service. It can also be used as a general purpose amplifier or mixer.

CANADIAN INGERSOLL-RAND Co. Limited's new VP/VPA pumps designed for low to medium capacities at pressures up to 750 p.s.i.g. and temperatures from minus 400 degrees to plus 750 degrees F. are particularly adaptable to refinery and process services, as well as boiler-feed and heater drain services. VP pumps are built in 1, 1½, 3, 4 and 6 inch sizes. VPA pumps are built in 1½, 3, 4 and 6 inch sizes. Diffusor construction provides complete radial balance, and a balancing sleeve reduces axial thrust to a minimum.

CANADIAN GENERAL ELECTRIC has announced the Horizon Line panel meters designed to harmonize with modern panels and control boards. The new line includes 2½-inch, 3½-inch and 4½-inch models. The line includes ac iron-vane models, dc D-Arsonval models and ac rectifier models. DC meters can be furnished with either pivot-and-jewel or taut-band mechanisms. All dc mechanisms are completely self-shielded, core-magnet types.

STEEL AND TIMBER STRUCTURES LIMITED has announced the manufacture of one of the largest glue-laminated timber arches ever produced in Canada. The "Tudor' arches, when erected will form the 50-foot high conical vault of St. Odile Church in Quebec City. Each arch weighs 12,000 lb. and provides a free span of 107 ft.

INDUSTRIE CHIMIQUE
ÉNERGIE NUCLÉAIRE
COMPRESSEURS ET POMPES A MEMBRANE

CHEMICAL INDUSTRY
ATOMIC ENERGY
DIAPHRAGM COMPRESSORS AND PUMPS

CORBLIN

78, 80 Boulevard Saint-Marcel — PARIS 5e

pour tous gaz purs
PRESSION JUSQU'A 2000 atm.
Modèles en acier inoxydable, monel, titane . . . pour gaz corrosifs
A TÊTE INDÉPENDANTE
pour fluides dangereux ou radioactifs

for all pure gases
PRESSURES UP TO 30000 psi.
Models in stainless steel, monel metal titanium . . . for corrosive gases
WITH REMOTE HEAD
for hazardous and radioactive fluids

SOLE AGENTS IN NORTH AMERICA:
AMERICAN INSTRUMENT COMPANY, INC.
8030-8050, GEORGIA AVENUE
SILVER SPRING, MD. USA
TELEPHONE: JUNIPER 9-1727

RUSTON & HORNSBY LIMITED, Toronto have announced the availability of the new Vee formation ATC diesel engine. This British designed engine has a British Standard rating of 200 psi b.m.e.p., and incorporates several special features including a very rigid crankcase design which provides exceptional dimensional stability for the main bearings and, a cylinder block casting of great torsional and bending stiffness in which flat surfaces have been avoided so as to enable the cooling system to be operated under pressure. By a patented arrangement for transferring cooling water from the cylinder block to a cylinder head, the entire upper portion of the liner is effectively cooled. In the region of the combustion chamber, the scrubbing velocity of the cooling water over the liner has been increased so as to give higher rates of heat transfer where these are most necessary. The engines have been designed to run on residual fuels, the b.m.e.p. being adjusted to suit the characteristics of the fuel involved.

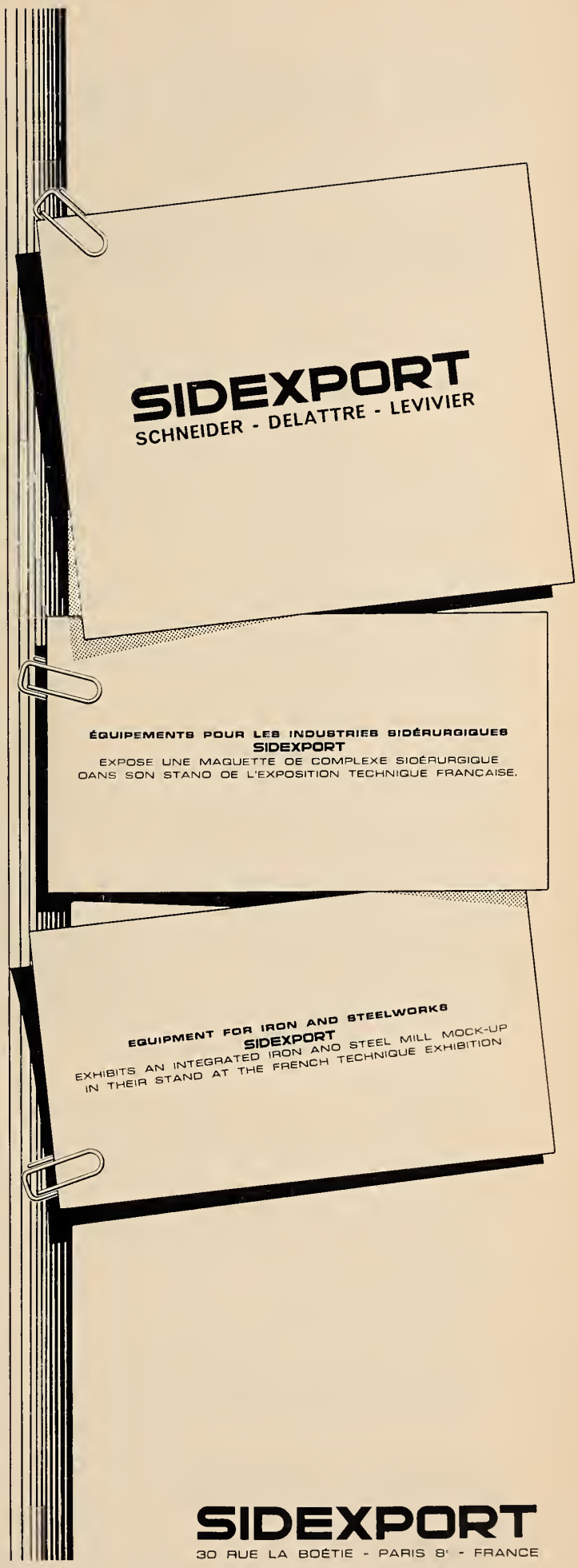
A MICROMETER for measuring internal diameters of a bore without removing the boring bar is available from Hildon Corporation, Toronto. The bow of the frame is clear of the specified bar diameter within the capacity stated. Sizes are available to cover bar diameters from 3 to 12 inches.

AN OPEN COIL TYPE plastic dry reed relay has been announced by the Lind Electric Division of Industrial Timer Corporation, and their agents, Sperry Gyroscope Ottawa Ltd. The relay, series FR, was especially designed for use in computer and data handling applications or in any case where high speed switching is required. The new series, operated in a maximum of three milliseconds, including bounce, has a life span of 100 x 10^6 operations at rated load 1 x 10^{12} under dry circuit conditions. Maximum current for this series is 0.5 amps with a maximum voltage of 110 volts.

A FLOATING DISC TRAP, designed for operating conditions where there is a wide variation between start-up and operating load, or in the operating load; or where a trap must be operational over a wide range of pressures from 10 psi to 600 psi—750 degrees F. is available from Clark Manufacturing Company's Canadian representative, the Masdom Corporation Ltd., Toronto. The Clark Floating Disc Trap features trouble-free operation, easy installation, and maintenance. It has a replaceable seat and disc which triple trap life. It is offered in a choice of long-lasting stainless steel or carbon steel body.

THE RPS-1200, featuring direct drive "air-screw" compression unit, is a new portable air compressor from Joy Manufacturing Company. It delivers 1200 cfm at 100 psi. Designed for jobs where there are big air requirements, the RPS-1200 consists of two matched, helically grooved rotors. The direct drive feature eliminates several maintenance-causing movable parts, such as timing and speed reducing gears, gear bearings, an auxiliary oil pump and oiler pins. The RPS-1200 is designed to run at the same speed as the engine, 1750 rpm at rated speed. The unit, which is 13 ft. 6 in. long, 7 ft. 4 in. wide and 8 ft. 2 in. high, also features dry-type air cleaners, a thermal by-pass oil system and side location of receiver and fuel tank.

(Continued on page 107)



THE FRENCH ELECTRICAL AND ELECTRONIC ENGINEERING INDUSTRIES

proudly invite you to visit their exhibit at the French Exhibition in Montreal. Areas represented will include: Production, Transportation, Transformation, Distribution and the industrial utilization of electrical energy.

Displays will reflect the experience gained by the French electrical industries in many international contracts fufilled during recent years; e.g., the equipping, outside France, of 60 hydro-electric and thermal powerhouses, numerous distribution and interconnection stations and many plants; the construction (in France or under French license) of 2,000 electric or diesel-electric locomotives which are now in use in many parts of the world.

A Few Records of Special Interest

- 600,000 kw turbo-alternators operating on a single shaft line.
- A 188,600 kva hydraulic group.
- A 735,000 Volt, 40,000 MVA circuit-breaker.
- Two stock electric locomotives with a speed of 206 m.p.h. — world record.

PROGRAMME OF TECHNICAL PAPERS TO BE PRESENTED

I. In the Hydro Quebec Amphitheatre, 75 Dorchester Blvd., West.

Wed. Oct. 16, 3.45 PM
ON THE VARIOUS DESIGN APPROACHES USED FOR HIGH-VOLTAGE CIRCUIT-BREAKERS
by M. Francois Kirchner, Technical Director, Ateliers de Constructions Electriques de DELLE.

Thurs. Oct. 17, 3.45 PM
THE PROTECTION OF HIGH-VOLTAGE POWER TRANSMISSION GRIDS
by M. Rene Langlade, General Manager, Compagnie des COMPTEURS.

Fri. Oct. 18, 2.30 PM
DESCRIPTION OF A FULLY TRANSISTORIZED TELEMETERING SYSTEM WITH 5, 10, 15 OR 20 TERMS
by Colonel Jean Rene Bergeron, Engineer, Asst. Mgr. of the Societe des Tele-communications, Radioelectriques et Telephoniques.

4:00 PM
MEASUREMENT, MONITORING, CONTROL AND AUTOMATION IN THE GENERATION, TRANSMISSION, DISTRIBUTION OF ELECTRIC POWER
by M. Rene Langlade, General Manager, Compagnie des COMPTEURS.

Tues Oct. 22, 3.45 PM
HIGH-POWER TRANSFORMERS
by M. Bernard Hochart, Engineer, Department Chief "Transformer Research", Societe ALSTHOM.

Wed. Oct 23, 3.45 PM
VERY HIGH-POWER TURBO-ALTERNATOR SETS
by M. Andre Guyet, Engineer, Compagnie ELECTRO MECANIQUE.

II. In the Conference Rooms of the Exhibition, Show Mart, 1650 Berri St.

Wed. Oct. 16, 9.30 AM
MODERN RADIO LINKS
by M. Savely Schirmann, Engineer, Dept. of Telecommunication, Compagnie Generale de Telegraphie Sans Fil.

11.00 AM, Main Room
MODERN TECHNIQUES IN THE FIELD OF RADIO LINK "TRANS-HORIZON" AND "SINGLE-SIDE BAND" RADIO-COMMUNICATIONS
by M. Maurice Olivier, Director, Dept. of Communication, Compagnie Francaise THOMSON HOUSTON.

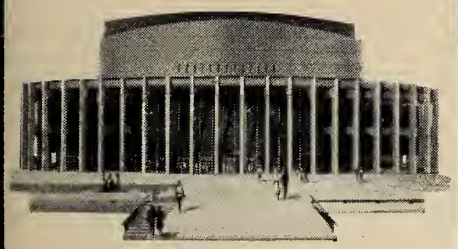
Thurs. Oct. 17, 10.30 AM
STORAGE TUBE TYPE BIXED ECHO SUPPRESSORS
By M. Robert Cogne, Engineer, V.P. and Gen. Mgr. of INTEC (U.S. branch of Compagnie Generale de Telegraphie Sans Fil).

Fri. Oct. 18, 9.30 AM, Room No. 2
PUBLIC TELEVISION AND INDUSTRIAL TELEVISION
by M. Jacques Donnay, Director, TV Department, Compagnie Francaise THOMSON HOUSTON.

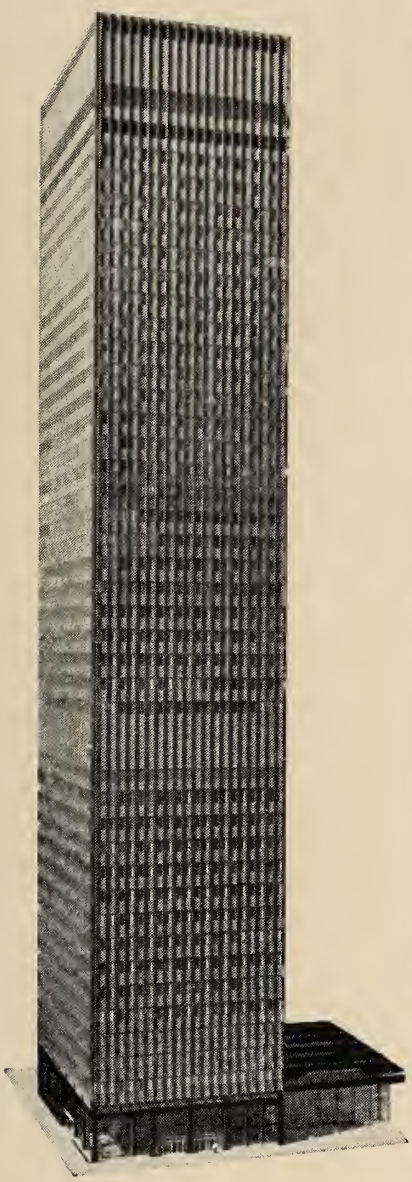
11.00 AM
NEW TRENDS IN THE FIELD OF TELEVISION IMAGE EQUIPMENT
by M. Raymond Cahen, Engineer, TV Dept., Compagnie Generale de Telegraphie Sans Fil.

Mon. Oct. 21, 10.00 AM, Room No. 3
EQUIPMENT FOR LOW-FALL INSTALLATIONS WITH AXIAL SETS
by M. Severin Casacci, Engineer, Chief of Turbine-Pump Dept., Etablissements NEYRPIC.

11, rue Hamelin, Paris, France



La Grande Salle de La Place des Arts. Installation: 3 DK10-10 35,000 PPH Steam Boilers. Consulting Engineers — Mech: and Elec: McDougall & Friedman, Montreal.



Canadian Imperial Bank of Commerce Building. Installation: 3 DK10-7 29,000 PPH Steam Boilers. Consulting Engineers — Mech: G. Granek & Associates, Toronto.

Standard Life Assurance Company Building. Installation: 2 TJW, 10 x 10^6 BTU/HR High Temperature Water Generators. Consulting Engineers — Mech: Wiggs, Walford, Frost and Lindsay, Montreal.

. . . all heated with boilers built and installed by

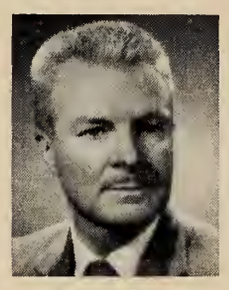
CANADIAN VICKERS LIMITED

MONTREAL • TORONTO

MEMBER OF THE VICKERS GROUP

Personals

C. D. Carruthers, M.E.I.C.



Dr. J. J. Green, M.E.I.C.

Clare D. Carruthers, M.E.I.C. (Toronto '27), has been elected president of C. D. Carruthers & Wallace, Consultants, Toronto. During his long association with this firm, Mr. Carruthers has been responsible for the structural engineering design of such buildings as the Crown Life Insurance Co.; the Imperial Oil Building; Toronto General, Sunnybrook, Riverdale and Sick Childrens' Hospitals; the CNE Grandstand and the Maclean-Hunter Building.

Dr. J. J. Green, M.E.I.C. (D.I.C. '29), has been appointed Director of Research of Litton Systems (Canada) Limited. Until 1943, Dr. Green was employed by the National Research Council as Head of the Aerodynamics Section, Mechanical Engineering Division. After serving with the RCAF in 1945 he was appointed Chief Research Aeronautical Engineer of the Air Transport Board of Canada, and in 1949 he joined the Defence Research Board of Canada. In 1959 he became Chief Superintendent of the Canadian Armament Research and Development Establishment.

J. C. L. Gregory has been appointed President of Morganite Canada Limited. **A. F. Taylor** succeeds to Mr. Gregory's former position as Vice-President, and **D. B. Hosie** assumes the duties of Sales Director and Secretary.

W. A. Dimma has been appointed general manager—plastics co-ordination for Union Carbide Canada Limited. Mr. Dimma will also become a member of the company's operating committee. In his new position he will be responsible for recommending to management, business opportunities in the plastics field that fall outside the product areas of any one of the company's six divisions. Mr. Dimma joined the company in 1948. He was associated with the engineering and production control departments of the Consumer Products Division until 1957 when he was appointed assistant to the vice-president of the company. Most recently, he was manager of sales and development for the company's Chemicals and Plastics Division.

L. M. Cuddy has been appointed Director of Manufacturing for Allied Chemical Canada, Ltd. Mr. Cuddy will be in charge of all manufacturing operations in Canada and will be located in Montreal. In addition to extensive manufacturing experience, Mr. Cuddy spent six as a management consultant serving a wide variety of manufacturers in Canada and the United States.

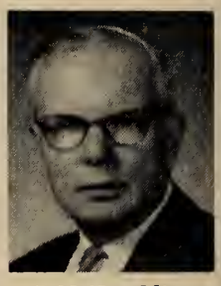
Walter Bedford has been appointed District Manager for the Province of Quebec for General Motors Diesel Limited. Formerly he was District Manager for the Prairie Provinces. He will be located in Montreal. **G. L. Stephenson,** formerly District Service Manager for British Columbia, has been named District Manager for Alberta, Saskatchewan and Manitoba. **Peter Morris** has been appointed Service Representative for British Columbia and will be located in Vancouver. **Jacquesa A. Latagne** has been named Service Representative for Quebec with headquarters in Montreal, and **William A. Christiani** Service Representative for Ontario with offices in London.

Edward M. Beggs has been appointed Metallurgical Manager for Anaconda American Brass Limited, New Toronto. Mr. Beggs joined Anaconda in 1940 as a laboratory technician. In 1951 he was appointed chief laboratory technician, laboratory foreman in 1953 and mill metallurgist in 1962.

J. G. E. Ellis has been appointed Project Co-ordinator for Rayonier Canada (B.C.) Limited. He will act as liaison between the various consultants, field and construction and operating departments. **Bob Dekking** has been appointed Acting Chief Engineer and will take over the duties formerly carried out by Mr. Ellis. **D. M. Story** has been appointed Project Superintendent and will be in charge of construction at Woodfibre.

Gilles Gouin has been appointed Technical Representative and a member of the Engineering Group of Canadian Formwork Limited. Mr. Gouin will be responsible for servicing the accounts of the major general contractors in everything relating to formwork. Andre Grenier has been appointed to a new division of the company which will specialize in the supply of water-reducing agents, finishes, hardeners and other concrete additives for the ready-mix industry.

Professor J. Bordan, M.E.I.C.



J. N. Franklin, M.E.I.C.

John N. Franklin, M.E.I.C., has been appointed a consultant with the J. Kaiser Company (Canada) Ltd. Mr. Franklin has over 30 years' exeperience in the pulp and paper industry in Canada, the United States and New Zealand. He has specialized in process control and mill operation and management.

J. Bordan M.E.I.C., has been named Dean of the Faculty of Engineering of Sir George Williams University, Montreal. Mr. Bordan joined the staff in 1952 as Lecturer in Physics and was appointed Associate Professor of Engineering and Chairman of the Department of Engineering in 1957.

D. A. Hansen, General Sales Manager, Calgary Power Ltd., has been elected President of the Canadian Electrical Association, **J. M. Hambley,** General Manager, Hydro-Electric Power Commission of Ontario, and **H. L. Hurdle,** Assistant to the President, Montreal Enginering Co. Ltd., were elected Vice-Presidents.

Obituaries

Barnes, Charles M., Life M.E.I.C.

Benjafield, P. Grant, M.E.I.C. (Queen's '32)

Benny, W. W., (McGill 1898)

Embley, R. A., S.E.I.C.

Farrell, J. W. D., (Queen's '15)

Green, F. C., M.E.I.C. (New Brunswick 1893)

Hvilivitzky, Jasha, (Toronto '28)

Laperriere, Gilles, S.E.I.C.

Legg, J. H. M.E.I.C., (McGill '29)

MacKenzie, G. L., M.E.I.C. (Queen's '19)

Scott, W. M., M.E.I.C. (McGill 1895)

Simpson, F. J., M.E.I.C.

Slaniceanu, R. D. P., M.E.I.C. (Bucharest '33)

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High Efficiency/Low Maintenance

with precision built
IRON BODY BRONZE MOUNTED GATE VALVES...

Designed and built with your continuing satisfaction well in mind, Jenkins Iron Body Gate Valves have been consistently preferred by those whose plant operations demand valves of high quality and long endurance. Jenkins are proud of the reputation they have built up over the years for meeting and exceeding such service standards in a multitude of plants all across Canada. From low to extra heavy pressures...electrical, cylinder, gear or handwheel operation... you will find the exact Jenkins Iron Body Gate Valve you require. Leaf through your Jenkins Catalogue or write to Jenkins Bros. Limited, Lachine, Que.

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VALVES
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Jenkins Bros

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In applications where a large number of buildings spread over several acres have to be supplied with heating, cooling and process steam the high temperature water boiler installation has very definite advantages.

These are evident in lower overall costs due largely to the absence of corrosion, elimination of condensate traps and separators, and the fact that mains may be laid with minimum regard for levels or grades. Because of the high thermal storage of the system a smaller capacity plant is possible, thus reducing fluctuations in the firing rate to give better overall efficiency. Capital costs are comparable with H.P. steam installations.

Boiler Products Division of Dominion Bridge has had extensive experience in the design, construction and installation of H.T.W. units. Four applications of these are featured here.

12

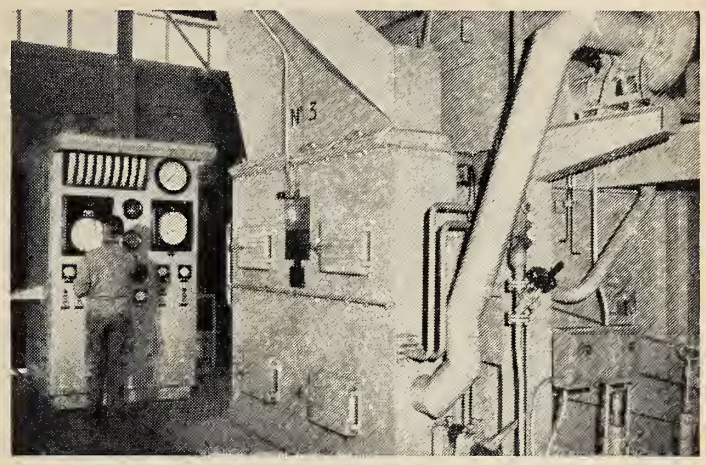
Boiler Products Division **DOMINION BRIDGE**

DOMINION BRIDGE COMPANY LIMITED • SIXTEEN PLANTS COAST-TO-COAST

eater efficiency, lower overall costs

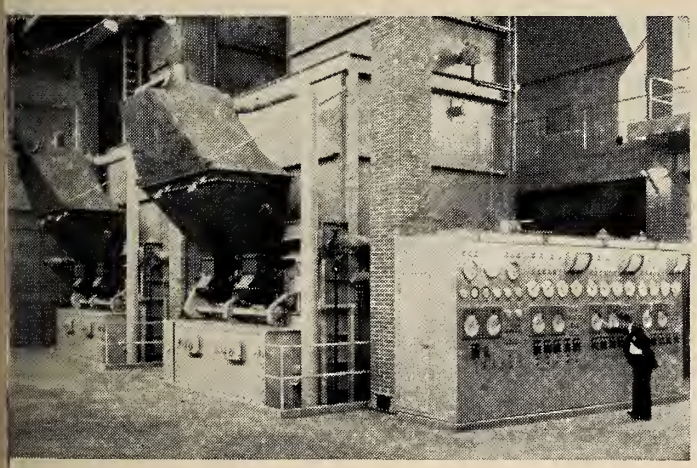
IRON ORE COMPANY OF CANADA

Capacity: 30,000,000 BTU/HR. *Design pressure:* 400 psig. *Inlet temperature:* 250°F. *Outlet temperature:* 380°F. *Fuel:* Oil. *Number of boilers:* 2. *Location:* Carol Lake in Western Labrador. *Engineers & contractors:* Bechtel & Company. *Application:* Supplies heating and hot water requirements for ten buildings spread over several acres.



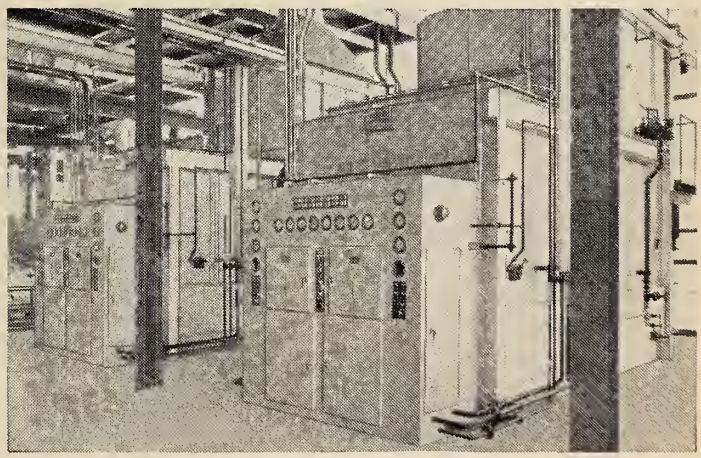
CENTRAL EXPERIMENTAL FARM

Capacity: 30,000,000 BTU/HR. *Design pressure:* 300 psig. *Inlet temperature:* 225°F. *Outlet temperature:* 366°F. *Fuel:* Bituminous coal or oil. *Number of boilers:* 3. *Location:* Ottawa, Ontario. *Consultants:* Wiggs, Walford, Frost & Lindsay. *Application:* Space heating, domestic hot water and steam for air conditioning, autoclaves, sterilizers, pressure cookers, laboratory outlets, etc.



DEPARTMENT OF PUBLIC WORKS

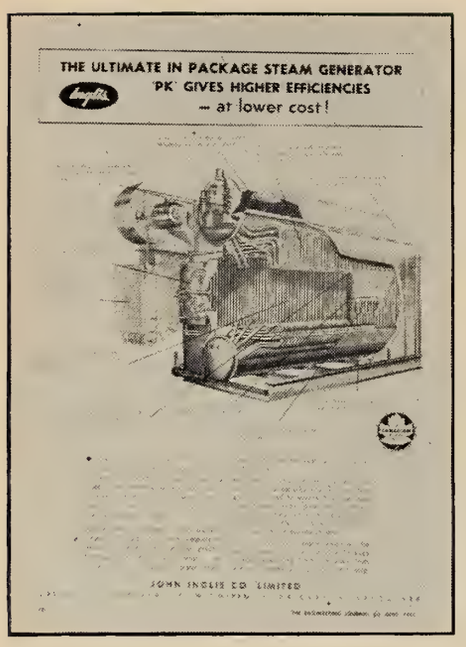
Capacity: 40,000,000 BTU/HR. *Design pressure:* 300 psig. *Inlet temperature:* 220°F. *Outlet temperature:* 350°F. *Fuel:* Bituminous coal. *Number of boilers:* 3. *Location:* Ottawa, Ontario. *Consultants:* J. Klassen & Associates. *Application:* Central heating for ten large office buildings spread over several acres.



MALTON INTERNATIONAL AIRPORT

Capacity: 27,500,000 BTU/HR. *Design pressure:* 300 psig. *Inlet temperature:* 220°F. *Outlet temperature:* 320°F. *Fuel:* Oil or gas. *Number of boilers:* 2. *Location:* Malton, Ontario. *Consultants:* John B. Parker & Associates. *Application:* Central heating for all buildings in the terminal complex.

EIC CERTIFICATE OF ADVERTISING MERIT



A detailed cutaway drawing of a steam generator was a highly appealing feature of a single-page black-and-white ad by John Inglis Co. Limited which won the June award for the best advertisement in the Engineering Journal. The ad, which caught the eye of most engineers in the selection jury, told of "The Ultimate in Package Steam Generator . . ." The cutaway drawing and a small amount of text completed the ad.

Those responsible for the winning advertisement are Hugh Hendry, P.Eng., Manager of Boiler Division, John Inglis Co. Limited, and their Advertising Manager, George Holm. The advertising agency is Ferres Advertising Limited, T. S. Glover, account executive.

Judging for the award is done each month by an impartial jury of engineers from all parts of Canada whose only instructions were to select the best advertisement on the bases of ACCURACY—INFORMATION—ATTRACTION.

When you need capital, look into the

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SYSTEM OF FINANCING

WE provide term funds, at reasonable rates and under reasonable conditions, to commercial and industrial companies for periods of 3 to 10 years and in amounts of $25,000 and up.

YOU can obtain information and a descriptive booklet from the manager of any of the *1,600 offices* of RoyNat's shareholders,
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Head Office and District Office:
MONTREAL—620 Dorchester Blvd. West, Telephone 866-6861
District Offices:
HALIFAX—5675 Spring Garden Road, Telephone 423-8134
TORONTO—4 King Street West, Telephone 363-5404
WINNIPEG—211 Portage Avenue, Telephone 943-3070
CALGARY—444 7th Avenue, S.W., Telephone 269-8411
VANCOUVER—409 Granville Street, Telephone 682-1811

COMING EVENTS

Society of Motion Picture and Television Engineers. 94th Semi-Annual Convention. Boston. Oct. 13-18.

Royal Aeronautical Society, American Institute of Aeronautics and Astronautics, Canadian Aeronautics and Space Institute. Ninth Anglo-American Aeronautical Conference. Boston & Montreal. Oct. 13-24.

Audio Engineering Society. 14th Annual Fall Convention. New York City. Oct. 14-18.

American Society of Mechanical Engineers, American Society of Lubrication Engineers. Lubrication Conference. Rochester. Oct. 15-17.

Illinois Institute of Technology. 1963 National Conference on Industrial Hydraulics. Chicago. Oct. 17-18.

Chemical Institute of Canada. 13th Chemical Engineering Conference. Montreal. Oct. 19-23.

Institute of Power Engineers. Power Engineering Seminar and Show. Toronto. Nov. 6-8.

American Concrete Institute. Fall Convention. Toronto. Nov. 11-14.

Building Research Advisory Board. International Conference on Permafrost. Purdue University, Lafayette, Ind. Nov. 11-15.

Union Panamericana de Asociaciones de Ingenieros. International Conference. New York City. Sept. 23-25.

Institute of Electrical and Electronics Engineers, Inc. Sixth Canadian Electronics Conference. Toronto. Sept. 30-Oct. 2.

American Welding Society. National Fall Meeting. Boston. Sept. 30-Oct. 3.

Prestressed Concrete Institute. Ninth Annual Meeting. San Francisco. Oct. 5-11.

American Institute of Mining, Metallurgical and Petroleum Engineers, Inc., Society of Petroleum Engineers. Fall Meeting. New Orleans. Oct. 6-9.

Water Pollution Control Federation. 36th Annual Meeting. Seattle. Oct. 6-10.

Technical Association of Pulp and Paper Industry. 18th Plastics-Paper Conference. Cleveland. Oct. 7-9.

American Society of Civil Engineers. Annual Convention and National Structural Engineering Conference. San Francisco, and Honolulu, Hawaii. Oct. 7-11 & Oct. 19-23.

Societe Francaise des Electroniciens et des Radio electriciens. International Symposium on Nuclear Electronics. Paris, France. Nov. 25-27.

Northern Electric

COMPANY LIMITED

PILC POWER CABLES

cable is the work-horse of the power cable field. Its extensive background of long trouble-free service makes it one of the most dependable power cables presently available. It is relatively low in cost, has high ampacity and is suitable for all types of feeder and distribution work. As examples of its versatility, it can be used underground directly buried, in ducts, in tunnels or in submarine crossings. It can also be installed above grade on poles or on racks and trays. For complete details please write for Bulletin P6-A.

The Northern Electric Company's long experience and modern engineering, laboratory and manufacturing facilities ensure a quality PILC power cable that is second to none.

"Second to none" is a specific term–and a challenge. We meet it by exceeding the minimal standards of engineering bodies... by maintaining five of the best-equipped cable laboratories devoted to research and development. We demand the best from our raw-material suppliers...from our processes and our people. We are proud that our manufacturing tolerances are increasingly narrow–that our process controls detect–and correct–unwanted deviations before they could be hidden by subsequent operations.

Our laboratories, our resources and experience are at your disposal. If you are concerned with the design or installation of cable, it will pay you to consult Northern Electric.

Northern Electric

COMPANY LIMITED

The law of supplying demand

At Hydro-Quebec, it reads: Keep ahead. The current proofs are Carillon and Manic 2. In 1964, Carillon will add 2,500 million KWH per year to the power supply demanded by the homes, farms and industries of Quebec. By the end of 1965 Manicouagan 2 will be in production with 680,000 H.P. That's power to grow on. Carillon's generators are powered by fourteen automatic Kaplan Turbines of 60,000 H.P. each; Manic 2 is getting eight 170,000 H.P. Francis Turbines. That will make 2 million H.P. for Hydro-Quebec—with hydraulic turbines—designed, engineered, built and installed by Dominion Engineering.

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ACID RESISTANT THIOPOXY 60 FLOOR TOPPING CURES OVERNIGHT

This remarkable two-component floor topping and patching compound is designed to withstand severe corrosive and abrasive conditions.

1. Thiopoxy 60 combines flexible Thiokol liquid polymers and epoxy resins in an exclusive formulation developed by Horn Research Laboratories.
2. It has outstanding resistance to strong corrosive chemicals.
3. The dense, slip-resistant surface wears like iron, even under heavy traffic.
4. Its impact and abrasion resistance is excellent.
5. Thiopoxy 60 has proven resistance to acids, chemicals, salts, solvents, alkalis, detergents, oils and greases which ordinarily destroy and disintegrate concrete floors.
6. At a ¼ of thickness, develops to a compressive strength of 10,000 lbs. per square inch.
7. Its surface helps maintain a low bacteria food count.
8. Apply Thiopoxy 60 easily and quickly with a trowel at a thickness of ¼" or more.

9. Write for a sample of Thiopoxy 60 and the Horn Construction Handbook or phone Toronto — PL 9-4461.

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W. R. GRACE & CO. OF CANADA LTD.
DEWEY AND ALMY CHEMICAL DIVISION
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Engineering Information Service

The following books have recently been received.

PRINCIPLES AND APPLICATIONS OF TENSOR ANALYSIS, Matthew S. Smith, Howard W. Sams, $6.75

ELECTRONICS REFERENCE DATA, VOL 3, The Engineering Staff, Aerovox Corporation, Howard W. Sams, $2.95

ENGINEERING MECHANICS, VOL 1, Archie Higdon and William B. Stiles, Prentice-Hall, N.J., $6.75

DIAKOPTICS, Gabriel Kron, MacDonald, London, 50s

PROFESSIONAL ENGINEERS AND THE COMMON MARKET, Headley Brothers, London 10/-

ELECTRICITE INDUSTRIELLE-LOIS GENERALES DE L'ELECTROTECHNIQUE, TOME III, Andre Busson, Masson & Cie, Paris, 63F

ELECTRICITE INDUSTRIELLE-LOIS GENERALES DE L'ELECTROTECHNIQUE, TOME II, Andre Busson, Masson & Cie, Paris, 75F

ELECTRICITE INDUSTRIELLE-LOIS GENERALES DE L'ELECTROTECHNIQUE, TOME I, Andre Busson, Masson & Cie, Paris, 68F

MOBILE AND MOVABLE CRANES, Roly Hammon, C. R. Books, London, 45s

TRAFFIC ENGINEERING PRACTICE, Ernest Davies, E. & F. N. Spon, London, 75s

PROBLEMS IN ELECTRONICS WITH SOLUTIONS, F. A. Benson, E. & F. N. Spon, London, 42s

FUNDAMENTAL ELECTROMAGNETIC THEORY, Ronold W. P. King, Dover, New York, $2.75

ELEMENTS OF ENGINEERING REPORTS, Dale S. Davis, General Publishing, Toronto, $10.65

HYDRAULIC TRANSIENTS, George R. Rich, Dover, New York, $2.50

LIGHT PRINCIPLES AND EXPERIMENTS, George S. Monk, Dover, New York, $2.45

OPERATIONAL METHODS IN APPLIED MATHEMATICS, H. S. Carslaw and J. C. Jaeger, Dover, New York, $2.25

ENGINE NOISE ANALYSIS AND CONTROL, C. H. Bradbury, Temple Press Books, London, 21s

DESIGN AND OPERATION OF DIGITAL COMPUTERS, Dr. Gerhard Haas, Howard W. Sams, $6.95

MARINE SCIENCES INSTRUMENTATION, VOL 2, R. D. Gaul, Plenum Press, New York, $10.

ADVANCES IN CRYOGENIC ENGINEERING, VOL 8, K. D. Timmerhaus, Plenum Press, New York, $17.50

TRANSISTORS A SELF-INSTRUCTIONAL PROGRAMED MANUAL, Prentice-Hall, N.J.

DIE PUMPEN, Fuchslocher/Schulz, Springer-Verlag, Berlin, DM28

PRECIS d'ENERGIE NUCLEAIRE, G. Cohen, P. Treille, Dunod, Paris, 54F

PHYSIQUE DES VIBRATIONS MECANIQUES, R. Mathey, Dunod, Paris, 46F

INVITATION A LA RECHERCHE OPERATIONNELLE, A. Kaufmann and R. Faure, Dunod, Paris, 28F

ELECTROTECHNIQUE, TOME 2, Francois Cahen, Gauthier-Villars, Paris, $9.50

TECHNOLOGIE DES REACTEURS NUCLEAIRES, Thomas Reis, Eyrolles, Paris, 90.OOF

INTRODUCTION TO ELECTRONIC COMPUTERS PROBLEM SOLVING WITH THE IBM 1620, Fred J. Gruenberger and Daniel D. McCracken, John Wiley, New York, $2.95

ENVIRONMENTAL TECHNOLOGIES IN ARCHITECTURE, Bertram Y. Kinzey, Jr. and Haward M. Sharp, Prentice-Hall, N.J.

ELEMENTS OF TRANSISTOR TECHNOLOGY, Robert G. Middleton, Howard W. Sams, $6.95

LA PRATIQUE DES TRAITEMENTS THERMIQUES DES METAUX INDUSTRIELS, Gerard de Smet, Dunod, Paris, 58F

AN INTRODUCTION TO ELECTRONICS, Denis F. Shaw, Longmans, Toronto, $6.

MECHANICS OF FLUIDS, A. C. Walshaw and D. A. Jobson, Longmans, Toronto, $6.

DEVELOPMENTS IN APPLIED SPECTROSCOPY, VOL 2, J. R. Ferraro and J. S. Ziomek, Plenum Press, New York, $16.

DEVELOPMENTS IN THEORETICAL AND APPLIED MECHANICS, VOL 1, Southeastern Mechanics Conference, Plenum Press, New York, $16.

REGULATION AUTOMATIQUE INDUSTRIELLE, D. P. Eckman, Dunod, Paris, 68F

GUIDE PRATIQUE DE VENTILATION, W. C. Osborne, C. G. Turner, Dunod Paris, 28F

BRITISH STANDARD 341: PART 2:1963, SPECIFICATION FOR VALVE FITTINGS, British Standards Institution, London, 6/

BRITISH STANDARD 690: 1963, SPECIFICATION FOR ASBESTOS-CEMENT SLATES AND SHEETS, British Standards Institution, London, 7/6

BRITISH STANDARD 1965: PART 1:1963, SPECIFICATION FOR BUTT-WELDING PIPE FITTINGS, British Standards Institution, London, 6/

BRITISH STANDARD 3627: 1963, SPECIFICATION FOR DIMENSIONS OF COMPRESSION AND OIL CONTROL RINGS AND PISTON RING GROOVES FOR I.C. ENGINES, British Standards Institution, London, 6/

CSA STANDARD G163.1-1963, METHODS OF DETERMINING WEIGHT OF COATING ON ZINC-COATED (GALVANIZED) STEEL SHEETS, Canadian Standards Association, Ottawa, $1.25

CSA STANDARD C130-1963-EXPLOSION-PROOF ENCLOSURES FOR ELECTRICAL EQUIPMENT, Canadian Standards Association, Ottawa, $1.25

CSA STANDARD C133-1963, INDUSTRIAL CONTROL EQUIPMENT, OIL-IMMERSED FOR USE IN HAZARDOUS LOCATIONS, Canadian Standards Association, Ottawa, 75 cents.

CSA STANDARD C22.2 NO 53, 1963, ELECTRIC WASHING MACHINES, Canadian Standards Association, Ottawa, $2.25

ASTM SPECIAL TECHNICAL PUBLICATION NO. 326, SYMPOSIUM ON SKID RESISTANCE, American Society for Testing and Materials, Pa. $3.40

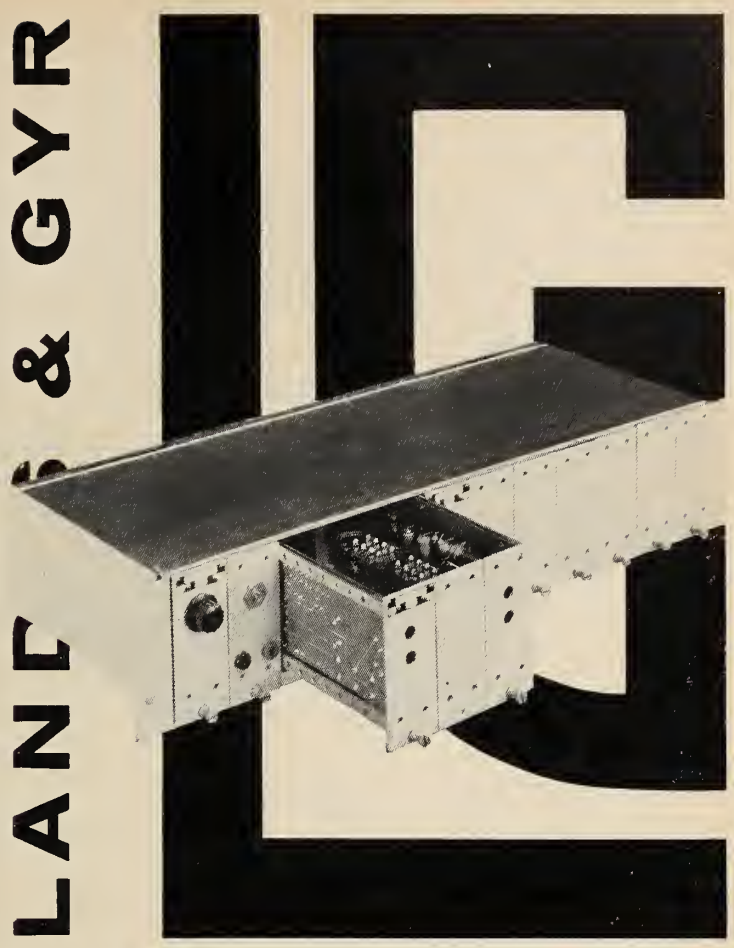
ASTM STANDARD ON CEMENT, 16TH EDITION, Dec. 1962, American Society for Testing and Materials, Pa. $3.40

SURVEY OF OILS, 1963, The Financial Post, Maclean-Hunter Publishing, Toronto, $5.

A COMPREHENSIVE BIBLIOGRAPHY ON OPERATIONS RESEARCH, Operations Research Group Case Institute of Technology, John Wiley & Sons, N.Y., $8.75.

ELECTRONIQUE ET RADIOELECTRONIQUE, Vol. I and II, H. Aberdam, Dunod, Paris, 8F.

(Continued on page 98)



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Some specific advantages are: 1) Theoretically unlimited life. 2) Low operating voltages. 3) Simple power supply units, since *one* voltage only is required. 4) Battery operation possible. 5) Instant starting. 6) Low weight, small size.

LG telecommunications equipment, designed on the building block principle, allows maximum flexibility, interchangeability and extension. Each "block" is a self-contained, plug-in unit, (1 to 4 basic units wide). Installations are engineered and assembled in Canada and supplied in dust-proof cubicles or on 19″ chassis, as illustrated.

There are units for mains and for battery connections, filters, transmitters and receivers, test sets, etc. For complete details write for LG Bulletin 1 16 44—E.1.09, or discuss your requirements with LG engineers.

LG18

LANDIS & GYR INC.

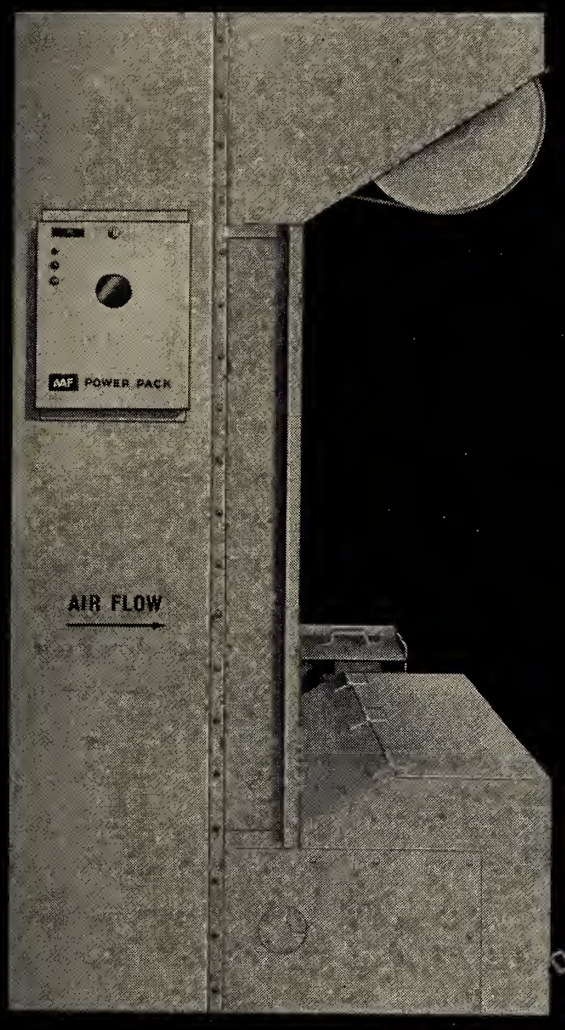
P.O. Box 1216, St. Laurent 9, Que., Tel. 744-2893

AAF makes a good air filter

1957 ROLLOTRON

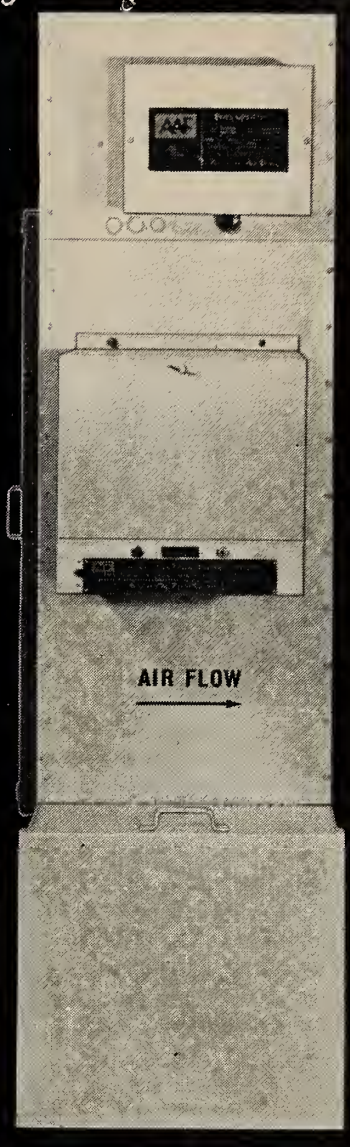
New Rollotron cuts space requirements in half!

. . . better. . . . . again!



40 in.

1959 ROLLOTRON



20 in.

NEW ROLLOTRON

■ ROLLOTRON is the one air filter that offers
1. the efficiency of an electrostatic precipitator, and
2. the minimum maintenance of an automatic-renewing, disposable media air filter

with no water, no washing, no freezing problems, no drains, no oiling of plates.

Now you can get these benefits in half the space. The new AAF ROLLOTRON is just a fraction over twenty inches deep (compared with 40″ for the previous design).

And space savings isn't the only advantage. Both sections (agglomerator and storage) now can be serviced from the dirty air side, eliminating need for two access spaces.

For complete information on the brand new compact ROLLOTRON, call your local AAF representative or write us direct.

AAF CANADA American Air Filter OF Canada LTD.

Factory and General Offices: 400 Stinson Blvd., Montreal 9

Discussion

(Continued from page 48)

per in.". The coefficient of soil reaction "k" is correctly stated in terms of "lb per cu. in."; in reality it should be visualized as "lb per sq. in. per in." of deflection; derived from the relationship:

$$k = p/d \quad \text{.....(A)}$$

where:

k = coefficient of soil reaction, lb per sq. in. per in.
p = soil pressure, lb per sq. in.
d = conduit deflection, in.

The soil pressure distribution on a circular conduit assumed by Marston and Spangler in the derivation of the authors' Equation (1) indicates that the deflection "d" is the horizontal deflection of the conduit, and the coefficient "k" represents the horizontal coefficient of soil reaction. The equation originally contained a "deflection lag" factor which was required to explain the continued yielding of the soil over a considerable period of time after the maximum vertical load had developed. This yielding results in a continuation of the conduit deformation. The deflection lag factor cannot be less than unity and has been observed to range upward toward a value of 2.0

In the discussor's opinion, it would be more realistic to omit the deflection lag factor and to view the coefficient "k" as a factor which decreases with increasing yield of the soil after the maximum vertical load has developed. This may have been the authors' intentions. If so, this could have been elaborated upon.

General observations of the deflection of flexible conduits and measurements of the La Fleche and Lethbridge culverts indicate that the maximum deflection into the soil generally does not occur at midheight of a conduit, but usually in the area some 20° to 40° below midheight. For conduits with negligible flexual rigidity, it is important to obtain good compaction of the soil surrounding the lower quadrants. Unfortunately, this is the area most difficult to compact.

In general, the horizontal deflection at conduit midheight has been observed to be in the range of 80% to 95% of the vertical deflection. Based on the performance of the La Fleche experimental culvert, it would seem advisable that the ultimate horizontal deflection not exceed 4.5% of the conduit diameter. Using this limit in conjunction with the authors' Equation (2), (11), (12), and (13), it seems desirable to obtain the following:

$$k > 30\ p_o/r \quad \text{..... (B)}$$
$$(K_c = E_s) > 45\ p_o \quad \text{..... (C)}$$
$$(K_s = E_s/h) > 45\ p_o/h \quad \text{.. (D)}$$

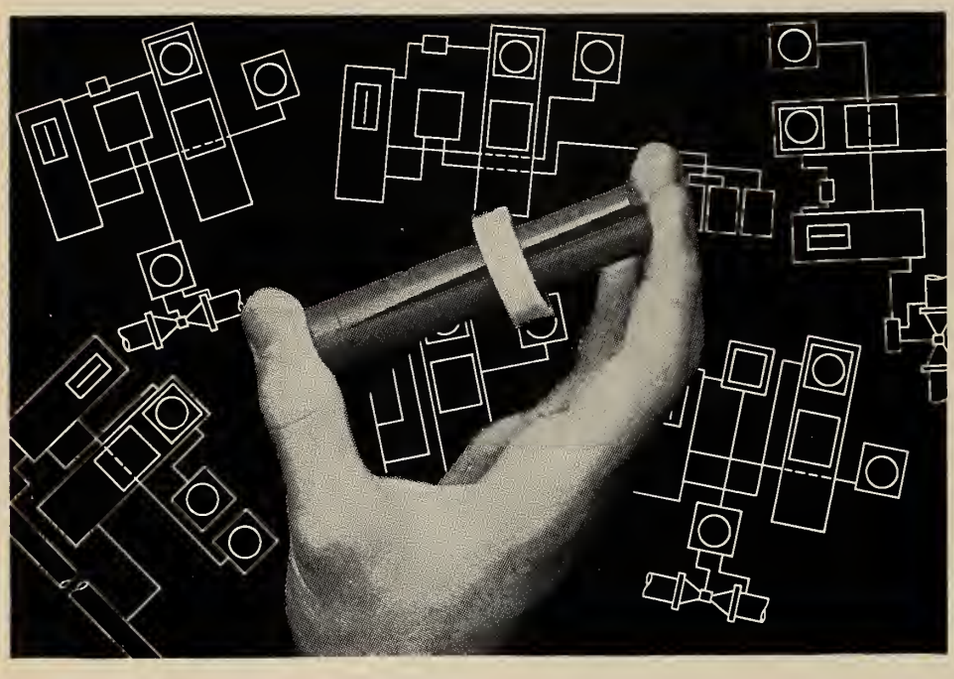
where all terms are the same as those employed by the authors.

Typical values for the constants of soil reaction "K_s" and "K_c" are suggested in their Table 1. However, due to the wide range of values, the selection must be tempered by judgement and experience. Where there is any doubt regarding the adequacy of a proposed backfill for an installation, appropriate tests should be conducted. It should be pointed out that a cohesive backfill adjacent to a flexible conduit could not be used for an unlimited fill height, since the modulus of elasticity "E_s", ($E_s = K_c$) is practically independent of fill height. It would seem theoretically possible to use a granular backfill for practically unlimited fill height. The above, of course, presupposes proper design of the conduit itself. The flexible structure must be safely designed against crushing or buckling, as given by the authors' Equation (9) and Fig. 3.

Other information has been gleaned from the La Fleche and Lethbridge culvert installations. The cohesive backfill at La Fleche was a medum plastic, alluvial clay, placed in the range of 0% to 2% dry of Proctor optimum moisture. The density of the hand-tamped and pneumatic-tamped material within ½ diameter from the culvert averaged 93% of standard Proctor, and beyond this distance averaged 96%. Settlement and deflection gauges indicate that the composite action between cohesive soil and conduit extends to a distance of about *three* diameters away from the conduit. Differential settlements of the soil, measured more than one diameter below invert level, were reflected in the culvert deformations; deflection gauges up to 2½ diameters out from culvert midheight indicated lateral movement of the soil at these points.

At the La Fleche experimental culvert, the backfill became saturated some 1½ to 2 years after construction due to impounding of water in the reservoir. The compression and deformation of the backfill during saturation caused a further reduction in the values of "k" and "E_s" of the soil, and the conduit deflections increased about 1½% to 2%. It was during this interval that Section B, the 20 gauge section referred to in the authors' paper, failed by buckling. The coefficient of soil reaction at midheight at time of failure was estimated by Equation (1) to be about 12 lb per sq. in. per in. From culvert shape measurements, it was estimated that the coefficient some 20° to 40° below midheight may have been of the order of 8 lb per sq. in. per in.

In the design of underground flexible structures, the effects of saturation of the backfill must be considered. In order to minimize these effects, cohesive backfills should be compacted to *greater* than 95% standard Proctor at a moisture content not less than Proctor optimum.



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From Fig. 3, it is estimated that the average factor of safety of Section B was about 1.1. Axial strain measurements indicate that the actual axial stress varied by as much as ±25% of the average. It can be seen that the actual factor of safety was in the range of 0.8 to 1.4; failure by buckling is therefore understandable. Section C is a 16 gauge section adjacent to Section B, under the same conditions of backfill. Recent measurements indicate that the vertical deflection is about 7.6% and the horizontal deflection at midheight about 6.7%. The coefficient of soil reaction at midheight is estimated to be about 11 lb per sq. in. per in., and the range of actual factor of safety about 1.0 to 1.8. Shape measurements confirm that the areas below midheight may be approaching a state of buckling failure.

At Lethbridge, the culvert and backfill performance is different in many respects. The discussor disagrees with the classification of the backfill soil type given by the authors in Table 2. The pad below the culvert consisted of a well compacted gravel-sand-clay mixture, placed on a hard glacial clay foundation. The remainder of the adjacent backfill, which extended to one diameter away from the culvert at midheight, consisted of a sandy gravel containing some silt and clay fines. This granular backfill was well compacted against the lower quadrants for a height of about 2 to 2½ ft above invert level, but was not as well compacted above this level. The remainder of the fill above culvert midheight, and adajcent to it beyond about one diameter, consisted of a medium plastic clay compacted to about 94% standard Proctor; however, it does not appear that the soil type for this remainder had any effect on the performance of the culvert and adjacent granular backfill. It is apparent from the measurements that the composite action of the culvert and adjacent soil was that of a non-cohesive granular backfill rather than cohesive.

In Table 2, the constant of soil reaction "K_s" can be added for the Lethbridge culvert, its value at culvert midheight being about 3.7 lb per sq. in. per in. It can be seen from Table 1 that this value indicates a loose to compact state, and this is in agreement with the field densities taken in the area adjacent to and below culvert midheight. The relative density of the above mentioned zone was of the order of 30% to 50%, whereas the relative density of the zone below the culvert haunches and of the pad below invert level was of the order of 50% to 80%. Placement moisture content of the granular backfill was generally in the range of 5% to 10%.

Composite action between soil and conduit, using a non-cohesive granular backfill, seems to extend to a distance of about *one* diameter away from the conduit; it would appear advisable to have a minimum of 1½ diameters opposite the lower diagonal points, and about one diameter below invert and opposite midheight.

The example given by the authors in Table 2 in Section C, which received less compaction than the adjacent Sections A and B due to interference by existing bridge towers immediately adjacent to Section C. At Sections A and B, under the same fill heights, the coefficient of soil reaction "k" at midheight is estimated to be about 70 and 65 lb per sq. in. per in. respectively. The constant of soil reaction "K_s" is about 4.9 and 4.6 lb per sq. in. per in.

The last point to be discussed is the apparent relation between ultimate vertical pressure on a flexible conduit, in relation to the fill height, and the characteristics of the backfill in terms of the coefficient of soil reaction. At both the La Fleche and Lethbridge installations, an attempt was made to reduce the ultimate vertical pressure on the culverts by placing a zone of relatively uncompacted material above culvert crown. This zone was about one diameter in width at both installations, and about ½ diameter in height at La Fleche and one diameter in height at Lethbridge. Yet the vertical pressure on the La Fleche culvert, estimated from axial strain measurements, is about 60% to 65% of the overburden, while at Lethbridge it appears to be a little greater than 100% overburden.

It would be interesting to observe whether the following may be of the right order of magnitude:

k (p.c.i.)	p_r/wh
10	0.6
20	0.8
40	1.0
60	1.1
100	1.2

It is thought that the more deformable the backfill the lower will be the coefficient of soil reaction and the ultimate pressure on the flexible conduit in terms of overburden. Although it may seem desirable to obtain lower pressures on the conduit, the lower resistance of some soils may cause excessive deflection of the conduit.

It is hoped that the authors' excellent and timely article will stimulate further discussion of this important subject. With additional observations and research, it should be possible some day to arrive at a more comprehensive analysis of the pressure distribution and shear stresses acting on a flexible structure. Additional knowledge in regard to the composite action of the struc-

(Continued on page 92)

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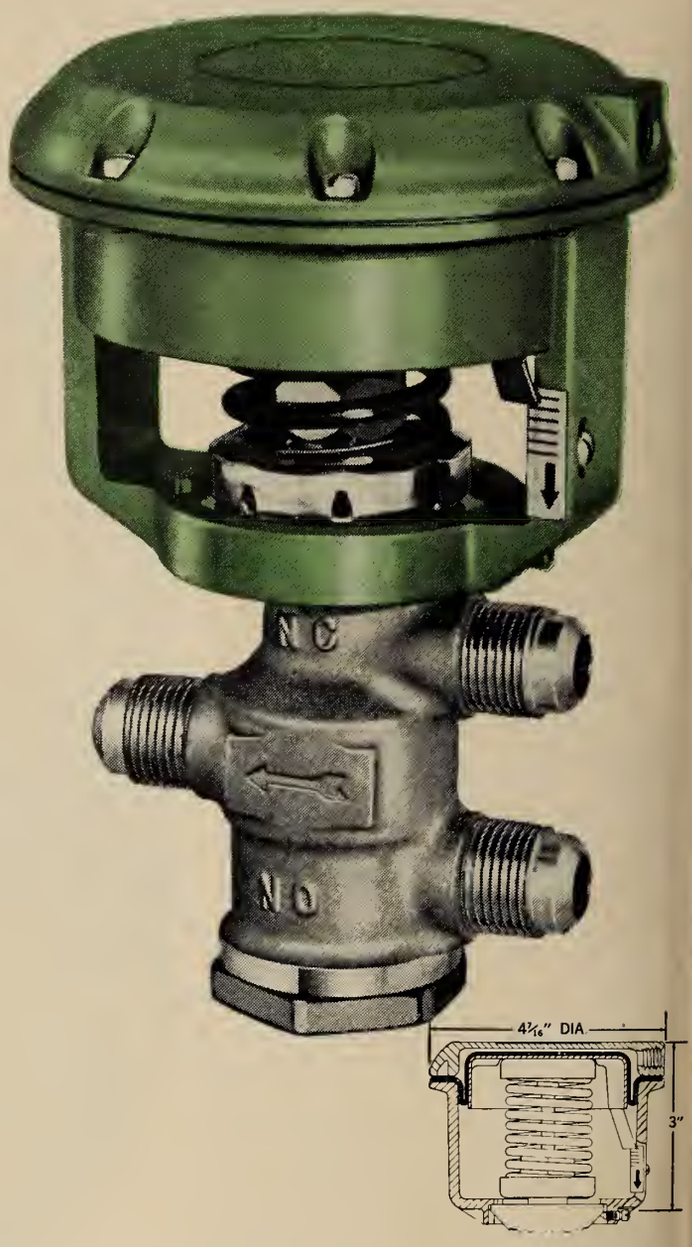

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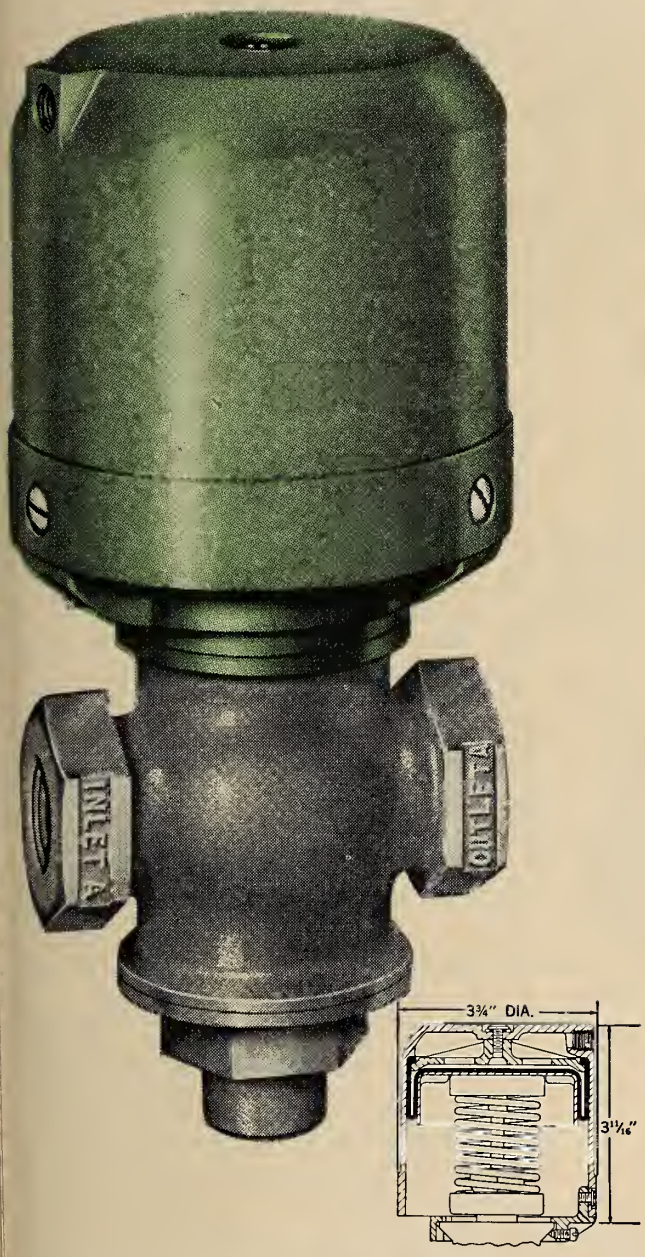

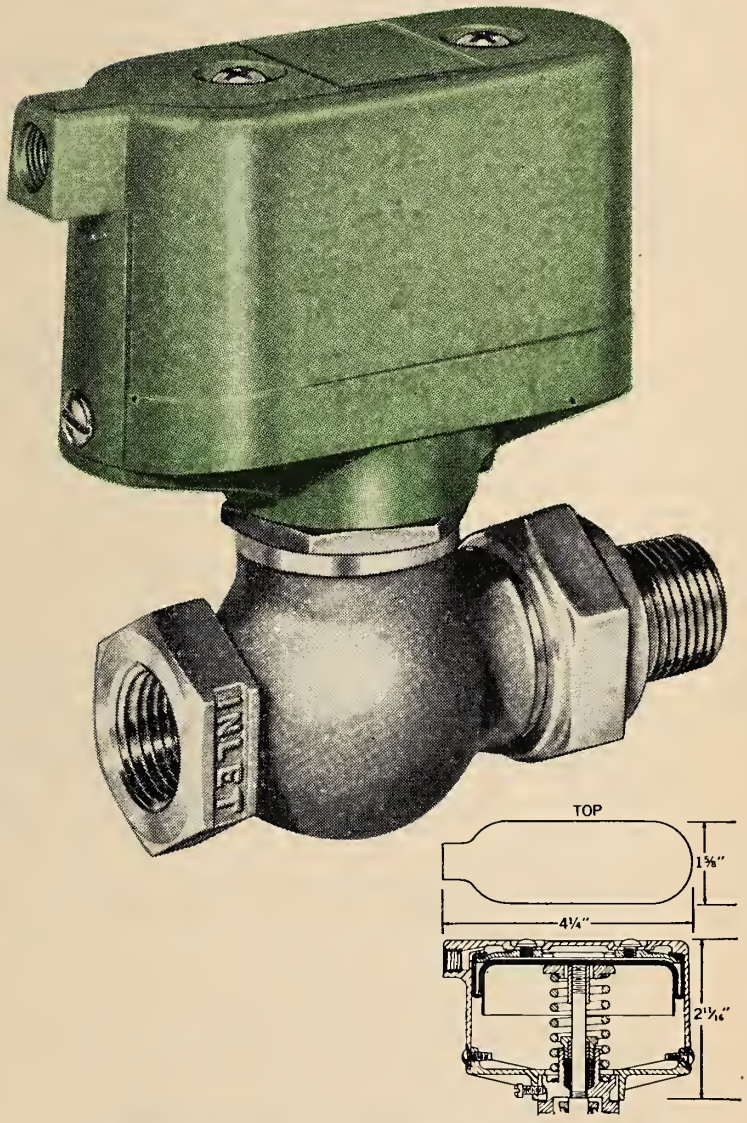

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Discussion

(Continued from page 89)

ture and backfill could lead to further economies in the design and installation of such structures.

CLOSURE

"Composite Design of Underground Steel Structures" by G. G. Meyerhof and C. L. Fisher (77th Annual Meeting, E.I.C., Quebec City, 1963, Geotechnical Engineering Division Paper No. 5).

The Authors are grateful to Mr. Jasper for his kind comments on the paper, and they agree that any gradual increase of culvert deflection with time can conveniently be taken into account by using a reduced modulus of deformation or coefficient of soil reaction. This reduced coefficient would also govern the critical buckling stress in culverts and is particularly important in clay backfills, which should probably be compacted to more than 95 per cent of the standard Proctor density, as is suggested by Mr. Jasper.

His additional information on the interesting field observations on the culverts at La Fleche and Lethbridge are particularly welcome because they were only briefly mentioned in the paper. Although movements in the clay fill at La Fleche were observed to a distance of about 3 diameters from the culvert, it is believed that the major zone of composite action, especially at failure, is located within a width of about one diameter around the culvert, as mentioned in the paper. It is of interest to note that the observed critical stress in section B (20 gauge material) of the culvert agrees well with the theoretical buckling stress estimated by the Authors, and that recent measurements in section C (16 gauge material) also confirm the estimated approach of buckling failure.

Although the fill near the culvert at Lethbridge varies as mentioned by Mr. Jasper, it had been briefly classified as very stiff clay in Table 2 because this material was used in most of the fill and also formed the foundation soil some 2 or 3 ft. below the invert. The analysis of the field observations which the Authors gave for the clay fill can, however, also be made for the gravel-clay mixture used for backfill below midheight of the culvert, as suggested by Mr. Jasper. The corresponding values of the constant of soil reaction of this backfill vary with the relative density of the material in a similar way as for the culverts at Ames.

The interesting results of differential zone compaction used on the above culverts form an important area for further research and should lead to an increased economy of underground structures because the cost of soil compaction usually represents only a few per cent of the cost of the fill.

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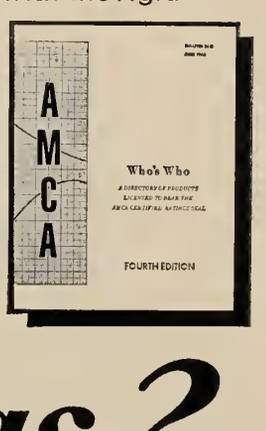


HYDROLOGICAL SIMULATION OF A RIVER BASIN — AN AID IN FLOOD CONTROL PLANNING

I. W. McCaig M.E.I.C.
F. H. Jonker
J. M. Gardiner M.E.I.C.

The Engineering Journal, June, 1963, Page 39

Discussion by
R. H. Clark
Department of Northern Affairs

Since the authors have presented only the basic considerations in a hydrologic simulation of a river basin, a discussion of the paper must be made in general terms.

The hydrologist now has available to him a method, through electronic computers, a means of carrying out quickly a great volume of computation which are required in the new hydrologic techniques which he has developed. I hope that we shall see more study devoted to the application of electronic computers to hydrologic problems so that the hydrologist will become familiar with the new computation techniques available to him. For example, Linsley and Crawford[1] have reported on a budgeting approach for determination of daily flows from meteorological data on a small watershed in California.

We must not, however, lose sight of the objective of these computations nor of the data with which we have to deal. The hydrologist may become so entranced by the complexity of his computations that he loses sight of his objective. In the particular example which the authors have presented, the simulation seems to be fairly good—at least on the scales which they have used to show the results. Yet, we have obtained a similar simulation of runoff at Pokiok from rainstorms, using a modification of the isochrome technique and carrying out the computations with desk computers. With this techniques, it should be possible to keep abreast of six-hour rainfall reports. We should proceed cautiously in adopting new procedures and not accept without question such procedures simply because they appear to be more sophisticated.

In this particular example, I would say that the program is much too complex for the data which are now available for the

Saint John River basin. Before it could be considered "operational", a program for the collection of the data necessary for its effective and efficient application will be an important prerequisite. We should not, therefore, discard the simulation program but should ensure that the appropriate data are being collected."

REFERENCE

1—Linsley, R. K. and Crawford, N. H., *"Computation of a Synthetic Streamflow Record on a Digital Computer"*, Proc. Int. Assoc. Sci. Hydrology, General Assembly of Helsinki, Publ. 51, 526-538, 1960.

Discussion by

Mr. D. N. McMullen
Ontario Department of Lands and Forests

I wish to congratulate the authors, Messrs. McCaig, Jonker and Gardiner, on their well prepared and very interesting paper. It is most encouraging to see this awareness of the potential of electronic computers in hydrologic analysis.

Here, as the authors indicate, is a field which "is involved with computations of large numbers of variables, complex relationships and repetitive operations". Th's is a consequence lends itself so well to programming with electronic computers.

The manual calculations and manipulation of graphs which have been the tools of hydrologic analysis have, to a certain extent, been responsible for the slow development in this science as compared with other fields where measurements and calculations of specific elements give concrete results. The electronic computer offers a means of removing this time-wasting manual drudgery for which we cannot but be grateful.

In our enthusiasm for more glamorous tools and procedures, however, we must not overlook the fact that the science of hydrology has a crying need for sound basic research. A simulation program, such as is outlined, even with the refinements of the electronic computers still has the limitations and inadequacies of empirical and statistical formulae. It is a "means to an end". It does not in itself solve the problems created by the interaction of meteorological and hydrologic variablets. The results from any calculations are still dependent on the data and formulae used and until these are adequately defined the results will be suspect and open to conjecture.

The authors have indicated, though only in a very general way, some satisfactory results from their methods of calculation. I can go along with their enthusiasm for the use of electronic computers in hydrologic analysis but until more details on the method of calculation are available, I must take a cautious view of the general application of their program.

In the interdisciplinary field of hydrometeorology a unique solution is by no means a universal one.

Author's Reply

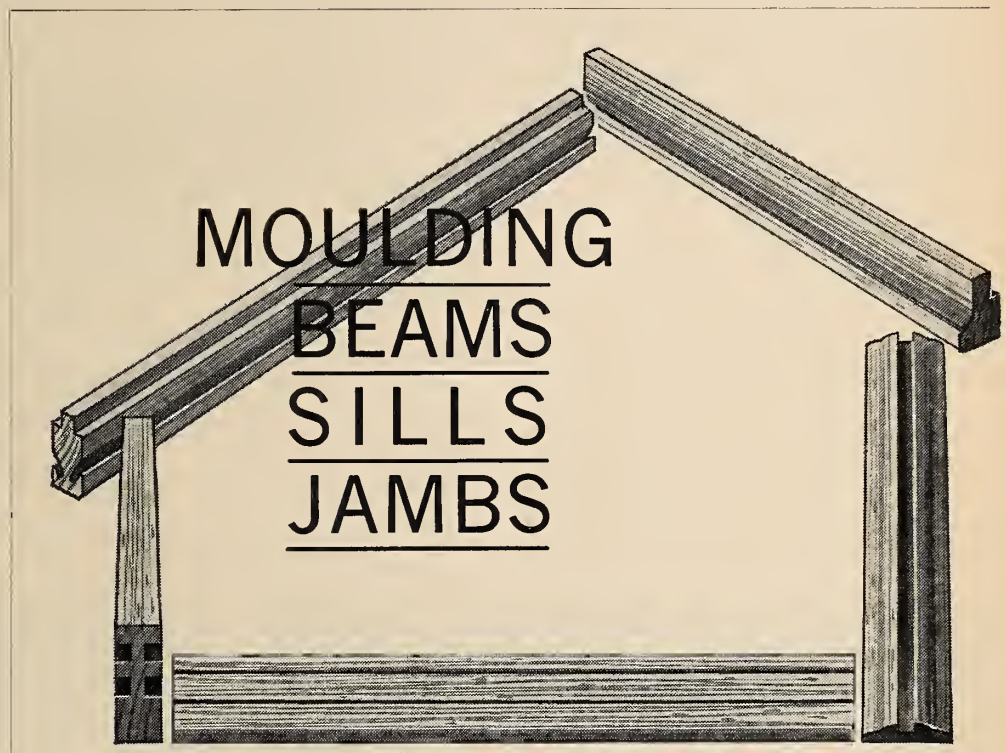
Both Mr. Clark and Mr. McMullen have agreed with the authors on the value of modern electronic computers in carrying out the great volume of computation that is required for the more refined hydrologic techniques, but Mr. Clark feels that in many river basins insufficient data is available for full utilization of the simulation program. Mr. McMullen points out the need for sound basic research to improve the accuracy of present empirical and statistical formulae.

The authors, in developing the simulation described in their paper, were very aware of the present limitations of empirical formula and knowledge in the field of hydrology, and allowed in the computer program sufficient flexibility for adjustment of empirical constants to fit conditions pertaining to the watershed being examined. They felt that provided the program included the various mechanisms by which rainfall or snowmelt contribute to a flood, adjustments could be made for conditions pertaining to the drainage area being examined. In this manner it was possible to extend the field of research from the small experimental catchments to the larger drainage areas of our major rivers. Much basic research on experimental catchments is, however, still required; in particular the role of groundwater flow needs careful study.

The authors certainly agree that the use of a computer program of the type they described would be greater if more hydrological information were available. In the case of the Saint John River basin, for which the paper gives an example of hydrologic simulation, there is a fairly extensive coverage of meteorological stations over the entire drainage area. This amount of information might not, however, be available in other cases.

This spring, the simulation was used for a continuous forecast of flows in the Saint John River. Five-day weather forecasts were employed, and the results obtained proved to be quite accurate for high river flows.

(Continued on page 94)



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Discussion

(Continued from page 93)

For lower river flows, particularly at the beginning of melt and during the falling limb of the flood, agreement between predicted and measured flows was not so good and we are at present endeavouring to improve the accuracy of the program under these conditions.

PROBABILITY CHARTS FOR PREDICTING ICE THICKNESS

G. P. Williams, M.E.I.C.
Research Officer, Snow and Ice Section
Division of Building Research
National Research Council, Ottawa

The Engineering Journal, June, 1963, Page 31

Discussion by
P. D. McTaggart-Cowan
Director
Meteorological Branch
Department of Transport Toronto

The chief value of the method for predicting ice growth rates and hence of ice thicknesses at some future date, appears to be in the possibility of estimating the upper and lower limits of the rate of ice growth. The method must be used with caution, realizing that the probability curves are derived from observed growth rates covering a wide geographical area. Mean winter temperature and snow covers may vary considerably over say, Region #3, resulting in different growth rates throughout this region. Hence the probability curves can only be expected to give the likely extremes of growth which may be expected, and might be useful for general planning purposes.

It would appear desirable to investigate the possibility of correlating ice growth over a certain period with the corresponding number of degree-days, and average snow cover. Maps of mean degree-day isopleths for given periods may be readily constructed, from which an estimate of ice growth may be made for a given location.

Discussion by
M. S. Slivitzky

My remarks on this excellent paper will be made on one major point which is:

The limitations and the applicability of the method proposed by the author and in general the use of probability forecasting.

Mr. Williams has several times mentioned in his paper, the limitations of probability charts for predicting ice thickness. However, I feel that this point has not been emphasized enough. Reading this paper one has the impression that the only factors effecting ice growth on rivers and lakes are meteorological factors, that is that within a particular region the growth rate will be similar for one particular period. No mention is being made of the possibility of local variations due to different thermal regimes of the body of water considered. Also, we must keep in mind that the phenomenon of ice growth on rivers is quite a complex one and, I am wondering how this phenomenon can be considered on the same basis as the ice growth on lakes.

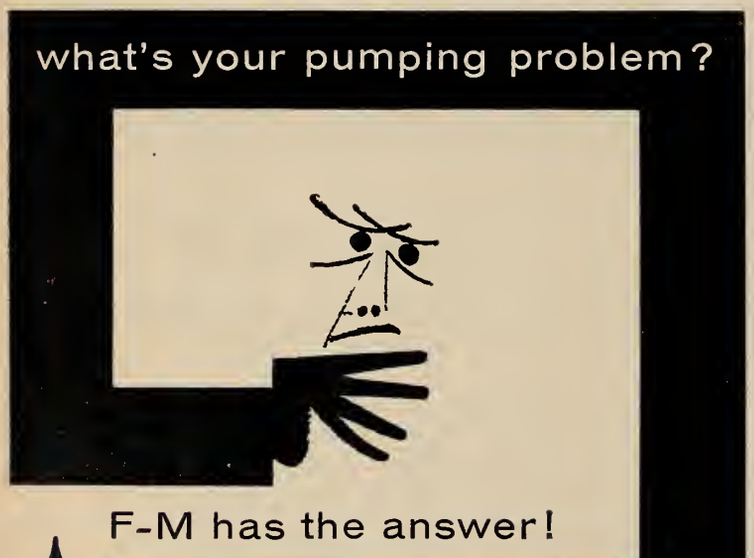
It is not unusual that one finds, when travelling during the winter time in the Canadian North, a lake with an ice thickness of about 8 to 10 inches, while at the same time, a neighboring lake only one mile apart, is covered with ice 20 to 25 inches thick; and sometimes, one will even find in the same region an ice cover so thin that it will not permit travelling across it.

Furthermore, the situation becomes much more complex when one considers now the growth of ice on rivers and, I feel that this case should not even be mentioned in the paper so as not to mislead the reader.

I know that Mr. Williams is completely aware of the complexity of this problem, but I may say that this paper has a tendency to oversimplify the problem. I cannot but wonder how this method could be an "useful alternative for predicting ice growth and ice thickness . . ."

Much use has been made lately in different fields of what may be called "probability forecasting" that is predictions based on past observations but I have yet to find a proper way to use this information completely for operational purposes.

The use of probability charts is certainly an excellent procedure to analyse, present and map a maze of information and, in this respect, the work presented in Mr. Williams' paper is a very good example, and the author must be congratulated for it. However, may I be permitted to mention that the word "prediction" or "forecasting" used in conjunction with probability charts is misleading since it does not, in my opinion, give enough information to make



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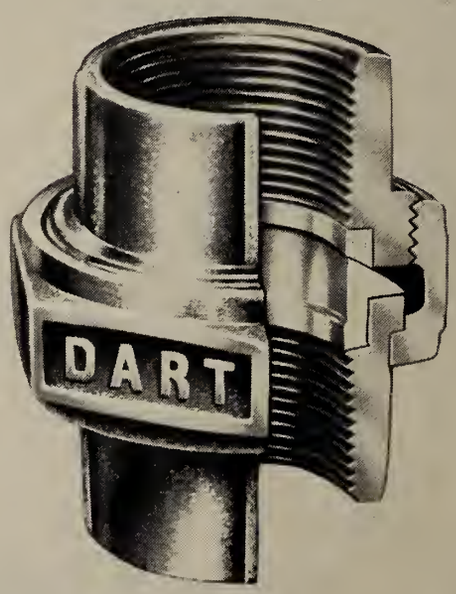

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an operational decision. How for instance can one rely on it to estimate the bearing capacity of an ice sheet?

Take for instance the example mentioned in Mr. Williams' paper, with an ice cover on a fresh water lake of 6 in.—50% of the time, that is, you have one chance in two (the probability in a game of heads and tails) that the growth rate will be greater than 5 in. in 14 days—but it may be more as it may be less.

You have only one chance in 10 that the growth rate will equal or exceed 10 in. in 14 days. Conversely you have 9 chances in 10 that the growth rate will be greater than 2 in. in the next two weeks.

As long as we cannot obtain accurate long-range weather forecasts for the next two weeks, we cannot decide on which side of the 50% case the growth rate will be—so, how can we use this information for predicting the bearing capacity?

If we do obtain accurate weather forecasts for the next two weeks (with an unknown probability) I still believe that the physical approach to the problem (heat exchange) will produce a better prediction of the expected growth of the ice.

Author's Reply

I wish to thank Dr. McTaggart-Cowan and Mr. Slivitsky for their useful comments.

Dr. McTaggart-Cowan brings into focus the purpose of the paper by stating that the chief value of this method of predicting ice growth rates, and hence ice thickness, is that upper and lower limits are obtained for ice growth rates. For many engineering problems a knowledge of these limits is often all that is required.

Dr. McTaggart-Cowan suggests the possibility of correlating ice growth over a certain period with corresponding degree-days and average snow cover. The major difficulty in applying this technique is to obtain estimates of snow depth and density. Unless these detailed measurements are available, the degree-day technique, or the heat exchange approach suggested by Mr. Slivitsky, cannot be used with confidence.

Because of space limitations the various ways in which ice covers can form on lakes or rivers were not explained in detail. As Mr. Slivitsky suggests, the process of ice formation, particularly on rivers, can be quite complex. Remarks in the paper, however, were relevant to sheet ice formation on lakes and rivers, the type of ice cover commonly used for transportation purposes.

Mr. Slivitsky mentions the possibility of local variation in ice thickness and ice growth due to different thermal regimes of water bodies. Naturally if there is a source of heat, such as warm springs or outflow from a large deep lake, ice formation will be delayed or perhaps never occur even during extremely cold weather. Once a body of water has cooled sufficiently for sheet ice to form, however, in the absence of local sources of heat the major factors causing variations in ice thickness will be weather conditions and the depth and density of the snow cover.

As Mr. Slivitsky points out, if one is forecasting ice growth and ice thickness for periods in the future, reliable weather forecasts are needed. This is true for whatever method or technique is used. If one is estimating present ice thickness at isolated sites where, in general, past weather conditions are known, probability charts can be used to advantage. If, for example, air temperature has been below average and there has been no snow in a region for a 14-day period, the rate of ice growth could be estimated with reasonable confidence from the appropriate probability chart. With this information it should then be possible to make better operational decisions on such problems as the transporting of heavy equipment or the landing of aircraft on ice covers where it has not been possible to make ice thickness measurements ahead of time.

It should again be emphasized that ice probability charts should be used with discretion, remembering that they are only a means of defining the upper and lower limits of ice growth rates. It should also be remembered, however, that the alternative methods of estimating ice thickness are not very satisfactory. One can either guess at the ice thickness or attempt to use formulae requiring detailed observations on weather, snow and ice conditions. In most cases, if one is in a position to obtain this detailed information at a site, including measurements of the snow depth and density on the ice cover, one would also be in a position to measure the thickness of the ice cover by drilling appropriate holes.

THE CANADIAN TOPSIDE SOUNDER SATELLITE ENGINEERING PERFORMANCE

R. K. Brown
Defence Research Board, Ottawa
The Engineering Journal, June, 1963
page 44

Discussion by
G. L. Lortie
Defence Research Board
CARDE

Mr. Brown's paper points out the engineering problems encountered in the design of a satellite; they are numerous and highly diversified both in nature and complexity, due to the fact that a satellite has to live in a rather peculiar environment after surviving the processes of launch, boost and orbit injection.

Mechanical stressing of the structure and payload equipments to survive 'g' loading and vibration of the launch phase does not normally present difficult problems. The automatic deployment out in space of dipoles respectively 75 and 150 ft. long now looks simple; it surely did not look that simple when this requirement was first mentioned

The description given by Mr. Brown of the different electronics systems in this satellite leads one to believe that the engineers involved in the design of these units had their share of problems considering the complicated functions these circuits had to perform and the somewhat severe restrictions of space and weight on this type of vehicle.

The results achieved in stabilizing the operating temperature of the different packages speak for themselves.

Mr. Brown had only very few words about reliability; there is no doubt that this particular factor has been a major concern to all the engineers participating in the design of the satellite. Such an experiment represents a major investment when we total all the costs, i.e. the development and production of the satellite itself, the launching rocket, the launching operation and all other logistic support. Furthermore, a satellite in orbit is in a rather awkward position from servicing point of view. It is obvious that such a system must possess a very high degree of reliability to achieve its mission successfully.

The performance of the Alouette so far has been excellent. For nearly eight months now it has been broadcasting experimental data to the Ground Recording Stations each time it has been commanded to do so.

Alouette has been a major Canadian engineering achievement in 1962. For the Canadian engineers involved, it was their first contact with space and all its unknowns. They have successfully met the challenge. I am fully confident that the forthcoming satellites of this series will be equally successful.

Discussion by
W. L. Haney
National Research Council
Ottawa

I am impressed with Mr. Brown's paper but even more so with the performance of the satellite. It is evident that the performance of the satellite is the result of more than ordinary engineering effort. Mr. Brown specifically mentions conservative ratings as an important factor, and implies, without saying so, that careful engineering studies were made. It is also true that careful pre-flight environmental tests were made. I believe most of these techniques have been used on other satellite projects. I would like to ask Mr. Brown if there are other methods, not mentioned, to which the success of the satellite can be attributed. Mr. Brown was associated with another successful and advanced electronic engineering project, the Doppler Navigator, now being manufactured by a Canadian company and successfully sold abroad in the face of considerable competition. I believe that these two successes are not a coincidence.

I understand a good many of the components in the "Alouette" are made by industry in Canada and elsewhere. Some are to Defence Research Telecommunications Establishment specifications, others of proprietary design. It would be helpful if Mr. Brown could outline the industrial contribution to this project and its effect on that part of Canadian industry taking part in the project.

A question which I believe any good engineer must ask himself, on the completion of a project, is "What did I learn from this job?" I feel that Mr. Brown probably asked himself that question, and I am sure that in spite of the obvious success of the "Alouette" he learned some better ways of doing the job a second time.

An area which is of interest to me, and I hope to others, is: How do you go about organizing a project of the scope and difficulty of the engineering of a satellite, bearing in mind the lack of previous experience, the diversity of effort required and the advanced scientific knowledge and engineering skill required?

I believe it could profitably be pointed out that while the aim of this project is to carry out a number of scientific experiments, the implementation is mainly an engineering effort of considerable magnitude and of the most advanced kind. This leads to two significant points:

i. The public, and even some of the engineering professions, are likely to regard this as solely a scientific achievement, which is only partially true.
ii. That many, if not most significant scientific experiments today are in the same class. There are many examples: giant radio telescopes, electron accelerators, space probes and so on. In all of these it is conceivable that the advances in engineering may, in fact, be as large, or larger, than the scientific gains.

To conclude, Mr. Brown and his scientific and engineering colleagues are to be congratulated on a well conceived, planned and executed engineering achievement.

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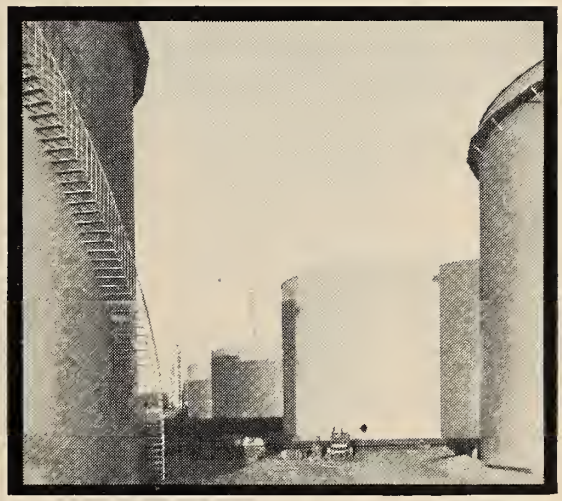

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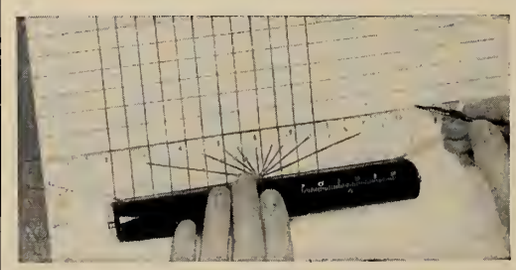

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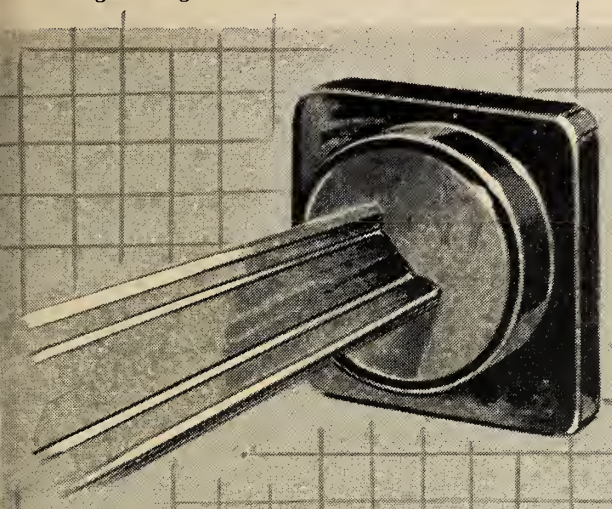

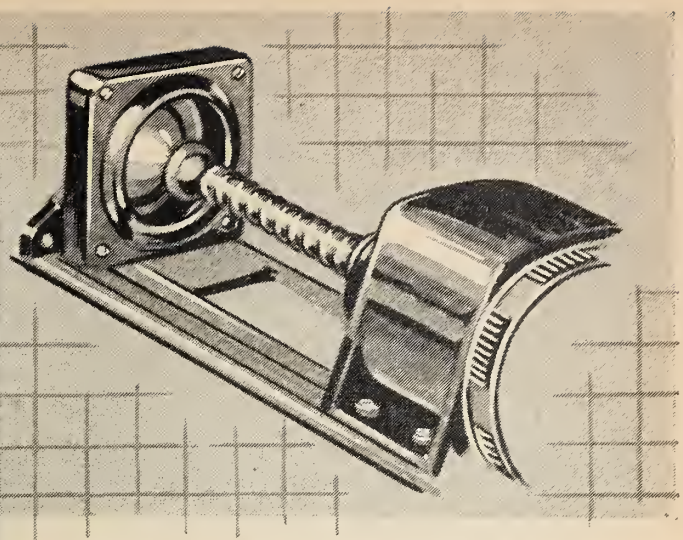

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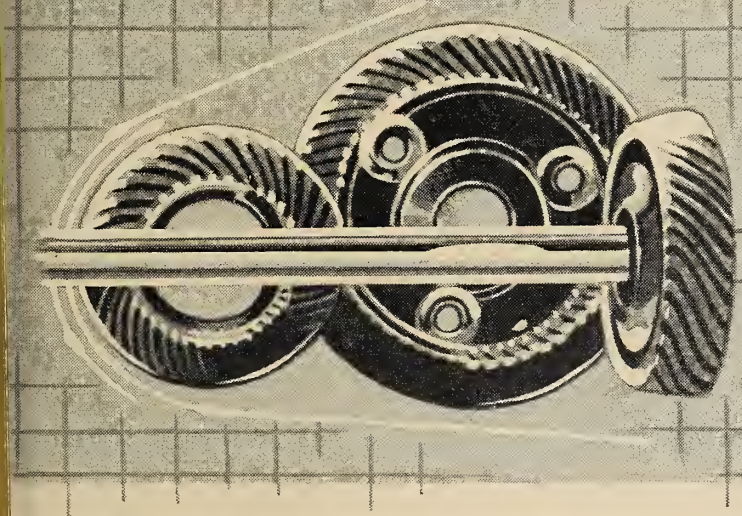

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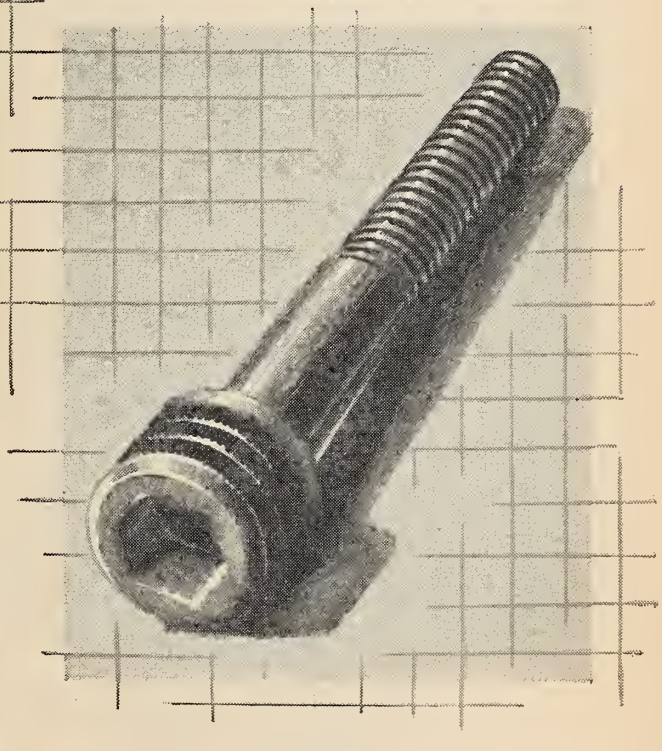

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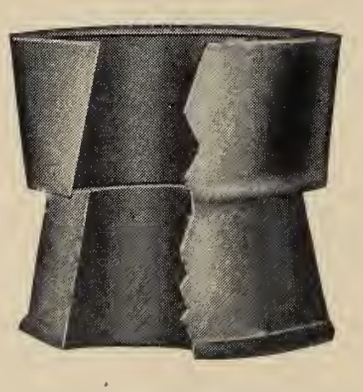

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There are openings for one senior and one junior engineer interested in a wide range of engineering relating to design, construction, testing, launching and performance analysis of earth satellites and high altitude rocket probes. This includes both design work and applied research studies in spacecraft structural systems, vibrations, vehicle dynamics, stress analysis, mechanisms for use in outer space, material behaviour, temperature control, and environmental assessment by laboratory testing and high speed computer techniques.

The work offers opportunities for travel and contact with industry and space agencies in Canada and USA.

QUALIFICATIONS:

Graduation from a recognized university with honour standing, and preferably an advanced degree. The senior position requires several years research or design experience, the mathematical maturity to carry out theoretical analysis, and potential ability to take the lead in complicated design projects. The junior position requires strong analytical and creative design potential.

CITIZENSHIP:

Candidates should be either Canadian citizens or British subjects.

STARTING SALARY:

Up to $8,800 depending on qualifications and experience.

Please apply in writing, enclosing curriculum vitae, to the:

Chief of Personnel,
Defence Research Board,
National Defence Headquarters,
Ottawa, Ontario.

and refer to File 63-DRTE-2(h)

SITUATIONS VACANT
MECHANICAL

GRADUATE MECHANICAL ENGINEER — between ages 30 and 35, wanted to head up Plant Engineering Department of medium size, long established Montreal manufacturing plant. The position involves the usual plant maintenance duties, but in addition offers considerable scope in product design and development, and via this route offers a good opportunity to a man wishing to work into a business rather than the pursuit of straight engineering duties. The company enjoys a good reputation in its field and has additional manufacturing plants across Canada. The successful applicant will be assured of the usual company benefits, such as Insurance, Retirement Plan, etc. In replying, please give full details as to education, experience, salary required, etc. to File No. 499-V.

SENIOR MECHANICAL ENGINEER — For large firm of Architects and Engineers in Toronto. Mechanical Engineer with minimum of 6 years' experience in mechanical services for large institutional, commercial and industrial buildings. Location Toronto. Potential: Chief Mechanical Engineer in Mechanical-Electrical Dept. Salary open, based on qualifications. Reply in confidence giving full resume to File No. 500-V.

MECHANICAL ENGINEERING GRADUATE — Experienced man for maintenance and engineering department of a large manufacturing firm in East Toronto. Employee benefits include group insurance, medical, hospital and pension plan. Good opportunity for advancement. State full particulars regarding experience, personal data and salary acceptable to File No. 481-V.

SCIENTISTS
SYSTEMS ENGINEERS

Continued expansion in our research and development activities has created a number of excellent growth opportunities for ambitious and imaginative Engineers. Immediate positions are available for:

SCIENTISTS — at all levels, capable of analyzing data and developing computer methods for the recognition of sound patterns. Applicants should have University standing in Physics, Maths or Engineering, and a knowledge of multivariate analysis. Experience in Computer applications will be an asset.

SYSTEMS ENGINEERS — with experience in Digital and Analogue Systems, Navigational and Tactical Systems, Input and Output and Display Systems, Avionics Systems.

Reply, giving full details of qualifications to:

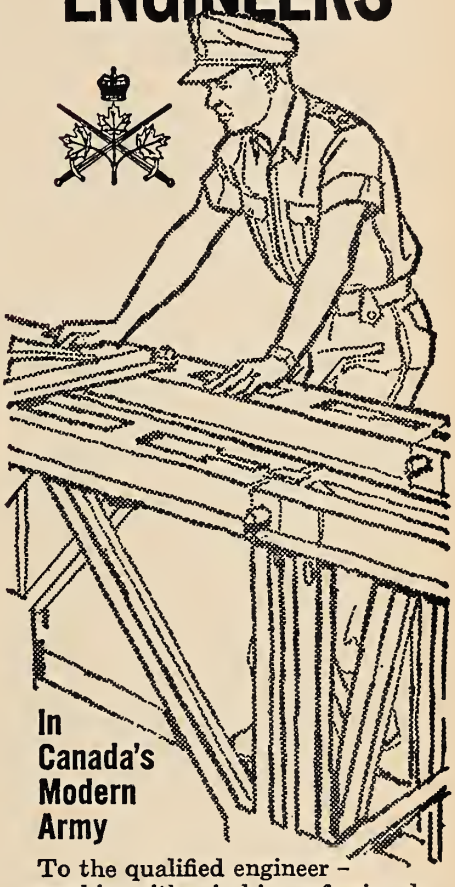
Industrial Relations Department
COMPUTING DEVICES OF CANADA LIMITED
Box 508, Ottawa, Ontario.

SITUATIONS VACANT
MISCELLANEOUS

SALES ENGINEER — An ambitious Sales Engineer required by a long established manufacturer of scientifically designed lighting equipment. Because of plans for expanding facilities during the balance of this year and 1964, an excellent opening for a man looking to his future. Training will be given the right man in application procedures with consultants, architects, utilities, industrial and municipal engineers. Although a younger graduate preferred, this could be a profitable opportunity for a more mature man in the sales engineering field. File No. 501-V.

INDUSTRIAL ENGINEER — Registered Professional Engineer required by modern distillery, located approximately 40 miles from Montreal. Work will involve the setting of production standards and other varied engineering work. One to five years' industrial experience. Salary commensurate with training and experience. File No. 502-V.

A REWARDING CAREER FOR ENGINEERS



In Canada's Modern Army

To the qualified engineer – working either in his professional capacity or using his training to solve problems of command — Canada's modern Army offers a career rich in interest and rewards.

Applications from graduate and professional engineers between 18 and 30 for commissions in the Canadian Army (Regular) are now being accepted by the Royal Canadian Engineers, the Royal Canadian Corps of Signals and the Royal Canadian Electrical and Mechanical Engineers.

Here is your outstanding opportunity to combine an engineering career with the prestige and benefits of life as a serving officer.

Apply to —

DIRECTORATE OF MANNING
ARMY HEADQUARTERS
OTTAWA, ONTARIO

E62-7

SALES ENGINEER

Major U.S. manufacturer of mining and construction equipment, with Canadian facilities, selling through independent distributors, seeks Sales Representative for Ontario, Quebec, and the Maritime Provinces. Qualifications include college degree, preferably mining or mechanical engineering, or equivalent experience with mining or construction equipment. Applicant should be Canadian citizen, between age 30 and 37, bilingual (French and English), and have capabilities for assuming broader responsibilities in reasonably near future. Write to File No. 505-V.

SITUATIONS VACANT

MISCELLANEOUS

PLANT MANAGER — Required by leading metal and plastic toy manufacturing organization in Montreal. This is a key administrative position that requires top-flight management skills in an atmosphere of high speed manufacturing. While a professional engineer is preferred, serious consideration will be given to men with comparable education and practical experience. This is a very challenging position that offers complete responsibility for production, personnel and plant. Salary open. Age 30-40. Enquiries invited in confidence. Please send resume to File No. 504-V.

ENGINEERING GRADUATE — We require an engineering graduate familiar with surface mining plant equipment to take charge of our plant maintenance activities. This is a desirable opening in a good location. Send outline of experience and qualifications to File No. 498-V.

STRUCTURAL ENGINEER — New expanding firm requires structural engineer with experience in reinforced concrete and structural steel for industrial buildings. Good salary commensurate with experience. Excellent opportunity for leadership and advancement. File No. 496-V.

ENGINEERING SALES — industrial instrumentation and control field. Opening available for young engineer as sales trainee. Plant experience helpful but not necessary. Send qualifications and resume to E. R. Huckman, Sales Manager, Foxboro Co. Ltd., 707 Dollard Ave., LaSalle, Que. File No. 497-V.

TEACHING

THE UNIVERSITY OF MANITOBA. Applications will be received for the position of Head of the Department of Civil Engineering. Qualifications required are Ph.D. and experience in research. Duties will commence September 1st, 1964. Write to J. Hoogstraten, Vice-President — Development, University of Manitoba, Winnipeg 19, Manitoba. File No. 425-V.

THE UNIVERSITY OF MANITOBA. Applications will be received for the position of Dean of Engineering. Qualifications required are Ph.D. and experience in research in Civil, Mechanical or Electrical Engineering. Duties will commence September 1st, 1964. Write to J. Hoogstraten, Vice-President — Development, University of Manitoba, Winnipeg 19, Manitoba. File No. 425-V.

DIRECTOR PUBLIC HEALTH ENGINEERING required for Public Health Services VICTORIA B.C. Civil Service

SALARY $9,840 PER ANNUM, RISING TO $11,100 PER ANNUM.

Duties include organizing and supervising staff of professional engineers and assistants engaged in the investigation of all engineering problems affecting public health.

Appliants must be Canadian citizens or British subjects eligible for registration in the B.C. Association of Professional Engineers; must possess a degree in Engineering plus a post-graduate degree in Public Health or Sanitary Engineering, or equivalent qualification; must have an excellent knowledge of water and sewage problems, epidemiology, refrigeration, and ventilation and the relationship between engineering and medicine; should be an accomplished public speaker and able to prepare comprehensive technical reports.

For applicatioin forms apply IMMEDIATELY to The Chairman, B.C. Civil Service Commission, 544 Michigan Street, Victoria, B.C. COMPETITION NO. 63:388.

AERODYNAMICIST or AERONAUTICAL ENGINEER for the DIRECTORATE OF INDUSTRIAL RESEARCH

DEFENCE RESEARCH BOARD

OTTAWA, ONTARIO

The Directorate administers an extensive program of applied research in Canadian Defence Industry, including several major aeronautical projects relating to STOL and VTOL aircraft, and power plants.

The immediate requirement is for a competent engineer to be responsible for initiating and monitoring research in advanced aerodynamic concepts applicable to V/STOL flight performance and aircraft design; aircraft performance analyses; evaluating research proposals in relation to defence requirements; carrying out liaison with laboratories in Canada, USA and Britain on advanced aerodynamic research, and co-ordinating and advising on aeronautical research programs in Canadian universities.

QUALIFICATIONS:
At least a Bachelor degree with honour standing in Aeronautical Engineering or Engineering Physics from a recognized university, and several years' relevant experience in industry or an advanced research laboratory.

CITIZENSHIP:
Candidates must be Canadian citizens or British subjects.

STARTING SALARY:
Up to $10,500 a year, depending on qualifications and experience.

Please apply in writing, enclosing curriculum vitae, to the:

CHIEF OF PERSONNEL, DEFENCE RESEARCH BOARD
NATIONAL DEFENCE HEADQUARTERS,
OTTAWA, ONTARIO

and refer to File 63-DIR-1 (j)

Present staff is aware of this advertisement.

NOTICE

TO ADVERTISERS

DEADLINE — Please note that requests for insertions must be submitted in writing not later than the **12th of the preceding month.**
Cancellations: same as above.

SITUATIONS VACANT — Classified rate: $6 per column-half-inch per insertion. Display rates: Per insertion — 1/12 page — $100; 1/8 page — $115; 1/6 page — $155; 1/4 page — $195; 1/3 page — $255; 1/2 page — $320.

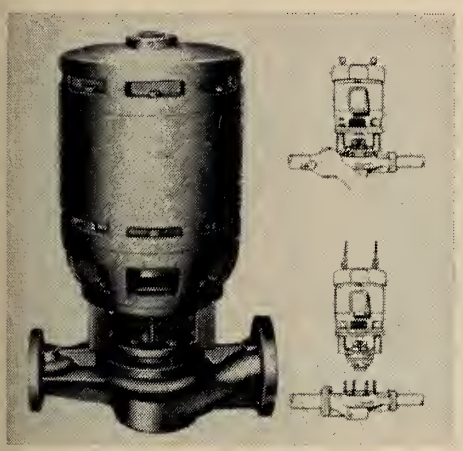
DATE IN CIRCULATION — 20th of month.

SITUATIONS WANTED — Accepted free of charge from Members of The Engineering Institute of Canada only.

Engineering Briefs

(Continued from page 73)

THE CENTRIFUGAL VERTICAL in-the-line pump introduced by Canadian Ingersoll-Rand Co. Limited, requires little or no floor space, cuts installation costs and reduces maintenance checks due to its pull-out design. The in-the-line pump allows easy change of the impeller or motor to match the required operating condition. The pump has no base-plate or base mountings and therefore alignment problems during installation or replacement are eliminated. The pump, a single-stage, radially-split centrifugal unit, is mounted directly in the pipe line on reinforced suction and discharge flanges. The pump is available in 1, 1½, 2 and 3 inch discharge sizes. The horsepowers range from 1½ through 100. Head limits range to 520 feet, with capacities to 725 gallons per minute.



Ingersoll-Rand's Centrifugal Pump.

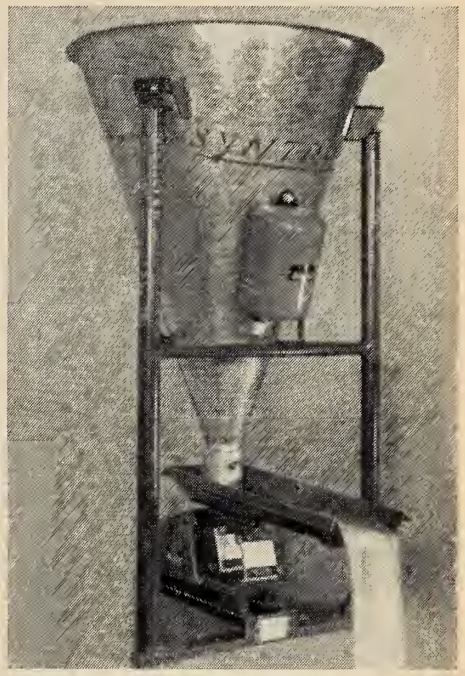
PROCOR LIMITED has announced the availability of new tank cars that keep food cold without refrigeration. The "cold" car holds fruit juices and other food products near freezing during long hauls in hot weather. No mechanical cooling is needed. The tanks use the thermos principle of a "tank within a tank", the cars stainless steel inner tank being enclosed in a foot-thick pillow of plastic foam insulation.

ROBERT MORSE CORPORATION LIMITED is the new name of The Canadian Fairbanks-Morse Company Limited, distributor of scales, pumps, diesel engines, machine tools and other industrial products. The reason for the name change is to eliminate any confusion between this independent Canadian company and the United States Fairbanks, Morse & Co.

CANADIAN GENERAL ELECTRIC has announced the availability of the new Type 185 edgewise indicating instruments. These self-shielded ammeters and voltmeters, designed for vertical or horizontal mounting, measure 2¼ inches wide by .91 inch high by 3 inches long. They are available in a-c rectifier models and in d-c ratings from 20 microamps to 10 amps self-contained, 300 volts maximum self-contained.

THE MODEL AHF-K WIRE FEEDER, combines light weight rugged construction with high wirefeed speed and scratch start option. Designed for use with either standard or heavy duty Model 21-B water-cooled push-type Aircomatic gun, the feeder will handle aluminum wires from 3/64-inch through 3/32-inch diameter. The feeder, available from Air Reduction Canada Limited, will also handle hard wire from 0.035-inch through 1/16-inch, and 5/64-inch stranded wire. It is ideally suited for production line welding of aluminum.

SYNTRON DRY FEEDER MACHINES are compact packaged units designed for accurate volumetric metering of dry materials in any process. Feeding capacities run from a minimum of 5 lb. to 20,000 lb. per hour in standard range of outputs. Each unit is complete with a vibrated hopper and an electromagnetic vibratory feeder operated by a flow control mounted at a nearby spot or a remote location. The units available from Syntron (Canada) Limited, Stoney Creek, Ont., can be set for continuous operation or controlled for intermittent operation where necessary.



Syntron Dry Feeder Machines

DYMAX is a new nonmetallic strapping material introduced by Signode Canada Ltd., which has the ability to contract more than five per cent after tensioning. The Dymax strapping has been developed jointly by Signode and the DuPont Company. The new material is one of DuPont's Dymetrol continuous precision forms made of a nylon about four times as strong as conventional nylons. Its average tensile strength is 60,000 p.s.i. Dymax is offered in tensile strengths of 475 lb., 630 lb., 790 lb., and 950 lb. Each of the four is ½ inch in width.

MASTERSEAL is a new compound that both cures and seals concrete surfaces in one application. Available from The Master Builders Company, Toronto, Masterseal exceeds ASTM moisture retention requirements at the usual rate of 200 sq. ft. per gallon, and also exceeds requirements at 450 sq. ft. per gallon. Masterseal need not be removed to set tiles, develops higher concrete strengths, reduces dusting by sealing the surface, dries colorless and can be use on plain or colored architectural concrete.

OPPORTUNITIES
in HYDRODYNAMICS AND SUPPORTING ENGINEERING
with THE DEFENCE RESEARCH BOARD OF CANADA
in A HYDROFOIL RESEARCH PROJECT
at THE NAVAL RESEARCH ESTABLISHMENT
DARTMOUTH (HALIFAX), NOVA SCOTIA

The Minister of National Defence announced on 17 May, 1963, that plans had been approved for design and construction of a prototype hydrofoil ship for the Royal Canadian Navy, and that an industrial contract had been awarded. This is a key development in a new and unproven field, to extend the anti-submarine capability of the RCN. More than ten years of hydrofoil studies at the Naval Research Establishment will now be expanded to support this development and prepare NRE for future requirements. For example, the hydrodynamics of towed sonar bodies and cables needs special study.

Several requirements exist, one for a senior experienced man, the others for more junior staff, who would be employed in the team.

QUALIFICATIONS:
Senior Position: An aeronautical engineer or naval architect with ability and experience in hydrodynamics (for aerodynamics), both theoretical and experimental, who has the capability to head the team now forming. This man must command the professional respect of fellow workers, military technical staff, and industrial engineers. He must have personal suitability — the leadership, tact, and drive needed in a team head — and have been employed for several years in a responsible position.

Junior Positions: The three following are sought:
(a) An engineer or physicist with experimental ability and some background in hydrodynamics or aerodynamics.
(b) An engineer with instrumentation and servo-mechanism experience.
(c) A mechanical engineer with experience in the design of experimental equipment.

SALARY:
Initial annual salaries may reach $13,600 for the senior, and $10,500 for the junior positions, depending on qualifications and experience.

Enquiries are invited from qualified Canadians or British subjects. Information and application forms are available from:

Chief Superintendent
Naval Research Establishment
c/o Fleet Mail Office
Halifax, N.S.

or

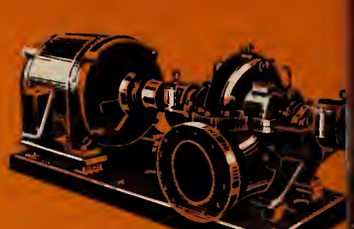
Chief of Personnel
Defence Research Board
National Defence Headquarters,
Ottawa, Ontario.

and refer to file 63-NRE-1g

Present staff is aware of this advertisement.

CA-C ENGINEERING IS ON THE MOVE

Motors



Pumps

Texrope Drives

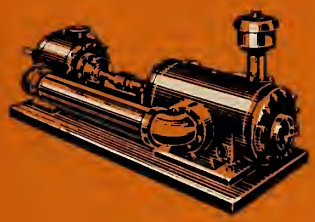
Centrifugal blow

Hydraulic Turbines

Condensers

High voltage cc

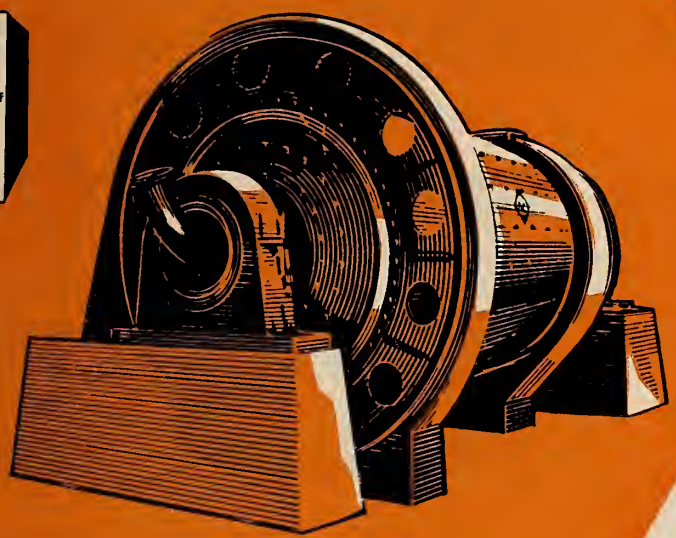
Low voltage control



Crushers

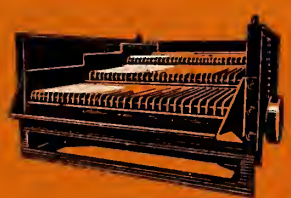
Rotary compressors

witchgear



alves

Grinding Mills



Screens

Rotary Kilns

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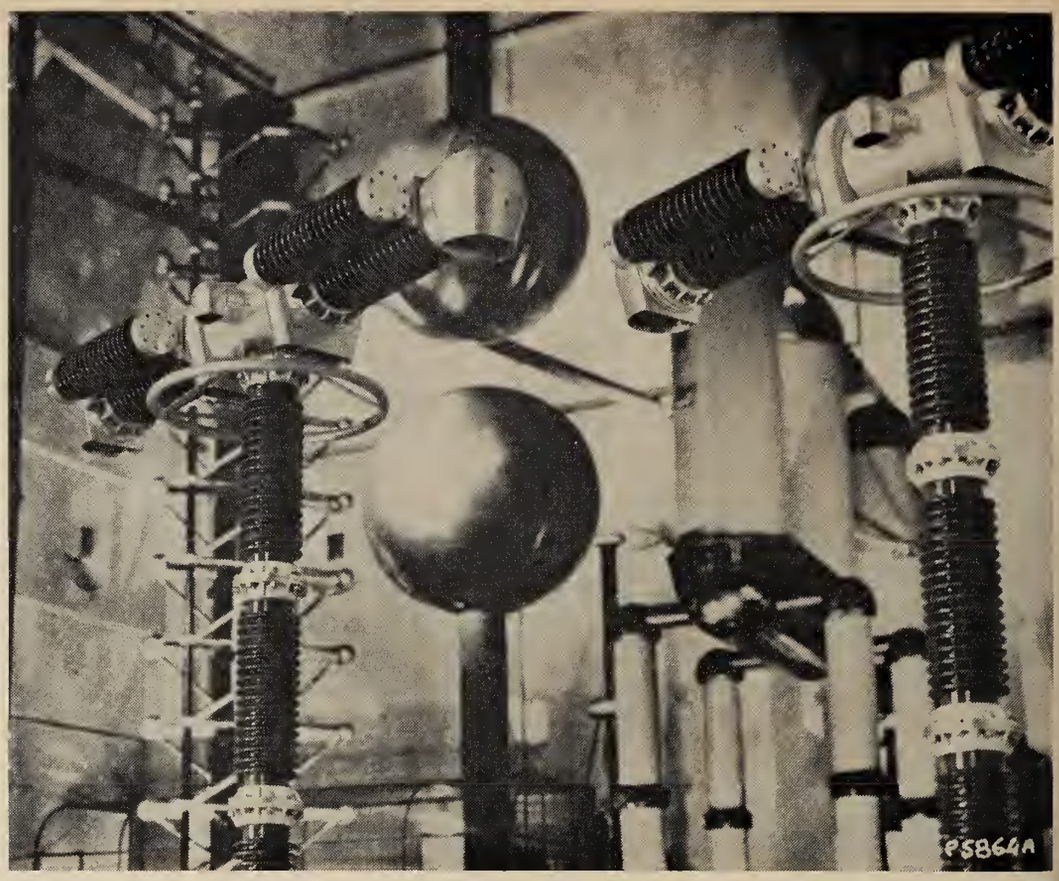
There are new products, new functional designs, new refinements on proven ideas in Canadian Allis-Chalmers products these days. CA-C engineering is on the move . . . making good products better. Check the unusual diversity of the Allis-Chalmers line, as illustrated, then get our *latest* product facts before you specify.

62CI

CANADIAN ALLIS-CHALMERS



P K Air blast circuit breaker under tests at CERDA Laboratory (Villeurbanne, France)

Some News in E. H. V....

A.C.E. DELLE ("Switchgear" branch of the French group "Compagnie Générale d'Electricité") will deliver extra high voltage circuit breakers to Canada in 1965 and 1966.

FOUR of these breakers will be installed on the 735 kv. Hydro-Quebec system and will be a part of the equipment transmitting electrical power from Manicouagan River scheme to Montreal area.

THREE of these breakers will be installed on the 525 kv. HEPC of Ontario system and will be a part of the equipment transmitting electrical power from the Moose River scheme to Toronto area.

On the occasion of the French Exhibition in Montreal (October 11-27, 1963) one 735 kv. prototype pole will be displayed.

Also at the same exhibition it will be possible to examine

- a 69 kv. outdoor draw-out unit with circ. break. and met. Transf.
- a 12-13.8 load break switch associated with fuses
- a L.V. limiting circuit breaker, etc.

CEGELEC

Delle

Please address enquiries to:

CEGELEC CANADA INC.
P.O. Box 130,
Laprairie, P.Q.
Tel. 659-5495

France in Canada Exhibition

MONTREAL

THE SHOW MART

October 11-27

The latest achievements of French engineering and of French industry will be featured during this ambitious exhibition.

A technical program is being held in conjunction with the exhibition. Sessions will be from October 15 through October 25. Papers will be presented in French but will be translated simultaneously into English.

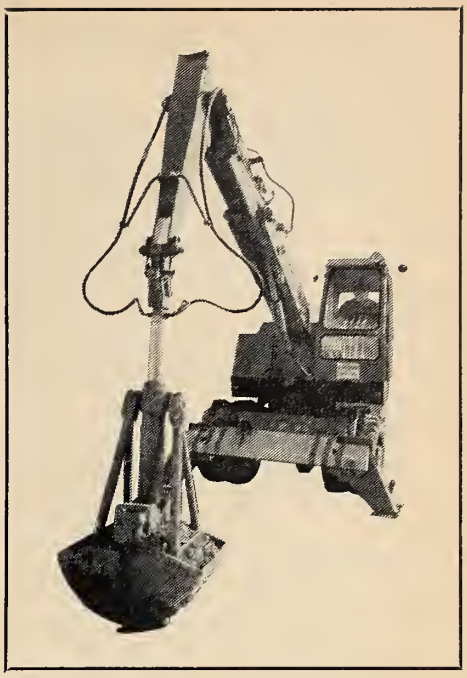
Topics will cover a wide range of engineering and science and in many instances two or three sessions will be held simultaneously. Papers will be presented at the Show Mart and at the Hydro Quebec Building in Montreal.

FOURTH INTERNATIONAL ANALOGUE COMPUTER MEETING — 1964

A world-wide conference on automatic control will be held in Brighton, England, starting Sept. 14, 1964. The conference will be known as the Fourth International Analogue Computer Meeting, 1964. It is being sponsored by the International Federation of Automatic Control (IFAC) of which the Engineering Institute of Canada is a member.

Papers are being sought for this meeting. The deadline for the submission of summaries is Oct. 31, 1963. Authors will be informed by a refereeing committee within three months whether their papers have been accepted for presentation.

Those interested in submitting papers should write to the Manager of Technical Services at the Headquarters of the EIC, 2050 Mansfield St., Montreal 2, Que.



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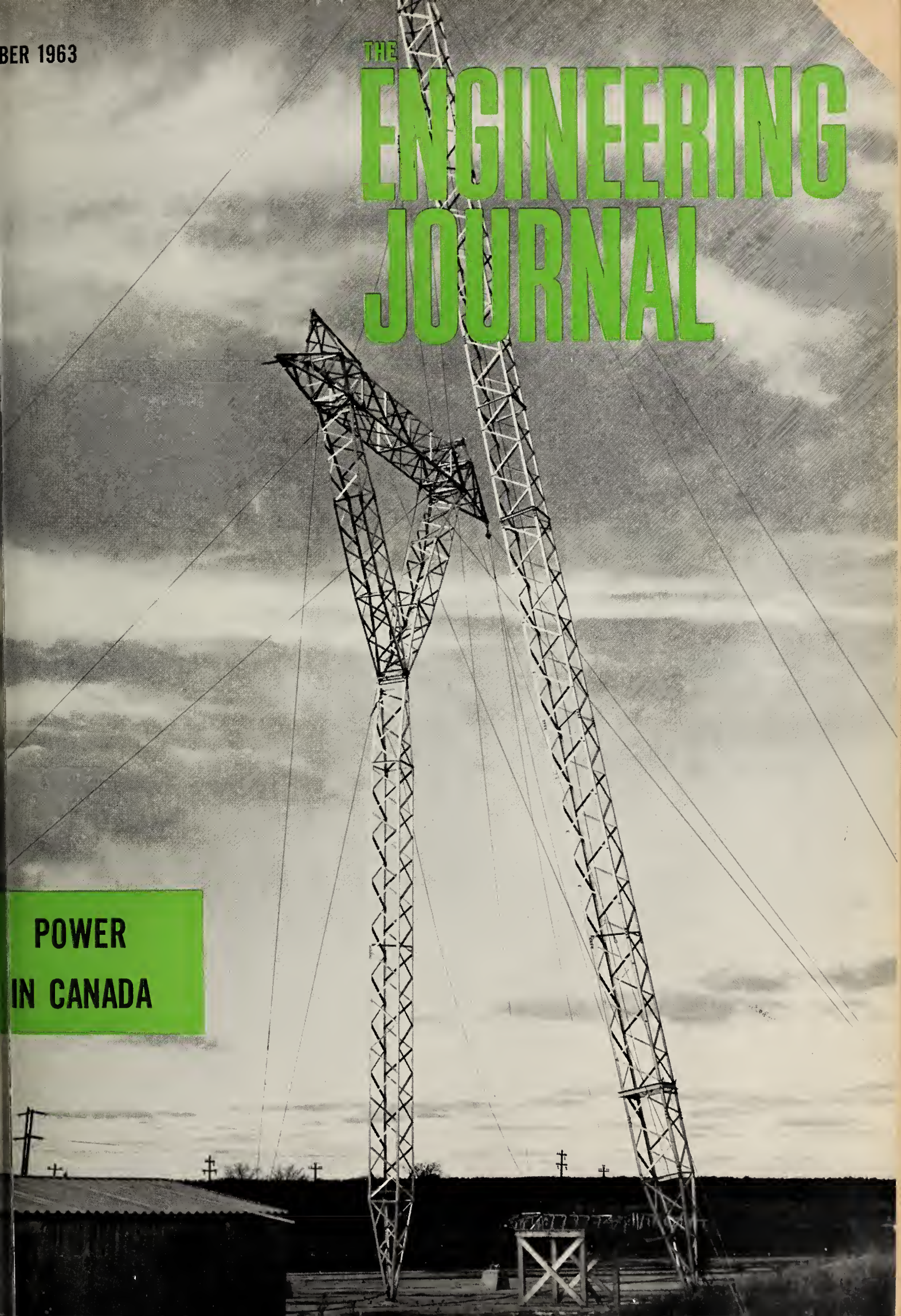
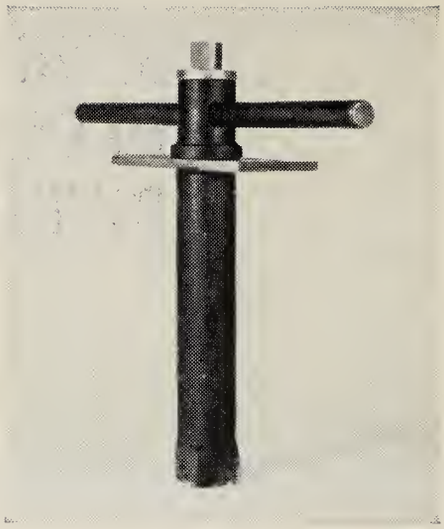
THE ENGINEERING JOURNAL



POWER IN CANADA



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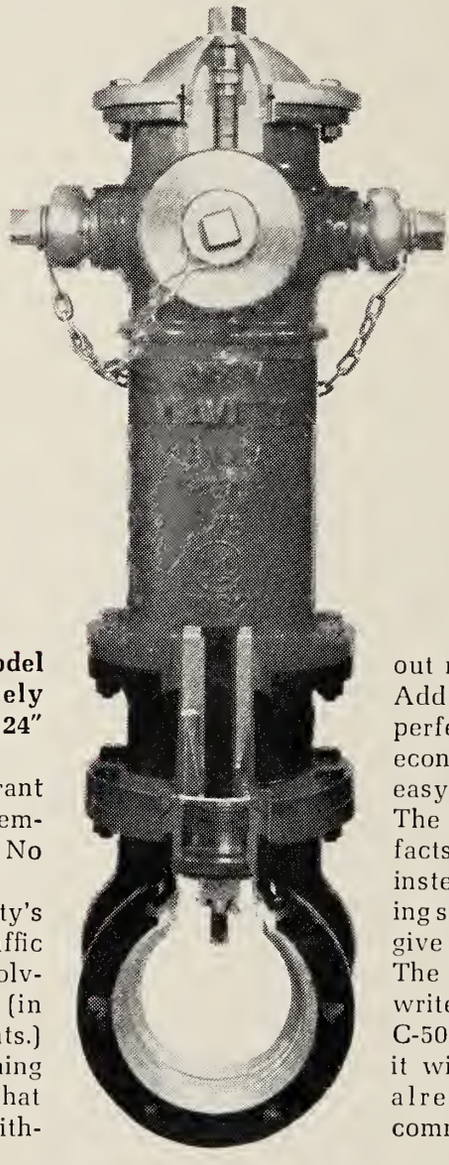

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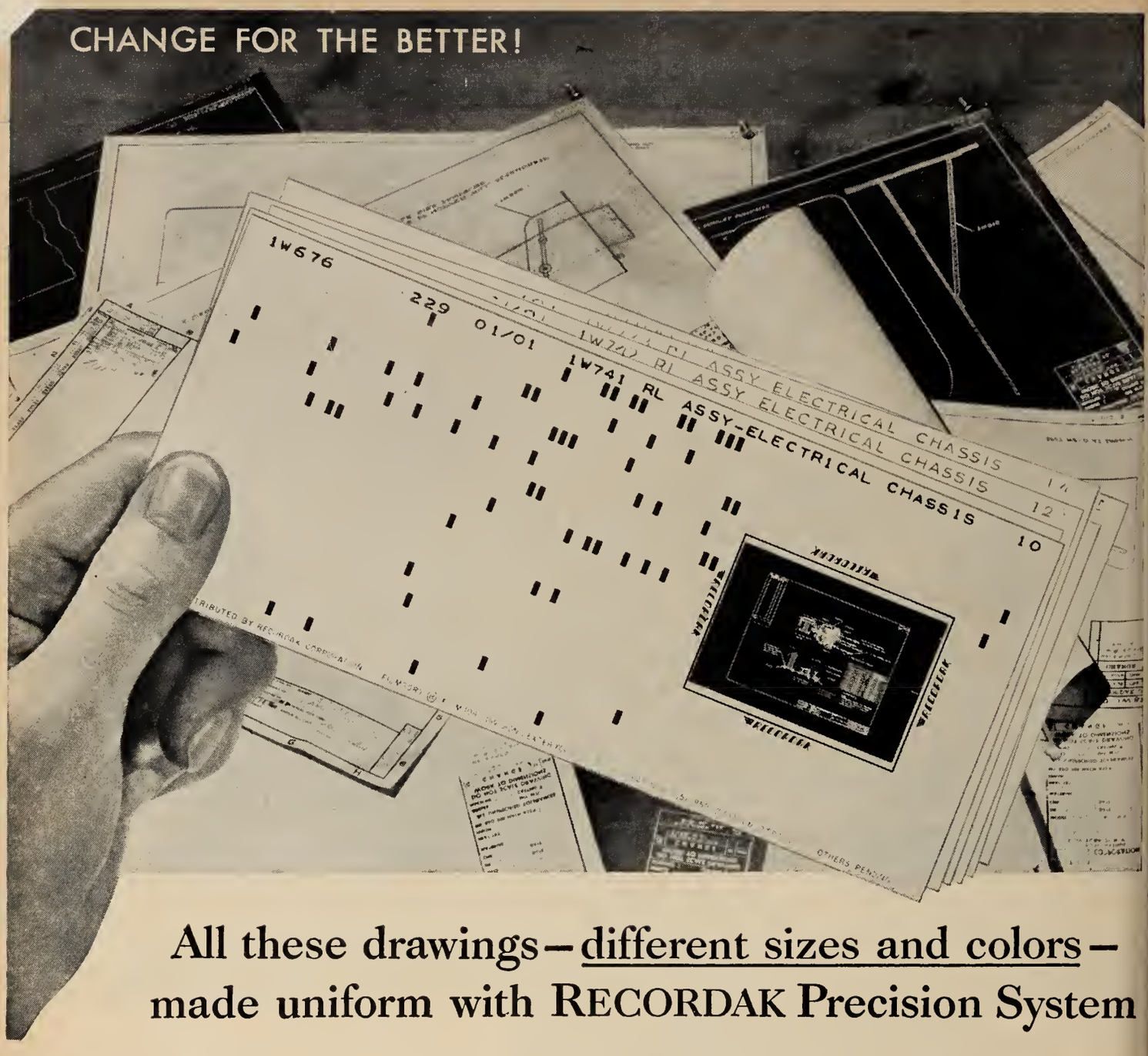

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Photomicrograph courtesy Forest Products Research Branch, Department of Forestry, Ottawa showing the innocent looking, bamboo-like tubes called hyphae, (or, in mass, mycelium) which cause wood rot. They are an air-borne form of plant life of a very low order.

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IN THIS ISSUE

COVER ILLUSTRATION

Symbolizing Power in Canada is one of Alcan's new "Y" transmission towers being tested near Kingston, Ont. The Hydro-Electric Power Commission of Ontario has ordered 200 of these towers and Calgary Power has 134 on order. (Photo courtesy the Aluminum Company of Canada).

By taming the Manicouagan and Aux Outardes Rivers, the Quebec Hydro-Electric Commission plans to meet the next 15 years' soaring power demands in the province. Started in 1959, the project now is well underway and work is progressing in accordance with established plans. In his paper, **The Manicouagan-Aux Outardes Power Project, F. Rousseau,** Assistant General Manager, Power Development, Hydro-Quebec acquaints members of the engineering profession with the broad lines of the project, points out some of its highlights and the progress to date.

R. M. Harvey, M.E.I.C. of the Aluminum Company of Canada, Shipshaw, Que., in his paper, **Installation of In-Span Transpositions in 345 KV Transmission Lines,** describes the unique project of installing the transpositions with full tension on the conductors. The lines which were transposed consisted of two, single circuit, 345 kv. transmission lines strung with two 850 MCM ACSR conductors per phase carried on waist type towers in a horizontal configuration.

Design and Operation of Coal Handling Facilities at the Wabamun Steam Plant by **Zen Kolisnyk** of Montreal Engineering Co. Ltd., presents the coal handling methods used and the coal handling system design at the Calgary Power Ltd., Wabamun Steam Plant. The design considerations for the provision of a continous flow of fuel to the steam generators at a minimum cost per ton are set forth and discussed. The paper outlines the development of the final design as the result of solving problems peculiar to the installation, selecting the most suitable alternatives and catering for the future extensions to ultimate capacity. The resulting design, equipment and controls are fully described. The paper closes describing the subsequent operating experiences of the system.

In their paper, **Till Cofferdams Dumped in Water,** authors **J. I. Adams,** Engineer in the Soils Section, Structural Research Department, of the Hydro-Electric Power Commission of Ontario, and **D. J. Bazett,** Supervising Engineer, also with the HEPC state that a number of cofferdams have been successfully constructed by dumping till directly into water. These have consisted of homogeneous sections in water up to 25 feet deep and till-faced rock fill sections in water up to 40 feet deep. In all observed cases a succession of slips allowed partially-saturated material to form the bulk of the tills; borings in the tills and a few piezometer measurements confirmed this. Reasonable factors of safety were obtained in analysis where assumptions based on the initial placement of partially saturated material were used. A study of the quantities placed in a number of cofferdams indicated that reasonable estimates could be made for this type of material.

SPECIFY AND
BUY CANADIAN

Outside appearance is no indication of boiler performance. Where design *really* counts is *inside*. In Inglis Type "PK" water tube package boilers, design is based upon one aim — to give you more steam for your money!

Outstanding features of Inglis design include tangent tube construction in both the furnace and outer side walls; sealed inner or "skin" casing; extra heating surface for greater heat absorption; and faster circulation through shorter tubes.

Other features include the integral mounted burner and control system stack mounted on boiler to save floor space; bolted outer steel casing; and factory piping, wiring and testing of all units.

Call your local Inglis engineer to get *all* the facts on efficient, lower cost steam generation.

Inglis **TYPE 'PK' STEAM GENERATORS**

JOHN INGLIS CO. LIMITED

TORONTO MONTREAL WINNIPEG CALGARY VANCOUVER

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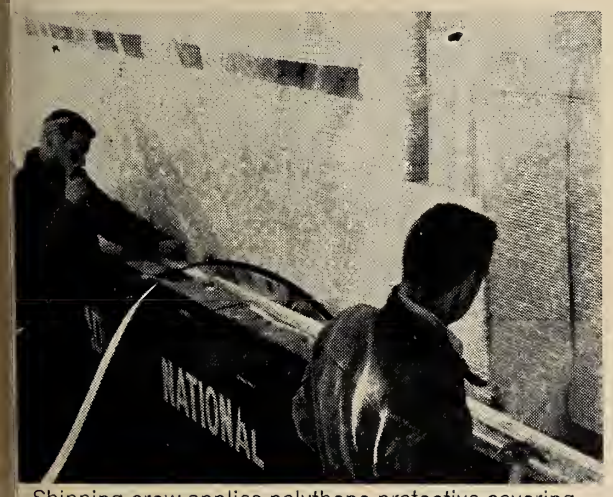
Sixty tons of Steel-strapped wallboard on CNR flatcar equipped with permanent-end bulkheads. Acme heavy-duty strap is used.

Acme Steel Strapping made it possible

to double the load in one-third the time with open-top, stakeless loading



Shipping crew applies polythene protective covering then secures load with Acme Steel Strapping.

High manhour costs of loading and unloading such bulky commodities as wallboard were a problem—until Acme Steel sales engineers combined with Canadian National Railways to solve the problem. The solution? Flatcars equipped with permanent-end bulkheads . . . loads securely anchored with Acme Steel Strapping.

Now 60 tons of wallboard can be loaded instead of the usual 30 . . . "open-top" loading takes only 6 to 9 manhours compared with 18 to 24 in closed equipment . . . shipments can be weatherproofed . . . delivery time is substantially reduced . . . savings all along the line from mill to customer.

Acme Steel Strapping applications are not confined to wallboard alone—lumber, plywood and many other commodities can be loaded and strapped just as well.

ACME STEEL IDEA LEADER IN **STRAPPING**

Canadian Produced for Canadian Progress

ACME STEEL COMPANY OF CANADA, LTD.
Dept. EJ-10, 743 Warden Ave., Toronto 13, Ont.
Please send me examples of how others in my business are saving time and money with Acme Steel Strapping.

Name_____ Title_____

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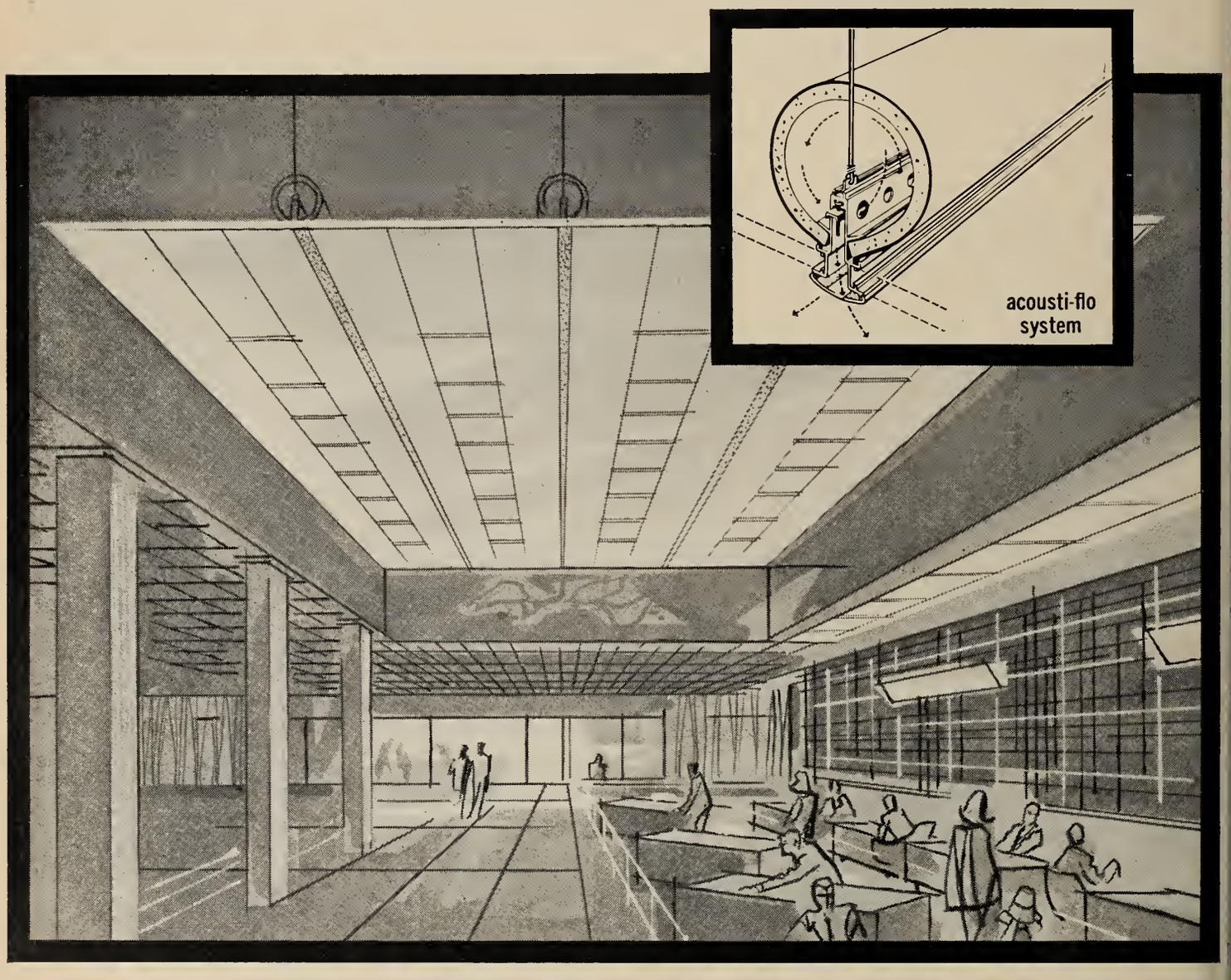
New Product from Fiberglas

ACOUSTI-FLO AIR DISTRIBUTION SYSTEM

DELIVERS AIR SILENTLY, UNIFORMLY THROUGH DIFFUSER BARS THAT ALSO ACT AS A T-BAR CEILING SUSPENSION



Fiberglas Acousti-Flo System is a new low velocity method of introducing conditioned air into a room quietly and uniformly through perforated metal bar diffusers integrated with the ceiling. The diffuser bar also becomes a T-bar hanger for ceiling suspension.

Add Fiberglas Acoustical Ceiling Modulars and polarizing light panels, and you have an attractive, functional ceiling system with built-in air distribution, soft even lighting, noise control and thermal efficiency. The Acousti-Flo tube conveys air down the length of the bar, absorbs system noise, and insulates against heat loss or gain. Ceiling soil around outlets is virtually eliminated. Simple, 4-step installation. An important feature of this Fiberglas system is that it eliminates the costly relocation of diffuser outlets when partitions are being moved.

Acousti-Flo is particularly adaptable for difficult cooling and heating jobs where a large number of air changes are required. It performs well under these conditions without creating annoying drafts or noise. Write today for full details.

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Late Engineering News

Shawinigan Conference Outstanding Success

An excellent technical program and extremely hard-working committee members contributed to an outstanding technical conference at Shawinigan, Que., Sept. 27-28. The conference, organized by the St. Maurice Valley and Eastern Townships Branches of the Institute, included a meeting of the Executive Committee, plant visits, and fine ladies' and social programs. Chairman of the Conference was Wally Ingram of Shawinigan.

The Conference was off to a head start Sept. 26 with evening registration and a civic reception at City Hall offered by the City of Shawinigan.

President Higginson opened the conference officially the following morning before some 150 delegates split to attend the technical sessions. Seven papers were presented in two sessions. Two of the papers were presented in French, three in English, and two had bilingual presentation.

The Executive Committee worked through a heavy agenda while the technical sessions were being held.

An overflow crowd was present at lunch which had as its highlight a very entertaining and thought-provoking speech. The speaker was Ken Farthing, Manager of Advertising and Public Relations at Canadian Westinghouse Limited, Hamilton, who talked "About Half An Hour."

At the close of the afternoon's technical sessions there was a plant visit to the Shawinigan Water and Power Company Generating Station at Shawinigan. The evening consisted of a cocktail hour, dinner at which President Higginson spoke, and a dance.

On the final day visits were organized at the Domtar Coating Operation, and the Municipal Water Filtration Plant, both in Trois-Rivieres. A mixed golf tournament was planned at nearby Grand'Mere.

Vancouver Branch Chairman Represents Institute At National Highway Meeting

Charles F. Ripley, M.E.I.C., Chairman of the Institute's Vancouver Branch, represented the EIC at the National Highways Conference held in Ottawa Sept. 18 and 19.

The Canadian Construction Association sponsored the Conference of all Associations and other groups interested in promoting a national highways policy for the co-ordinated development of roads and highways in Canada.

The Conference was called to permit all interested parties to meet and present papers outlining their approaches to the need for a National Highways Policy with a view to presenting a consolidated brief to the federal government on the need for, and advantages of such a policy.

Institute Ably Represented At Automation Conference

A. George Morton, M.E.I.C. ably represented the EIC at the Ontario Government's Conference on Automation and Social Change held in Toronto Sept. 17-19. Mr. Morton is Management Assistant, Manufacturing Department, Imperial Oil Enterprises Ltd., Toronto. The conference was under the joint sponsorship of the Ontario Economic Council and the Department of Economics, Development, Labour and Education.

To ensure that the Conference will have a lasting effect, the Ontario Economic Council will be appointing a Committee on the Impact of Technological Change on Provincial Legislation. Its purpose will be to carry on where the Conference leaves off and to formulate specific recommendations for government action. The committee will also provide a forum for continued representation from outside bodies.

National Group Studies Teaching Of Mathematics

The Engineering Institute has been asked to assist a national study on modern methods of teaching mathematics to engineering students. The study is being conducted by the Committee for Scientific and Technical Personnel of the Organization for Economic Co-operation and Development.

The matter was given serious consideration at the Sept. 27 meeting of the Executive Committee held in Shawinigan, Que. It was decided to establish a special committee on which the Engineering Education Division of the Committee on Technical Operations, the Deans' Committee, and the Student Guidance Committee will be represented.

Robert Shaw, M.E.I.C., Named Deputy Commissioner For 1967 Canadian World Exhibition

Robert F. Shaw, M.E.I.C., President of the Foundation Company of Canada Ltd., has been appointed Deputy Commissioner General of the Canadian World Exhibition (Montreal 1967).

Mr. Shaw, a native of Montreal, joined the Foundation Company as a laborer and foreman in 1933, the year he graduated from McGill University as a civil engineer.

He was, successively, a steel erector with Dominion Bridge, labor foreman with A. Janin and Company Limited, and construction manager with Duranceau and Duranceau, Montreal, before rejoining the Foundation Company in 1937 as an engineer and estimator.

Since then he has served as: salvage engineer and construction manager; assistant to the Vice-President in charge of construction; assistant to the President; and manager of Engineering.

In 1951 he joined Defence Construction (1951) Limited, on loan as Vice-President, Director and Chief Engineer. The following year he was on special assignment to NATO in Paris as a member of the working party engaged in assessment of the SHAPE airfield construction program.

On his return to Canada in 1953, Mr. Shaw was appointed Vice-President of special projects for the Foundation Company. One of the major projects under his direction was the DEW line. In 1958, he became Executive Vice-President of the Foundation Company, and in 1962 was appointed President and Director.

EIC World's Fair Committee Active

The Institute's strong World's Fair Committee consists of Chairman F. L. Lawton, Brig. J. P. Carriere, Brig. M. L. Archer, and Dr. R. L. Dunsmore. A prime reason for its formation was the need to further the participation of engineers in the 1967 World's Fair. The Committee has asked for the assistance of Life Members and EIC Branches in producing a source book on Canadian engineering achievements.

The Institute was invited by H. Leslie Brown, Chairman of the Canadian Government Committee, 1967 Exhibition, to be represented on a working group on Canadian achievements appointed to assist the Committee. It was arranged that Mr. Lawton, immediate past-President of the Institute, to undertake this assignment.

Strong Team Of European Experts Examine Canada's Technical Manpower Pool

A team of five European experts have just completed a five-week visit to Canada during which they reviewed the scientific and technical personnel situation here. The importance of the inspection is underlined by the number of examiners, and by the length of their visit. In most cases visits of well less than a month are undertaken by three-man teams.

The visit is part of the operation of the Organization for Economic Co-operation and Development, of which Canada is a member.

The members of the examining team for Canadian review were:

Roger Gregoire, Counseiller, Conseil d'Etat, Paris, and Consultant, Development Department of the Organization for Economic Co-operation and Development;

Dr. Ralph W. Tyler, Director, Center for Advanced Study in the Behavioral Sciences, Stanford, Calif. Dr. Tyler is also a member of the United States National Science Board, and of the Panel on Educational Research and Development, U.S. Office of Science and Technology;

Dr. G. Norman Burkhardt, Assistant to the Vice-Chancellor Senior Tutor, the Faculty of Science, University of Manchester, England. Dr. Burkhardt is a member of the Promotion Council for the new University of Lancaster, of the Executive of the Universities Central Council on Admissions, and is a Fellow of the Royal Institute on Chemistry;

John E. Vaizey, Fellow of Worcester College, Oxford, England, and formerly Director, Research Unit in the Economics and Administration of Education, Institute of Education, University of London;

George L. Payne, Chief, Special Projects Branch, Office of Program Planning, National Institutes of Health, Bethesda, Md. Mr. Payne is also Head, Country Review Section, Directorate for Scientific Affairs, O.E.C.D.

The Organization for Economic Co-operation and Development was established under a Convention signed in Paris three years ago by the member countries of the Organization for European Economic Co-operation and by Canada and the United States. This Convention provides that the O.E.C.D. shall promote policies designed to:

Achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;

Contribute to sound economic expansion in member and non-member countries in the process of economic development.

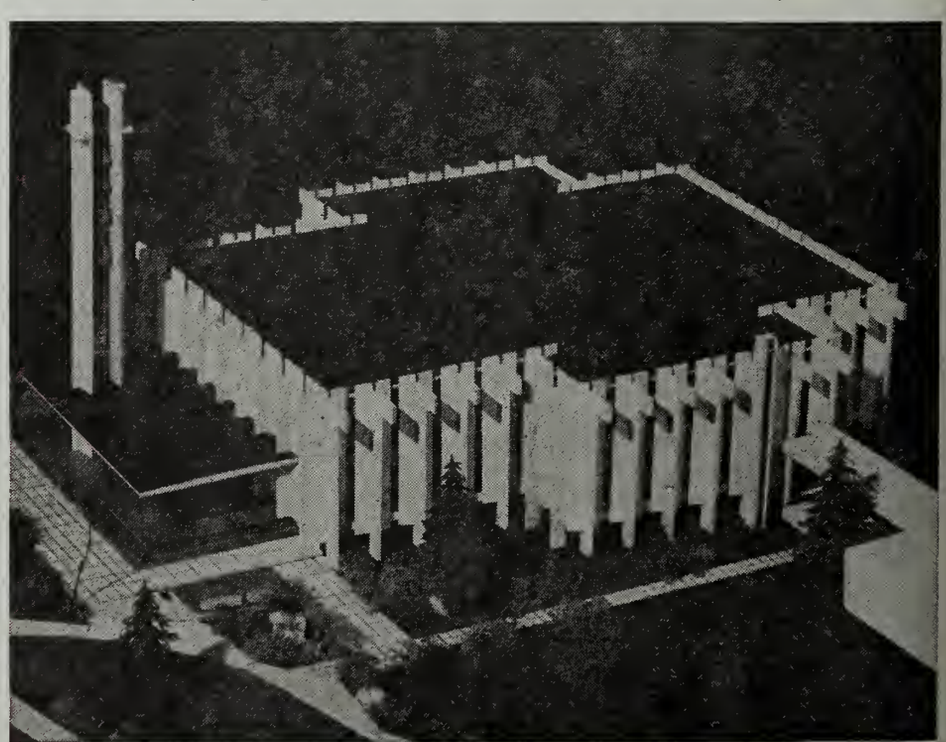
Contribute to sound economic expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The members of the O.E.C.D. are Austria, Belgium, Canada, Denmark, France, West Germany, Greece, Iceland, Ireland, Italy, Luxemburg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

A program for the periodic review of the scientific and technical manpower problems of individual member countries was started in 1958. These reviews were started to help the national authorities to assess their future technical manpower needs, and to provide a forum for discussion of these needs.

Canada's Advisory Committee on Professional Manpower, on which the E.I.C. is represented, has already provided the O.E.C.D. with considerable background material on scientific and technical personnel in Canada.

A church in the Montreal suburb of Cote St. Luc has won for its designer, Maurice Robillard of Montreal, the Prestressed Concrete Institute 1963 Award. The winning structure features prestressed concrete tee forms on the sides and bell tower, as well as for the floor and roof. Mr. Robillard's design was selected from more than 100 entries in five provinces and 28 states in the United States. All the judges were American. Among the entries beaten by Mr. Robillard's church was the United States Science Pavilion, 1962 World's Fair, Seattle. According to Mr. Robillard, the use of prestressed and precast techniques were especially advantageous because of the economies effected in allowing construction during winter months. The 16,000-square-foot church was built at a cost of $230,000.



The Government of Ontario
invites you to the

MANUFACTURING OPPORTUNITIES SHOW

Queen Elizabeth Building
Exhibition Park
Toronto, Nov. 26-27-28

TO DISPLAY IMPORTED PARTS

The Government of Ontario invites Canadian industries to take space at the Manufacturing Opportunities Show. By displaying component parts which you now import, you may locate Canadian suppliers which will mean better service and lower overall costs.

TO ATTEND AND QUOTE

The Government of Ontario invites Canadian fabricators and other secondary manufacturers to visit the Manufacturing Opportunities Show and to quote on the parts on display. These parts are now imported by Canadian manufacturers: you may be able to supply them at a profit for your business, and at the same time contribute to the stability of the Canadian economy.

GOVERNMENT OF ONTARIO

MANUFACTURING OPPORTUNITIES SHOW

Queen Elizabeth Building, Exhibition Park, Toronto, Ontario • November 26-27-28, 1963

Name _____

Title _____

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Address _____

☐ I am interested in displaying imported parts at a booth in the show.

☐ I am interested in attending the show and quoting on imported parts.

Please send me full information.

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Mail to Trade and Industry Branch, Department of Economics and Development, 454 University Avenue, Toronto 2, Ontario.

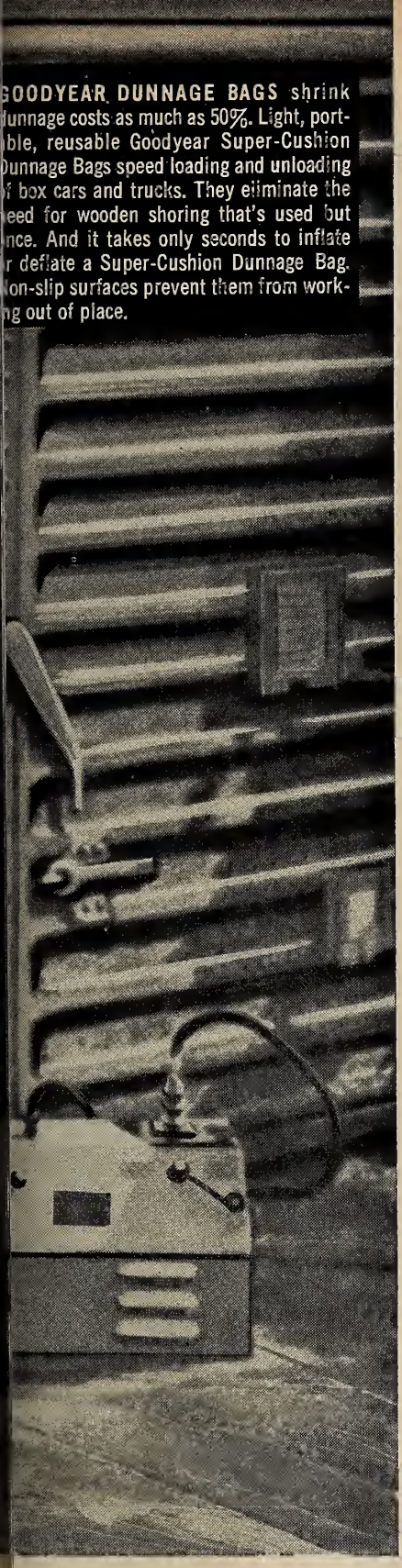
LONGER LIFE FOR PUMPS. Rubber lined pump casings and impellers provide a high degree of resistance to corrosion and abrasion. There are few limits on sizes or shapes of equipment that can be protected.

IDLER COVERING SLEEVES extend idler life . . . have successfully defeated the ravages of build-ups of corrosive, sticky "fines" that play havoc with unprotected steel idlers. Can be applied by your maintenance staff.

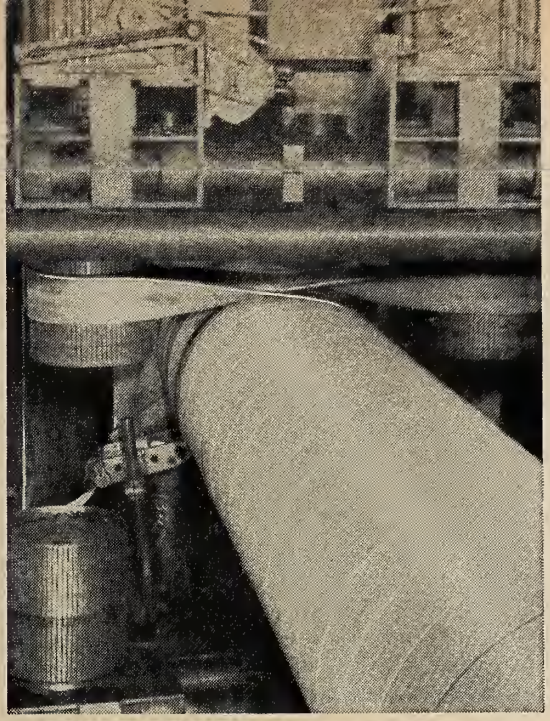
HOW GOODYEAR HAS SOLVED VARIED PRODUCTION PROBLEMS

Thousands of men in industry are well awar that Goodyear is an outstanding producer of belting and hose . . . that is good, and a it should be. However, there is far more to industrial rubber products than meets the eye For instance, Goodyear supplies hundreds of products and services that are seldom seen o heard about. Illustrated are but a few. Such items as rubber linings for pumps, rubbe coverings for idlers, dunnage bags, sheet packing, pillow tanks, molded and extrude rubber products are proven money-saving solutions for specific problems. Goodyea

TO BE SURE CAL

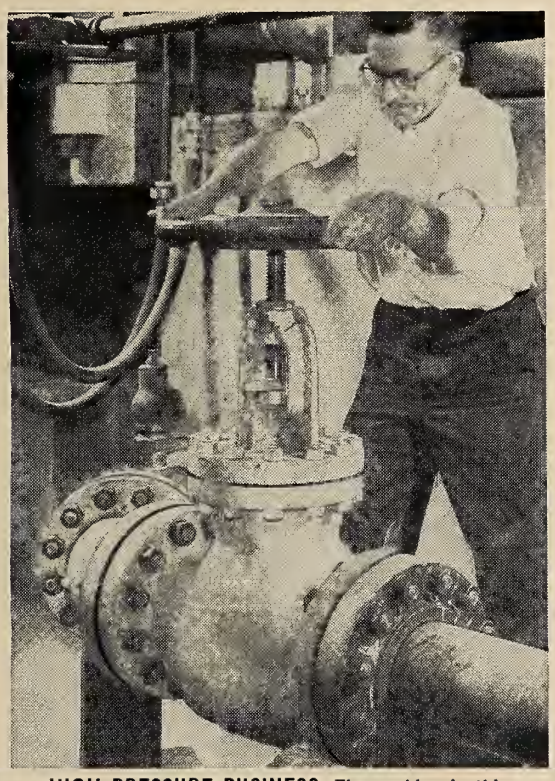


GOODYEAR DUNNAGE BAGS shrink dunnage costs as much as 50%. Light, portable, reusable Goodyear Super-Cushion Dunnage Bags speed loading and unloading of box cars and trucks. They eliminate the need for wooden shoring that's used but once. And it takes only seconds to inflate or deflate a Super-Cushion Dunnage Bag. Non-slip surfaces prevent them from working out of place.

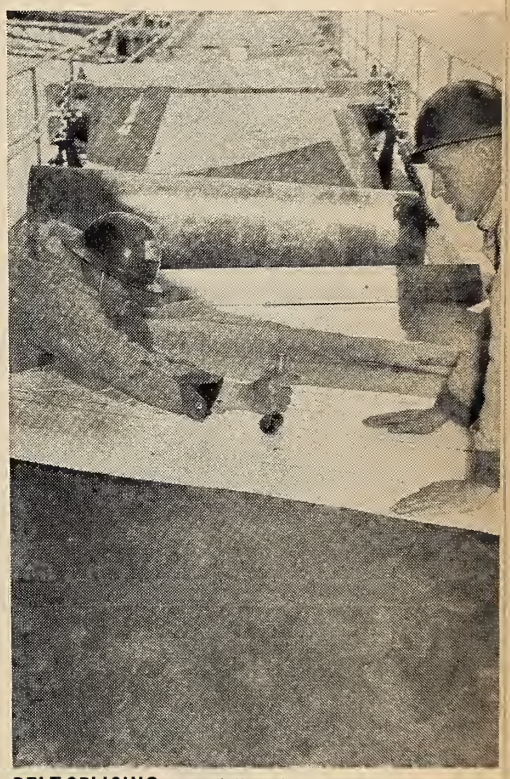


DOING THE TWIST! This Compass Belt literally rolls glued paper into place, evenly and smoothly on a steel mandril to form sturdy cardboard tubes. Severe action on the belt is constant tension and twisting.

GOODYEAR PLIOWELD RUBBER LINING for large or small tanks is ideal for the storage of acid or corrosive materials. Goodyear can design and supply metal tanks with Plioweld lining for any job . . . any size.



HIGH PRESSURE BUSINESS. The packing in this stop valve holds 250 lbs. of hydraulic pressure. Goodyear Sheet Packing stops burn-outs, blow-outs and squeeze-outs of steam, acids, alkalis, fats and petroleum products.



BELT SPLICING, a specialized Goodyear service. When the splice is vulcanized a belt becomes a complete unit with equal guaranteed strength throughout. Goodyear is equipped to service the belt splicing needs of industry.

Technical Service is extremely versatile . . . has an open mind . . . works to a dual objective of improving operations and holding your costs to a minimum. To help achieve this, Goodyear will work with your personnel, to analyse situations on existing equipment and on projects in the planning stages. □ Again and again, Goodyear Technical Service has proved that the right solution to a problem boils down to the right job analysis . . . the right recommendation and the right industrial rubber product. Make sure you get all three, call your nearest Goodyear Branch or Head Sales Office, Bowmanville, Ontario.

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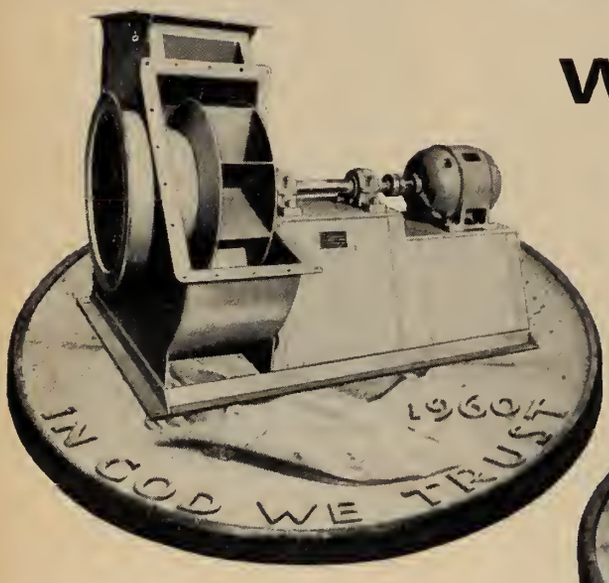

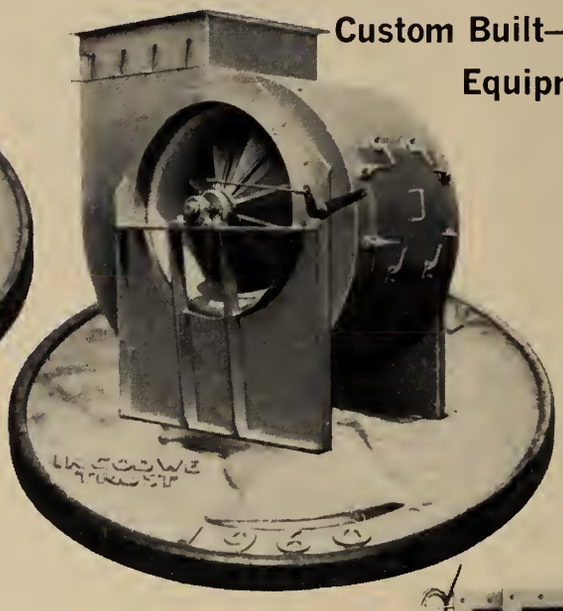

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- Wet Collectors
- Induced Draft Fans
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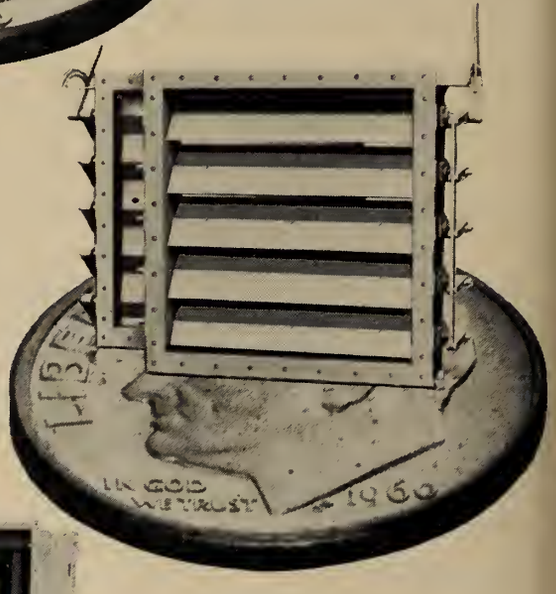

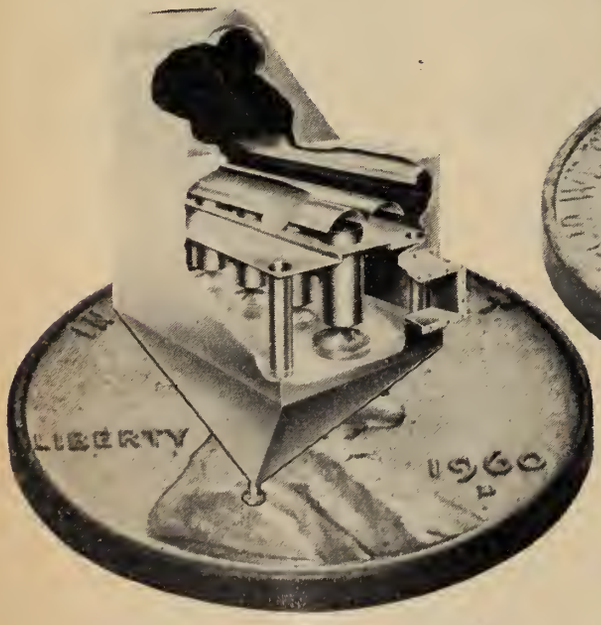

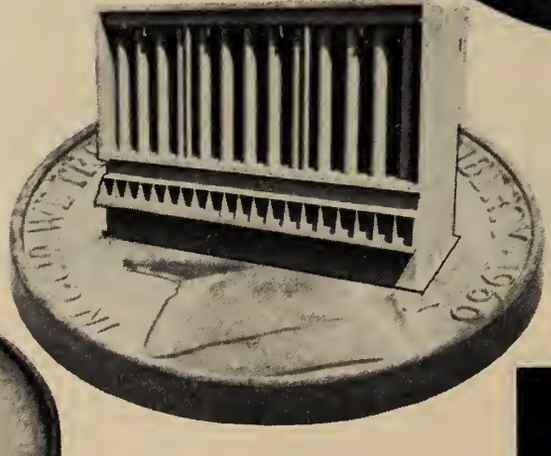

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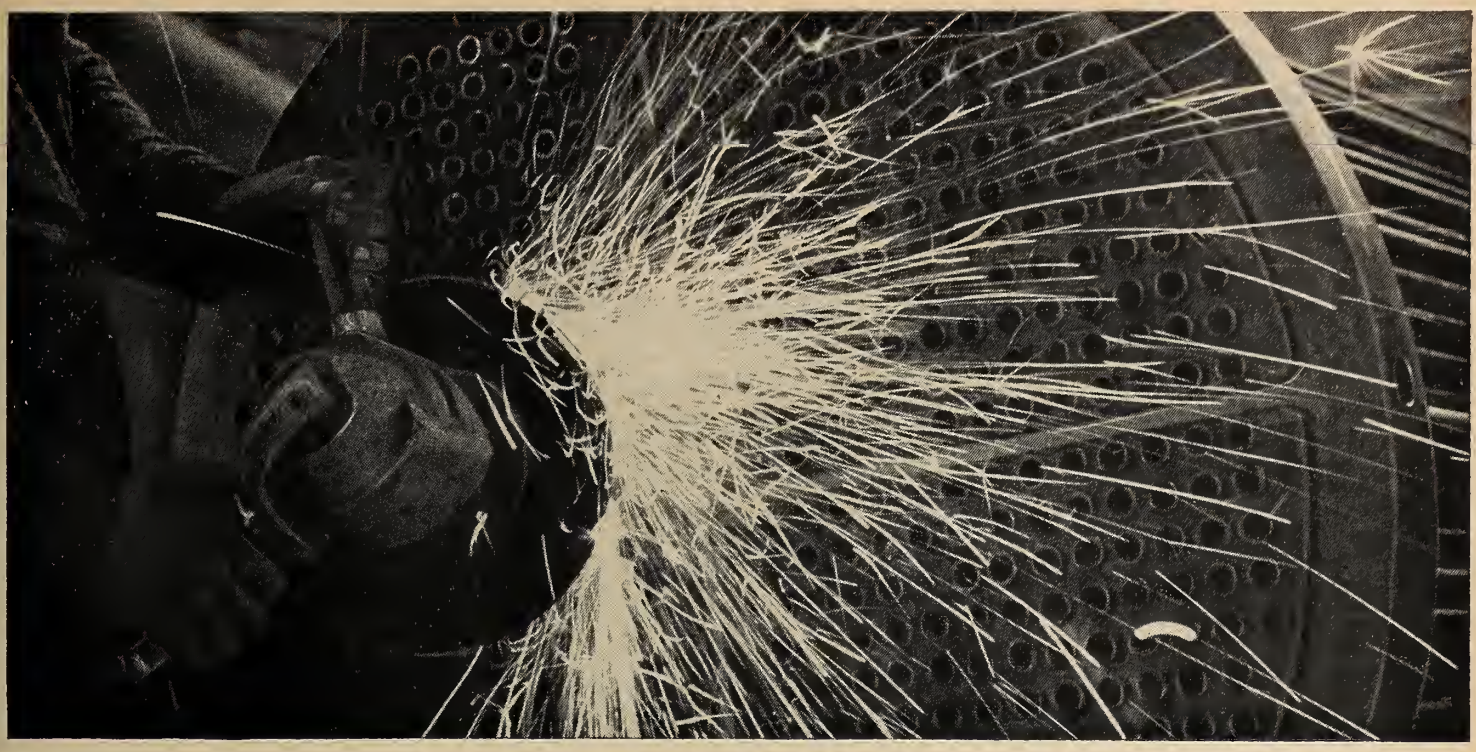

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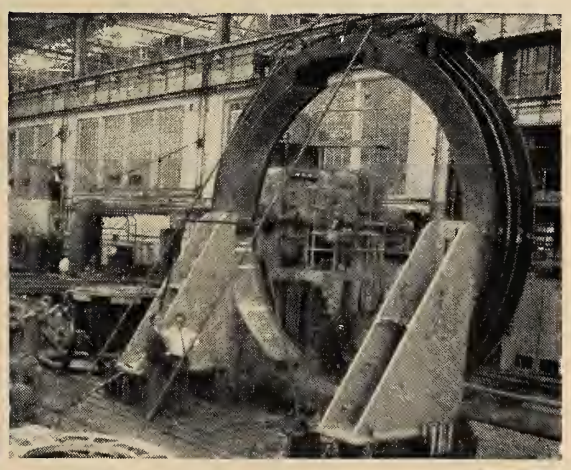

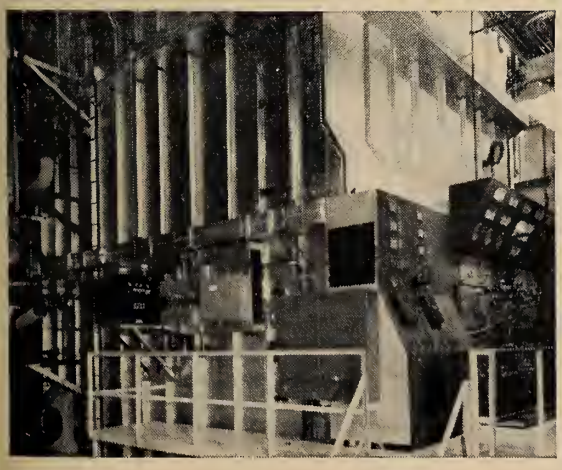

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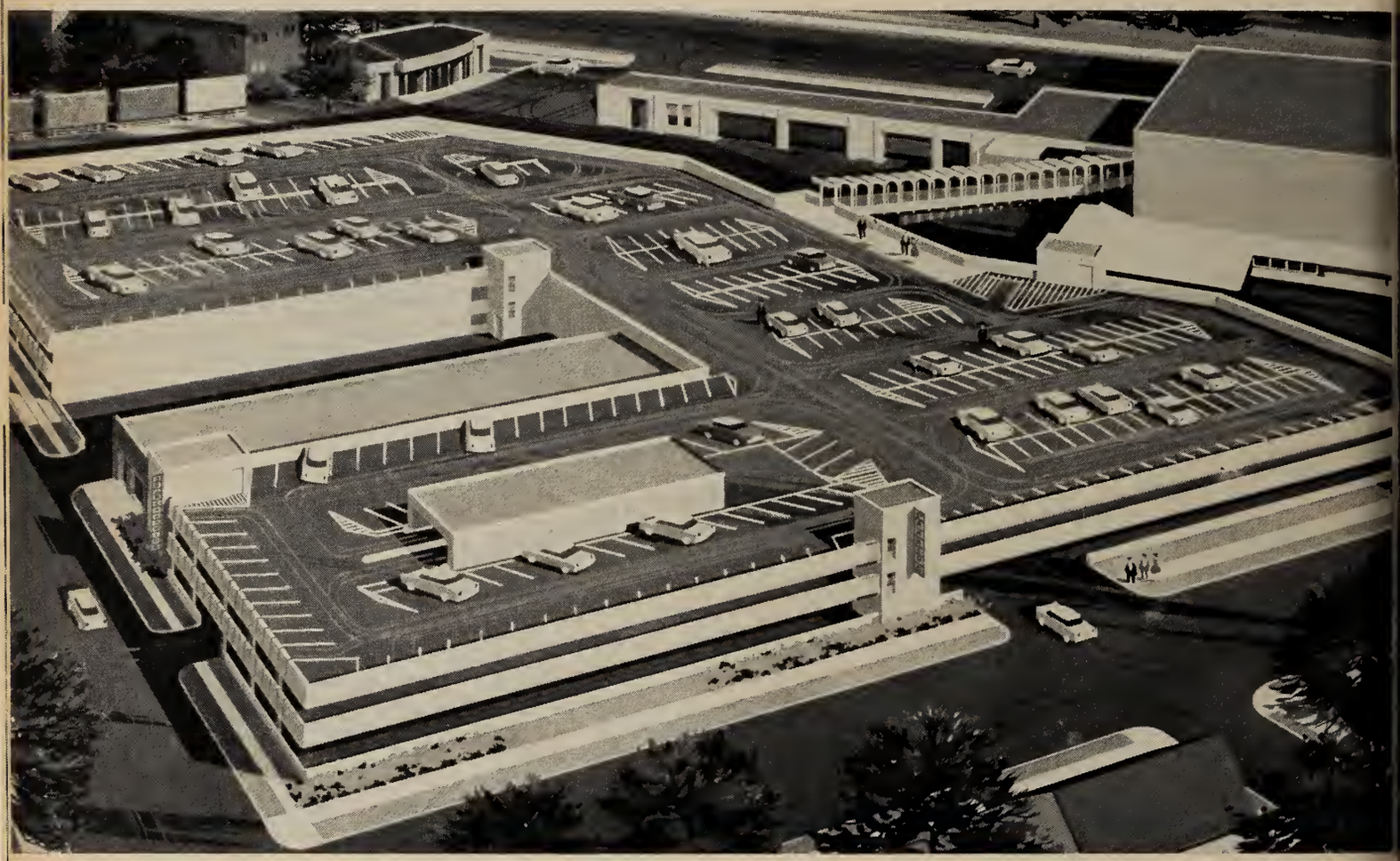
1. Sluice gates for Hydro-Quebec electric power development at Carillon, on the Ottawa River
2. End shields for CANDU nuclear power project, Douglas Point, Ontario
3. 100,000 lbs. per hr. steam generator at McGill University, Montreal
4. 32,500 gal. stainless steel fermenter tanks for Molson Breweries Ltd. in Montreal.

The ramp, on which construction was completed in October, 1962, triples the parking capacity of Sears' Main Street store in Buffalo. Two of the ramp's three levels are roofed over. A canopied walkway connects the second and third levels with the second floor of the Sears store.



Composite design helps cut cost of 1,000

. . . compared to average cost of $1,700 to $1,800 per car for reinforced concrete parking ramps

Thanks to the new AISC design rules, which now permit composite construction in buildings as well as bridges, the 1,000-car parking ramp for the Main Street, Buffalo, store of Sears, Roebuck and Co. was built at a construction cost of only $1,250,000.

The Ballinger Company, Philadelphia, Pa., architects and engineers for the three-level ramp, reports that a 20 per cent reduction in steel tonnage was effected by using the composite design and higher-stress A36 steel. In composite construction, shear connectors tie in concrete floor slabs with steel floor beams and form an integral unit, which can support more load than conventional designs.

80,000 STUD SHEAR CONNECTORS SHOP-WELDED

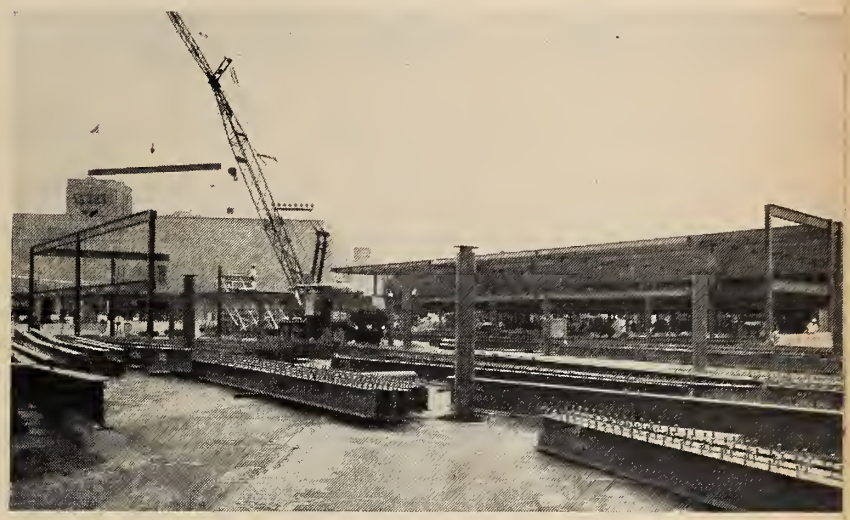
Thomas R. Coyne, general manager of Buffalo Structural Steel Corp., gives a big share of the credit

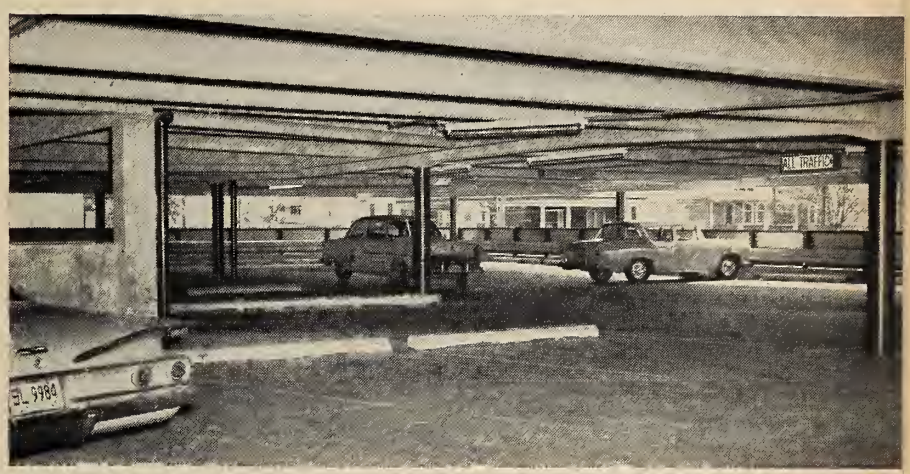
BETHLEHEM STEEL

BETHLEHEM STEEL

Continuous Sheet Mill, Structural Mills, Carbon and Alloy Bar Mills, Plate Mills, and Piling Mills are located at Lackawanna, N.Y. (near Buffalo), a location from which convenient, quick shipment can be made to the Canadian market.

Bethlehem Steel Export Corporation, 25 Broadway, New York 4, U.S.A.





car parking ramp to $1,250 per car

for the speedy construction to the design which incorporated *shop*-welding the stud shear connectors—80,000 of them—to the 16-inch floor beams. Erection of the 1,350-ton structural steel framework ran a month ahead of schedule.

SHOP-WELDING COMBINED WITH WELDING AND BOLTING AT SITE

Besides the connectors, Buffalo Structural Steel shop-welded alternate lengths of the continuous 21-inch main girders. These girders are pitched ¼ inch to the foot to allow drainage, as is the reinforced concrete slab deck. The main girders, shipped to the site in lengths up to 52 feet, were field-welded to round columns to achieve continuity. All other field connections were made with A325 high-strength bolts.

ROUND COLUMNS SAVE SPACE

John D. de Moll, project partner of The Ballinger Company, says the use of round Fire-Trol columns provides more room for parking than conventional square reinforced concrete columns, which would restrict the parking angle. Ceiling clearance is the 7½ foot maximum permitted by the Buffalo building code.

COLUMNS PRE-FIREPROOFED TO SAVE TIME

Outside diameter of the *largest* Fire-Trol column is only 12¾ inches. Each of these steel columns is prefabricated and fireproofed, and saves considerable construction time.

The structural shapes for the ramp framework, plus 270 tons of reinforcing bars, were supplied by Bethlehem. Bethlehem also supplied a half-mile of highway guard rail, erected on steel posts, for the parking areas of the ramp. The John W. Cowper Company, Inc., Buffalo, was general contractor for this project.

For more information about Bethlehem products, call or write:

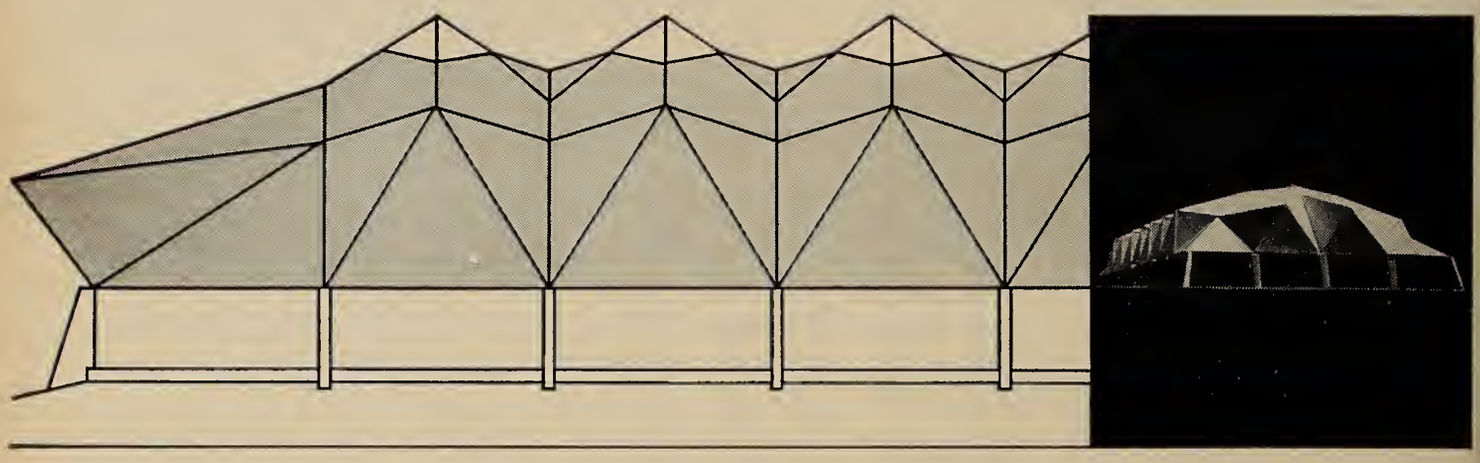
Bethlehem Steel Export Company of Canada, Ltd.
- Dominion Square Bldg., Montreal, P.Q.
- 170 University Avenue, Toronto 1, Ontario.

A. L. Murray, Marine Bldg., Vancouver, B.C.

James G. Crawford, St. Johns, Newfoundland.

An imaginative adaptation of the plywood stressed skin panel is displayed in the roof design for the new plywood testing laboratory in North Vancouver, B.C. The roof utilizes 86 plywood panel components in triangular and trapezoidal shapes, covering a total area of 7,200 square feet. From an exterior view, the roof presents an intricate pattern of light and shadow, while inside it inspires a sense of soaring space. Within the open area of the laboratory the repeated peaked arches of the roof system add a richness of design unusual in a large spanning structure of this type.

Aside from its aesthetic appeal, the roof is designed to take advantage of plywood's structural properties.



VARIATIONS ON A PANEL COMPONENT

The plywood panel components are partially self-supporting, serving to strengthen the light glue-laminated arches spanning the roof area. Components were largely preassembled, with a glass-reinforced plastic coating applied in the plant. Translucent sky-lights were added at peaks after the components were installed.

The variety of shapes utilized in the laboratory roof indicates the design possibilities of plywood panel components. Information on new uses of waterproof glue fir plywood, in component and other forms, is available from your Association field man.

The plywood testing laboratory is the work of: J. O. McCutcheon, M.Eng., consulting engineer; R. J. Thom, MRAIC, consulting architect; F. R. Brown, P.Eng., consulting electrical engineer.

Waterproof Glue

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Davie is building, transporting and erecting the penstocks for Calgary Power Limited's Big Bend Power Development Project on the Brazeau River. Industries served by BIG DAVIE include those associated with Hydro-Electric and Irrigation Developments; Petro-Chemical Processing; Mining; Defence Research and Development; Bulk Storage, etc.

Shown above are sections of steel penstocks up to 1¼" in thickness and 19'6" in diameter. Each completed penstock will measure 1,750' in length. (Consultants: Montreal Engineering Co. Ltd.)

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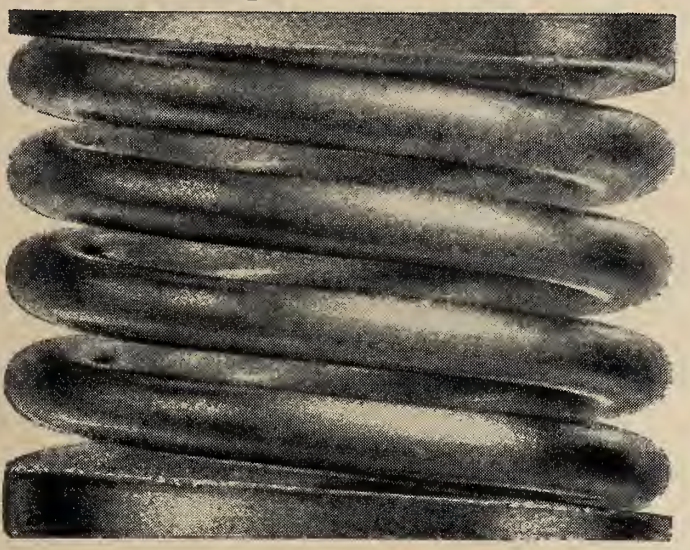

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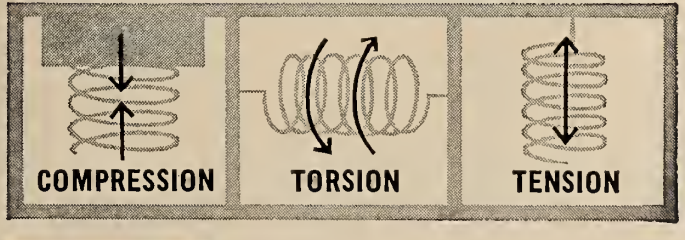

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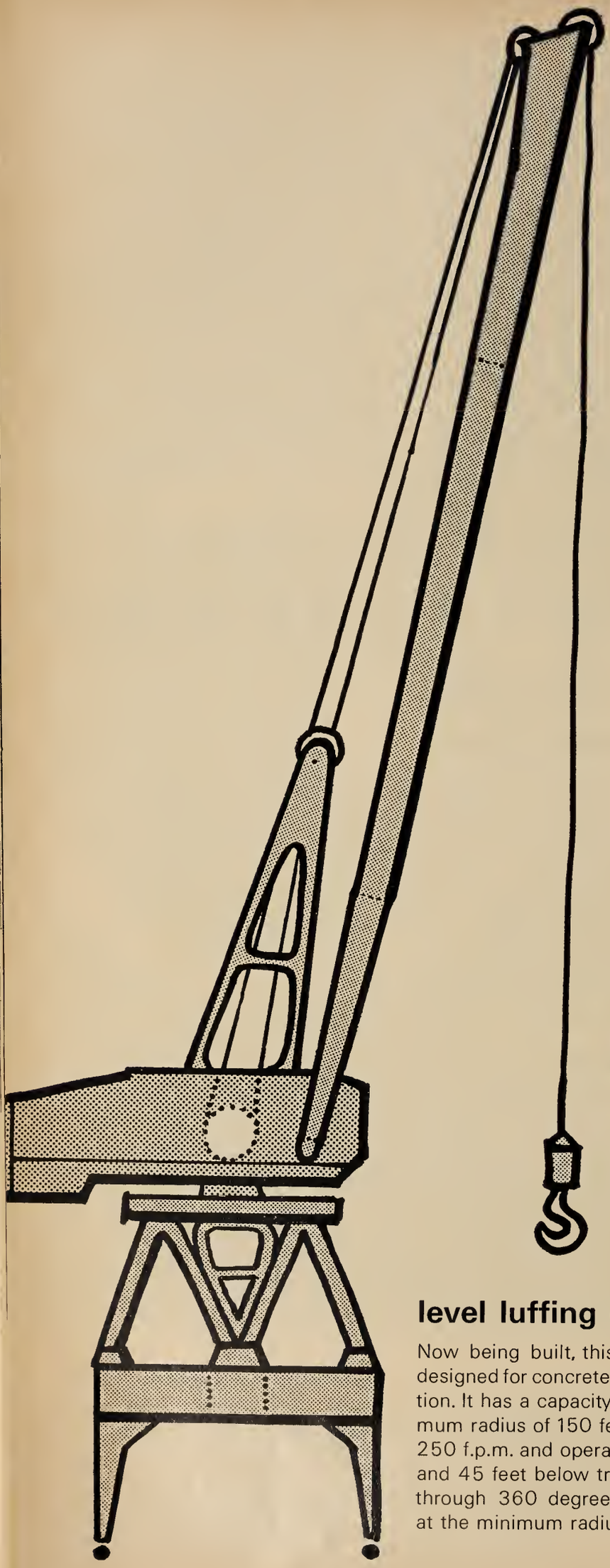

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The Mechanical Division of Dominion Bridge designs and builds custom cranes of every type. As illustrated here, they range from modified standard production units to cranes designed for specific applications and performance requirements.

Custom cranes from Dominion Bridge include gantry cranes, magnet and bucket cranes, shiploading and unloading cranes, level luffing and derrick jib cranes, stiff-leg derricks, tower cranes, hammerhead cranes, swing jib cranes, deck cranes, wall cranes—cranes of every category.

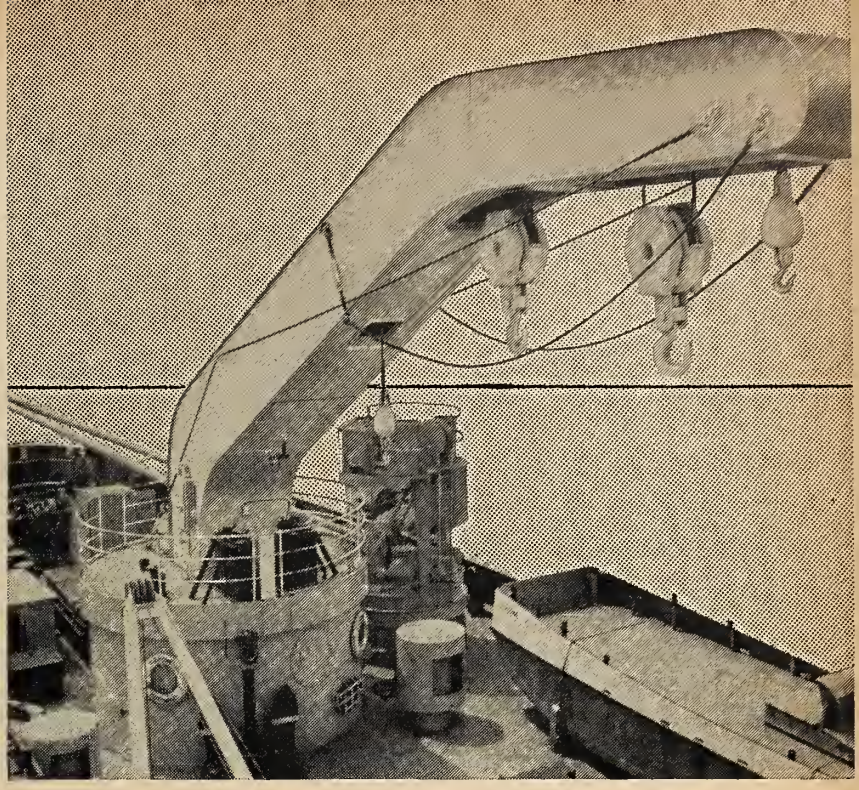
If you need a specially constructed crane—for use in Canada or anywhere in the world—you'll find it worth while to discuss your requirements with D.B.

143

MECHANICAL DIVISION
DOMINION BRIDGE

level luffing crane

Now being built, this crane is specifically designed for concrete work in dam construction. It has a capacity of 11 tons at the maximum radius of 150 feet. The hoist speed is 250 f.p.m. and operates at 200 feet above and 45 feet below track level. It will swing through 360 degrees. Maximum capacity at the minimum radius is 50 tons.

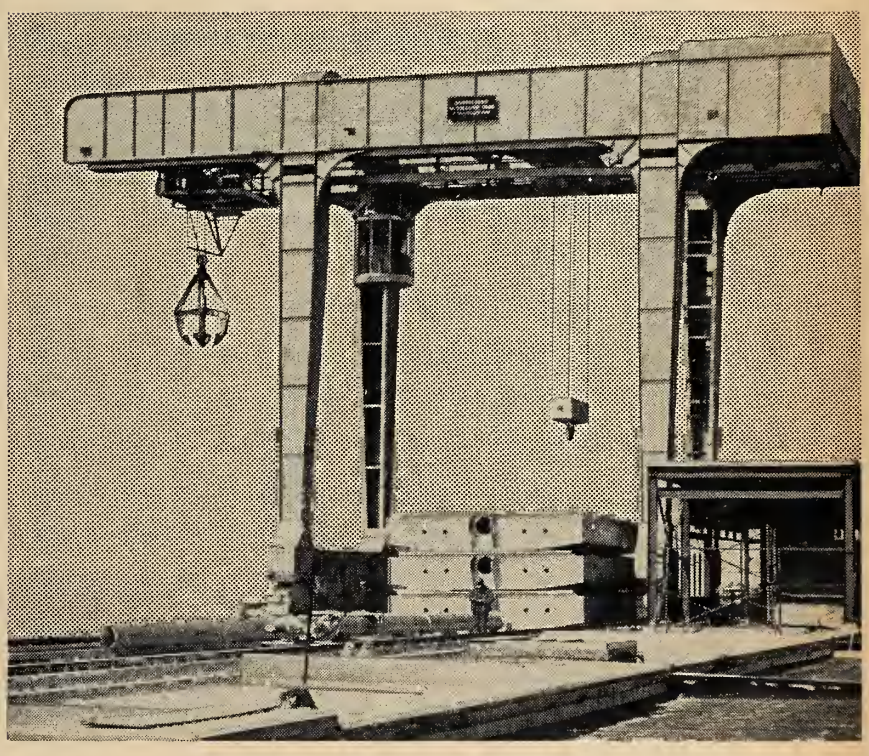


deck crane

This crane is used for handling navigation buoys on an arctic patrol ship. It has two main hoists and one auxiliary hoist all operating on fixed radii. The unit will turn through 360 degrees. Capacity: Two main hoists, 15 tons each; auxiliary hoist, 4 tons.

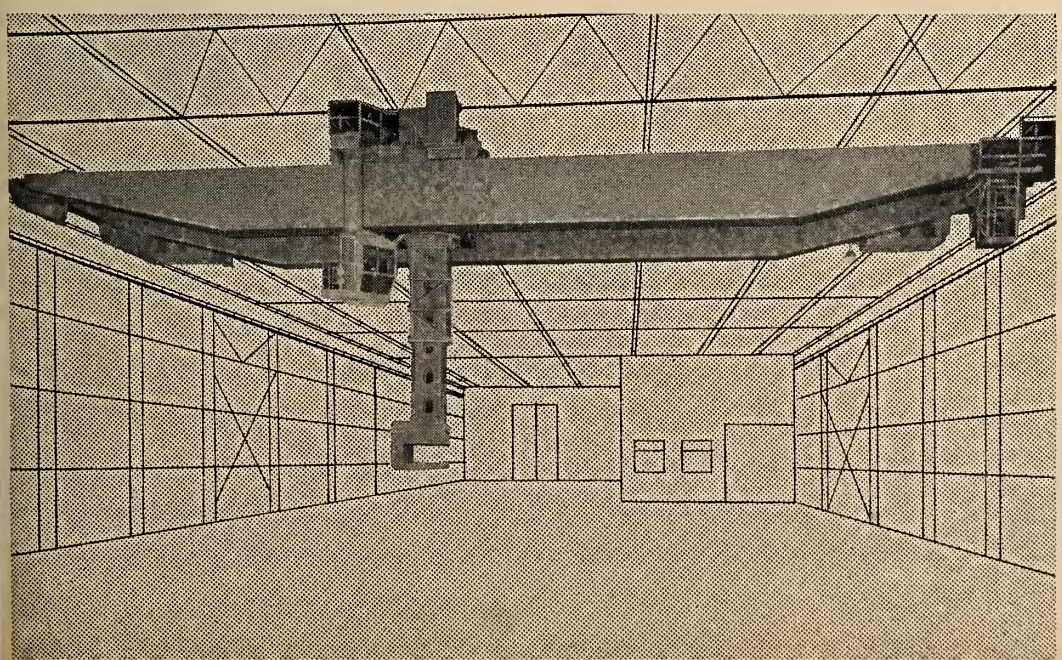
intake gantry

Broadly typical of many power house gantry cranes. This one has hoisting and trolley travel mechanisms located in a machinery house built over the downstream cantilever extension of the portal girders. A trash grapple is also fitted to the upstream side. Capacity: 80 tons. Hoist speed: 8 f.p.m. Trolley travel: 76 f.p.m. Gantry travel: 120 f.p.m.



stacker crane

The stacker crane is becoming increasingly popular for handling piece goods. This one is designed to handle steel billets in free standing stacks with alternate layers at 90 degrees to each other. No load slinging is required. Capacity: 30 tons. Main hoist speed: 50 f.p.m. Trolley travel: 200 f.p.m. Bridge travel: 450 f.p.m.



Control of thermal expansion in piping

Flexible support can prevent destructive stresses in high temperature piping

Heat 100 linear feet of alloy steel pipe to 1000°F, and it will expand approximately 9 inches! When this thermal expansion takes place in a piping system, the resultant forces — if uncontrolled — can do incalculable harm.

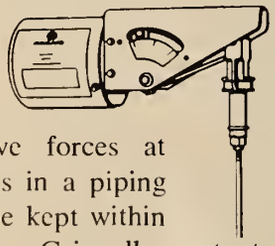
Helical coil springs

Using helical coil springs to compensate for thermal expansion in piping is now common practice. However, designing or selecting flexible supports is often done haphazardly. In fact, any specifications covering the support of important high temperature piping simply say "spring hangers shall be provided." But it is not enough to merely admit that thermal expansion may be dangerous.

Safety of entire system at stake

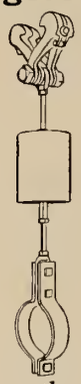
Careful study must be given to the design and selection of spring supports which will maintain a balanced piping system. If not, the transfer of weight from one hanger to another, or from a hanger to a terminal point, will endanger the safety factor of the entire system. Today, you're often confronted with 8–9–even 10 inches of thermal deflection. That's why flexible support for piping in all positions of travel is a definite "must"!

Constant-support hangers



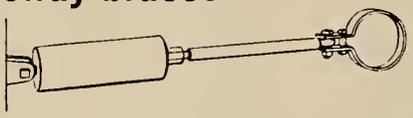
Where reactive forces at terminal points in a piping system must be kept within specified limits, Grinnell constant-support type hangers are recommended. They are designed to provide uniform supporting force equal to the pipe load throughout the range of thermal movement. Constant-support hangers should be used at superheater outlets, turbine connections, and on high temperature and other critical lines.

Variable spring hangers



When pipe lines are subject to vertical movement — and restrictive conditions do not require a constant-support hanger — variable spring hangers are recommended. They should be designed for a maximum variation in supporting effect of 25% for the total travel resulting from thermal conditions.

Vibration control and sway braces

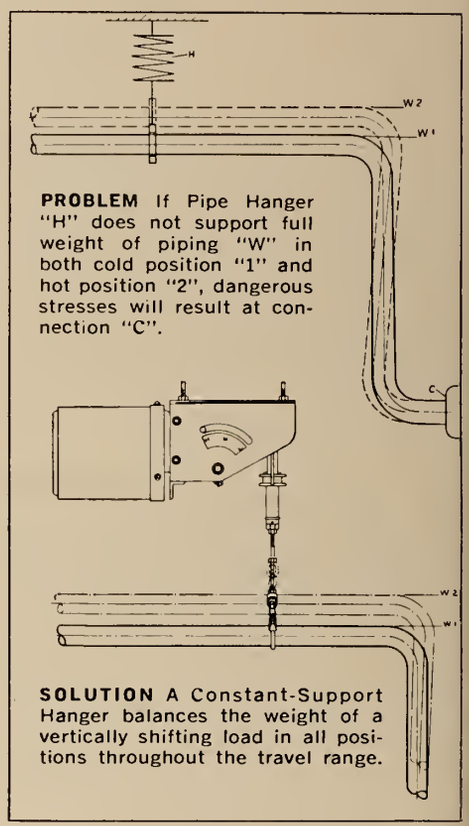


When you have to prevent abnormal movement or vibration in pipe lines, controls or sway braces of the energy-absorbing and instant-acting counter force type are recommended. They dampen vibration, oppose pipe sway, absorb shock.

Grinnell Hanger Engineering Service

Grinnell Company's Pipe Hanger Department offers design service to engineers who appreciate the specialized knowledge required. Grinnell will help you compute hanger loads . . . and select proper supports for a *balanced* pipe suspension system.

What's more, Grinnell manufactures a complete line of pipe hangers and supports — and offers stocks of pipe hangers close to any job!



PROBLEM If Pipe Hanger "H" does not support full weight of piping "W" in both cold position "1" and hot position "2", dangerous stresses will result at connection "C".

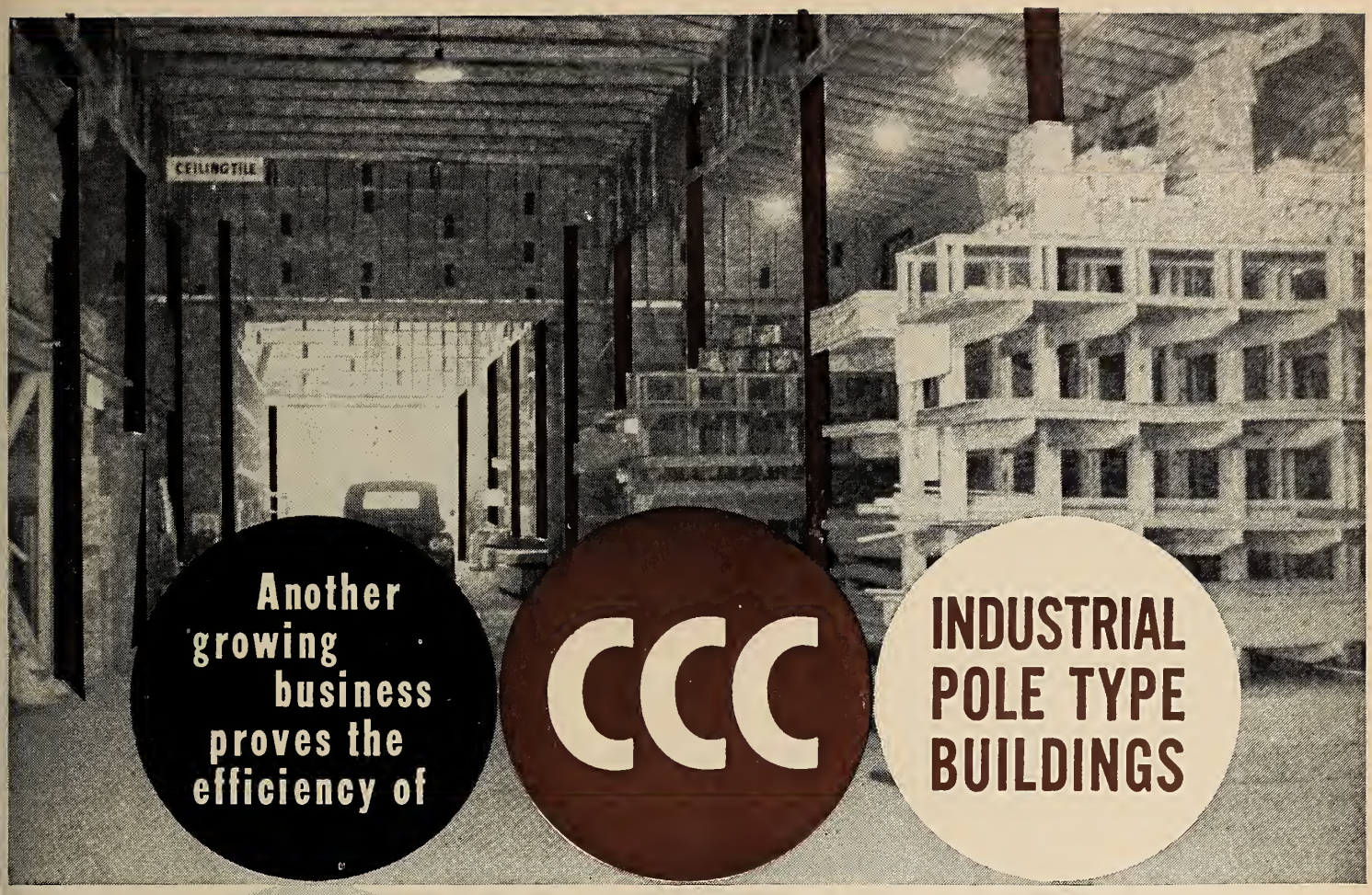
SOLUTION A Constant-Support Hanger balances the weight of a vertically shifting load in all positions throughout the travel range.

Grinnell maintains an experienced staff of technicians to discover better ways of solving pipe suspension problems, too.

Hanger load calculation booklet

Grinnell will be glad to send you — without obligation — a 32-page booklet, "Calculations for Hanger Loads and Thermal Movements". This helpful booklet furnishes necessary data and procedures to determine pipe hanger loads and thermal movements. Tabulations of piping weights and thermal expansion are arranged for convenient selection of data that usually takes considerable time to develop. Send for your copy *today*.

Grinnell Company of Canada, Ltd., Edmonton, Montreal, Toronto, Vancouver, Winnipeg.



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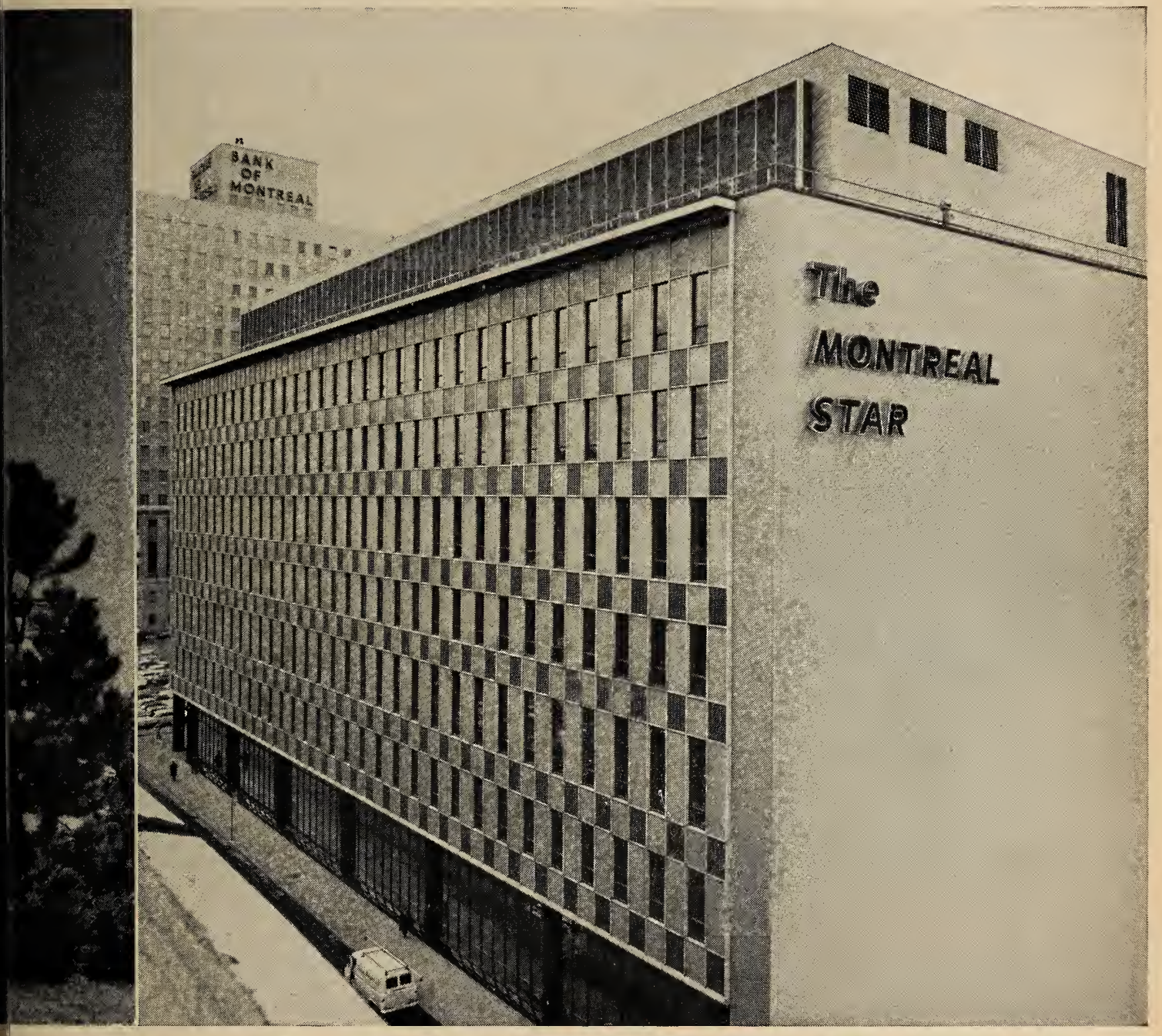

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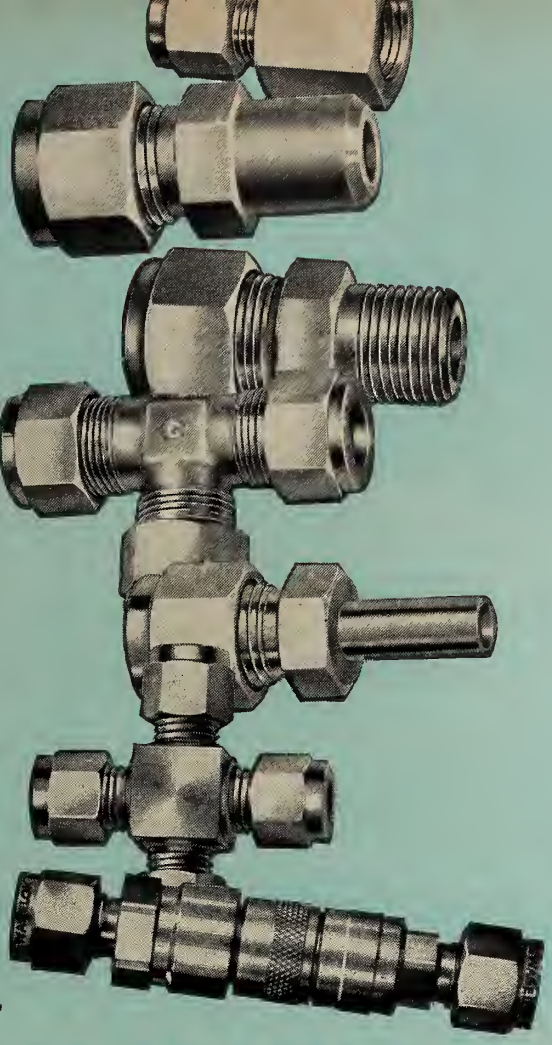

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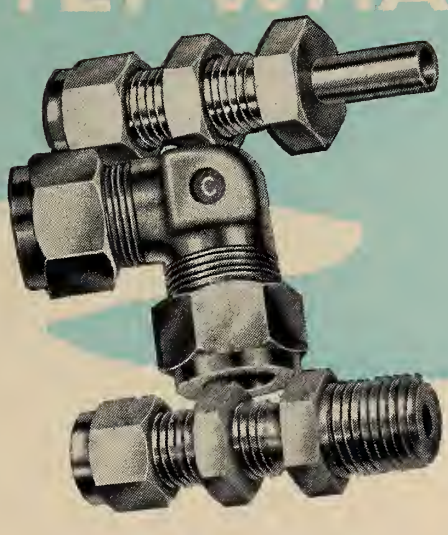

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POWER IN CANADA

The scope of power in Canada is immense. The wide range of construction, transmission, manufacturing and research would be impossible to cover properly in one issue of a publication. The following story outlines in words and photographs a few of the major projects during 1962 not mentioned elsewhere in this issue.

Nineteen sixty-two was the second consecutive year in which the amount of thermal-electric capacity installed in Canada exceeded that of hydro-electric capacity. New hydro capacity was installed only in Quebec, New Brunswick and Newfoundland, while thermal capacity was added in all provinces except Nova Scotia and Saskatchewan.

Information released by the Water Resources Branch of the Department of Northern Affairs and National Resources reveals a good increase in electric capacity. During 1962, Canada's total electric power producing capability was increased by the installation of 415,468 hp. of hydro-electric turbine capacity and 713, 210 kw. of thermal-electric generating capacity.

At the end of last year the total hydraulic turbine capacity in Canada was 27,100,000 hp., and the total thermal-electric capacity is slightly more than 5,660,000 kw.

The year 1963 will see a return to predominance of new hydro capacity with an estimated 1,203,600 hp. scheduled for installation. This compares with 660,500 kw. of new thermal capacity scheduled for installation.

Developments scheduled for completion after 1963 will produce almost 7,700,000 hp. of hydro-electric and nearly 2,100,000 kw. of thermal-electric capacity. Development of Quebec's Manicouagan and Outardes Rivers is expected to increase that Province's hydro capacity by more than 5,000,000 hp., and accounts for most of the proposed 7,700,000 hp. increase.

In addition, plans and initial preparatory work are in hand for a number of developments which eventually will add a further 5,000,000 hp. to Canada's developed hydro capacity. Most of this would become available with the development of two sites on the Peace River in British Columbia.

During 1961 and 1962 there was a preponderance of thermal over hydro installations. This reversal of previous practice stems partly from the fact that many of the hydro-electric sites considered economic under existing conditions have been developed, and partly from the increasing recognition of the benefits to be derived from the integrated operation of hydro-electric and thermal-electric power plants.

Recent rapid advances in the techniques of extra-high-voltage transmission provided a means of transmitting hydro-electric power from relatively remote sites to demand areas at costs competitive with costs of thermal-electric power. As a result, decisions have been made to develop a number of hydro sites which previously had been considered outside the economic transmission range.

Following is a province-by-province review of some major works completed in 1962, and of future plans.

British Columbia

No new hydro-electric capacity was brought into service in British Columbia during 1962 although several sites were under construction or were being surveyed for possible future development. Scheduled for commissioning in 1963 is 120,000 hp. of hydro capacity.

In the thermal-electric field a net total of 182,325 kw. of generating capacity went into service in 1962. An additional 180,000 kw. is scheduled for completion in 1963 and another 600,000 during subsequent years.

Last year the British Columbia Hydro and Power Authority completed two contracts for preliminary projects associated with the future development of the Peace River. The first power is scheduled to be available by 1968. Preliminary plans indicate a feasible installation of up to 4,200,000 hp. at two sites on the river.

Operation started at the Authority's Burrard Thermal-Electric Generating Station near Vancouver with the completion of a 150,000 kw. unit. A second similar unit went on line this year and a third unit is scheduled to operate in 1964. The ultimate generating capacity of the Burrard plant will be 900,000 kw. in six units.

Two projects of the Consolidated Mining and Smelting Company of Canada were finished early this year.

Concrete lining of three tunnels at Peace River power project will provide strong, smooth passage for water diverted past site of Portage Mountain Dam this fall. Tunnels, each about 2,500 feet long, are 48 feet inside diameter.

One was the company's Waneta Hydro-Electric Development on the Pend d'Oreille River. This consists of a turbine, rated at 120,000 hp. under a 210-foot head, connected to a generator of 72,000 kw. at 0.80 power factor. The other, made necessary by the Company's expanding industrial production, was additional substation capacity totalling 60,000 kva.

Alberta

The total hydro-electric generating capacity in Alberta did not increase during 1963, and no addition is expected until late 1964 when 200,000 hp. is scheduled to be placed in service on the Brazeau River.

One 150,000 kw. thermal-electric unit was installed at Wabamun.

Calgary Power Limited continued construction of its hydro development at Big Bend on the Brazeau River. The storage dam has been completed and construction of the powerhouse is continuing.

Addition of a 150,000 kw. unit at the Wabamun plant raised the Company's installed capacity there to 282,000 in three units.

The City of Edmonton this year completed installation of a 75,000 kw. steam unit at its municipal thermal-electric plant.

Saskatchewan

No new electric capacity, either hydro or thermal, was placed in service in Saskatchewan during 1962. However, 187,600 hp. of hydro-electric power was added or is to be added during 1963 and an additional 367,600 hp. is expected to be added later.

Not only is no new thermal capacity anticipated, but about 60,000 kw. was removed from service this year.

For the Saskatchewan Power Corporation construction at the site of its Squaw Rapids development on the Saskatchewan River continued on schedule. The units, eight in all, will consist of turbines rated at 46,900 hp. under 107 feet of head, connected to generators of 34,000 kw. The first four units are to be commissioned this year, two others in 1964, and the remaining two in 1966. When completed the development will have a total installed turbine capacity of 375,200 hp.

The Prairie Farm Rehabilitation Administration of the federal Department of Agriculture continued construction of its Saskatchewan River dam and reservoir during 1962. The dam and reservoir are being provided for irrigation purposes, but hydro-electric facilities will be included. Installation of these facilities will be the responsibility of the Saskatchewan Power Corporation which plans initially to install three units, each of approximately 60,000 hp., with the possibility of extending the installation to include two additional units, giving an ultimate capacity of 300,000 hp. Two units are expected for service in 1967 and a third unit the following year.

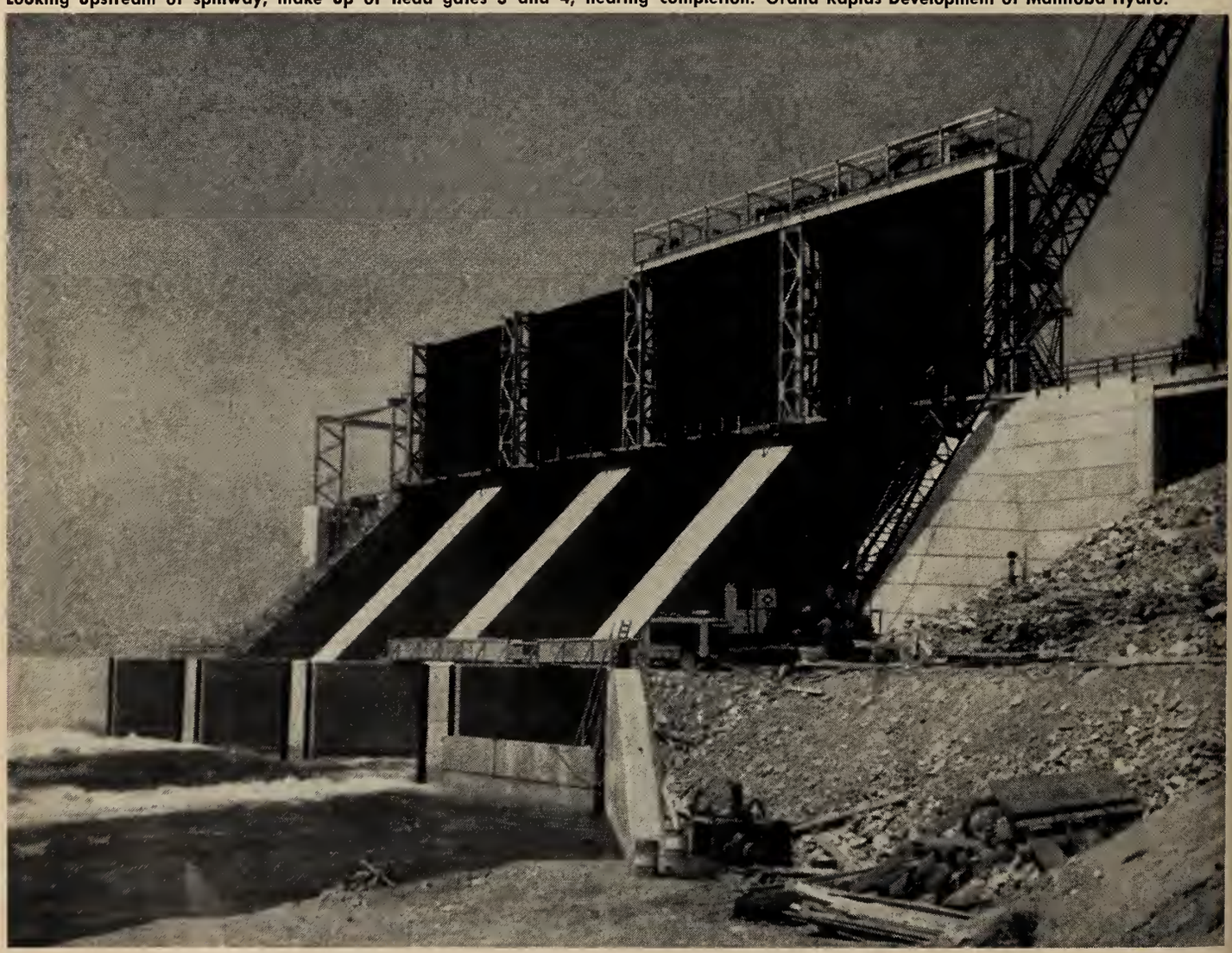
The City of Regina built a 5,000 kva. sub-station during 1962.

Manitoba

There was no increase in Manitoba's hydro-electric generating capacity during 1962, and no increase is expected until 1964 when 300,000 hp. of capacity will be added.

Only 1,180 kw. of new thermal-electric capacity was placed in operation in 1962. As in Saskatchewan the substantial amount of hydro capacity

Looking upstream of spillway, make up of head gates 3 and 4, nearing completion. Grand Rapids Development of Manitoba Hydro.



soon to become available has modified, at least for the present, the need for developing thermal-electric generating facilities.

Construction at the site of Manitoba Hydro's Grand Rapids development on the Saskatchewan proceeded favorably last year. Initial installation at this site will comprise three 150,000 hp. adjustable-blade Kaplan turbines operating under a normal head of 120 feet, and three generators, each rated at 110,000 kw. at 0.95 power factor. Two units are scheduled to start operation late in 1964 and the third unit early in 1965. Provision is being made for the eventual addition of a fourth unit.

The initial stage of the Kelsey Generating Station on the Nelson River was completed in 1961. Other than normal maintenance no further work has been undertaken at this site.

In the thermal-electric field Manitoba Hydro placed an additional 1,100 kw. unit in service at The Pas Generating Station. A diesel generating station of two 40 kw. units was built at Baker's Narrows to serve Flin Flon airport.

Ontario

For the first time in 17 years there was no increase in Ontario's total installed hydro-electric capacity. However, 320,000 kw. of thermal-electric generating capacity was installed during 1962.

For many years hydro-electric capacity supplied most of Ontario's power needs. Recently the emphasis has been on the development of thermal capacity. The main reason for this is that most hydro-electric sites located within economic transmission range of Southern Ontario had already been developed.

However, recent developments in extra-high voltage transmission techniques have increased significantly the distance over which electric power may be carried economically. This has led to the investigation of a number of sites which had been considered too expensive to develop because of their remote locations.

The Hydro-Electric Power Commission of Ontario estimates that during the next five years power loads will increase at a compound rate of about six per cent per annum. To meet this load the Commission was engaged last year in the construction or planning of eight generating stations—four hydro, two conventional thermal, and two nuclear thermal.

In addition, extensive engineering investigations are being carried out at a number of potential power sites on rivers in the James Bay watershed. Studies of the Madawaska River, to be completed this year, may indicate the feasibility of developing another site on this river. Other potential sites within reach of the present demand areas are located on the Montreal, English and Mississaga Rivers.

There is also considerable interest in the development of pumped-storage installations such as the pumping-generating station at Niagara Falls which permits conversion of surplus off-peak power into valuable peak capacity. A similar installation now being considered would be capable of delivering more than a million kilowatts during the period of peak demand in the Southern Ontario system.

Additions to hydro-electric capacity during 1963 were scheduled at the Otter Rapids Generating Station on the Abitibi River and at the Little Long Station on the Mattagami River.

At Otter Rapids two units were added to the two already on power. Each unit consists of a turbine rated at 60,000 hp. under a head of 107 feet, coupled to a generator rated at 43,700 kw.

At the Little Long Station there are two units with the turbines rated at 84,000 hp. each under a head of 90 feet and the connected generators have a capacity of 57,000 kw. each. Provision has been made for the later installation of two additional units.

Two other projects on the Mattagami River are scheduled for completion within a few years. At the Harmon Generating Station it is planned that by 1965 there will be two units of 94,000 hp. each with provision for two additional units later.

At the Kipling Generating Station the plant will house two units of 94,000 hp. each, operating under a head of 102 feet—the same head as at Harmon—and provision will be made for eventual installation of two more units. The first two units are scheduled for service in 1966.

In the thermal-electric field a second 300,000 kw. unit was installed in the Lakeview Station, doubling the total generating capacity. Unit 3 went into service this year, unit 4 is scheduled for 1964, unit 5 in 1966, and unit 6 in 1967 or later. The ultimate capacity of the station will be 1,800,000 kw.

At the Thunder Bay thermal Generating Station a number of modifications of the 100,000 kw. unit delayed the in-service date from 1962 until this year.

The 20,000 kw. Nuclear Power Demonstration Station near Rolphton was built as a joint undertaking of the Commission, Atomic Energy of Canada Limited and Canadian General Electric Company Limited. Operation of the reactor started April 10, 1962 and 16 hours later, on April 11, the critical stage was reached. On June 4, following a number of tests

A recent view of the Douglas Point Nuclear Power Station which is being built by Atomic Energy of Canada Limited on the eastern shore of Lake Huron in Ontario. The station will generate 200,000 kilowatts of electricity when it goes into operation in 1965. Ontario Hydro is co-operating in the construction and will operate the station.

on the reactor, the station produced its first electric power and has performed satisfactorily since then.

The Douglas Point Nuclear Station on the shore of Lake Huron is being built jointly by the Commission and Atomic Energy of Canada Limited. Concrete work for the interior floors and walls continued in several buildings, including the reactor, service, turbine, water treatment, pumphouse, and administration buildings.

In the turbine building the placing of concrete for the turbine block and the installation of the powerhouse crane was completed. The intake for cooling water from the lake was completed and the cofferdam was removed. The station, with a total generating capacity of 200,000 kw. is scheduled for service in 1965.

Quebec

During 1962 the Province of Quebec continued its extensive program of harnessing the tremendous water power resources. A total of 240,000 hp. of new hydro-electric capacity was installed during the year and a further 480,000 hp. is expected to be in service by the end of 1963. In years subsequent to 1963 the current construction program will yield more than 5,200,000 hp. of new capacity. In addition, the flow regulation resulting from the construction of storage on the Manicouagan and Outardes Rivers will permit an estimated 627,000 hp. increase in capacity at two existing downstream developments.

Although the increase in thermal-electric generating capacity amounted to only 80 kw. in 1962, construction of a 300,000 kw. thermal station went ahead, and tentative plans were made for the building of another station, with a generating capacity of 10,000 kw.

The Quebec Hydro-Electric Commission purchased the shares of 11 privately - owned power companies during 1962.

Construction of Quebec Hydro-Electric Commission's Carillon development on the Ottawa River continues. Initial operation of the plant occurred in 1962 and by the end of the year four units totalling 240,000 hp. had been placed in service. The Carillon development, expected to be completed in 1964, will have a total installed turbine capacity of 840,000 hp. in 14 units.

During the year the Commission continued its studies relating to the proposal to increase the installed capacity of its Rapid II plant on the upper Ottawa River. The proposed expansion of generating facilities at the plant will involve the installation of one 16,000 hp. turbine connected to a 12,000 kw. generator. The date of installation for this unit has not been decided.

Construction progresses on the huge Manicouagan-Outardes development scheme. This project involves the harnessing of the headwaters of the Manicouagan and Outardes Rivers, both of which empty into the St. Lawrence River near Baie Comeau. Development of three major sites on the Manicouagan River will yield 3,650,000 hp. while a further 1,440,000 hp. can be produced at two sites on the Outardes River. Flow regulation from upstream storage reservoirs on both the Manicouagan and Outardes Rivers will benefit existing downstream plants to the extent of permitting an increase in capacity at the Manicouagan Power Company's McCormick Dam Project near Baie Comeau from the present figure of 292,400 hp. to about 580,000 hp., and at the Quebec North Shore Paper Company's Outardes Falls plant from the existing installation of 70,600 hp. to 410,000 hp.

At the Manicouagan 5 site, situated just below the outlet of Manicouagan Lake, a start has been made on what will be one of the highest and most massive dams of its kind in the world. The dam, a buttressed, multi-arch concrete structure, will be 4,000 feet long and 650 feet high. The pillars of the main arch will be 450 feet apart, with those of the other arches 295 feet apart. This huge structure, expected to take eight years to complete, will create a reservoir containing 115 million acre-feet of water and covering a surface area of 800 square miles. The powerhouse is designed to house eight units with a total installed capacity of approximately 1,500,000 million horsepower, operating under a head of 505 feet. The original plans called for the incorporation of the powerhouse in the base of the main arch, but in the revised design, the powerhouse will be constructed on the east side of the river channel.

During the year, the cofferdams designed to protect the main dam site during construction were completed and the shielded areas excavated to bedrock, a depth of 280 feet. Construction of the dam has started in this great excavation.

The Manicouagan 2 site is about 10 miles from the mouth of the Manicouagan River. The proposed development of this site involves the installation of 10 units of 110,000 hp. each, operating under a head of 240 feet. By the end of 1962, preliminary construction was well advanced with the completion of diversion tunnels, bridge and construction camp sites. Power is expected to be available from Manicouagan 2 before the end of 1965.

The third major site scheduled for development on the Manicouagan River is Manicouagan 3, a series of falls about 50 miles from the mouth of the river. At this site, a rock-fill dam will impound 8,000,000 acre-feet of water. The powerhouse will be built undergrounnd and will house seven units of 150,000 hp. each, operating under a 310-foot head.

Surveys carried out on the Outardes River have established the feasibility of developing substantial amounts of power at Mile 58 and Mile 45 sites, so designated because of their respective distances from the mouth of the river. The installed capacities at the two generating stations will be 700,000 hp. at Outardes 58 under a head of 425 feet, and 740,000 hp. at Outardes 45, under the same head.

A significant development in the field of electric power transmission is a decision by the Commission to transmit power from the Manicouagan complex to the Quebec-Montreal system at 700/745 kv. This transmission voltage is the highest now planned for long-distance transmission anywhere in Canada.

Construction of the 300,000 kw. thermal-electric plant at Tracy for the Shawinigan Water and Power Company is going ahead on schedule and the first of two 150,000 kw. steam turbines is expected to be in operation in July, 1964. The second unit is scheduled for installation in July, 1965.

The City of Megantic's 4,500 hp. Gayhurst - Hydro - Electric Station on the Chaudiere River ceased operation in April, 1962. During the spring break-up, high flows in the Chaudiere River threatened to wash out the earth dam at the power site and, to avert a major disaster involving enormous damage to property and possible loss of life, a relief channel was cut to by-pass the dam and relieve pressure on the weakened structure. Because of unrestricted flow through the emergency channel, the headpond cannot be maintained at a high enough level to permit operation of the turbines.

The City is now buying its power from another company.

New Brunswick

New Brunswick's hydro - electric turbine capacity was increased during the year by the addition of 55,468 hp.

No additions are anticipated for 1963 but various proposals under study could add significantly to the Province's hydro capacity in subsequent years.

Thermal-electric development in New Brunswick amounted to 50,240 kw. in 1962. Indications are that the next addition to the total thermal capacity will be the installation of 60,000 kw. in 1964.

For the New Brunswick Electric Power Commission the third and final unit at the Beechwood plant on the Saint John River was placed in service in April, raising the total capacity of this development to 145,000 hp.

While this new unit completes the presently scheduled construction on the Saint John River, preliminary engineering studies were continued on the proposed 600,000 hp. Mactaquac development upstream from Fredericton. Attention is being given to the possible extension of the Grand Falls development, where a large amount of energy is still available.

In the thermal-electric field, the Commission installed a 50,000 kw. unit in its Courtenay Bay Station at East Saint John. This unit was installed in 1961, but was not put into service until April, 1962. Ultimate generating capacity at the Courtenay Bay Station is 300,000 kw.

Nova Scotia

No new hydro or thermal-electric capacity was brought into operation during 1962 in Nova Scotia, nor was any construction underway on the installation of new capacity. Planning of several hydro-electric projects, however, is expected to lead to the installation of 22,000 hp. and possibly a further 90,000 hp. in the years ahead.

The Nova Scotia Power Commission is actively considering the construction of two hydro-electric developments at Riverdale on the Sissiboo River and at Wreck Cove on the Wreck Cove Brook. Plans for the Riverdale development call for the installation of a single 8,000 hp. unit while estimates for the Wreck Cove plant indicate a possible ultimate capacity of 90,000 hp.

The Nova Scotia Light and Power Company Limited is giving active consideration to the construction of hydro-electric developments on the Allain (Lequille River) at Lequille, and on the Nictaux River at Alpena. However, 7,500 hp. the Allain River development is not expected to be completed until at least 1970. The Nictaux development, with a single 3,500-hp. unit, is not expected to be in service before 1968.

Prince Edward Island

Prince Edward Island depends almost exclusively on thermal electric generation to satisfy its power needs, and in 1962 increased its total thermal capacity by 2,200 kw.

For the second consecutive year, the capacity of the Summerside plant was increased by the installation of a 2,200 kw. unit. Total generating capacity now is 7,281 kw. in nine units.

Fifteen miles of distribution line was added to the town's system in 1962.

The Maritime Electric Company Limited completed 35 miles of distribution line in 1962. Some 490 new farm customers were provided with service in 1962, bringing the number of farms supplied by the Company to 15,530.

Newfoundland

Newfoundland's hydro-electric generating capacity was increased in 1962 by the addition of 120,000 hp. in Labrador. A total of 128,000 hp. of hydro capacity is scheduled to be added this year while active consideration is being given to the installation of another 191,000 hp. in later years.

In thermal-electric development, a total of 4,100 kw. of new generating capacity was brought into service during 1962 with a further 2,000 kw. scheduled for this year.

The Twin Falls Power Corporation Limited, which was formed by Hamilton Falls Power Corporation Limited, Iron Ore Company of Canada and Wabush Iron Company Limited, began initial operation of its Twin Falls development on the Unknown River in Labrador. Two 60,000 hp. units operating under a 290-foot head were brought into service in June, 1962. Two identical units are scheduled to be added late this year. Another 60,000 hp. unit will be added later.

Construction of a 230 kv. line, 110 miles long, was completed between the Corporation's new plant and the centre of mining activity in the Wabush Lake area. An identical line, parallel to the first, was also begun in 1962.

During 1962 the Newfoundland Light and Power Company Limited began construction of a hydro-electric development on Sandy Brook. The plant, to be located some eight miles west of the town of Grand Falls, will consist initially of a single 8,000 hp. turbine.

Southern Newfoundland Power and Development Limited, a subsidiary of the British Newfoundland Corporation Limited, is planning to construct a hydro-electric generating station on the Salmon River at Head Bay d'Espoir. It is expected that initial installation will consist of 77,000 hp. in two units, operating under a head of approximately 550 feet. Ultimate development of the site may reach 350,000 hp.

The Bowater Power Company Limited proposes to install a 54,000 hp. hydro-electric development operating under a head of about 683 feet on Hinds Brook. Construction has not yet been scheduled.

Yukon and Northwest Territories

During 1962 the total generating capacities of the Territories was increased by a net amount of 3,100 kw. of thermal-electric capacity, all of which was installed in the Northwest Territories. It is expected that 3,500 kw. of thermal capacity will be installed in the Northwest Territories by the end of 1963.

To encourage the development of the resources of Northern Canada, the Government of Canada in 1948 established an agency now known as the Northern Canada Power Commission.

In 1962 the Commission increased the generating capacity of the Fort Simpson plant to 1,075 kw. with the installation of a 600 kw. unit. At the Fort Smith plant, a 400 kw. diesel unit was added, bringing the total installed capacity of the plant to 2,275 kw.

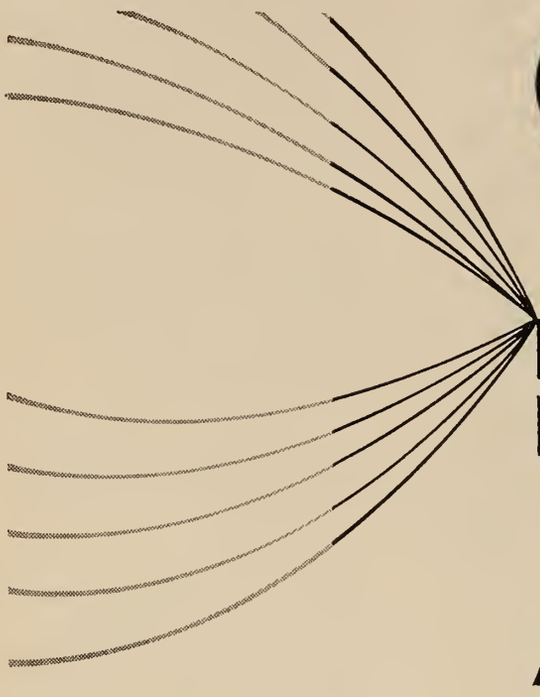
At Frobisher Bay, construction of a new power and central heating plant started in 1962 to serve the general Frobisher Bay area. Two 1,000 kw. units will be transferred to the new plant from the existing Frobisher Bay plant, and two new 1,000 kw. units will be installed.

The Commission expects to install a 1,500 kw. diesel unit at the Inuvik plant in 1963, increasing the total capacity of the plant to 3,960 kw.

The Canada Tungsten Mining Corporation Limited installed four diesels with a total installed capacity of 1,600 kw. at its Flat River mining operation.

Northland Utilities Limited reported that in 1962, one 652 kw. diesel unit was installed at the Hay River plant. At the same time, two units totalling 152 kw. were removed from this plant.

(Cntinued on page 88)



OVER 40 BILLION KWH

Ten thousand employees ensure continuity of service to 1,315,000 customers who pay rates comparable with the lowest in the world.

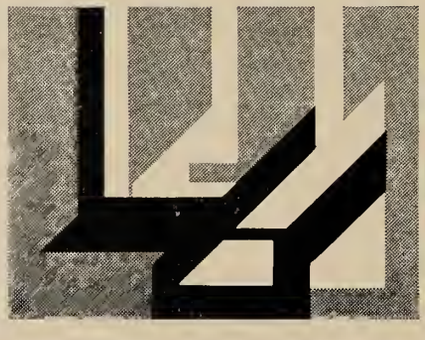
To meet future demands, work is now in progress on the Manicouagan - Outardes project which will add more than 5,000,000 kilowatts to the capacity of the province-wide Hydro-Quebec system. First power from Manicouagan will be transmitted in 1965 over one of three 735,000-volt transmission lines now under construction.

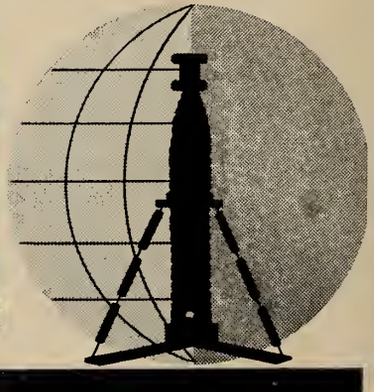
Water-power reserves amount to many millions of horsepower not yet developed. Electricity for the future is assured in Quebec -

THE POWER PROVINCE

Electricity consumption in Quebec during 1963 will amount to an average of 9,819 kilowatthours for each of the 5.5 million inhabitants of the Province. Of the total production, Hydro-Quebec will generate and distribute more than 40,000,000,000 kilowatthours.

This power will be generated in 48 hydro-electric stations of which 16 are rated over 100,000 kilowatts, including the renowned Bersimis plants and the 1,600,000-kilowatt Beauharnois giant.





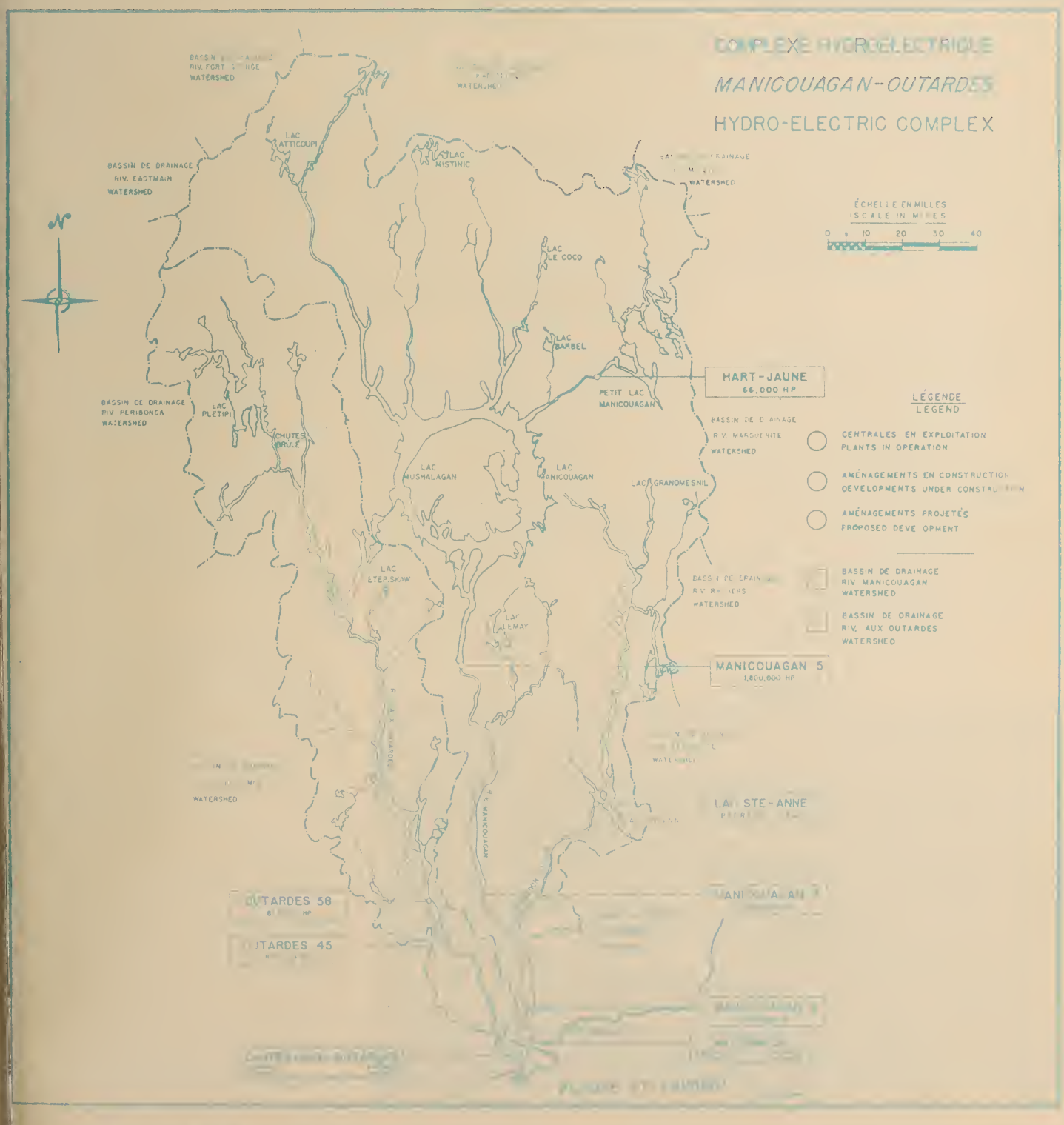
HYDRO-QUEBEC, 75 Dorchester Blvd. West, Montreal, Que.

EIC-63-HYDEL 12

MANICOUAGAN-AUX OUTARDES POWER PROJECT

Francois Rousseau
Assistant General Manager,
Power Development, Quebec Hydro-Electric Commission

THE Manicouagan and Outardes rivers discharge into the St. Lawrence on the North Shore some 10 miles apart approximately 200 miles downstream of Quebec City, in the vicinity of Baie-Comeau. They flow in a southerly direction respectively some 250 and 350 miles on almost parallel courses through a watershed bounded on the west by the Bersimis, Peribonka, Eastman and Fort George watersheds and on the east by those of the Godbout, Moisie and other small rivers, and to the north by the basin of the Kaniapiskau



SITE		Capacity in hp.	Head in feet
Manicouagan Power Co. Ltd.	Expansion to	580,000 hp.	124
Manicouagan 2		1,360,000 hp.	240
Manicouagan 3		1,505,000 hp.	310
Manicouagan 5		1,800,000 hp.	505
Outardes 58		800,000 hp.	425
Outardes 45		860,000 hp.	425
Outardes Falls	Expansion to	500,000 hp.	—

river which discharges in Ungava Bay (see map).

The total fall in the course of the Manicouagan river is 1,900 ft. and that of the Outardes is 1,500 ft. The average annual precipitation over the entire drainage area of the two rivers is calculated to be 36.3 in. of which approximately 31% occurs as snow. The mean annual temperature varies between 30°F. and 35°F. while the average July daily maxium is around 70°F.

The total area contributing run-off to the Manicouagan river is estimated at 17,600 square miles of which 11,290 square miles lie upstream from the major storage dam site at Fifth Falls.

The approximate long-term average flows of the Manicouagan when the planned reservoir at Fifth Falls has been filled, and on which the capacity of the power plants will be based is as follows:

Fifth Falls—21,600 c.f.s.
Third Falls—25,300 c.f.s.
Second Falls—35,000 c.f.s.
First Falls—35,000 c.f.s.

The total drainage area of the Outardes river is 7,460 square miles and the long term average flow at the mouth of the river is estimated at 14,000 c.f.s.

Full regulation of the two rivers will allow two existing plants, one at the mouth of the Manicouagan and the other at the mouth of the Outardes, to be expanded.

The above installations are to be expected:

These installations are based on a load factor of approximately 58% which was determined after exhaustive economic studies involving capital investment, production and transmission costs, and the characteristics of the system demand for power.

The plants will be capable of producing yearly 33 billion kwh. It is interesting to note that all of the drop between the forebay of Manicouagan 5 and the St. Lawrence river will be used for the production of power; the tailwater elevation of a plant being the forebay elevation of the downstream plant.

As the greater part of the total storage that can be impounded is in the proposed reservoir above Fifth Falls and a minimum of seven years will be required to fill this reservoir to its economic limit, it is evident that construction of a dam at this site must start early in any sequence of development.

MANICOUAGAN 5 DEVELOPMENT

The Reservoir — The economic elevation of the reservoir was calculated to be 1180 ft. Its storage capacity above Manicouagan 5 is 5,000 billion cu. ft. or 115 million acre-feet ranking it among the largest in the world, surpassed only by Aldeavilla in Spain and Kariba in Africa. The nearest approach to it in North America, the reservoir impounded by Hoover dam, is about one-quarter this size. The reservoir will be 125 miles long embracing an area of 800 square miles. Live storage to assure complete long-term regulation is 900 billion cu. ft.

The Dam — Of the various types of dams considered the choice narrowed down to either a rock fill or a concrete multiple arch dam. It was finally decided to build the multiple arch dam because it was considered that doing so would effect a substantiol saving on the overall cost of a development at this site, there being very little to choose between the two tvpes as regards stability, safety and the effect on the construction schedule with respect to filling the reservoir.

The crest will be 4,000 ft. long and 705 ft. above the lowest foundation point.

It will consist of one main arch 530 ft. wide spanning the river bed, and 13 smaller buttressed arches at 250 ft. centres straddling the gorge.

The maximum thickness of the archcs is 75 ft. at the rock line and the minimum thickness at the crest is 10 ft. The counterforts on which the main arch rests are approximately 400 ft. long and 125 ft. wide at the foundation. The crest will be straight and will provide for a 17 ft. roadway.

Most of the 500,000 cu. yd. of rock excavation required for the foundation has already been blasted with great care to prevent any loosening of the solid foundation.

The total volume of concrete will be 2,850,000 cu. yd. Concreting is now proceeding at the rate of 110,000 cu. yd. per month, and is not expected to be finished before the end of 1966.

RIVER DIVERSION

The river flows over a bed of permeable alluvial materials 250 ft. deep upstream of the dam, and 120 ft. deep downstream. Unwatering and excavating the dam site to good rock posed quite a problem for the engineers and it was finally decided to adopt the following scheme, which is just a classical example of what is often done in such cases.

The river is diverted by means of two 47 ft. diameter tunnels each 2,200 ft. long, driven in the right bank sufficient to pass flood flows. The intakes are located just above a cofferdam blocking the entire river upstream from the main dam site; the outlets are below another cofferdam downstream from the main dam. The difficulty of the problem was to insure watertightness of the 250 ft. deep alluvium on which the 100 ft. high cofferdam would sit. Different methods were considered and it was finally decided to build a 24 in. thick cut-off concrete diaphragm down into bed

Photograph of Manic. 5 scale model dam

rock from the base of the cofferdam under construction. This was accomplished by using the ICOS-VEDER process as follows:

Two foot diameter holes at 4 ft. intervals were drilled by means of a specially developed well drill operating a chisel weighing approximately 1½ tons. The walls of the holes were kept from collapsing during drilling by circulating bentonite slurry of suitable specific gravity and keeping the hole full. When the hole was drilled 2 ft. deep in the rock, concrete was poured continuously by means of a tremie until the hole was filled. When the concrete hardened, the 2 ft. intervals between piles were then drilled to rock by means of the well drill, using a special chisel with an expandable bit and guided by the adjacent piles, the bentonite mud being replaced by concrete as explained before.

As the downstream cofferdam rests on only 110 ft. of alluvial permeable material, it was decided in this case to resort to grouting to achieve the required water barrier below it. The SOLETANCHE-RODIO process which allows stage grouting and regrouting almost at will without any redrilling, was used for this work A grout mixture consisting of water cement and clay, was injected into holes drilled by means of a percussion tool in three parallel lines 10 ft. apart and 10 ft. centre to centre.

The diversion of the river was completed by May, 1962, and excavation of the river bed was started immediately after the dewatering of the dam site which was kept dry by two 1000 g.p.m. submersible pumps, lowered in two 24 in. deepwells in the toe of the upstream cofferdam. The average rate of pumping was approximately 800 g.p.m.

THE POWER HOUSE

The on-line date at Manicouagan 5 has not yet been scheduled definitely. This is a complicated problem the solution of which depends on the rate of filling of the reservoir and the quantity of water which will be required for the operation of the downstream plants.

The powerhouse will be located on the left bank of the river 2,500 ft. below the dam. Two concrete lined tunnels each 36 ft. in diameter and 3,400 ft. long with separate intakes tapping the reservoir 600 ft. from the east end of the dam, will bring water to the turbines. Sill elevations at the intake will be 1,020 and 1,065 ft. respectively and the tunnels will terminate in a manifold feeding four partly steel lined penstocks, each 750 ft. long. Eight 225,000 hp. Francis type turbines will be connected to the steel penstocks through eight spherical valves.

The electrical layout is still being studied. But it has been decided that no switching station will be built at the site and that the power plant will be directly connected by four 315 kv. circuits to a collector station located some 70 miles South in the vicinity of Outardes 58.

CONSTRUCTION HIGHLIGHTS

Cement — A special type II cement with low hydration heat of 63½ cal./gr. has been specified for all concrete.

Concrete — 4,500 p.s.i. concrete composed of special type II cement, plus four classes of coarse aggregate and two sizes of sand, is used for mass work.

Coarse Aggregate — is granitic gneiss quarried at the job site, crushed in a 500 ton per hour capacity plant and stockpiled over a collector tunel in the following four different size groups: 6 in. to 3 in.; 3 in. to 1½ in.; 1½ in. to ¾ in.; ¾ in. to ⅜ in. Aggregates are fed to the batching plant through a coarse aggregate washing plant.

Sand — A local pit is trucked to two stockpiles over a collector tunnel near the mixing plant after it has been washed and graded in the two following sizes: ⅜ in. to 16 m.; 16 m. to 200 m.

A classifying plant was specially designed to produce adequately-graded sand. Sand smaller than ⅜ in. and water are fed at one end of a tank measuring 40 ft. x 10 ft. x 10 ft. deep; in their travel, the particles of sand settle to the bottom of the tank according to their weight and size; the heaviest at the intake and the lightest at the outlet. Each of 11 valves at the bottom of the tank can be set to feed the desired amount of each size of particles to produce the specified granulometry. In our case, the 11 sizes of particles are recombined in the right proportion to produce the two required classes of sand.

Batching Plant — The batching plant containing four 4 cu. yd. mixers is equipped with fully automatic weight batchers and controls. The nominal capacity of the plant is 320 cu. yd. per hour.

Concrete Placing Equipment — Concrete is being placed in final position by means of three radial cableways spanning 3,650 ft., and equipped with 8 cu. yd. buckets. For the upper part of the dam the buckets will be changed to 4 cu. yd. because of the tightening of the cables to provide clearance. Concrete is delivered from the batching plant to the cableway pick-up points by means of special concrete carts of 8 cu. yd. capacity. The concrete outside the reach of the cableways is being placed by means of cranes.

Ice as Aggregate — When the average ambient temperature is over 60°F., ice is substituted for part of the mixing water to neutralize some of the hydration heat and minimize contraction. The plant erected for this purpose is capable of producing 250 tons of flake ice a day.

Size of Concrete Lifts — The dam is being concreted in blocks approximately 45 ft. long and 5 ft. high. To facilitate the cooling of concrete and prevent its contraction, intervals of three to five days are being observed before overlapping blocks are poured. Where a 6 ft. lift is necessary to maintain the concrete schedule, refrigeration coils of aluminum tubing circulating 50°F. river water are inserted in the concrete to hasten the transfer of heat.

Formwork — The formwork is of the cantilever type with steel framework and ¾ in. plywood sheathing. The formwork is raised after each pour and bolted to anchors set in the previous pour. Thus only one set of forms will be used from bottom to top of dam.

Measuring of Deformation and Temperature — Some 1,000 strain gauges and more than 1,000 temperature measuring devices, connected to control panels, will be set in the concrete mass at specific places to measure the stresses to which the concrete will be subjected. Readings will be recorded during the construction of the dam and the filling of the reservoir; observations will also be made during changes of air temperature and water levels both before and after completion of the dam.

This will enable the designers to check the design stresses under varying conditions and provide useful data for future work. Deformation of the structures under varying conditions of loading will also be accurately measured by means of precise optical instruments set on the banks of the river and markers set at specific places in the concrete during construction.

Control of Concrete — Project control is being exercised to ob-

tain the necessary strength and qualities against deterioration from freezing and thawing. A most modern concrete laboratory with a press of 1,200 ton capacity is used to test to destruction concrete specimens 18 in. x 18 in. x 56 in. containing 6 in. aggregate. The laboratory also contains a refrigeration unit for submitting the concrete to freezing and thawing cycles in order to determine and control its resistance to the severe winter conditions at the site.

Vertical Joints — The vertical joints between the blocks forming the arches necessitate positive sealing in order to prevent leakage or weeping under the tremendous pressure. A copper water stop will be inserted in each joint a few feet from the upstream face. Each joint will be grouted in separate sections, each section being totally enclosed by a strip of plastic interstop. Cement grout will be injected and reinjected by means of pipes and special valves inserted in the concrete as the dam is being built up.

Lighting the Dam Site During Construction — To date, lighting of the dam site has not posed any unusual problem as most of the work has been carried out below bank level. However when the dam will emerge above bank level, lighting could become quite awkward and unsatisfactory if setups have to be provided at each block level. To obviate this difficulty and reduce lighting costs, a system installed once for all for the duration of the construction activities and not interfering with the operations of the cableways is being erected. It consists of a single overhead suspension cable running parallel to the axis of the dam above the cableways and supported by two steel towers 3,400 ft. apart on opposite banks of the river. A maximum of eighty 1000-watt mercury vapor flood lights with ballast mounted on retractable carriages, will be fed by a single 4,160 volt power cable using the grounded steel cable for neutral. Illumination will be 40 ft. candle at ground level.

MANICOUAGAN 2

This development is located immediately below the Second Falls, about eleven miles upstream from the existing McCormick Dam; the latter is at tidewater in the Manicouagan estuary and its headpond is at the tail water level of Manicouagan 2, 123 ft. above mean sea level (Geodetic).

The dam at Manicouagan 2 will raise the water level to elevation 360 ft., flooding out the third falls. It will require 148 billion cu. ft. to fill the forebay, of which 20 billion cu. ft. will be live storage thus providing a 10 ft. drawdown.

Diversion of the river was very similar to Manic. 5; the two unlined 46 ft. horseshoe tunnels were free flowing rather than pressurized, as it was felt that there would be less danger of pulpwood log jams. The tunnels were 1,500 and 1,200 ft. long respectively. One tunnel intake was made 20 ft. higher than the other allowing final closure to be made without gates. The low tunnel has no centre pier and will be closed across its 46 ft. unobstructed width by stop logs which not be salvaged.

The cofferdams were much the same as at Manic. 5, the upstream seal was a concrete diaphragm against a design head of 135 ft.; the downstream cofferdam rock fill was blanketed with sand and silt and subsequently grouted. The two cofferdams totalled 750,000 cu. yd.—good sized dams in themselves.

The downstream tunned plugs blasted to effect diversion, had a volume of 28,000 cu. yd. and a depth of 70 ft.

The concrete coarse aggregate is crushed from quarried granitic gneiss and the fine aggregate, a blend of two natural sands mixed at the site. The automatic concrete plant has four 2 cu. yd. tilting mixers. Placing is effected by cableway (8 cu. yd.) spanning 2,000 ft., two whirley cranes, a double derrick on tracks, and mobile cranes as required.

Photograph of Manic. 2 scale model dam

The main dam is a concrete gravity type, with hollow joints. As far as known, it is the first of its type outside Europe. These hollows result in a reduction of the concrete quantity by 15% and a saving of about 10% in the cost of the concrete. The reduction in uplift allows a reduction in weight and also an excellent opportunity is afforded for observation and carrying out of grouting or other remedial measures only as required.

The eight Francis turbines have a rating of 170,000 hp. each. The 141 mva. generators have rectifier type ultra high speed excitation supplied by auxiliary alternators rather than A.C. exciters. Two generators are coupled to each main transformer bank, requiring only four circuits at 315,000 volts to the collector station two miles downstream. The control is arranged for self-synchronizing and the governors are electro-hydraulic.

Work was started in October, 1962, on erection of the camps. The river diversion was completed in April, 1963. Some 150,000 cu. yd. of concrete have been placed out of the total 1,069,000 and the first unit will be operating in July, 1965.

TRANSMISSION OF POWER

Power from the seven power plants composing the Manicouagan-Outardes Complex will be transmitted over 315 kv. circuits, the length of which may vary from 2 to 70 miles, to two collector stations where voltage will be stepped up to 735 kv.; one located in the area of Outardes 58 and the other near Manicouagan 2.

Three 735 kv. circuits connected to the high tension bus of the collector stations will transmit power towards Montreal. Two circuits originating at the Manicouagan 2 station, will follow the North Shore to almost Quebec City, cross the St. Lawrence River, go through an intermediate station at Levis and then along the South Shore to a terminal station to be built near Boucherville. The third circuit will depart from the other collector station and will follow the North Shore of the St. Lawrence River to a terminal station near Montreal. This circuit will go through an intermediate station in the area of Quebec City.

The two collector stations will be interconnected on the high tension bus. The two intermediate stations near Quebec and Levis and the two terminal stations will also be interconnected on the high tension bus. Connections to the existing system will be effected at the collector stations, intermediate and terminal stations.

EIC-63-ELEC 4

INSTALLATION OF IN-SPAN TRANSPOSITIONS

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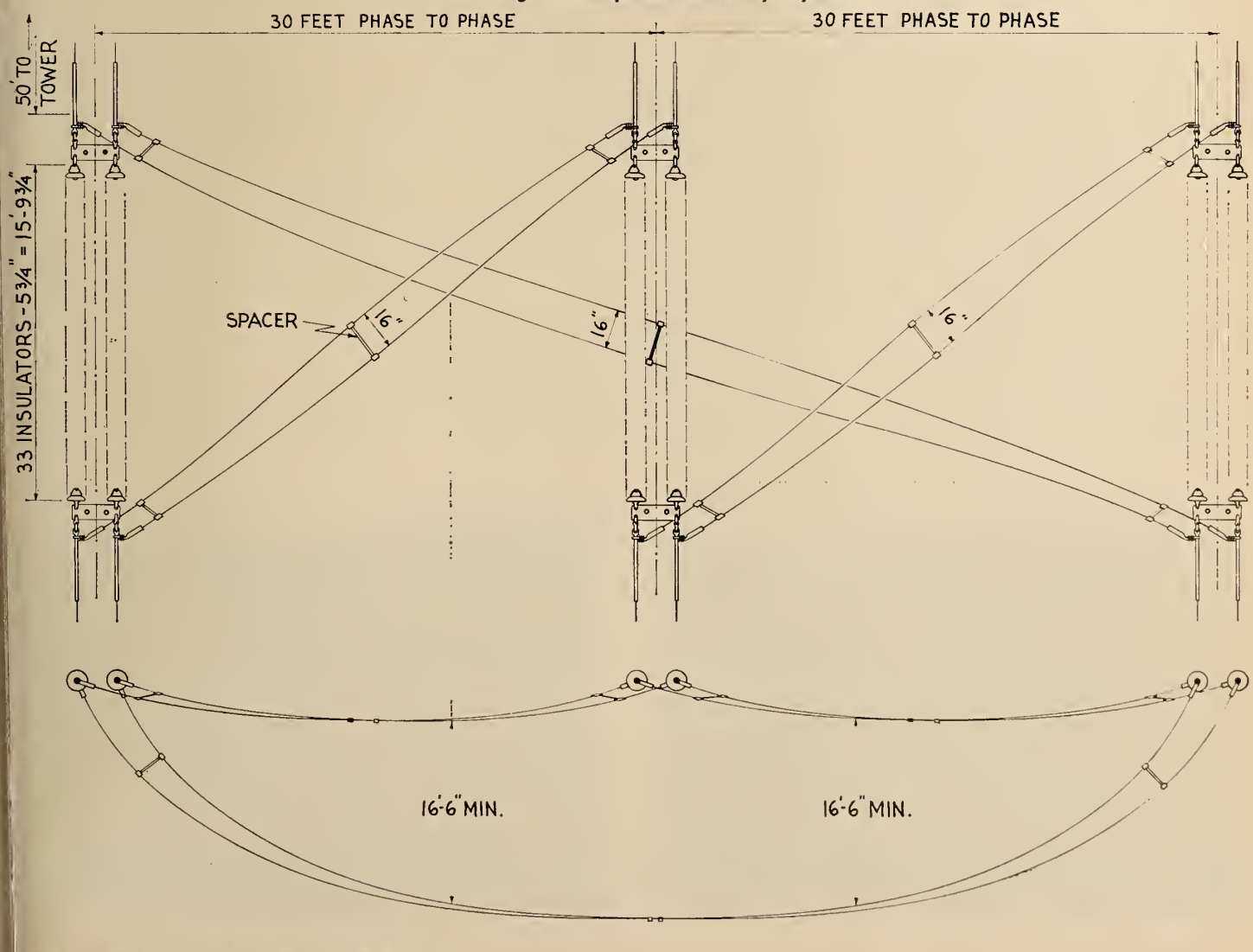
THE 345 kv. TRANSMISSION lines in which the transpositions were installed consist of two single circuit, horizontal configuration lines, 91.5 miles in length from the Chute-des-Passes 1,000,000 hp. generating station on the Peribonka River to a Terminal Station at Isle-Maligne, Que. These lines consist of two 850 MCM ACSR conductors per phase spaced 16 in. apart strung on waist-type towers. The lines cross rough semi-mountainous terrain over most of their length. They were constructed in 1958/59 and the transpositions were added in 1961.

In-span transpositions eliminate the need for special towers and are made by removing a section of conductor, inserting a double string of suspension insulators, and transposing the phases by means of jumpers looped below the line. This method has been used both in America and Europe, particularly in Sweden, and has proved satisfactory. This paper deals with the installation of in-span transpositions after the lines had been constructed and with full tension maintained on the conductors at all times.

The installation of transpositions during the construction of these lines was rejected for several reasons. Firstly, the experience of other large utilities with high voltage lines had shown that the lack of transpositions did not affect their operations adversely. This avoided the extra cost of their installation. Secondly, the cost of installing in-span transpositions after the line was built would not be prohibitively more than during construction should it be found later that they were necessary.

Operating experience after one and one-half years at 161 kv. indicated that the electromagnetic and electrostatic unbalances present in the untransposed lines were high. These produced adverse effects on communication circiuts, apparently caused false relay operations and interfered with proper protective relay settings. Significant unbalances were also caused in the generator phase currents which reduced their thermal capability. At Chute-des-Passes the relays on the

Fig. 1. Transposition Assembly Layout.



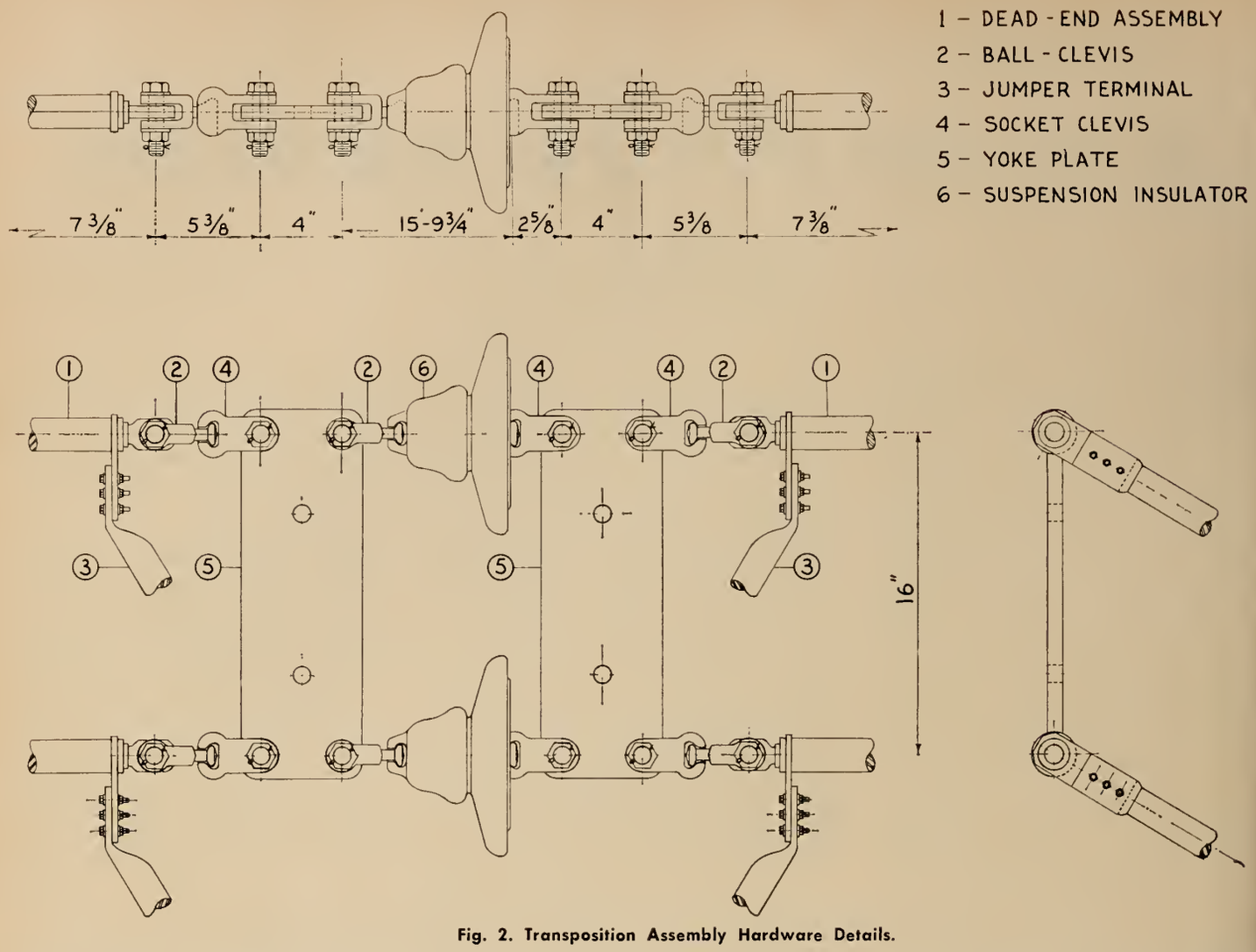


Fig. 2. Transposition Assembly Hardware Details.

high tension neutral connections of the unit transformers had to be set at a higher point than desired after several false trips. At this station there are five transformer banks, any number of which can be in service at one time, to feed power into the two lines. Thus when five banks were in service the currents flowing in the neutral of each bank were low whereas if only one bank was in service the current was quite high. Furthermore, the sensitivity of the line protection was greatly reduced because of the residual currents due to the unbalanced phase currents. Due to these undesirable effects it was felt that transpositions were necessary and should be installed as soon as possible, even though operation at the normal voltage of 345 kv. would lessen these effects.

Three transpositions were installed in each line to obtain a complete rotation, with each phase occupying each position for one third of the length of the line. To obtain this and to keep the phase positions unchanged at the two extremities of the line the transpositions were installed at the one-sixth, one-half and five-sixth points.

The one-sixth and five-sixth points were accessible only with considerable difficulty, whereas men and equipment were easily transported along a bush road into the mid-point. This difficulty of accessibility, plus the fact that work camps had to be set up at each site, led to the installation of the transpositions in a definie sequence to reduce line outages and costs. Work commenced at the five-sixth point which was just north of the Peribonka River approximately 14 miles from the Isle-Maligne Terminal Station. On the first line the insulators were installed and bypassed

Fig. 3. Come-alongs and special yoke plate installed approximately 200 feet from tower.

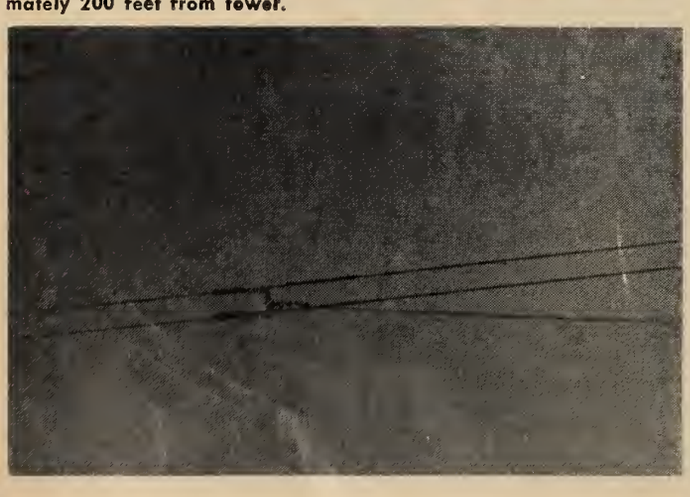
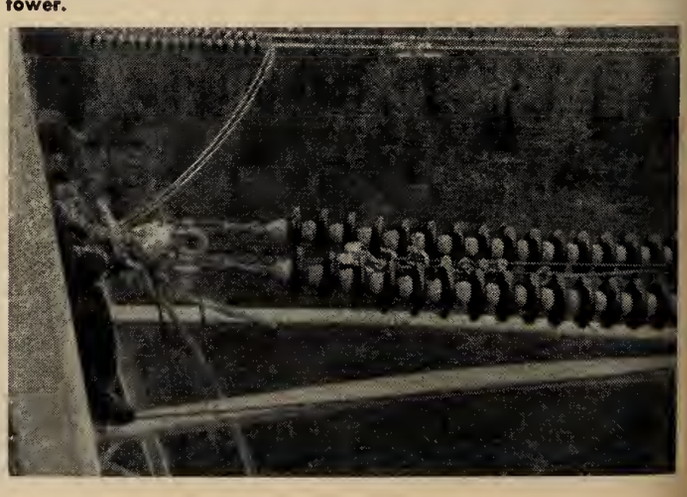


Fig. 4. Arrangement of equipment to relieve tension at dead-end tower.



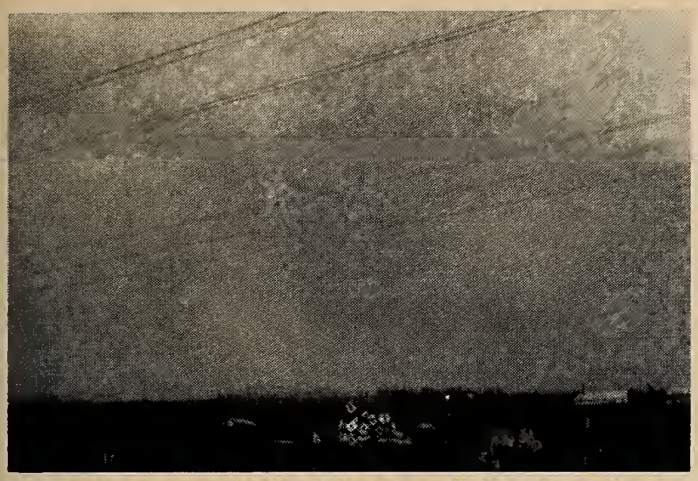


Fig. 5. Compression dead-end being installed on lowered conductor.

Fig. 6. Transposition Insulators and conductors near end of raising operation.

with temporary straight-through jumpers, i.e. no transposing, (although jumpers for transposing had been prepared) and then this line was returned to service. The second line was then removed from service and transposed at the five-sixth point, the mid-point and the one-sixth point. While the men and equipment remained at the one-sixth point the second line was returned to service and the first again removed from service. The first line was then transposed at the one-sixth and one-half points and a small group of men sent into the five-sixth point to remove the straight jumpers and transpose the phases. This latter work took only one day and did not necessitate setting up camp. By using this sequence the setting up of one campsite was saved.

Two of the transpositions in each line were at light angle (3°) suspension towers and the other at a dead-end tower. Although it would have been preferable to install all the transpositions at dead-end towers, this was not practical due to the small number of these towers. The closest dead-end towers to the one-sixth and one-half points in the direction of Chute-des-Passes were 44 and 30 spans away respectively, while in the direction of Isle-Maligne they were 39 and 20 spans away.

To avoid undue stresses on the towers, special precautions had to be taken to maintain the conductor tensions at all times during the installation of the transpositions. The tension in each conductor at the time of installation was approximately 4,000 lb. The procedure used differed between the dead-end tower and suspension tower installations and further, at the suspension towers between the middle and outer conductor installations. The basic operation in all cases consisted of taking up the tension in the conductors for a length of 200 ft. from the tower, as described later, to create a slack section. A piece was cut out of each conductor in the slack section to allow the installation of the insulators and hardware. The assembly consisted of two strings of 33, 25,000-pound class, suspension insulators each attached to yoke plates at both ends by means of ball and socket hardware as shown in Figs. 1 and 2. Ball and socket hardware was used in order to set the angle of the jumper terminals for the loops as closely as possible to the angle at which the conductor would hang when in its final position. These angles were approximately 60° to the horizontal for the long jumpers and 30° to the horizontal for the short jumpers. The weight of the assembly, i.e. insulators plus hardware in each phase was 1060 lb. This extra weight in the span increased the tension causing the suspension strings at the adjacent towers to swing slightly towards the tight span and therefore the section of conductor removed was cut 6 in. shorter than the assembly length to avoid an increase in tension and allow the suspension strings to remain vertical. This allowance was measured in the field by hanging the assembly on the conductors approximately 60 ft. from the tower before cutting.

The procedure used at the dead-end towers was to install two come-alongs at a distance of approximately 200 ft. from the tower (Fig. 3). At first each come-along was tied back to the tower through a ⅝ in. steel wire rope and a six-ton puller. This caused some difficulties due to twisting of the conductors as a result of differences in tension. Therefore a special yoke plate was used which equalized the tension (Fig. 3). This permitted the tension to be taken up with only one wire rope, simplfying the procedure and eliminating the twisting. The single puller was hooked on to the shackle at the centre of the yoke plate shown in Fig. 4. When the tension had been taken up by the wire rope the conductors

Fig. 7. Long jumper being measured between outside phases.

Fig. 8. Lineman being raised by means of pulley and winch arrangement to install spacers in middle of short jumper.

Fig. 9. Special platform installed in suspension tower for working on middle conductors.

Fig. 10. Close-up of platform installed on suspension tower for working on middle conductors.

were unhooked from the dead-end strings and lowered to the ground. The conductor was then cut at a point 50 ft. from the tower and a section of approximately 18 ft. 6 in. long, measured from the cut toward the span, was cut out and dead-ends compressed onto all the free ends as in Fig. 5. The transposition insulator assembly was then attached to the span conductors. The short conductor sections close to the tower were reattached to the dead-end insulator strings and the complete assembly raised and pulled together by a pulley block arrangement (Fig. 6). When the yoke plate of the insulator assembly was close enough to attach the dead-ends to it a lineman would crawl out on the conductors and do this. A large muskeg tractor equipped with a 7.5-ton winch with a ½-in steel wire rope was used with the pulley block arrangement. The assembly was then placed under tension in the span by slowly releasing the pulley. The come-alongs were removed and dampers and spacers re-installed.

Installation of the loop jumpers was made after all the insulator assemblies had been installed. The jumpers were cut to approximate length and jumper terminals installed at one end only. They were then raised into position, attached to the dead-ends at one end, measured and marked. The jumpers were then lowered, cut and terminals installed. Figure 7 shows the long jumpers being measured at one of the dead-end tower installations. The short jumpers were installed first and pulled up as tight as possible. The long jumpers were then installed such as to leave approximately 16 ft. 6 in. clearance to the short jumpers. The spacers on the jumpers could only be put in position after the jumpers were installed since it was difficult to judge exactly how they would hang after installation. The middle spacers of the small jumpers and all the spacers of the large jumpers were set using an arrangement as seen in Fig. 8. The ½-in. wire rope from the muskeg tractor winch was attached to a yoke plate of the insulator assembly. The wire rope then passed through a pulley onto which the lineman would attach himself, using a special harness. Another pulley was attached to the yoke plate of the insulator assembly on an adjacent phase. This permitted the lineman to be raised and lowered freely using the winch on the tractor.

The methods used for the outer and inner phases at the suspension towers were quite different. The outer phases were lowered to the ground where two sets of come-alongs were installed, one approximately 200 ft. from the suspension point and the other a few feet on the opposite side of the suspension point. The tension in the section of conductor between these come-alongs was taken up by six-ton pullers and ⅝-in. wire ropes creating a slack section in which the insulator assembly was installed. The conductors were then raised and clamped back into position.

The centre phases at the suspension points presented a more difficult problem since the conductors could not be lowered to the ground due to the shape of the tower. After cutting, the end closest to the tower could not be lowered to the ground for installation of dead-ends since this end was only 50 ft. long and the conductor suspension point was at a height of 80 ft. A special platform was therefore made and suspended from the tower crossarm just below the suspension string as seen in Figs. 9 and 10. Two sets of come-alongs were used on the centre phase as on the outer phase. Two of the come-alongs were installed just behind the armour rods at the suspension point as seen in Fig. 10. Figure 10 also shows the special cradle which was installed behind these come-alongs to prevent the conductor from buckling underneath the suspension point. The other come-alongs were installed at points 200 ft. from the tower. The tension was relieved by the pullers and steel cable as before. The weight of this 200 ft. section made it difficult and dangerous for the lineman to cut and therefore Klein Chicago grips were installed on both sides of the point of cut and the tension in this small section was taken up by a pulley block arrangement using the muskeg tractor winch. After the conductor was cut the winch would let out its cable and the two free ends would slowly drop as in Fig. 11. The longer end, away from the tower, would reach the ground where a section was cut out of it and dead-ends and insulator assembly installed. Figure 12 shows the short end falling against the tower. This end was pulled up onto the platform. After the dead-ends were installed the complete assembly was raised, the two ends attached and jumpers installed as in the case at the dead-end towers.

Fig. 11. Conductor being lowered at suspension tower.

Figure 13 shows a complete transposition at a dead-end tower and Fig. 14 a complete transposition at a suspension tower.

Six and one-half weeks were required to complete the installation of the transpositions on the two lines. Approximately 20 men were required

TABLE I

January 27, 1961 — Before Transposing

Station Load — 632 Mw.
402 MVARS
Voltage at CdP Bus — 189 Kv.

	Line 61		Line 62	
	At CdP	*At I.M.*	*At CdP*	*At I.M.*
Phase A	1,040	1,078	1,020	1,018
Phase B	1,090	1,100	1,080	1,128
Phase C	1,020	1,010	1,070	1,097
Neutral		116.5		122.0

July 25, 1961 — After Transposing

Station Load — 460 Mw.
250 MVAR
Voltage at CdP — 180 Kv.

	Line 61		Line 62	
	At CdP	*At I.M.*	*At CdP*	*At I.M.*
Phase A	770	785	800	790
Phase B	800	790	800	790
Phase C	800	790	790	785
Neutral		0		0

TABLE II

January 9, 1963 — 345 Kv Operation

Station Load — 757 Mw.
104 MVARS
Voltage at CdP — 347 Kv.

	Line 61		Line 62	
	At CdP	*At I.M.*	*At CdP*	*At I.M.*
Phase A	600	600	600	602
Phase B	604	601	604	605
Phase C	602	600	600	604
Neutral		0		0

including the cook and mechanics. The total cost of installing the six transpositions was $19,686 which consisted of $7,200 for material, $10,238 for labor and contractors overhead and $2,248 for room, board and travelling expenses.

Table I lists the phase and neutral currents measured before and after transposing. It can be seen that neutral currents have been eliminated completely. This now allows setting of the protective relaying at its most sensitive point.

Fig. 13. Complete transposition at dead-end tower.

Also in Table I can be seen the magnitude of the unbalanced line currents before transpositions were installed. The unbalances thus present in the generators reduced the thermal capability of the station by as much as two and one-half percent at full load.

There are no neutral currents with operation at 345 kv., as seen in Table II.

Two severe lightning seasons have passed since the installation of these transpositions and although the lines were often hit with resulting flashovers at suspension strings the transposition points have not presented any problems.

The installation of in-span transpositions can therefore be considered to be an economical and effective method of reducing the unbalance present in transmission lines after they are in service, should these unbalances be large enough to warrant it.

Fig. 12. Short end of conductor falling close to suspension tower.

Fig. 14. Complete transposition at suspension tower.

EIC-63-THERMAL-PWR 2

WABAMUN
Coal Handling Facilities

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THE DESIGN of a coal handling system for a thermal power station is based on providing a reliable method of handling the coal from the point of delivery to the steam generator at a minimum cost per ton including installation and operating costs; and considering the following factors:

(a) Method and schedule of delivery of coal to the power station.

(b) Burn rate schedule.

(c) Processing required between point of delivery and the steam generator.

(d) Provision for future power station extension.

(e) Integration with basic concepts of design and operation of the power station.

The above limitations differ from one power station to another, and accordingly exhibit themselves in some special way in every coal handling system. Within the framework of these limitations, coal handling systems have been characteristically designed to include for 36 to 60 hour indoor coal bunkers, and operation confined to the usual intermittent, manually supervised, 40-hour work week, regardless of the size or location of the power station.

The layout of the coal handling system for the Wabamum Steam Plant of Calgary Power Ltd. has departed from the conventional weekend indoor capacity bunker design, and is the first power station in Canada to use a fully automatic, free-flow live storage, reclaim system.

WABAMUN STEAM PLANT

The Wabamun Steam Plant is located approximately 40 miles west of Edmonton, Alberta, on the north shore of Lake Wabamun.

The steam plant comprises two 66,000 KW natural gas-fired units which were installed in 1956 and 1958, and a 150,000 KW reheat coal-fired unit which went into commercial operation in October, 1962.

The plant site features a proven reserve of 60 million tons of strip mine, sub bituminous coal, located adjacent to the site, and an abundant supply of circulating water for an ultimate development of 1,000,000 KW.

The 66,000 KW units were designed for ultimate conversion to pulverized coal firing. The coal and ash handling systems were initially deferred due to the availability of low cost natural gas.

The increased annual fuel requirements resulting from base load operation of the 150,000 KW unit justified the installation of the coal and ash handling systems, and the opening of a large scale strip mine operation, over the uncertain supply and future price of natural gas. The pilot and standby fuel for the 150,000 KW unit is natural gas, although the total maximum supply of natural gas to the steam plant is limited to the generation of approximately 140,000 KW.

The development of the Wabamun Steam Plant has been based on an overall concept of automatic control from a central control room with minimum operating staff, and as a result consideration was given to an automatic coal handling system, in addition to the conventional manually supervised systems commonly used elsewhere.

BURN RATE SCHEDULE

The coal burn rate tonnages for the present and proposed future extensions at Wabamun are as follows:

It is readily apparent from these tonnages that the design of a coal handling system for a thermal plant burning a sub bituminous coal presents unusual problems of handling substantially larger tonnages than those associated with units in thermal stations of comparable size burning Great Lakes or Eastern Seaboard coals. Furthermore, it is impractical to consider indoor bunker capacity of weekend storage, or for that matter, more than a single day's operation, if conventional, intermittent, manually supervised operation is contemplated.

In order to overcome the excessive operating costs with a conventional system with two shift reclaiming, it

BURN RATE SCHEDULE

Unit	*MW*	*Burn Rate* *Tons/Hr.*	*Total Tons/Hr.*	*Annual Tons* *80% Load Factor*
3	150	106	106	740,000
2	70	58	164	1,150,000
1	70	58	222	1,550,000
4	200	140	362	2,500,000
5	250	175	537	3,800,000
6	250	175	712	5,000,000

Fig. 1. Stocking Out Plant

is necessary to consider a scheme of outdoor live storage. The alternative of a manual reclaim operation can be evaluated against a system of free flow, fully automatic, operation.

OPERATING CONDITIONS

The coal seams in the mine generally fall into three zones, namely an upper 5 ft. seam, a middle 9 ft seam, and lower 2 and 3 ft. seams, all interbedded with layers of clay and shale, and covered with 40 to 60 ft. of overburden. Due to drainage problems, the lower seams may be saturated with water, and the range in total moisture is expected to vary from 22% to 32%. The maximum ash content will vary from 18% to 25%.

Winter weather conditions in the Wabamun area are such that, although snow fall is light to moderate, —20°F temperatures are common, and have fallen to as low as —40°F. The combination of high moisture and low temperature promotes freezing and start-up difficulties. In order to overcome this, the approach has been to maintain a continuous flow of coal to the plant bunkers. It even appears inconsistent to attempt to provide large indoor storage time if the coal has been continuously exposed to the outdoor temperatures in the mine.

High moisture coals also present many difficult problems during summer operation, if confined for long periods in indoor storage. Decomposition will produce explosive vapours, and water run off will plug feeders and flow into the mills. Minimum indoor storage and continuous flow of coal will relieve this condition, and it is felt further minimize the possibility of bunker fires.

Large indoor bunkers also generally have dead storage areas which present hazards to operators, who may have to enter the bunkers to either clean them out or to promote the flow of coal.

DESCRIPTION OF COAL HANDLING PLANT

The Wabamun Steam Plant coal handling system is designed to handle the run of mine coal delivered at the coal hauler delivery hopper, screen, crush and stock out the ¾" x 0 product to a live storage (Fig. 1) stock pile which is developed over a tunnel housing 2 reclaim belt conveyors. The coal feed to the steam plant is automatically regulated by level probes in the 5 bunker silos which initiate the sequential start and stop of the equipment.

The run of mine coal processing equipment comprises the coal hauler delivery hopper (Fig. 2), a duplex plate feeder, and a double roll primary crusher under the hopper outlet. It is capable of reducing the run of mine coal to a 12" by O size at the rate of 800 tons/hr. initially, and loading the secondary crusher house feed belt (Fig. 3). Provision has been made in the delivery hopper structure for a second hopper, primary crusher and duplex feeder to handle an ultimate rate of 1600 tons/hr. An induction loop has also been provided to detect magnetic ferrous and manganese tramp material from entering the plant stockpile.

The conveyors are of the cable supported permanently lubricated idler type which provide flexibility for frequent start-stop operation, and are equipped with training idlers, belt scrapers, and dribble chutes.

The four secondary crushers are of the double roll two-stage type, each provided with a bypass inlet screen and are capable of reducing the coal feed to a ¾" x 0 product at an initial rate of 800 tons/hr. It is then weighed, sampled, and delivered to the plant live storage stockpile by a 54" mobile shuttle belt and adjustable boom stacker. The ultimate capacity of the secondary crusher house of 1600 tons/hr. will be developed by extending the secondary crusher house to include 4 additional crushers, screens and distributing and collection conveyors.

Withdrawal of coal from the stockpile (Fig. 4) is regulated by vibrating magnetic feeders located in the seven dual hoppers over the two 42" reclaim belt conveyors.

A frozen coal scalping screen and crusher house (Fig. 7) reduces unmanageable lumps of conglomerated coal to ¾" x 0 during winter operation in a double roll 2-stage crusher. The crusher will be normally bypassed during summer operation.

The two plant feed belt conveyors are capable of handling 800 tons/hr. each, and feed the two scraper plate conveyors located over the bunker silos.

The five silos (Fig. 8) are each capable of storing 320 tons of ¾" x 0 coal and represent 12 hours storage at full load.

The flow of coal from each silo is controlled by a drum type feeder located at the outlet of a Bituminous Coal Research Easy-Flow bin.

Each feeder supplies a 30 ton/hr. capacity pulverizer which is capable of reducing the ¾" x 0 feed to 70% through a 200 mesh screen product to corner fired burners. Four mills are capable of maintaining full load on the unit firing 7000 BTU/lb. coal, the fifth mill being out of service for maintenance purposes.

In order to assure mill drying under high moisture conditions, the steam generator is designed with an economizer gas bypass system which can raise the air temperature from the air heaters to the mills to 700°F.

Fig. 2. Coal Hauler Delivery Hopper

Fig. 3. Secondary Crusher House and Stocking Out Control Room

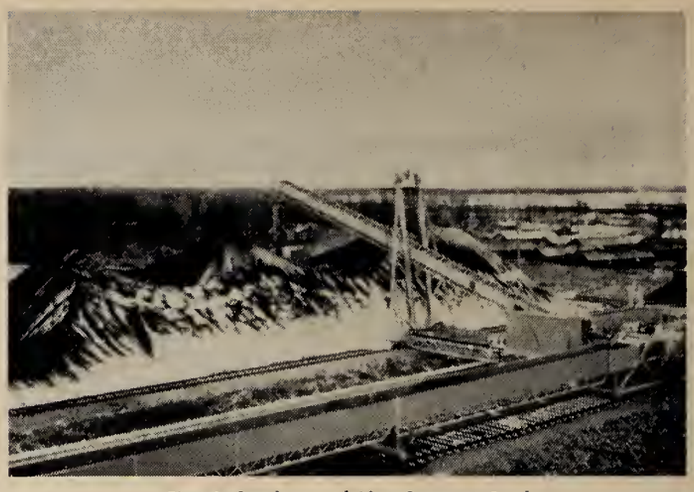


Fig. 4. Stacker and Live Storage Coal

DEVELOPMENT OF DESIGN

The factors which modified the design of the coal handling system during the course of development were:

(a) Frozen Coal
(b) Automatic Control
(c) Ultimate Development
(d) Bunker Capacity

The preliminary designs included for continuous crushing in both the stocking out and reclaim plants. The primary sizing was handled by a rotary breaker from run of mine to 2" x 0 size to the stockpile, and secondary crushing by double roll crushers on the plant belt to the bunkers. In this way frozen coal retrieved from the stockpile was reduced to ¾" x 0 along with all of the 2" x 0 coal feed, assuring the elimination of delivery of all lumps of coal over ¾ in. This arrangement presented a number of problems, namely the possibility that the feed from the delivery hopper to the rotary breaker would eject considerable quanties of frozen coal with the tramp material. In addition continuous processing of reclaim coal involved the difficulty of automating many pieces of equipment which would have to be subject to frequent sequential start-stop operation.

The decision was made to stock out ¾" x 0 coal, and to reduce unmanageable slabs of run of mine coal in a double roll primary crusher at the outlet of the delivery hopper. To overcome the problem of delivery of frozen coal to the plant bunkers, a frozen coal crusher house was installed between the tunnel and the plant belt, to handle oversize coal and would be normally bypassed during normal operation.

The preliminary design of conveyors over the bunker silos was based on a conventional belt conveyor tripper scheme. It was abandoned in favour of drag chain conveyors which top up the silos, sequentially in order from the tail end loading point. The problem of maintenance was overcome by providing a standby conveyor and simplified the controls of feeding coal to the bunkers.

Consideration was given to the possibility of deferring one set of tunnel plant belt and bunker scraper conveyors. Inasmuch as the foundations and structural steel would have to be provided, the initial saving in the deferred equipment was not enough to justify the risk of outage due to the limited availablity of natural gas.

Alternative locations of delivery to the plant bunkers were investigated before the feed to the east side of the 150,000 KW was decided. This location is situated in the approximate center of the ultimate steam plant and feeds two bunker feed conveyors travelling initially westward to units 1, 2 and 3 and ultimately eastward to units 4, 5 and 6. It offers freedom in converting units 1 and 2 to coal firing, savings in reduced bunker conveyor sizes and flexibility in sizing of the east feeding bunker feed conveyors to units 4, 5 and 6.

The development of the coal handling plant to its ultimate capacity will involve the installation of the second hopper and primary crusher at the coal hauler delivery point, and doubling the capacity of the secondary crusher house. The addition of a head end drive on the shuttle conveyor will permit reverse belt direction operation in order that the outdoor live storage stockpile may be extended to include 5 more free flow hoppers.

It is anticipated that the indoor bunkers for future units will be further reduced in size, perhaps down to 4 hours storage capacity.

Fig. 5. Reclaim Plant Panel on Left in Station Control Room

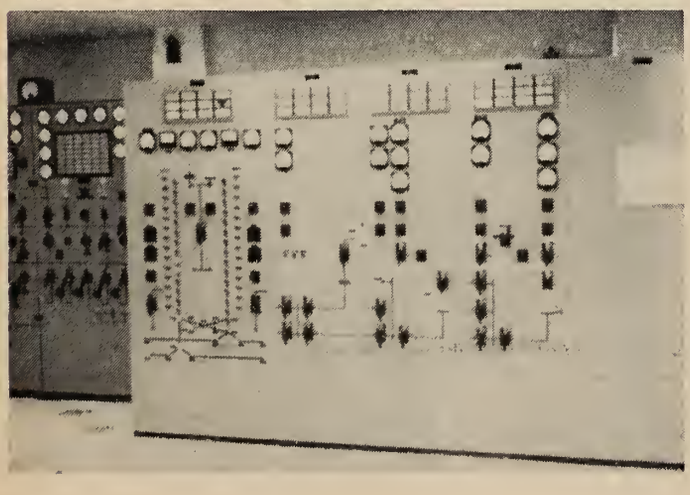
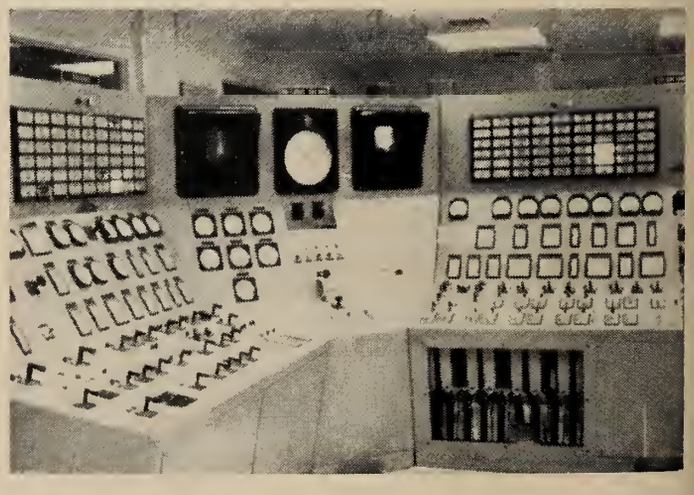


Fig. 6. Bunker Level Indicator Lights in Corner Section of Desk in Station Control Room



ECONOMICS OF FREE FLOW LIVE STORAGE

A number of alternative methods have been devised to develop outdoor live storage, and these generally fall into the following groups:

(a) Continuous pile and tunnel with either a shuttle conveyor or travelling tripper feed to a mobile stacker.
(b) Swing boom tower or radial stacker.
(c) Fixed stacker.

The continuous piles developed with either mobile, radial stackers, or a swing boom tower are suited for large live, free flow, storage capacity. The fixed stacker with a single reclaim hopper is more suited to smaller requirements. The continuous stock pile presents advantages of freedom for future extension with virtually no limit to the number of reclaim hoppers that can be provided where land is readily available. The swing boom tower is limited to several hoppers and depends on height of stockpile, to provide the necessary storage, and is more suitable for restricted site areas.

The Wabamun continuous live storage stockpile is developed to a height of 34 ft with a track mounted, cable winch driven, mobile shuttle belt conveyor and end connected stacker. It is provided with an adjustable boom and telescopic chute. The five initial dual reclaim hoppers are located on 60 ft. centers and provide an initial total capacity of 20,000 tons, of which a maximum of 10,000 tons is available for free flow reclaim.

The permanent dead storage area located along side the tunnel live storage pile has a capacity of over 150,000 tons. Surplus coal from the stocking out plant which is in excess of daily requirement for the live storage pile is placed into the dead storage pile with a dozer. Reclaim from the permanent storage area to the live storage hoppers is handled by a dozer during shutdown of either the mine or stocking out plant. The end grizzly hoppers can be used under adverse weather conditions which limit the use of the free flow system.

The capital cost of structures and equipment for storing outdoor free flow coal is $45/ton as compared with $285/ton storage capacity for the indoors bunkers.

The capital cost of the complete coal handling system is approximately $3.30/KW on the ultimate site development.

The expected installation and operating cost is approximately $0.10/ton on the ultimate development.

CONTROLS

The operation of the stocking out plant is controlled by one operator from the control room, located in the secondary crusher house overlooking the stockpile.

The stocking out plant is designed for automatic sequential or remote manual start-up and shut-down operation. Motion switch devices have been provided on the conveyors, crushers and vibrating screens which must be satisfied on an automatic start-up before the preceding piece of equipment can start up. Similarly, during normal operation, if a motion switch indicates loss of speed which may be due to either a belt splitting or a mechanical failure it trips all preceding equipment.

To overcome the possibility of plugging at transfer chutes, electronic probes have been provided to trip all preceding equipment. In addition to the equipment control switches, emergency stop buttons have been installed near the equipment and in the control room for system trips. Motors are also protected by overload relays which trip all preceding equipment. In all cases except the emergency trip, the following equipment continues to operate and clear itself of coal and permits the operater to see where the trouble originated.

The reclaim system is designed for fully automatic unattended operation and is started and stopped by electronic probes in each of the bunker silos. A low level probe in any bunker sequentially starts up the reclaim system which continues to operate until the last high level probe is satisfied. Motion switches transfer chute probes and motor overload devices are also provided on the reclaim system. A plugging switch is installed at the head end of each bunker scraper conveyor to stop the system in the event of failure of the last high level probe.

Switches are provided on a panel in the central station control room (Fig. 5) to select the vibrating feeder and outdoor hopper for free flow withdrawal it also permits the operator to blend good and poor grade coal or select either type depending on plant load requirement. Selector switches enable the control operator to choose either train of reclaim tunnel, plant and bunker conveyors. An indicating weightometer shows the instantaneous coal flow rate and an integrator provides total coal tonnage locally on the plant belt conveyor.

The cause of the reclaim system trip can be determined by lights on the panel board. The bunker high and low level probe indicating lights in the central station control room (Fig. 6) inform the operator which bunker is being filled, when the system will stop, or if it should start.

COAL PLANT SERVICES

The coal handling system is provided with a high pressure lake water piping system for purposes of fighting fire or washing down equipment. A high temperature hot water heating system has been installed to prevent freezing and start up problems in the crusher buildings, the reclaim tunnel, and the delivery hopper, during winter operation.

Fig. 7. Plant Belt Conveyor Showing Frozen Coal Crusher House

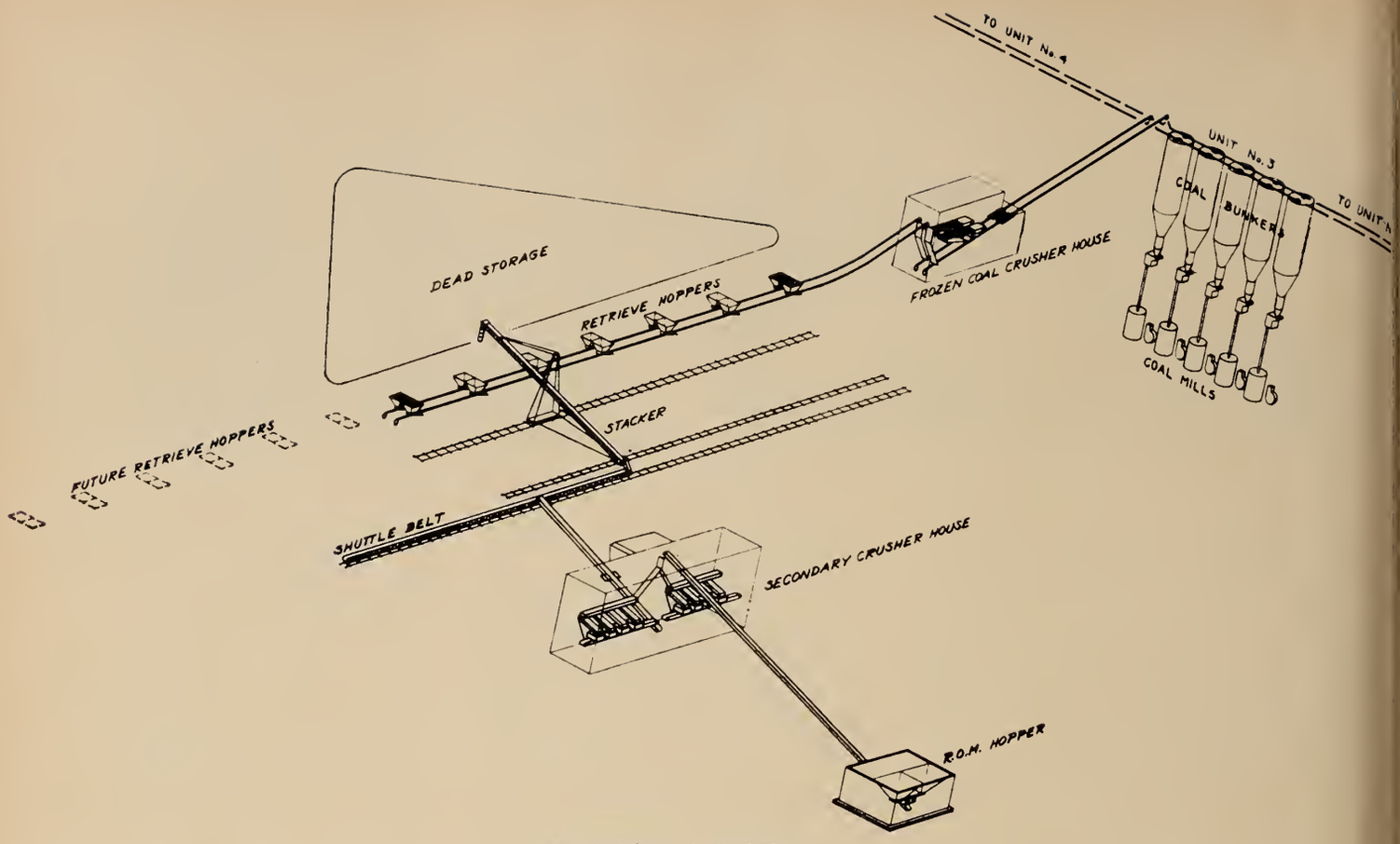


Fig. 8. Schematic Coal Plant

The stacker and shuttle belts are open to the weather and the plant belt conveyors have been equipped with belt covers to minimize cleaning of galleries.

A dust collection system has been installed in the secondary crusher house.

COAL CONTRACT

Coal delivered from the mine is purchased on a tonnage basis which is adjusted by the difference in ash content between coal in place in the mine seams, and coal actually delivered to the plant stock pile.

OPERATING EXPERIENCE

The Wabamun Coal handling plant went into regular operation in October 1962 with the No. 3 unit extension, and has processed approximately 500,000 tons of run of mine coal to date.

Incidents occurred during the commissioning stage and early commercial operation which can be attributed to the following principal factors:

1. Nature of the coal
2. Mining and operating practices
3. Weather
4. Equipment design.

The coal is characteristically high in ash content which has proven to be abrasive on chutes and hoppers where changes in cross section affect the flow pattern. Sliding surfaces have become polished and promote the flow of coal. The only case of localized wear developed on the liners of the chutes at the head end of the plant feed belt.

Although the past winter was generally mild, temperatures dropped to −20° F on several occasions. Under low ambient temperatures belt icing and conglomeration of frozen lumps occurred during early operation when freshly mined 5 ft. seam coal with moisture contents over 26% was handled. In addition, excessive clay inclusions in the lower coal seams have caused plugging of the double roll crushers. The above difficulties have been overcome by the blending of 9 ft. seam coal which is granular and lower in moisture.

Improvements have been considered to the belt cleaners, which are of the counter balanced scraper blade type, and a beater type pulley may be installed on one belt on a trial basis.

Heating cable has been installed in the stacker power and communication bus duct to prevent the formation of hoar frost. This has caused arcing and brush wastage.

The upper face of the plant belt conveyor developed striations and a crack at the vulcanized joint. It has been felt that this was due to improper vulcanizing and has been repaired.

The frozen coal crusher on the reclaim system was installed as a precautionary measure to eliminate the possibility of delivering frozen coal to the plant bunkers. The crusher was used only sparingly as it has been found that by keeping the coal moving in the pile and introducing 9 ft. seam coal when extremely wet coal is handled, frozen coal problems can be prevented.

CONCLUSIONS

The design of a coal handling system for a thermal plant presents challenging problems of integration into an overall power plant design and operation concept and maintaining flexibility for future extension.

The design of an automatic, live out-door storage coal plant of the Wabamun type yields both minimum unit handling costs and minimum capital investment by virtue of its lower capacity. This offers economic advantages in reducing site development costs for new power plants.

We feel that the predicted unit handling costs will be maintained, and that automatic, outdoor live storage coal handling systems are suitable for power plant service under rigourous Canadian weather conditions.

The operating experience on the Wabamun coal handling plant has met our best predictions and the performance has been completely satisfactory.

EIC - 63 - GEOTECH 7

TILL COFFERDAM DUMPED IN WATER

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A NUMBER of cofferdams have been constructed by the simple expedient of end dumping earth or a combination of rock and earth into water. Doubts as to the safety and effectiveness of such structures arose with proposals for their use on the St. Lawrence Power Project. The results of laboratory model tests and a full-scale field trial did not remove the uncertainties. The method was successfully used, however, on the project primarily in channel improvement work, usually at the contractors option. In the light of this experience, data on the existing structures were obtained and observations have been continued on more recent examples, including borings in several cases and a few piezometer measurements. All of the cofferdams studied were constructed of till or till-faced rock fill and were located in southern Ontario on the St. Lawrence River or in northern Ontario on the Abitibi and Mattagami rivers.

The collected data apply specifically to cofferdams constructed of till: homogeneous sections in water up to 25 feet deep and till-faced rock fill sections in water up to 40 feet deep.

The foundation material has in each case, been dense till or rock. Detailed observations of the methods of construction and the behaviour of the material are presented and an appraisal of the stability of the structures under varying conditions, is given. In addition, a study of the material quantities was made and it is believed that reasonable estimates can be made for similar placing conditions.

DESCRIPTION OF MATERIALS

The cofferdams studied were located between Cornwall and Prescott on the St. Lawrence River, at Otter Rapids on the Abitibi River and at Little Long Rapids on the Mattagami River.

The till in the St. Lawrence area is believed to be of Wisconsin age and has been described by MacClintock/1/, as an upper and lower till. The upper till occurred largely in the form of a ground moraine and was the source of borrow material for cofferdam construction.

Similarly, at Otter Rapids and nearby at Little Long Rapids, upper and lower tills of Wisconsin age were encountered. The upper till was overlaid by alluvial deposits at Otter Rapids but exposed at Little Long Rapids. At both sites outwash deposits of silty sands and gravels or interstadial lacustrine sediments were frequently found between the upper and lower tills.

At Otter Rapids the till from the upper formation was used and proved to be a reliable source of borrow. At Little Long Rapids material from the tailrace excavation was used. Here the upper till was shallow and erratic and appreciable quantities of the underlying outwash were included in the fill. While the material was till-like in grading, frequently the water content was high and this factor is believed to have a bearing on the characteristics of the finished cofferdam.

Grading curves representative of the materials used, are to be found in Figure 1, and the properties of the three materials are listed in Table I. Details of both St. Lawrence and Otter Rapids tills have been reported by Adams/2/. The particle sizes of all of the materials used ranged from clay to boulders. At the St. Lawrence sites the till was notably well-graded and contained boulders in appreciable quantity; at both Otter Rapids and Little Long Rapids boulders were scarce, the Otter Rapids material was higher in clay sizes and the Little Long Rapids material was higher in silt and sand sizes. It is typical of these tills that they compact easily to form a dense fill if the water content at placement is close to proctor optimum. The plastic range of these materials is small, however, and the addition of a small amount of water will raise them to their liquid limit.

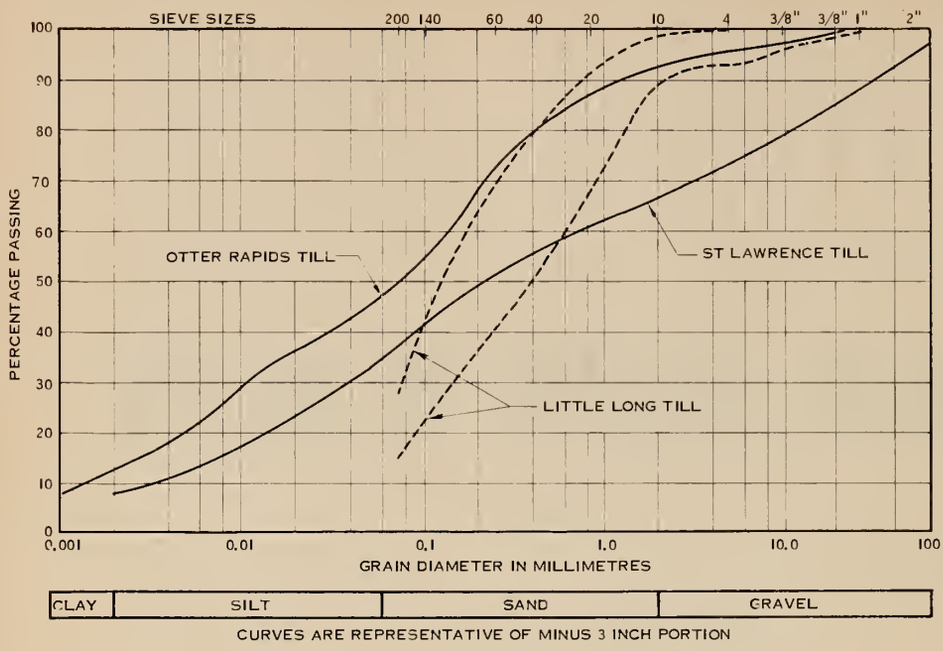


Figure 1 — Grading curves of till

PRELIMINARY LABORATORY AND FIELD TRIALS

Preliminary to the construction of full-scale cofferdams, two model cofferdams were constructed in a glass-fronted tank. Loose till at the natural moisture content was used. In the first test the material was dumped in small quantities in the water to form an embankment aproximately 18 inches high. The water was then drawn down on one side. In the second test the material was dumped in the dry against one end of the tank. The tank was then flooded and the fill was extended in the water by continued dumping. This model was also subjected to drawdown. In both tests a succession of slips occurred during dumping and in both tests failure occurred on drawdown.

The full-scale field trial was made at the site of the Barnhart Island powerhouse. Dumped till was extended 90 feet into water up to 10 feet in depth. Slips similar to those observed in the model tests, occurred in the advancing face of the fill during placing. Although drawdown was not included in the field trial, the placement factor of safety was thought to be close to unity and drawdown was expected to cause failure of the cofferdam. The trial indicated that flat slopes would occur thereby making the material requirements excessive for the cofferdams then proposed.

COFFERDAM CONSTRUCTION

The cofferdams are of two types, that is, homogenous till and till-faced rock fill. The construction methods with regard to handling the till, however, are similar in both instances. In use the two types are significantly different, however, as only in the homogeneous dam is till subjected to drawdown on dewatering. For all the dams the method of construction involved the movement of trucks on the dumped fill, end dumping from the trucks, and final positioning of the fill by bulldozers.

The cofferdams of homogeneous till type were located at the St. Lawrence Power Project. They were of generous cross-section to provide ample working width for vehicle movement and were intended for low heads generally in the order of 25 feet. They were used chiefly for channel improvement work where large quantities of material were available from excavation, and where channel closures were not required. Construction usually commenced from two ends working towards closure near the mid-section. Where large areas were to be enclosed a compartment layout was usually employed permitting dry excavation to proceed with cofferdam construction. Because the till was placed in many instances in relatively fast water, the washing out of the fines in portions of the fill appeared to affect the final slope.

On the Abitibi River a till-faced rock-fill cofferdam was constructed in relatively static water up to 40 feet in depth. Initial closure was made with rock fill. After placing of an intermediate filter, till was dumped from one end to provide a 10-foot width of material parallel to the rock. The fill was then dumped from trucks and pushed to the leading edge of the fill to provide the required cross-section. The till was raised to a final grade about 25 feet above the water level and 65 feet above the river bottom. Filling above water level was accomplished by normal rolled-fill construction. The till used for construction was relatively dry, the moisture content being generally less than the standard optimum.

On the Mattagami River site the cofferdam was located downstream from the powerhouse and was the barrier between the tailrace excavation channel and the Mattagami River. The water varied up to 30 feet in depth at the time of placement and due to back eddying at this location the water movement was essentially lateral to the cofferdam. The method of construction was similar to the Abitibi cofferdam consisting of rock fill faced with till. The final height of this cofferdam was 10 feet above normal water level and 40 feet above river bottom. The material used for impervious fill was quite wet at the time of placement, due to the inclusion of the underlying outwash material.

Photographs illustrating the use of some of the cofferdams are shown in Figure 2.

TABLE I

Typical Properties of Till Used for Construction of Cofferdams

Property	*St. Lawrence Till*	*Otter Rapids Till*	*Little Long Till*
Natural density, pcf	147	—	—
Natural Moisture Content, % dry wt.	8.5	8.0	—
Proctor Optimum Density (Std), pcf	142	141.6	122—124
Optimum Moisture (Std), % dry wt.	9.0	10.9	9—11
Permeability, fpm	1.0×10^{-6}	1×10^{-8}	—
Liquid Limit, % dry wt.	14.7	13.4	—
Plastic Limit, % dry wt.	9.6	10.7	—
Shear Parameters in terms of Effective Stresses Saturated and Undrained			
c' (apparent cohesion psf	290	150	—
ϕ' (angle of shearing resistance, degrees)	38	38	—

FIELD OBSERVATIONS

Detailed observations were made during the placing of several cofferdams and the behaviour of the material in each case observed was similar. As the loose till was positioned at the end of the cofferdam by bulldozer, slips would occur near the top edge of the fill and little or no earth would roll down the outer face of the fill. With greater depths of water the slips were more extensive and started farther back from the edge of the water. Grade stakes placed in the advancing face of the fills indicated rotational movement. The advancing face of the cofferdam consisted of soft material and was observed to remain intact during placing.

The shape of the underwater sections varied considerably but the characteristic form was that of a steep slope extending to 4 to 5 feet below water level, at which level there was an abrupt change to a flat slope extending to river bottom. Typical sections are found in Figure 3. Details of slope, water depth, water velocity etc., (for a number of the St. Lawrence cofferdams) are found in Table II.

Borings were made in several of the completed cofferdams, and samples of the fill both above and

TABLE II

Physical Data on Homogeneous Till Cofferdams

	Dimensions (ft).				*Slopes (degrees)*					
					Upstream		*Downstream*			
Location *Point 3 Points*	*Width*	*Height*	*Free-board*	*Water Depth*	*Over-all*	*In Water*	*Over-all*	*In Water*	*Water Velocity (fps)* 9	*Material* Sandy till
10 + 00	38	6.5	3.0	3.5	21	21	12	—		
18 + 00	34	8.7	3.0	5.7	18	12	35	35		
22 + 00	24	19.0	5.5	13.5	13	12	20	18		
25 + 00	25	13.0	2.0	11.0	12	12	18	18		
30 + 00	37	16.5	1.5	15.0	18	10	33	33		
Average					16.4	13.4	23.6	26.0		
South Galop									7—13	Till & rock
3 + 00	50	32.5	6.5	26.0	17	17	8	8		
4 + 00	54	45.0	6.5	38.5	18	18	10	10		
5 + 00	45	47.0	6.0	41.0	20	20	14	14		
6 + 00	43	44.5	5.0	39.5	18	18	18	18		
7 + 00	50	32.5	4.0	28.5	17	17	13	13		
Average					18.0	18.0	12.6	12.6		
Iroquois Point									5.5	Sandy till
65 + 00	30	15.0	9.0	6.0	21	16	27	—		
68 + 50	38	15.0	10.0	5.0	24	20	20	—		
74 + 00	26	16.5	12.5	4.0	32	26	28	—		
76 + 50	49	24.0	13.0	11.0	20	16	22	—		
78 + 00	43	28.0	12.0	14.0	19	17	27	—		
80 + 00	40	24.5	12.5	12.0	15	12	23	15		
81 + 50	35	35.0	14.5	20.5	18	10	18	12		
83 + 50	48	23.0	10.0	13.0	29	29	28	28		
84 + 50	34	28.0	22.5	5.5	18	9	26	—		
86 + 00	55	19.0	17.0	2.0	16	12	12	—		
Average					21.2	16.7	23.1	18.3		
Iroquois Dam (Can.) *Dividing Cofferdam*										Sandy till
Typical section	47	40	15	24	22	14	—	—	10	
Galop Island									Low	Sandy till
243 + 00	64	19.0	5.5	13.5	13	13	20	15		(some rock)
289 + 00	50	33.0	11.0	22.0	30	25	20	10		
300 + 00	30	16.5	11.5	5.0	35	—	32	24		
301 + 50	42	21.0	9.5	11.5	24	16	16	12		
304 + 50	40	21.0	7.5	13.5	18	13	22	12		
310 + 50	42	27.0	9.5	17.5	24	13	20	12		
316 + 50	43	28.0	15.5	12.5	28	17	24	11		
335 + 50	38	31.0	7.0	24.0	16	10	11	7		
Average					23.5	15.3	20.6	12.9		
Toussaints									7	Sandy till
Range 71	36	31.5	12.8	18.7	28	9	25	25		
Range 75	44	22.0	11.3	10.7	14	11	16	7		
Range 76	26	22.0	12.3	9.7	15	24	24	9		
Range 83	32	22.0	10.3	11.7	29	20	25	12		
Range 87	27	25.0	11.3	13.7	17	8	35	35		
Average					20.6	14.4	25.0	17.6		
Cofferdam A1 *Upstream Blanket*									0	Sandy till
2 + 20	—	7.0	—	7.0	—	15				
2 + 40	—	8.1	—	8.1	—	15				
3 + 00	—	10.0	—	10.0	—	11				
3 + 40	—	16.7	—	16.7	—	7				
4 + 00	—	8.7	—	8.7	—	12				
Average						12				
OVER-ALL AVERAGE					19.5	15.2	20.6	15.4		

Test cofferdam St. Lawrence project

Rockway Point cofferdam (U.S.) St. Lawrence project

Iroquois Point cofferdam St. Lawrence project

Upstream cofferdam Otter Rapids project

Figure 2 — Photographs of till cofferdams

below the water line were obtained. The results of moisture and density determinations are shown in Table III. It will be seen that for the St. Lawrence and Otter Rapids cofferdams the percentage saturation was low, and the moisture content was essentially that of the borrow. The percentage saturation for the Little Long Rapids cofferdam was far higher, and in some cases approached 100 per cent. This condition can be attributed to the placement moisture content which was also high. Prior to removal, some cofferdams were trimmed on the de-watered side to relatively small sections exposing the core materials. Observations indicated no segregation or voids and confirmed the relatively dry and sound conditions found in the boreholes.

In construction of the Otter Rapids cofferdam, three piezometers were installed in the till, as shown in Figure 3 when the level of the fill was approximately 13 feet above the water level. Each piezometer consisted of a porous stone tip with a twin-line plastic tubing led to a terminal on the

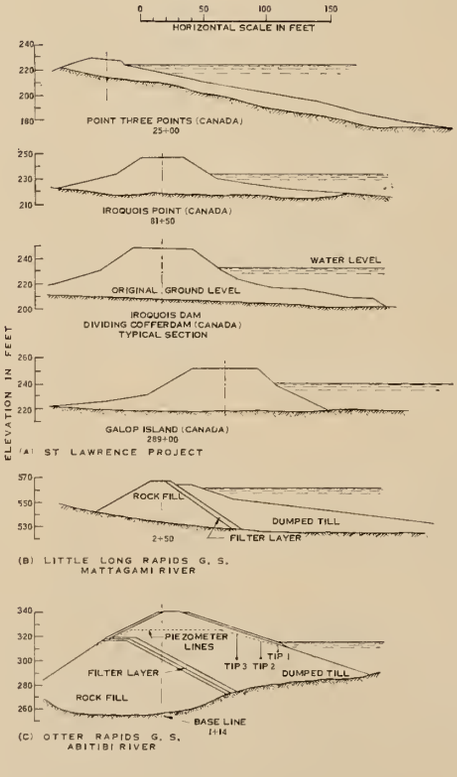


Figure 3 — Sections of till cofferdams

downstream slope where pore-water pressure was read by Bourdon gauges. Only the initial readings of the gauges are shown in Table IV, as unfortunately the piezometer lines were accidently destroyed in the course of construction a short time after installation, and long-term readings were not possible. It will be noted that the readings reflected no excess construction water pressures.

In all cases the behaviour of the cofferdams has been satisfactory and the amount of seepage through them has been negligible. Failure did occur in one instance, the cofferdam involved being that built for channel-improvement at Iroquois Point. The cause of the failure was not determined, although from eye-witness accounts it seems likely that the failure was due to foundation piping.

QUANTITIES

The quantities of material placed in each cofferdam were calculated from the data presented in Table II, and from the cross sections shown in Figure 3. These calculated values

TABLE III

Results of Tests from Borehole Samples

Project	*Location*	*Sample Depth in Relation to River Level feet*	*Moisture Content %*	*Dry Density pcf*	*% Saturation*	*% Std. Proctor Density*
St. Lawrence.....	Test Cofferdam	+ 0.5	7.9	119.2	49.5	91.0
		− 1.5	7.9	120.5	52.2	92.0
		− 3.0	10.3	117.8	61.5	89.8
		− 5.0	7.2	127.5	59.0	97.3
		−11.0	9.0	105.0	36.8	80.2
		−12.0	8.0	132.5	78.8	101.0
Otter Rapids.....	Upstream Cofferdam 1 + 14, 88L	+ 8.0	7.2	129.8	62.8	101.0
		+ 6.5	7.8	137.0	86.9	106.2
		+ 2.0	7.5	137.7	85.5	107.0
		+ 1.0	9.1	124.8	67.4	96.8
		− 3.0	7.7	122.2	53.2	94.8
		− 3.5	7.5	127.6	61.1	99.1
		− 7.0	7.8	112.5	40.6	87.4
		− 8.5	8.3	119.1	53.9	92.5
Little Long Rapids...	Downstream Cofferdam 3 + 50	+ 0.5	14.7	117.0	94.0	95.8
		− 3.0	16.9	111.0	91.4	91.0
		− 4.0	16.8	106.9	81.0	87.7
		− 5.0	15.3	118.1	96.9	95.2
		− 7.0	12.5	121.0	85.0	97.5
		− 9.0	13.0	126.1	100.0	101.5

have been plotted against the depth of water as shown in Figure 4. For comparison a curve is shown based on the quantity required to form an idealized section with an underwater slope of 2:1 (horizontal:vertical) changing to 8:1 at a depth of 5 feet. This idealized section is based on that of the Galop Island cofferdam, which is considered to be typical.

It can be seen that the observational data fits reasonably well with the curve drawn from the idealized section. The major deviations from this curve can be explained in terms of the variables that affect construction of this type. The chief factors that determine the quantity of material required appear to be the depth of water, the slope of the river bottom, the water velocity, the grading of the till, and the placement water content.

In a study of the effect of the slope of the river bottom on the quantity of material required, two cofferdams may be considered: one at Otter Rapids and the other at Point Three Points. At Otter Rapids the till was dumped against a rising slope of about 4:1, while at Point Three Points the bottom fell away in a slope of 6: or 8:1. Although the quantities of these cofferdams and that at Little Long Rapids deviate from the ideal curve, Figure 4, they will be found to be in close agreement if the true slope of the bottom is considered.

The effect of high water velocities on the till is the removal of fines to leave a berm of relatively coarse material. The data in Figure 4 are shown with upstream and downstream quantities linked for each section, where both were available. In most cases the smaller quantity appears on the side of the cofferdam exposed to erosion. The lesser quantity is therefore thought to reflect the removal of fines. For the Iroquois dam, till was dumped in water with a velocity of 10 fps. A long flat berm was formed consisting of well-graded clean sand and gravel (see Figure 3). The core material, however, was subsequently found to consist of relatively unsorted till. It was estimated that the loss of fines in the berm material was about 30 per cent by weight. The quantity of material required for this section is shown on Figure 4, and includes a correction for the lost fines. Although the quantity of material lost was considerable, it appears that the total amount required for the section differed little from that predicted from the theoretical section.

In dealing with high water velocities, consideration of the till grading is obviously necessary. In this connection it is worth noting that for the cofferdam constructed for the U.S. powerhouse tailrace excavation, the contractor found the addition to the till of pit-run gravel in proportions up to 1:1, to be economical, the different materials being placed alternately in truck loads. The water velocity was 14 fps and, although details are not available, the procedure was said to have resulted in the formation of steeper slopes and lower per cent loss.

TABLE IV

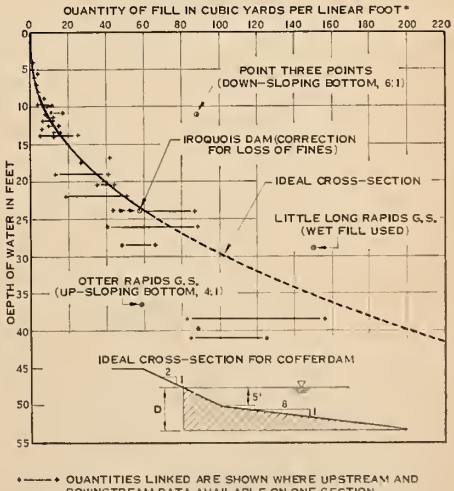
Initial Piezometer Readings Otter Rapids Cofferdam

Tip No.	*Elevation Feet Tip*	*Top of Fill*	*River Level*	*Piezometer Reading Gauge psi*	*Tip Ft. of Water*
1	309	315	315	2.3	5.8
2	301	323	315	—3.0	1.6
3	301	323	315	—3.0	1.6

STABILITY ANALYSIS

In order to appraise the stability of dumped till cofferdams, an analysis in terms of effective stresses was carried out for a typical homogeneous till cofferdam (Galop Island, a section at chainage 289 + 00) and the Otter Rapids cofferdams (section at chainage 1 + 14). Uniform slopes were

Figure 4 — Materials requirements of till cofferdams



•——• QUANTITIES LINKED ARE SHOWN WHERE UPSTREAM AND DOWNSTREAM DATA AVAILABLE ON ONE SECTION

• QUANTITIES CALCULATED FROM CROSS-SECTIONS (FIGURE 3)

• – NOTE: IN CALCULATIONS OF QUANTITIES FREE-BOARD AND TOP WIDTH ARE NEGLECTED

assumed and failure was considered possible only in the fill. The analysis was made, using the stability curves given by Bishop and Morgenstern /3/. These curves were found ideal for the purpose because although precise information relative to pore-water pressure, shear strength, placement moisture and density was lacking, it was possible to analyze the two sections for a wide range of conditions covering the most extreme possibilities. In the analyses both construction and drawdown stability were considered, with varying assumptions with respect to soil parameters and pore pressures. Due to the simplifying assumptions the calculated factors of safety are approximate and therefore the results are intended only to indicate the importance of certain variables.

The factors of safety for the cases considered are plotted in Figure 5 against pore pressure expressed as a percentage of the weight of the fill. For construction stability the pore pressure considered is the excess pressure relative to the placement water level.

It will be seen that, provided pore-water pressure is low, the factor of safety in all cases is high. For the case in which a cofferdam becomes saturated subsequent to construction and then is drawn down, the pore pressure can be taken as 50 per cent of the weight of the fill; this is equivalent to assuming the change in pore pressure equal to the change in vertical stress ($\overline{B} = 1$), see Bishop/4/. It will be seen that in this instance the factor of safety is about unity where cohesion is zero and is between 1.3 and 1.9 where cohesion is mobilized. The factor of safety was higher for the steady seepage condition than for the combined conditions of saturation and drawdown.

DISCUSSION

The model tests indicated that the dumped till had very little underwater stability. In the initial field trial the behaviour of the material was similar to that noted in the model, and it was thought that failure of such a structure would occur on a drawdown. In subsequent use of the till cofferdams on the St. Lawrence project, drawdown did not result in failure. Similarly at Otter Rapids and Little Long Rapids the use of till dumped in water, although not subjected to drawdown, resulted in a satisfactory impervious barrier to water up to 40 feet in depth.

In observations of the cofferdam construction procedure it became clear that placement was achieved by

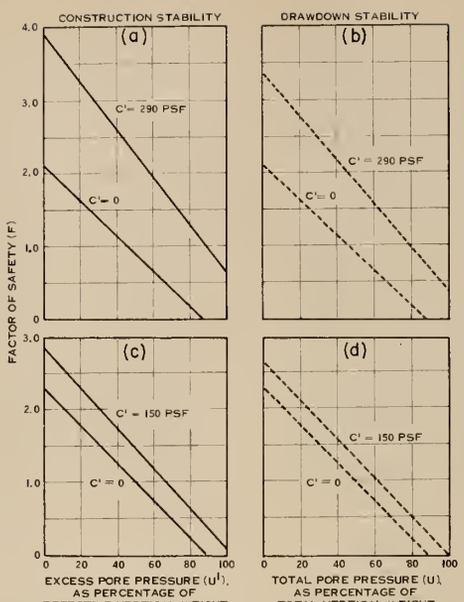


Figure 5 — Results of stability analysis

successive slips of the dumped fill and not by loose material rolling down the face of the dam. Tests on samples taken from boreholes in the dumped till indicated degrees of saturation and moisture contents comparable with those of the in situ borrow material. Piezometer measurements in one case indicated zero or very low construction pore pressures.

The stability analysis indicated high factors of safety for the partially saturated condition in which pore-water pressures are low. It has been shown that this condition applies for the period immediately following construction. For the case in which a cofferdam becomes saturated subsequent to construction and is then drawn down, the factor of safety is about unity where cohesion is neglected, but within an acceptable range where cohesion is mobilized. Since the assumption that cohesion will be zero is extreme, it appears reasonable to expect such structures to perform satisfactorily over a long period of time. For long-term use the provision of drainage facilities at the downstream toe would be necessary.

It appears obvious that the success of the structures was the direct result of the slips which occurred in construction and which permitted the material to be placed in a partially saturated condition. The manner in which the slips occur can only be deduced, but a likely explanation is that they occur in the weaker underlying earlier placed fill, which is continually displaced forward and replaced by the drier fill working down from the surface.

Many factors have been shown to govern the quantity of the dumped till required. These factors include water depth, bottom slope, water velocity, and the grading of the material. Of these, water depth and river-bottom slope will usually be the most important, and a knowledge of them will provide a reasonable basis for estimating the quantity of till required.

To ensure that harmful pore-water pressures do not develop during construction it seems reasonable to ensure that the water content of the dumped material is not greatly in excess of the standard proctor optimum value.

CONCLUSIONS

Cofferdams constructed entirely of glacial till dumped in water have shown satisfactory behaviour both during construction and after drawdown, in water depths up to 25 feet. In the study no account was taken of foundation stability, which may present problems at particular sites. Cofferdams constructed of rock fill with till dumped in water to form an upstream impervious zone, have shown satisfactory behaviour for water depths up to 40 feet.

The underwater stability of the till is attributed to low construction pore pressures which result from the till being placed at a relatively low degree of saturation. The partially saturated condition, which was confirmed by observation, sampling, and pore-water pressure measurements, is thought to have been achieved by a progressive outward slippage of the initially placed till of softer consistency. It has been shown by analysis that the danger of failure under drawdown and steady seepage was remote.

The underwater slopes of the till depend on many factors including moisture content, water velocity and the grading of the material. Despite the fact that these factors varied, quantities based on an idealized cross-section were in reasonable agreement with measured quantities.

Since moisture content is thought to influence the stability of the structures it is suggested that the placement moisture content should not exceed the standard proctor optimum value.

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4. Bishop, A. W., 1954, "The Use of Pore-Pressure Co-Efficients in Practice", Geotechnique, Volume 4, No. 4.

KODAK Industrial X-Ray Film plays a vital role in new skyway construction

The Homer Bridge which will span the Welland Canal with a six lane skyway will be open to traffic late 1963. It is estimated an average of 18,000 cars per day will pour across its surface and twice that during peak summer days.

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Discussion

DIAGNOSIS OF DISTRESS AND FAILURE IN STRUCTURES

Dr. Jacob Feld
Consulting Engineer
New York City

The Engineering Journal
May, 1963, page 43

Discussion by

H. P. Godard
Chemical Division
Aluminium Laboratories Limited
Kingston, Ont.

Author Feld asserted (on page 47) that aluminum conduit should not be embedded in concrete because of resulting corrosion problems.

This is incorrect, as reference in literature will show clearly. Aluminum embedded in concrete does not corrode appreciably, even when coupled to steel. This is borne out by tests carried out during a ten-year period[1, 2]. Embedded steel promotes the galvanic corrosion of aluminum only in the presence of calcium chloride.

Much aluminum conduit has been embedded in concrete slabs in Canada, yet in the past 15 years only two cases of corrosion have occurred, and both were due to calcium chloride additions to the concrete.

References

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2. I. H. Jenks, T. E. Wright, H. P. Godard, The Resistance of Aluminum to Concrete, Stucco and Brick Mortar—Ten Year Test Results, The Engineering Journal, Vol. 45, No. 1, pp. 46-51.
3. T. E. Wright, An Unusual Case of Corrosion of Aluminum Conduit in Concrete, The Engineering Journal, Vol. 36, No. 10, pp. 1357-1362.

Discussion by

Kenneth E. Dixon
President
Preload International Inc.
Stamford, Conn.

Dr. Feld's paper contains statements and conjectures regarding the collapse of a prestressed digester tank that are not in accord with any other investigator of this occurrence.

The collapsed structure was one of eight similar tanks built in two rows of four each. Wall and roof sections were added between tanks to form an enclosure for operating equipment and personnel. Brick facing was applied over most of the exposed exterior and was separated from the tank wall by a two-inch air space. The brickwork was tied to the tank wall by means of galvanized metal ties fitted into galvanized metal dovetail slots embedded vertically in the gunite overcoat. There was no adequate protection of the horizontal stressing wires behind the dovetail anchor slots.

Corrosion of the horizontal prestressed reinforcement was primarily caused by the continued passage of roof drainage into the wall cavity at the parapet wall construction joint. No waterproofing detail was provided at the roof parapet to prevent this.

The galvanized ties and slots were corroded to the extent of complete destruction. They had acted as channels to the prestressing steel for the flow of water from the roof. This leakage was probably mixed with sewage gas resulting in severely corrosive liquid being in almost direct contact with the stressed wire.

Dr. Feld inferred that an inexplicable internal deterioration of the wire through stress corrosion resulted in this failure. All metallurgists agree that a corrosion medium is quite essential for stress corrosion to take place. Those made familiar with this tank agreed that the evidence gathered from the collapsed structure without exception points to ordinary corrosion induced by the roof leakage.

The stressing of the wire by die drawing in the field parallels in all important aspects the manner in which all cold drawn wire is processed in the mill. Repeated tests of wire temperature in the field demonstrate that a maximum temperature level of no more than 450° F. is reached in the die. The metal structure of the wire would change only after a temperature in excess of 1,100° F. is attained.

Professor F. C. Thompson of the Department of Metallurgy, University of Manchester (England), after a review of Dr. Feld's detailed findings on this collapse wrote:

"It is self evident that had Dr. Feld's view of the nature of hard-drawn steel wire been justified, the whole of the industry engaged in the production of this material would have passed out of existence many years ago."

This failure has served to re-emphasize the importance of complete protection of the prestressed reinforcement with sound mortar. Detailing errors coupled with construction errors combined to produce a regrettable happening. The 3,000 prestressed concrete tanks constructed by Preload and its associates throughout the world are, however, ample evidence of the suitability of the basic methods employed.

Author's Reply

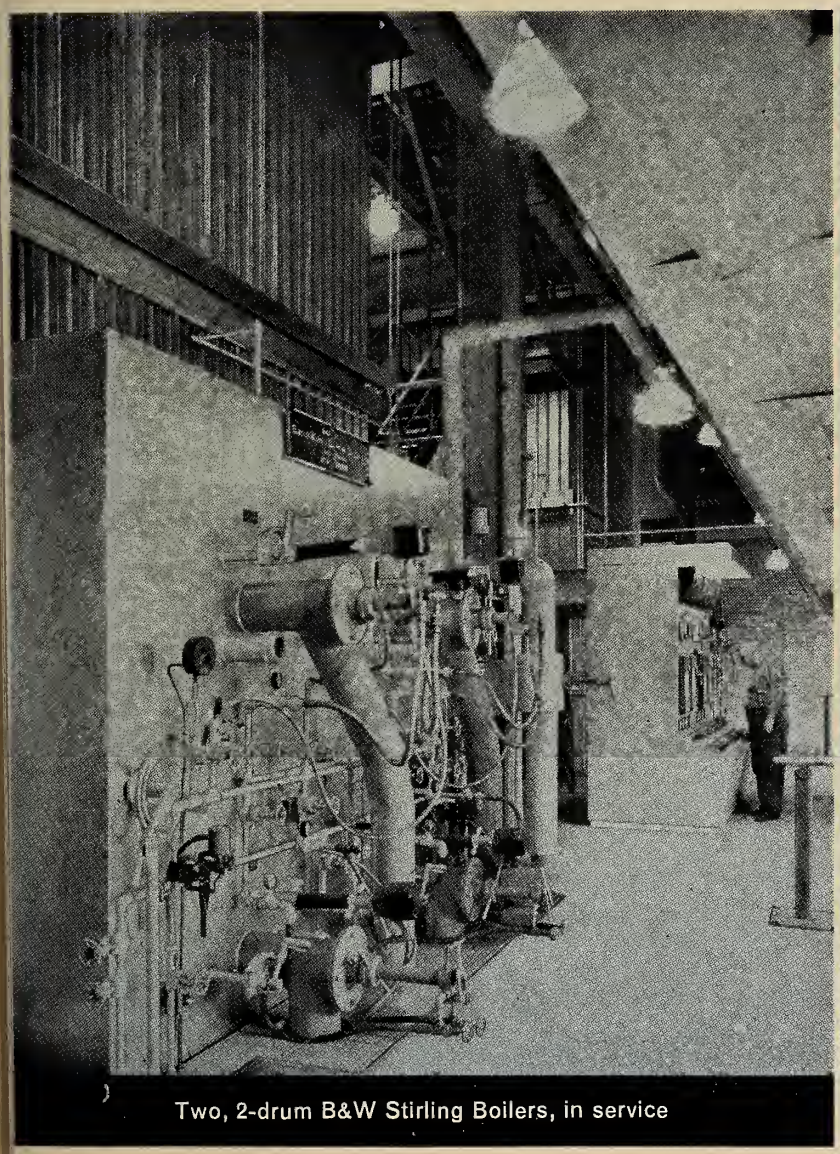
The difficulties encountered from imbedment of aluminum conduit in concrete floor slabs has been noted in several such installation in the New York City area following a short-time strike at the steel mills when steel conduit became unavailable and by special permission, aluminum conduit was substituted. The incidents include a large multiple story housing project which is located near the seashore and concrete ceilings have been cracking and popping in the few floors of each building where such conduit was used. Of course, this area does have high salt concentration in the air. Constructed during the same time period was a multi-storey apartment house in the Murray Hill area of New York City, which is certainly not due to such salt air action and the same difficulty has been found.

The incident mentioned in my paper concerns a first floor of a residence at one of the universities in the northern part of New York City in an area which is certainly not affected by salt air. None of these concreting jobs had any calcium chloride in the mix. A discussion of the difficulty with the manufacturer of the conduit resulted in a frank admission that certain of the alloys should not be used, that they have been called to investigate 12 complaints of similar nature but could not tell us how many buildings included their product. This is the largest manufacturer of aluminum products in the U.S.A. It seems that in spite of the references given by Mr. Godard, and until more proof of sufficiency in actual installations is available, it would be wise to avoid the imbedment of aluminum for electric conduits in concrete.

Mr. Dixon's repetition of objections to my report on the failure of the Owl's Head Tanks and reference to a considerable volume of published data to indicate that stress corrosion in steel wires will not occur unless there is a corrosive medium present, is still not borne out by the facts uncovered in the investigation of the tank failures. Only about one-third of the tank perimeters was covered by brick facing. The remainder of the perimeter exposure is

(Continued on page 115)

B&W ADDS STEAM TO UNIVERSITY OF TORONTO EXPANSION



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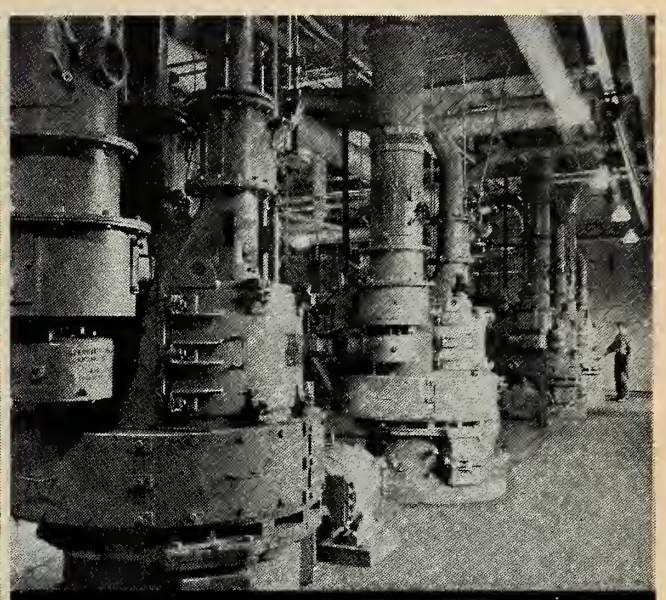

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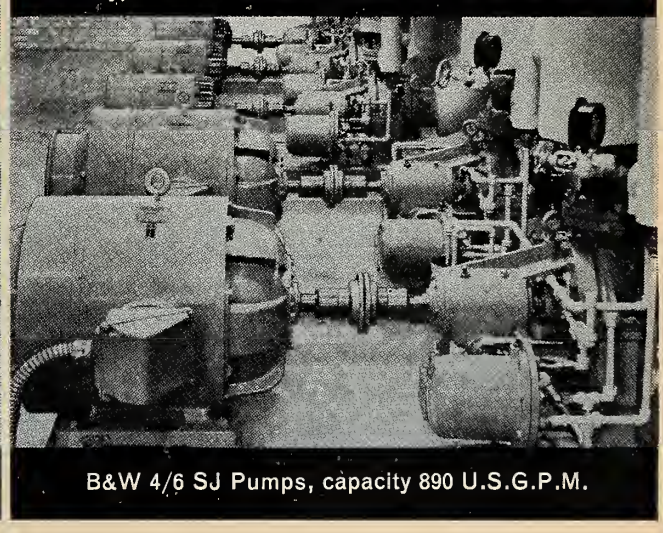

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Branch News

BAIE COMEAU
G. W. Scott

Sir William Strath, President of the Canadian British Aluminum Company Limited, and Chairman of the British Aluminum Company Limited, London, England was the guest speaker at the June 10 meeting of this Branch, and of the local Chamber of Commerce. In his talk, Engineering Prosperity, Sir William dealt with the problems encountered and some of the steps being taken by the British Government and British industry in an endeavor to stimulate the economic growth of the United Kingdom. The aim is to achieve a faster and more even pace than that of the past. Sir William's observations were largely concerned with the work of the National Economic Development Council. His comments were related directly to the economy of the United Kingdom, but they were also applicable to other countries faced with the same type of problems.

In his opening remarks, Sir William said that success in maintaining economic growth depends on keeping an adequate pressure of total demand on the resources of manpower, plant and equipment and raw materials available in the country. Total demand consists broadly of the consuming public, government services, capital investment and exports and one of the prime jobs of modern governments was the management of this total demand. If the total demand does not add up to enough to utilize all the resources, idle factories, unemployment and a slow rate of growth result. On the other hand, if the pressure of total demand is too great, very rapid economic growth would develop for a time, but this would be followed by increased costs, rising prices and an uncompetitive trading position in overseas markets. Balance of payment difficulties would follow and to bring the situation under control it might be necessary to put a check on the rate of growth thereby frustrating the original purpose of the exercise.

Sir William said that the National Economic Development Council spent about a year trying to decide what would be a reasonable rate of growth for the United Kingdom. It eventually arrived at a figure of 4% for the next five years. Of this increase, 1% would come from increased labour utilization, the unemployed, those now entering industry as a result of the bulge in the birth rate during World War II, and the balance from immigration, mostly from the West Indies. The additional 3% would have to come from increased output per worker, the term "worker" meaning all wage or salary earners. This increased output would result from labour-saving devices, improved production methods, and technological advances. Sir William stressed the importance of relating wages and salaries to the rate of economic growth. In the final part of his talk, Sir William dealt with the impact of international trade on the planned economy of a country such as the United Kingdom which depends so greatly on world trade and is responsible for financing 50% of it.

About a month prior to the June 10 meeting, a one-day symposium entitled, The Engineer in the Community, was held. The morning session comprised addresses by Maurice Carpentier, Town Treasurer; Paul Poirer, Town Manager, and Rev. Ronald Crowther, Rector of the Anglican Church of St. Andrew and St. George. Following lunch, Mr. Poirer, assisted by Guy Mascotte, Town Engineer, outlined the various municipal plans for the future development of Baie Comeau.

CORNWALL
G. Peter Schwarzkopf

The 1963-64 program opened with a field trip to the Reynolds Aluminum Company's plant at Massena, N.Y. One of the high points of interest was the pot lines rectifier station. The field trip was well attended.

ESTEVAN SECTION
O. P. Lesiuk

D. B. Furlong, President of Producers Pipeline Ltd., Regina, was the guest speaker at the June 3 meeting. In his speech, The Engineer in Administration, Mr. Furlong suggested that to obtain administrative status, the engineer must first prove his capabilities as an engineer. He said there are no sharp differences between engineering and administration, and that engineering was not confined to "slide rule" techniques. He discussed the difficulties encountered in the formation of the Committee for the Canadian Pipeline Code for Oil and Gas companies.

It was recommended at this meeting that this Section become a Branch of the Institute.

SAINT JOHN
Garnet A. Phinnery

W. O. Johnson, Sales Manager for the Atlantic Provinces for Union Carbide Canada Limited, was the guest speaker at the Branch's meeting held recently at the Riverside Golf and Country Club. Mr. Johnson presented a very interesting paper entitled, "The Cold, Cold World of Cryogenics" which he illustrated by performing a few basic cryogenic experiments with liquid gases.

President T. C. Higginson spoke briefly on confederation.

COMING EVENTS

Institute of Electrical and Electronics Engineers, Inc. Tenth Annual Nuclear Science Meeting, and Second International Symposium on Plasma Phenomena and Measurement. San Diego, Cal. Oct. 29-31.

Society of Automotive Engineers Inc. National Fuels and Lubricants Meeting. Tulsa, Okla. Oct. 30-31.

American Institute of Aeronautics and Astronautics. Conference on Design and Propulsion for Future Aerospace Vehicles. Dayton, Ohio. Nov. 4-6.

American Society of Civil Engineers. Irrigation and Drainage Division Conference. Los Angeles. Nov. 6-8.

Institute of Electrical and Electronics Engineers, Inc. American Institute of Mining, Metallurgical and Petroleum Engineers, Inc. American Institute of Physics. Ninth Annual Conference on Magnetism and Magnetic Materials. Atlantic City. Nov. 10-15.

American Petroleum Institute. 43rd Annual Meeting. Chicago. Nov. 11-13.

American Concrete Institute. Fall Convention. Toronto. Nov. 11-14.

Technical Association of the Pulp and Paper Industry. 14th Testing Conference. New Orleans. Nov. 12-14.

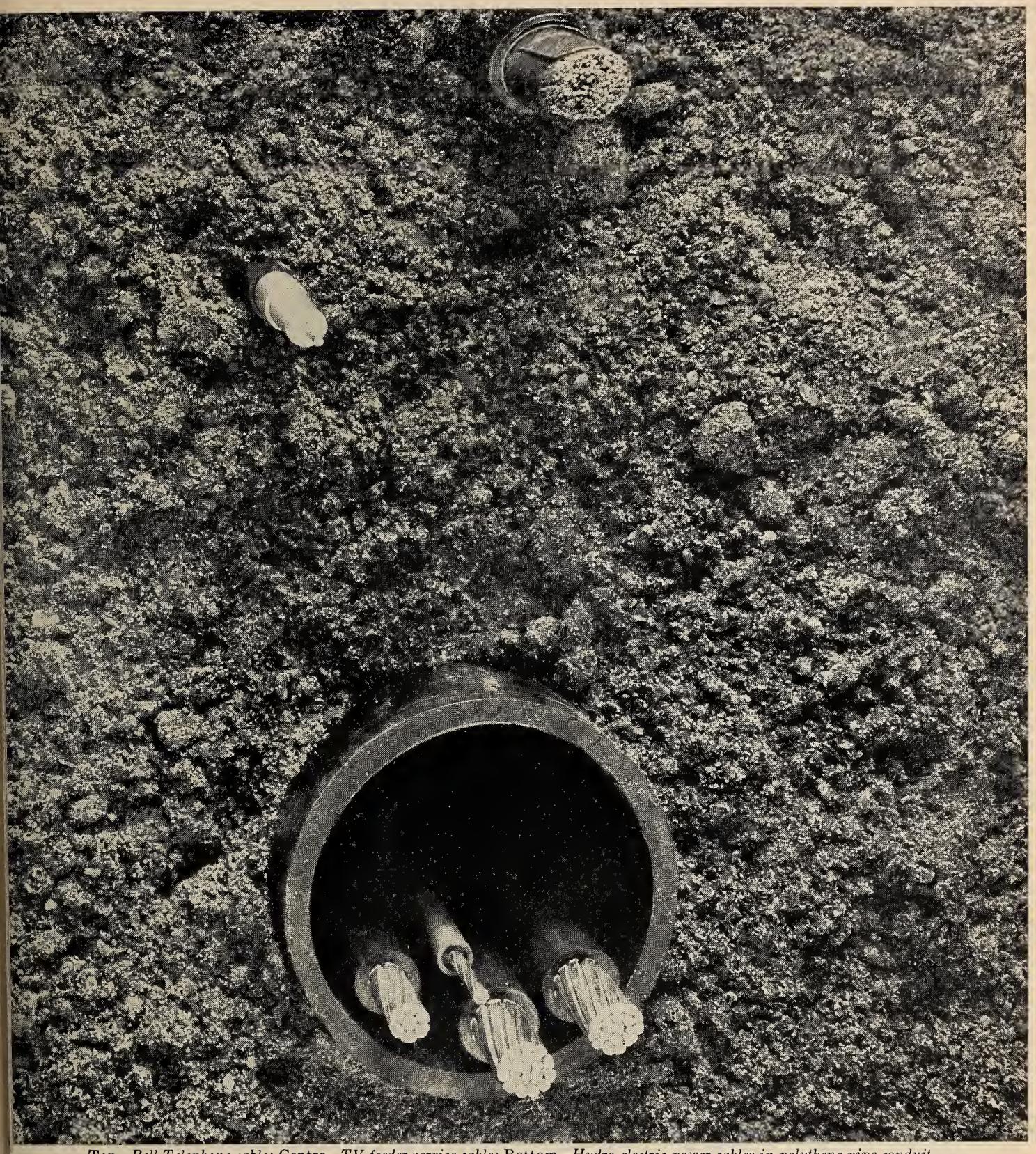
American Chemical Society, Division of Industrial and Engineering Chemistry. 30th Annual Symposium. College Park, Md. Nov. 14-15.

Air-Conditioning and Refrigeration Institute. Annual Meeting. Hot Springs, Va. Nov. 17-20.

Society of Aerospace Materials and Process Engineers. Symposium on Materials for Space Applications. Washington, D.C. Nov. 18-20.

American Nuclear Society. Winter Meeting. New York City. Nov. 18-21.

The Engineering Institute of Canada. Lakehead Technical Engineering Conference. Port Arthur, Ont. Dec. 6.



Top—*Bell Telephone cable:* Centre—*TV feeder service cable:* Bottom—*Hydro-electric power cables in polythene pipe conduit.*

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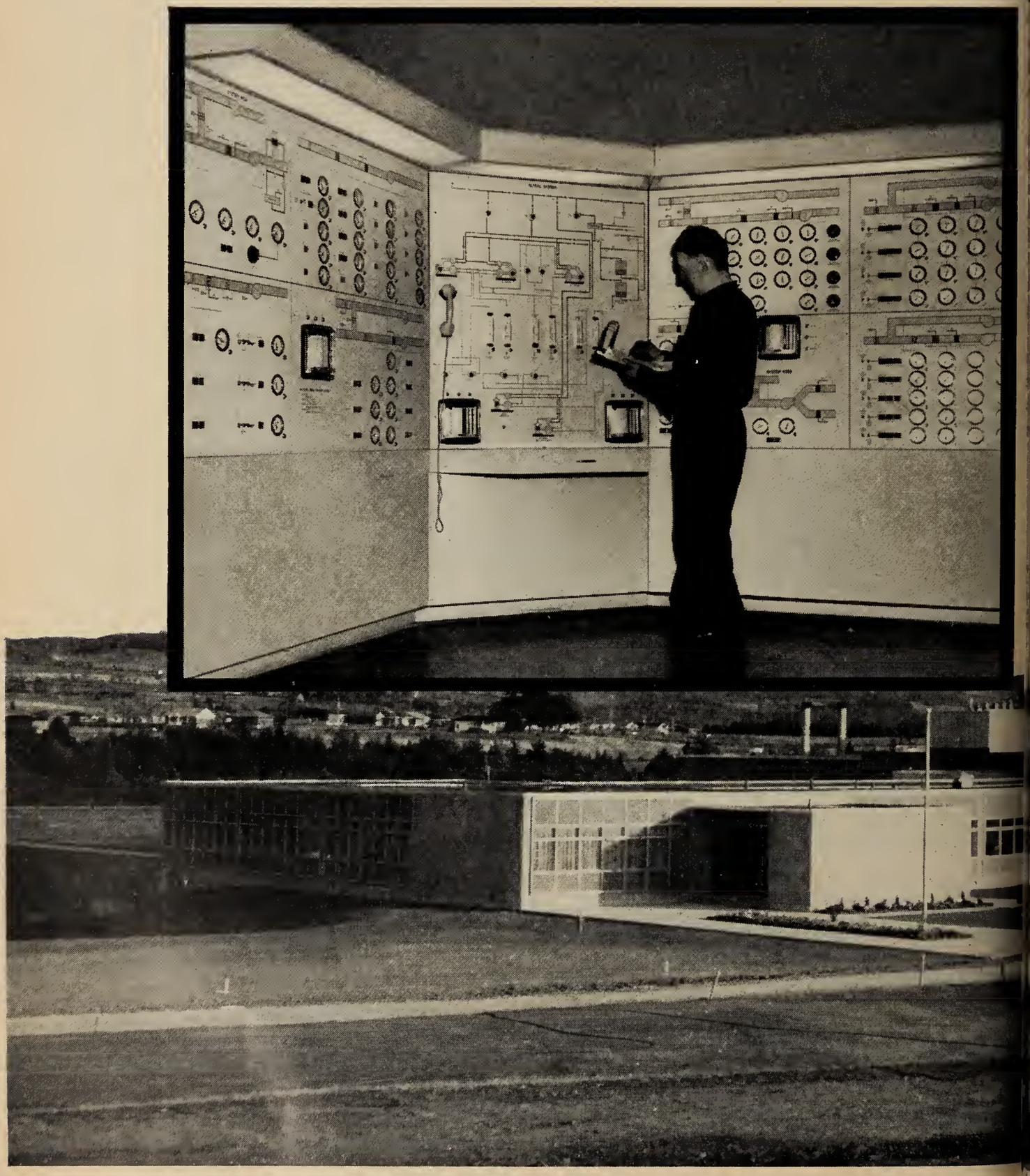

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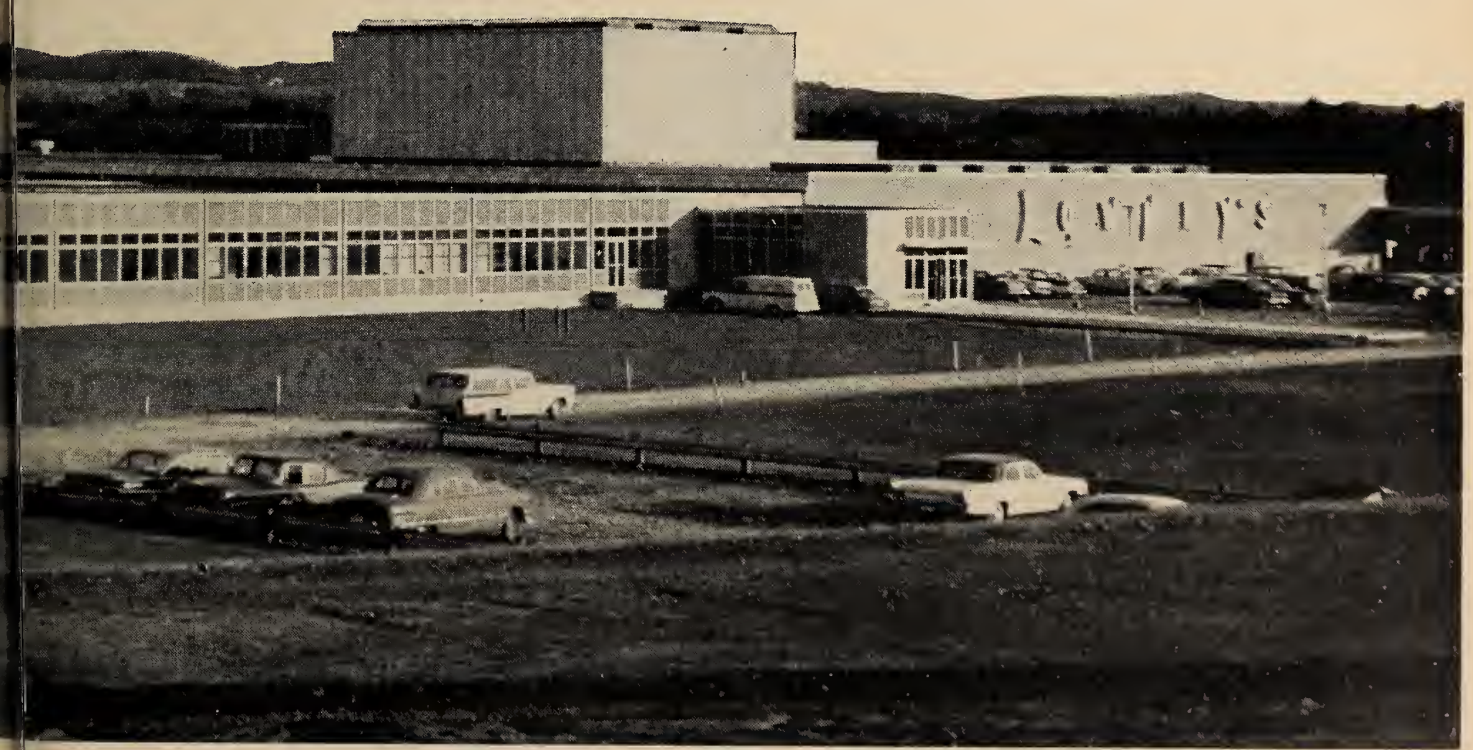


Personals

Reginald Bowering, M.E.I.C. (Manitoba '38), formerly Director of the Division of Public Health Engineering, Department of Health Services and Hospital Insurance, Province of British Columbia, has joined the International Bank for Reconstruction and Development and will be located in Washington, D.C. The International Bank is a specialized agency of the United Nations. It provides financial assistance for worthy projects around the world. Mr. Bowering will serve as sanitary engineer with the Operations Division. He will be sent to various countries to investigate the engineering feasibility of sanitary engineering projects such as water works or sewage systems. He will check on some of these projects during construction and early maintenance periods to assure that the Bank's loans are thoroughly protected.

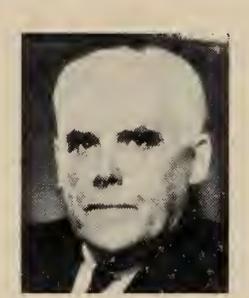
R. B. Hill,
M.E.I.C.

R. A. Reid,
M.E.I.C.

Robert B. Hill, M.E.I.C. (Toronto '50) who joined Dominion Bridge Company Limited in 1958 has been appointed manager of manufacturing services at the company's head office in Montreal.

Robert A. Reid, M.E.I.C. (McGill '42) has been appointed general manager of the Montreal Branch of Dominion Bridge Company Limited. Mr. Reid was formerly manager of manufacturing and marketing services. He has been with the company 23 years.

Hugh G. Conn, M.E.I.C. (Queen's '31), Dean of the Faculty of Applied Science, has been appointed Vice-Principal (Administration) of Queen's University. Vice-Principal Conn retains his position as Dean, a post he has held since 1955. He has relinquished his duties as head of the Department of Mechanical Engineering. Vice-Principal Conn joined the University in 1946 as a lecturer in mechanical engineering. Vice-Principal Conn is a past Vice-President of the Engineering Institute.



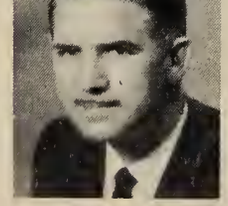
T. W. Eadie,
M.E.I.C.

Thomas W. Eadie, M.E.I.C., (McGill '23) has been succeeded as President of The Bell Telephone Company of Canada. Mr. Eadie, President since 1953 and Chairman of the Board of Directors since 1957, continues as Chairman. The new President is Marcel Vincent, latterly the Company's Vice-President—Public Relations. Mr. Eadie was awarded honorary degrees from Université de Montréal in 1959 and from Dalhousie the following year.

M. J. Hillier has been appointed Associate Professor, Mechanical Engineering at the University of Waterloo. Mr. Hillier has been teaching and conducting research at the University of Manchester, England. He has had extensive experience in industry in Britain with such firms as the Anglo-Iranian Oil Company, Rolls Royce Limited and the English Electric Company Limited. Mr. Hillier received his B.Sc. and M.Sc. from the University of London.

William A. Dexter, M.E.I.C. (Alberta '50) and **Lawrence H. Bush** have formed a consulting firm, Dexter, Bush & Associates Ltd., with offices in Yorkshire House, Vancouver, B.C. Services will be offered in the structural, mechanical and general civic fields. Mr. Dexter was formerly a partner and director of Haddin, Davis & Brown Co. Limited. Mr. Bush was a partner in the same company holding the position of senior bridge and structural design engineer.

W. A. Dexter,
M.E.I.C.



L. H. Bush

Allan H. Finlay, Professor in the Department of Civil Engineering, University of British Columbia, retired at the end of June. He had been a member of the department since 1927. He received his Masters degree in civil engineering from the University of Illinois. Early in his career, he was employed by the Canadian Pacific Railway as resident engineer for the construction of the Crystal Gardens in Victoria, B.C. He designed the ice skating and curling rink in Revelstoke, and the overcrossing which carries the Stanley Park road over from Lion's Gate Bridge road at Prospect Point, B.C. He acted as consultant for the Dominion Bridge Company. In 1935 Mr. Finlay was a member of the three-man board of enquiry which investigated the collapse of the Forum building at Exhibition Park.

N. Lapierre,
M.E.I.C.

A. Kotliar

Norman Lapierre, M.E.I.C. (Laval '55) has been appointed a regional engineer for Quebec and the Atlantic Provinces of the Canadian Institute of Steel Construction. Mr. Lapierre will have headquarters in Montreal.

Alan Kotliar has been appointed President and chief executive officer of Sola-Basic Products, Ltd. Mr. Kotliar has been general manager of Sola-Basic since 1962. Prior to that, he was assistant to the president of Basic Products Corporation, Milwaukee, Wis.

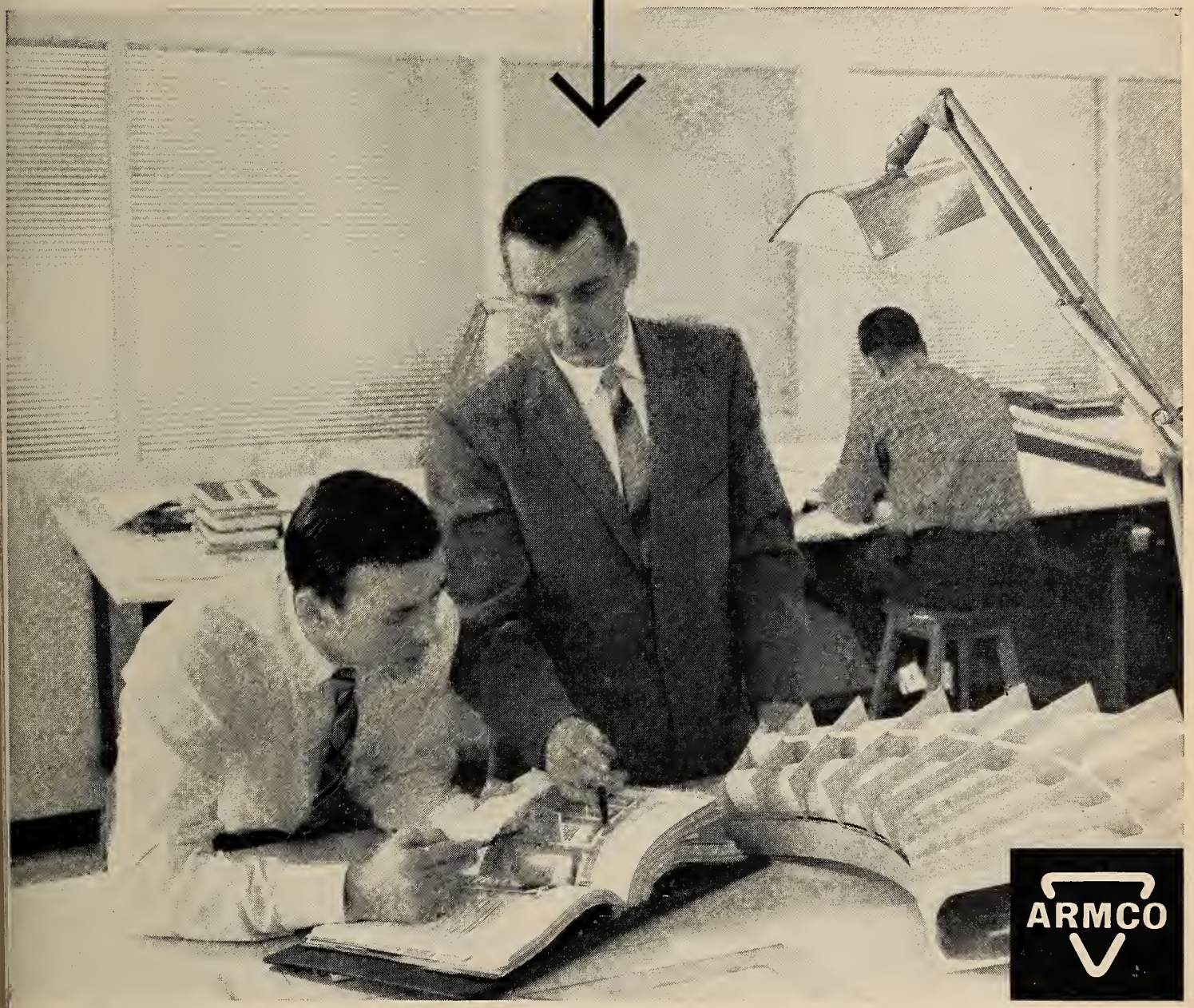
T. V. Berry, M.E.I.C. (U.B.C. '23), Commissioner of the Greater Vancouver Water District, and the Greater Vancouver Sewerage and Drainage District has retired, and **Kenneth E. Patrick,** M.E.I.C. (U.B.C. '36) has been appointed as Commissioner.

Jean-Paul Vinet, A.M.E.I.C. (Ecole Poly. '62) has joined the Mine Equipment Company Limited's Flygt pump division. Mr. Vinet will cover the company's Montreal area.

(Continued on page 86)

OUTSIDE HELP WITH INSIDE KNOW/HOW

MEET THE ARMCO MAN



CREATIVE ENGINEERING FROM ARMCO: Armco's Jacques Domingue and M. Boissonneault of Lauriault and Lauriault, Montreal, discuss application of Armco sluice gates.

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for storing feed

Ten steel ingredient bins, each with a capacity of 60 tons, were designed and fabricated in Winnipeg by Manitoba Bridge to specifications laid down by the consulting engineers.

Zinc metallized box beam (8′ x 11′ x 80′) for the new Richelieu River Bridge—part of the Trans-Canada Highway—near Beloeil, Que.

Box beams on new Canadian bridge protected by metallizing with zinc

From two to ten thou of molten zinc was sprayed right onto these vital members for the new Richelieu River Bridge. The metallizing process provides a continuous adherent coating of zinc to protect the steel from the ravages of rust. Metallizing with zinc is a flexible process—it can be done in the fabricating shop or on the site—thickness can be controlled to suit protection requirements. By reducing maintenance and repair costs due to corrosion, *zinc coatings provide savings* that can run into thousands of dollars annually for many types of large steel structures. To get optimum service from any structure exposed to industrial, marine or rural atmospheres, combine the strength, versatility and low cost of steel with the protection of a zinc coating.

Consulting Engineers for the Richelieu River Bridge: Lalonde & Valois. Fabrication and Erection: Canada Iron Foundries, Limited, Structural Division. Metallizing Sub-Contractor: Lagendyk and Company Limited.

Write for information on metallizing to: Dept. SD-4

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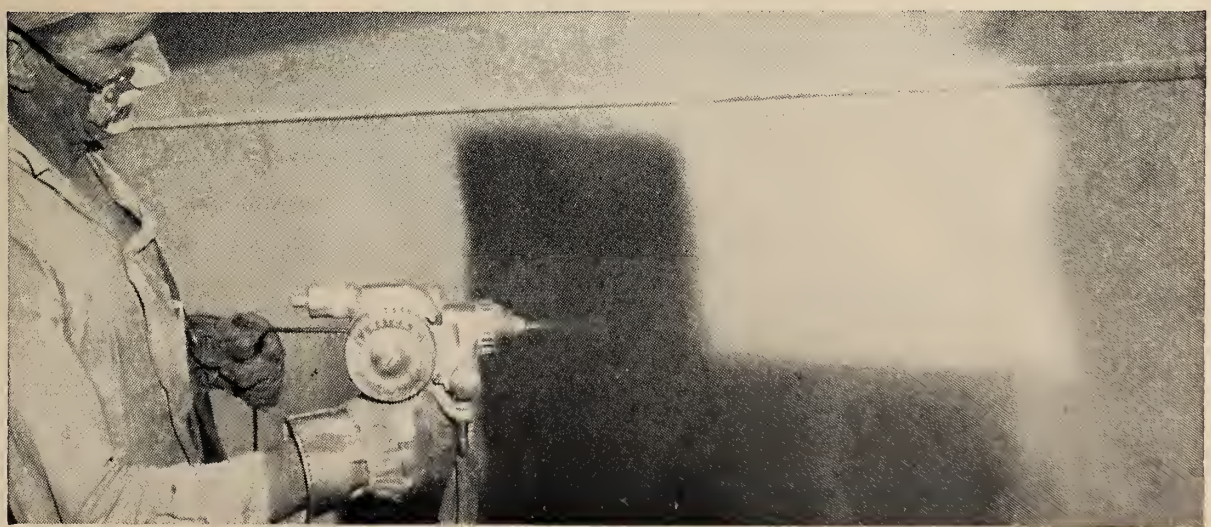
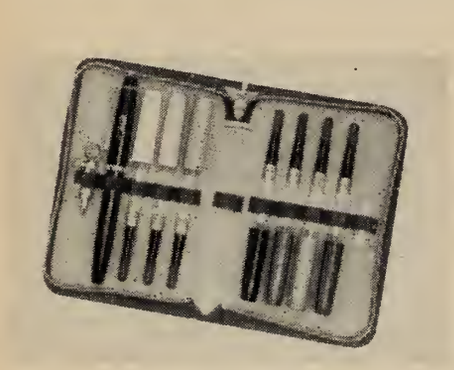


Metallizing a box beam for the Richelieu Bridge.

Engineering Briefs



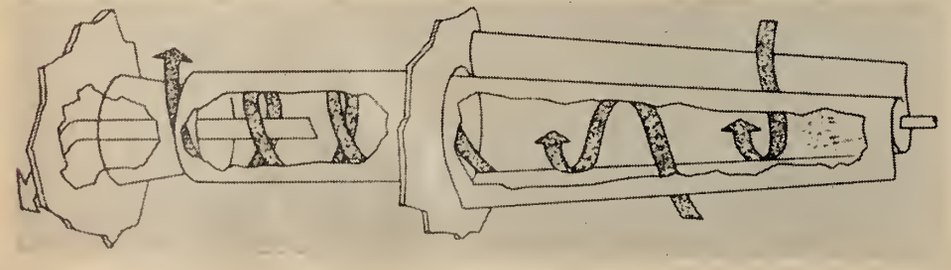
Alphagraph set

ALPHAGRAPH, available from Carsen Instruments Limited, Toronto, offers seven line widths in a self-filling reservoir pen. The Alphagraph set no. 9910 contains one barrel with pocket clip, seven piston-sections with nibs ranging from 00 to 4, each color coded for quick identification, one compass attachment.

CANADIAN GENERAL ELECTRIC Company has added a 1½" model in both dc and ac rectifier ratings to its Big Look line. This instrument designed to save panel and control board space, has DC ratings of 20 microamps to 10 amps self-contained, one to 300 volts self-contained, and 50/100/200 millivolts (shunt-rated ammeter). AC ratings are 500 microamps to 20 milliamps and 10 to 150 volts. Scale rotation is 90 degrees—scale length is 1.4 inches.

AMERICAN AIR FILTER of Canada Ltd. has introduced a revolutionary principle in wet centrifugal dust collection. The Type R Roto-Clone consists of a series of specially-designed double-inlet tubes. At 6-0 in. w.g. collector resistance, each tube handles 4500 c.f.m. nominal rating. The resistance through tubes varies proportionally to the air flow. The Type R-Roto-Clone is lightweight, has no moving parts, requires a nominal amount of water and a small amount of space.

Roto-Clone



GENERAL MOTORS Diesel Limited, London, Ont., has announced the availability of two new, more powerful Bedford diesel motors with 220 cubic inch and 300 cubic inch displacement. The four cylinder Bedford 220 and six cylinder 330 models provide an increase of 11% in net power over earlier models. Both engines are in-line vertical four stroke units with overhead valves. They both have direct injection and develop high torque at low engine speed and maintain it over a wide speed range. The engines have varied application, and can be used in welders, pumps and generator sets.

ELECTROVERT LTD. has announced a new Teflon Coated Fluxer to handle highly corrosive fluxes. The FW-12-T Fluxer is coated throughout with ten layers of Teflon, each individually baked at 750°F. The Fluxer is completely inert to all known chemical solutions, with the exception of fluorine and molten alkali metals at elevated temperatures.

Engineering Briefs

Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.

THE ORENDA ENGINES DIVISION of Hawker Siddeley Canada Ltd., has manufactured the 6200 hp. industrial gas turbine, OT-F-2, for Trans-Canada Pipe Lines Limited. The turbine is capable of pumping approximately 500 million cu. ft. of natural gas per day. With heat recuperator — 80% effectiveness, the turbine has the following performance with full load standard conditions at 80° F. and 1000 feet altitude: gas producer, 7500 r.p.m.; power turbine, 7500 r.p.m.; thermal efficiency, 27.4%; heat rate, 9380 BTU/hp/hr.

Ingersoll-Rand's Control System

A FULLY-PNEUMATIC CONTROL SYSTEM for compressor cylinder clearance pockets on integral engine compressors has been announced by Canadian Ingersoll-Rand Company Limited. Tendamatic TQ-100 Aptimizing Load Control is based on a continuous measurement of the loading on a four-cycle gas engine as a function of its fuel manifold pressure and speed. If a preset load is reached, the control automatically opens one or more fixed clearance pockets to hold the engine within the prescribed load limit. A simple pneumatic computer continuously determines horsepower change that occurs due to the closing of one clearance pocket, based on measurement of prevailing pipeline pressures. If the engine drops below the preset limit, by this amount, the control immediately closes one pocket to return the engine to a fully loaded condition.

THE PNEUCO MACHINERY Company, a Divisions of the National Rubber Company has introduced a new concept in metal forming. The Pneuco Press Brake, powered by an expandable pressure chamber, is made with a minimum of moving parts, operates without an electric motor and is lightweight and portable. The one-piece welded frame combined with the steel plate ram and bed give maximum rigidity and minimum deflection during operation. Available in 52-inch and 78-inch bed widths, the Press Brake has a 35-ton rated capacity. With no cams, eccentrics or gears to acute the ram, the machine is quiet operating, practically without vibration or shock. Its cushioned air power makes it ideal for drawing operations due to its ability to "inch" with controlled pressures. The Pneuco Press Brake accommodates standard ½-inch die tongues, is a compact unit capable of handling heavy-duty forming work.

(Continued on page 102)

This is a lightweight USS "T-1" Steel spiral case used in a hydroelectric power plant. It looks like a giant seashell. Water gushes through it under tremendous pressure to drive a water turbine that produces electrical power. Thirty-one spiral cases have recently been built of USS "T-1" Steel for such famous power projects as Niagara, New York; Oahe Dam, South Dakota; Brownlee, Idaho; Noxon Rapids, Washington; and Swift, Washington. (Also, 7 large penstocks using "T-1" Steel have been built in various countries; one in Canada, one in India, one in Norway, three in Switzerland, and one in United States.) USS "T-1" Constructional Alloy Steel is three times as strong as structural carbon steel. Its great strength permitted almost 50% reduction in plate thicknesses and weight. Less weight means less freight. Welding costs are reduced . . . and expensive stress relieving after welding is eliminated. If you are building rugged equipment of any kind, find out how USS "T-1" Steel can make your product stronger, lighter, and more durable. For additional information, write United States Steel International (New York), Inc., 7 King Street E., Toronto 1, Ontario, or the office nearest you. USS and "T-1" are registered trademarks.

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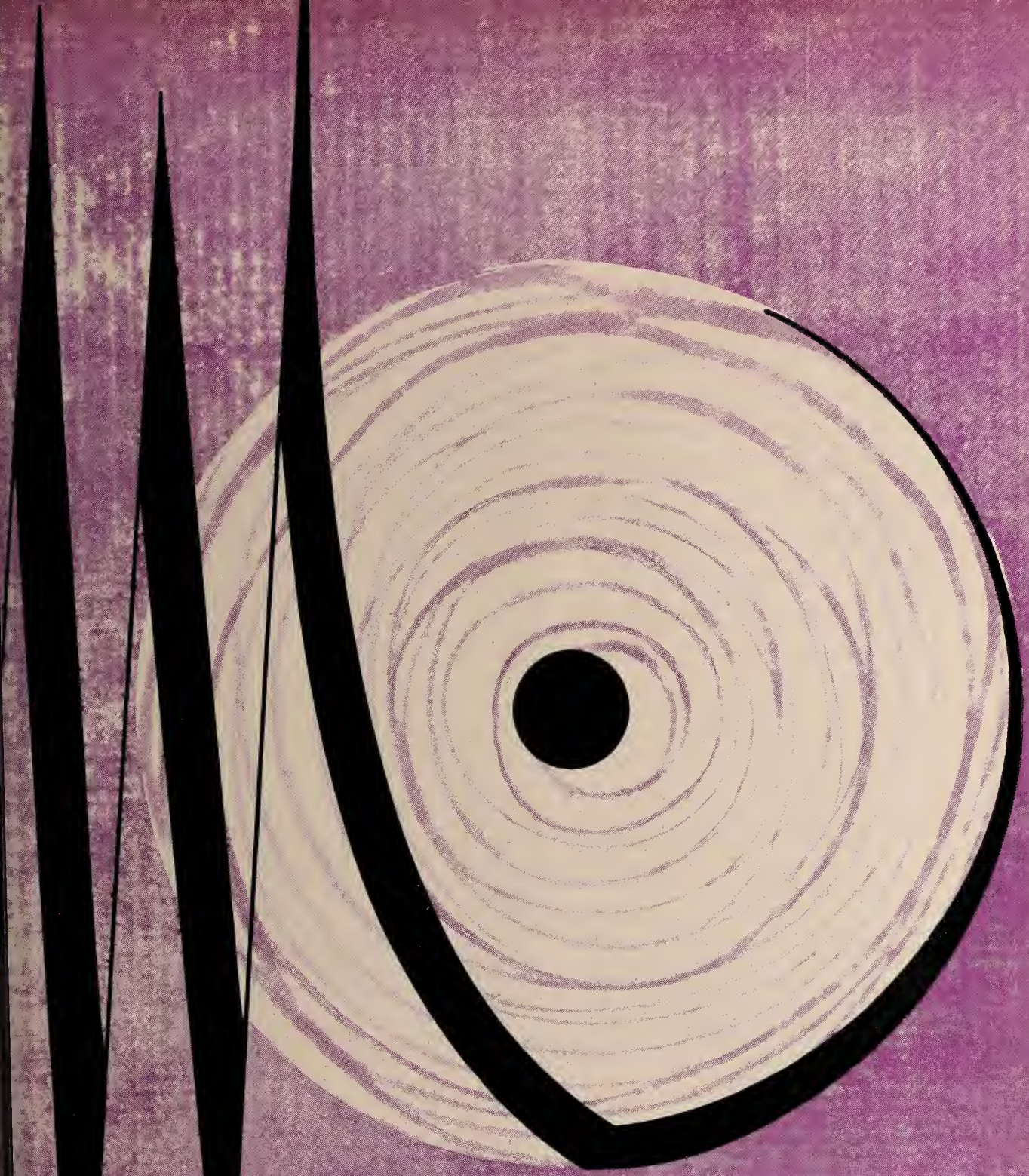

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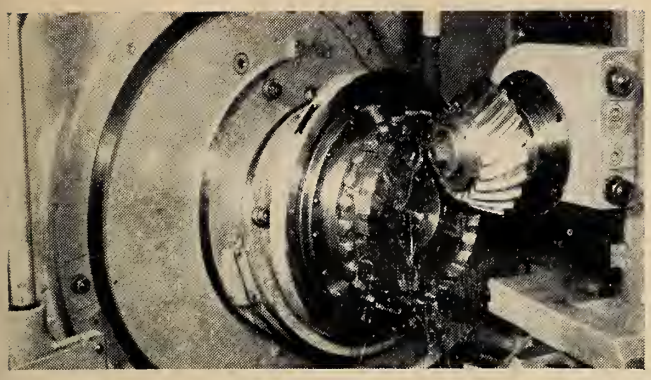
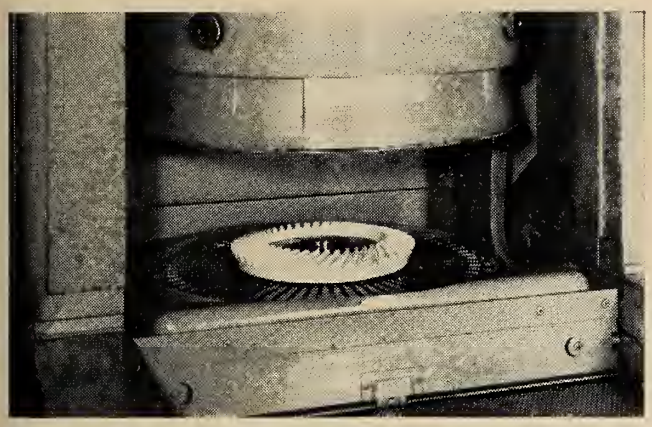
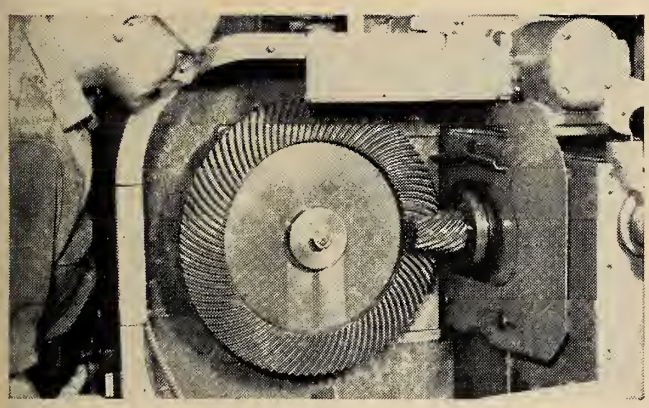


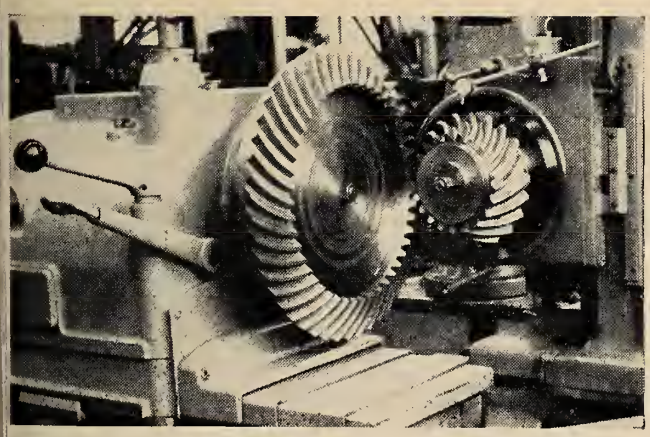
Modern Gleason Spiral and Hypoid Bevel Gear Generator.



Quenching—under hydraulic pressure prevents warping.



Lapping machine for exact mating of the ring and pinion.



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EIC-63-CE&A 13 "The Current Distribution on a Prolate Spheroidal Antenna" by H. P. Hsu

EIC-63-HYDEL 2 "Considérations générales sur le dimensionnement des cheminées d'équilibre" par B. Michel

SERIES "D" MANAGEMENT; RESEARCH; EDUCATION

EIC-63-RES 1 "Research in Britain on Current Ratings for Cables and Overhead Lines" by E. E. Hutchings

THIS PAPER WAS LISTED IN THE JANUARY JOURNAL AS A DIVISION PAPER. IT WILL NOW BE DISTRIBUTED AS A TRANSACTIONS PAPER.

SERIES "E" CHEMICAL; MINING & METALLURGY; OIL & NATURAL GAS

EIC-63-MIN & MET 5 "A New Type of Mineral Classification" by Dr. R. P. Charbonnier

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10:00 a.m. until noon Technical Sessions

Noon Luncheon

2:30 p.m. until 4:30 p.m. Technical Sessions

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ABSTRACTS

Transactions of the E.I.C.

EIC-63-MECH-28

"Analysis of the Performance of the Buried Pipe Grid of a Heat Pump"

W. G. Brown and A. G. Wilson

Measured and theoretical pipe surface temperatures of a buried pipe grid extracting heat in intermittent operation during a heating season were found to be in good agreement, indicating that simple heat conduction theory could be applied without attempting to account for ground freezing or temperature induced moisture migration. The agreement of measured data and theoretical calculations based on ground thermal properties determined prior to the heating season and normal undisturbed ground temperatures during the heating season showed further that design based on theory could be expected to yield reasonably accurate results. The factors entering design calculations for buried pipes and pipe grids are discussed.

EIC-63-ELEC 8

"Power System Protective Relays Using Semiconductor Devices"

R. J. Fleming

This paper describes a semiconductor electronic circuit technique which has been developed to perform certain power system protective relay functions. The principles and circuits which were used for a Mho Relay, a Differential Current Relay and a Percentage Differential Current Relay are described. These devices utilize the unique switching characteristics of the silicon controlled rectifier. It is used to control the flow of energy to the trip coil of a power circuit breaker. A transistorized logical decision making circuit monitors the power system electrical conditions and applies a tripping pulse to the silicon controlled rectifier when these conditions are such that tripping action is required.

Typical results of static operating tests on the devices are included. They are sufficiently encouraging to warrant further development and study of these techniques.

EIC-63-CE & A 13

"The Current Distribution on a Prolate Shperoidal Antenna"

H. P. Hsu

The induced current distribution on the surface of a prolate spheroidal antenna due to a uniform applied field was investigated. The results were reduced to a form suitable for practical application and numerical evaluation with available tables. The results of numerical evaluation for the cases of $l/a = 2.69$, 7.12, 71 (where l is the length of the major axis and a is the half length of the minor axis of the prolate spheroid antenna) were given. Quasi-static approximation solution to this problem is also obtained.

EIC-63-HYDEL 2

"Considerations generales sur le dimensionnement des cheminees d'equilibre"

B. Michel

Dans cet article nous discuterons d'abord d'une façon très générale l'influence de tous les éléments d'ordre technique et économique qui entrent en jeu dans l'élaboration d'un projet de cheminée d'équilibre. Nous montrerons que l'on aboutit presque toujours, finalement, à dimensionner la section centrale d'une chamber d'équilibre par le critère de la stabilité.

Cela indique donc que les projeteurs auraient intérêt à débuter le calcul d'un projet de cheminée d'équilibre par les considérations de stabilité au lieu de celles relatives aux surpressions et aux dépressions maximales que l'on rencontre habituellement dans les exposés sur cette question.

Malheureusement, le critère de la stabilité, qui a une si grande importance, est le plus imprécis de la théorie des chambres d'équilibre. Il donne uniquement une valeur limite à la section de la cheminée. Pour assurer un amortissement convenable des oscillations il faut majorer la section par un certain coefficient de sécurité qui ne possède aucune base générale et, par conséquent, varie d'un pays à l'autre ou d'un projeteur à l'autre. Pour préciser cette question, nous avons défini une valeur mesurable de la stabilité qui permet de calculer un optimum économique à donner à la section d'une cheminée d'équilibre afin d'assurer cet amortissement convenable des oscillations. Cette définition a l'avantage d'être analytique et universelle, en s'appliquant à tous les types de chambre d'équilibre. Nous l'avons appliquée, ici, aux cas particuliers des cheminées simples, déversantes et des chambres à épanouissements.

EIC-63-RES-1

"Research in Britain on Current Ratings for Cables and Overhead Lines"

E. E. Hutchings

The basic current rating formula for solid-type cables is given and it is shown how account may be taken of the particular features of high-voltage cables of other types.

The thermal resistance external to the cable surface is dependent on environment. For buried cables this depends on the thermal resistivity of the soil, methods for determining which are described. Reference is made to a system of soil classification which has been developed for use by cable engineers. Details are given of investigations into seasonal variations and the onset of runaway conditions due to drying of the soil by the cable. Some observations are made on the use of special back-fills and on the possible adoption of different ratings for summer and winter. For cables in ducts similar considerations apply but the external thermal resistance is more complex due to the air space within the duct-way and the danger of drying out is alleviated because of the lower temperatures which occur in the soil. The permissible

EIC-63-MIN & MET 5

"A New Type of Mineral Classification Equipment"

R. P. Charbonnier

The Lavodune, recently developed in France and already adopted in a number of size or gravity classification plants in several countries, seems to have great possibilities for the sorting of coal, ores, sands, and many mineral and chemical products. Generally speaking, most ores suitable for gravimetric processing in sizes from 0.5 to 20 mm (in a size ratio of 1 to 8) may be washed at a density of separation from 1 to 4, with an imperfection coefficient of 0.08 to 0.15. Likewise, most pulverulent products of homogeneous densities may be classified at separation diameters between 0.1 and 1 mm, with an imperfection coefficient of 0.12 to 0.25.

The Lavodune is basically an inclined tube, containing an upward flowing liquid. The materials to be processed are fed in at point halfway along its length. The flow is only sufficient to carry up the finer and lighter particles. The coarser and denser particles sink to the bottom end, where they form a highly turbulent "dune". There, the finer and lighter particles, which may have escaped the initial separation, are reclaimed and taken up again by the rising liquid stream, while the coarse and dense particles continue on their way down. The much greater efficiency of the Lavodune as compared with flow classifiers is obtained by the special profile shape of the inside of the tube. This shape is designed to suit each particular case of separation, by using theoretical considerations but mainly practical experience obtained in numerous tests with an extensive range of materials.

ABSTRACTS

Transactions of the E.I.C.

The main advantages of the Lavodune are its simplicity, absence of moving parts, ease of control, low power requirements, low initial and operating costs, low sensitivity to variations of the feed, low consumption of water (which is recycled), and negligible regradation of the material and wear of the equipment. The defects of the Lavodune are minor: relatively low unit capacity, and limited range of sizes to be processed. Separation efficiencies may not be quite as high as for some other equipment such as magnetite cyclones, but they are generally satisfactory (better than with the usual equipment) and obtained at much lower costs.

Division Papers of the E.I.C.

EIC-63-BR & STR 16
"Differential Shrinkage Stresses in a Composite Slab"
O. S. Narayanaswamy, J. B. Kennedy and J. B. Mantle

The stresses due to differential shrinkage between two homogeneous slabs of specific proportions made of the same material are analysed and compared with results obtained by photoelestic stress analysis techniques. The problem is reduced to one of solving for stresses in a rectangular plate having end loads. A stress function in the form of a Fourier series is assumed and the Fourier coefficients are calculated to satisfy the boundary conditions. A method for eliminating the residual stresses incurred, suitable for programming on an electronic digital computer, is indicated.

EIC-63-BR & STR-17
"Ultimate Strength of Long Lap Joints"
Whitman Wright

A method is presented for estimating the ultimate strength of lap joints which are sufficiently long in the line of stress to cause shearing of the end fasteners before the full capacity of all the fasteners is developed. Use is made of the stress-strain curve for the connected material and the shear stress versus shear distorition curve for the fasteners, both to the point of failure. The predictions of the method are compared with the results of three tests on lap joints fastened with one-quarter inch iameter machine bolts, with good agreement between predicted and measured joint capacity.

EIC-63-CE & A 14
"Mixer Generation of Constant Phase Angle Difference Audio Sine Waves"
K. A. Steele and D. Layton

This article describes a method of generating two sinsusoids of the same frequency which have constant relative phase over the frequency range 30 cps to 3000 cps. The basic circuit is a dual beat frequency oscillator using common fixed and variable frequency oscillators and two mixers. The fixed oscillator signal is phase shifted before being applied to one of the mixers. This results in a constant phase difference between the outputs from the two mixers independent of the frequency of the variable oscillator. A resolver or selsyn is used to obtain continuous adjustment of phase. Phase error in amplifiers and low pass filters following the mixers can be less than 2° over a two-decade frequency range.

EIC-63-GEOTECH-8
"Soil Sampling in Permafrost Areas"
G. H. Johnston

The need for adequate subsurface explorations, particularly with regard to determining the ice content of frozen soils in permafrost areas is stressed. Methods and techniques for obtaining samples of perennially frozen ground are discussed under four main headings: sampling natural exposures, hand borings, test pits and core drilling.

Exposures can be examined by digging shallow trenches or test pits and by probing. Frozen soil samples, both disturbed and undisturbed, can be obtained by driving pipe and by hand augering methods—or by a combination of these methods. Test pits can be excavated by natural or artificial thawing, pick and shovel, or power tools and permit detailed in situ examinations of frozen materials, particularly granular deposits. Core drilling is normally used to obtain undisturbed samples when an extensive subsurface exploration program is proposed or when information is desired to depths exceeding 20 ft. Special drilling techniques have to be followed. Good core recovery can be obtained in frozen fine grained soils but coring of granular materials has proved to be difficult.

The application and limitations of each method are noted and lists of pertinent equipment required are given.

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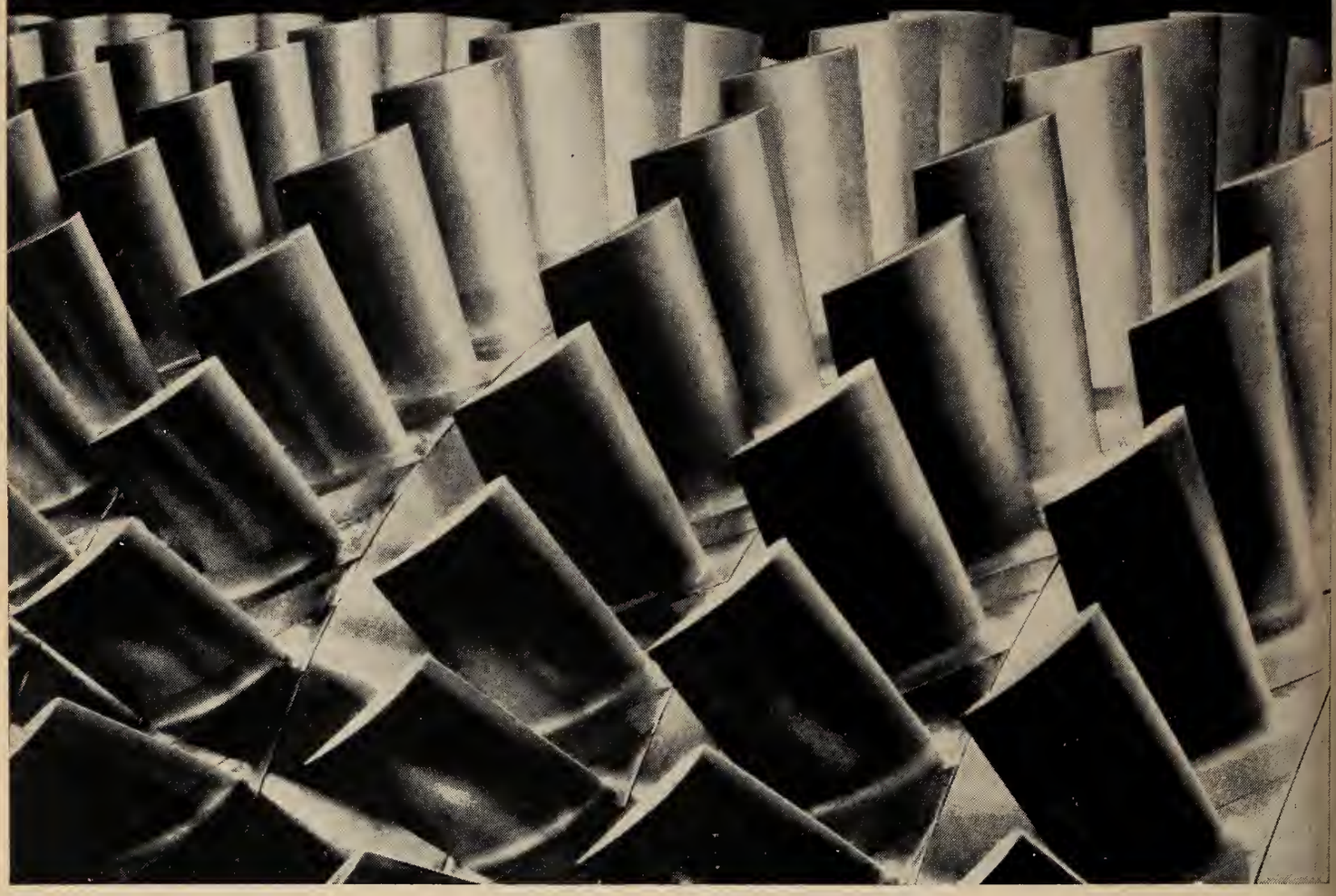

Compressor section of a typical Sulzer Gas Turbine

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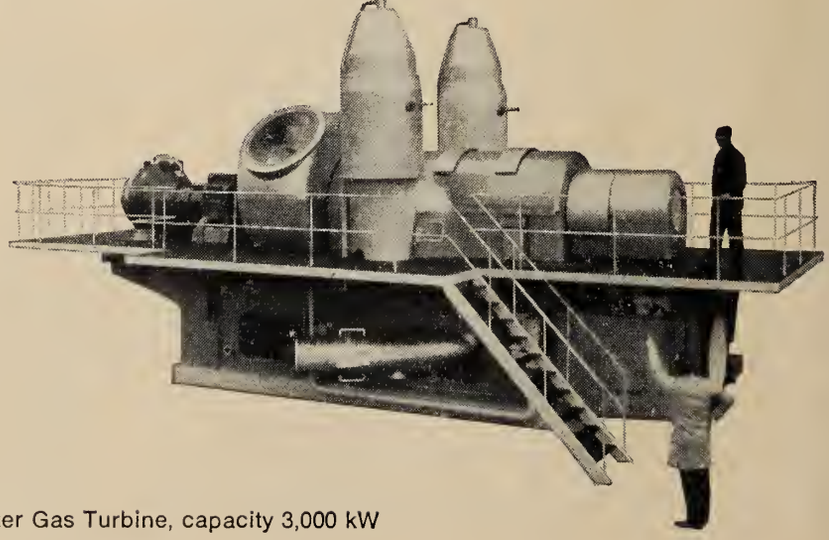

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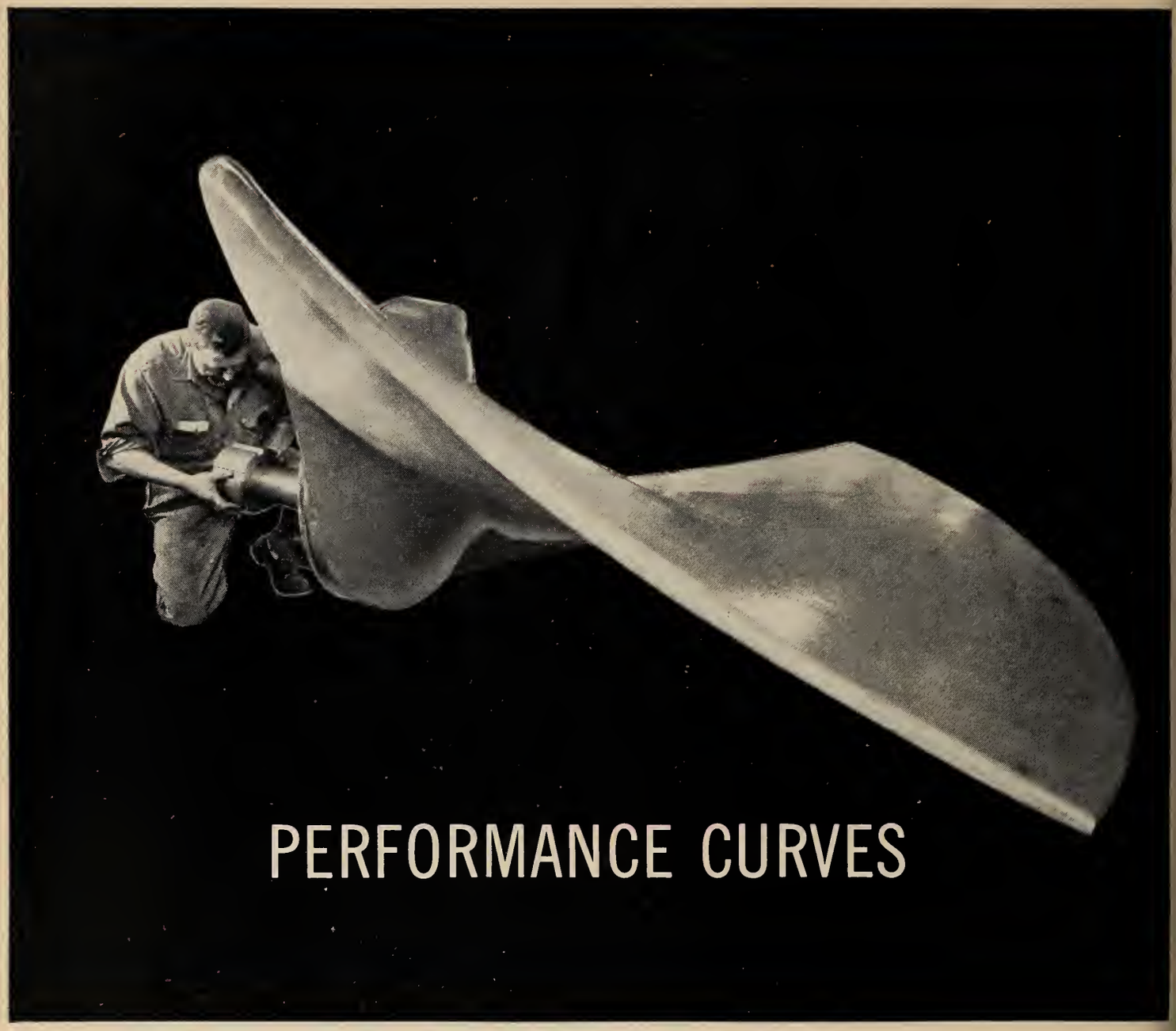

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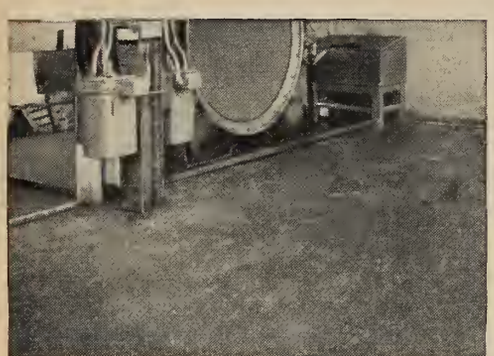

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Personals

(Continued from page 64)

S. Dembicki, M.E.I.C. (Alberta '40) has been appointed Chief Advisor by the International Labour Office for a United Nations Special Fund Project. Mr. Dembicki will head a team of international experts attached to the National Institute for Training in Industrial Engineering in Bombay, India. This Institute has been established to assist industry, government departments, public utility undertakings and public and private enterprises, to provide training and to improve managerial performance and industrial productivity. Mr. Dembicki is a consulting engineer with wide experience in the industrial engineering field in Canadian industry.

S. Dembicki,
M.E.I.C.

G. Perron,
M.E.I.C.

Gilles Perron, M.E.I.C. (Laval '46) gérant des ventes à l'Hydro-Québec, vient d'être élu président de L'Institute of Electrical and Electronic Engineers section de Montréal. Il en est le premier président puisque cette société provient de la fusion récente de l'Institute of Radio Engineers et de l'American Institute of Electrical Engineers.

J. E. Daccord, M.E.I.C. (McGill '53) has joined the management consulting firm of Urwick, Currie Limited. Mr. Daccord was formerly manager of operations with Canada Iron Foundries Ltd., Structural Division.

Dr. G. E. Hall has been appointed to the Board of Directors of International Business Machines Company Limited. President and Vice-Chancellor of the University of Western Ontario, Dr. Hall was elected at the company's recent annual meeting. Dr. Hall has served on numerous government councils and associations, including the National Productivity Council.

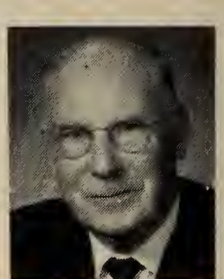
K. P. Furness,
M.E.I.C.

B. Netupsky

Kenneth P. Furness, M.E.I.C. (Liverpool, Eng. '42) traffic engineer with the Toronto consulting engineering firm of De-Leuw, Cather & Company of Canada has been assigned as Highway Needs Analysis Engineer to conduct a major highway study project in Thailand. The study, to result in a detailed engineering and economic feasibility report for a new 175-mile highway in North Thailand, is expected to take six months to complete.

John McLaren, former Treasurer and a Director of Foster Wheeler Limited, St. Catharines, Ont., retired at the end of June. Mr. McLaren had been with the company for fifty years. He was elected Assistant Secretary and Assistant Treasurer in 1937, and elected as a Director of the company in 1948. In 1955 he was elected Treasurer of the company and held that position until 1960.

K. R. Dunphy



J. McLaren

Boris Netupsky, President and Chief Engineer of Netupsky Engineering Company Ltd. has announced that after September 1, 1963, the offices of the firm will be located in Vancouver.

Kenneth R. Dunphy has been appointed Manager — Codes and Approvals for Canadian General Electric Company Limited. Since joining the company in 1938, Mr. Dunphy has held the positions of Manager-Lighting Equipment Sales, Manager-Construction Materials Sales, and Sales Manager-Meters and Instruments. Prior to his recent appointment, he was in charge of marketing research activities for the Industrial Division.

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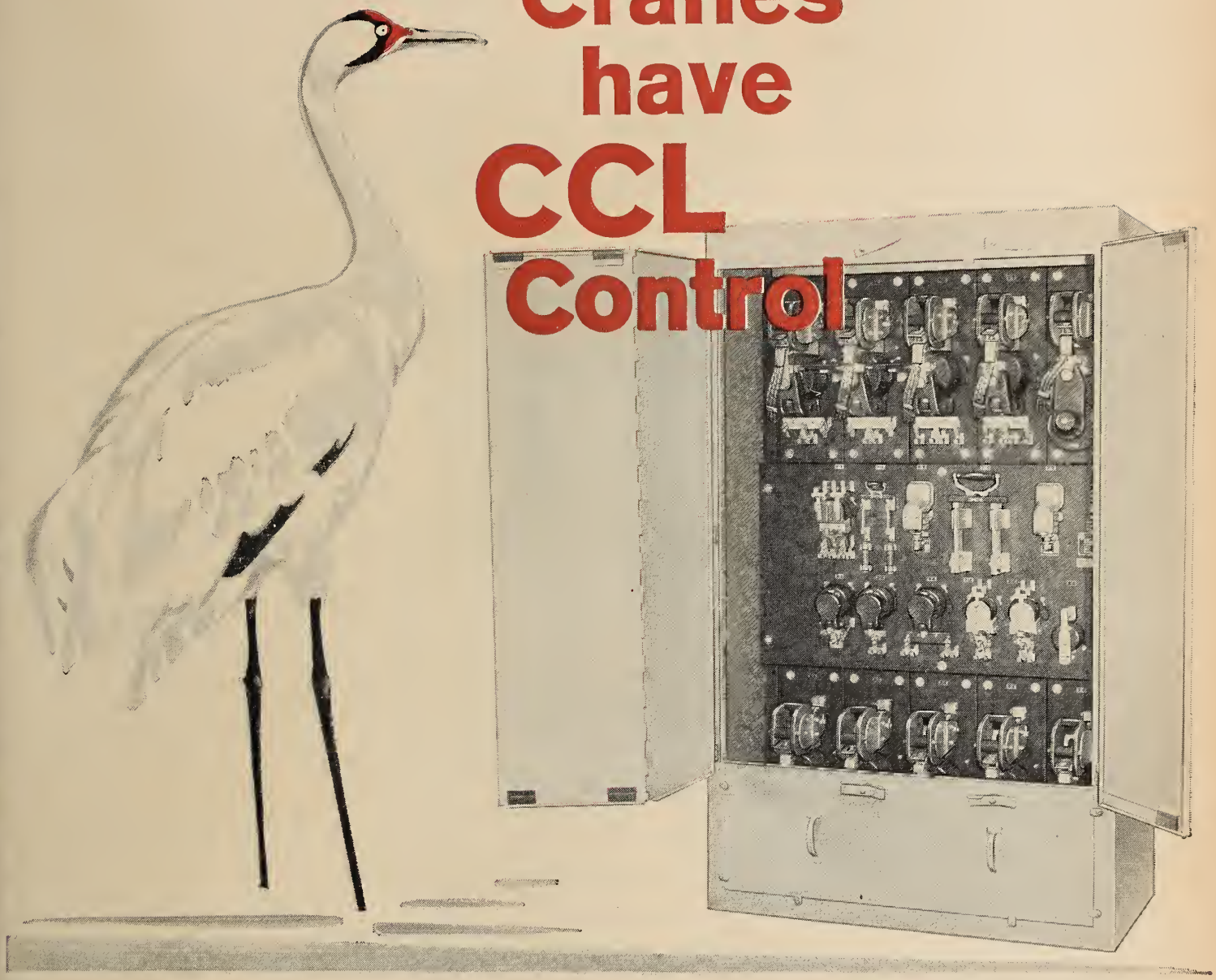

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POWER IN CANADA

(Continued from page 35)

Columbia River Development

A mammoth engineering challenge since the 1930s, the Columbia River Development is nearing the point where persistent study and meetings may at last result in physical fact.

The development, a bone of contention gnawed by men of politics from British Columbia, Ottawa and Washington, now only requires agreement between Canada and the United States on clarification of certain clauses of the Columbia River Treaty —signed by the two countries in January, 1961—and agreement on price to be paid for Canada's share of downstream power benefits.

Steady progress continues on B.C. Hydro and Power Authority preparations for the three storage dams involved in the treaty—the Lower Arrow Lake, 36 miles upstream from the International Boundary, Mica Creek damsite, a further 235 miles upstream, and Duncan Lake damsite, on the connecting Duncan River system. This will permit storage of flood waters for year-round release and allow increased annual power generation in the U.S., also providing greater flood control. At Mica Creek, and other sites downstream, generating plants will be installed at later dates.

Continuing field investigations and design have advanced to the stage where design and construction specifications have been completed for the Duncan Lake dam, an earthfill structure about 120 feet high and 2,600 feet long at the crest. Tenders for its construction could be called very soon after the problems of treaty ratification have been settled.

All controlling dimensions and sequences of construction have been established for the Lower Arrow Lake storage dam, which will be a concrete gravity structure about 700 feet long on the north bank of the river and an earthfill dam extending 1,800 feet to the south bank, rising about 190 feet above the river bed. The dam will contain a lock to handle the passage of logs and marine traffic.

Preliminary construction on the Mica project could begin shortly after ratification. This dam will be of earth and rockfill construction, will rise about 650 feet above the riverbed, will have a crest length of 2,400 feet and will have an ultimate reservoir capacity of about 12 million acre feet.

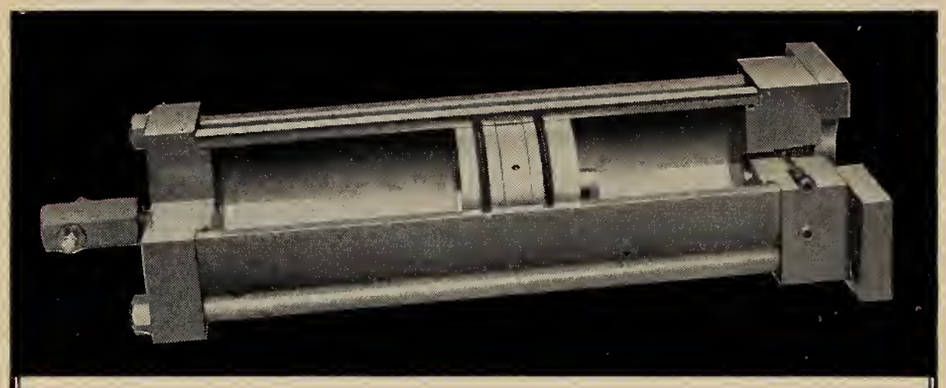
The total estimated downstream power benefits from the three storage projects would be very large and Canada would receive one-half of these, amounting to 1,375,000 kw. of dependable capacity and 768,000 average kw. of usable energy.

The Peace River

Water of the Peace River in British Columbia is scheduled for diversion around a 3,000 foot section of Peace River Canyon in mid September to make way for construction of 600 foot high Portage Mountain Dam.

The diversion marks the completion of the first major stage of one of the world's great power projects. Since the spring of 1962, Portage Mountain Constructors have been racing against time to complete the $17 million task of gouging the diversion system under the river's west bank.

A million cubic yards of rock were blasted to form an 800 foot channel into the west bank of the Peace. From the channel, three 48-foot diameter tunnels were blasted 2,500 feet through the river bank, returning to the river below the damsite.



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- Operating pressures to 3000 psi.
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The tunnels were lined with concrete ranging from two to four feet in thickness. Entrances to the tunnels were equipped with steel semi-circular stoplogs and a huge crane for lowering the logs to block off the flow of water through the tunnels when required.

While the river bed dries up at the dam site below a temporary diversion dam, preparations will proceed at full speed for the construction of Portage Mountain Dam, a $73.5 million job scheduled for completion in 1968.

Contract for construction of the dam was awarded last spring to a consortium of three firms: Peter Kiewit Sons Company of Canada Ltd.; Al Johnson Construction Co. Ltd.; and Dawson Construction Ltd.

The dam contractors arrived at the construction site late in June and immediately began preparing camp facilities; clearing the right-of-way for a conveyor system and the site of a screening plant; and scraping overburden from the dam abutments.

In September a low diversion dam was constructed across the Peace to direct the low autumn flow of water into the diversion system. Then work will begin on a second-stage diversion dam, 140 feet high and 1,100 feet long which will contain about a million cubic yards of fill. This dam must be completed next spring in time to control flood waters on the river.

While the second diversion dam is being built, other crews will work through the winter scraping gravel, sand, and rock from the dry river channel and preparing foundations for Portage Mountain Dam. A grouting culvert will be erected from which deep grouting can be carried out while the main dam is being built.

The dam contractors report the design well advanced on the $10 million conveyor and screening plant complex which will be the backbone of the construction operation.

A 5½ foot wide conveyor belt will extend 15,000 feet from loading facilities at gravel deposits to the fill treatment and storage area just above the dam.

The fill processing facilities will include dry and wet screening plants and a complex of eight small conveyors. The conveyor and screening facilities are scheduled for completion next spring.

The powerhouse planned for the Portage Mountain site will be located beneath the dam's left flank and have a generating capacity of about 2.3 million kw.

Transmission of power 580 miles to the main markets in the southwest corner of the province will be at 500,000 volts. First power from the Peace project is scheduled to be delivered to B.C. Hydro customers in 1968.

Big Bend Project

By the fall of 1964, the first of several 200,000 hp. generators, now being installed on the Brazeau River, will be ready for operation. The power house is located about 12 miles downstream from the main Big Bend dam and storage reservoir. Concrete work at the project is proceeding on schedule and it is expected that steelwork and enclosure of the power plant will be completed by winter of this year.

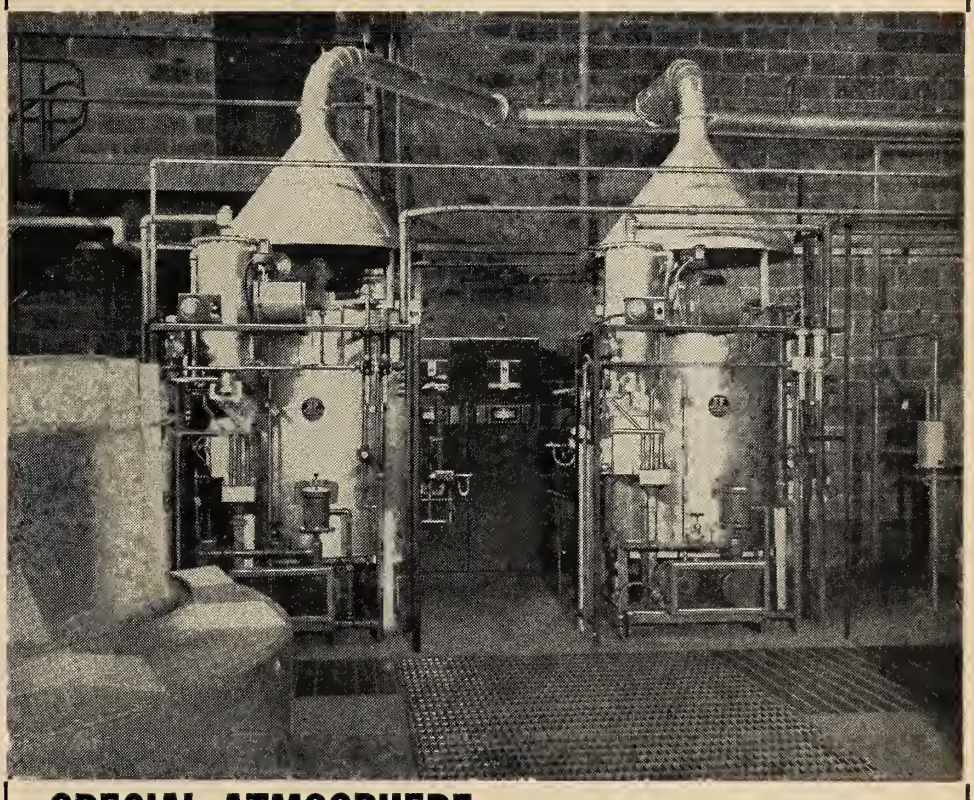
Water from the reservoir will reach the plant by way of a canal, diking of which has involved the placement of some 2,750,000 cubic yards of material. The outlet works from the reservoir to the upper end of this canal is now under construction.

The latter is one of the unusual and interesting phases of the project

(Continued on page 90)

PROTECTIVE ATMOSPHERE EQUIPMENT

METALLURGICAL APPLICATIONS



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For descriptive literature and analysis curves—send for Bulletin 611.

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POWER IN CANADA

(Continued from page 89)

and will be made up of electrical and mechanical equipment housed in the pumphouse which is now being built. Since it is an integral part of the hydro plant operation, its construction progress must parallel that of the power house.

The pumphouse will incorporate two turbine-pump units of more than 12,000 hp. One of these is now being installed for use in conjunction with the first generating unit downstream.

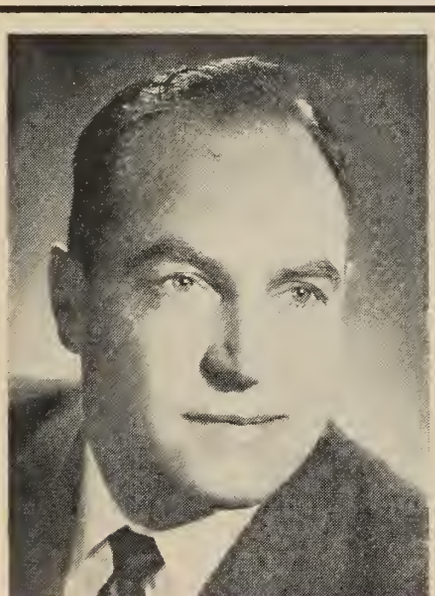
The pump-turbine will have a double function. It will generate additional power when the reservoir storage level is higher than the canal elevation. When the reservoir is lower than the canal level, the machine will be used as a pump, pumping the water up to the canal and thence to the power plant.

Construction of the pumphouse and power house at this time makes it possible for delivery of heavy equipment during winter. Heavy parts weighing as much as 125 tons, can be more easily transported to the site between December and March of 1964.

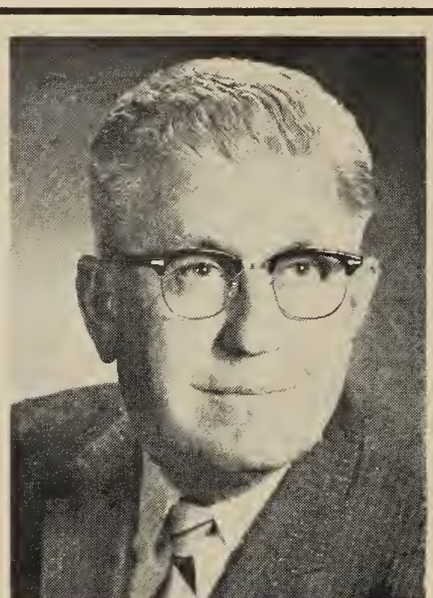
Formwork and concrete buried in this 100 foot deep excavation are part of outlet works construction. The pumphouse will soon rise another 60 feet above ground level. The bulldozer in the foreground is working in the canal area. Part of the Big Bend storage reservoir can be seen beyond the outlet works.

Grand Rapids

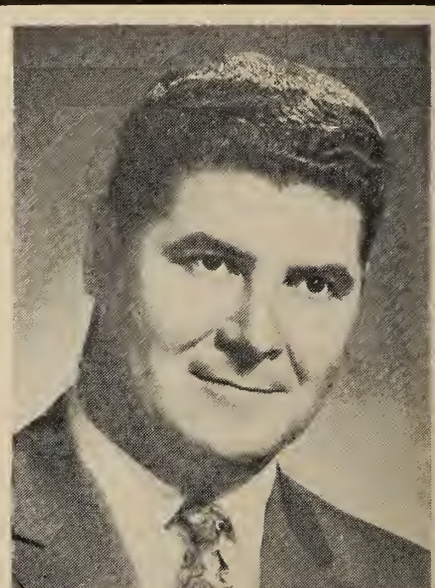
Work on the 330,000 kw. hydro electric generating station of Manitoba Hydro at Grand Rapids on the Saskatchewan River in northern Manitoba has advanced well beyond the midway point. With first power scheduled for 1964 construction schedules are being maintained. Grouting along the 18 miles of dike line is approximately 85% completed. Dike construction is



J. M. BALLACHEY, B.A., LL.B.



E. V. HUNT, P.ENG.



G. W. WALKER, P.ENG.

J. C. Mahaffy, Q.C., Executive Vice-President and General Manager of The Alberta Gas Trunk Line Company Limited, announces the appointment of J. M. Ballachey as Vice-President, Administration; E. V. Hunt as Vice-President, Operations and G. W. Walker as Vice-President, Engineering.

Mr. Ballachey joined Trunk Line in February 1955 as Executive Assistant to the General Manager, and in April 1957 was appointed Assistant General Manager. In September 1957 Mr. Ballachey was appointed Secretary-Treasurer, which office he will continue to hold.

Mr. Hunt, who has been associated with the natural gas industry in various capacities since 1928, was appointed Chief Engineer of Trunk Line in December 1954, and General Superintendent of Operations in April 1958.

Mr. Walker was appointed Manager of Technical Services for Trunk Line in September 1962, and prior to such appointment was associated with various pipeline construction and operating companies.

about 70% finished with approximately 4½ million cubic yards of impervious material, largely clay, positioned. The excavation of some four million cubic yards of rock and overburden from the spillway, powerhouse and tailrace areas is nearing completion. The only area where a notable amount of excavating remains to be done is in the intake approaches of the forebay. Although the flow of the Saskatchewan River has been passing through the spillway structure for some time, subsurface concrete rollways are yet to be constructed. To date 309,382 cubic yards of concrete have been placed in the powerhouse and tailrace areas. Assembly and welding of the scroll cases for units 1 and 2 are underway. When the project is completed in 1965 it will provide Manitoba Hydro with an additional 330,000 kw. of generating capacity with provisions made for the later installation of a fourth 110,000 kw. generator when load demands indicate the need.

Nelson River Investigations

Extensive preliminary investigations of the power potential of the lower reach of the Nelson River are being conducted under an agreement between the Government of Canada and the Province of Manitoba. The reach under examination extends from the Kelsey Generating Station, 425 miles north of Winnipeg, to Hudson Bay. On this reach there is a cumulative fall in excess of 550 feet.

Based upon a preliminary reconnaissance survey and subsequent aerial photography at a scale of 1000 feet equals 1 inch, extensive contour mapping (with contours at 5 foot intervals at a scale of 400 feet) was completed by the spring of 1963. This information enabled the selection of six sites for detailed survey and exploration at Upper Gull, Lower Gull, Kettle, Long Spruce, Limestone and Gillam Island.

Because of the extent of the undertaking and the limited time available to obtain a preliminary assessment, three of the sites, Kettle, Long Spruce and Limestone, were selected for prior attention. Detailed programs for topographical surveys, bed rock drilling, dike fundation investigations and construction material explorations have been defined.

Detailed investigations of the first three sites should be completed about freeze-up to enable office studies to advance to the point where plant layouts and cost estimates will indicate the potential at these locations.

Tentative heads and generating capacities for the six sites are as follows:

Upper Gull	40	216,000
Lower Gull	60	324,000
Kettle	90	486,000
Long Spruce	85	459,000
Limestone	185	999,000
Gillam Island	70	378,000

*Assuming 0.8 Load Factor, 85% efficiency and 60,000 c.f.s. flow.

Whiteshell

Atomic Energy of Canada Limited began operations at its Whiteshell Nuclear Research Establishment in Manitoba on July 15. There are now more than 50 AECL employees at the nuclear centre and it is expected that close to 100 will be on staff by the end of 1963.

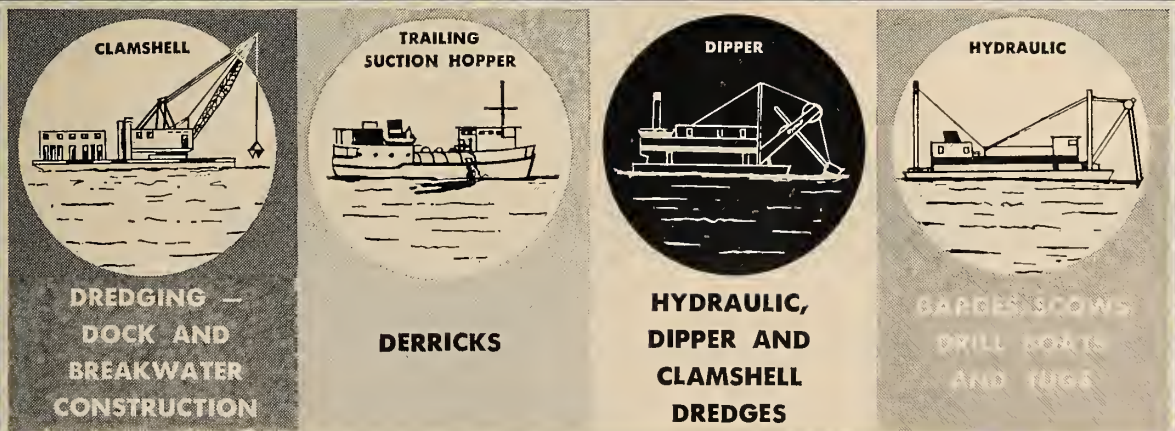
(Continued on page 92)

New T-E-L Director

BRIG. JEAN P. CARRIÈRE

Brigadier Jean P. Carrière, E.D. & F., P.Eng., MEIC, FASCE has been appointed a member of the Board of Directors of Turnbull Elevator Limited, at a meeting of the Board held on October 1. Brigadier Carrière is Executive Vice-President and General Manager of Franki of Canada Limited, Montreal. He is well-known to Canadians for his distinguished service to both the engineering and military professions, in which latter capacity he served overseas with the Royal Canadian Engineers and as an Aide-de-Camp to His Excellency the Governor-General of Canada and His Honour the Lieutenant-Governor of Quebec. Brigadier Carrière is a Director of Mutual Life Assurance Company of Canada and a Life Governor of Notre Dame Hospital, Montreal.

"GETTING DOWN TO THE JOB" – with J. P. PORTER



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POWER IN CANADA

(Continued from page 91)

The new centre is located on the Winnipeg River about 65 miles northeast of Winnipeg, midway between Lac du Bonnet and Seven Sisters Falls. The town of Pinawa, to house employees and their families, is under construction seven miles east of the research centre, on the shore of Sylvia Lake.

Emphasis at Whiteshell is on power reactor development and the first major area of investigation will be the organic cooled concept. The research and development effort in the early years will be confined largely to the fields of chemistry, chemical engineering, metallurgy, fuel development and instrument engineering.

Major buildings in use now include the medical and health physics building, the research and development laboratory and the "active area" workshop. A powerhouse and central heating plant, which will provide high temperature water for heating, stand-by electrical power and process air, is nearing completion and will be placed in operation within the next few weeks. Underground piping for water, heating and other services is being installed throughout the plant area.

The first engineering test reactor, Whiteshell Reactor No. 1 (WR-1), is under construction by the Canadian General Electric Company Limited and is scheduled for operation in 1965. Excavation work began in January and concrete pouring for the reactor building structure is in progress. The reactor will be used for a variety of engineering tests, including the large-scale testing of nuclear fuels, coolant systems and components for organic cooled, heavy water moderated power reactors.

Shielded "hot cave" facilities for the examination of highly radioactive materials, a decontamination building, an "active area" laundry and other services will be needed for use in 1965 when the WR-1 reactor goes into operation. Most buildings are being designed for future expansion and new facilities will be added when required.

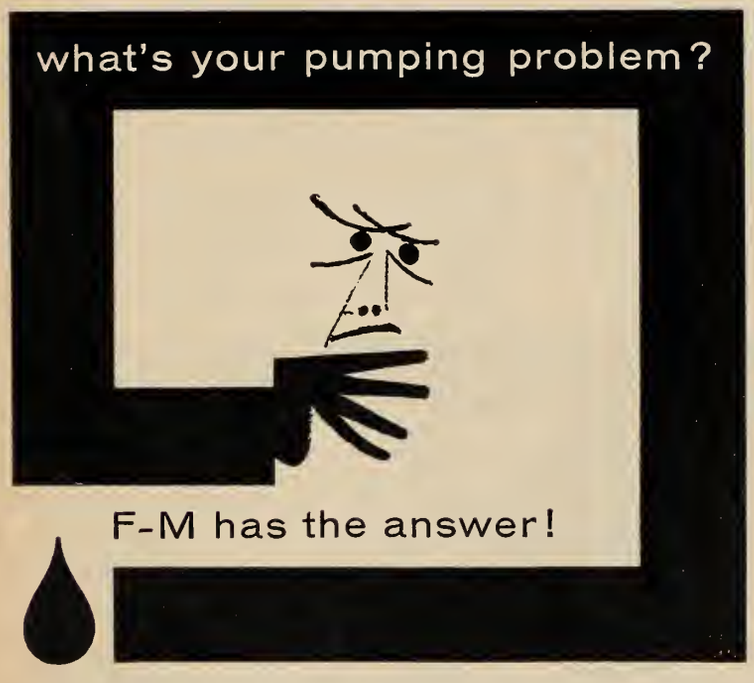
Douglas Point

The main nuclear components now have arrived at the Douglas Point Nuclear Power Station. The station, Canada's first full-scale nuclear power station, is being built by Atomic Energy of Canada Limited on the shore of Lake Huron near Kincardine, Ont. When it goes into operation in 1965, it will produce 200,000 kw. of electricity.

By the end of last year, civil construction at the station had been largely completed, and 1963 saw the delivery and installation of equipment begin. Ontario Hydro, which is co-operating in the construction, has a site force of almost 500 men at the project.

The major buildings at the site are a concrete reactor building 135 feet high containing the nuclear reactor and eight steam generating units, a turbine building, and a service and fuel storage building.

Inside the reactor building, the heavy concrete vault — which will contain the nuclear reactor — has been placed and work is underway installing the three separate steel liners inside the vault. Also installed in the vault are the end-shield ring assemblies which serve to locate the reactor and its associated end-shields. The reactor vessel itself was shipped by barge from the manufacturer's



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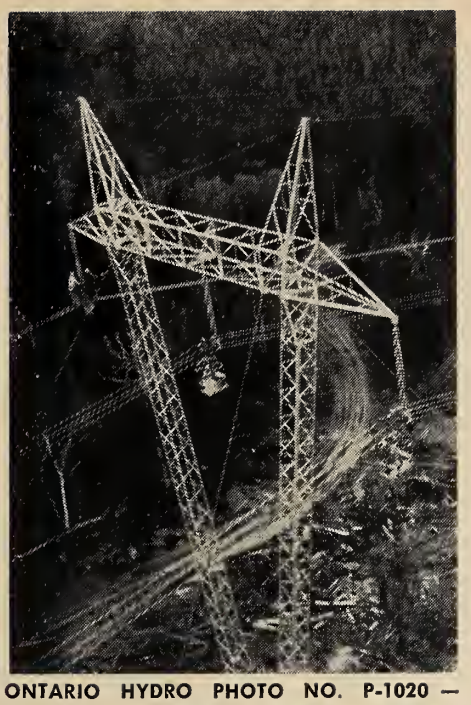
shops in Montreal May 30 and the 800-mile trip was accomplished in five days. The vessel, a stainless steel tank 22 feet in diameter and 17 feet in length with 306 horizontal Zircaloy tubes, now is stored at the site and will be installed later this year.

Both end-shields for the reactor now have arrived at the site. These massive end-shields will be installed in the reactor vault within the next month. Other work inside the reactor building includes the installation of the first steam drums for the eight boiler units which will raise steam for the turbine.

On the conventional side of the plant, work is well advanced. The circulating water system is virtually complete, and the pumps and main condenser are installed. Delivery of the turbine will take place this year. The switchyard towers have been erected and the main transformer is in place. This summer, work was started on a 30-mile, 230,000 kw. steel tower transmission line to Hanover. Most of this line is complete except for stringing conductors.

Although much of the major equipment has now been delivered, considerable work on control, instrumentation, fuel and smaller components in the station remains to be done. Work on design and manufacture continues. In the Toronto Laboratories of Atomic Energy of Canada Limited, the prototype fuelling machine is undergoing tests. Two of these machines will be installed at the station to carry out remote on-load fuelling of the reactor.



ONTARIO HYDRO PHOTO NO. P-1020 — High-wire acrobats, shown here are actually Hydro linemen at work spacing Extra-High-Voltage (E.H.V.) conductors.

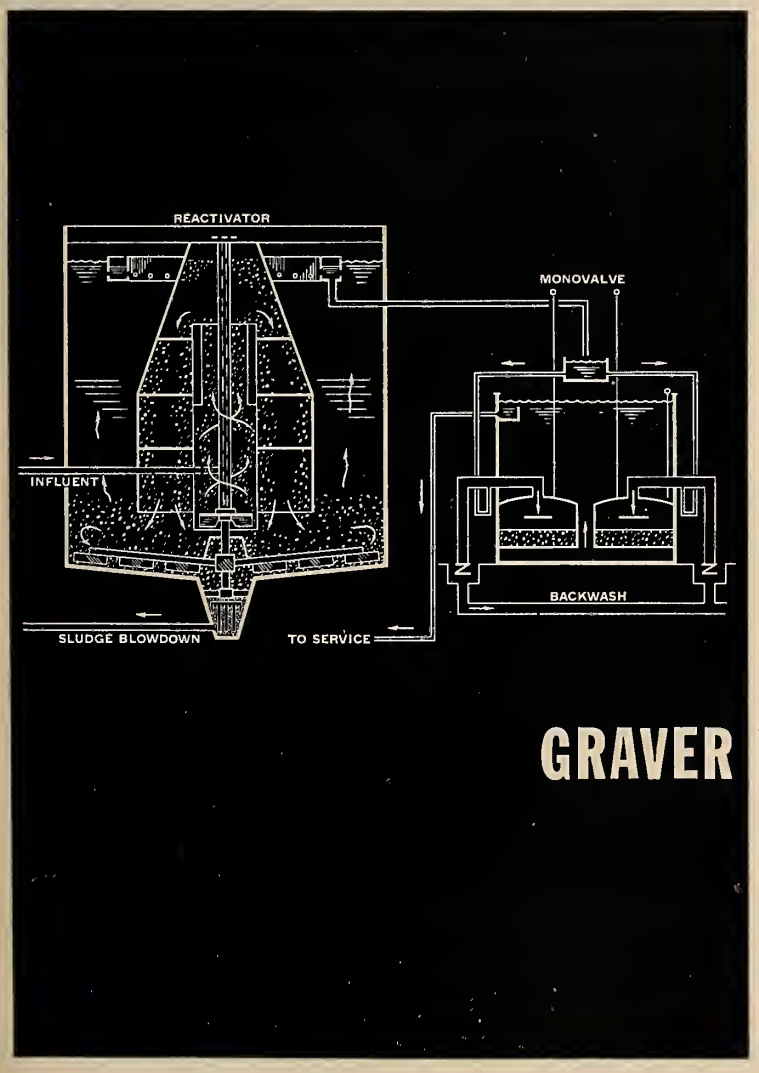
EHV

By mid-September this year, Ontario Hydro completed the first phase of its EHV transmission line from the James Bay watershed to Toronto — an overall distance of 450 miles. This leg from Pinard T.S., 60 miles north of Cochrane to Hanmer T.S., near Sudbury crosses 230 miles of the most rugged muskeg swamp and rocky terrain in the province.

To take advantage of the improved transportation conditions during the winter months, the line forces have continued their work 12 months of the year since the fall of 1961, clearing rights-of-way, setting footings, erecting the specially designed V-towers of steel and aluminum, and stringing the conductor bundles under tension.

The line is part of a $200 million development plan which includes

(Continued on page 96)



UNIQUE . . .

Edmonton, West Pakistan, New Brunswick— the unique Graver Water Treatment Plant removes turbidity, colour and hardness from raw water the world over. The Graver *Reactivator* produces a colour and turbidity effluent of less than 5 ppm turbidity. Polishing in the automatic Two Compartment Monovalve Filter makes effluent useable for potables or fine processes. The Monovalve stores its own water for automatic backwashing, and comes in one, two and three compartments with headrooms as low as 8 feet. Canadian Reactivator installations from 20 to 20,000 gallons per minute, Monovalves from 4 feet to 18 feet diameter.
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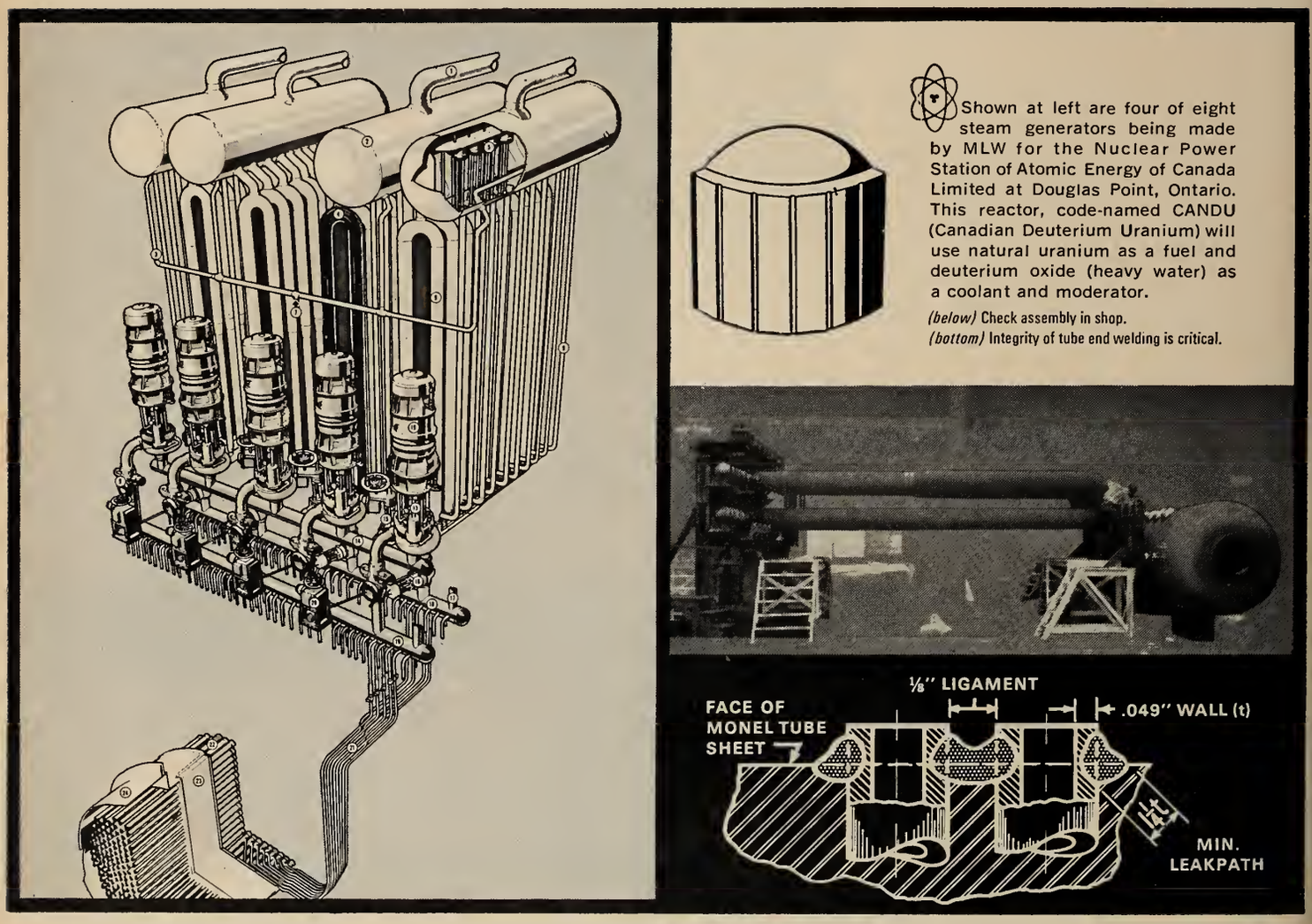
MLW meets the challenge of ATOMIC ENERGY...

MLW experience and facilities are put to a new test on the nation's first full-scale nuclear power project.



Shown at left are four of eight steam generators being made by MLW for the Nuclear Power Station of Atomic Energy of Canada Limited at Douglas Point, Ontario. This reactor, code-named CANDU (Canadian Deuterium Uranium) will use natural uranium as a fuel and deuterium oxide (heavy water) as a coolant and moderator.

(below) Check assembly in shop.
(bottom) Integrity of tube end welding is critical.

A vital part of the Douglas Point "CANDU" reactor is the group of eight generators which produce steam by exchanging heat from heavy water. Generating 2,500,000 lbs. of steam per hour they have to be of unquestionable quality, therefore thermal engineering and fabrication ability of the highest order are imperative. A major goal is to minimize both hold-up and leakage of high-cost heavy water (about $1500 per cubic foot). For this new challenge, MLW is employing new techniques, equipment, and procedures for producing tube to tube sheet welds of extraordinary integrity and dimensional consistency. In addition, new scientific inspection methods are demanded... new shop assemblies are necessary... new solutions to many other problems have had to be worked out. All this is being achieved by combining up-to-date knowledge with time-proven experience and skills.

As additional nuclear energy stations are built in Canada and overseas, MLW stands ready to provide the unique combination of knowledge, skills and special equipment which are going into these steam generators.

MLW

For further information write to:
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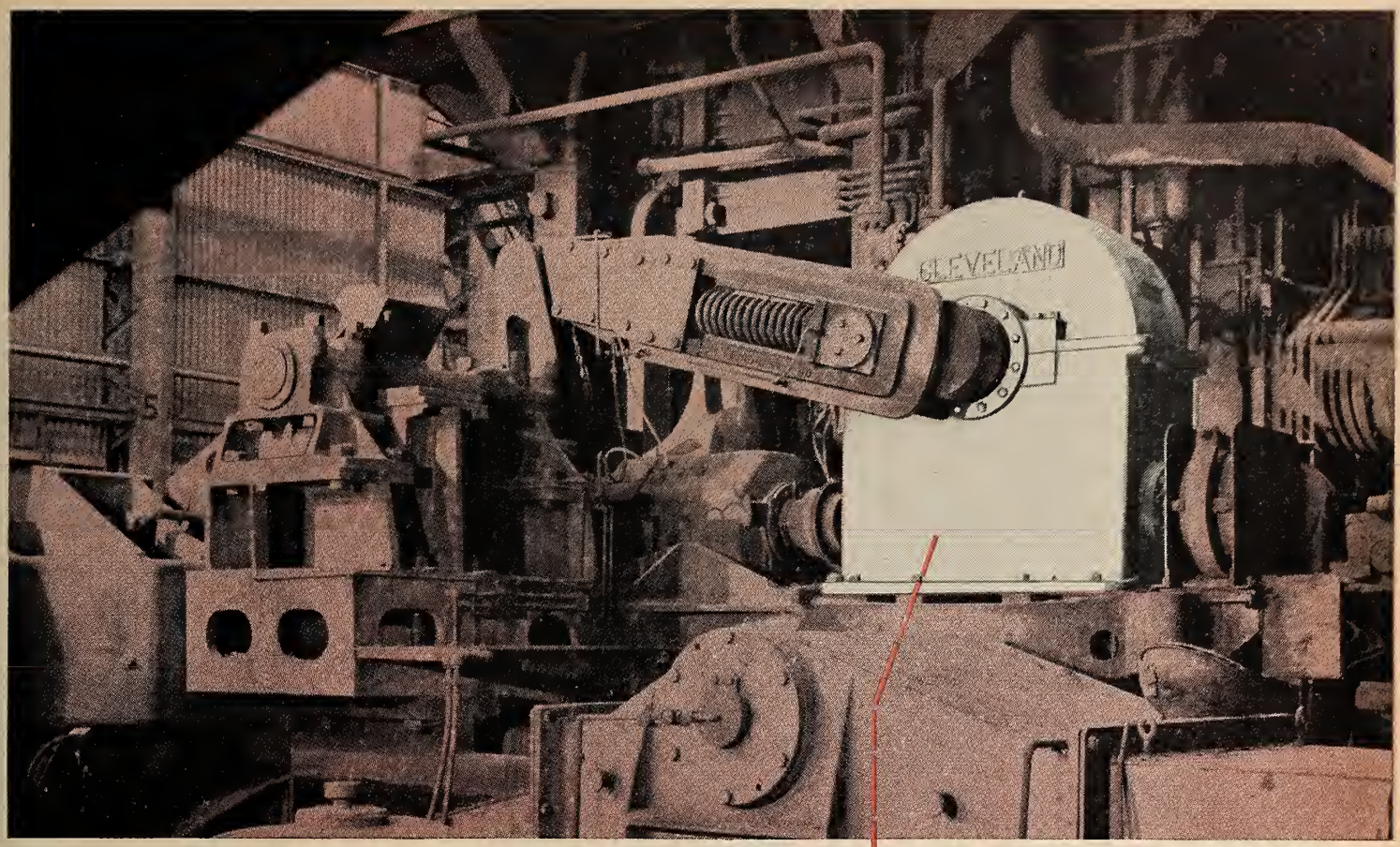
1505 Dickson Street, Montreal 5, P.Q., Phone CL. 5-3681

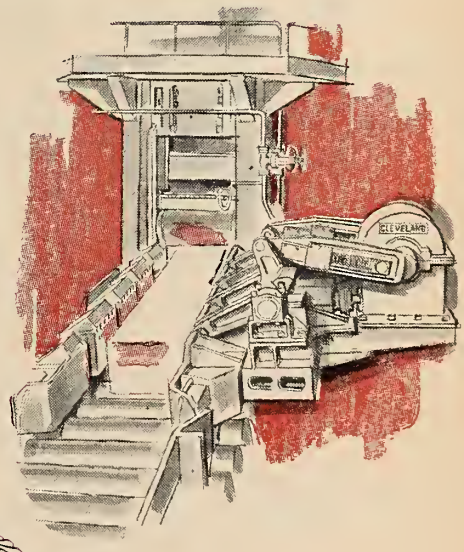


Two Cleveland Speed Reducers drive "Magic Fingers" on Kaiser Steel's New Slabbing Mill

Here's one of two rugged 3000-AT Cleveland Worm Gear Speed Reducers busy at work driving the manipulator finger lift mechanism on Kaiser Steel Company's new 45 x 90-inch Universal Slabbing Mill at Fontana, California. With these Cleveland Reducers, mounted on the slab pusher, turning massive slabs between mill passes is a simple, rapid operation.

In these large, yet compact, space-saving Clevelands, worm and gear shaft bearings are supported by a massive internal structural framework that enables the units to withstand extreme shock loads. Their right angle shaft arrangement provides a distinct advantage over other forms of gearing that might not fit the space limitations of a specific installation.

In all types of industrial plants, wherever rugged, compact and dependable speed reducers are needed, Clevelands handle the toughest assignments. Call your Peacock Representative today, or write for Bulletins 145 and 410-A to get complete information on how to handle your most demanding power transmission jobs.



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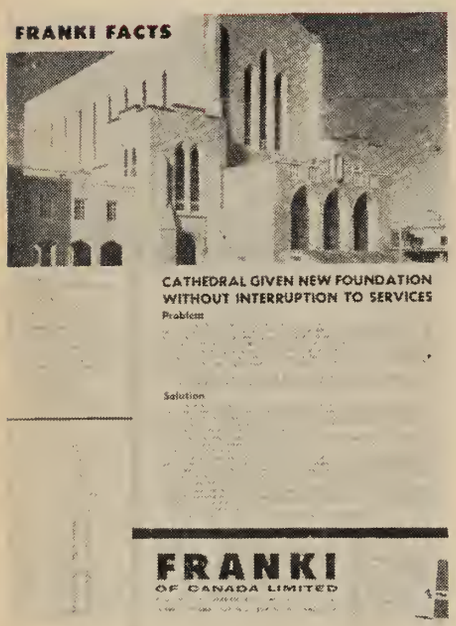

A factual, detailed advertisement designed for the engineer won for Franki of Canada Limited the EIC Certificate of Advertising Merit for July. The single-page black-and-white ad told how Franki of Canada gave a cathedral in Edmonton a new foundation without interuption to services. A photograph of the cathedral illustrated the bulk of the job. The ad included a typical soil profile and a detailed resume of the problem and the solution.

Advertising Director of Franki of Canada Limited (Montreal) is Robert F. Grisar. The ad was prepared by Industrial Advertising Agency Ltd., Montreal, A. George Temple, Account Executive.

Judging for the award is done each month by an impartial jury of engineers from all parts of Canada whose only instructions were to select the best advertisement on the bases of ACCURACY—INFORMATION—ATTRACTION.

You're all wet...
AND
SAFE!

in a HAWS Emergency Drench Shower.

Burning, corrosive, caustic contamination can inflict injuries more dangerous than blazing clothing! Contamination by acids, chemicals, volatile fuels, radioactive elements, etc., must be instantly countered by *first aid*. Immediate drenching with clear water is the first precaution against permanent injury. HAWS leads in design and production of Emergency Drench Showers! *Ask for our complete catalog.*

Model 8590
Multiple nozzle shower drenches victim from all angles.

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P.O. Box 84, Sta. K

POWER IN CANADA

(Continued from page 93)

Otter Rapids Generating Station on the Abitibi River, commissioned early in September, and three hydraulic stations now in various stages of planning and construction on the Mattagami River.

Power from these stations will be collected at Pinard T.S. stepped up to 500,000 volts — twice the potential of any existing line in Ontario — and carried to markets in southern Ontario.

In tests conducted by Ontario Hydro it was established that the most economical method of transmission would be at 500 kv., which made it necessary to develop new methods of construction and design new equipment.

To reduce line scratching — an important factor in corona losses — the conductor bundle, four lines held in a square formation, were strung under tension of 2,000 lb. each by a special puller and tensioning machines.

While the majority of towers are of steel, aluminum has also been used to advantage where transportation conditions made the lighter material cheaper to handle.

Perhaps the most formidable challenge was one of logistics. Except for a brief encounter with civilization at Timmins, the line to Sudbury was far removed from normal channels of supply by road, rail or water. Each component was delivered on site to a closely integrated schedule — from heavy tower steel and huge reels of cable to the smallest item of conductor hardware.

Supervision of the work forces and more than $1 million worth of construction equipment was aided by the use of helicopters, the only effective means of rapid travel.

Each mile of line requires more than 25 tons of tower steel, two tons of insulators, some 24 tons of conductor, 14 anchors, three to four tower bases, and hundreds of smaller items of hardware.

The second phase of the line from Hanmer to Essa T. S. near Barrie is now underway with footing crews preparing for the tower gangs, scheduled to move in later this fall.

Initially the line will operate at 230,000 volts and be stepped up to 500,000 by the fall of 1965, when 425,600 kilowatts of power will be available. Further development on the James Bay watershed is expected to raise the amount of power produced in the area to more than a million kilowatts.

EIC

Amphibious!

Underground or underwater Northern Electric's Oil-filled Pipe Cable transmits electrical power—economically!

Since 1957 Northern has manufactured and installed six major oil-filled pipe cable circuits in Canada, totalling 105,800 circuit feet. The most recent is a 4,000 foot run under the St. Lawrence River near Quebec City. Oil-filled pipe cable was chosen over the double wire armoured PILC because of its greater ruggedness under severe winter ice conditions. This installation has a unique feature in that the present 25 kv operating voltage can be increased to 62 kv simply by installing a pumping station to increase the present oil pressure of 8 psi to 200 psi.

In underground installations, oil-filled pipe cable needs only a narrow trench and, because it is frequently installed beside or under public thoroughfares, it seldom requires a special right of way. Each cable is similar to standard single-conductor PILC, with a spiral D-shaped skid wire replacing the lead sheath. Installation is fast because three cables are pulled into the pipe together in continuous lengths up to 5,000 feet.

Oil-filled pipe cable has a high ampacity and can be operated at voltages up to 345 kv. Every length is tested to AEIC requirements for high pressure pipe type cable.

If you are concerned with economical transmission of power at high voltages under difficult environmental conditions, ask for Northern Electric's Cable News S-1A. The facts are impressive, the advantages profitable.

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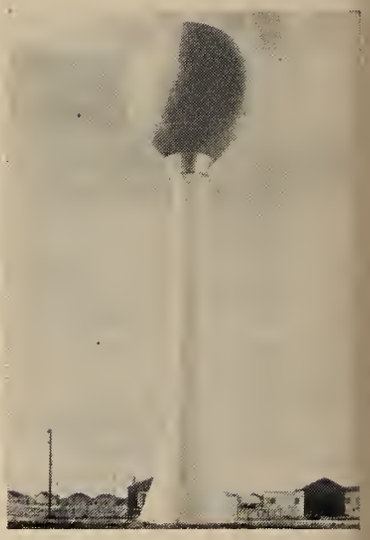
being First is a 50 year habit at

In 1913 Horton fabricated and erected many of these early elevated storage tanks — some of which are still in use today, after over 50 years of service.

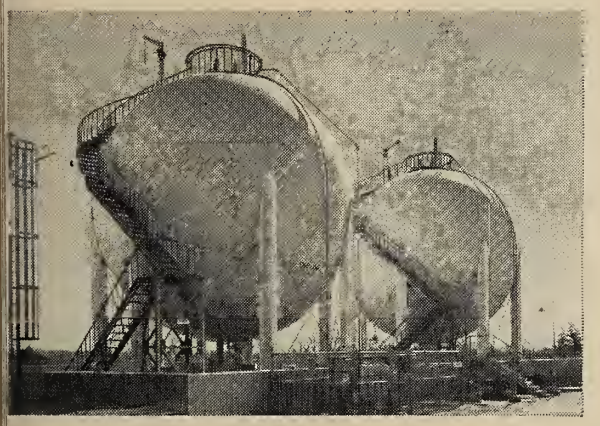
In 1959 Horton developed, fabricated and erected the first "covered pan" floating roof tanks that conserve vapors while protecting against snow and ice under severe weather conditions. These tanks are sold under the trade name 'Weathermaster'.



In 1947 Horton fabricated and erected the first Watersphere, creating out of strong welded steel plate a modern, landscape-blending design that is both attractive and completely efficient.

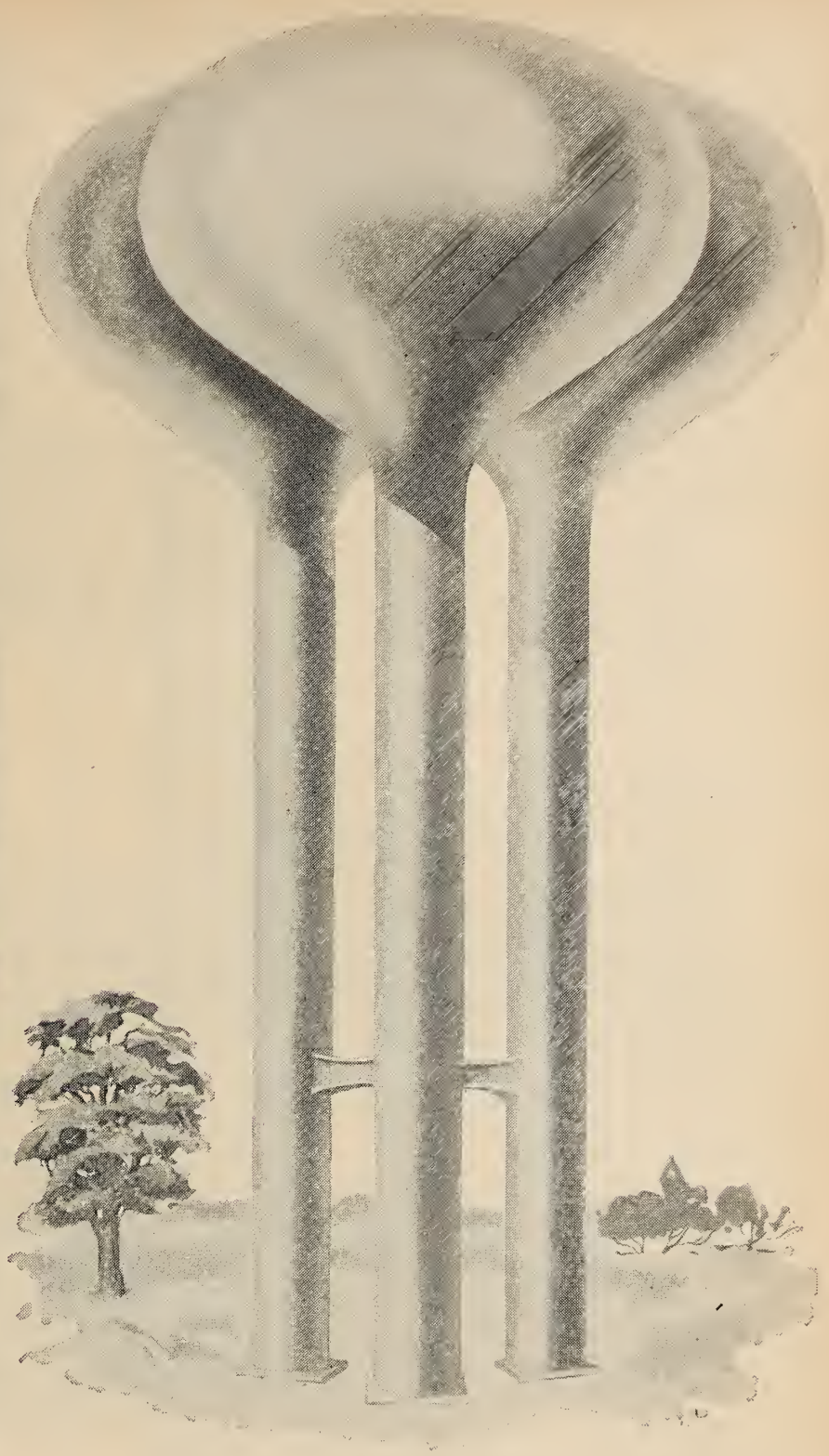
HORTON!

Fifty years of forward-thinking in the design, fabrication and erection of steel plate keeps Horton ahead!



In 1925 Horton constructed the first spherical storage vessel in Canada. Many Hortonspheres have been built in the intervening years — including ten constructed in a single, recent contract . . . five in stainless steel!

Since 1913, Canada's industrial complex has grown considerably. Horton has been equally busy — formulating and executing the most advanced new ideas in steel plate construction — keeping pace with modern industrial needs year after year. That's why today, Horton's range of services include research, engineering, fabrication and field erection. That's why today, Horton is involved in the very newest fields of cryogenics and nuclear containment vessels. That's why today, the industries served by Horton are legion and include hydro-power, gas-processing, petroleum, pulp and paper, mining, chemical processing, nuclear research and industry at large. That's why, today in Canada, there's a *name* for steel plate fabrication, Horton!



Horton's "firsts of the future" include this ultra-modern Polyspheroid — an enlightened design in elevated water storage, comprising 2, 3, 4, 5 or 6 steel plate sections, integrated to provide up to 4,000,000 gallon capacity!

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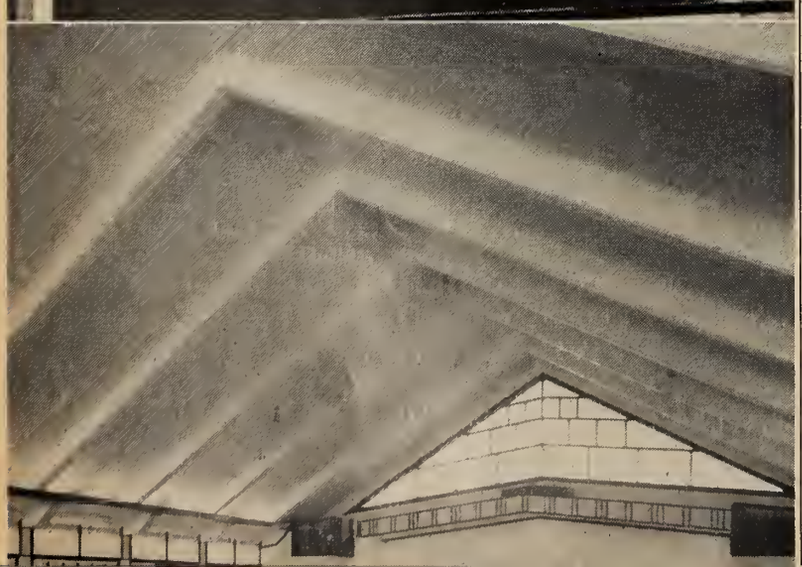
HSW-635



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Street Bridge, Streetsville, Ont. Owner: County of Peel. County Engineer: R. A. Cruise. Contractor: Finley W. McLachlan
tion Co. Ltd., Toronto. Prestressed concrete beams supplied by: Schell Industries Ltd., Woodstock, Ont.

Cola Bottling Plant, Ottawa, Ont. Architects: Mathers and Haldenby. Consulting Engineers: C. D. Carruthers & Wallace
nts Ltd. General Contractor: Angus Robertson Ltd. Suppliers & erectors of prestressed concrete units: Francon Limited.

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Engineering Briefs

(Continued from page 70)

DISPENSI-PAK, a portable self-contained strapping station, requiring no tools and weighing slightly more than two pounds has been announced by Signode Canada Ltd., Scarborough, Ont. The Dispensi-Pak contains a 300 foot coil of Dymax, Signode's non-metallic strapping made from a strengthened form of nylon, and 50 Dylocks — nylon, self-sealing buckles which permit tensioning of Dymax without a tool. The Dymax strapping is Signode's Class 502, which has a breaking strength of 475 pounds, an elongation of 12% to 15%, and almost total elastic return.

A HIGH VOLTAGE regulated power supply unit for laboratories, or in industry, for cathode ray tube supplies, component testing, particle acceleration, image intensification and other electrostatic processes, is available from Conway Electronic Enterprises Ltd., Toronto. Operated by power valve oscillators, working at approximately 8 kilo-cycles per second, the unit is used with an encapsulated ferrite cored transformer to provide the output which is fed to a selenium type rectifier system, arranged as a voltage multiplier. The DC output is monitored with a 100 microamp movement and a high stability series resistor which also provides the feedback to the stabilizer. The output voltage range is from 7 kilovolts to 75 kilovolts with an output current range from 0 to 0.5 mA.

A SIMPLE ATTACHMENT which makes chart changing fully automatic has been announced by Canadian Meter Company Limited. The attachment known as the Canadian Chart Changer, was designed to relieve personnel of the chore of manually changing charts, and provides a consistent drop-off time throughout the system. Charts may then be picked up at the user's convenience. The Changer is adaptable to a wide range of instruments and can be adjusted for any recording cycle desired.

FABRI-BOND Welded Wire Reinforcement Fabric has been announced by The Steel Company of Canada, Limited. Fabri-Bond features cleat-like deformations precisely positioned along the wire, providing a toothed surface to the concrete. Stelco claims that this surface distributes stresses far more widely and uniformly than smooth surfaced wire. With a minimum yield of 75,000 p.s.i., Fabri-Bond is designed primarily for concrete pipe, above-ground structural slabs, precast sections and continuously reinforced concrete highways.

HOWDEN ROTO-PAK HEAT EXCHANGER, a unit which preheats 0 degree incoming air to 62 degrees F, has been introduced by James Howden & Co. of Canada Ltd., Scarborough, Ont. The unit is designed to take heat from the air being discharged from the working space, and to transfer this heat to the fresh air intake in a continuous rotary cycle. In one day, with an outside temperature of 0 degrees F, the Roto-Pak saves 1,860,000 B.T.U.'s from every 100 c.f.m. of stale air discharged. The Roto-Pak is built in seven standard diameters 4 ft to 10 ft with flow capacities from 3000 to 30,000 c.f.m.

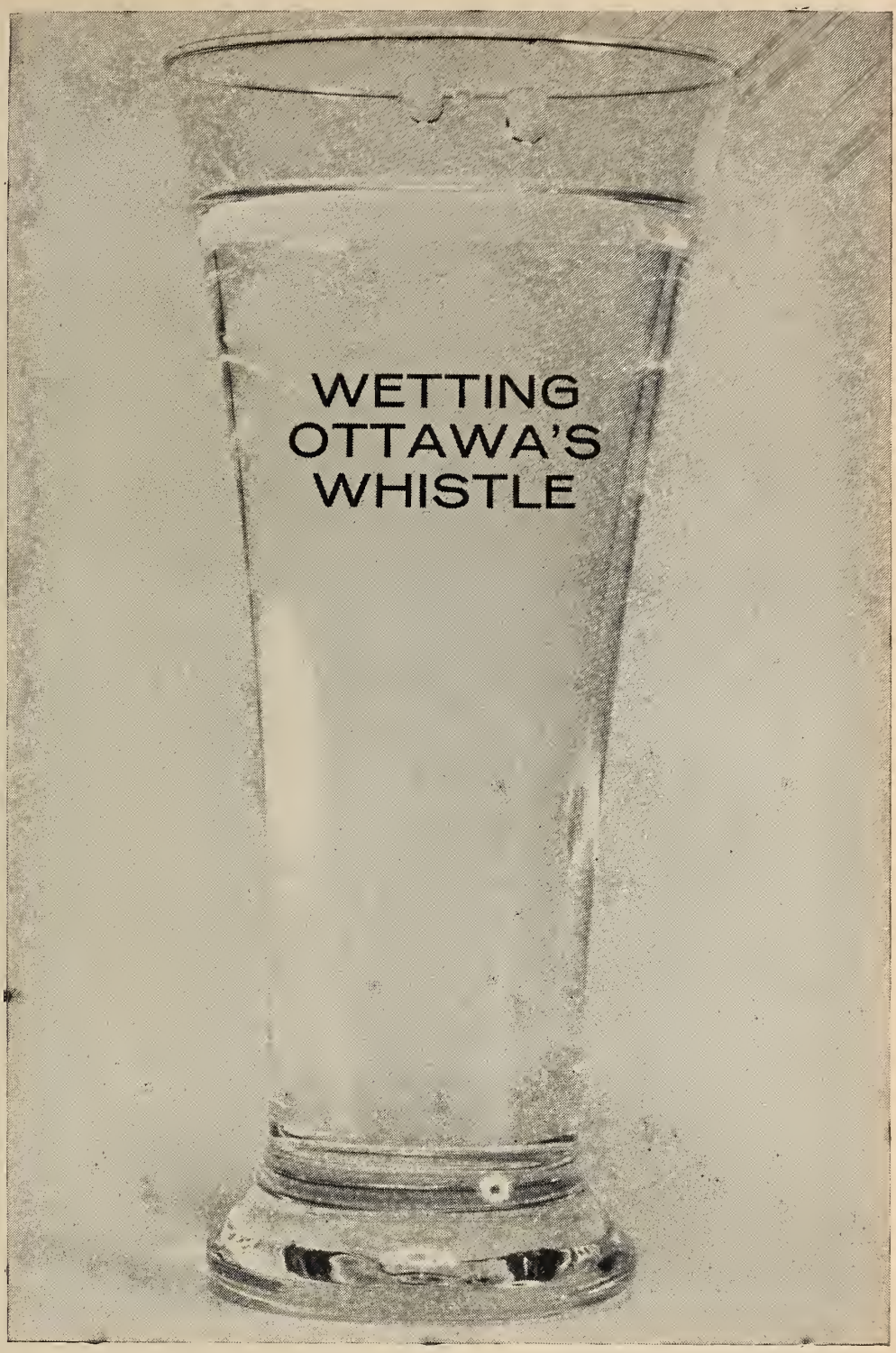
THE MODEL F-3 is a medium capacity Colmonoy Spraywelder for flame spray application of powdered hard-surfacing materials. Available from Wall-Colmonoy (Canada) Ltd., Montreal, the Model F-3 is rated for deposit of approximately 3 lb. of powder per hour. It operates on 5 p.s.i. oxygen and 10 p.s.i. acetylene pressure and has an air pressure level of 3 p.s.i.

BYE-NATIONAL have introduced a new line of circuit breaking connectors called Bar-Line. These industrial connectors are waterproof, corrosion-proof, and resistant to dust, gas, shock, vibration and pressure. These connectors have a proven capturing capability at ratings of 20 to 100 amps. 600 V. AC. They are readily connected to pre-mounted inserts, and give ample wiring space in cable housings.

THE PNEUMATIC CORE SPLITTER available from Boyles Bros. Drilling Co. Ltd., Vancouver, eliminates manual splitting of diamond drill cores. The Core Splitter fractures as much as 100 ft. of "EXT" core per hour, and handles all sizes up to BX. The main frame and cylinder are a one-piece steel casting. Drives are designed for long service. The splitter will operate on a portable paint spray compressor if compressed air is not available.

PEACOCK BROTHERS LIMITED, Montreal has announced the Peacock-Bowell Series 4000 pumps for water and clear liquid transfer. These horizontal split case, double suction, single stage centrifugal pumps are available in sizes from 1½-inch to 14-inch for capacities up to 7,000 U.S. GPM and heads up to 300 ft. A six-page bulletin, available from the company, gives capacity and head ratings, specifications and dimensions.

(Continued on page 106)



42,000,000 gallons a day, electrically pumped from $5,000,000 Britannia Water Purification and Pumping Station, keep much of Ottawa from going dry. During failure of the public mains three 1575 b.h.p Paxman diesels would still pump the full daily capacity *and* provide the plant's lighting and power load. Millions of Paxman horsepower are standing by like this to protect vital services and processes all over the world.

there's no stopping with **PAXMAN** *diesel alternator sets*

Paxman diesels are backed by a world-wide service which brings you men and spares whenever and wherever you need them — and fast!
100-395 kVA standard range available from stock. Sets built to customers' requirements from 100-1500 kVA with medium/high speed diesel engines; also dual fuel engined sets from 1000 kVA.

DAVEY, PAXMAN & CO LTD COLCHESTER ENGLAND A Member of the RUSTON Group

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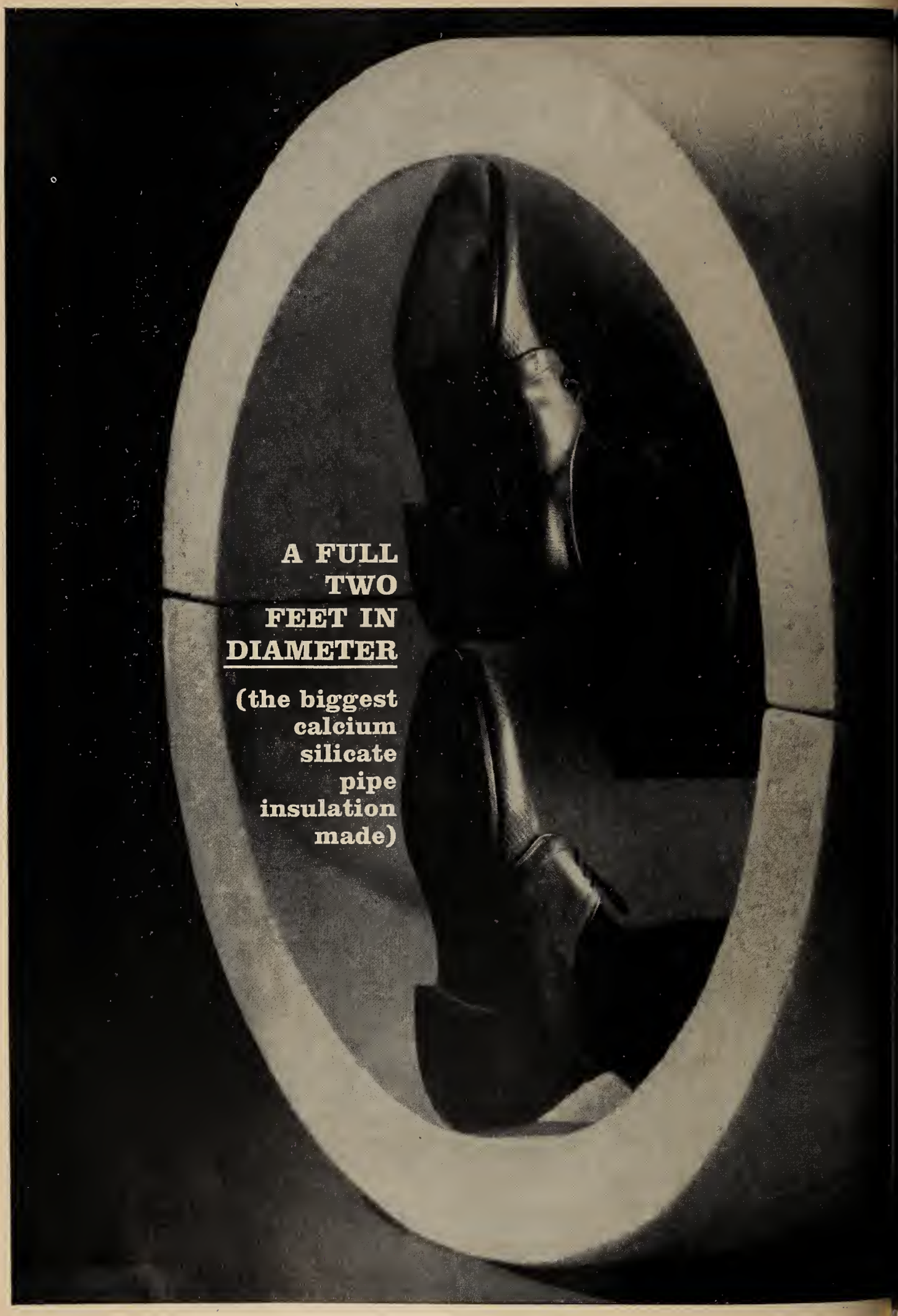
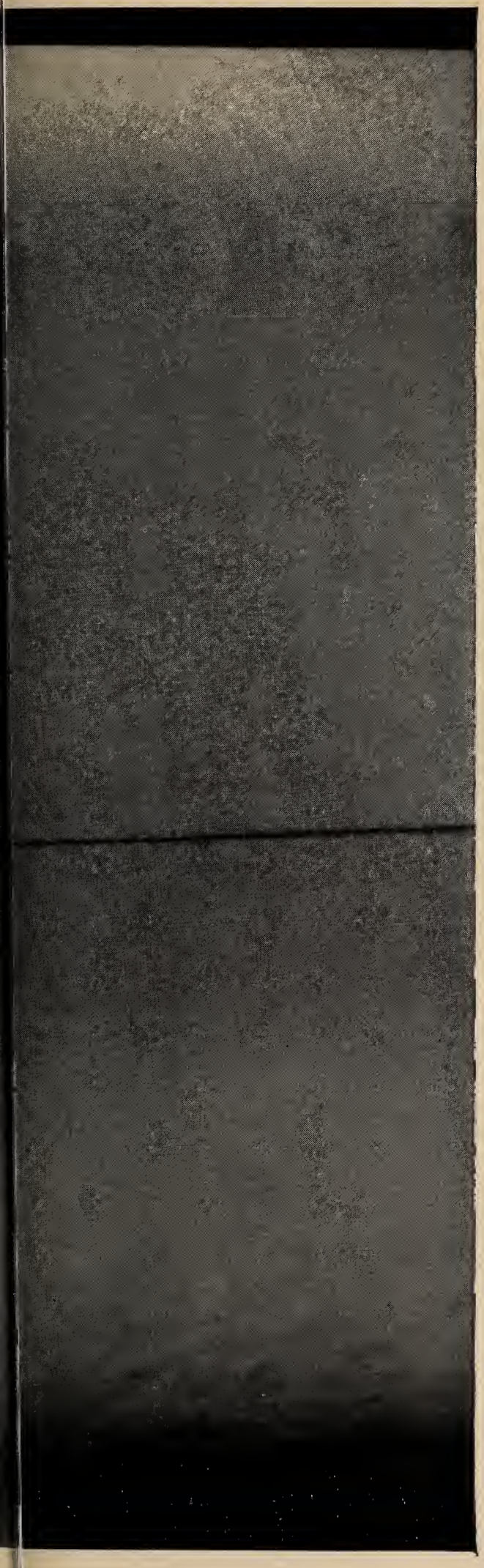

A FULL
TWO
FEET IN
DIAMETER
(the biggest
calcium
silicate
pipe
insulation
made)



J-M Thermobestos– the easiest to install, most effective insulation for high-temperature pipes

Now, pipelines up to two feet in diameter can be protected against heat loss with the *only* calcium silicate insulation made in big 24″ half-sections–J-M Thermobestos®. In a jiffy, two of these king-size halves can be placed around the pipe. It's a smooth job, with few joints. This means *faster installation and less heat loss.*

J-M Thermobestos is the result of a special manufacturing process that gives it greater strength than is possessed by any other calcium silicate insulation on the market. What's more, Thermobestos is not affected by repeated or prolonged wettings . . . and it will not burn or carry flame. Your benefit? *The lowest possible maintenance costs!*

Although exceptionally strong, Thermobestos is light enough to enable one man to handle the largest section (24″ x 3″ x 36″). This means low shipping costs and easy, on-the-job handling.

These benefits, plus a low k factor, make J-M Thermobestos the preferred insulation for both indoor and outdoor pipelines operating at temperatures up to 1200F.

Thermobestos is available for other standard pipe sizes, and you can specify the thickness you need. This superior insulation is also made in block form for special uses. For complete details, plus the name of the nearest authorized J-M insulation contractor, write Canadian Johns-Manville, Dept. IA, 565 Lakeshore Rd. East, Port Credit, Ontario. Cable address: Johnmanvil.

I-8015

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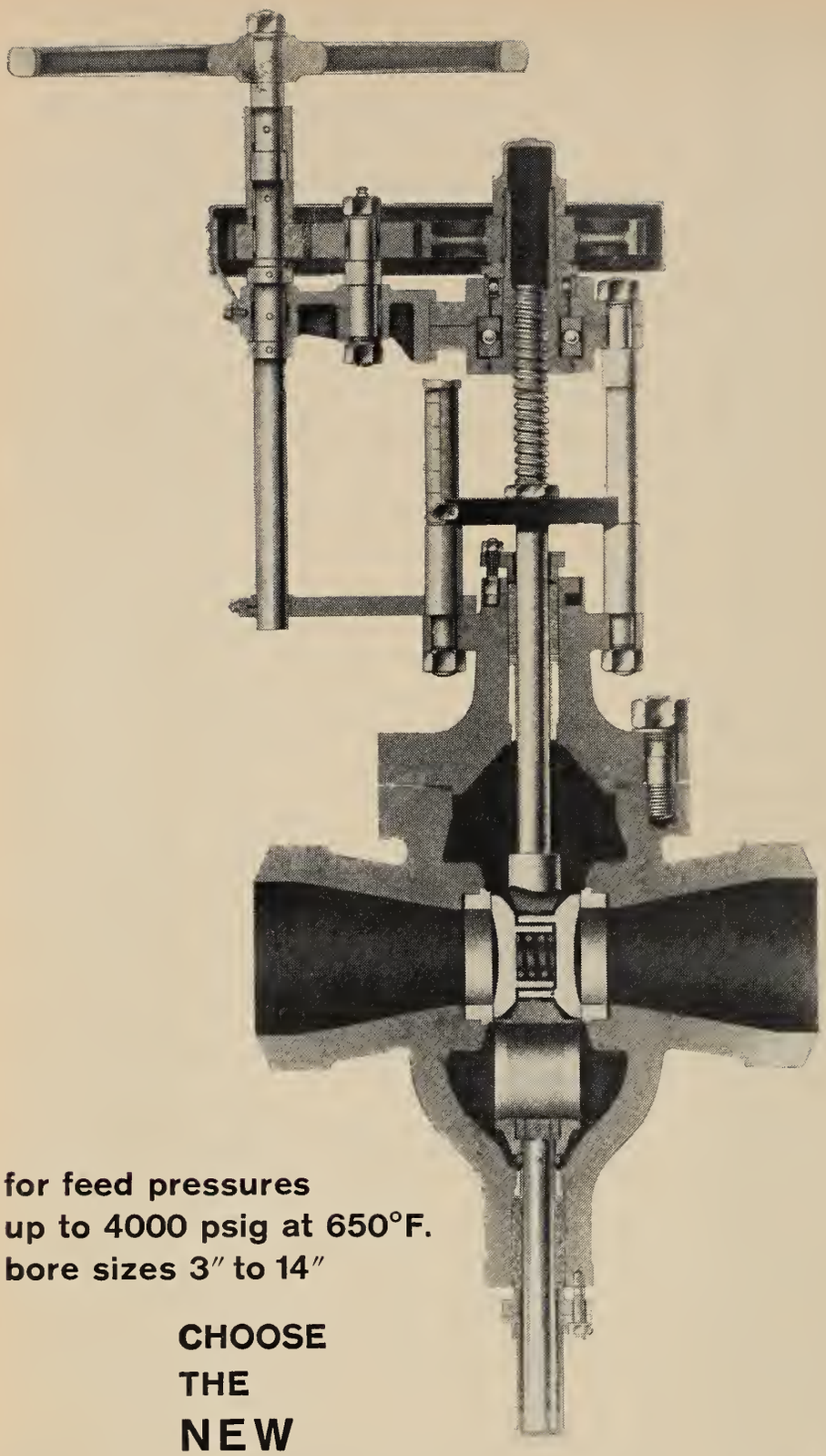
THERMOBESTOS INSULATION IS MADE IN CANADA



for feed pressures up to 4000 psig at 650°F. bore sizes 3″ to 14″

CHOOSE THE NEW

HOPKINSON-FERRANTI BOILER FEED STOP VALVE

with the balanced spindle (except 3″&4″)

For these high pressures, Hopkinsons' feed valves incorporate where necessary a balanced spindle assembly which removes the unbalanced load on the spindle. The Ferranti design results in a lighter and more compact valve.

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PEACOCK BROTHERS LIMITED
P.O. BOX 1040, MONTREAL 3, QUE.
BRANCHES ACROSS CANADA

PEACOCK

Engineering Briefs

(*Continued from page 103*)

CANADIAN GENERAL ELECTRIC'S new voltmeters incorporate zener-diode references, and provide accuracy of ±0.5% and excellent narrow-range readability. Expanded-scale meters are available in 3½ inch and 4½ inch self-contained a-c or d-c models. Standard a-c ratings are 110-130 and 105-125 volts. Standard d-c ratings are 24-30, 110-130 and 220-260 volts. Maximum sensitivity is 100 ohms per volt. Current drain is 10 milliamp.

TYPE TC, a transistorized power line carrier for protective relaying, telemetering, supervisory control, and maintenance communication is available from Canadian Westinghouse, Switchgear and Control Division. Rated at 10 watts and featuring constant band width at all frequencies, and low battery drain, the Type TC with crystal controlled oscillators, provides selected frequency between 30 and 200 kc in 0.5 kc steps with 20 cycle stability under wide variations in temperature and supply control. High power level overcomes noise and high attenuation problems.

THE CSM2-60 is a fully transistorized microwave system newly introduced by ITT Canada Limited. This system operates within a frequency band of 1700 to 2300 mc and with a capability of 60 voice channels. Designed for toll service over short hauls.

LIMPET ASBESTOS FIBRE, available from Atlas Asbestos Co. Ltd. can be applied to any surface or contour without mechanical support. Thickness and densities can be pre-determined to achieve the desired thermal conductivity. It can be used for insulating boilers, heat exchangers, flue gas ducting, stacks, precipitators, diesel engine exhaust systems and steam and gas turbine casings. Limpet Asbestos has proved to be versatile and efficient for insulating plant machinery and equipment within the temperature range 200°-1250° F.

INTEGRAL CANNED PUMPS, available from Consolidated Engines & Machinery Co. Ltd., Montreal, are seal-less, centrifugal, leak-proof canned pumps for the handling of chemicals, radioactive fluids, volatile and corrosive fluids. The interchangeability of parts between the various series of integral pumps make for minimum cost.

The pumps are manufactured in a full range of motor sizes from ¾ HP. through 15 HP., and in port sizes from 1¼″ x 1″ through 4″ x 3″.

a *practical* example of CO-OPERATIVE ENGINEERING

Project: to outwit pothead potshooters!

Vandalism is a curse we seem to have to live with. And pothead insulators are a favourite target. The trouble with the average pothead is that if one insulator is damaged, the whole pothead has to be replaced.

Appreciating the problem, Canada Wire engineers got down to the business of designing a full range of potheads with economically replaceable insulators. It was no mean task. Potheads contain gas or oil under pressure and therefore need exceptionally fine tooling. Seeing a problem and solving it is *life* to Canada Wire engineers. If your company has an unusual problem involving power cable or accessories, in any part of the world, you will receive willing and *inventive* help from Canada Wire.

CANADA WIRE

CANADA WIRE AND CABLE COMPANY LIMITED

Postal Station R, Toronto 17 (Leaside), Ontario.

Employment Service

THE ENGINEERING INSTITUTE OF CANADA

This service is operated for the benefit of members of the Engineering Institute of Canada and for organizations employing engineers.

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Advertisements are inserted free of charge for members of all classes. Maximum length is 60 words, and repeat insertions must be separately requested in writing for each desired appearance.

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Rate: Six dollars per column-half-inch per insertion.
Replies to advertisements should be addressed to the file number, Employment Service, 2050 Mansfield Street, Montreal. Interviews with the Employment Service may be arranged by calling VI 2-8121 at the above address.

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CIVIL ENGINEER — M.E.I.C., P.Eng., B. E. (Sask. 1960). Age 27, married. 3½ years experience in design and project engineering of municipal and highway projects in Western Canada. Desires challenging position with consultants, municipal corporation, industry or government. Location open. File No. 568-C.

CIVIL ENGINEER — A.M.E.I.C., B.Eng. McGill '61. 2 summers in heavy construction and housing; 2 years in railway bridges, maintenance and design. Desires position with either consultant or construction firm in field of construction management, in particular Critical Path Method scheduling. Location Montreal area. File No. 563-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. (Ont), B.Sc. C.E. Manitoba 1936. Some experience in mining and highways. 20 years Canadian Army Officer involving regimental and staff employment including technical staff, supervising production, design and development weapons. Employed past 5 years vice-president manufacturing firm. Considerable talent for management, organization and administration. Excellent physical condition. Desires management position with more scope. File No. 566-C.

CIVIL ENGINEER — M.E.I.C., P.Eng., McGill '56. Age 32, married, 1 child, completely bilingual. 4 years' structural steel design, 3 years as structural design engineer of plant engineering (reinforced concrete, specifications, steel, and supervisory experience). Desires position at management or associate level. Location, Montreal area. Available on short notice. Resume on request. File No. 557-C.

ENGINEER - ECONOMIST — M.E.I.C., M.A.S.C.E., (Civil), McGill '57. Diploma in Management and Business Administration. Experience in various phases of structural steel and concrete design and supervision of erection projects. Project managing, market research, planning and co-ordination, economic appraisals, management consulting, contract negotiation and policy recommendations. Seeks position where technical, managerial and administrative aspects are of an asset. File No. 6482-C.

GRADUATE, P.ENG., **M.E.I.C.** Age 41, with 12 years experience in engineering, sales, and management in structural steel fabrication. Client contact and contract negotiations a specialty. Desires position in management or sales. File No. 565-C.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., G. I. Mech. E., B.Eng. (McGill), Dip. Bus. Admin. (U.W.O.). 2 years plant engineering experience, 7 months construction experience in multi-million dollar expansion program. Bilingual. Seeks an interesting position in plant engineering, maintenance engineering or production. Location preferred Montreal, but if position is interesting enough, would consider elsewhere. File No. 267-M.

MECHANICAL ENGINEER — M.E.I.C., P.Eng. (Ont). Experience background mechanical and marine: installation, operation, maintenance, inspection, testing, administration. Interested in relocation British Columbia. File No. 567-M.

PROFESSIONAL ENGINEER — P.Eng. (Ont.) B.Eng. (Elect) N.S.T.C. 1959. Age 30. 4 years diversified experience in industrial and commercial design. Seeks responsible position in electrical engineering in design of power distribution, supervision, production in industry, or consulting field. Montreal area. File No. 522-E.

PROFESSIONAL ENGINEER — M.E.I.C., P.Eng. (Que.), McGill 1950 (Mechanical). Age 39. Experienced in the design and supervision of fabrication and testing of diversified medium and heavy machinery; some experience in administration. Seeks position with consulting engineer, manufacturing firm or public utility. File No. 569-M.

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CHEMICAL

RESEARCH AND DEVELOPMENT CHEMIST — required by large Textile Coating Company. Must be fully experienced in Vinyl Plastisol Compounding. Excellent starting salary, fringe benefits. Reply in detail to File No. 517-V.

SITUATIONS VACANT

CIVIL

CIVIL OR SANITARY ENGINEER — with not less than two years experience in design or construction relating to water supply and sewerage facilities, and with ability to speak fluent Spanish, required by consulting engineers with offices in downtown Toronto. This is a permanent position in which the applicant should be prepared to travel to South America as well as to work on projects in Canada. Depending on the applicant's experience his role may be that of a senior engineer varying to a position of a junior co-ordinating engineer. Reply in writing giving details of professional experience, education and salary expected. The inclusion of a recent photograph would be desirable. File No. 516-V.

SENIOR PUBLIC HEALTH ENGINEER — ($604-$734) for Sask. Dept. of Public Health. M.Sc. degree and considerable experience in municipal engineering; to evaluate waterworks and sewerage plans, advise on environmental sanitation, and to conduct stream pollution studies. If there are no fully qualified applicants consideration may be given to applicants with bachelor's degree and experience in municipal engineering for Public Health Engineer with a salary range of $516-$628. Applications and further information available at Public Service Commission, Legislative Bldg., Regina, Sask. Quote File No. 8555.—File No. 510-V.

GIFFELS & VALLET OF CANADA, LTD. Consulting Engineers, have immediate openings in Toronto for SENIOR CIVIL ENGINEERS with at least 5 years Canadian experience in design of roads, sewers, and water systems. JUNIOR CIVIL ENGINEERS with minimum of 2 years experience in design of roads, soil mechanics, foundations, construction. Apply in writing only, giving experience, age, references, qualifications, salary requirements and other pertinent information to: Giffels & Vallet of Canada, Ltd., 44 Eglinton Avenue West, Toronto 12, Ontario. File No. 513-V.

MECHANICAL

MECHANICAL ENGINEERING GRADUATE — Experienced man for maintenance and engineering department of a large manufacturing firm in East Toronto. Employee benefits include group insurance, medical, hospital and pension plan. Good opportunity for advancement. State full particulars regarding experience, personal data and salary acceptable to File No. 481-V.

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The continued expansion of our company, a leading manufacturer of microwave tubes, has resulted in the following openings:

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— Senior Engineer to develop or produce microwave tubes.
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Employee benefits include company paid surgical and hospital plan, profit sharing and stock purchase.

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Georgetown, Ontario.

GRADUATE ENGINEER

or equivalent required as area supervisor for the direction of instrumentation and combustion practices.

Experience in combustion and instrumentation is desirable, however considerable emphasis will be placed on administrative and leadership qualities.

Salary commensurate with qualifications and experience.

Apply in writing giving full particulars as to background, experience and approximate salary requirement to:

Mr. D. W. Murray,
Supervisor of Employment,
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MECHANICAL

MECHANICAL PROCESS ENGINEER P.Eng.) — Required by leading manufacturer of household appliances. Duties o include design establishment and control of process equipment. Preferred age 30-35. Applicants should send a detailed resume of education and experience to: C. L. Stephen, Vice President Engineering, Kelvinator of Canada Limited, P.O. Box 3180, London, Ontario. File No. 512-V.

MISCELLANEOUS

STRUCTURAL DESIGN ENGINEER — A large consulting engineering firm in Western Canada has an opening for a senior engineer with particular qualifications in Bridge design. This position can lead to branch management within the firm. Applicants should be eligible for registration in any province, and post-graduate training in structural engineering is desirable. Salary will be in keeping with qualifications and is likely to exceed earnings in comparable positions in industry or public service. Applicants should submit comprehensive resumes. File No. 518-V.

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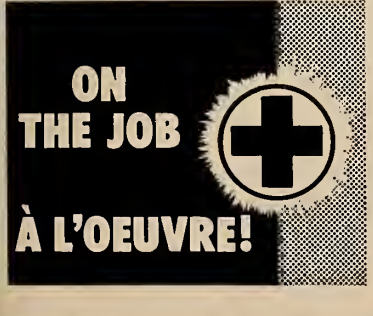

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Salary commensurate with qualifications.

Our present staff has been advised of this advertisement. Applications will be treated confidentially.

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DEADLINE — Please note that requests for insertions must be submitted in writing not later than the **12th of the preceding month.**
Cancellations: same as above.

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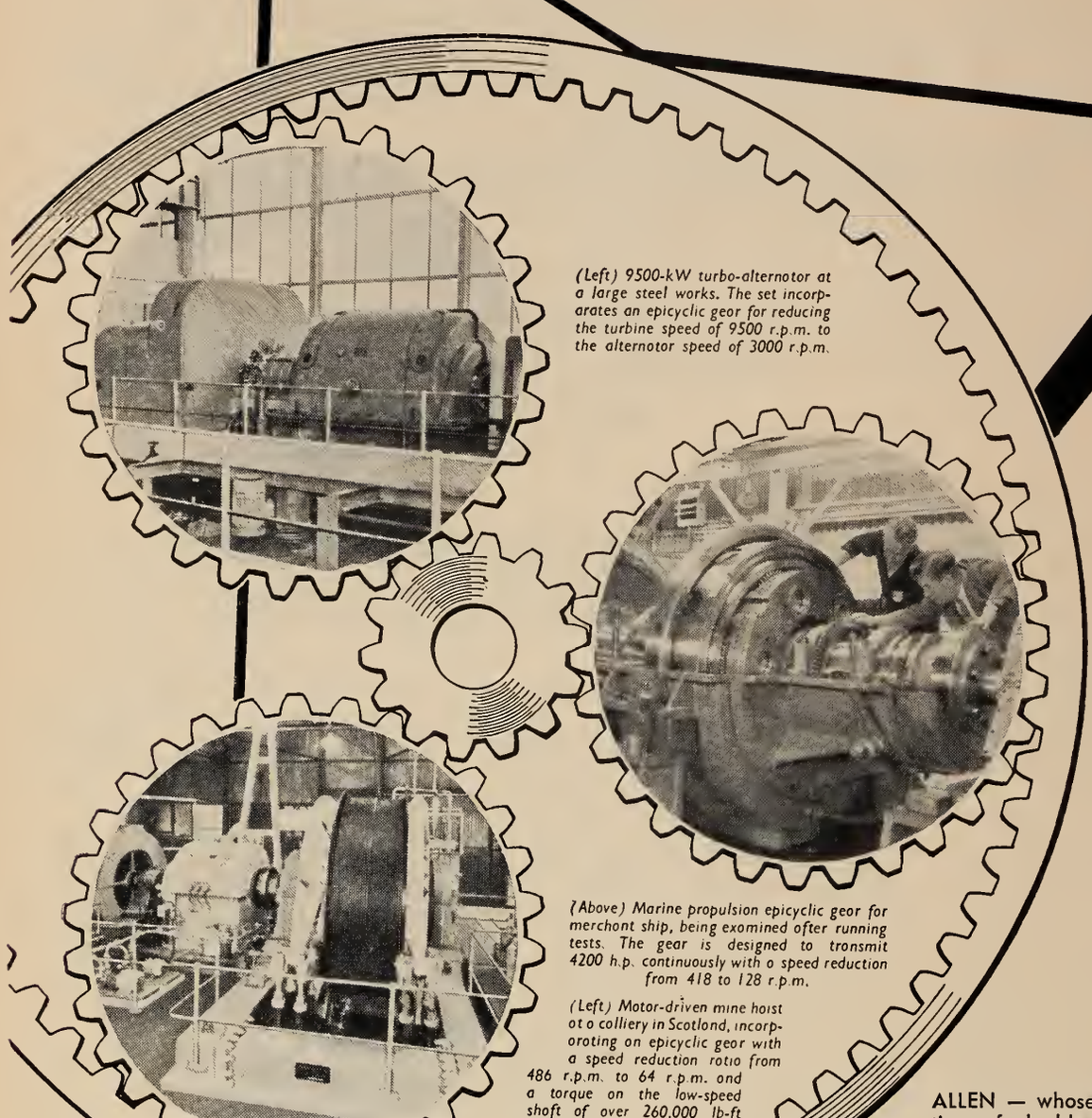
DATE IN CIRCULATION — 20th of month.

SITUATIONS WANTED — Accepted free of charge from Members of The Engineering Institute of Canada only.

Over 15 years' experience!



(Left) 9500-kW turbo-alternotor at a large steel works. The set incorporarates an epicyclic geor for reducing the turbine speed of 9500 r.p.m. to the alternotor speed of 3000 r.p.m.

(Above) Marine propulsion epicyclic geor for merchont ship, being exomined ofter running tests. The gear is designed to transmit 4200 h.p. continuously with o speed reduction from 418 to 128 r.p.m.

(Left) Motor-driven mine hoist ot o colliery in Scotlond, incorporoting on epicyclic geor with a speed reduction rotio from 486 r.p.m. to 64 r.p.m. ond a torque on the low-speed shoft of over 260,000 lb-ft (35,000 kg/m).

ALLEN — whose experience in the application of double-helical epicyclic gearing is unrivalled anywhere in the world — is the only British firm with more than 15 years' manufacturing experience and an aggregate of two million horsepower of gear units constructed for a wide variety of industrial and marine applications.

This type of gear offers the most compact speed-reducing or speed-increasing arrangement for all types of prime mover and/or driven machinery, transmitting powers up to 20,000 h.p. for any speed ratio.

Other advantages include: — reliability • high efficiency • quiet and smooth running long life • low weight • small size • co-axial arrangement.

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A DIVISION OF THE BLACK-CLAWSON COMPANY

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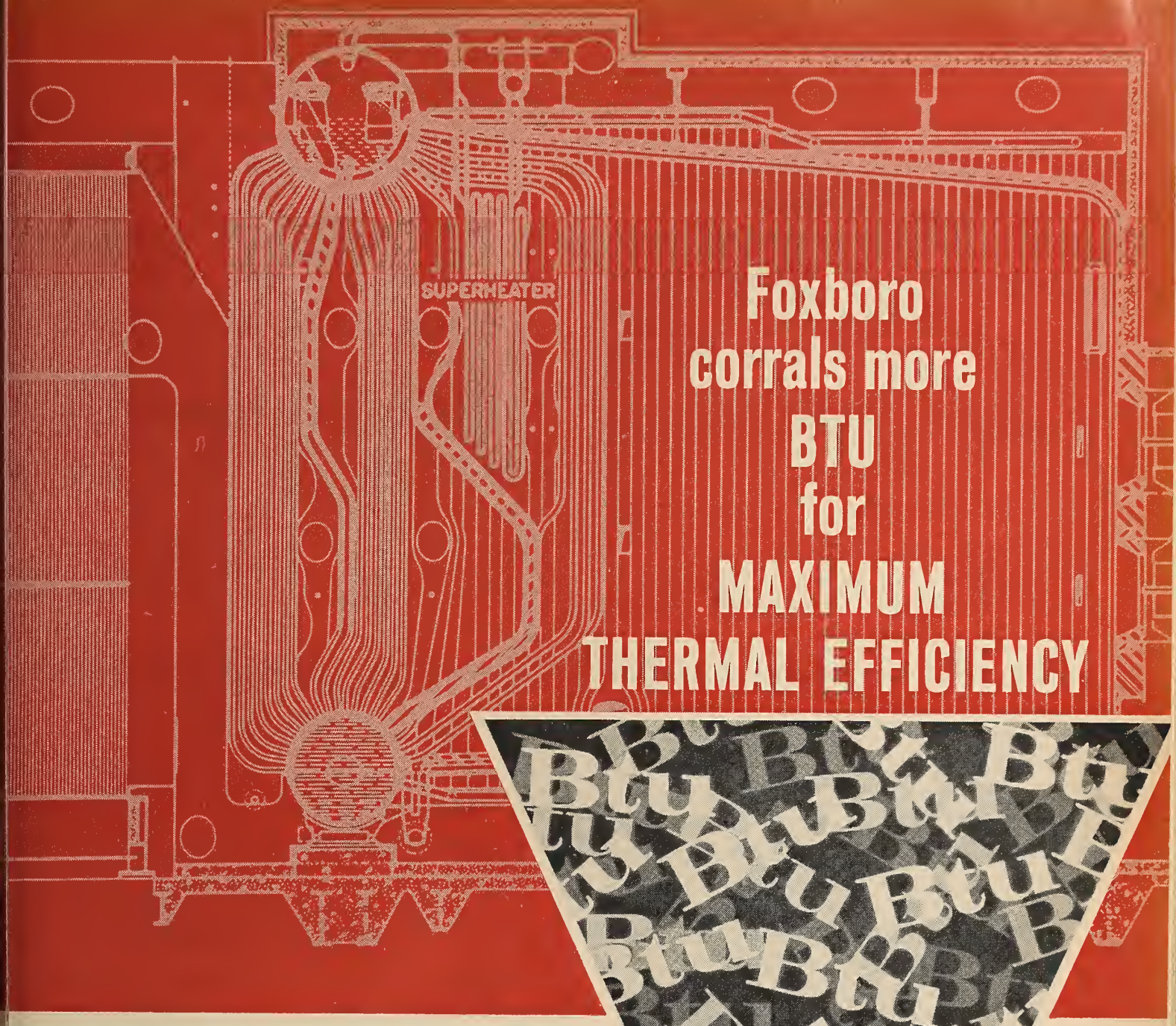

Foxboro corrals more BTU for MAXIMUM THERMAL EFFICIENCY

The Foxboro Company's capability for waste heat or power boiler control is clearly demonstrated by the installation shown below.

Here, the accuracy of Foxboro Electronic Consotrol* instruments assures maximum use of waste Btu by maintaining extremely close control over flue draft and other variables. Measurements are electrically transmitted over standard 2-wire leads, unaffected by dust or freezing weather conditions. The simple, maintenance-free Foxboro system controls all boilers from a single, central location.

Waste-heat, power, chemical recovery—whatever your boiler control problem—you can rely on Foxboro systems—engineered instrumentation to help you solve it better. For detailed information contact the Foxboro branch office nearest you. A Foxboro sales engineer will be happy to discuss your problem with you.
For Bulletin 21-10 ELECTRONIC CONSOTROL INSTRUMENTS, write:
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707 Dollard Avenue, LaSalle, Quebec.

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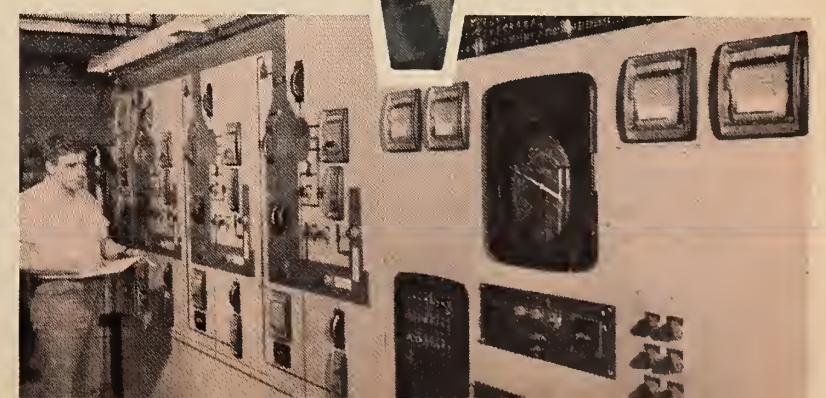

Operator checks readings on Foxboro Electronic Consotrol all-solid-state indicating recorders and controllers. System controls three open hearth waste heat boilers.

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iscussion

(Continued from page 58)

thin the operating rooms, where there no leakage from any roof drainage, ere is no exposure to the outside air, nperatures and humidities are kept at rly constant levels and the exposed tal in equipment and piping shows no n of rusting.

Actually, the first signs of distress were ted within the operating rooms when rtions of the gunite covering showed ruming" condition, evidently loose en tapped. The removal of some of se areas showed disintegrated wires d also a complete disintegration of minum connectors between the ends the wires. In addition, the vertical stressed wires which were of identical nufacture but were straight and not die-stressed showed no exterior or interior corrosion.

A complete discussion of my report on these tanks will be published in Volume 2 of the Proceedings of the Third International Prestressed Concrete Congress, Rome, June, 1962 in English. However, the discussion was translated into German by the editor of the Congress Discussions and printed in Beton-und-Stahlbeton, V. 57, November-December, 1962, pages 7-9 and Volume 58, January, 1963, pages 21-23.

It might also be pertinent to mention that wire of this general nature, used in two suspension bridges, Detroit-Windsor and Mt. Hope, about 1930, showed so many failures at the bend or change in direction at the saddles on top of the towers that both bridges required the complete removal of the cables, and in the case of the Mt. Hope Bridge, also the entire structural steel and even some concrete decking and replacement with a wire of different metallurgy.

The public announcement of wire difficulties in prestressed tanks is not common. There has been some information in a report given by Mr. M. Schupack in the Seattle meeting of the ACI in September, 1962 and a paper is being prepared by Professor I. Cornet for the coming western region meeting of the National Association of Corrosion Engineers. The writer realizes that there are thousands of prestressed concrete tanks in service which had not shown any signs of distress, but he also has record of at least 20 where the stress has caused either the abandonment or expensive correction. It seems that possibly a slight change in procedure may be sufficient to avoid these few but expensive incidents.

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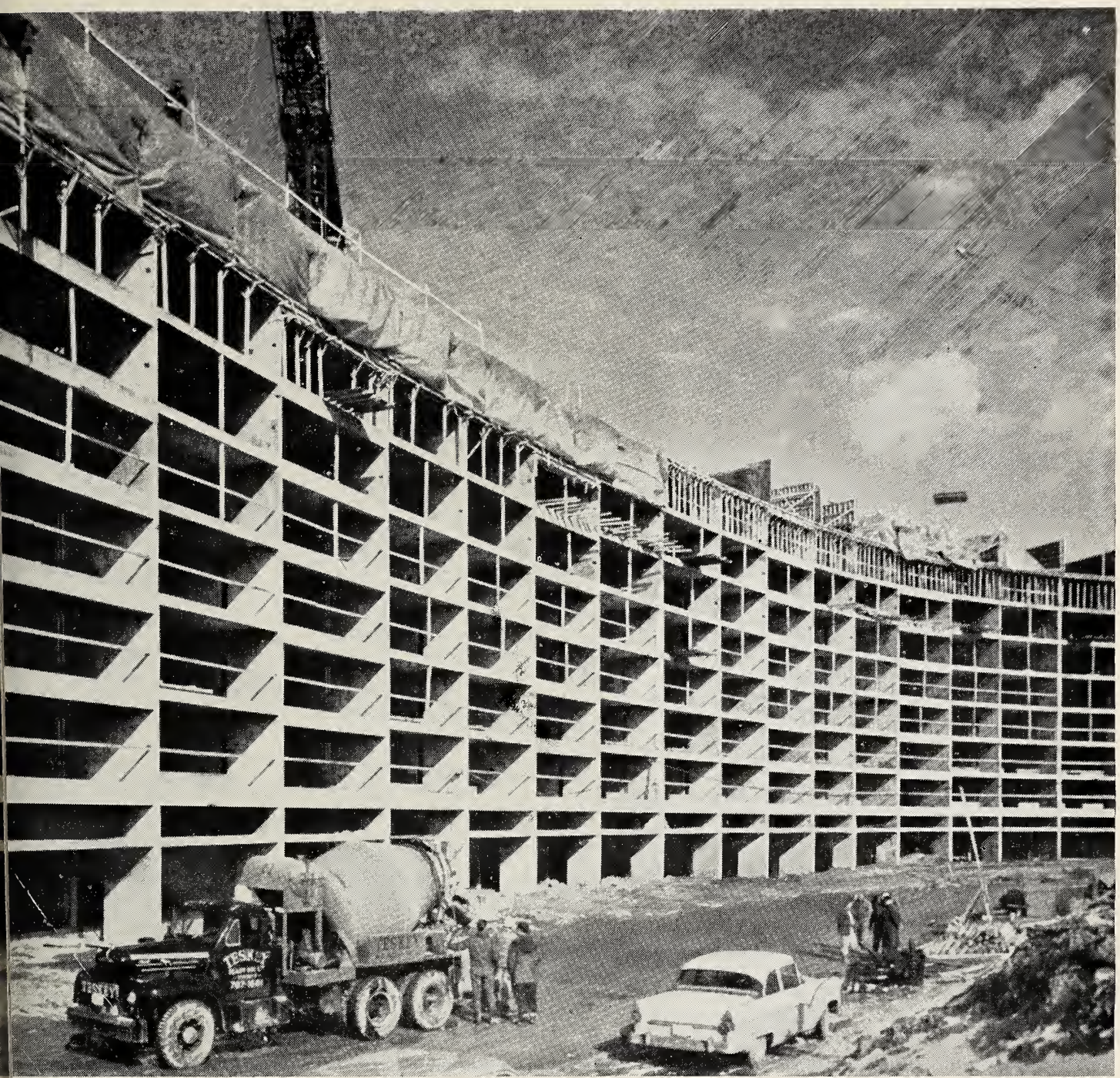

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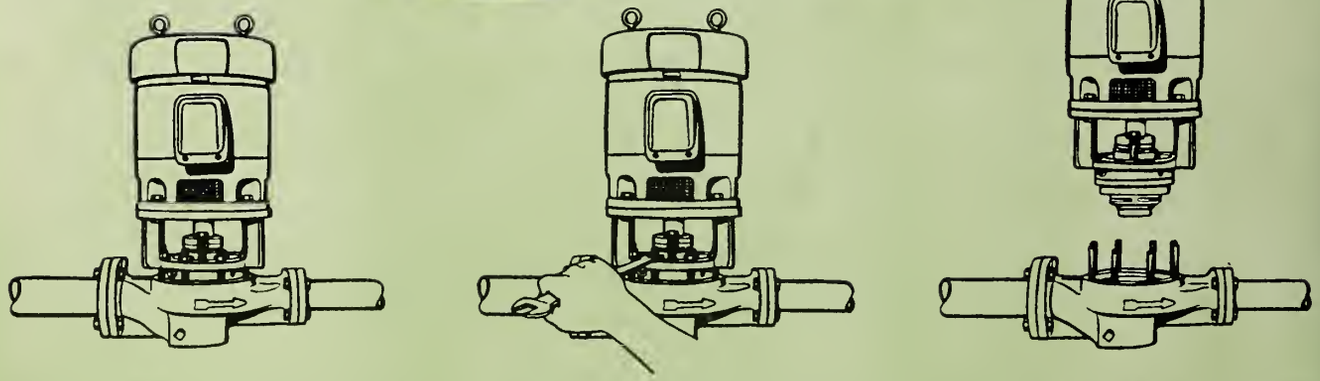

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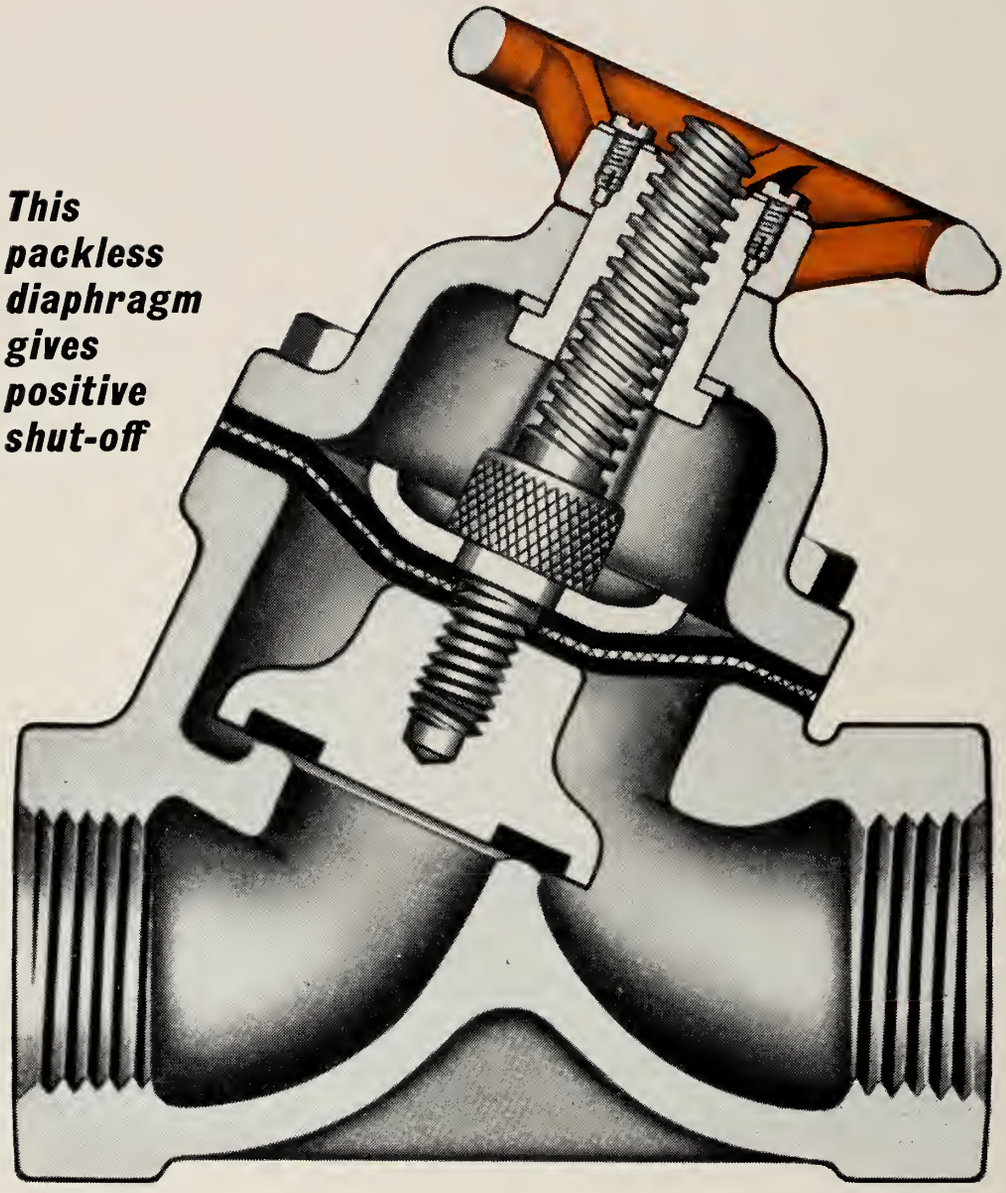

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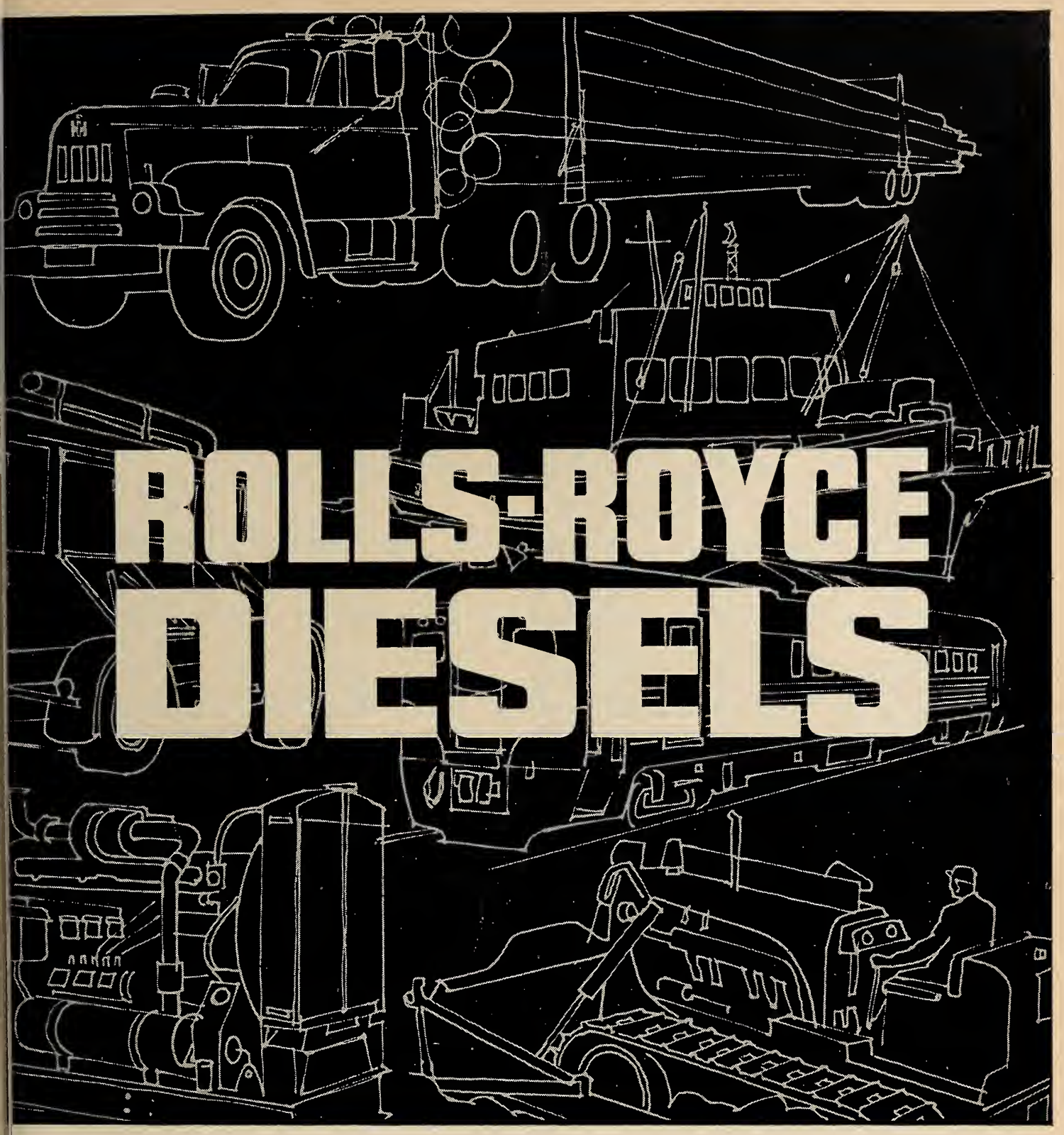

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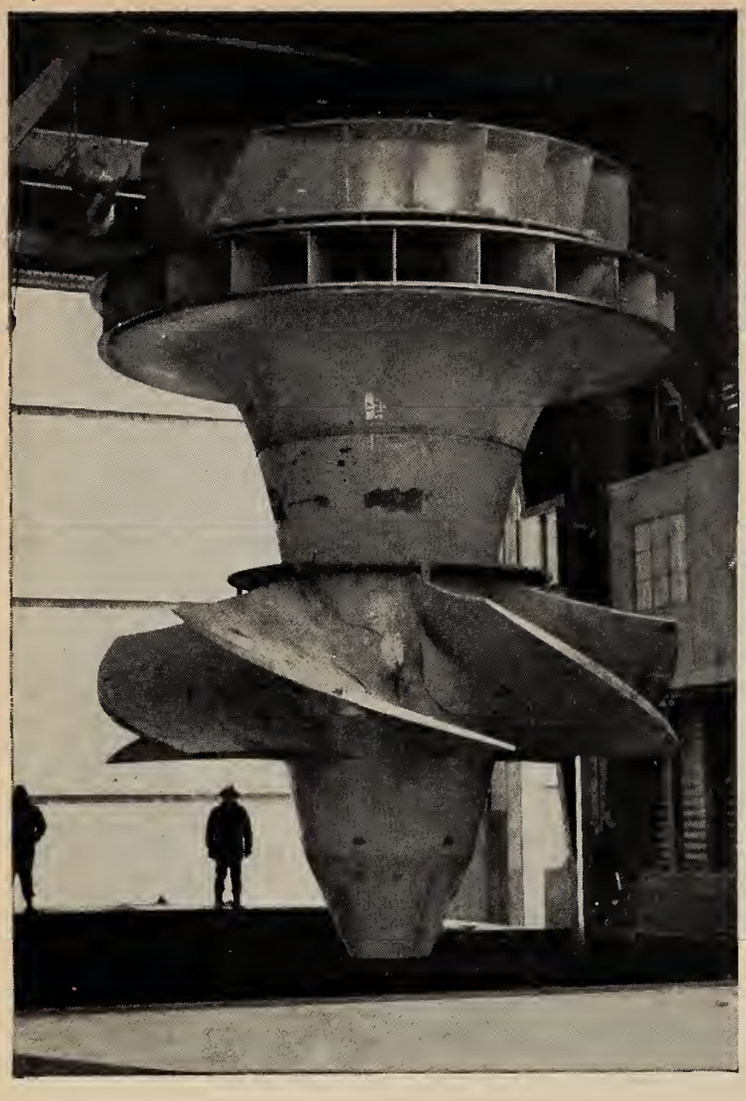

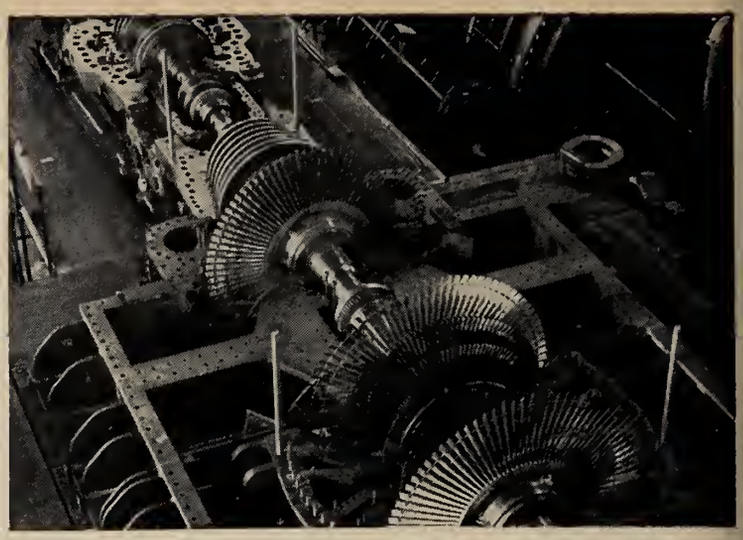

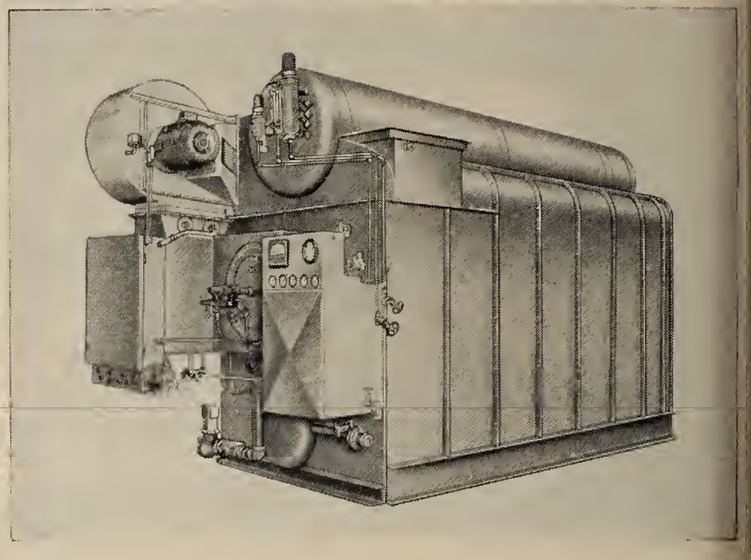

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COVER ILLUSTRATION

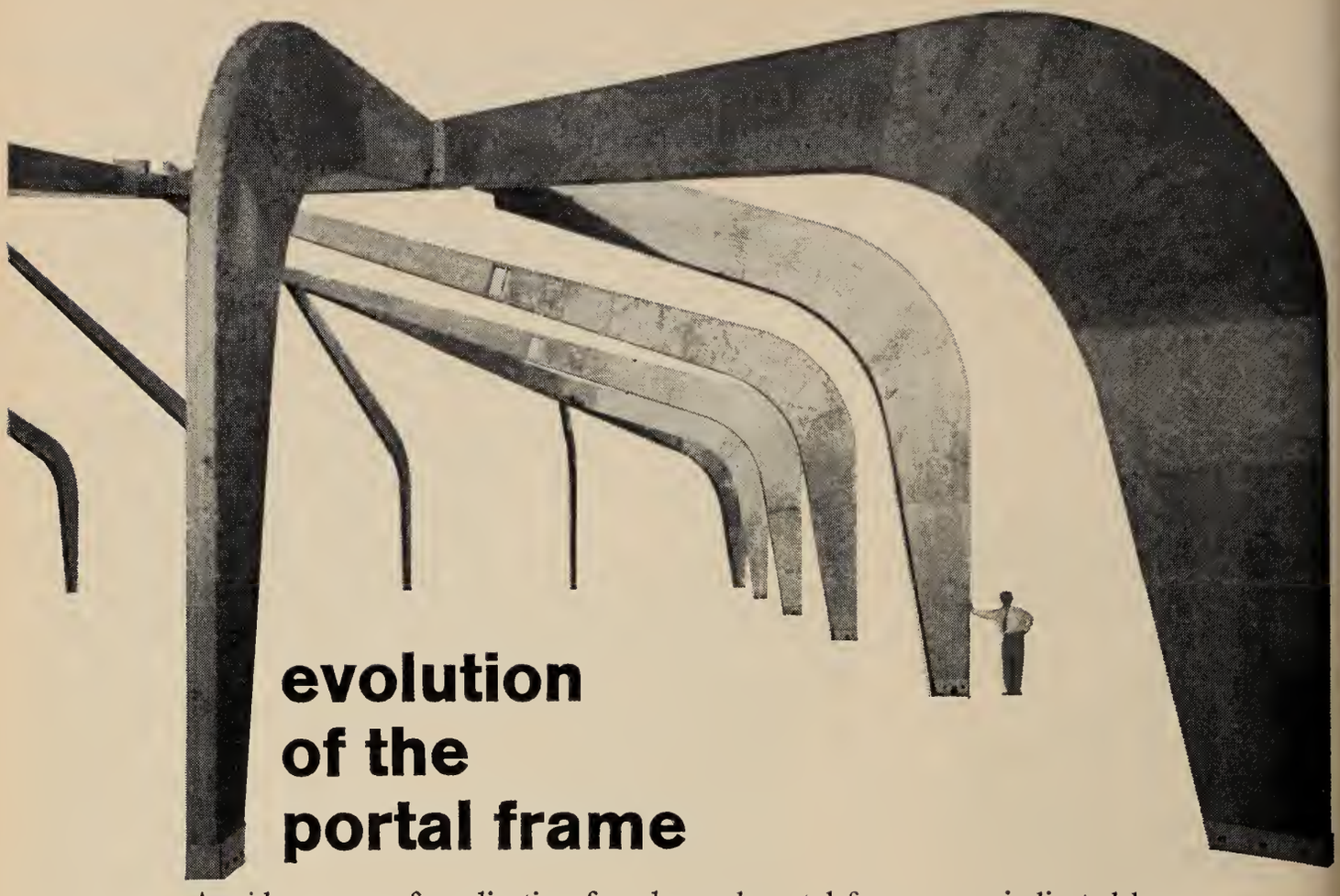
"Foundation Aspects of the Rainy Lake Causeway" is the paper illustrated on the cover of this month's Engineering Journal. Shown is work being done in preparation for lateral load testing of a pier. (Photo courtesy Per F. Andersen).

In their poper, **Foundation Aspects of the Rainy Lake Causeway, M. A. J. Matich,** M.E.I.C., Vice-President and Chief Engineer of Geocon Ltd.; **A. Rutka,** M.E.I.C., Materials and Research Engineer, Department of Highways, Ontorio; and **Per F. Anderson,** M.E.I.C., Project Engineer, Foundation of Canada Engineering Corp. Ltd., state that the Causeway consists of alternoting embankments and bridge structures. Significant physicol conditions at the site are woter depths up to 50 feet underlain by about the some thickness of soft to firm clay, and an onnuol ice cover three to four feet thick. To ochieve stable embankments the underlying clay was remoulded by dynamite blasting so that total displacement of the clay would occur during construction. Various tests ore described in some detoil.

Conductor icing is an appreciable hazard for the reliable operation of transmission lines, states **Dr. A. S. Timascheff,** M.E.I.C., in his paper, **Non-Icing Conductors.** De-icing of ice-covered conductors is olwoys difficult. One method is to melt the ice using lorgely increosed currents; it is not suitoble however for EHV lines; mechonical removol by insulated strips con be convenient in certoin cases, but not in locations with restricted occess, as in mountains or at river or lake crossings. In such cases, the prevention of ice formation becomes particularly important; any device increasing the chonces of ice prevention appears worth-while consideration. The greatest danger arises when an ombient temperature just below 0° C coincides with a low conductor current. A solution could be provided by o cable which produces a small but oppreciable temperoture rise at low currents, and a relatively limited one at high currents.

B. J. Bradstreet, Head, Welding Research Laborotory, John Inglis Co. Limited, Toronto, in his paper, **Methods to Establish Procedures for Welding Low Alloy Steels,** states thot the crock resistonce of arc welded low alloy steels can be determined experimentally using suitable weldability tests. One testing scheme, using the "CTS" test is outlined, and o new, alternotive form of the CTS test is described. Another method of determining weldability entails working out the "carbon equivalent" of o steel from its composition; this can be reloted to the weldability as meosured experimentally. Once the weldability of o steel has been established, it is shown how welding procedures can be worked out for any given joint geometry using simple tobles or graphs.

The recent construction of o perforated breakwater and the number of popers published on this occosion have aroused new interest in the possibility of realizing vertical types of breakwaters with low coefficients of reflection. In his paper, **Comments on Vertical Breakwaters with Low Coefficients of Reflection, Richard Boivin,** M.E.I.C., of LaSalle Hydraulic Laboratories Ltd., Montreal, states that most of these papers have emphasized the physical principles of the function of perforated breakwoters, but no data is available with reference to the optimum characteristics and efficiency of such breakwaters. Some papers have at mosr insisted on the importonce of selecting properly the diameter and length of the perforated holes in order to obtain on optimum attenuation effect. To determine the exact influence of the optimum characteristics of the holes and of the chamber width over the breakwoter effectiveness, o few tests were run. This study confirmed the advantages of perforated breokwaters, but showed thot the choracteristics of the perforations are less important than the total void rotio of the seaward face and the chamber width itself.



evolution of the portal frame

A wider range of application for plywood portal frames was indicated by the recent use of giant size frames in Sunderland, England. The huge plywood components served as supporting members in covering a 12,000 square foot playing field. The combination of plywood's light weight and structural strength proved an ideal solution to a load bearing restriction (imposed because of a feared subsidence cleavage at the site). In all, 20 portal frames were constructed. The largest, 62 feet in length, stretch from the 4 corners to a central 22 square foot area of plywood box beams. Of the others, placed around the perimeter, 8 are 44 feet long, the remainder 22 feet in length.

A new method of construction was employed in producing frames of this size, beginning with fabrication of a simple box core using 7″ x 2″ softwood members, with ⅜″ plywood both sides. Prelaminated chords were then glued to top and bottom of this core and, after planing, the entire structure was covered with a further skin of ⅜″ plywood. Finally, the portal frames were finished with polyurethane varnish.

The use of large plywood portal frames enabled construction of a covering area of the required size, within the limitations imposed and at a low cost. As a further step in development of this form, it indicates the increasing value of the portal frame as a structural and design element. Information about structural uses of fir plywood is available from the Association field offices.

Covering structure for the Sunderland playing field is the work of H.C. Bishop, A.R.I.B.A., and A. R. F. McGahan, A.M.I.C.E., A.R.I.B.A., A.I.W.S.C.

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Davie is building, transporting and erecting the penstocks for Calgary Power Limited's Big Bend Power Development Project on the Brazeau River. Industries served by BIG DAVIE include those associated with Hydro-Electric and Irrigation Developments; Petro-Chemical Processing; Mining; Defence Research and Development; Bulk Storage, etc.

wn above are sections of steel penstocks up to 1¼" in thickness and 19'6" in diameter. Each completed penstock will measure 1,750' in length. (Consultants: Montreal Engineering Co. Ltd.)

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Late Engineering News

New Zealand Doubles Canadian Diesel Order

New Zealand has ordered 10 more diesel-electric locomotives from General Motors Diesel Limited, London, Ont. This doubles the original order from New Zealand Government Railways, and increases the sales value of the order to $4 million from about $2 million.

John McAlpine, New Zealand Railways Minister, said the order was increased to meet an urgent need for more mainline motive power. The first 10 units, ordered last March, have been delivered. Delivery of the other 10 is expected next summer.

A total of 37 locomotives built in London are already in service in New Zealand, and completion of the current order will give the country 57 built-in-Canada Model G-12 units, each rated at 1310 horsepower.

Calgary Firm Awarded Gas Scrubber Contract

The Ralph M. Parsons Company of Canada, Limited (Calgary) has been awarded the major construction contract for British American Oil Company's new fuel gas scrubbing plant at the Clarkson, Ont. refinery. Engineering and purchasing for the plant has begun.

Off-site manufacture of equipment has already started, and foundation excavations are scheduled for December. When the plant is completed early in May, 1964, Clarkson will have one of the most modern refinery pollution control systems in Canada.

The new plant will eliminate 80 per cent of sulphur dioxide impurities in the stack gases by removing hydrogen sulphide from refinery fuel gases. The hydrogen sulphide then is converted to elemental sulphur, and the fuel gases are consumed to provide heat for refinery purposes.

The new unit is the latest item in a continuous anti-pollution program at the Clarkson refinery which already has cost an average of $250,000 a year for the past four years.

Port Mann Bridge Steel Completed

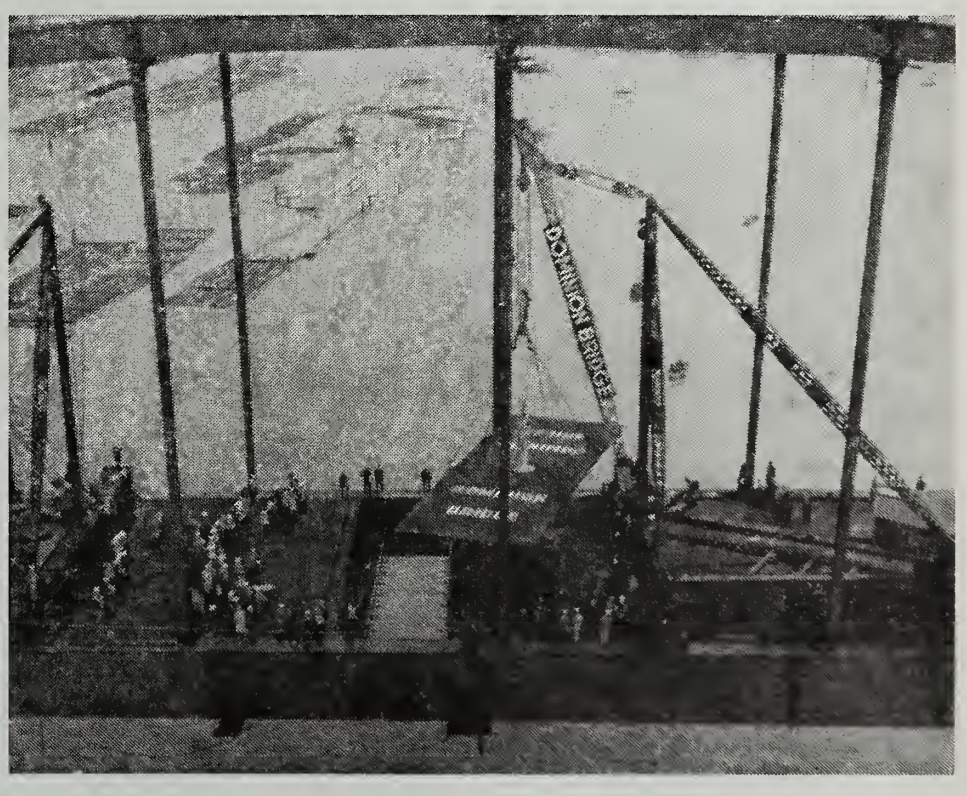
Steelwork for the $25 million Port Mann Bridge has been completed. The bridge is unique in North America and the longest of its type in the world. The gap-closing ceremony was presided over by British Columbia's Highways Minister Gaglardi who "talked" the deck piece into position using a field telephone.

The structure is the world's longest high-level, stiffened tied-arch bridge; the longest in the world with an orthotropic steel plate deck; and the first in North America to use this type of deck system.

The bridge spans the Fraser River 15 miles east of Vancouver and four miles upstream from New Westminster, and is the last major river crossing on the Trans Canada Highway system in British Columbia. When opened for traffic next year it will hook up with the new Burnaby Freeway leading to and across the second Narrows bridge over Burrard Inlet to the upper level highway passing through West Vancouver.

The 1200-foot main span and the 360-foot side spans of the four-lane highway crossing were erected in 15 months. The main superstructure contains 9500 tons of steel, 60 per cent of which is of special, high strength. There is 146 feet of vertical clearance under the main span above high water.

The last 30-ton deck panel is being worked into place on the Port Mann Bridge, 15 miles east of Vancouver. Helping to "talk" the steel work into place by a field telephone was Hon. P. A. Gaglardi, British Columbia's Minister of Highways, assisted by MacKenzie Murray, President of the Dominion Bridge Company.



Ontario Hydro linemen are shown making the final connection on the initial stage of Ontario's first Extra High Voltage line near Sudbury. Operated initially at 230,000 volts, this super-highway of power will be stepped up to 500,000 volts by 1965.

Ontario's Extra High Voltage Transmission Line In Service

The first link in the EHV transmission line of the Hydro-Electric Power Commission of Ontario went into service last month when electricity from new hydro-electric plants on the James Bay watershed was transmitted 230 miles to the Sudbury area.

The line will operate initially at 230,000 volts. When additional hydro-electric developments now underway are completed in 1965, the operating voltage will be increased to 500,000 volts, providing more than four times the carrying capacity of conventional 230,000-volt transmission lines now used in Ontario.

Designed to carry electric power farther and in greater quantity than any other transmission circuit in Ontario, the EHV line extends from a collector point near Fraserdale, 60 miles north of Cochrane, to Hanmer, outside Sudbury. By 1966, the EHV line will extend 450 miles south to the Toronto area.

Sinking Of 4,050-Foot Mine Shaft Commences

The sinking of the 4,050-foot No. 4 shaft at Geco Mines Limited at Manitouwadge, Ontario began this month. When completed, the new opening will be one of the deepest single-stage shafts in North America, and one of the most modern mining facilities in the world.

The Geco Mine produces concentrates containing minerals of copper, zinc and silver at a treatment rate of 3,500 tons per day. The new No. 4 shaft, located 3,700 feet south and east of the main plant, is designed to mine the orebody at depth.

Manitouwadge is about 40 miles from Lake Superior, and 150 miles northeast of Fort William.

Canadian Trade Mission Returns From Caribbean

A 16-man Canadian trade mission has just returned from the Caribbean and a three-week campaign to increase trade between Canada and the West Indies.

Canada and the West Indies have been trading partners for more than two centuries. The principal Canadian exports to the Caribbean now include wheat flour, fish, newsprint, tobacco, automobiles and a wide variety of consumer goods. The West Indies' main exports to this country are bauxite and alumina, raw sugar, molasses, crude petroleum and a large selection of foodstuffs. In 1962, Canadian imports from the West Indies and British Guiana totalled some $83 million while exporting approximately $62 to the area.

Recent economic developments in the Caribbean are raising the area's import capacity, and indications point to a continuing rapid rise in commodity consumption. The mission included top executives of some of Canada's largest domestic appliance and houseware manufacturing firms, and a commodity officer of the Department of Trade and Commerce. Products manufactured by the firms represented on the mission range from every type of electrical and gas home and commercial appliance, through all kinds of commercial and home kitchenware, to textbooks and a wide selection of stationery and hardware items.

The Canadian Geotechnical Journal Begins Publication

Vol. 1, Number 1, of the Canadian Geotechnical Journal was published in September. The handsome publication, printed by University of Toronto Press, contained an introductory broadsheet which stated that it ". . . is intended to provide a publication medium for papers in the applied geotechnical field.

"It is anticipated that most of the papers it presents will deal with soil mechanics. In keeping, however, with the liaison with allied fields that has always characterized Canadian soil mechanics work, papers dealing with associated subjects such as engineering geology, pedology, muskeg, hydrology, and the mechanics of snow and ice will always be welcomed by the Editorial Board."

Papers will be published in English or French.

The Journal will be published quarterly under the sponsorship of the Associate Committee on Soil and Snow Mechanics of the National Research Council, and the Geotechnical Engineering Division of the Engineering Institute of Canada.

The yearly subscription price is $5. Correspondence should be sent to The Editor, Canadian Geotechnical Journal, c/o Civil Engineering Department, University of Toronto, Toronto 5, Ont.

Toronto Consultants Survey 624 Yukon Iron Ore Claims

A Toronto firm of consulting engineers, Marshall Macklin Monaghan Limited, has been engaged to survey 624 iron ore claims in Canada's Northwest. The claims cover about 110 square miles along the Snake River at the headwaters of the Arctic Red River straddling the Yukon-North West Territories boundary. Being completed for Crest Exploration Limited (parent company — Standard Oil of California) which made the discovery last year, the job provides a fascinating challenge to engineering and surveying ingenuity.

The remote location of the claims, some 300 miles north of Whitehorse in the Backbone Mountain Ranges, is not unusual for a survey company specializing in this type of work. However, the extreme slopes and rugged terrain, coupled with elevation differentials across the work area of some 4,000 feet, dictated the use of electronic distance measuring equipment and helicopter support and transportation from a centrally located base camp.

This mid-summer photograph suggests some of the difficulties which can be encountered in an Arctic surveying job being undertaken by Marshall Macklin Monaghan Limited, consulting engineers of Toronto. To be surveyed are 624 iron ore claims along the Snake River at the headwaters of the Arctic Red River.

Taum Sauk pumped storage power project has first USS "T-1" Steel penstock in United States

cated section of USS "T-1" Steel penstock for the Taum Sauk project of Union Electric Company, uis. Capacity: 350,000 KW.
ulting Engineers: Sverdrup & Parcel and Associates, Inc. Fabrication and installation by Nooter . General Contractor: Fruin-Colnon Const. Co. & Utah Const. & Mining Co. Total USS "T-1" Steels approximately 2300 tons.

Engineers blasted off the top of 1500-foot-high Profitt Mountain in the Missouri Ozarks and dug a tunnel-penstock 7,179 feet long through solid granite to build this unique power project. Where pressures were highest, in the lower sections of the penstock, they lined the tunnel with two extra-strong steels, USS "T-1" and "T-1" type A brands.

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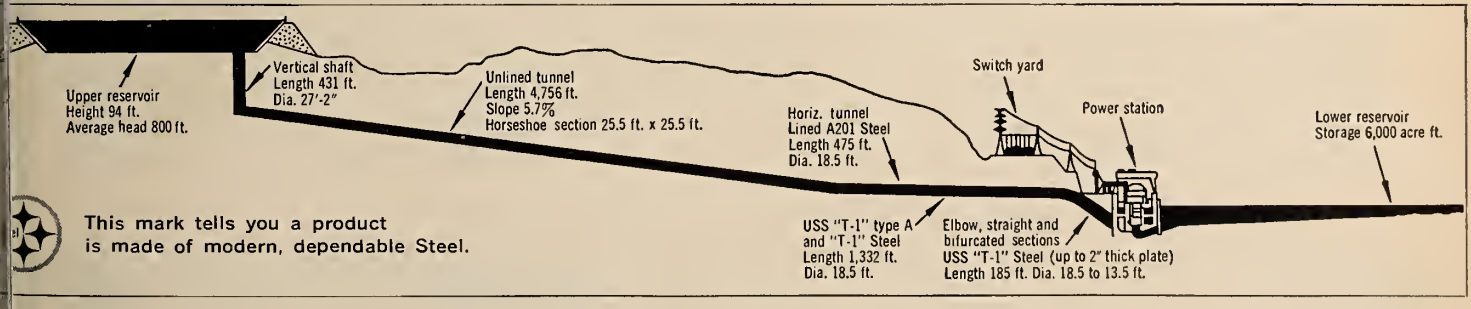
In the middle section of this penstock, with ample rock cover, USS "T-1" type A Steel was used at a working stress of 50,000 psi compared to 24,000 psi for ASTM A201 carbon steel. In the lower section, with little or no rock cover, working stresses of USS "T-1" Steel were reduced to 28,750 psi, which meets the ASME Code Case 1204-10. Spaces between steel lining and rock tunnel were filled with concrete and pressure-grouted to eliminate voids and aid further in resisting high pressures.

Where the penstock connects to the two turbines, operating pressures are highest with a maximum head of 863 feet. Here, an elbow, a straight section and a bifurcated section were built with USS "T-1" Steel using the allowable working stress of 28,750 psi.

Other penstocks and scroll cases built of USS "T-1" Steel have been installed in Canada, Switzerland, and India where weight savings of 40 to 50% have been realized. Savings in freight and welding costs were also substantial.

Write for our booklet on the use of USS "T-1" Steels in penstocks and spiral cases. United States Steel Export Company, 7 King Street, E, Toronto, Ontario. USS and "T-1" are registered trademarks.



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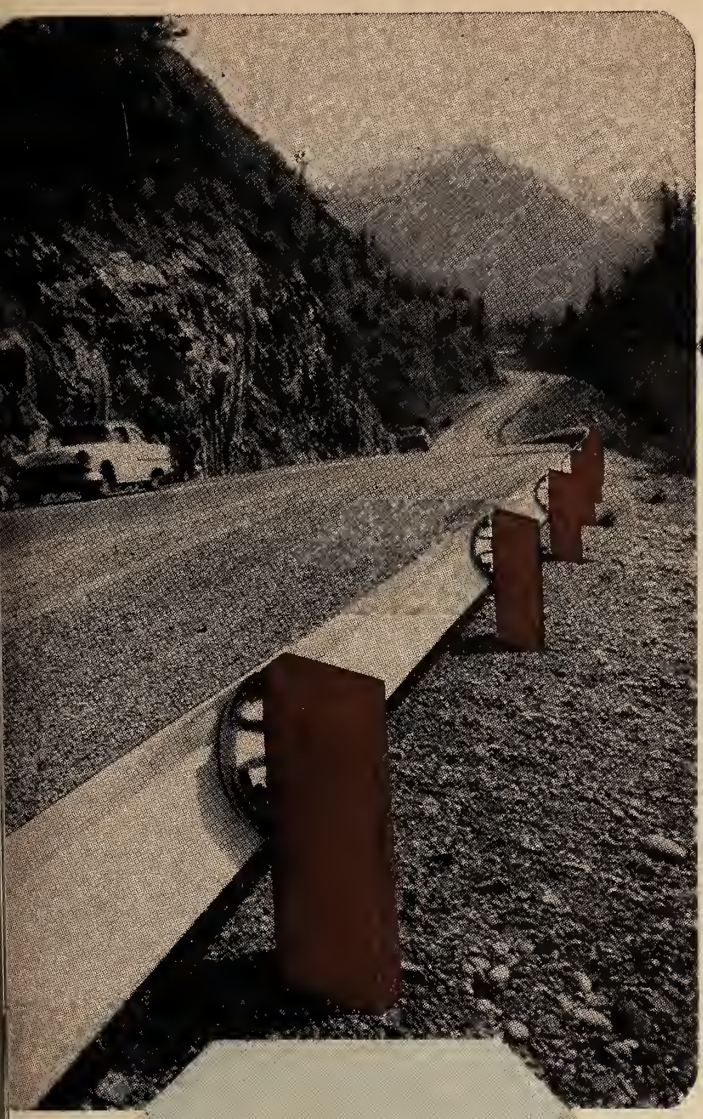

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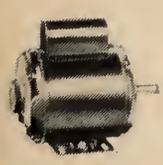

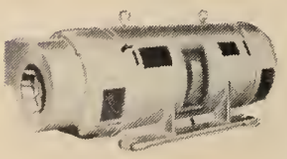

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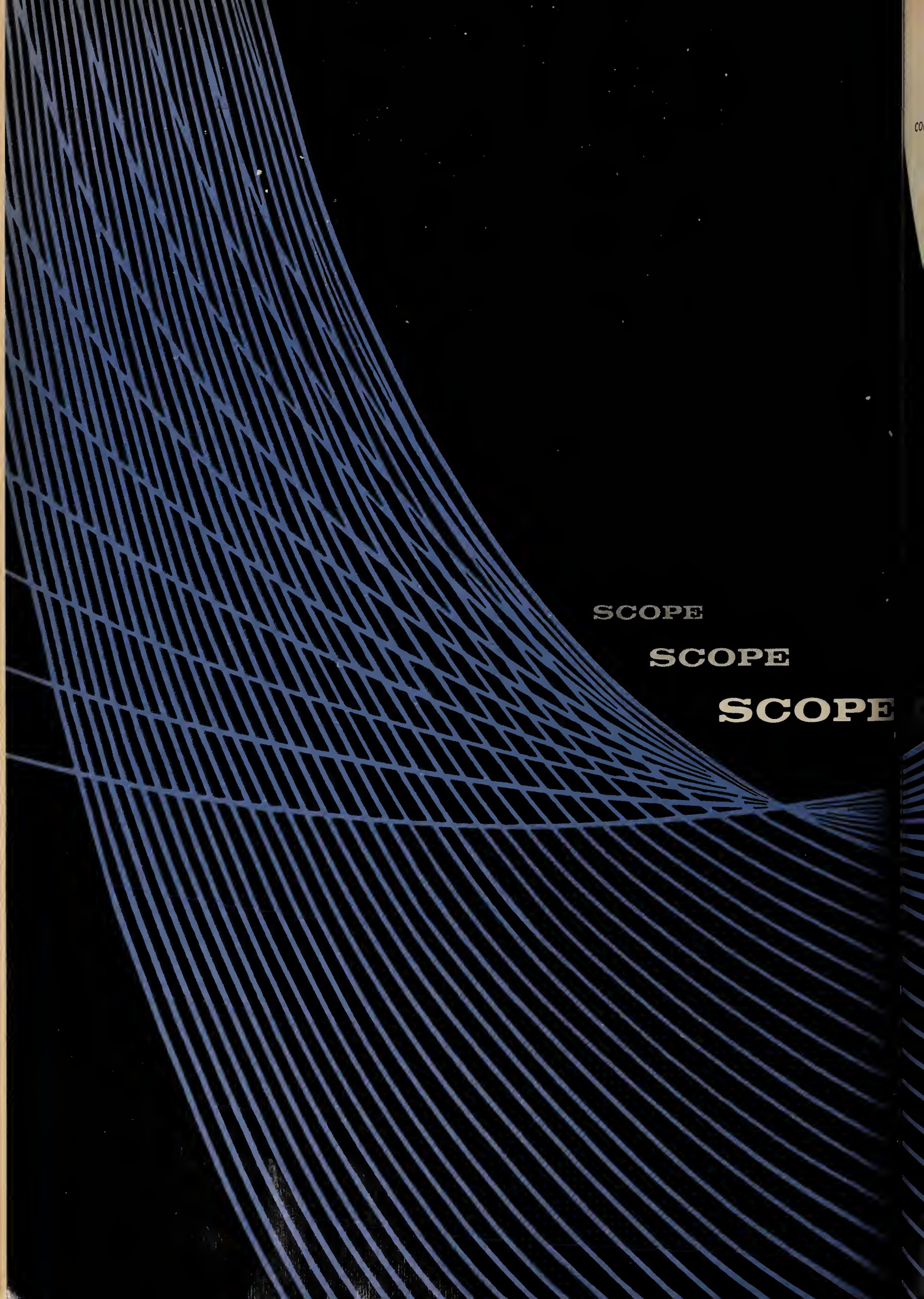
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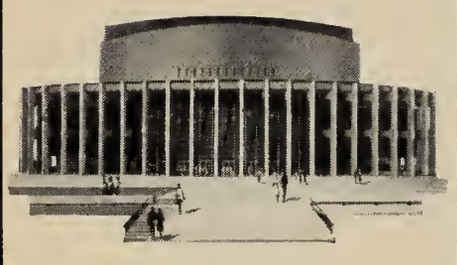
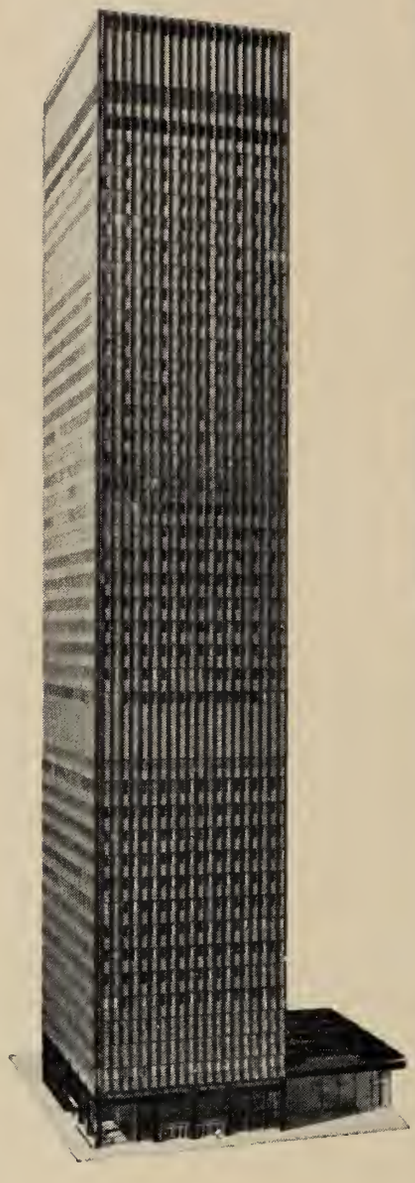


La Grande Salle de La Place des Arts. Installation: 3 DK10-10 35,000 PPH Steam Boilers. Consulting Engineers — Mech: and Elec: McDougall & Friedman, Montreal.



Canadian Imperial Bank of Commerce Building. Installation: 3 DK10-7 29,000 PPH Steam Boilers. Consulting Engineers — Mech: G. Granek & Associates, Toronto.

Standard Life Assurance Company Building. Installation: 2 TJW, 10 x 10^6 BTU/HR High Temperature Water Generators. Consulting Engineers — Mech: Wiggs, Walford, Frost and Lindsay, Montreal.

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Begg & Daigle Ltd., Rexdale, Ont.
Foundation Co. of Canada Ltd.
SOILS CONSULTANTS:
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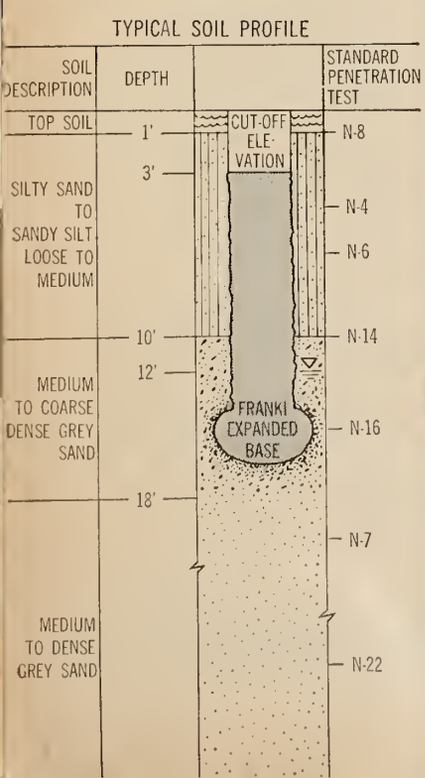
1008 Pressure Injected Footings
DESIGN LOADS:
70 to 90 tons
AVERAGE DRIVEN LENGTH:
16'
AVERAGE CONCRETED LENGTH:
13'

TYPICAL SOIL PROFILE



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Problem

Tests were made an the site chasen for the canstruction af this impartant shapping centre, and the sail was faund ta cantain loase silty sand ta sandy silt, ta a depth of 10 feet, averlying fine to caarse sand far at least 50 feet below the surface.

Because af the uncertainty af the bearing af the upper stratum, the ariginal intention af installing spread faatings, 5 feet belaw surface, was abandoned.

The problem, therefare, was to decide upon the best and mast reliable type of pile foundation which wauld pravide unifarm bearing aver the vast area.

Canventianal end-bearing or frictian piles wauld have had ta be abaut 50 feet lang and would have made the cast af such a faundatian inardinately high.

Solution

Shart Franki Displacement Caissans (alsa called Pressure Injected Faotings), which cauld be forged in the sand at an average depth af abaut 16 feet, were recammended by aur Engineers and accepted, because they cauld be guaranteed to safely suppart design laads af 70 tans. A load test af 140 tans was made and showed a gross settlement of 0.346" and, after remaval of the laad, 0.185", thus substantiating the Franki theory that Franki units can replace any ather type af pile whenever a suitable stratum af cahesionless sail is available.

Enlarged Franki cancrete bases were farmed 16 feet belaw the surface by campacting zera slump cancrete and the surraunding soil with blaws af 100,000 ft-lbs af energy. This cantralled Franki installatian pracedure pravides unifarm bearing capacity despite variatians in sail density.

The first faundatians were far a large Simpsons-Sears stare, and 344 Franki Pressure Injected Faotings were installed. Architects and Engineers satisfied with the efficient handling of this cantract alsa selected Franki ta carry aut the faundations far the twa ather phases af the vast praject.

Franki is praud af its association with this fine develapment and gratified ta have provided impartant savings in the averall cast af the faundatians.

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EIC-63-GEOTECH 10

FOUNDATION ASPECTS OF THE RAINY LAKE CAUSEWAY

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RAINY LAKE CAUSEWAY consists of alternating embankments and bridge structures. Significant physical conditions at the site are water depths up to 50 ft. underlain by about the same thickness of soft to firm clay, and an annual ice cover to 4 ft. thick.

To achieve stable embankments the underlying clay was remoulded by dynamite blasting so that total displacement of the clay would occur during construction. Tests to determine the amount of dynamite required to effect sufficient reduction in the shear strength of the clay are described, and a method of rapid loading of dynamite is given.

To cope with ice pressure the bridge structures are designed to flex and adopt total ice movements. Tests to determine maximum annual ice movements are discussed.

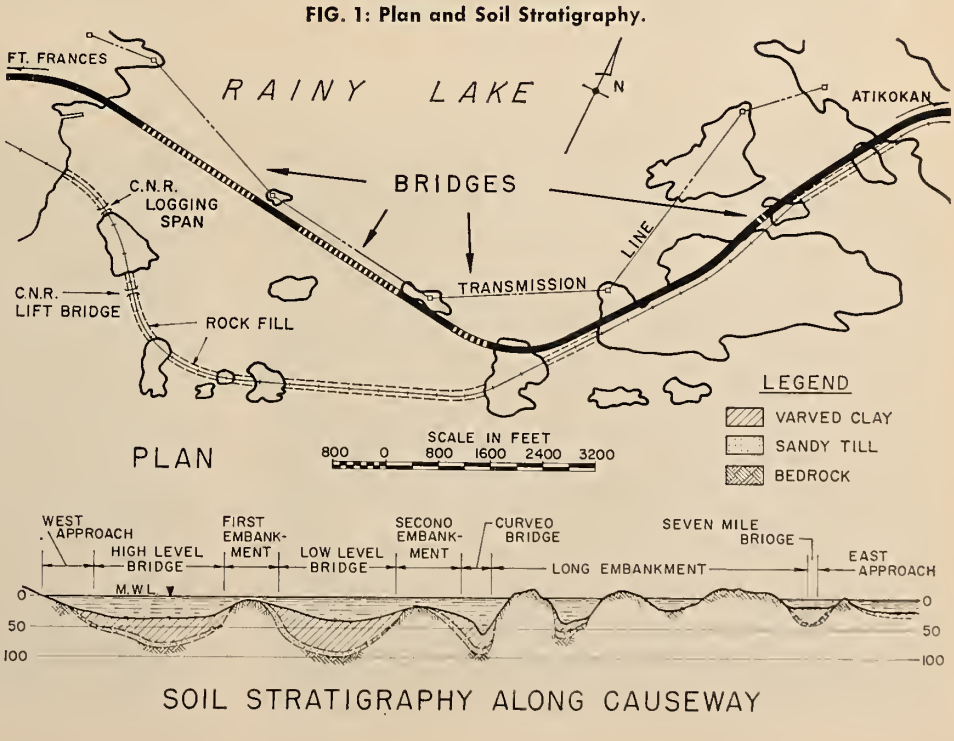
Introduction

The Rainy Lake Causeway is a major link in Highway No. 11 between Atikokan and Fort Frances, Ont. This highway is currently under construction and the causeway is due to be opened shortly. The Highway 11 program has been undertaken by the Ontario Government to provide an alternative route between the Canadian Lakehead and Winnipeg. It will also open up the Rainy River district for tourists at a favorable time when the Mississippi Parkway will be extended into Minnesota, and the traffic over the Lake Superior North Highway can be expected to gather momentum. Rainy Lake extends south into Minnesota and the causeway results in a saving of 40 miles which would otherwise be involved if the new highway were carried around the north end of the lake.

For many years Rainy Lake has been used as a transportation route for timber and pulp logs destined to sawmills and paper producing plants located in Fort Frances and International Falls, Minn. In 1900, the Canadian National Railways completed the rail link between Port Arthur, Ont., and Winnipeg. The line was carried across Rainy Lake at Rocky Inlet on a temporary timber trestle. In 1912, the C.N.R. completed a rock fill causeway which incorporates a bascule type lift bridge for navigation purposes, and a fixed bridge span for logging operations. This causeway is reported to have cost $2 million. A transmission line crosses the Lake to the north of the railway embankments. It is suspended between towers located on islands in the Lake, and clears the water by about 50 ft. The railway and transmission line crossings are shown in plan on Fig. 1.

The new causeway is 2.8 miles long and will cost about $4.5 million. It is located between the existing railway embankment and the transmission line, and incorporates an elevated bridge over the navigation and logging channels. It consists of alternating fill embankments and bridge structures named as below, from west to east.

FIG. 1: Plan and Soil Stratigraphy.



West approach embankment	740 ft.
High level bridge	2014 ft.
First embankment	808 ft.
Straight low level bridge	1811 ft.
Second embankment	1002 ft.
Curved low level bridge	453 ft.
Long embankment	4892 ft.
"Seven Mile" bridge low level	138 ft
East approach embankment	3042 ft.

The actual alignment of the causeway and the locations of the various structures are shown on Fig. 1. The main navigation span and a span for logging operations are located near the middle of the highway level stretch. Figures 2 and 3 show the full length of the causeway.

The causeway provides for 60 m.p.h. two lane traffic and H20-S16 loading. The high level portion gives a clearance of 36 ft. above high water level for shipping purposes.

Site and Geology

Site studies were started in 1957 and, at an early stage, a first order triangulation and a co-ordinate system was established for the soil exploration and the general survey. Bench marks referenced to geodetic survey were also erected on shores and on islands in the lake.

The site investigation included: a comprehensive soil exploration; drilling through the existing embankment; a study of gravel deposits in the area; a general topographical survey, soundings; and an investigation of ice conditions and lake currents.

The geology of the site is typical of the Canadian Precambrian Shield. A high degree of glaciation is in evidence. Sound acidic igneous bedrock, metamorphosed in places, persists throughout. Rock outcrops, practically void of drift, occur frequently and usually have smooth rounded profiles and show evidence of striation. Along the causeway alignment the water is 30 to 50 ft. deep. Immediately below lake bottom there is a stratum of varved clay, which is believed to have been deposited during the last glaciation. In places, a layer of compact glacial till occurs between the clay stratum and the bedrock.

Rainy Lake is the beginning of a long waterway extending through Lake of the Woods, Lake Winnipeg and the Nelson River to Hudson Bay. Its level is high at 1107 ft. above sea level. The level of the lake is controlled at the Fort Frances power dam by The International Rainy Lake Control Board.

Soil Conditions

Along the causeway alignment, lake bottom is generally underlain directly by a stratum of soft to firm varved clay which varies in thickness from a few feet in shallow areas, to 30 to 50 ft. under the deeper parts of the lake. The maximum clay thickness recorded elsewhere was 85 ft. A generalized stratigraphic profile along the causeway is given on Fig. 1.

The clay has a pronounced varved structure. Laminae are generally horizontal and are alternately grey and light grey; occasionally they are grey and reddish brown. Their thickness varies from 1/32 in. to 1 in. with an average of about 1/4 in. A photograph of a sample of the grey clay showing the varving is given on Fig. 4. The same figure shows the chunky structures of individual clay lamina in the reddish brown clay, and the inclination of some of the varves to the horizontal. The chunky structure is where the stratum is reddish brown in colour.

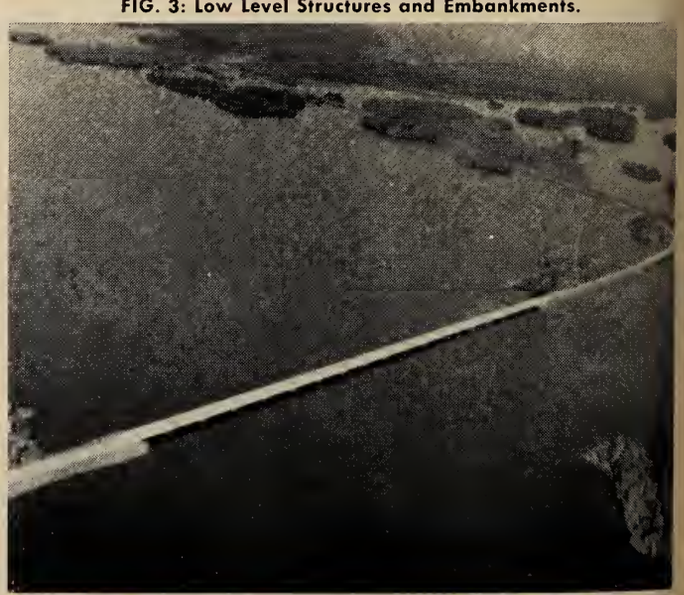
The clay generally has a high plasticity. Liquid limits of 50 to 96 were obtained for the grey clay, with corresponding Plastic Limits of 15 to 31. For the reddish coloured clay the corresponding range in Liquid and Plastic Limits was 88 to 134, and 33 to 49, respectively. The natural moisture content of the stratum was found to vary between 40 and 140% with a general value of 60 to 70%. It tends to decrease with depth. Typical pressure void ratio curves for the clay are given on Fig. 5. The Casagrande construction generally gave preconsolidation pressures of the same magnitude as the existing overburden pressure, indicating that the clay is normally loaded. Some preconsolidation is however indicated in the upper part of the stratum in locations where water depths are less than 20 ft.

The undrained shear strength of the clay as measured by vane tests varies from 100 to about 2000 p.s.f. and there is a trend towards uniform increase with depth below lake bottom, where water depths are greater than about 20 feet. A shear strength versus depth plot is given on Fig. 6. Where water depths are less than 20 ft. the clay strength in the upper 10 ft. of the stratum was variable, but the average shear strength is about 400 p.s.f. Undrained triaxial compression tests gave results which are plotted as shear strength on Fig. 6. The sensitivity of the clay was generally in the range of 3 to 6.

The clay stratum is often underlain directly by bedrock. Between the clay and the bedrock in places, however, there is a stratum of grey sandy till containing boulders. The maximum measured thickness of the till is 32 ft. The till is of variable density but it is generally in the

FIG. 2: High Level Structure.

FIG. 3: Low Level Structures and Embankments.



loose to compact range. "N" values varied from 1 to 44.

Boreholes through the existing railway embankment indicated that the rock fill had displaced the clay to bedrock over part of the length of the embankment as shown on Fig. 7. Other borings, however, revealed that complete displacement of the clay was not a general condition, and that in some cases the rock fill was "floating" in the clay as shown on the same figure. In some of the boreholes, individual boulders of rock fill were separated by up to one foot of soft clay.

According to construction records for the railway embankment, quarried rock up to 10 ft. in size was placed by end dumping. During construction of the western end of the embankment, difficulties were encountered due to progressive slipping at the end of the embankment. The fill operation became hazardous and it was deemed advisable to support the rail track at the dumping face. For this purpose a large floating gantry was rigged up, which in part straddled the embankment at the end. Penetration tests made at the time indicated up to 60 ft. of soft clay in places. Since completion of the embankment, subsidences apparently caused by both consolidation and progressive displacement of underlying clay have continued and at intervals, most recently in 1949, it was necessary to raise the tracks to grade

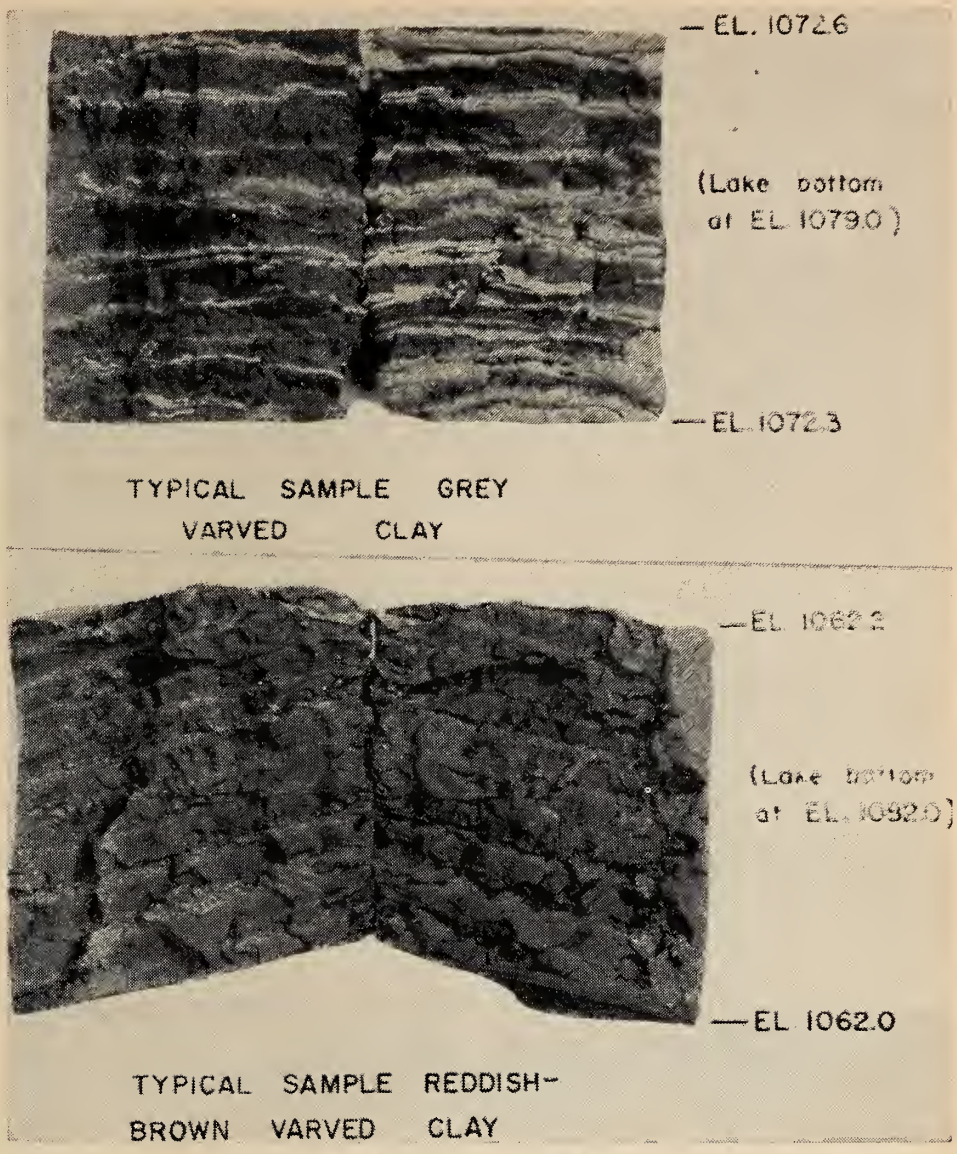
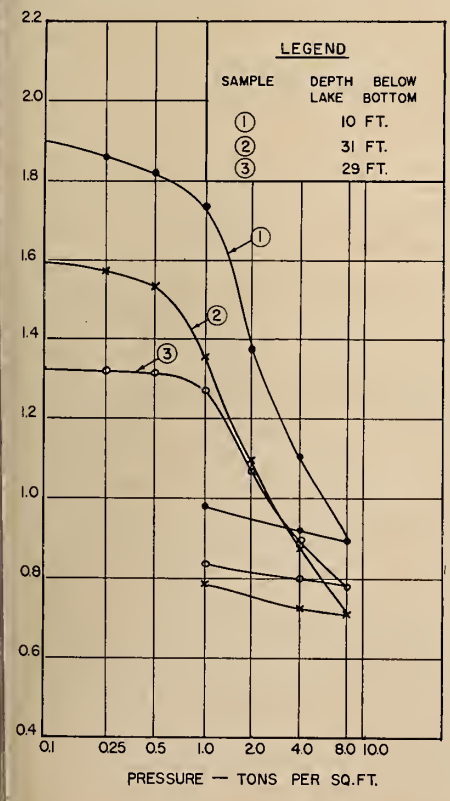


FIG. 4: Samples of Varved Clay.

FIG. 5: Pressure-Void Ratio Curves for the Clay.



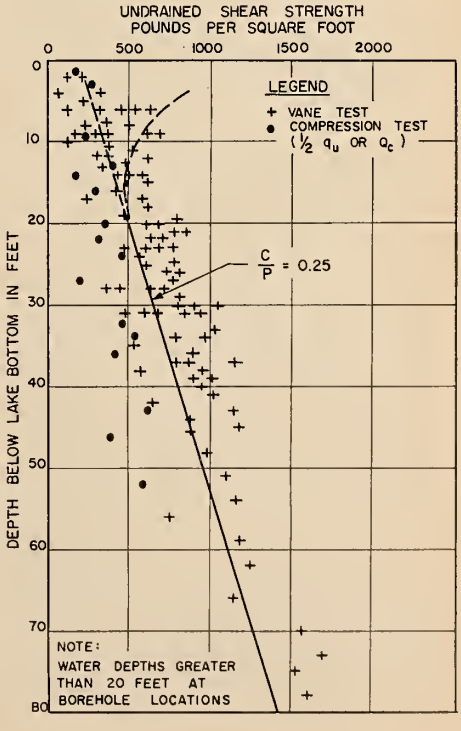
by adding more ballast. In places the total settlement since 1912 amounts to 10 ft.

Ice Conditions

Rainy Lake is ice covered five months of the year. Due to the altitude of the site and the climate, an extremely heavy ice cover is developed, sometimes reaching 4 ft. in thickness. Ice formation always starts in calm bays as board ice. With offshore wind, the ice sheet may proceed on its own lee, towards more open water. If the wind turns, the waves may break up areas of ice cover, although the resulting ice floes at this early stage are not substantial enough to cause damage. Total ice cover usually coincides with the first period of adequate calm and frost which occurs in December. The studies of ice conditions on the lake are described later in the paper.

When a lake gets covered with ice, compressive stresses develop in the

FIG. 6: Strength Versus Depth Profile for the Clay.



ice sheet. The magnitude of compression at any given point is equal in all horizontal directions due to certain plastic qualities of the ice sheet. Cold weather renders the upper layers of the ice sheet stressless and only warm weather creates full ice pressure.

Since water has maximum density at 39.2°F, the temperature profile for the ice-covered lake is always characterized by a gradient which is increasing with depth from 32°F at the underside of the ice sheet, to a possible maximum of 39.2°F. The presence of the coldest water at the underside of the ice sheet has some influence on the uniform growth of the ice sheet. Because of the lower density of this cold water it will flow towards an opening made in the ice sheet, or any hollow in the underside of the ice sheet, providing accelerated freezing in such locations at the expense of the surrounding ice sheet.

In general, the tendency of nature is to maintain the underside of the ice sheet at an even level. However, at a rock fill embankment or a shore of very coarse material, the flow of cold water from the underside of the ice sheet towards the ice free interior of the coarse material will cause thinner ice at the boundary. Horizontal ice movements result from inadequate lateral support along the edges of the ice sheet or from buckling failure of the ice sheet. Any tendency for the ice sheet to move relative to a bridge structure will cause horizontal ice pressure in the sub-structure of the bridge.

In an effort to establish realistic design criteria for ice pressure, an extensive program of field observations of ice movements and related physical conditions was undertaken. It was considered desirable to record ice movements to one tenth of an inch and a fix by triangulation from shore would not be of sufficient accuracy. Control points on the ice were therefore arranged along straight lines across the ice sheet. Each line was defined at the ends by fix-points on shore. The control points on the ice consisted of nails placed on timber horses securely imbedded in the ice sheet. These are shown on Fig. 8. By placing an instrument over one fix-point and sighting the corresponding point across the lake, it was possible to observe movements of the intervening control points. It was not possible to measure the actual movement, only the component perpendicular to the line; but the error in measurement was small.

The ice sheet at the Highway crossing is bounded about 1000 ft. to the south by the railway embankment, but to the north there is an open expanse of about eight miles. At a very early stage the ice sheet forms a pressure ridge north of the causeway alignment approximately along the middle of the open expanse, and this appears to be an annual occurrence. A photograph of the ridge is shown in Fig. 9. As might be expected, therefore, the ice movements at the causeway centre line are initially found to be towards the north and away from the railway embankment. Northward movements are small, never exceeding ½ in. They cease early in January, presumably because the ice gets too heavy to allow relative movement at the ridge.

For the remainder of the winter the ice sheet moves south towards the railway embankment corresponding to a general expansion of the ice sheet. At the causeway centre line location, movements are about one inch per month reaching a total of three inches at mid-March, about which time the ice sheet starts to melt. The accumulative ice movements at mid-March are indicated on Fig. 10.

The southward ice movement is believed to be caused by reduced lateral support of the ice sheet along the railway embankment. Control lines along and close to the embankment indicate a total ice movement of 4 to 5 in. At the railway bridges, where the current maintains small openings in the ice sheet local movements may be larger. It is believed that the reduction in support along the rock fill embankement is caused by the retarded growth of the ice sheet along the embankment as mentioned above. At any time the ice thickness elsewhere is found to be very uniform across the lake and it reaches 36 to 40 in. When warm weather arrives at about the middle of March, melting starts, not only on the top and bottom but also inside the ice sheet forming water-filled holes in the ice. The ice loses strength as it gets increasingly honeycombed and by the time the ice sheet breaks up it is very weak. A serious condition of drift ice is thus prevented.

FIG. 7: Cross-Sections through existing Railway Embankment.

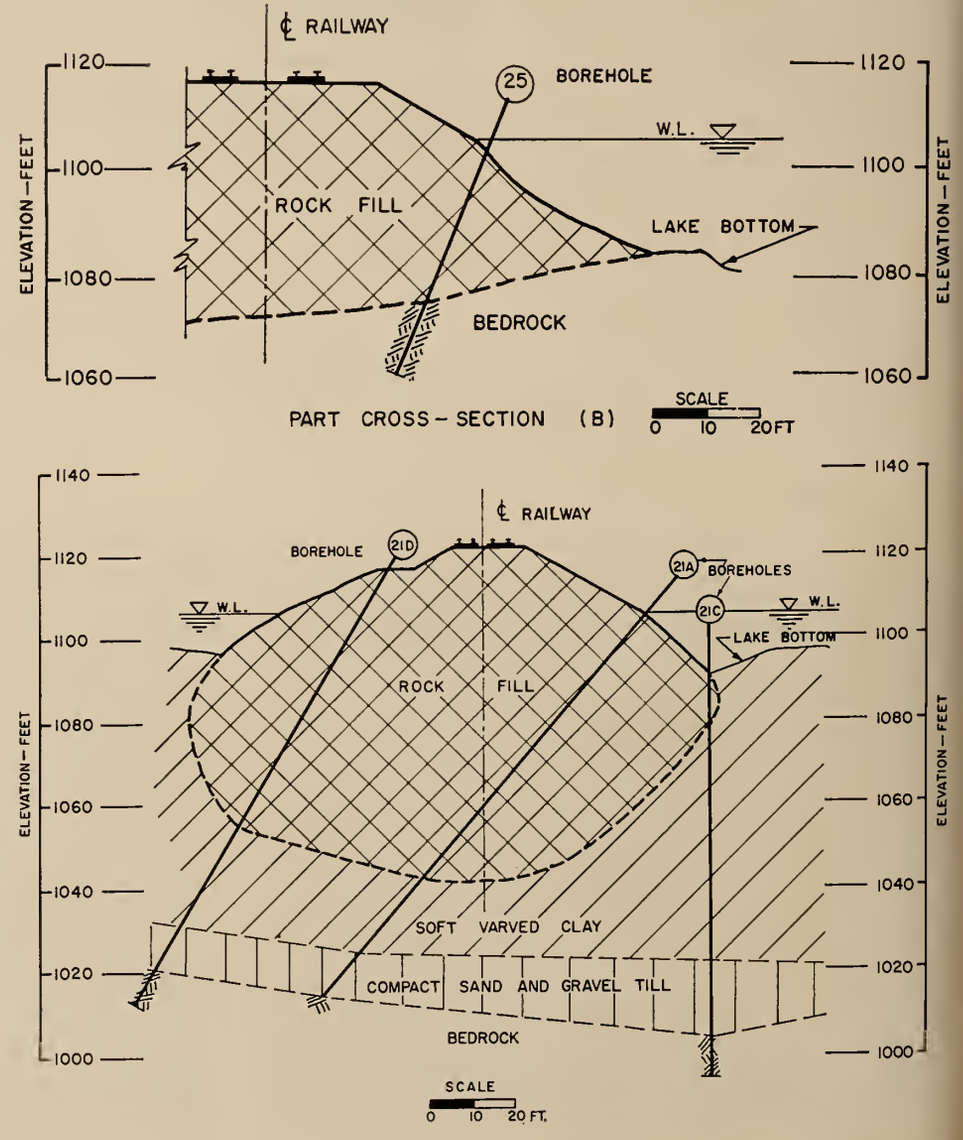


FIG. 8: Timber Horses for Measuring Ice Movement.

FIG. 9: Ice Ridge on Rainy Lake.

Design

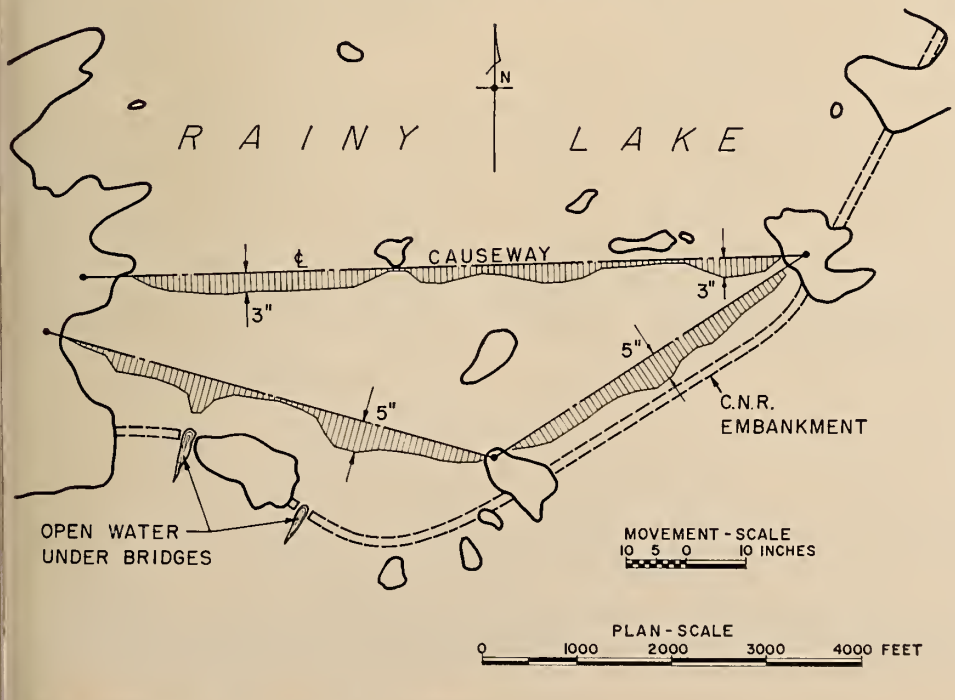
The final alignment was determined by the following considerations:

1. The east half of the railway embankment has performed well. Locating the Highway embankment alongside it, would take advantage of relatively favorable soil conditions and would facilitate construction;
2. Because of considerable depths of clay, however, construction of stable embankments for the Highway in the west half of the crossing would require dynamite blasting to achieve displacement of the clay. In addition, the causeway alignment would have to be kept at a safe distance from the railway embankment;
3. Maneuvering room for navigation and the logging operations between the Highway and the railway was required;
4. The final alignment provides a short 2.8 mile crossing, compared to 3.2 miles for the railway embankment.

The placing of the navigation span and logging span side by side was decided on because it would require a minimum length of elevated bridge. Slight asymmetry in the general profile of the High Level Bridge was adopted to effect an appearance of continuity between high and low level bridges.

The location of the transition points between embankment and bridge were firstly dictated by soil conditions, because it was not considered economically feasible to provide stable embankments where the thickness of clay exceeded 20 to 25 ft. Since the greatest thickness of clay occurred where the water was deep, however, the final project also showed approximate equality in cost of embankment versus structure at all points of transition. The cost of embankment islands was estimated on the basis of winter haul, since the ice sheet on the lake allows transport of fill over ice roads.

FIG. 10: Ice Movements on Rainy Lake.



EMBANKMENTS

The causeway is 44 ft. wide at road level and has a free board of 10 ft above high water level. It was assumed that overall side slopes of 1.5 horizontal to 1 vertical would be developed during construction.

Since the clay over much of the site is normally loaded and sensitive, it could not generally safely support more than about 10 ft. of rock fill on its surface. For end-dumped embankments of the heights that were required, sinkage of the rock fill into the clay was therefore expected as a general condition. It was also considered that such sinkage would occur for the most part by progressive sliding at the face during dumping. Preliminary estimates of the depth of sinkage of the rock fill into the clay were made. These were based on the assumption that sinkage would occur until the ultimate bearing capacity of the clay at a given elevation was equal to the applied load of the fill.[1] The actual sinkage of the rock fill railway embankment was checked by borings, and it was found that the sinkages computed as above were generally less than those which occurred in practice.

Based on the estimated sinkages, preliminary settlement computations were carried out to check on the amount of consolidation which would take place in the undisplaced clay under the embankment. These showed that settlements of the roadway at the centre line of up to about 5 ft. could be expected. The analyses also showed that only about one half of the anticipated settlement would be completed in the first five years after construction. These results indicated that with partial displacement only, the performance of the embankment

would not be satisfactory. It was, therefore, considered essential to completely displace the clay from beneath the new rock fill embankment, particularly in the areas of the structural abutments. Where the clay was less than 8 ft. thick, it was estimated that adequate displacement could in general be achieved if a continuous rate of end dumping was maintained. In the event that incomplete displacement occurred along the sides of the embankment it was felt that this could be improved by toe shooting after the initial fill pass.

To effect positive displacement where clay depths were greater than 8 ft., however, it was considered essential to lower the shear strength of the clay to about 100 p.s.f., or less, in advance of fill placement. Field tests were carried out to determine if the required degree of remoulding could be produced in the clay stratum by blasting. The tests were carried out from the ice at locations where the in-situ undrained shear strength of the clay varied from 400 to 500 p.s.f. For the blasting, 50% Forcite ditching dynamite was used. The strength of the clay, both natural and remoulded, was measured using a penetration type vane.

In all, test blasting was carried out at five locations.

The results of one of the tests, expressed as shear strength profiles are given on Fig. 11.

The rate of regain of shear strength of the remoulded clay was checked by vane tests taken up to 10 days following blasting, and some results are given on Fig. 11. The measurements indicated that there was generally no appreciable regain in shear strength of the clay for at least several days after remoulding by blasting. The test results also showed that maximum remoulding was effected by the combined effect of a group of concentrated charges placed near the base of the clay stratum. On the basis of the results obtained it was concluded that a powder factor of one pound of dynamite for each cubic yard of clay was necessary to effect a lowering of the shear strength below 100 p.s.f.

Since the remoulding of the clay by blasting was a major part of the embankment construction it was important to find a practical and economical way of loading and detonating dynamite in the clay fast enough to keep up with the fill operation. Several methods were tried, and

FIG. 11: Results of Blasting and Vane Tests, Test No. 4.

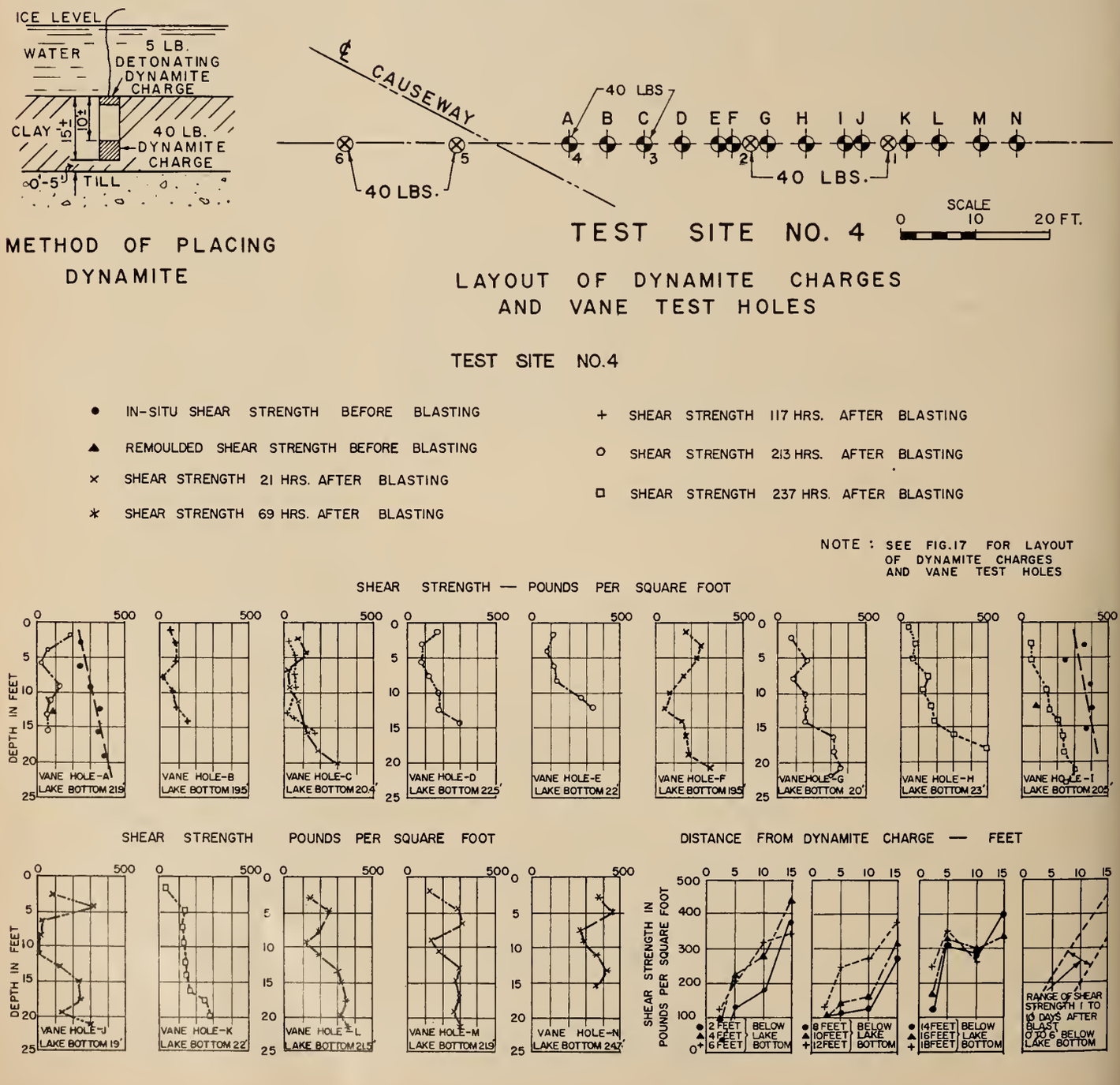


FIG. 12: Jetting of Dynamite into Clay Below Lake Bottom.

after considerable experimentation it was discovered that it was feasible to water jet sticks of dynamite into the clay. This method was only found to be satisfactory when the jetting pipe was between 1½ to 2 in. in diameter and the jet pump powerful enough. The successful test set-up consisted of a 2 in. sectional jet pipe and a 4 in. four-stage centrifugal pump developing up to 200 p.s.i. pressure with an output of 600 gallons per minute. See Fig. 12.

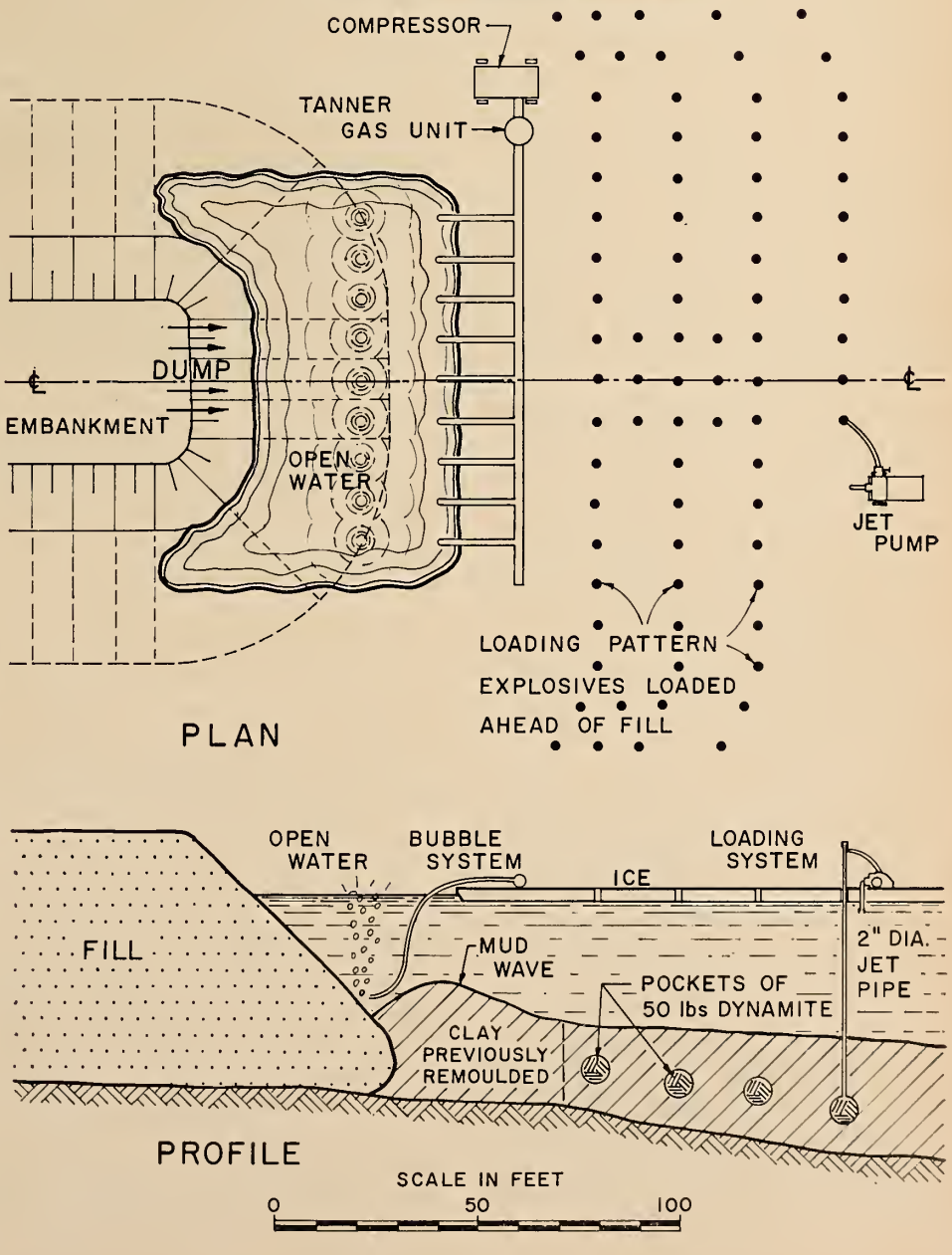
By using ditching dynamite it was possible to effect explosion by propagation and a whole pattern of dynamite pockets with proper spacing and loading could be discharged by a single "primer". It was found that 50-pound pockets of dynamite would explode by propagation if spaced as much as 18 ft. apart. In practice a 10 ft. spacing between 50-pound charges was recommended.

The specifications for embankment construction called for continuous end-dumping of rock fill to final grade. Where the clay layer in the lake bottom exceeded 8 to 10 ft. in thickness the specifications called for remoulding of the clay ahead of the fill by dynamite blasting using a loading of one pound of ditching dynamite for each cubic yard of clay to be remoulded. Dynamite was to be placed in pockets of not less than 50 lb. per pocket at a spacing one way not exceeding 10 ft. and at a depth in the clay equal to two-thirds of the clay thickness. It was recommended that each blast contain a total of at least 3000 lb. of dynamite. As a special precaution, the specifications also provided for toe shooting along the sides of the embankments if this was deemed to be necessary to complete displacement in local areas after the initial fill operation. Figures 13 and 14 show typical details of embankment construction. When the ice thickness is substantial, the centre of the fill can generally break through the ice during dumping but the sides of the embankment tend to get hung up on the ice sheet. It is, therefore, advisable to clear the ice ahead of dumping. In Rainy Lake it was possible to do this by melting the ice using an air bubbling system shown schematically on Fig. 13.

BRIDGES

Considerations of ice pressure and ice movement had a very important influence on the final design of the bridge structures. Based on ice obser-

FIG. 13: Construction of Embankments.



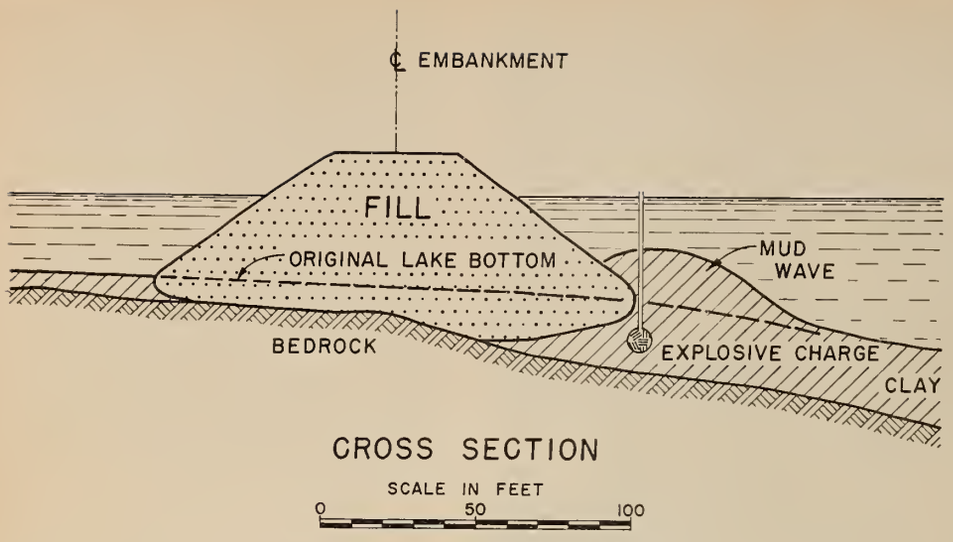


FIG. 14: Shooting at Toe of Fill.

vations, it was concluded that piers or pile bents must either have enough lateral strength to resist an ice thrust of 5L to 10L tons, where L indicates the spacing in feet, or else be capable of adopting most of the annual ice movement up until mid-March.

The following detailed observations were pertinent:

1. In Northern Ontario and Quebec it is usual to use 20,000 lbs/foot for ice thrust in design of rigid structures;

2. Reduction in potential ice thrust due to a small expansion of the ice sheet is negligible. This was confirmed by "liberating" an area of ice from the lake at low temperature and measuring its immediate expansion, which was found to be one inch in 380 ft. At the bridge site, which is located on the periphery of an eight mile stretch of ice cover, the stress relief offered by a few inches of lateral movement will not greatly reduce the latent thrust of the ice sheet;

3. The relative flow of the ice sheet around and past a pile is negligible unless the ice pressure is very high, because such a flow will require very large differential movements in the ice. This was confirmed by jacking between two test piles, see Fig. 15. Pointed or streamlined shape of the pile section at ice level will not improve the flow of the ice sheet. (This is distinct from bridge piers in rivers which are often plow-shaped to prevent jamming of ice floes.);

4. During the spring when the temperature of the ice sheet approaches 32°F throughout, melting of the ice in the pressure zone at front of the piles will arrest the growth of pressure between piles and ice. At this time it was found that the two test piles could be jacked apart by exerting very low jacking pressure. The test piles are shown on Fig. 15. The brackets extending from the piles are fitted with lugs. The distance between the lugs was measured by micrometer in the manner shown on Fig. 16. By adjusting these readings for temperature changes in the brackets, it was possible to determine accurately variations in the distance between test piles;

5. Variations in annual ice movements are probably small. A comparison of different years indicates that movements depend on the condition of the shore and on a certain constant condition of stress and plasticity in the ice sheet.

Daily records of weather, water level and water outflow from Rainy Lake were available from the year 1947. The temperature curves from mid-December to mid-March for the years on record were compared and it was found that accumulation of any of the pertinent aspects of the curves showed little variation over the years.

During the winter the inflow to Rainy Lake is small due to rocky up-land, and a relatively constant outflow is maintained through the Fort Frances Power station;

6. The introduction of rock fill embankments for the highway route may affect the general ice movement. At the east half of the lake crossing where the highway and the railway embankments are adjacent, the movement of the ice sheet will probably not be altered. At the bridge centre line the main southward movement of the ice sheet is undoubtedly restrained by the islands in the vicinity, since these islands consist of solid rock outcrops with steep shores.

By locating the fill embankments south of the islands they should tend to reduce the southward ice movement. Piers or pile bents would tend to restrain and reduce the "plastic" ice flow;

7. An artificially-created opening in the ice sheet will produce ice movements. Large ice movements caused by man's interference are not likely to happen due to the difficulty of maintaining a substantial area ice free for any length of time.

In places along the centre line the depth to solid bottom reaches 100 ft. The initial study of a bridge on solid piers was not pursued very far because the large weight required to resist overturning from the ice thrust indicated that this solution would be uneconomical.

The following alternatives received closer study:

1. A floating bridge on cellular concrete pontoons, which would adopt the ice movements;

2. A bridge with light superstructure on bents of vertical piles with mounds of fill around each pile bent for lateral support. The supporting fill to be conveyed in place from the completed bridge;

3. A flexible bridge with medium light superstructure on bents of vertical piles flexible enough to adopt the total ice movement.

The flexible bridge scheme was selected because economy was the main consideration and the following design criteria were adopted:

1. Each pile bent to allow a minimum deflection of 4 in. at lake level;

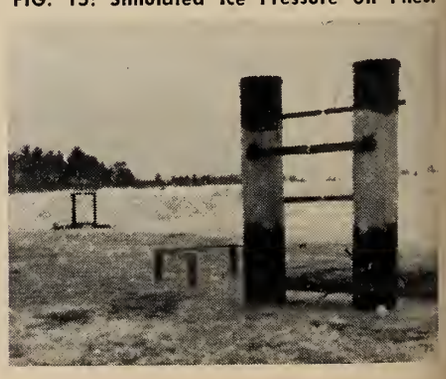
2. Each of the three centre bents in the High Level Bridge which define the navigation and logging spans to develop at least 200 ton resistance to ice thrust;

3. Each other bent in the High Level Bridge to develop at least 100 ton resistance to ice thrust;

4. Each bent in the Low Level Bridge to develop at least 50 ton resistance to ice thrust.

These requirements were met by using vertical concrete filled steel

FIG. 15: Simulated Ice Pressure on Piles.



IG. 16: Checking the Distance Between Test 'iles.

ube piles at all bents, but varying hc diameter of the piles from 16 in. o 24 in., and the number of piles n the bents from 12 to 90.

Almost all pile caps and girders or the superstructure consisted of recast prestressed concrete. For econmy and easy erection only two basic nits were used throughout.

The pier cap unit was box-shaped ith compartments. By filling a difrent number of compartments with w grade concrete after the pier cap as erected it was possible to provide esired individual loading of the pile ents.

In the design of the pile bents the ear strength of the soil was taken s 400 p.s.f. and the point of contraexure was determined by methods ggested by Rowe[2] and Minikin[3]. ormulae for the deflection and maxium fibre stress for the piles was eveloped from first principles.

The flexibility and lateral strength f the completed pile bents were also sted during construction. See outde front cover. The lateral loading sts were carried out during the winter and the ice sheet was used to jack against. The piers to be tested were completely isolated by cutting a one foot wide slot in the ice around each one. Hydraulic jacks were placed in the slot and the bearing edge of the ice was reinforced by steel beams frozen into the ice prior to the test. The load against the piers was determined by the hydraulic pressure. Movements were measured at several points on the pier by sighting with instruments located on adjacent piers. One of the test piers is shown on the outside front cover. Due to the flexible nature of the pile bents special attention was given to the design of the bearings and the anchor pins were extended to prevent the girders from "pulling out". This may be seen on Fig. 17. which shows a model of an expansion bearing.

FIG. 17: Model of Typical Expansion Bearing.

ABUTMENTS

At the transition points between the embankments and bridges it was not possible to carry out the clay remoulding ahead of the embankment because this would destroy the lateral support provided by the clay to the piles of the bent adjacent to the abutment. At these points therefore a special treatment was required as shown on Fig. 18. This involved stopping blasting 50 ft. from the pile bent adjacent to the abutment, and the provision of a gravel stabilizing berm as shown.

To facilitate driving of piles for the abutments, the embankment fill was changed to gravel at the abutment locations. The gravel embankments were protected by rip-rap.

ACKNOWLEDGMENTS

The writers are indebted to H. W. Adcock, Assistant Deputy Minister, Engineering, Department of Highways, Ontario, for permission to publish engineering data from the Rainy Lake Causeway Project and for reviewing the manuscript.

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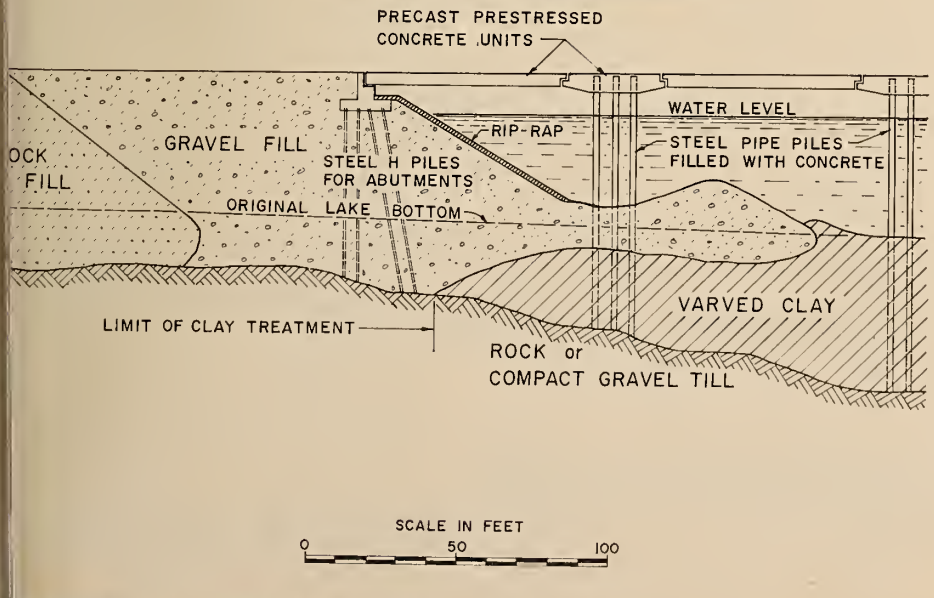
A special acknowledgment is made to W. G. Noden, M.P.P. Rainy River for his interest and assistance.

FIG. 18: Typical Profile at Abutments.



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EIC-63-ELEC 6

NON-ICING CONDUCTOR

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Conductor icing is an appreciable hazard for reliable operation of transmission lines. "De-icing of ice-covered conductors is always difficult. One method is to melt the ice using largely-increased currents. It is not suitable, though, for EHV lines. In some cases mechanical removal by insulated strips can be done conveniently.

CONDUCTOR ICING is an appreciable hazard in the operation of transmission lines.

"De-icing" of ice-covered conductors can be difficult. One method is to melt the ice using largely increased currents[1]; however, this is not always possible for EHV lines. Mechanical removal by insulated strips has been attempted in certain cases[2] (Sweden) but is impractical in locations with restricted access, as in mountainous territory or at river and lake crossings.

In such cases, the prevention of ice formation becomes particularly important and any device decreasing the chances of ice formation appears worth considering. The greatest danger arises when an ambient temperature just below 0°C[1,2,3] coincides with a low conductor current. A solution could be provided by a cable producing an appreciable temperature rise at low currents and a relatively limited temperature rise at high currents.

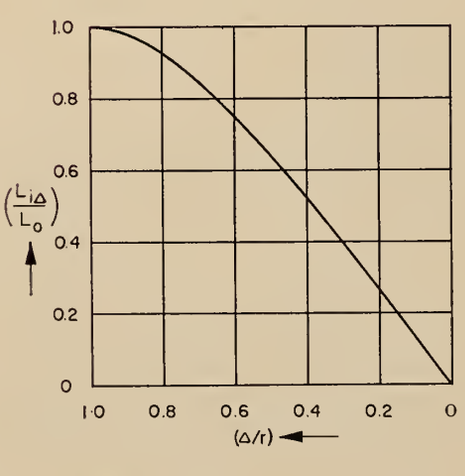

Fig. 1. Internal inductivity $L_i\Delta$ of a tube of thickness Δ referred to the internal inductivity L_0 of a solid conductor (current density constant).

The use of a special composite ACSR "Non-icing" cable with one or several outside layers of high-permeability steel wire can be suggested. At low currents the permeability μ is high and the penetration depth $\delta \sim \sqrt{(\rho/\mu f)}$ very restricted; therefore, the effective AC resistance is increased several times over the DC value. At higher currents, μ drops rapidly and so does the AC resistance. Therefore, losses and conductor heating at small currents are relatively high and at high currents still tolerable.

The use of steel wire on the outside of the non-icing conductor makes it practically impossible to calculate accurately its characteristics due to the

variable permeability μ. Tests of a general character to determine the main properties of non-icing conductors and individual tests to predict the performance of a specific design, are necessary.

The following investigation is an attempt, however incomplete, to demonstrate the main features and possible applications of non-icing conductors based on theoretical approximations and several series of preliminary tests.

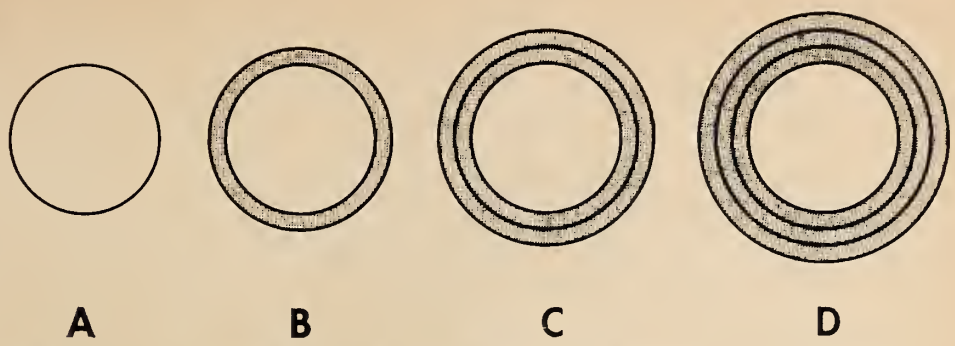

Fig. 4. Copper-core-cables: A—bare; B. C. D—with a single, double and triple layer of steel wire.

Main Properties of the Non-Icing Conductor

I. Theory

The non-icing conductor is a composite cable. However, at times of its specific performance (small current load) it carries current almost only in its exterior layers of high permeability steel and in such a limited depth, that an average value of μ will be tentatively considered as approximately constant in this restricted area, whereas the inside of the conductor can be thought replaced by the same material (as it remains anyway almost current-less).

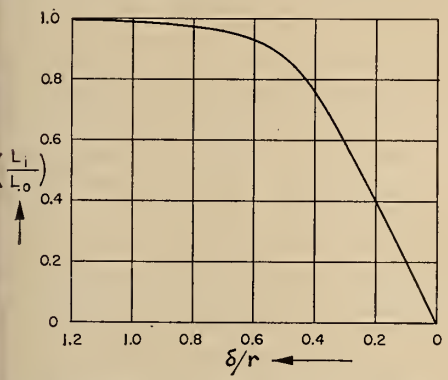

Fig. 2. Reduction of the internal inductivity L_i of a homogeneous solid conductor due to skin-effect. δ = "penetration depth".

It is useful to first consider the main features of a solid round conductor with homogeneously distributed values of the specific constants; the permeability thus can have any constant value, not necessarily the value one.

(a) *Resistance.* As it is well known,[4] the resistance ratio R_{AC}/R_D of a homogeneous round conductor increases with the increase of

$$rm = r\sqrt{\omega\mu'/\rho} = \sqrt{2}r\sqrt{\pi f\mu'/\rho} \quad (1)$$

where: r = conductor radius, f = frequency and ρ = resistivity. μ' is the absolute permeability equal to the relative permeability μ multiplied by the permeability of free space $\mu_0 = 4\pi \times 10^{-9}$ H/cm.

It is convenient to introduce an ideal equivalent "penetration depth" (Lord Rayleigh), defined as

$$\delta = \sqrt{\rho/\pi f\mu'} \quad (2)$$

For conductors of a very large radius the penetration depth is equal to the thickness of a hollow conductor of the same outside radius offering to a D.C. current the same resistance as the real conductor offers to the A.C. current. Equation (1) can be written as[5]

$$rm = \sqrt{2}\ r/\delta \quad (3)$$

providing the possibility to use everywhere r/δ instead of rm; this is advantageous because δ has a clear physical meaning. For a given transmission line r and f are constant; ρ is almost constant and changes only slightly due to temperature changes. The permeability μ, however, depends upon the magnetic field strength produced by the conductor current. At low current values μ and, therefore, ratio R_{AC}/R_{DC} are relatively large. At high currents they become much smaller.

(b) *Inductivity.* The total inductivity of a solid round conductor consists of an internal and an external components.[6] In abhenries per cm it is:

$$L \sim \tfrac{1}{2}\mu + 2\ln\frac{D}{r} = L_i + L_{ext} \quad (4)$$

where D is the effective phase to phase distance and the current density is assumed constant over the conductor cross-section. For conductors containing no iron or steel or at least none of them in the outside layers, the internal component becomes $\frac{1}{2}$, whereas the order of magnitude of the exterior component (with $D/r \approx 400$) is in the range of 12. The internal component is thus normally about 4% of the total inductivity.

The assumption of a homogeneous current distribution over the conductor cross-section is practically never fulfilled due to the skin-effect. To demonstrate the influence of the current distribution within the cross-section, the assumption will be made, that the current density remains constant within a tubular space underneath the conductor surface and that it is zero inside. Integrating the number of flux linkages for a tubular conductor it can be shown that its inductivity $L_{i\Delta}$ decreases with the decrease of the tube thicknessΔ; $L_{i\Delta}$ referred to the inductivity of the solid conductor with homogeneous current density becomes

$$\frac{L_{i\Delta}}{L_0} = 1 - \frac{2(1-\alpha)^2}{1-(1-\alpha)^2}\left[1 + \frac{2(1-\alpha)^2}{1-(1-\alpha)^2}\ln(1-\alpha)\right] \quad (5)$$

as represented in Fig. 1 with $\alpha = \Delta/r$.

In reality, the current density is distributed, however, not in a constant but in a non-homogeneous manner and also not only in a tubular space but throughout the whole cross-section. A more accurate value of L_i can be introduced instead of $L_{i\Delta}$ using skin-effect tables[4] and still assuming μ = const:

$$L_i/L_0 = \varphi(rm) = \psi(r/\delta) \quad (6)$$

see Fig. 2. L_0 here is again the value of the internal inductivity for μ = const and a homogeneous current distribution.

Fig. 3. Test arrangement.

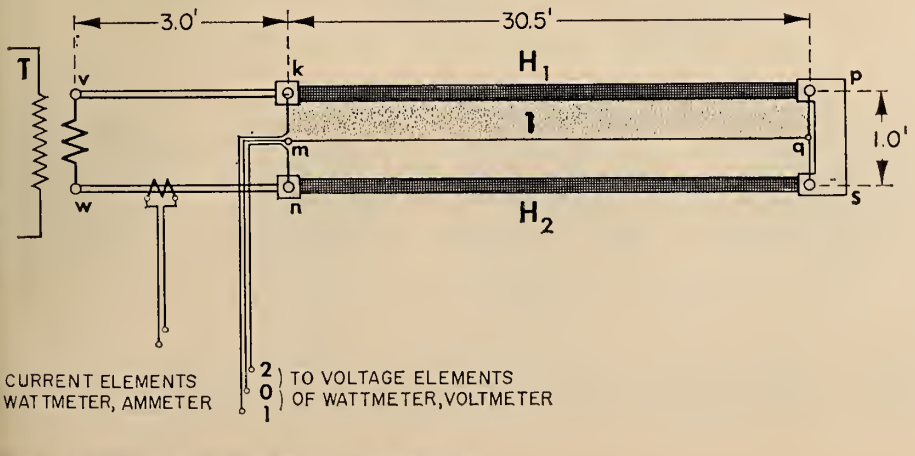

TABLE I

1	2	3	4	5	6	7	8
I	E	W	$Z = \frac{E}{I}$	$R_{AC} = \frac{W}{I^2}$	X_Σ	$X_i = X_\Sigma - X_{ext}$	H
Amp.	*Volts*	*Watts*	*m Ohms*	*m Ohms*	*m Ohms*	*m Ohms*	*A/cm*
300	3.2	385	10.67	4.28	9.77	5.74	26.7
400	4.25	670	10.63	4.19	9.77	5.74	35.6
500	5.4	1020	10.80	4.08	10.00	5.97	44.5
700	7.45	1850	10.64	3.78	9.95	5.92	62.3
1000	10.45	3350	10.45	3.35	9.90	5.87	89.1
1500	15.05	6300	10.03	2.80	9.63	5.60	133.6
2000	19.1	9620	9.55	2.40	9.24	5.21	178.1
3000	26.3	17,400	8.77	1.93	8.59	4.56	267.2
4000	32.7	26,000	8.17	1.62	8.01	3.98	356.2
5000	38.3	35,600	7.66	1.42	7.53	3.50	445.3

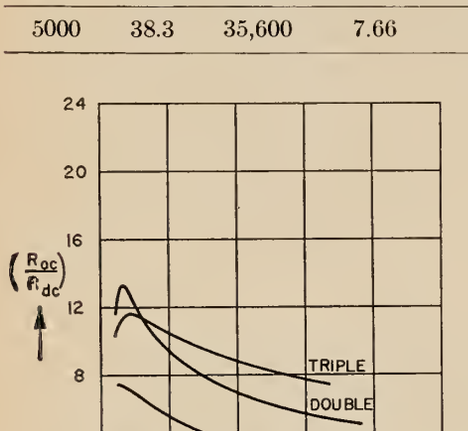

Fig. 5. R_{AC}/R_{DC} ratios for the cables B, C, D of Fig. 4 vs surface field strength (A/cm).

The effective penetration depth for the considered relatively large conductors (DIA $\approx$ 1 in.) at the industrial frequency 60 Hz*) remains so small that an average value of the permeability μ will be assumed effective and considered as almost constant in the active layer. The internal inductivity, which is $\frac{1}{2}$ for a non-magnetic conductor with homogeneous current distribution practically becomes : (a) μ times greater due to the effective constant value of μ and (b) again (L_i/L_0) times smaller due to the high skin-effect; in abh/cm it is:

$$L_i \sim \frac{\mu}{2}\left(\frac{L_i}{L_0}\right)_{\mu = \text{const}} \qquad (7)$$

Example : For a conductor with r = 20 mm, D = 25′ = 8,000 mm, f = 60 Hz and ρ = 10 microhm cm, the ideal penetration depth at μ = 1 is δ = 20 mm.[7] Assuming now μ = 100 the following figures can be obtained : $\delta = 20\sqrt{1/100}$ = 2 mm ; δ/r = 0.1 ; $L_i/L_0 \approx 0.2$ (from Fig. 2) ; $L_i \sim (100/2)0.2 = 10$. The total inductivity for the previously used phase spacing becomes now $L \sim 10 + 12 = 22$ or approximately twice the value corresponding to a normal conductor.

*The internationally accepted symbol Hz (for Hertz) is being used here instead of c.p.s.

With increasing current both μ and L_i will decrease, the change of L_i being a result of two counteracting trends. As the thickness of the outside steel layer increases, the "μ = const assumption" becomes less and less valid and it is difficult to predict, which of the two mentioned trends finally will predominate.

II. Tests

Preliminary tests were made to check the basic properties of the composite cables. Sections of 1,000,000 CM copper cable have been used as a base for all test specimens.

The test arrangement, Fig. 3, consisted of two cable lengths H_1 and H_2 interconnected by a heavy aluminum plate *ps* and tied by heavy cables to the secondary winding of the transformer T.

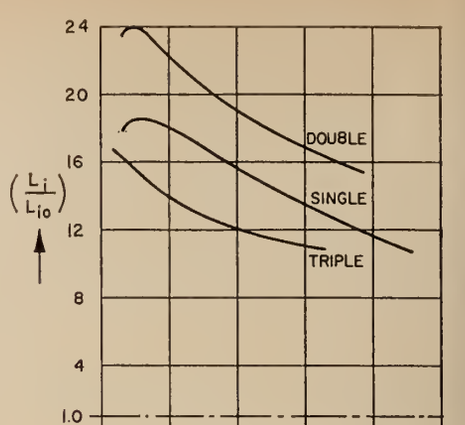

Fig. 6. Internal inductivity L_i of cables B, C, D of Fig. 4 referred to the ideal internal inductivity L_{io} of a solid cable with μ = 1 and canstant current density.

The potential leads were arranged as indicated in Fig. 3 and the part *mq* coincided with the centre line between H_1 and H_2. Rectangular arrangement of the potential leads permits to compute accurately the correction corresponding to the flux linked with the voltmeter loop (i.e. Loop 1 for the voltmeter reading V_{01}) which is required to obtain the pure IZ drop in the cable specimen. This procedure has been suggested by Kennelly as early as 1916.[8] Kennelly did use correction formulas by Rosa.[9] More convenient formulas[10] have been used in this paper ; they are but an improved representation of Rosa's equations.

A simple check-over was carried out in the following preliminary test. Two bare copper cables, 1,000,000 CM and 1.152 in. DIA (A in Fig. 4) have been taken as test specimens H_1 and H_2. The measured values for the total loop m n s q p k m were : I = 5,000 A, E = 23.8 Volts, P = 18.5 kW and therefore :

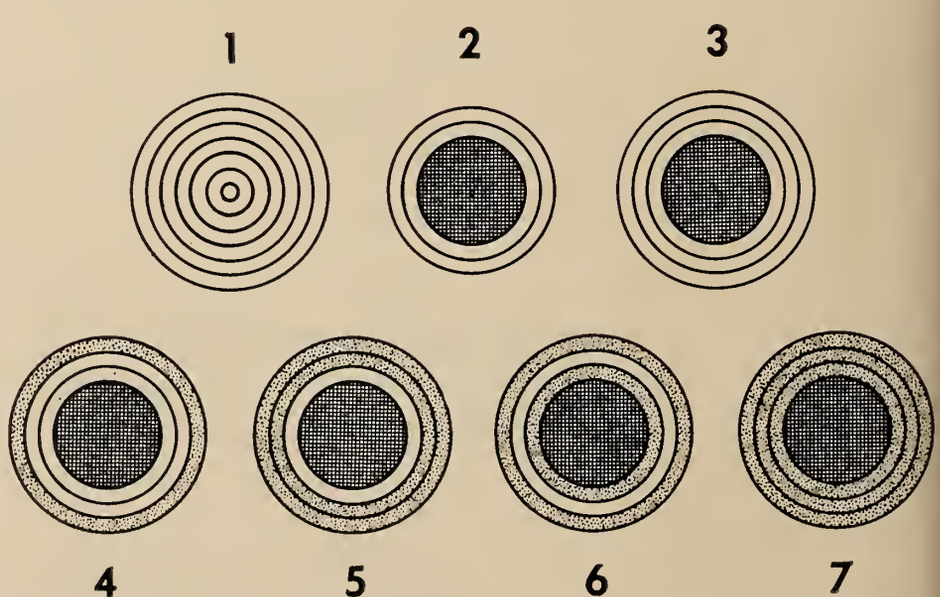

Fig. 7. Cable specimens used for heat-run tests. #1—whole aluminum, #2-7—have a 37 strand steel-core. White layers = aluminum strands; shaded layers = steel strands.

$R = 0.74m$Ohms, $Z = 4.56m$Ohms. The total reactance:

$$X = \sqrt{Z^2 - R^2} = 4.70m \text{ Ohms} \quad (8)$$

The internal inductivity of a non-magnetic cable is

$$l = \tfrac{1}{2}\, 10^{-9} \text{ H/cm} \quad (9)$$

disregarding the effect of a not exactly constant current density which in this case is slight. For two cables of a length of 30.5 ft. = 929.6 cm each, the internal inductivity becomes

$$L_0 = \tfrac{1}{2}\, 10^{-9} \times 2 \times 929.6 \text{ H} = 0.93 \text{ micro H} \quad (10)$$

At the industrial frequency 60Hz this represents a reactance of

$$X_0 = 377 \times 0.93 \times 10^{-6} = 0.35m \text{ Ohms} \quad (11)$$

The external reactance corresponding to the area between H_1 and H_2 can be found as

$$X_{ext} = 4.70 - 0.35 = 4.35m \text{ Ohms} \quad (12)$$

This "external loop reactance" can also be calculated according to[10]. With a GMR = 0.242 ft. of the plate *ps*, the main parts of the circuit contribute to the inductivity of the "external loop" in the following manner:

$vk + kp + ps + sn + nw = 0.028 + 5.580 + 0.079 + 5.580 + 0.028 = 11.30$ micro H

and

$$X_{ext} = 377 \times 11.30 \times 10^{-6} = 4.26m \text{ Ohms} \quad (13)$$

The deviation from the measured value is only 2% possibly due to the neglection of the circuit side *vw*.

For the samples with a single layer, double layer or triple layer of steel wire over the copper conductor (B, C and D in Fig. 4) and the corresponding diameters 1.408 in., 1.664 in. and 1.920 in. the external loop reactances were obtained in the same manner as follows: 4.03, 3.75 and 3.20*m* Ohms. The arrangement of the layers was selected in such a way as to assure at least a comparable average spirality effect in the "single", "double" and "triple" layer case. All measurements have been performed as quickly as possible to prevent an appreciable cable heating.

Table I contains averaged test results and their evaluation for the loop composed of two "single layer" cable specimens. Columns 5 and 7 respectively give the total values of R_{AC} and X_i and column 8 indicates the magnetic field strength at the surface in A/cm.

Figures 5 and 6 are graphical representations of R_{AC}/R_{DC} and L_i/L_{i0} for a single-layer, double-layer and triple-layer cables vs surface field strength in A/cm. L_{i0} is the ideal internal inductivity for a cable with $\mu = 1$ and homogeneous current density distribution.

Figure 5 shows that the resistance ratio curves R_{AC}/R_{DC} attain a high maximum at small surface field strength values of 20 to 50 A/cm and then decrease steadily. The values for a double-layer cable are higher, than for a single-layer cable. For the triple-layer cable the values are only slightly greater than those for the double layer in the region of higher surface magnetic forces, but even smaller for small values of these forces. The experimental specimens show a rather exaggerated behaviour: even at high currents the R_{AC}/R_{DC} ratios remain quite high. This is due, however, to the fact, that the R_{DC} value of all specimens is very low because of the large copper cross-section.

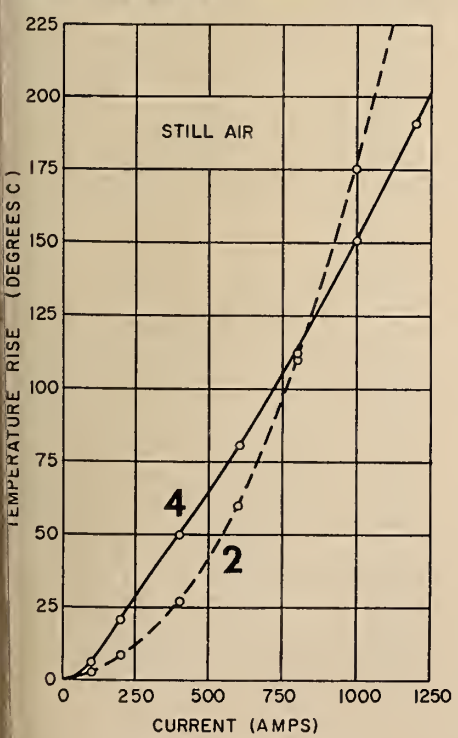

Fig. 9. Comparative performance of specimens #2 and 4 in still air.

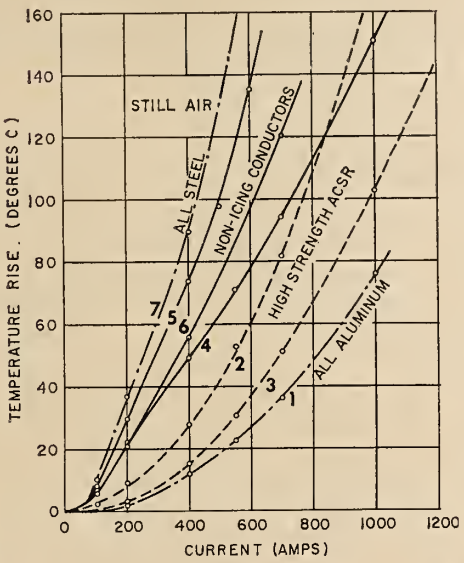

Fig. 8. Temperature rise vs current for all test specimens under stationary conditions.

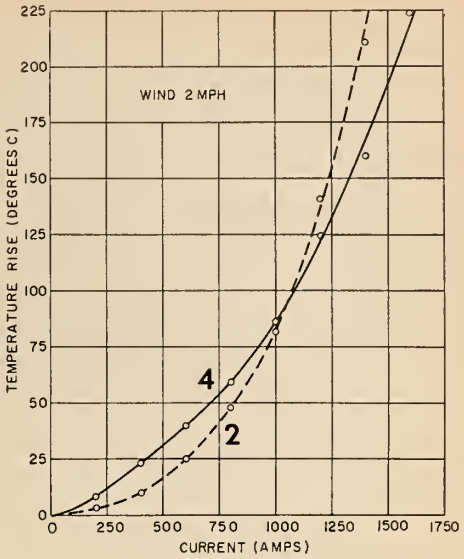

Fig. 10. Comparative performance of specimens #2 and 4 at 2 m.p.h. wind.

Figure 6 shows values of the internal inductivity in the range of 10 to 20 times the value with no skin-effect. The two-layer cable has higher values than the single-layer cable; however, the triple-layer produces smaller values. Apparently, the concentration of the current within a relatively smaller depth underneath the surface decreases the number of flux linkages to such a degree, that even the high value of μ can not counterbalance this influence.

Performance of the Special Cable

I. Heat Run Tests under stationary load conditions in still air and with 2 m.p.h. wind

As the preliminary tests were encouraging, some further specimens were manufactured keeping in mind the special conditions which would arise in the case of a practical application. The possible use of non-icing conductors of limited length in places with difficult access suggested a design as a high-strength ACSR cable with a strong steel core and relatively little aluminum. The resistance of such a cable is high even without the impact of skin-effect, however, not as extreme as it is for a pure steel cable. All specimens were manufactured in lengths of about 6 to 8 ft., out of strands having a uniform diameter of 0.0874 in. The stranding was: 1-6-12-18-24-30-36. Six specimens, No. 2 to 7 in Fig. 7, contained similar steel cores of 37 strands. Specimen No. 2 had two layers of Aluminum wire and an O.D. of 0.961 in., whereas the O.D. of all others was 1.136 in. Specimens No. 4 to 7 contained one to three layers of high permeability steel-wire layers arranged in different ways according to Fig. 7. Specimen No. 1 was manufactured from aluminum strands only for reasons of comparison.

Heat run tests were made as follows. All specimens connected in series were

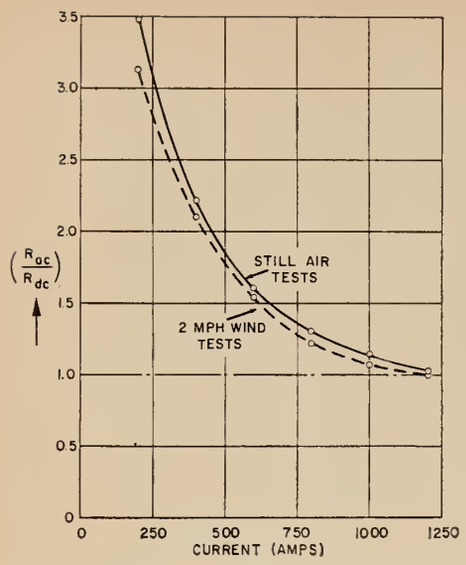

Fig. 11. R_{AC}/R_{DC} ratio vs current for the high strength specimen #4.

placed on wooden supports in a spacious and secluded room ; a special transformer supplied load current of a sustained value up to 1500 A. The cable temperatures were measured by thermocouples carefully adjusted near the middle of each specimen's length and their readings automatically recorded. Each current value was sustained for several hours in order to reach stationary conditions at the moment when readings were taken. Still air conditions could be maintained very closely ; it was more difficult to obtain steady wind conditions. Each specimen under test was finally provided with an individual blower arrangement consisting of a plywood prisme with a narrow longitudinal outlet parallel to the specimen and activated by three small fans. Wind speed was adjusted under the use of an anemometer.

Main test results are compiled in the charts of Fig. 8 representing the stationary temperature rise over ambient vs conductor current. Specimens No. 1 (all aluminum) and No. 7 (all steel) evidently represent the limits for the considered family of curves.

An inspection of Fig. 8 shows, that at small currents ($\approx$100 A) all specimens with outside high-permeability steel layers have almost the same temperature rise. The major part of the current is concentrated on the outside steel layer of 36 strands. With increasing current (200 A) the temperature rise for specimen No. 5 (two steel layers) increases over that of No. 4 and 6 (one outside steel layer) as the current penetrates deeper into the second layer due to the decrease of permeability. At still higher current values (400 A) the temperature rises of all specimens become different as current penetration reaches the third layer of 24 strands. Common to all specimens is the steep temperature rise in the region of small currents.

To demonstrate further the effect of different cable designs it is particularly interesting to compare the performance of specimens No. 4 and 2 ; the latter is equivalent to No. 4 with the outside steel layer removed. Fig. 9 and 10 show the comparative performance of both specimens in still air and in wind of 2 m.p.h. At small currents, specimen No. 4 provided with one outside steel layer becomes much warmer than No. 2 in spite of the larger heat dissipating surface. At larger currents No. 4 keeps cooler than No. 2.

Specimen No. 4 seems to be the most favourable among the tested items. Heat dissipation calculations carried out for this cable permitted the evaluation of its R_{AC}/R_{DC} values at different current levels and the corresponding temperatures, Fig. 11. It should be kept in mind, that the reference value R_{DC} is different for each current value due to the temperature variation vs current. The calculated UTS for this specimen is in the range of 54,000 lb.

All specimens tested are of preliminary design. The use of steel wire or perhaps even steel tape of higher permeabilities could give more favourable results.

II. Low Temperature Tests Under Artificial Freezing Rain Conditions

Tests under severe real conditions had been planned and were started in Ottawa, N.R.C., using the available cold chamber. However, other important tests carried out in the same room at the same time required the use of a much lower temperature (0°F = −18.7° C) than can be expected under freezing rain conditions. Following results were obtained for the most interesting specimen No. 4. A special nozzle was used, which produced a continuous freezing rain with droplets of 10 microns DIA.

A current of 300 A was sufficient to prevent any icing under still air conditions. Intermittent wind periods of v = 6 m.p.h. for five minutes and no wind periods also for five minutes produced a slow forming of ice, about 1/8 in. in 30 min. at 400 A. With 500 A only small ice traces started to remain on the surface after 30 minutes.

Conclusions

Tests carried out with the non-icing conductor confirmed the expected cable properties. Summing up it can be said that a suitably designed non-icing cable should be useful to reduce the occurrence of ice formation in locations of difficult access where icing conditions are severe and a large range in current values is encountered.

Mechanical design of the cable may present problems but they should not be too serious. The cable is very strong at temperatures up to 250°C and can take long spans, is not easily damaged and can be conveniently handled.

Electrically the cable can carry relatively large currents because of the aluminum used in its construction and high temperature at which it can operate, also due to the reduction of the skin-effect at high currents. At low current values the conductor develops considerable heat because of its exaggerated skin effect.

Power losses in the cable would have to be considered for each specific application and balanced by the savings that can be effected. However, as the non-icing cable would be used only in limited lengths and as the increased losses are effective only during periods of small loads, they are not likely to have an appreciable influence upon the overall operating and economic conditions of the transmission line.

The internal inductivity of the non-icing conductor may attain values in the range of 10 to 20 times the normal one. However, the total inductivity including the generally much larger external part will not increase more than twice. As this can happen only at high permeability values, in other words at small current values, the increase of reactive MVAR's will remain negligible for the whole transmission line.

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EIC-63-WELD 2

Methods to Establish Procedures for WELDING LOW ALLOY STEELS

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THE CRACK RESISTANCE of arc welded low alloy steels can be etermined experimentally using suitble weldability tests. One testing cheme, using the "CTS" test, is outned. A new, alternative form of the ontrolled Thermal Severity test is escribed. Another method of deterining weldability entails working ut the "carbon equivalent" of a steel om its composition; this can be reted to the weldability as measured xperimentally. Once the weldability a steel has been established, it is own how welding procedures can e worked out for any given joint eometry using simple tables or raphs.

ntroduction

Low alloy steels, as defined for the rposes of this paper, are the high-rength constructional steels being ed increasingly for such applicaons as mining and earth-moving mainery, ships, crane booms, long-span idges and pressure vessels. These eels contain from 0.1 to 0.3% carn, and alloying elements totalling t more than about 5%. They are ed mainly in the form of plate, t bar or rolled section, supplied as lled, normalized, normalized and tempered, or, for some of the more recent steels, quenched and tempered.

The welding procedures referred to in the title are for manual metal arc welding with covered electrodes, though it is hoped to extend the methods later for use with other arc welding processes.

Low alloy steels have better mechanical properties and better abrasion and corrosion resistance than mild steels, and so result in substantial economies for some applications, but they do demand stricter control of welding procedures to avoid the occurrence of cold cracking. Since cold cracks are usually internal, and are often very difficult or impossible to detect by non-destructive testing methods, it is very important to establish procedures which will prevent the occurrence of these insidious defects.

One way to be certain of crack-free joints is to make test assemblies which simulate each joint configuration in the structure, using the same type of steel, to weld these with various welding procedures and then to test them destructively. Since this method usually involves a very large expenditure of time and money, some simpler and quicker method is required, and it is hoped that this paper will show how this can be achieved.

This paper is based partly on a booklet[1] entitled "Arc Welding Low Alloy Steels", which was prepared by the author for the British Welding Research Association, and published in 1956.

Factors Affecting Cold Cracking

Cold cracks often occur in the parent material, in the region which had undergone transformation during welding, and very close to the weld fusion line. They are then referred to as "heat-affected zone cracks", "hard-zone cracks" or "underbead cracks". Recent work[2] shows, however, that cold cracking of a very similar nature occurs in the weld metal, particularly when high tensile electrodes are used, and it has been reported[3] that the location of the cracks depends upon the relative hardenability of the weld metal and the parent metal. To avoid confusion, therefore, the defects will be referred to here simply as cold cracks.

The main factors which affect the incidence of cold cracking in low alloy steels are: (a) the crack resistance of the steel itself (b) the type

and condition of the electrodes (c) the stresses present around the joint (d) the cooling rate of the weld. These factors must all be evaluated if cracking is to be avoided; they will not be considered separately.

Crack Resistance of the Steel

Such factors as the grain size of the steel, previous heat treatment, and number of non-metallic inclusions are all said to have some modifying effect on the incidence of cracking in a low alloy steel. But by far the most important factor connected with the steel is its chemical composition, which determines its hardenability and its mode of transformation during cooling after welding.

The resistance of a steel to cold cracking can be determined experimentally by means of suitable welding tests, or can be worked out approximately from the steel composition. Often the two methods can be combined, using the value calculated from the composition to reduce the number of weld tests which have to be evaluated.

It should be stressed that for critical applications, practical tests should always be used, since the relationship between steel composition and weldability is only an approximate one.

Establishing Crack Resistance using the CTS Test

Numerous tests have been devised from time to time for investigating the welding characteristics of various materials; these are generally called "weldability tests". The term "weldability" has a multitude of meanings, but here we take it to mean simply the resistance of a steel to cold cracking during welding.

Several tests have been devised for investigating cold cracking in low alloy steels; descriptions of some of these tests are given in the monograph by Stout and Doty[4], and in the more recent review by Borland.[5] It is proposed to confine consideration in this report, however, to the scheme of testing which uses the Controlled Thermal Severity test, usually known as the CTS test.

The CTS test was developed by Cottrell[6] at the British Welding Research Association. This test was the one described in the writer's previous booklet[1], and since then it has been the subject of investigations by Commission IX of the International Institute of Welding[7,8], so a large amount of data is now available on its operation and its relation to cracking in service.

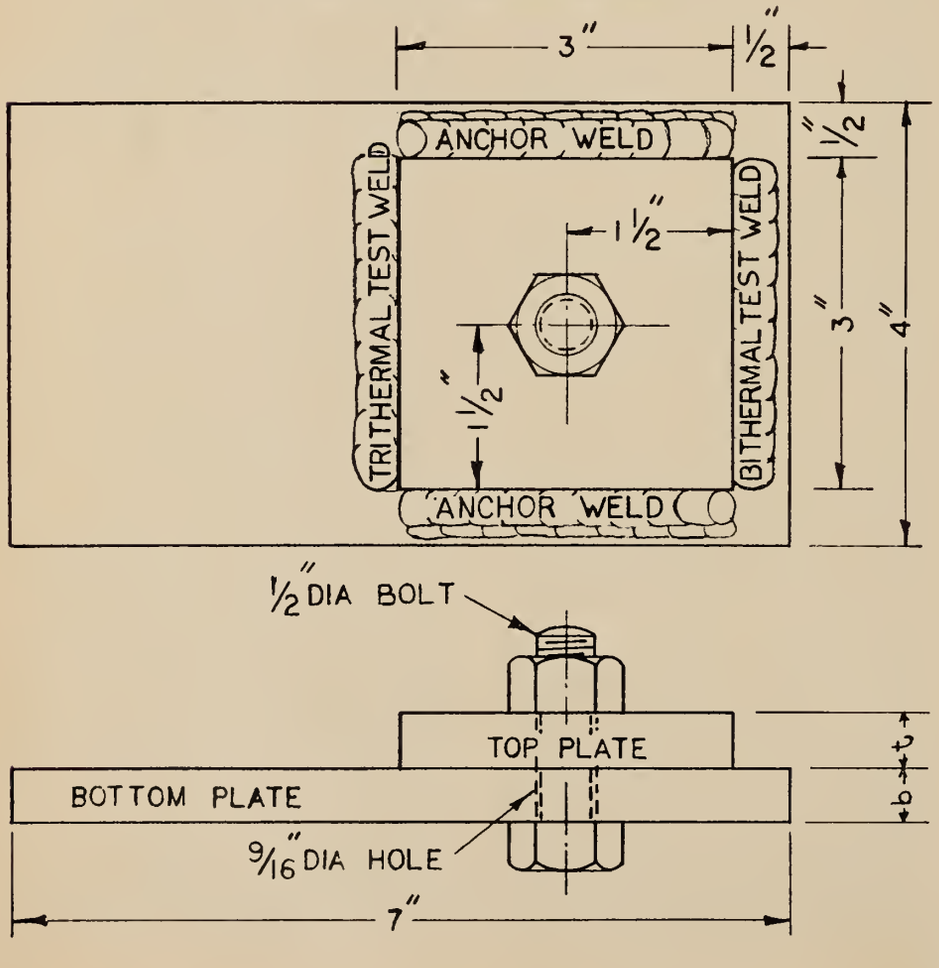
The method of making the test, and of determining the "weldability index" of a steel using a series of CTS tests has been fully described elsewhere[1,5,6,7], so will only be briefly summarized here.

Each test assembly contains two test fillet welds, made between two machined plates previously bolted and anchor welded together. The form and dimensions of the standard test assembly are shown in Fig. 1.

Of the two test welds on each assembly, one is "bithermal", meaning that heat is conducted away from the weld through two thicknesses of plate, the other is "trithermal", with heat being conducted through three plate thicknesses. The "Thermal Severity Number" (TSN) of a test weld is a measure of the total thickness of plate conducting heat away from the weld, with one ¼ inch thickness representing TSN 1. Thus if the standard test shown in Fig. 1 was made from ½ inch plate, the bithermal test weld would have a TSN of 4, and the trithermal test weld a TSN of 6. The higher the TSN of a joint, the faster is the cooling rate of the weld area, and the more severe the test.

The standard test series consists of three assemblies, made respectively with ¼ inch, ½ inch and 1 inch plates, giving a series of TSN values from 2 to 12. With test welds made using an arc energy of 32,000 joules per inch of weld (about ¼ inch leg length), these TSN values correspond to cooling rates in the weld heat-affected zone by varying from 2 to 32 centigrade degrees per second at 300°C. (The cooling rate at 300°C, or 572°F, was found by Cottrell[6] to give the best correlation with cracking.) The weldability index is based on the TSN required to cause cracking, as shown in Table 1, which also gives the corresponding critical cooling rates for crack formation.

Fig. 1. Standard CTS Weldability Test assembly



Proposed Modification of the CTS Test

It was considered that the CTS test could be improved and made more versatile by modifying the form of the test. In designing the modified test, the following features were considered:

(a) the test was designed[6] to contain a sufficient volume of metal so that the cooling rate at 300°C (572°F) in the heat-affected zone would not be affected by saturation of the available heat sink; in other words, the metal drawing heat from the weld was required to act as an infinite heat sink until the temperature of the heat-affected zone had dropped below 300°C (572°F). The original development work, however, indicated that the cooling rate was important down

TABLE 1

WELDABILITY INDEX FROM CTS TESTS

Critical Cooling Rate (at 300°C) above which cracks occur (°C/sec)	*TSN for cold cracking in CTS Test (1/4" leg length fillets)*		*Weldability*
	Present with TSN	*Absent with TSN*	
Over 32	—	12 and under	A
20—32	12 and over	8 and under	B
11—20	8 and over	6 and under	C
6—11	6 and over	4 and under	D
4—6	4 and over	3 and under	E
2—4	3 and over	2 and under	F
Under 2	2 and over	—	G

to about 200°C, (392°F) and recent work[2] tends to confirm the importance of the low temperature cooling rate. It was therefore considered essential to increase the volume of the test, so that it would act as an infinite heat sink down to lower weld temperatures.

(b) Recent Russian work[9] shows that in testing for cold cracking, a test weld length of at least 100 mm (approximately four inches) is required to give the stress conditions that occur in long welds. The use of a four inch test weld in place of the three inch weld was therefore considered advisable, to make the test more representative of normal structural joints.

(c) To extend the methods of establishing welding procedures, as detailed in this paper, a test was required for use with automatic and semi-automatic welding processes, in which faster travel speeds are the rule. In its standard form, the CTS test was found to be unsuitable for this application, since a three inch test weld was too short for high travel speeds, and the test geometry made it impossible to overcome this difficulty by using "run-on" and "run-off" plates.

A modified test has now been designed with these features in mind; the form of the test is shown in Fig. 2. To allow a four inch test weld, without increasing the width of plate required for the test, the bottom plate is slotted, so that the anchor welds are underneath. The modified assembly has a four inch square top plate on a four by nine inch bottom plate, giving a larger available heat sink than the standard test, and all paths for heat flow have been increased from three to four inches. When duplicate trithermal welds are required, the bottom plate should be extended to a length of 13 inches.

With this form of test, automatic welding can be used; two or more test assemblies can be welded at the same time, by butting them together, and holding them by a long clamp (such as a carpenters clamp). Alternatively, "run-on" and "run-off" plates of a similar form to the test assembly may be used. These may be made from mild steel, to conserve alloy material. After welding, the test assemblies are parted by cutting through the test welds at the plate intersections with a small cut-off wheel.

With the modified test, the sections examined should be one, two and three inches respectively from the start of each test weld; otherwise the testing procedure is the same as that used for the standard test, and the weldability index can be established in the same way.

Estimating Crack Resistance from Steel Composition

The use of the CTS test to establish crack resistance is sometimes attended by certain difficulties, one of these being that the steel may not be available in all the required thicknesses. An alternative method is to determine the crack resistance from the steel composition. Even when steel is available in a suitable form for CTS tests, time and money can often be saved by reducing the amount of CTS testing required by using a formula of this type to estimate the weldability before experimental work is started.

The method is to first calculate the "carbon equivalent" of a steel from its composition. For further details of this subject, the reader is referred to the excellent review by Winterton[10], in which the following formula is proposed for the carbon equivalent (CE)

$$CE = C\% + \frac{Mn\%}{6} + \frac{Ni\%}{20} + \frac{Cr\%}{10} - \frac{Mo\%}{50} - \frac{V\%}{10} + \frac{Cu\%}{40}$$

For a large number of low alloy steels, the error resulting from ignoring the molybdenum, vanadium and copper contents would be negligible, and the formula could be reduced to:

$$CE = C\% + \frac{Mn\%}{6} + \frac{Ni\%}{20} + \frac{Cr\%}{10}$$

The higher the carbon equivalent, the lower the weldability of the steel tends to be. The approximate relationship between the carbon equiva-

Fig. 2. Proposed Modification of CTS weldability test assembly

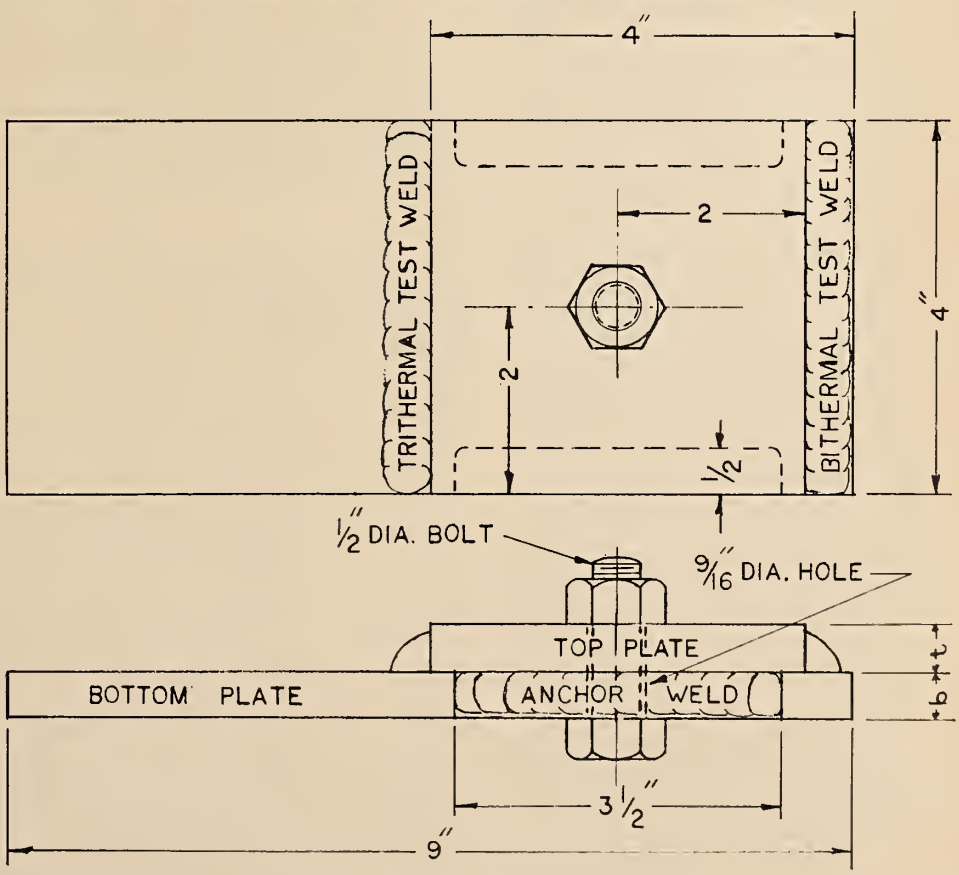


TABLE 2

WELDABILITY INDEX FROM STEEL COMPOSITION

(for low hydrogen electrodes)

Range of carbon equivalents, %	*Weldability Index*
Up to 0.40	A
0.41—0.45	B
0.46—0.50	C
0.51—0.55	D
0.56—0.60	E
0.61—0.65	F
More than 0.65	G

lent calculated from the above formulae, and the weldability index, assuming the use of low hydrogen electrodes, is given in Table 2.

Effect of Type and Condition of Electrode on Cracking

Numerous investigations have shown that cold cracking of the type considered here only occurs in the presence of hydrogen, which originates in the electrode coating. For this reason, the only types of electrode usually recommended for the welding of low alloy steels are the "low hydrogen" types, particularly AWS classes E7018, E7028 and their higher tensile equivalents, and this paper only gives conditions for these types of electrodes.

It is very important, however, that the electrode coatings are really dry; water in the coating makes a mockery of the "low hydrogen" label, and can cause serious cracking.[2] If there is any doubt as to their dryness, electrodes should be baked at 600°-800°F for one hour and then stored in an oven or a sealed container until required.

Effect of Stress on Cracking

There are always stresses present in any welded joint, some being applied from outside the joint area, and some being caused by changes in the materials of the joint itself, as a result of the weld thermal cycle. The procedures detailed in this paper are designed to avoid cracking in most normal structural joints, as represented by the test fillets of the CTS test.

In the following cases, however, the effective stress is apparently higher than that present in a CTS test fillet:

(a) In highly restrained joints, especially highly restrained butt joints.

(b) In joints similar to those found in the cruciform test. It has been found[11,12] that some steels, which do not crack in CTS test, will crack in a cruciform test which has the same weld cooling rate. This appears to be due to stresses caused by plate movement after the weld is cold; in other words, a cold weld may be cracked by stresses created when an adjacent weld is made.

(c) In joints with a big root gap. Recent work[13] shows that a 1/16 inch root gap appreciably increases the crack susceptibility of a weld.

In these cases the recommended preheat temperature for the joint, as worked out by these procedures, should be increased to compensate for the increased stresses. In critical applications, when one of these conditions is present, it would be advisable to make a practical test, simulating the actual joint.

Effect of Weld Cooling Rate on Cracking

In general, the higher the cooling rate of the weld and heat-affected zone of a low alloy steel, the more likely is cracking to occur. An increase in low temperature cooling rate has been found to eliminate cracking in some steels,[2] but within the range of cooling rates met in normal welding practice, the above statement is still true, and is taken as the basis of the recommendations in this paper.

The cooling rate of the weld and heat-affected zone depends upon:

(a) the total thickness of the joint

(b) the initial temperature of the plate materials

(c) the thermal conductivity of the plate material

(d) the heat input of the weld

The cooling rate increases with an increase of joint thickness or conductivity, and decreases with an increase of joint temperature or weld heat input.

The total thickness of the joint can be expressed in terms of the Thermal Severity Number of the joint, as explained in the description of the CTS test. It has been demonstrated previously[14] that the TSN of a joint can be estimated fairly accurately from the joint geometry. If the TSN varies along the length of the joint, the highest value should be taken.

The thermal conductivity of the types of steels considered here does not vary very much, and has been taken as constant for these calculations.

The heat input to the weld, which determines the cross-sectional area of the weld bead, is related to the arc energy, which is usually expressed in joules (or kilojoules) per inch of weld, and is found from the relationship:

$$\text{Arc energy} = \frac{\text{Amperage} \times \text{Voltage}}{\text{Speed of welding (in./sec.)}} \quad \text{joules/inch}$$

In practice, it can be derived more easily, and fairly accurately, from the length of weld run corresponding to a known length of electrode, as shown in Fig. 3 for typical electrodes of AWS type EXX18. It will naturally vary a little with the amount of iron powder in the electrode coating, but arc energies estimated from this type of graph will be accurate enough for practical purposes. Similar graphs can be drawn for electrodes of other types (EXX16 and EXX28).

Knowing the TSN of the joint, the initial plate temperatures and the arc energy, the cooling rate of the weld or heat-affected zone can be found by the following empirical relationship, which was derived from experimental data.[15]

$$\frac{1}{\sqrt{R}} = \frac{E + 1000N}{54T(1 + T/1000)(N + 1/2)}$$

where

R = Cooling rate at 300°C, in Centigrade degrees/second

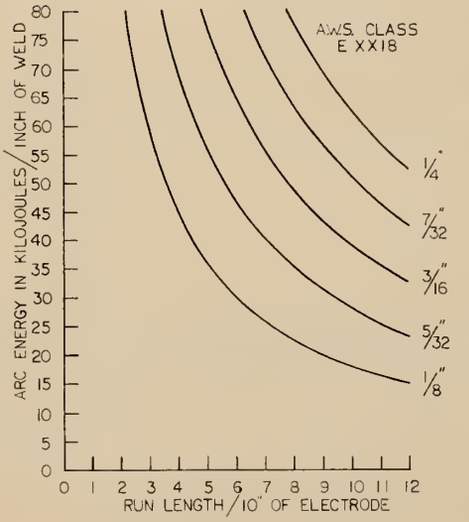
E = Arc Energy in joules/inch of weld

N = Thermal Severity Number (TSN) of the joint

T = $300 - t$, where t is the initial plate temperature in °C.

For any particular value of arc energy (or size of weld) however, there is a limiting value of cooling rate which cannot be exceeded by any further increase of plate thickness. This cooling rate is equal to that of a weld on an infinite plate, and has been calculated theoretically by Rosenthal.[16] It has been shown previously[15] that for our present pur-

Fig. 3. Graphs for deriving arc energy from electrode size and run lengths, for AWS class EXX18 electrodes



poses, the formula can be reduced, for fillet welds, to the form:

$$R = 10T^2/J$$

where J = energy input to the plate in joules/inch of weld. J has been determined experimentally, and found to be represented approximately by the empirical relationship:

$$J = 0.7E + 16\sqrt{E},$$

so that

$$R = \frac{10T^2}{0.7E + 16\sqrt{E}}$$

Thus, using the appropriate formula, or graphs based on these formulae, the cooling rate of any weld can be calculated.

Calculation of Welding Parameters to Avoid Cracking

When the weldability index of a steel has been established, the lowest critical cooling rate at 300°C (572°F) corresponding to that index, as shown in Table 1, can be substituted in the appropriate cooling rate formula. If the TSN for the joint is also substituted, the formula reduces to the relationship between arc energy and initial plate temperature (i.e. minimum preheat and interpass temperature) required to avoid cold cracking. These data have been calculated and reduced to tabular form in Table 3. All the temperatures in the table are in degrees Fahrenheit; the letter "W" denotes a temperature below —50°F, implying that welds can be made without preheat anywhere in the world.

Table 3 provides a guide for the avoidance of cold cracking in the constructional low alloy steels. It should be noted, however, that preheats or arc energies should not be too much higher than those recommended when the quenched and tempered steels are being welded, or the mechanical properties of the heat-affected zone may be destroyed.

TABLE 3

WELDING CONDITIONS FOR THE PREVENTION OF COLD CRACKING

Joint Severity	Weldability index of steel	Minimum plate temperature (°F)* for welds made with the following arc energies (Kilojoules/inch)						
		20	30	40	50	60	70	80
TSN 2.....	A	W	W	—	—	—	—	—
	B	W	W	—	—	—	—	—
	C	W	W	—	—	—	—	—
(Two 1/4 in. plates,	D	25	W	—	—	—	—	—
etc.)	E	125	W	—	—	—	—	—
	F	225	100	—	—	—	—	—
TSN 3.....	A	W	W	W	W	—	—	—
(Two 3/8 in plates, or	B	W	W	W	W	—	—	—
three 1/4 in. plates, or	C	25	W	W	W	—	—	—
1/4 in. on 1/2 in.	D	150	0	W	W	—	—	—
plate, etc.)	E	225	100	—25	W	—	—	—
	F	325	225	125	25	—	—	—
TSN 4.....	A	W	W	W	W	W	W	W
(Two 1/2 in. plates, or	B	—25	W	W	W	W	W	W
three 1/3 in. plates, or	C	125	W	W	W	W	W	W
1/4 in. on 3/4 in. plate	D	225	100	—25	W	W	W	W
etc.)	E	275	175	75	—25	W	W	W
	F	350	275	200	125	75	0	W
TSN 6.....	A	0	W	W	W	W	W	W
(Two 3/4 in. plates, or	B	100	—25	W	W	W	W	W
three 1/2 in. plates, or	C	225	100	0	W	W	W	W
1/2 in. on 1 in. plate,	D	300	200	125	50	—25	W	W
etc.)	E	350	275	200	125	50	0	W
	F	400	350	300	250	200	150	100
TSN 8.....	A	100	W	W	W	W	W	W
(Two 1 in. plates, or	B	175	75	W	W	W	W	W
three 2/3 in. plates, or	C	275	175	100	25	W	W	W
1/2 in. on 1-1/2 in.	D	350	275	200	125	75	25	W
plates, etc.)	E	375	325	275	200	150	100	50
	F	450	400	350	300	275	225	175
TSN 12.....	A	175	75	0	W	W	W	W
(Two 1 1/2 in. plates,	B	250	175	100	25	W	W	W
or three 1-in. plates,	C	325	275	200	150	100	25	—25
or 1 in. on 2 in. plate,	D	400	350	300	250	200	150	100
etc.)	E	425	375	350	300	250	225	175
	F	475	450	400	375	350	325	275
TSN 16.....	A	175	75	25	W	W	W	W
(Two 2-in. plates, or	B	250	200	125	75	50	0	W
three 1-1/3 in. plates,	C	350	300	250	225	175	125	75
or 1-in. on 3 in. plate,	D	400	375	325	300	275	225	200
etc.)	E	450	400	375	350	325	275	250
	F	475	450	425	425	400	375	350
TSN 24.....	A	175	75	25	W	W	W	W
(Two 3-in. plates, or	B	250	200	125	75	50	0	W
three 2 in. plates, or	C	350	300	250	225	175	150	125
any larger joint)	D	400	375	325	300	275	250	250
	E	450	400	375	350	350	325	300
	F	475	450	425	425	400	400	375

* Temperatures are quoted in 25°F steps.
W denotes a temperature below —50°F.

Conclusions

Methods have been detailed for establishing welding procedures to prevent the occurrence of cold cracking in constructional low alloy steels. These methods have been in use for several years, but have been modified in the light of recent research.

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Comments on Vertical Breakwaters with Low Coefficients of Reflections

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THE RECENT CONSTRUCTION of a "perforated breakwater", and the number of papers published on this occasion have aroused new interest in the possibility of realizing vertical types of breakwaters with low coefficients of reflection.

Most of these papers have emphasized the physical principles of the function of perforated breakwaters, but no data is available with reference to the optimum characteristics and the efficiency of such breakwaters. Some papers have at most insisted on the importance of selecting properly the diameter and length of the perforated holes in order to obtain an optimum attenuation effect.

We were puzzled by the theoretical approach followed for the selection of the optimum characteristics of the holes so we ran a few tests to determine the exact influence of these characteristics and of the chamber width over the breakwater effectiveness.

This study confirmed the advantages of perforated breakwaters, but showed that the characteristics of the perforations are less important than the total void ratio of the seaward face and the chamber width itself.

Even if the study has not yet reached completion, we hope that publication of the results already obtained will contribute to a better understanding of the advantages, limitations and possible use of slotted or perforated breakwaters.

REFLECTION AND STABILITY CONSIDERATIONS

A breakwater in deep water causes reflection of incoming waves. The wave momentum is stopped; part of the energy is absorbed by the structure and part is reflected seaward in the form of reflected waves.

Incoming and reflected waves will combine. If the incoming wave front is parallel to the breakwater, either a partial or a complete clapotis will be formed depending upon the coefficient of reflection of the breakwater. If the incoming wave front is oblique to the breakwater, a typical criss-cross pattern of waves will be formed.

In all cases, the reflection increases the wave height, the load exerted against the breakwater, the danger of the breakwater being overtopped, and navigation becomes more difficult.

If the water depth is limited, the combination of the reflected waves with the incoming waves can cause the resulting waves to break; this involves shock pressures much larger than the hydrostatic pressures experienced in wave reflection.

Breaking and reflection, moreover, often set up very severe erosive action of the sea bed capable of endangering the stability of structures.

COMPARISON OF VERTICAL AND RUBBLE-MOUND BREAKWATERS

The relative merits of these two types of structures have been much discussed in the past. Except under special conditions of foundation and depth, the main advantage of the caissons type over the rubble mound type is one of economy, whereas the rubble-mound breakwaters are often considered to be safer and less difficult to construct.

The rubble-mound breakwaters, for obvious reasons, are less reflective than vertical breakwaters which favor

Fig. 1

William SMITH Patent
for Sea Walls, Breakwaters and Similar Structures (1908)

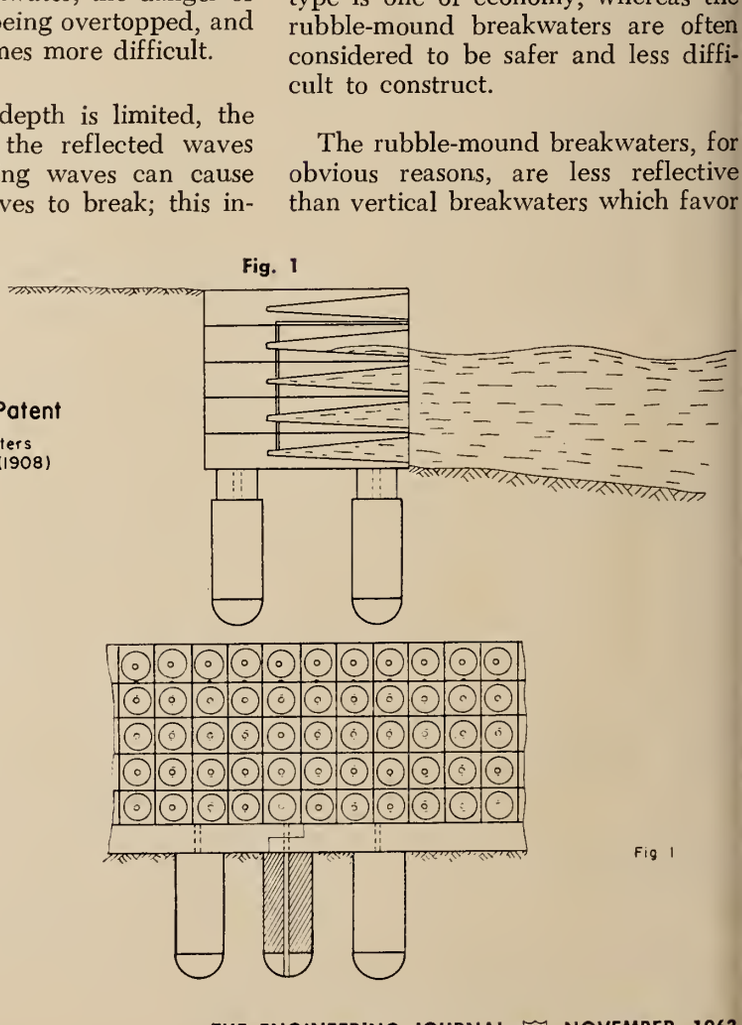


Fig 1

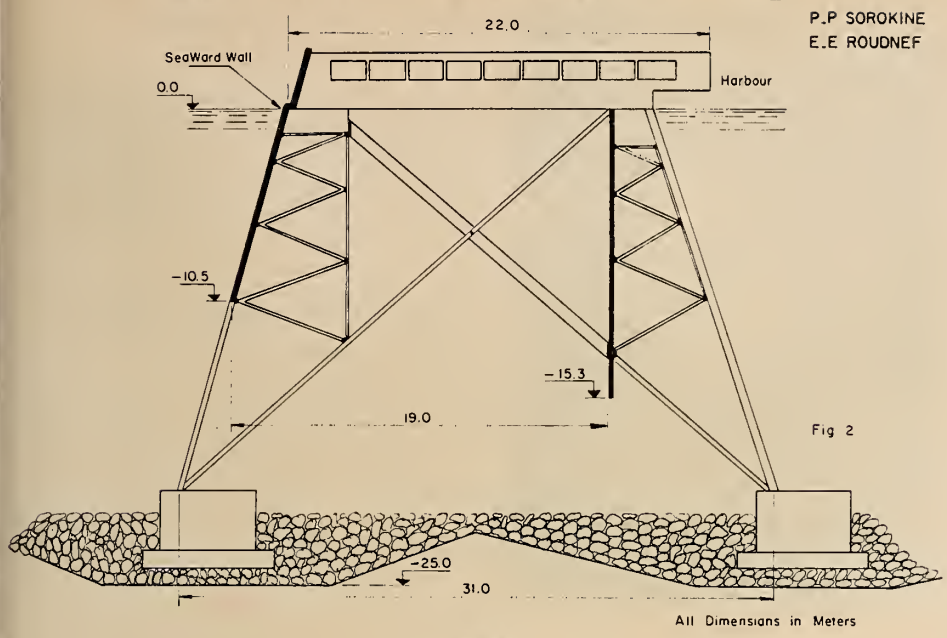


Fig. 2

the formation of standing waves. They can be erected on poor foundations, due to their flexibility, and require a smaller "stability safety factor" (contrasted with vertical structures) due to the possibility of repairing them after exceptionally severe storms.

On the other hand, vertical breakwaters permit large savings in material cost, especially when water depths are important. They must however be erected on safe foundations and designed with a large "stability safety factor". Exposed to complete destruction if they are unable to withstand the maximum waves expected, they are more vunerable than rubble-mound breakwaters. The well known accidents which occurred throughout the world since 1900 (Catania, Genoa, Bizerte, Algiers) demonstrate this fact.

Nevertheless, since the development of concrete caisson construction methods (built in dry dock, floated and sunk in place), and especially with use of pre-stressing techniques, vertical breakwaters know a new vogue in many areas, particularly where good armor stone for rubble-mound breakwaters is in short supply.

LOW REFLECTIVE VERTICAL BREAKWATERS

One will readily understand that any device combining to some extent the economy allowed by vertical structures and the low reflective coefficent of rubble-mound breakwaters, would hold great promise in marine design.

Various attempts have already been made in this way, as shown hereafter.

NEW SCHEMES IN VERTICAL BREAKWATER DESIGNS

Four devices which illustrate the constant effort of designers from several countries, to find less reflective vertical breakwaters, have been selected for consideration.

Proposal in the U.S.A.

As far as the writer is aware, one of the first attempts in this direction was made by the American, William Smith, in 1908.

He proposed to the U.S. Patent Office a new type of breakwater shown on Fig. 1 and "provided with cells or cavities in its exposed face to receive water and thereby reduce the shock due to the pounding of the waves thereon". This beneficial effect, according to the inventor, was due to the cushioning action of the air in the cavities. As indicated in the patent, the length of the cells or cavities had to be proportioned to the violence of the waves to which the structure was subjected, and the walls of the cavities or cells were convergent from the wider or open end to the apex.

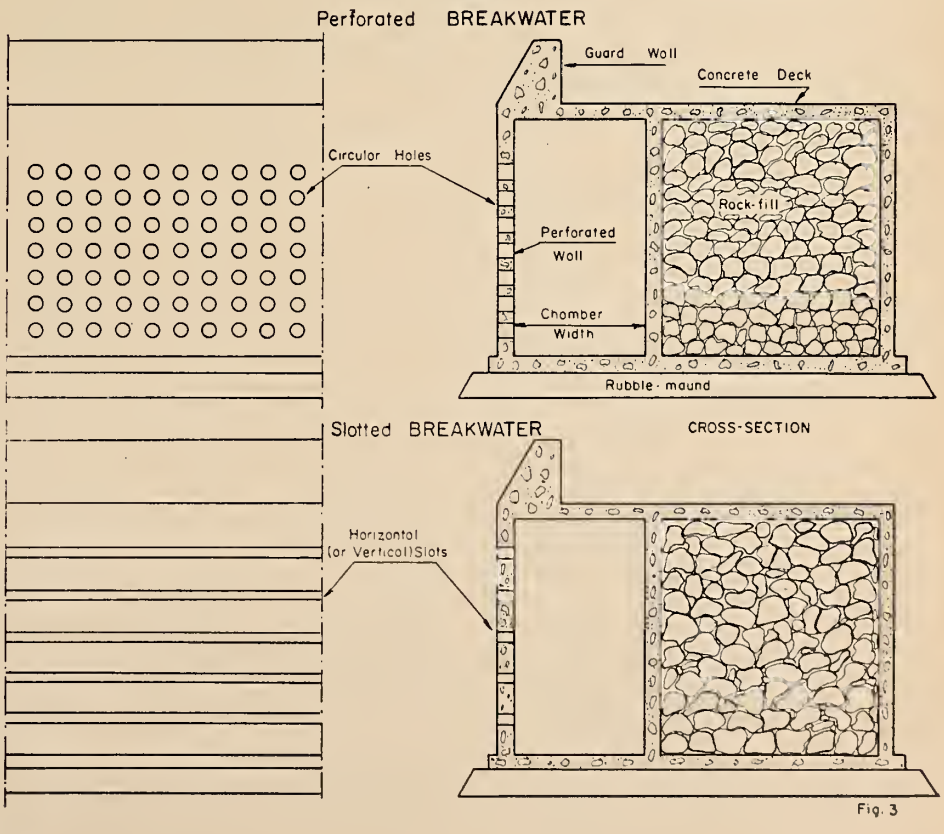
No data is available about the effectiveness of Smith's breakwater, but the writer is of the opinion that the idea probably was more attractive on paper than effective in reality.

Russian discontinuous breakwater studies

More is known regarding the Russian works carried out since 1937 on discontinuous breakwaters (sketched on Fig. 2). These projects take advantage of the fact that most of the wave energy is confined to the upper part of the water depth, in accordance with the wave theory which shows that the radii of the generating circles decrease with the depth below the surface in a geometrical progression of which the common ratio is $1/\sqrt{e}$ (where e is the base of the Naperian logarithms).

The essential elements in a discontinuous breakwater are the depth

Fig. 3



of immersion and the height above still-water level of the exposed face. The former determines the intensity of the oscillatory movement passing through the structure and the latter prevents wave overtopping.

Many theoretical and scale model studies have been conducted on the subject: Bogoledof (1937-41), Roudnef (1940-41), Khaskind (1945), Kouznetzof, S. P. Sourovtzef (1938), Grigorief (1945), Bojitch, Kondratief (1946) etc.

Unfortunately, the numerous conclusions and formulae available, most of the time are limited to very particular conditions, so they cannot be generalized.

Valembois' Hydraulic Resonators

Low reflective breakwaters could also profit by the principle of resonant structures, the possibilities of which appear in a paper presented at the Fifth Conference on Coastal Engineering in 1954 by Valembois and Birard, from the "Laboratoire National" of Chatou, France.

Resonators of various types were presented, one of which had a period of resonance independent of the variations of level due to tides.

Applications to harbor problems have been studied with success in Chatou. One of them concerned the protection of the inner harbor of Dunkerque and of the Watier Lock. Another study was conducted for Port-en-Bassin Harbor, in which resonant structures were used to complete the action of ordinary structures for a certain range of wave periods.

Some research could be done concerning the possibility of incorporating resonators into breakwaters in order to reduce their reflective power.

Fig. 4

N. R. C. Perforated Breakwater

About two years ago, a new idea was brought forward by the National Research Council of Canada.

It consisted of a breakwater composed of caissons which had circular holes on their seaward face.

When a wave surges against this vertical face, water jets through the perforations of the wall into a chamber. Inside, energy is dissipated through friction and turbulence. As the wave recedes, the flow is reversed. Jets from the chamber have a dampening effect on the incoming waves, as proven by earlier experiments using this action to obtain a local wave attenuation at the entrance of lock at Dunkerque (France). In addition, a certain resonance of the chamber is not excluded for some periods of the waves.

As far as we know, no quantitative results were ever published concerning this device, but a first application of the idea has been accepted, and the future will tell if the results prove to be as anticipated.

PERFORATED AND SLOTTED BREAKWATERS

The LaSalle Hydraulic Laboratory, being interested in the concept of non-reflective breakwaters, decided to conduct a series of scale model tests in order to obtain a better knowledge of the quantitative possibilities and optimum characteristics of perforated breakwaters.

We give hereafter the results of our experiments, in the hope that they will be of some help to marine designers.

Research of optimum characteristics

Not being convinced of the importance circular hole characteristics have in the effectiveness of perforated breakwaters, we first ran a few tests to compare various types of holes. Results showed that, keeping the same chamber width, the total void ratio of the seaward wall is much more important than the individual hole characteristics.

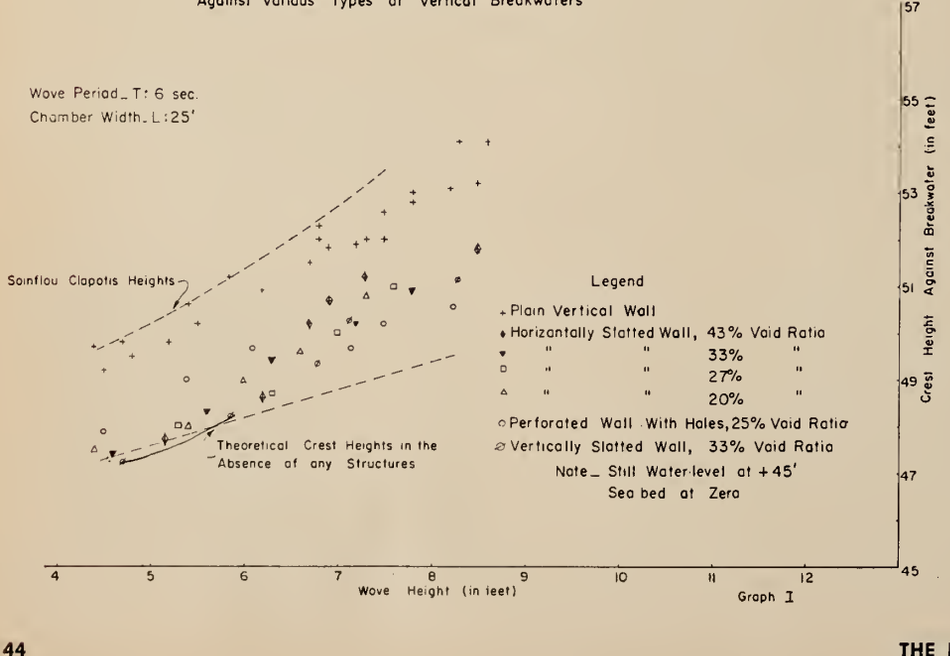
In fact replacing a series of circular holes by slots of equivalent area proved to be interesting from a breakwater efficiency point of view. So, for ease of construction and modification, most of our systematic tests were carried out with slotted walls (Fig. 3) instead of the perforated walls studied by the N. R. C.

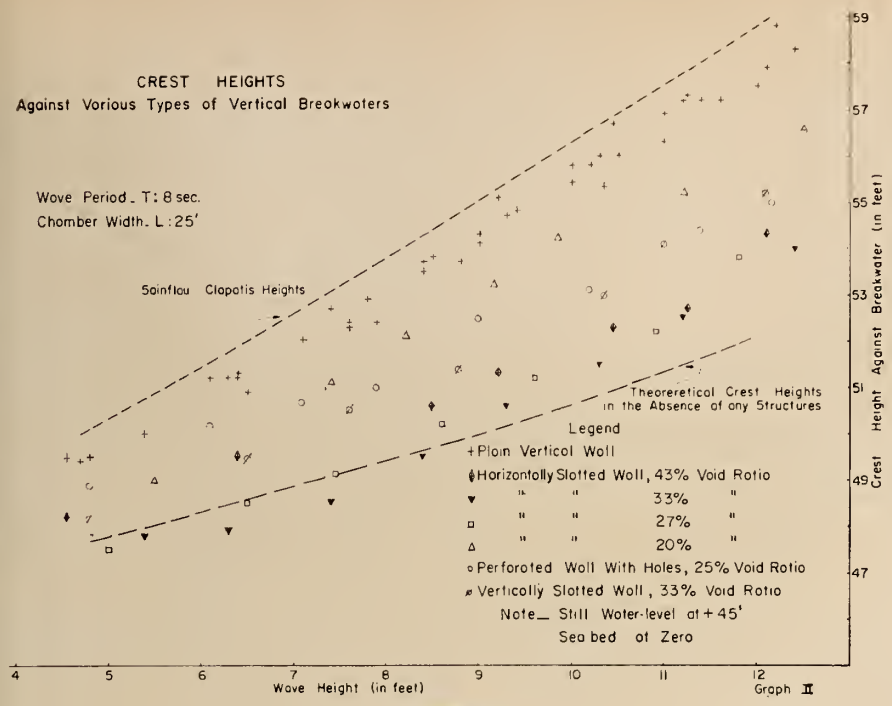
Considering that the variables which govern the effectiveness of perforated breakwaters are: the void ratio of the seaward wall; the shape of the openings and the width of the dissipating chamber, the following systematic tests were carried out:

i) 20%, 27%, 33% and 43% (void ratio) horizontally slotted walls were tested to determine an optimum wall void ratio (with a chamber width constant and equal to 25 ft.) the scale being 1/36;

ii) Assuming the constancy of the optimum void ratio within a certain range of chamber widths (this has not been verified and should be investigated in an exhaustive study), the optimum void ratio found in part (i) was kept on the model and the chamber width was varied systemati-

Graph I





Graph II

cally in order to demonstrate its influence upon wave attenuation;

iii) The influence of the shape of the orifices was determined by testing 25% (void ratio) circular holes and 33% (v.r.) vertically slotted walls in order to compare them with similar horizontal slots;

Waves from 4 to 13 ft. were despatched against the structures, with 6, 8 and 10 sec. periods and + 45 ft. still-water level (N.B. sea bed at 0 ft.).

Optimum wall void ratio

Graphs I, II and III show the run-up heights obtained using all the types of perforated structures in comparison with the clapotis heights that would be obtained with the same characteristics of waves and a plain wall. This corresponds to a 25 ft. chamber. Experimental data and Sainflou theoretical values are plotted as clapotis heights. This is equivalent to a total reflection of the waves against a plain vertical wall. Crest heights in the absence of any structure are also plotted on the graphs. They represent the conditions encountered with a zero reflection. The run-up heights obtained with the perforated walls lie between these 100% and 0% reflective curves. As can be seen, the 33% (v.r.) horizontally slotted wall has proven itself superior to similar 43%, 27% and 20% (v.r.) walls, and it ensures a noticeable absorption of incoming waves as compared with a plain wall.

Optimum chamber width

Graphs IV, V and VI give run-up results obtained with the best disposition (horizontally slotted wall 33% void ratio) for various periods and chamber widths.

With 6 sec. waves (graph IV) the width of the chamber does not appear to be important. Results are good: the run-up along the breakwater is only 55% to 70% of what it would be with a plain wall.

With 8 sec. (graph V) the 25 ft. chamber clearly out-performed the others. Results were excellent, the run-up height being only 50% to 55% of the Sainflou value (plain wall).

With 10 sec. (graph VI) the influence of the chamber width is not clear and results are not as satisfactory, the run-up being approximately 80% of what it would be with a plain wall.

Graph VII shows the variation of the coefficients of reflection of slotted structures as a function of the chamber width and the wave steepness. The graph is much more significant than the former graphs IV, V and VI in order to determine an optimum chamber width.

Reflection coefficients of a horizontally slotted wall (33% v.r.) are compared for three different chamber widths: 14, 25 and 40 ft. The reflection coefficient decreases as the chamber width and the wave steepness increase.

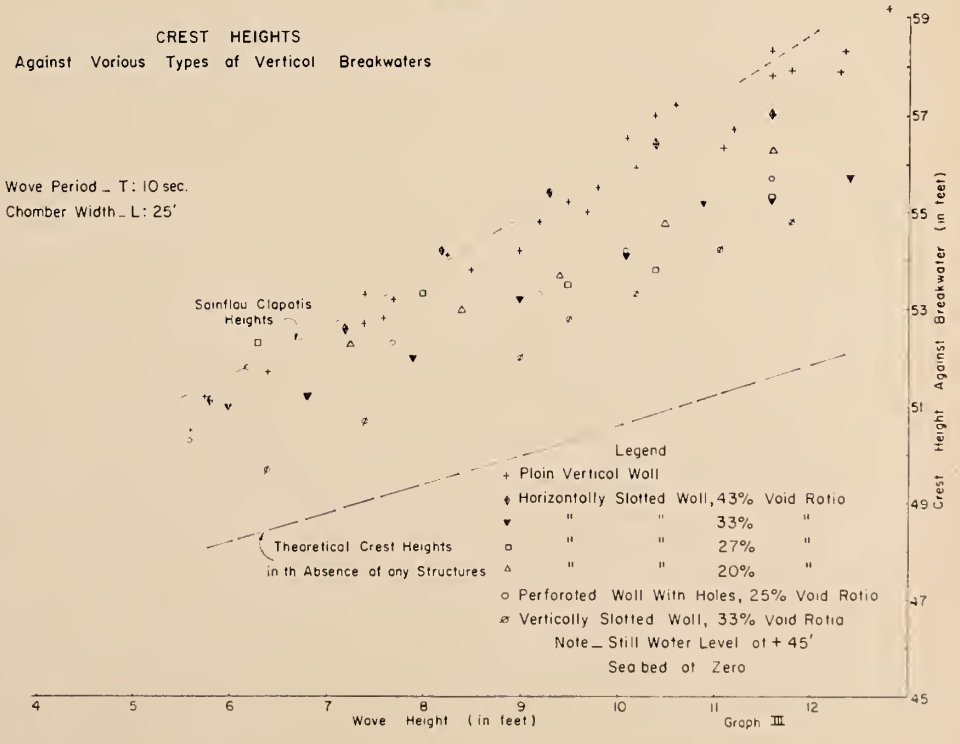
Graph VII, in addition gives reflection coefficients of slotted breakwaters with regard to typical reflection coefficients of mound breakwaters of various slopes.

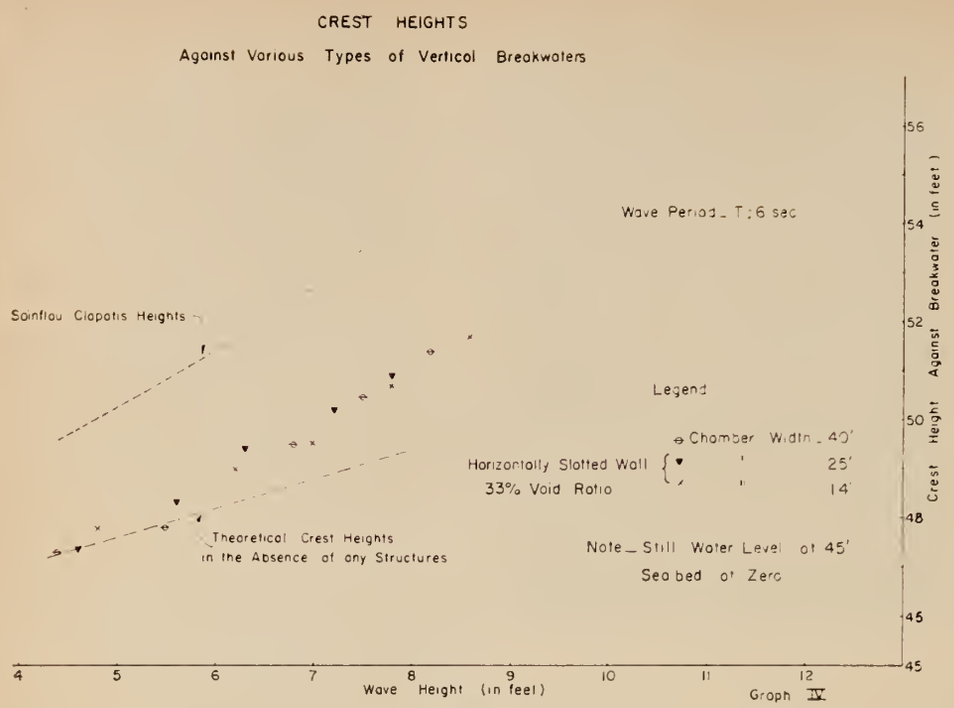
The curves are practically straight and were assumed to be so within the steepness range considered herein, but they should not be extrapolated farther than these limits.

Tetrapod artificial block facings (even with a steep slope) have lower reflection coefficient than natural stone rip-rap because of their higher permeability and roughness.

Reflection coefficient curves of slotted breakwaters are steeper than other similar curves with respect to wave steepness. In a practical case, let us say with a 25 ft. chamber width, the slotted breakwater corresponds to a mound of 5/3 slope, for smaller wave steepnesses, and to tetrapods of 4/3 slope, for steeper waves.

Graph III





Graph IV

Shape Influence

It seems that the shape of the openings has little influence over the perforated wall effectiveness.

Physically, the openings have of course different coefficients of contraction, depending on their shape, and with some shapes the law of discharge varies with the elevation of the openings: circular holes and horizontal slots are in charge at lower elevations while upper elevations flow as weirs (the same remark does not apply to vertical slots).

It is, therefore, understandable that slight differences appear in the run-up values due to some influence of the shape. However, it can be shown that the equations which give the wave amplitude along the wall apply closely to walls of equal void ratios having different shapes.

In other words, the shape could slightly affect the mean level rise, but has no practical influence on the amplitude of the agitation against the wall.

DESIGN FORMULA

We have up to now failed to derive the exact theory that can explain all the results obtained; however, in an attempt to interpret the experimental data, an expression based on the tests conducted with a 0.33 v.r. wall has been developed, relating H_1 the wave amplitude produced against the wall, to H_0, the incoming wave height. The expression has been verified for nine $\lambda 1/L$ ratios, ranging from 4.2 to 24.7, and for 6 ft. to 13 ft. incoming waves. (λ_1 is the wave length of incoming waves, reduced in accordance with the depths of water in front of the structure, and L is the chamber width) (both in feet).

Such an expression could be derived for any wall void ratio and type of wall; the experimental data gathered up to now was not sufficient however to make this generalization (only three $\lambda 1/L$ were tested with 0.20, 0.27, 0.43 horizontally slotted walls, 0.25 perforated wall and 0.33 vertically slotted wall).

The expression found has the form:

$$H_1/\lambda_1 = A(H_0/\lambda_1) + B(\lambda_1/L^{1/3}) + C$$

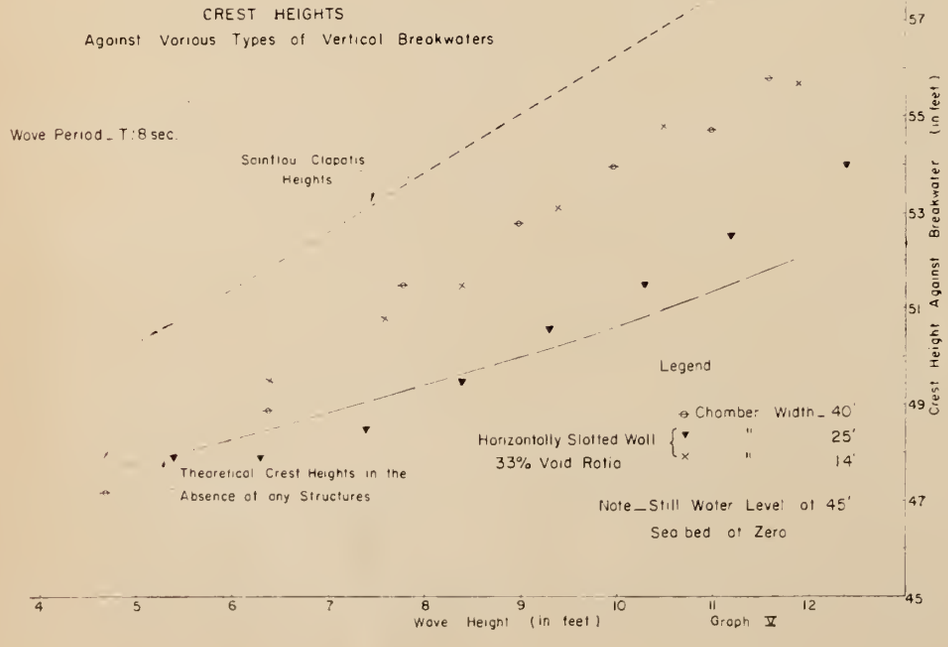
and numerical values of coefficients A, B and C are as follows for a 0.33 hor. slotted wall:

$$A = +1.35 \qquad B = +3 \times 10^{-4}$$
$$C = -3.1 \times 10^{-2}$$

The above equation is only empirical and has no meaning at the limits. An obvious defect in the expression is that H_1 is not equal to zero for $H_0 = 0$. The equation should therefore be used only within the limits of our tests.

While academically such an equation without theoretical justification should be discarded, having regard to the complexities of the problem and until a better general expression is forthcoming, it remains of use for the purpose of preliminary design assessments.

Graph V



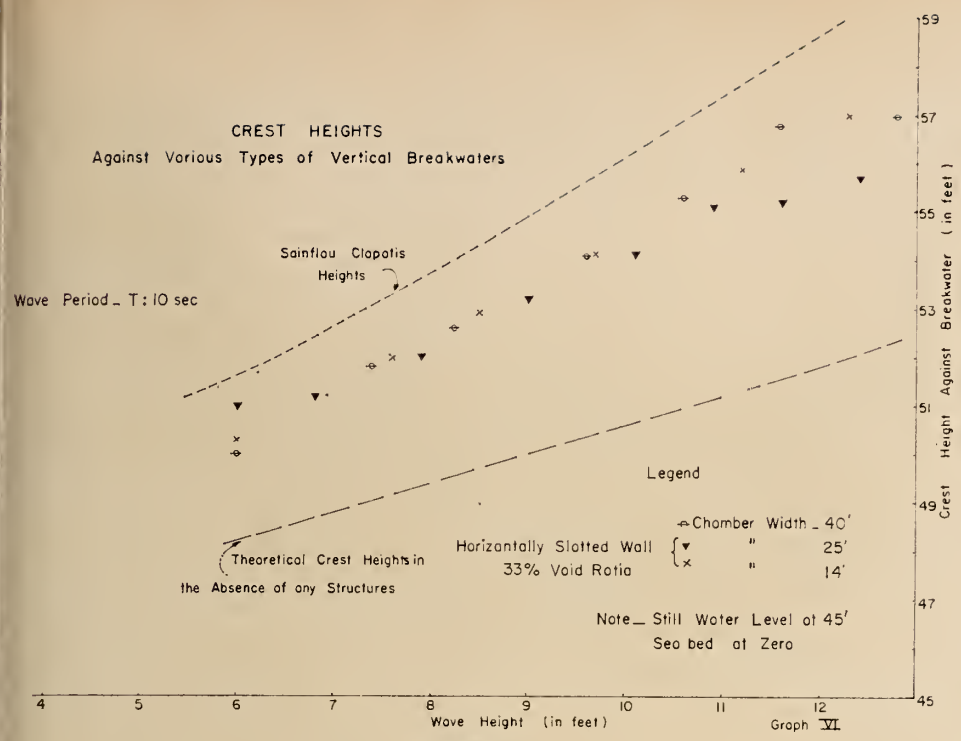
SOME REMARKS ABOUT PHYSICAL ASPECTS OF PERFORATED BREAKWATERS

Two different phenomena contribute to wave attenuation in perforated breakwaters.

a) The energy of the waves is dissipated by jets diffusing alternatively into the chamber and into the sea.

The effectiveness of this dissipation depends on the product of discharges exchanged and the differential head between seaward and landward sides of the slotted wall. This in turn depends on the percentage of void of the wall, the width of the chamber, the water depth and the wave characteristics.

b) The dissipation chamber can act in some respects, as a resonator; in effect, resonance only could explain how selective a perforated breakwater is with regard to wave periods, this being illustrated by the typical attenuation curves presented on graph VIII.



Graph VI

A theoretical analysis of the resonance phenomena is complicated by the fact that various factors can contribute together to create it: forced seiches can occur in the chamber itself, induced by breaking of jets against the inside wall; a mass oscillation, as in a surge tank, can also exist between the chamber and the sea. Due to their complicated limiting conditions, surge tanks formulae, however, do not apply to perforated breakwaters. Mass inertia, for instance, depends on the inertia of the jets themselves, and is not directly given by the thickness of the perforated wall.

To verify more accurately the possible influence of the resonance in the graph VIII curves, a forced oscillation was produced in various chambers and the corresponding natural oscillatory period was recorded.

With a 0.33 horizontally slotted wall, these resonance periods appeared to be as follows (measured values are underlined followed by their multiples).

L = 14′ To 3, 6, 9 .....sec.
L = 25′ To 3.6, 7.2, 10.8.....sec.
L = 40′ To 3.8, 7.6, 11.4.....sec.

On the other hand, 6, 8 and 10 sec. waves (T^*) were despatched against slotted breakwaters during our systematic tests.

Considering graph VIII, it is seen that a maximum attenuation was reached with:

L = 14 ft. for T_o = 6 sec.
L = 25 ft. T_o = 8 sec.
L = 40 ft. T_o = 8 sec.

These optimal points are in rather good agreement with the T_o values tabulated above which correspond to the possibility of resonance. The only discrepancy noted is that T_o = 10 sec. gives just a slight attenuation for L = 25 ft.

It is therefore thought that the resonance effect plays a role in the complex mechanism of wave attenuation. This is translated in addition to graph VIII, by a certain scattering of the experimental data used to plot the reflection coefficient curves presented in graph VII.

Another point with regard to the perforated breakwater effectiveness, is that the same attenuation laws do not apply to the wave run-up (connected to the mean level rise) and to the agitation measured against the perforated wall. The run-up heights of our tests are given by graphs I to VI while our design formula and graph VII correspond to agitation values.

WAVE ENERGY RECUPERATION

The noticeable wave height reduction obtained with a perforated breakwater is connected to a dissipation of the energy of the waves. To be more exact, a certain amount of the incoming wave energy is transformed into potential energy, in the chamber. The potential energy is then dissipated and a part of it contributes to dampen incoming waves by seaward jet action. Thinking in terms of wave energy recuperation, it is difficult to abstain from emphasizing the analogy that perforated breakwaters present with the "wave dihedral device".

Wave dihedrals were proposed at the "IVe Journées de l'Hydraulique" in Paris in 1956 by R. Dhaille, a Sotramer engineer, in order to ensure recovery of wave energy.

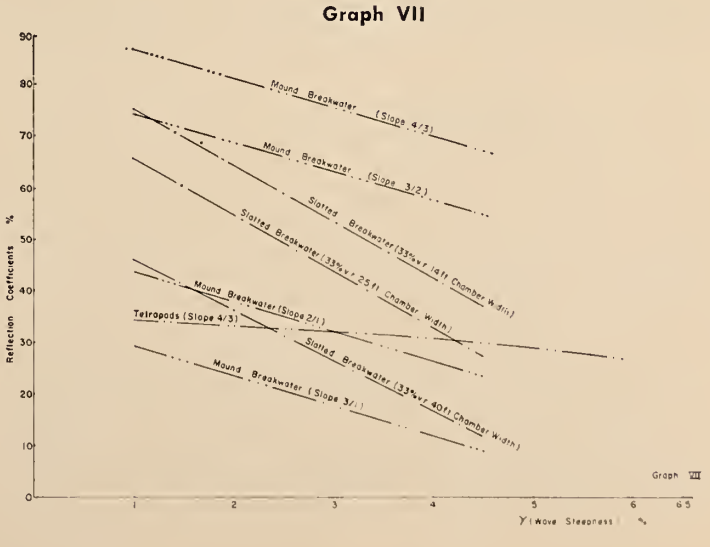
It consists of a series of dihedrals open to the sea and convergent from the wider part to a line of clappers open to an accumulation basin (Fig. 4).

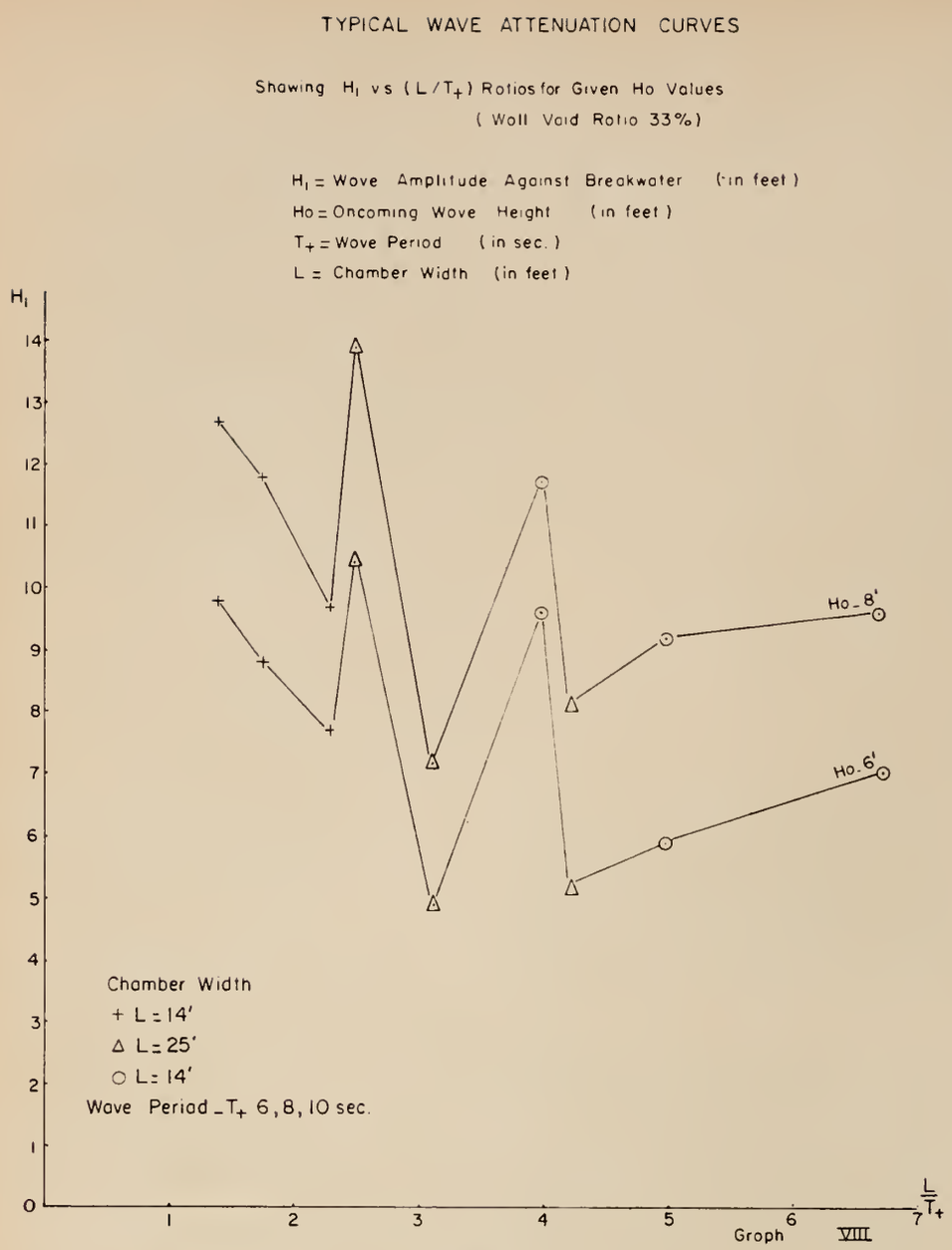
Waves enter the dihedrals and flow through the clappers into the basin; a water head is thus created which is capable of feeding hydraulic turbines coupled with electrical alternators.

R. Dhaille carried out about 300 distinct tests to investigate the energetic possibilities offered by various types of wave dihedrals under a wide range of wave characteristics such as amplitude, wave length and tides.

It follows from his tests that energetic efficiencies as high as 40% are reached; the effectiveness, however, is quite variable depending on wave characteristics. The wave steepness and the depth have a very capricious influence over the results, as shown by graphs IX and X.

Graph VII





Graph VIII

The main problem, however, lies in the nature of the waves themselves: the problematical and irregular character of the phenomenon makes feasibility difficult in the present economical conjecture, despite the rather good energetic efficiencies reached. Nevertheless, and for consideration, calculations show that waves bring an average of 100,000 kwh. per year and per linear meter of coast, at Casablanca.

The damping chamber used in slotted breakwaters offers energetic possibilities similar to those of wave dihedrals. Moreover, it would be possible to use, in certain cases, dyssimetric slots or holes to pump a discharge from the sea into a harbour to create currents that could be used to fight siltation and sand deposition. As both phenomena will be induced at the same time by wave energy, it is hoped that they can neutralize each other for all wave amplitude.

Conclusion

The brief scale model studies outlined in this paper offer another approach to the solution of a complex problem, that of finding vertical breakwaters with lower coefficients of wave reflection.

A clear idea is arrived at regarding the quantitative possibilities afforded by various types of perforated or slotted breakwaters.

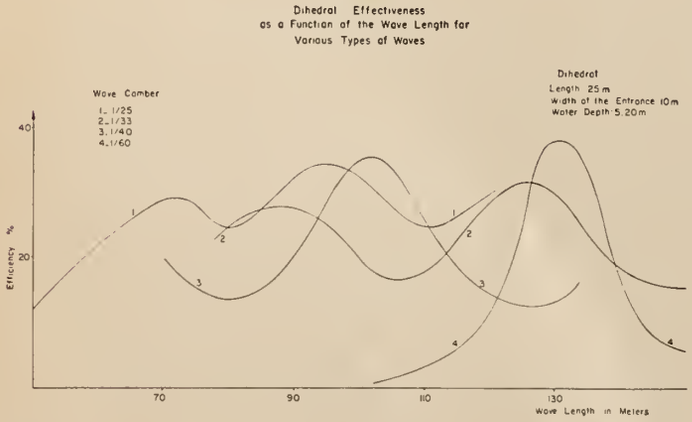
It is first seen from graphs I, II and III that the optimum wall void ratio is around 33%, under reserve of what already has been said in section (ii) entitled Research of Optimum Characteristics. Graph VII, in addition, shows that the wider the chamber the less reflective is the slotted breakwater. Reflection coefficient curves of slotted and mound breakwaters are presented in the same graph. An expression is finally derived for finding the wave amplitude which is maintained at the perforated wall for a given incoming wave height.

The wave attenuation which can be expected from a perforated or a slotted breakwater is therefore known within reasonable accuracy. The economical aspects will now decide their future.

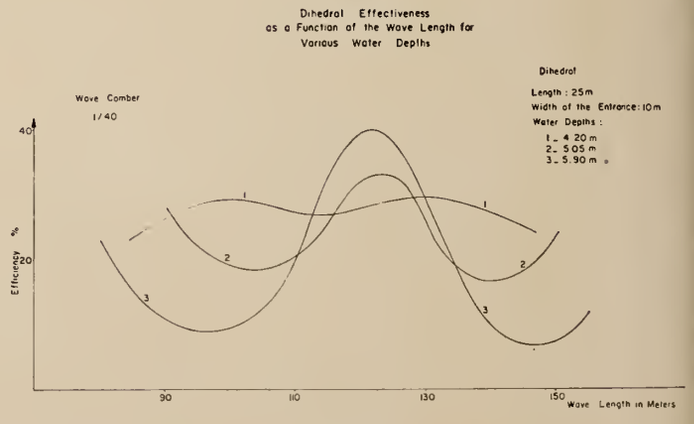
We nevertheless think that the most promising field of application for slotted breakwaters could be a use within harbors, as vertical faces of piers and docks with low coefficient of reflection. They would provide an easy means for reducing parasite reflections and residual agitation inside the harbors.

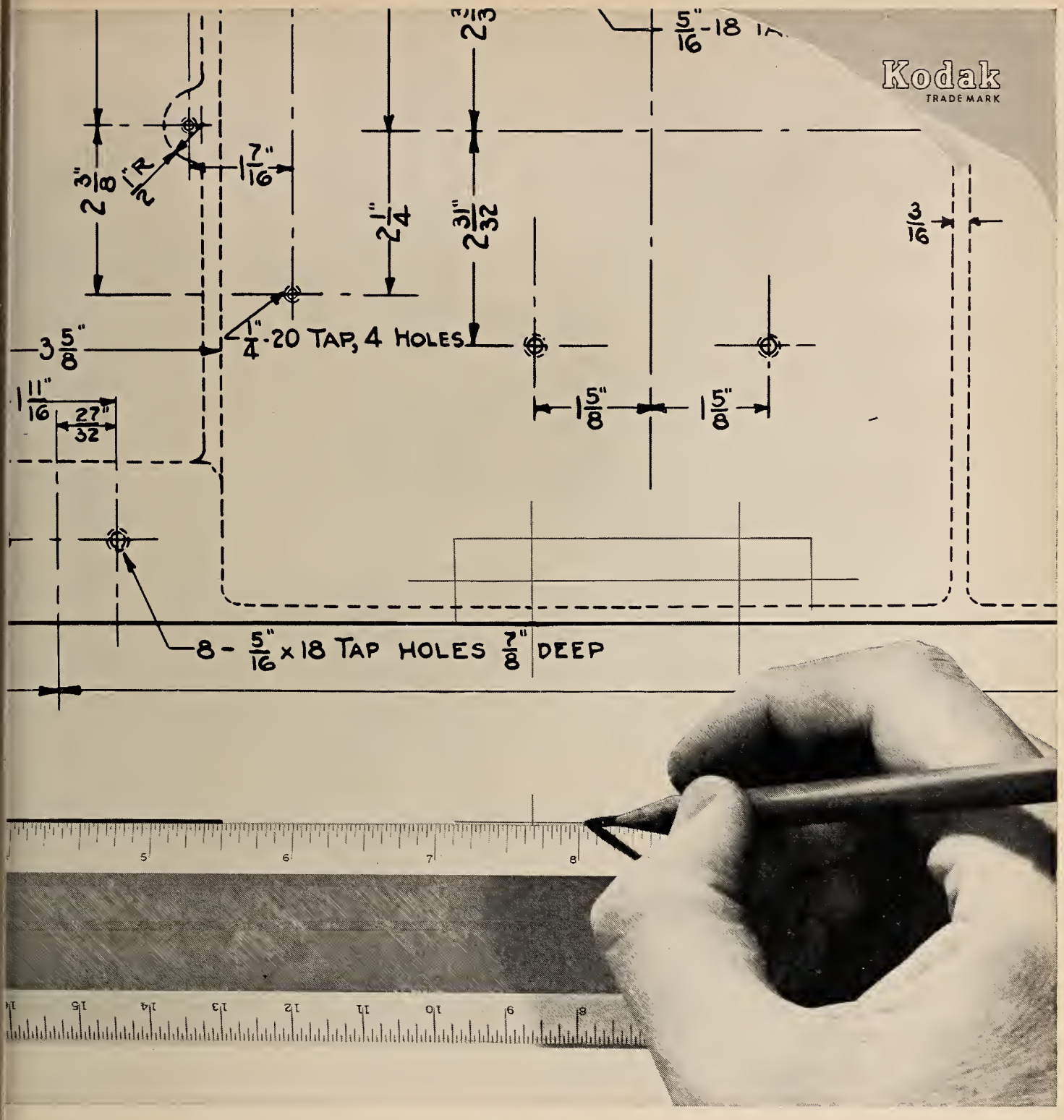
However, due to the increace of the reflection coefficient, which is related to the reduction of the wave steepness, a slotted breakwater will not be as efficient for seiches or long periods of waves as it would be for short ones.

Graph IX



Graph X





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E.I.C. News

Saskatchewan Offers Refresher Courses

The College of Engineering of the University of Saskatchewan, in co-operation with the Branch, offered for the first time this year, a three-day refresher course under the EIC's Technical Development program. The course, and program of study held September 5-7, was planned by a committee headed by Professor J. B. Mantle, M.E.I.C. Members of his committee included Branch Chairman, E. E. Brooks, M.E.I.C., Keith Bowers, M.E.I.C. and Bob Tennant, M.E.I.C. About 90 engineers from the four western provinces attended the courses. Courses given were: Engineering Implications of Digital Computers—presented by Dr. A. D. Booth, Dean of Engineering and head of Electrical Engineers Department and Dr. K. H. V. Booth, Research Fellow, Mathematics Department; Irrigation for Engineers — by Dr. D. M. Gray and Prof. J. M. Murray, Agricultural Engineering Department, and Prof. C. D. Smith of Civ. Eng. Dept.; Design of Automatic Control Systems—by Dr. P. N. Nikiforuk, Mechanical Engineering Department, University of Alberta and Prof. W. J. Kingma, Electrical Engineering Department. Aspects of Soil Mechanics—by Prof. C. A. Noble and Prof. W. G. Watt, Civil Engineering Department. A dinner was held Sept 7 where guest speaker was E. J. Cote, M.E.I.C., Chairman of the Saskatchewan Branch.

Dr. P. N. Nikiforuk, M.E.I.C. left, of the Mechanical Engineering Department explains the operation of a high pressure hydraulic controls test stand to participants of the controls course.

Executive Committee Meets in Shawinigan

A meeting of the Executive Committee of Council was held in Shawinigan, Que., on Sept. 27 in conjunction with a highly successful Regional Technical Conference. The technical conference was sponsored by the Eastern Townships and the St. Maurice Valley Branches of the Institute.

Following are some of the highlights of the meeting of the Executive Committee.

President's Report

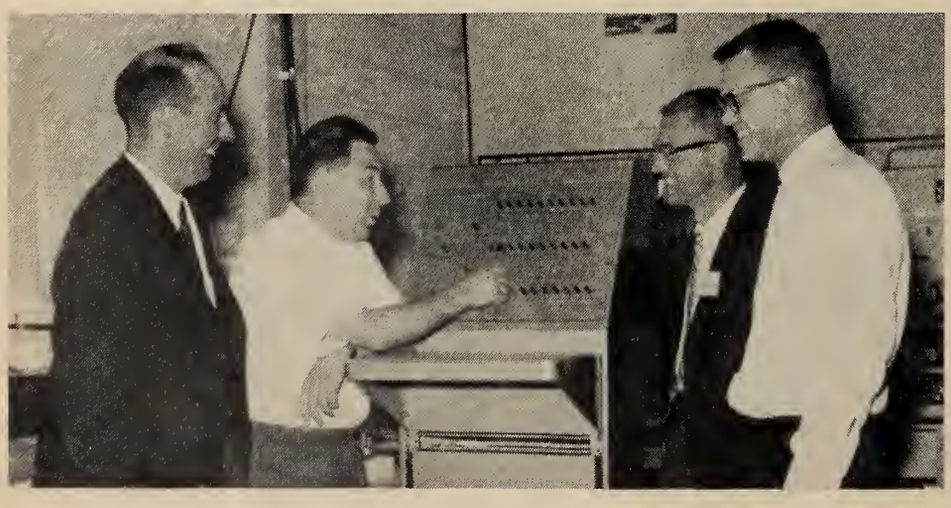
President Higginson reported that a letter of congratulations had been sent to Robert F. Shaw M.E.I.C., on his appointment as Deputy Commissioner of the 1967 World's Fair.

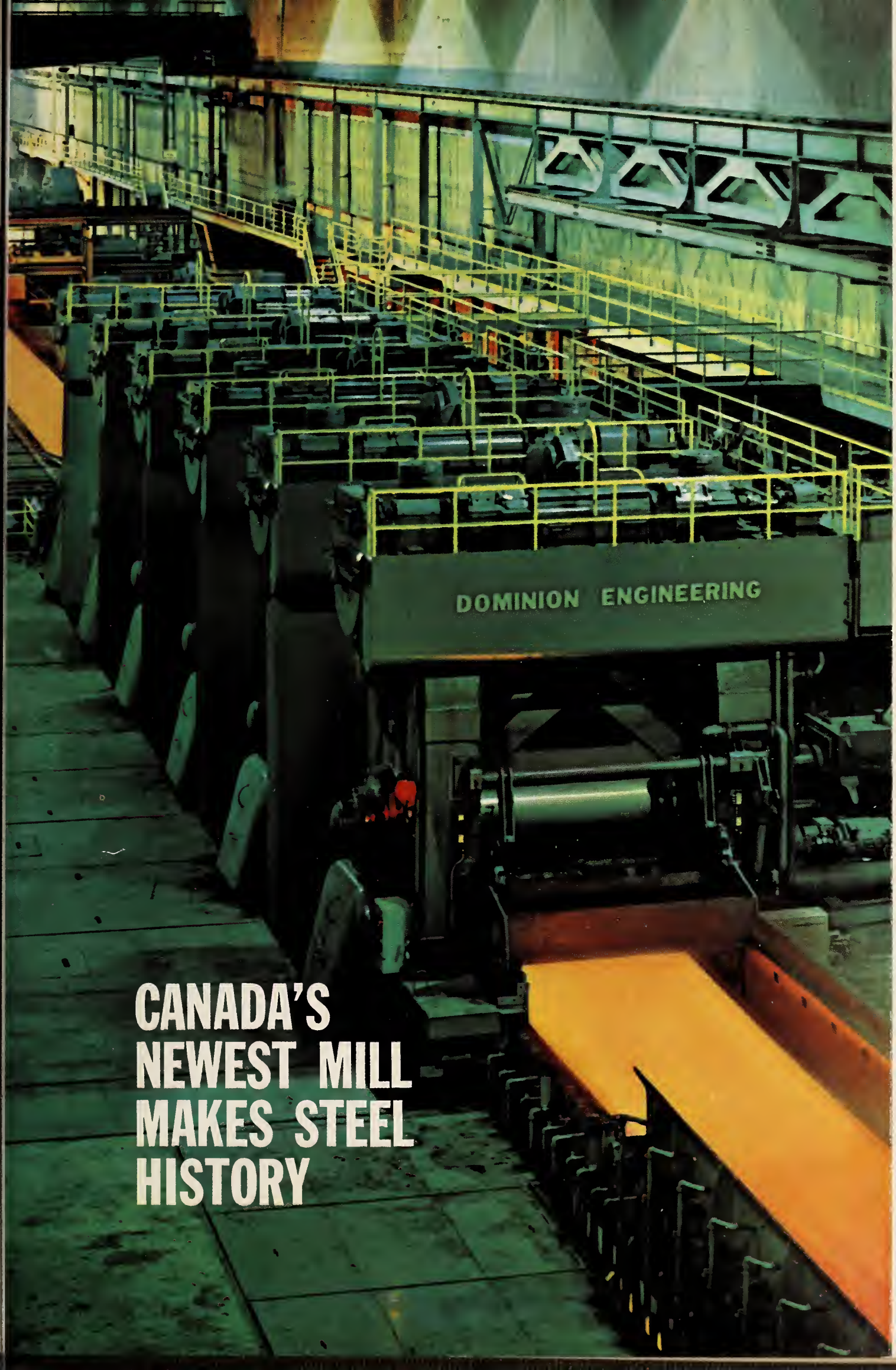
He also reported that flowers and good wishes had been sent to Dr. de Gaspe Beaubien, a past President of the Institute, who is ill.

The President summarized the position following the result of the Ballot on Confederation. He and the General Secretary han met with the President and Executive Secretary of the Canadian Council of Professional Engineers, and satisfactory informal discussions on the overall aspects of the situation were held. Further meetings were to be held, and recommendations are to be made to Council.

(Continued on page 76)

Dr. A. D. Booth, M.E.I.C. second from left, Dean of Engineering, U. of Sask., explains the operation of the M3 digital computer to Bruce Campbell left, and Gary Ursenbach, second from right, while graduate student Ken Cameron, S.E.I.C. right, looks on.





CANADA'S NEWEST MILL MAKES STEEL HISTORY

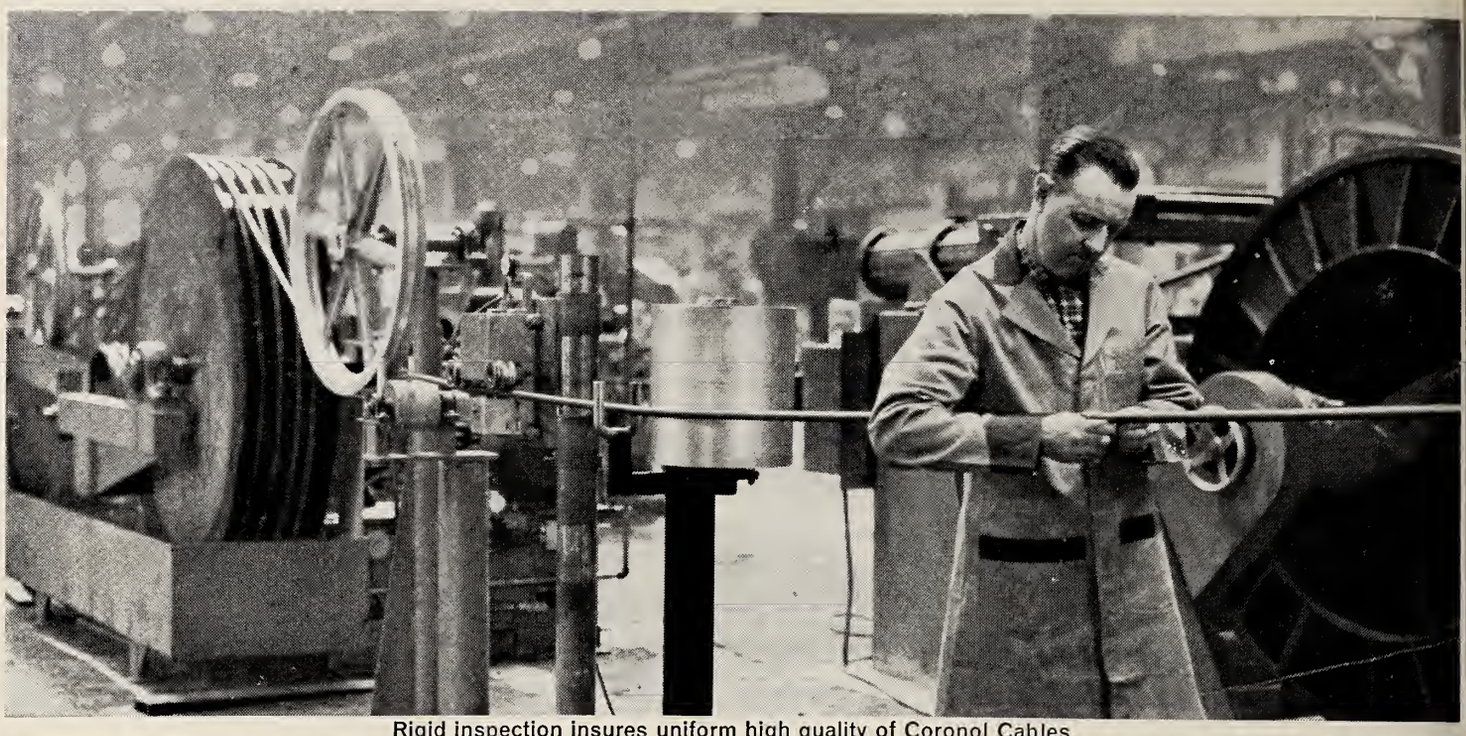
ALGOMA IS FIRST in Canada to produce hot rolled strip up to 96″ wide

Now, from Algoma's new 106″ hot strip mill comes steel strip up to a maximum sheared width of 96″... the widest ever produced in Canada. Algoma hot rolled strip is available in either cut lengths, or in coils weighing up to 45,000 lbs. This new electronically controlled mill... the most modern of its kind, was built in Canada. This history making advance in steel production is further evidence of our confidence in Canada's future... it is another major step towards our objective: to supply an ever-expanding range of Canadian produced steel products.

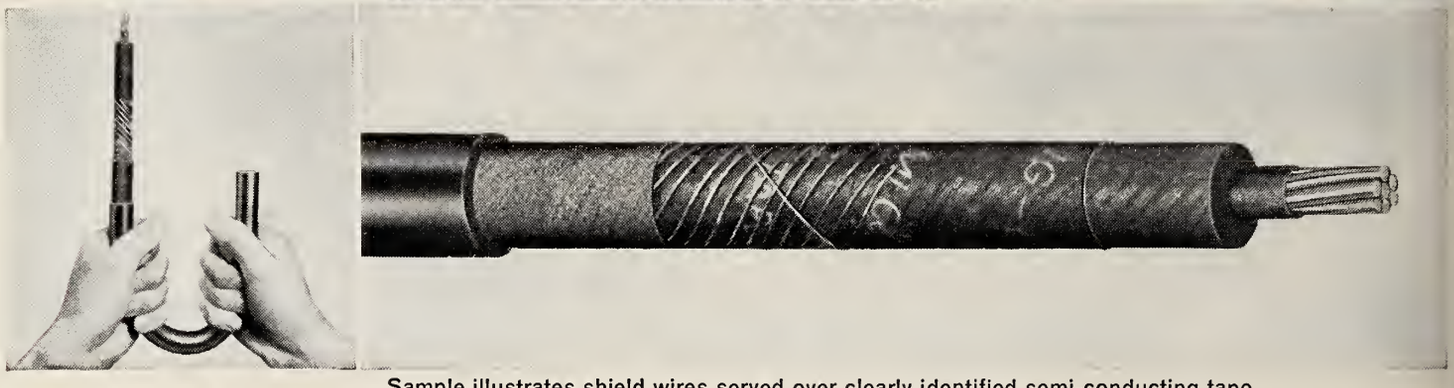
Helping to build a better, brighter future for Canadians

THE **ALGOMA STEEL** CORPORATION, LIMITED

SAULT STE. MARIE, ONTARIO • DISTRICT SALES OFFICES: SAINT JOHN, MONTREAL, TORONTO, HAMILTON, WINDSOR, WINNIPEG, VANCOUVER



Rigid inspection insures uniform high quality of Coronol Cables



Sample illustrates shield wires served over clearly identified semi-conducting tape

CGE CORONOL CABLE SHIELDING BENDS, TWISTS, WITHOUT BREAKING!

Coronol Geoprene Cables are now obtainable with *served wire shielding* laid helically around the insulation. This new CGE shield system provides a semi-conducting cloth tape *over* the conductor with another semi-conducting tape bonded directly over the insulation. The wire serving over the semi-conducting tape forms the metallic ground circuit of the shield assembly.

BRIEFLY, THE ADVANTAGES ARE:

- **Shield won't break under rough usage**
- **Bending radius is same as unshielded cable**
- **Shield buckling under the jacket is impossible**
- **Surge impedence is reduced 30%, to a value approaching a solid tube, thus effectively eliminating hazards associated with lightning or switching surges**
- **Cables are easier to splice and terminate**

You'll find it well worth while to get complete details from your nearest CGE Sales Office—or write the Apparatus Dept., 107 Park St. North, Peterborough, Ont.

AAD9204-31801

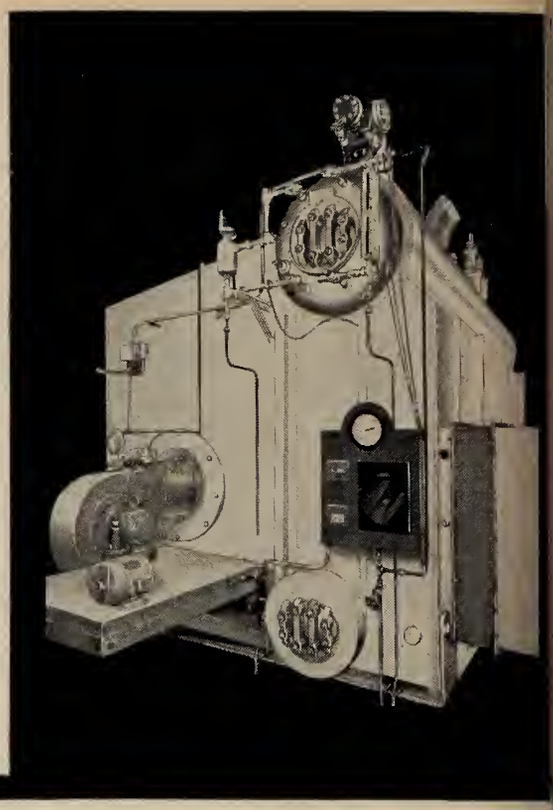
CANADIAN GENERAL ELECTRIC

Aptly named, the S.L.S. "HERCULES" has been especially designed for the maintenance and repair work of the St. Lawrence Seaway. This giant crane mounted on a self-propelled welded steel scow 200′ x 75′, reinforced for navigation in ice, will make history by lifting, at a speed of 4′ per minute, a lock gate 91′ long and weighing 275 tons. S.L.S. "HERCULES" is also available for the handling of very heavy lifts in the Montreal Harbour.

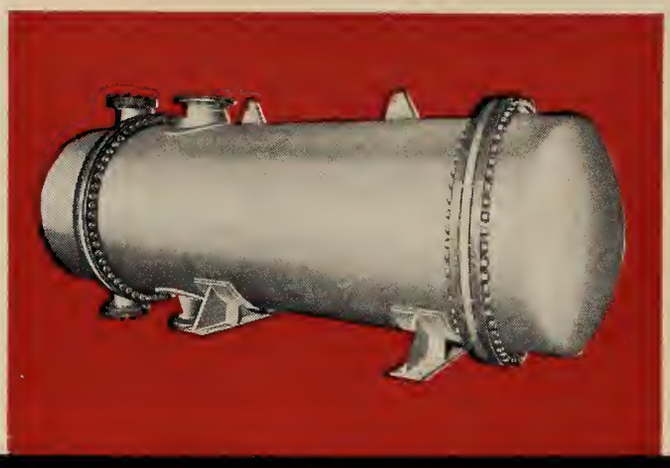
Marine Industries Limited

MONTREAL • SOREL

VAPOURIZER

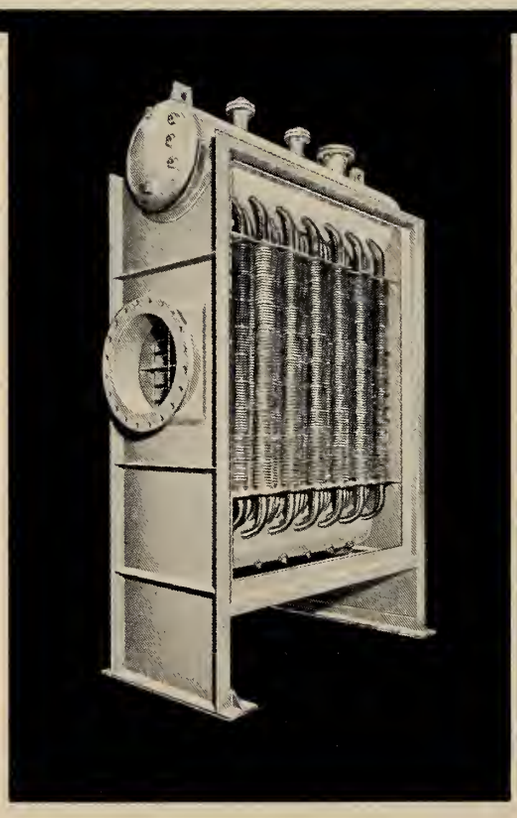


HEAT EXCHANGER



FOSTER WHEELER

Foster Wheeler's thermal equipment designs cover a wide variety of units and components in standard ranges. Through custom adaption, this line of standard items can be converted to special equipment.

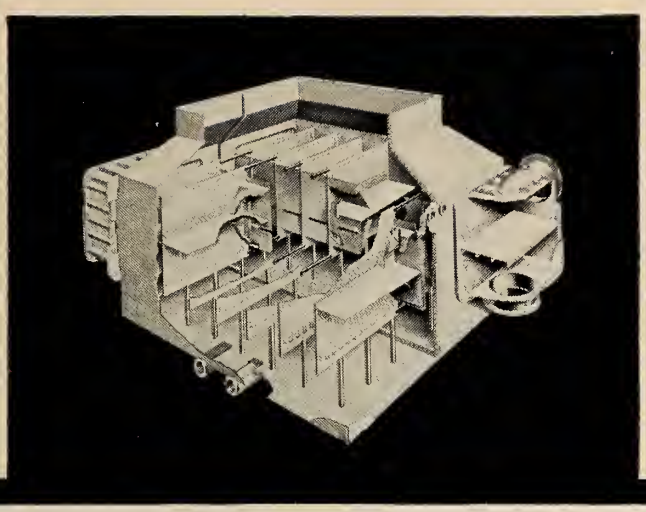


WASTE HEAT BOILER

FIRED HEATER

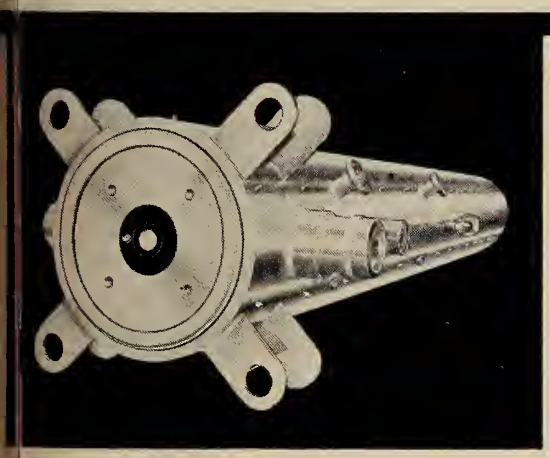
STEAM JET
AIR EJECTOR

DOUBLE-FLOW
CONDENSER

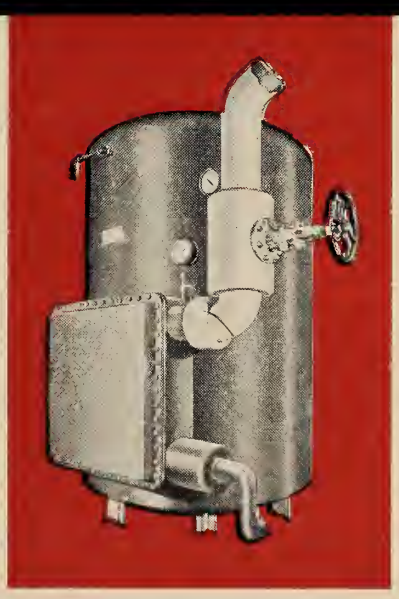


CUSTOM HEAT ENGINEERING

W engineering and manufacturing facilities, and a broad background of experience ensure industrial users of efficiency and economy in operation, through installations built to meet the specific needs for the job.



EDWATER HEATER



EVAPORATOR

FOSTER WHEELER LIMITED/ ST. CATHARINES, ONTARIO Halifax, Montreal, Ottawa, Toronto, Winnipeg, Edmonton, Vancouver

6310

Branch News

BAIE COMEAU

C. B. Prosser,
A.M.E.I.C.

The field trip scheduled by the Branch for October 5 was postponed. Manoir Comeau was the scene of the October 10 meeting. R. Gagnon, Systems Engineer, IBM of Canada, was the guest speaker. His talk was "An Introduction to Data Processing and Computing, and Applications of Computers to Business and Industry". A film was also shown. A field trip to Manicouagan 2 took place October 19.

BORDER CITIES

J. E. Sinnott,
M.E.I.C.

The Annual Dinner Dance was held September 20. 117 people attended. The presentation of a Life Membership pin to C. G. R. Armstrong was held recently at the University of Windsor. A presentation was also made to Past-Chairman F. P. Mascarin.

CALGARY BRANCH

Alan Short,
M.E.I.C.

The fall Branch activities began September 6 with a western style Bar B-Q at Colpitts ranch west of Calgary. Branch luncheon meetings will again be the policy this season. Luncheon meetings are held every Monday at the Caraboo Restaurant at 12:10 p.m. Visiting engineers are invited to attend these meetings with Branch members. On October 7, L. Rowland, Editor of "Oil in Canada", spoke on "Australia—The World's Latest Oil Frontier". On October 21, a film, "Tracks Around the World" was shown, courtesy of the Robin Nodwell Manufacturing Ltd. D. Campbell, City of Calgary Traffic Engineer spoke to the members Oct. 28 on "The Calgary Metropolitan Traffic Study".

LAKEHEAD

W. Buryniuk

On September 30 a Branch Executive meeting was held to begin organization for Engineers' Day to be held in December, and to make arrangements for the visit of C. G. Kingsmill, the Institute's Manager of Technical Services.

The Vancouver Branch visited the Port Mann Bridge on the Fraser River near New Westminster, B.C. August 3. Erection of the main and side spans was nearing completion at the time of the visit.

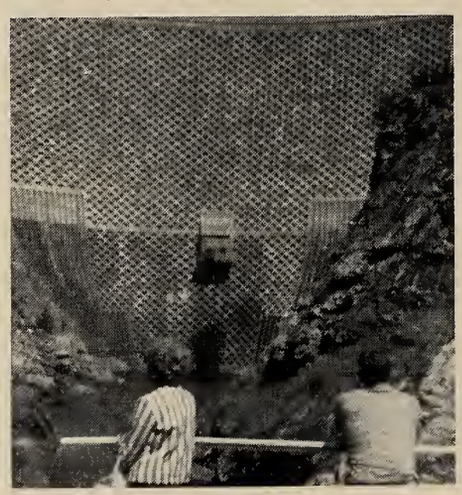
VANCOUVER

L. B. Davies,
M.E.I.C.

During the summer the Branch confined itself mainly to field trips organized in co-operation with A.P.E.B.C.

On July 13 a visit was made to the City of Seattle's Hydroelectric Project on the Skagit River. Seattle City Light, the earliest and still one of the largest municipally-owned electric utilities in the United States, has developed about 1,100 feet of head in an 11-mile stretch of the Skagit just south of the Canadian border to produce a maximum output of 786,000 kw. Head is concentrated at three sites, Ross, Diablo and Gorge, where concrete dams of arch construction have been built in narrow, rocky canyons.

A view of the downstream face of the Ross Dam on the Skagit River visited by the Vancouver Branch July 13. Also inspected were the Diablo and Gorge Dams, all components of the City of Seattle's Hydroelectric Project.



Three weeks later a visit was made to the Port Mann Bridge where a welcome was extended by Messrs. N. Hilton and G. Hardenberg of C.B.A. Engineering Ltd., Consulting Engineers to the Government of B.C. on the design and supervision of construction of the bridge, and by J. H. McNaughton of Dominion Bridge Co. Ltd., which is responsible for the steel erection.

After a brief description of the bridge design the visitors spent several hours inspecting the construction work. The bridge, a detailed description of which was given in the Engineering Journal of July, 1961, is a stiffened tied arch with a main span of 1,200 feet flanked by side spans of 360 feet, and by long approaches on both north and south banks.

Erection of the main and side spans, nearing completion at the time of the visit, was accomplished by temporary steel towers above the north and south piers, and a system of steel supporting cables.

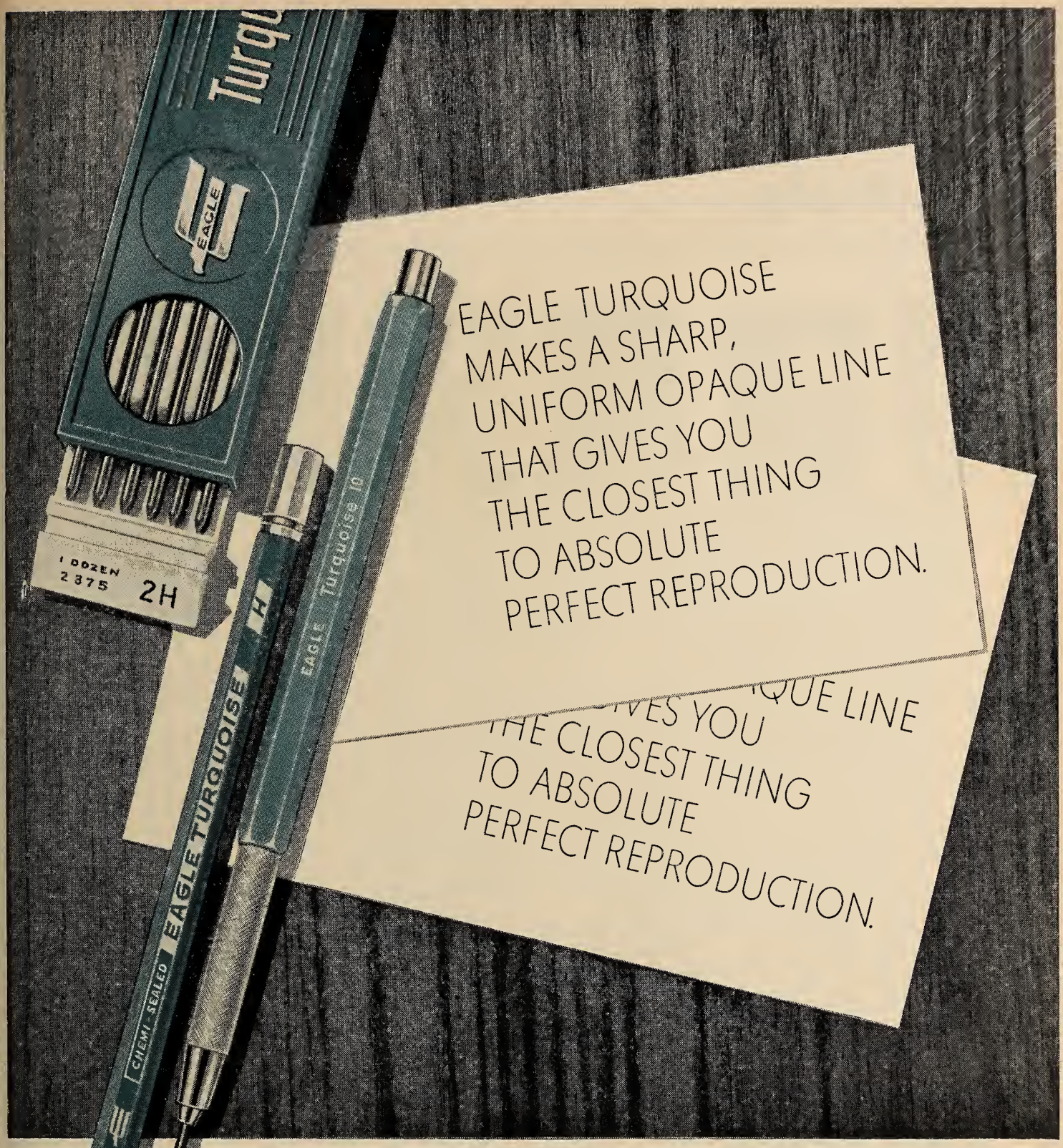
On August 17 a field trip was made to the Crofton Mill of the B.C. Forest Products Limited. The mill, in operation since December, 1957, is a bleached kraft pulp mill with a rated production capacity of 550 tons daily. The economic operation of the plant depends upon the recovery of chemicals used in the cooking process, and on the utilization of wood wastes and dissolved lignin from the cooking process as fuel to produce steam. Additional chemicals are recovered by passing the flue gases through a precipitator.

On the first Saturday in September the Vancouver Branches of the EIC and the APEBC were hosts to the Seattle and Tacoma Branches of the American Society of Civil Engineers at a joint meeting in Vancouver.

The Port of Vancouver was the theme of the technical program. At a session presided over by Col. W. G. Swan, M.E.I.C., Capt. W. A. Dobie, Harbour Master of the Port of Vancouver, and W. Duncan of the National Harbours Board, described the operation of the port which handles more cargo than all other ports on the Pacific Coast of North America combined.

The luncheon was presided over by Vancouver Branch Chairman C. F. Ripley. Head table guests included: Hon. R. W. Bonner, Attorney-General of British Columbia; Alderman T. Campbell representing the Mayor of Vancouver; G. Treadwell and P. Meyer, Chairmen respectively of the Seattle and Tacoma Sections of A.S.C.E. The guest speaker was Willard Ireland, Provincial Archivist, who spoke on the history of Vancouver harbour.

(Continued on page 82)



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Personals

G. N. Munro, M.E.I.C.

B. G. Long

G. N. Farantatos, M.E.I.C.

F. Schneider

E. G. Bennett

D. H. Ross, M.E.I.C.

G. N. Munro, M.E.I.C. (Sask. '26), former Chief Engineer of the Prairie Farm Rehabilitation Administration of the Canadian Department of Agriculture has retired after fourteen years of service. Mr. Munro joined PFRA in 1949 as Associate Chief Engineer, the position he held until his appointment as Chief Engineer in 1957. In 1962 he was appointed Senior Engineering Consultant to the organization.

Bryan G. Long has been appointed head of the newly formed industrial division of Gibb, Underwood & McLellan, Consulting Engineers, Toronto. Mr. Long has had extensive experience in the industrial field having worked on such projects as the design and layout of new chemical plants, the design of sewage treatment and water purification plants. Mr. Long has worked in varying capacities with both consulting engineers and contractors and in private industry in England, Switzerland, Nigeria and Canada.

G. N. Farantatos, M.E.I.C. (McGill '52) has been elected Vice-President — Civil Engineering at Giffels & Vallet of Canada Ltd., Consulting Engineers, Toronto. Mr. Farantatos joined the firm in 1956 and has since then been responsible for the firm's civil projects including bridges, highways, drainage systems and other related work.

Fred Schneider has been appointed Manager, Industrial Gas Products at Canadian Liquid Air Company, Limited. Mr. Schneider began his career in the Development and Engineering Department of the company as a development engineer in 1949. He has been manager of the Technical Development Department since 1958.

E. G. Bennett has been appointed Western Sales Manager in Winnipeg for Pioneer Electric Limited. Mr. Bennett is a U.B.C. engineering graduate and a graduate of the English Electric of England apprentice training course. He has worked in apparatus sales in England, Ontario and British Columbia, and was B.C. District Manager for Pioneer in Vancouver.

J. R. McGovern M.E.I.C.

H. W. Beckett, M.E.I.C.

J. R. McGovern, M.E.I.C. (McGill '51) has been appointed manager of marketing for Daystrom Limited. Mr. McGovern will be responsible for the marketing of the company's industrial equipment and component line. Mr. McGovern has had 12 years experience in the marketing of electrical and electronic field and was most recently associated with the Sola-Basic Products Limited.

H. W. Beckett, M.E.I.C. (Sask. '48), construction engineer for The Consolidated Mining and Smelting Company, has been appointed Assistant Superintendent of Construction. Mr. Beckett joined the company in 1948. While most of his service has been in the construction field, Mr. Beckett was maintenance superintendent for four years. He is at present superintendent of Cominco's new fertilizer project under construction at Kimberly.

D. H. Ross, M.E.I.C. (Manitoba '57) has been appointed District Manager in Vancouver for Pioneer Electric Limited. Mr. Ross has spent the last six years in sales and engineering work in the company's Winnipeg head office.

James B. Dick, M.E.I.C. (McGill '56) was awarded the post graduate degree of Master of Engineering from McGill University. Mr. Dick is on the engineering staff of Canadian Ingersoll-Rand Co. Ltd at Sherbrooke, Que.

Ronald E. Pelkey, M.E.I.C. (Sask. '52) has joined the firm of Underwood McLelland & Associates Ltd., Consulting Engineers in Saskatoon. Mr. Pelkey had been employed by the Saskatchewan Department of Highways since 1952, as resident bridge engineer, until 1956 when he was appointed bridge design engineer. Mr. Pelkey has been engaged on such projects as the new Prince Albert Bridge, the Petrofka Bridge, and the reconstruction of the Saskatchewan Landing Bridge.

Joshua Loring has been named manager of manufacturing for the Texas Instruments Incorporated Materials & Controls Division branch plant at Richmond Hill, Ont. Mr. Loring was formerly chief manufacturing engineer for motor controls at the company's main plant in Attleboro, Mass.

G. Graham has been appointed Mechanical Engineer in charge of antenna and filter design at Sinclair Radio Laboratories Limited. Mr. Graham is a Mechanical Engineering graduate of the Queens University of Belfast, Ireland. He worked for two years with the atomic products group of Hawker-Siddeley Canada Ltd. before joining Sinclair.

(Continued on page 70)

9% NICKEL STEEL SOLVES CRYOGENIC PROBLEMS DOWN TO -320° F.

When Canadian Liquid Air Company, Limited, Hamilton, planned to construct two cryogenic vessels, each a vessel within a vessel for storing 1500 tons of liquid oxygen and 410 tons of liquid nitrogen, engineers were faced with a problem. Because carbon steel loses ductility at very low temperatures, the inner tanks had to be made of a special alloy. Horton Steel selected 9% Nickel Steel, an alloy officially accepted for cryogenic service. 9% Nickel Steel provides high strength and notch toughness down to -320°F; ease of fabrication; no post-weld heat treatment; economy; proven safety; coverage by ASME and other National Boiler Code Rulings ☐ For more information on how 9% Nickel Steel can help solve your cryogenic metal problems write for your copies of (1) The Properties of Nickel Steel Plates at Low Temperatures; and (2) Code Case 1308 (Special Ruling), ASME Boiler and Pressure Vessel Committee. They're free to you from Inco.

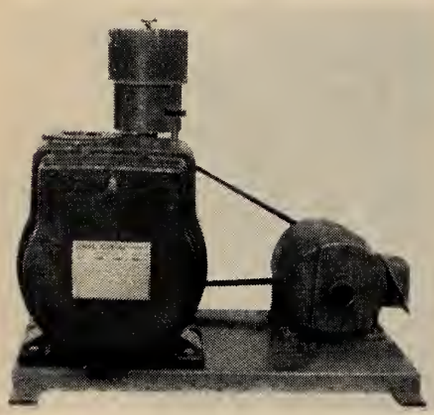
THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED

55 YONGE STREET, TORONTO, ONTARIO

These cryogenic vessels are the first field erected vessels in Canada, using 9% Nickel Steel. Design, fabrication and erection by Horton Steel Works, Limited, Fort Erie, Ont.

Engineering Briefs

A TWO - STAGE MECHANICAL vacuum pump with a free air capacity of 53 cubic feet of air per minute has been announced by Central Scientific Company of Canada Ltd. The Hyvac 150 was designed for industrial and research applications requiring a high capacity pump. The Hyvac 150 has a guaranteed vacuum of 0.05 microns of mercury. It is equipped with an adjustable gas ballast. Pumping speed of the unit is 475 rpm.



The Hyvac 150.

CANADIAN LOCOMOTIVE Company has announced the introduction of an end-suction Fairbanks-Morse water pump featuring simplified design and quick positive shaft realignment. A single-shield type of ball bearing is used to prevent over-lubrication and lengthen intervals between relubrications. The design requires only four frame sizes to bracket a line of pumps from one inch to four inch discharge diameter. Parts are standardized to permit interchangeability of parts.

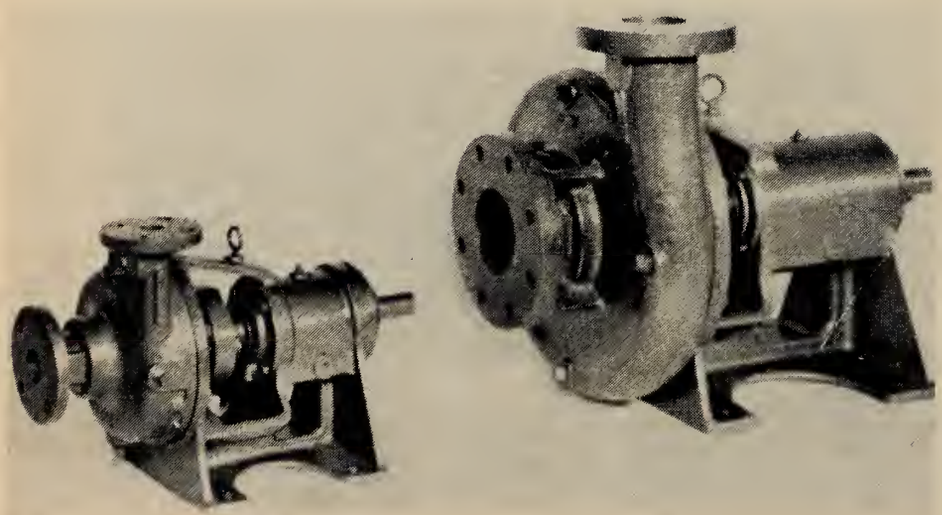
Crane Valves.

CRANE CANADA LIMITED has announced the Packless Diaphragm valve suitable for application in water, air, oil, gas and vacuum service for the pulp and paper, refrigeration, mining, chemical and textile industries. The Crane valves are available in ½" to 2" screwed end, and ½" to 6" flanged ends. The valves which seal the bonnet, have a seating member which a separate disc providing positive shut-off without loss. Available with neoprene diaphragm and disc insert.

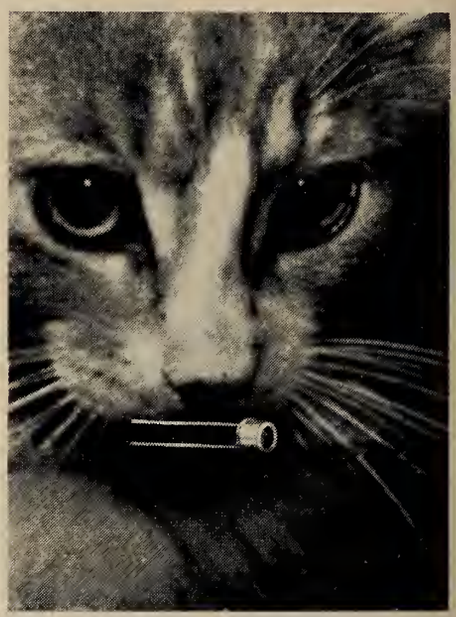
Engineering Briefs

Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.

Fairbanks-Morse Suction Pumps.



A CADMIUM SELENIDE PHOTO-RESISTOR reacting 400 times faster than a cat's eye, can change resistance over a range of one million ohms in five ten thousandths of a second. This is a new device, the EM-1502 photo-resistor, available from Raytheon Canada, Ltd., Waterloo, Ont. The Spectral response of the EM-1502 spans wave lengths from 5000 to 12,000 angstrom units with a peaking at 6950 A° making it applicable to infrared detection as well as visible light monitoring. The EM-1502 would have many applications as an opto-electronic switch in industrial controls and in devices such as counters, automatic inspectors, and limit switches.



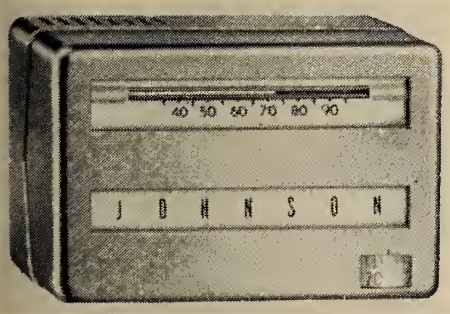
Raytheons' EM-1502.

THE TYPE 4 Watertight and Weatherproof Heavy-Duty control stations have been introduced by Allen-Bradley Canada Ltd., Galt, Ont. These water-tight control stations have a stainless steel enclosure with a gasket between the cover and base. Operators are die-cast and heavily plated. The enclosure and the individual control units can be purchased separately making it possible to assemble a large variety of stations in the field. These control circuits of magnetic starters and control panels.

ELECTRIC WIRING can be easily protected from moisture and corrosion by CRC 6-66 which is sprayed on to leave a thin, clear film of liquid that creeps under any moisture to displace it. Since it does not dry or thicken into a gummy film, the coating remains as protection from moisture and corrosion. A critical situation is typical in marine applications, where water, salt and moisture are hazardous. This product is available from Hellerman Canada Ltd., Don Mills, Ont.

Atlas Copco's LBB22 Drill.

ATLAS COPCO CANADA LTD., has announced the availability of a new series of small capacity pistol grip air drillers. The drills in the LBB22 series have a free speed range of from 1100 to 4900 rpm. The units weigh from 1½ to 2½ lb., and drill up to ¼ inch in most types of materials. Available in two models, the offset handle and straight drill, the LBB22 series produce ¼ hp and have five vanes which contribute to good starter and pulling torque.

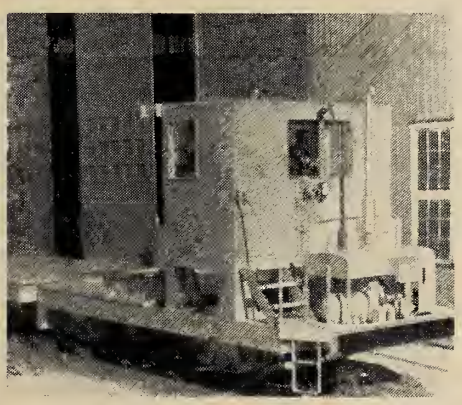


Johnson's T-4000.

JOHNSON CONTROLS LTD., Toronto, has announced the availability of a new series of compact, pneumatic room thermostats for heating, cooling and ventilating control. Measuring 3" x 2" x 1½" deep, the T-4000 Series thermostats are available in both horizontal and vertical models. The manufacturers claim that these thermostats respond to temperature changes twice as fast as other available pneumatic controllers. Greater control stability and accuracy has been achieved by incorporating a motion balance feedback system. By constantly comparing and balancing the thermostat output with incoming demand signals, precise and stable valve damper operation and minimized hunting and system cycling are assured.

SISSON ROTARY POSITIVE DISPLACEMENT PUMPS are designed to handle all types of non-abrasive fluids, particularly thick or viscous fluids and pastes. The pumps are simple in design, and have only three moving parts in a sliding vane type construction. Sisson pumps have many applications in the food and chemical industries. In cases where the temperature of the material being pumped must be maintained at a high or low level, the pump casing can be arranged with a jacket through which steam, hot water or brine can be circulated.

THE SILOBUS designed and constructed by Marine Industries Limited, Sorel, will be used for the transport of cement in the construction of the "Manicouagan 2" project north of Baie Comeau, Que. The Silobus has a self-loading hopper, and a capacity of eight cubic yards of concrete.



The Silobus.

FS/1 MIKROTEST THICKNESS GAUGE available from Electro-Physical Instruments, Ottawa, can measure coating thickness from zero to 200/1000 inch. This instrument enables thickness and uniformity testing and measuring of foils, aluminum sheets and other non-magnetic materials such as plastics and fibre-glass. The gauges operate on the attractive power of a permanent magnet and measure in any position. The FS/1 requires no calibrating.

FS/1 Mikrotest Gauge.

(Continued on page 78)

FLUIDICS SPOKEN HERE

Water treatment news

Will a Package Plant meet your water treatment needs?

by
Eugene D. Driscoll
Assistant
Technical
Manager
Permutit

This is the newest trend in water treatment —package plants, pre-assembled and stocked for fast delivery and simple installation.

Because of inherent advantages, package plants are gaining wide acceptance in both municipal and industrial process water treatment. The variety and size range of package equipment now available makes it practical for engineers to design complete water treatment systems around package components. Requests for package units of all types have increased in recent months. This is because it is possible to achieve custom dependability and flexibility, while taking advantage of the cost and time savings of package units.

Installation costs for a package plant are a bare minimum. In many cases, the units are skid-mounted, ready to locate. Frequently, you need only make connections for inlet water, treated water outlet, and drain.

Is there a package plant for you? Probably. Permutit has pioneered a comprehensive line of water treatment units. They are of matched, standard designs, manufactured and stocked in quantity. Factory tested, they're available for a variety of treatment processes and in many cases you can get delivery within ten days to two weeks.

Here are some typical Permutit package units:

PRECIPITATORS – provide for dealkalization, softening or coagulation at rates up to 100 gpm. Proportioning chemical feeders are standard accessories; pressure filters or carbon purifiers, optional.

SOFTENERS – Ion exchange softeners up to 48-inch diameter can remove as much as 1,400 kilograins of total hardness during each service run, at flow rates up to 100 gpm. Skid mounting optional.

DEMINERALIZING SYSTEMS – To produce water of specified low mineral content. "Skid mounted Package 2-step System" can use several types of resin to meet a wide range of operating conditions. Capacities up to 37 gpm. "Package Mixed Bed" units up to 24 inches in diameter produce up to 20 gpm of high quality water. (50 gpm in polishing service). Size will depend on water to be treated as well as on flow rate. Integral regeneration equipment is included.

DEAERATING HEATERS – The Permutit Type B, tank car design heater is available in capacities of 30,000, 50,000 and 70,000 pounds per hour.

For more information about Package Plants, or water treatment in general, write Permutit Company of Canada, Dept. EJ-113, 207 Queens Quay West, Toronto 1, Ontario.

PERMUTIT COMPANY of CANADA

CALGARY, MONTREAL, TORONTO
a division of PFAUDLER PERMUTIT CANADA, LTD.

Specialists in fluidics . . . the science of fluid processes

AAF makes a good air filter...

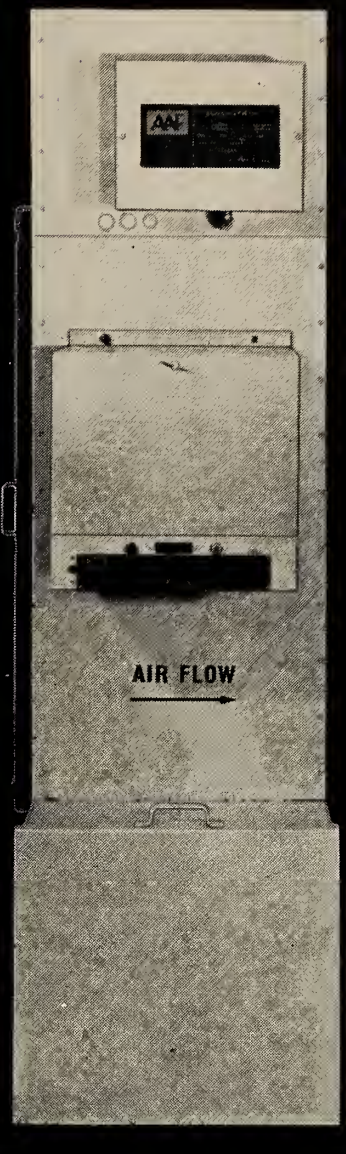
1957 ROLLOTRON

New Rollotron cuts space requirements in half!

. . better. . . . . again!

40 in.

1959 ROLLOTRON



20 in.

NEW ROLLOTRON

■ ROLLOTRON is the one air filter that offers
1. the efficiency of an electrostatic precipitator, and
2. the minimum maintenance of an automatic-renewing, disposable media air filter

with no water, no washing, no freezing problems, no drains, no oiling of plates.

Now you can get these benefits in half the space. The new AAF ROLLOTRON is just a fraction over twenty inches deep (compared with 40″ for the previous design).

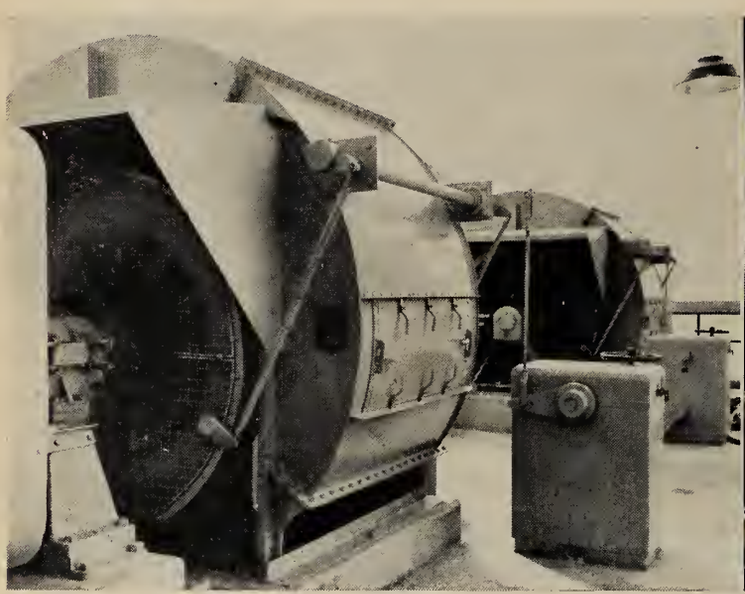
And space savings isn't the only advantage. Both sections (agglomerator and storage) now can be serviced from the dirty air side, eliminating need for two access spaces.

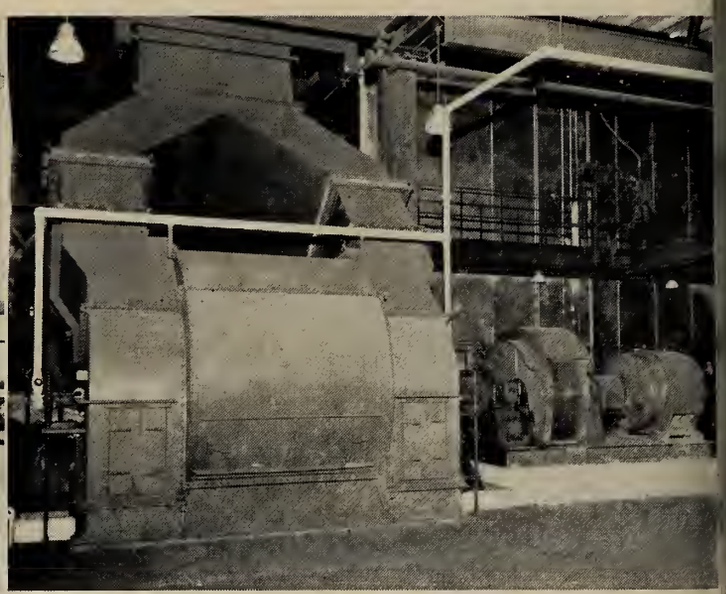
For complete information on the brand new compact ROLLOTRON, call your local AAF representative or write us direct.

AAF CANADA — American Air Filter of Canada LTD.

Factory and General Offices: 400 Stinson Blvd., Montreal 9

PERFORMANCE...





The Practical Measurement of Fan Economy

Like all capital equipment, the true economy of mechanical draft and other heavy-duty fans can be measured only in terms of performance.

"Lowest" initial cost and "promised" ratings are poor, often *costly* criteria.

'Canadian Buffalo' heavy-duty fans are quality-engineered to perform "as specified." Because of this engineering, 'Canadian Buffalo' fans use less power . . . require less maintenance . . . deliver extra years of efficient service.

As a result, the economy of 'Canadian Buffalo' fans can be accurately measured by actual year-to-year savings in power, maintenance, and replacement costs.

The Canadian Blower representative in your area is an air handling specialist. It will pay to discuss your requirements with him. Or, you can write direct.

CANADIAN BLOWER & FORGE COMPANY LIMITED

ASSOCIATED WITH CANADA PUMPS LIMITED • HEAD OFFICE: KITCHENER, ONTARIO

Engineering Sales Offices: Montreal • Toronto • Hamilton • Sornia • Ottawa • London • St. John • Winnipeg • Edmonton • Vancouver

'Canadian Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Canadian Buffalo' Machine Tools for production drilling and plant maintenance.

'Canadian Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Jack Matthews installs Phillips Power Cable at the 6575′ level, McIntyre Porcupine Mine

WHEREVER POWER MUST NOT FAIL

The bottom of a mine is no place to compromise on the quality of a cable. That cable *MUST* be reliable. And evidence of such reliability is available on the record . . . in all parts of Canada, Phillips cables are still operating today after 35 to 40 years of uninterrupted service. That kind of record means a lot to the men on the 6575′ level at McIntyre Porcupine. This kind of quality can mean a lot to you, too, whenever you need cable that *MUST* be dependable.

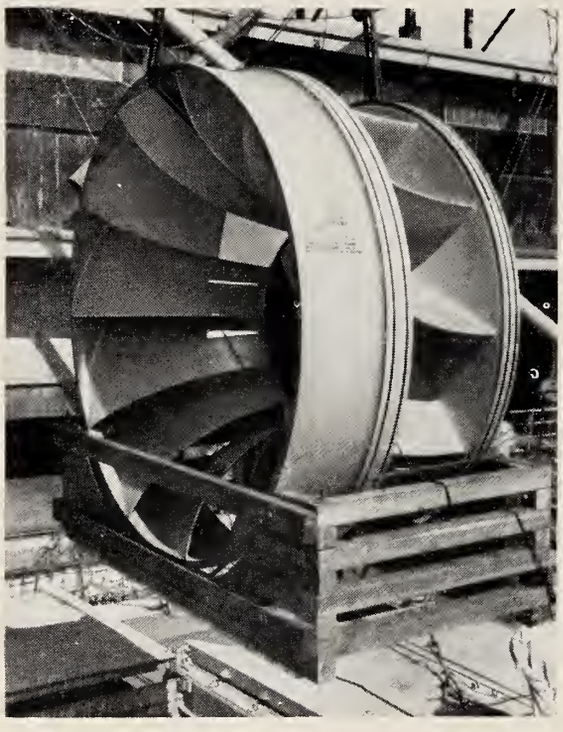
Phillips Electrical Company Limited, Head Office—Brockville, Ontario. Branches—Halifax, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Edmonton, Vancouver.

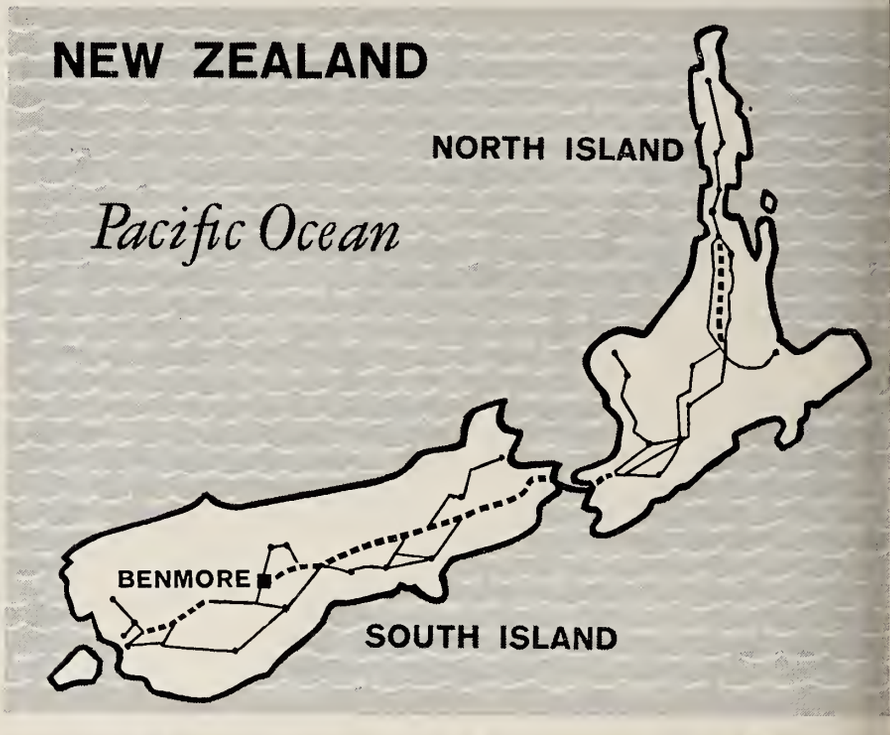
Phillips Electrical Company LIMITED

WIRE & CABLE

6306

ONE OF SIX 125,000 HP TURBINES FOR



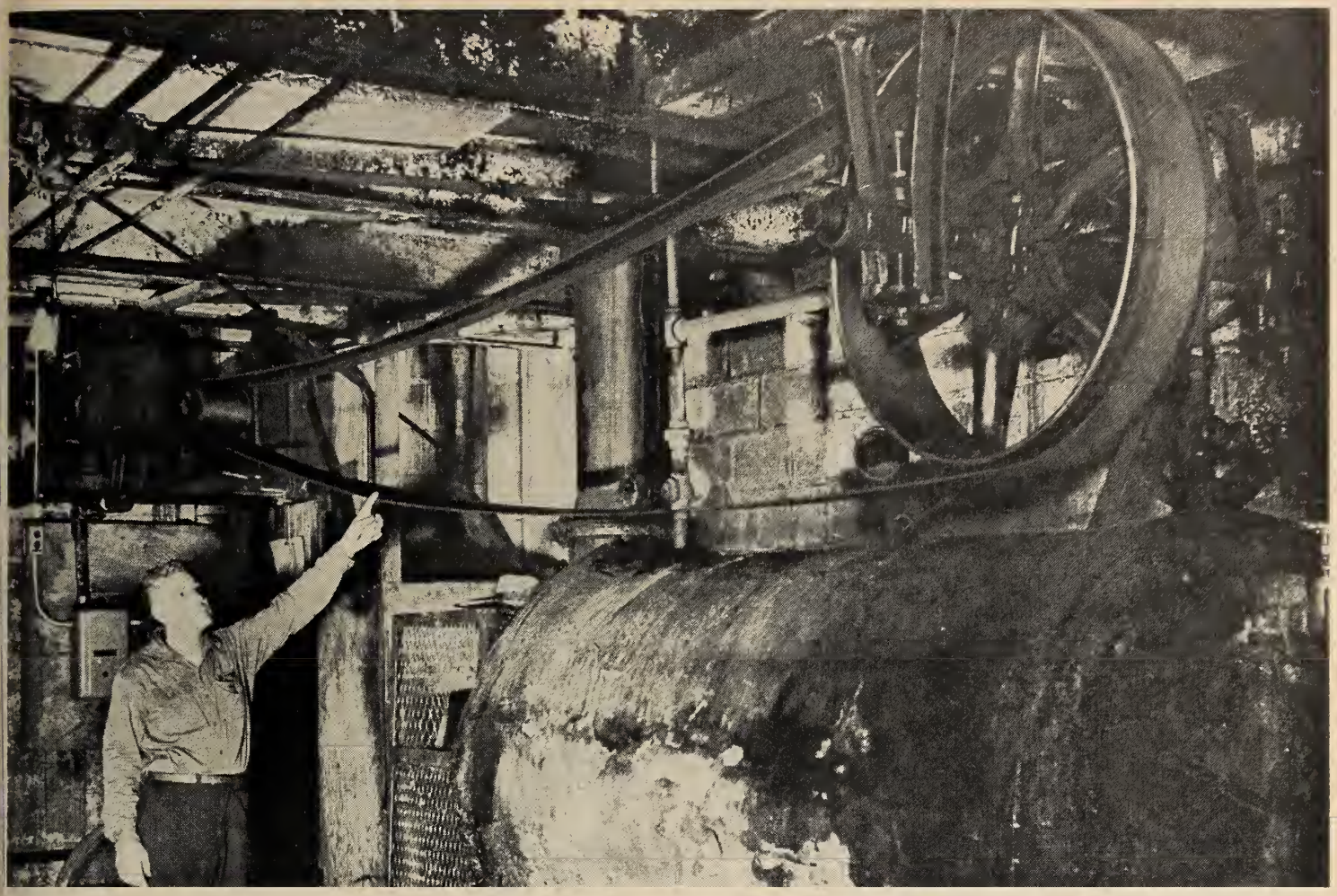


NEW ZEALAND'S LARGEST POWER STATION

Benmore alone will more than double the South Island's total hydro-power output. Much of its 540,000 KW will be carried, at 500,000 V DC, by overland and submarine cable to the North Island. The new lake on the Waitaki River is 18 miles long. The 360-foot high earth and concrete dam, containing a total of 27 million tons of material, provides a head of 300 feet for the six Francis Turbines, designed, engineered and built by Dominion Engineering.
The photos above show one of the turbine runners leaving Montreal for Benmore, New Zealand, half-way around the world.

Represented in New Zealand by MASON BROS. LTD.

Hydraulic Power
DOMINION ENGINEERING WORKS LIMITED
MONTREAL / TORONTO / VANCOUVER



Neoprene Belt Outlasts Plant!

Never repaired. Never shortened. Never spliced. Yet this belt made of Du Pont Neoprene operated 5 days a week for over 25 years . . . until recently, when the PLANT was retired from service!

The 43-foot belt drove a "cooker" agitator in an animal fats processing plant. It was exposed to lubricating oil, splashes of rendered fat and temperatures up to 130°F. above a steam heated autoclave. Except for some stretching, the quarter-century-old belt still appears to be in *excellent condition.*

Reliable long-term performance like this helps explain why Neoprene is widely used today in all kinds of belting. Neoprene has proved it has the ability to withstand abrasion, physical abuse, aging, weathering, most chemicals and offers the valuable property of flame resistance. For more information, please return the coupon.

EL-3-7

Du Pont of Canada Limited, P.O. Box 660, Room AEJ-1141, Montreal 3, P.Q.

Please send more information about belts for_____

_____

NAME_____

COMPANY_____

STREET_____

CITY_____ ZONE_____ PROV._____

PROVED RELIABLE SINCE 1932

NEOPRENE DU PONT CANADA

Du Pont makes elastomers. Products using these elastomers are made by manufacturers whose names are available on request.

Personals

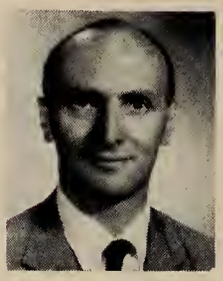
(Continued from page 60)

R. F. Bailey, M.E.I.C. (Alberta '41) has been appointed Administrative Assistant for The Consolidated Mining and Smelting Company. Mr. Bailey was formerly Supervisor of Projects. Mr. Bailey has held several supervisory positions with Cominco. He will continue to be located in Trail, B.C.

A. Ray Dow, M.E.I.C. (Toronto '49) has been appointed Vice-President Sales at Canadian Oxygen Limited. Mr. Dow joined Canox as General Sales Manager in 1960.

R. O. Campbell has been named manager of research and development at British American Oil Company Limited's new Research and Development Centre being constructed near Toronto. Mr. Campbell, a researcher with over 30 years experience, most recently served as manager of product development with the company. He has been with BA since 1931.

D. R. Fewer has been appointed Technical Assistant to the Vice President Technique of Schlumberger Well Surveying Corporation, a subsidiary of Schlumberger Limited. Mr. Fewer is a specialist in the field of semi-conducters and in his new position will work in the Engineering Department of the company.



J. Gieysztor, M.E.I.C.

E. V. Rippingille

Jan Gieysztor, M.E.I.C. has been appointed Manager, Eastern Region, Engineering Sales Division of the Robert Morse Corporation Limited. Mr. Gieysztor joined the company in 1952. He has had wide engineering and sales experience, and a knowledge of all the products handled by the division.

Edward V. Rippingille, Jr. has been appointed general manager of Frigidaire Products of Canada, Limited, Scarborough, Ont. Mr. Rippingille succeeds W. Carl Cannon who has retired after 20 years service with the company. Mr. Rippingille has also been elected president of the company.

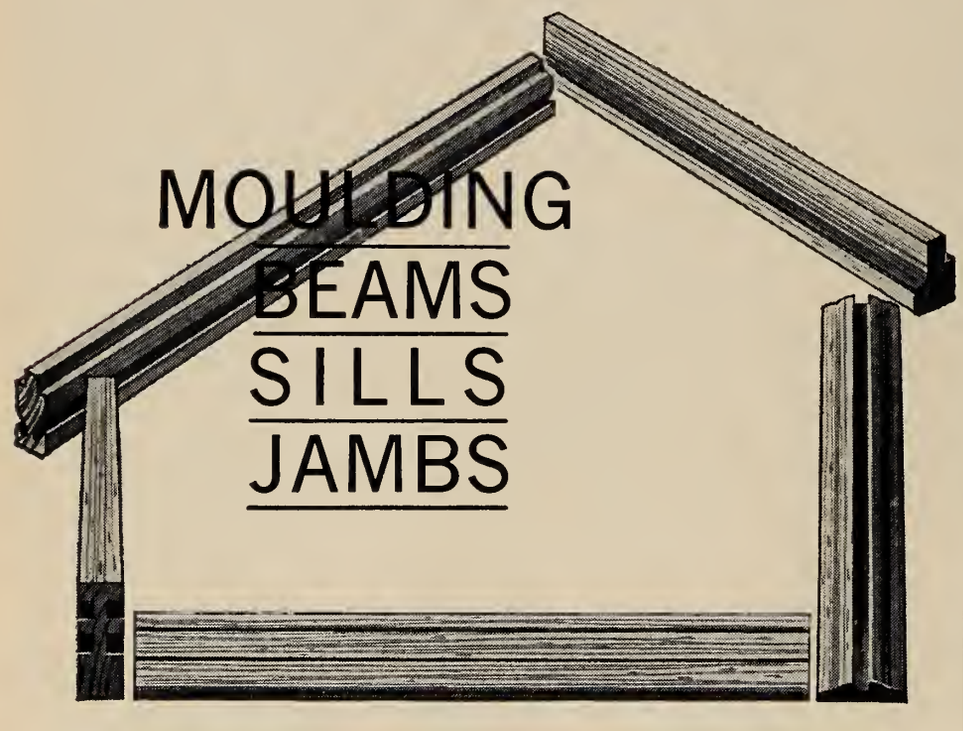
H. George De Young, President of Atlas Steels Company Limited and an Executive Vice-President of Rio Algom Mines Limited, has been elected President of Rio Algom. He succeeds R. H. Winters.

Alex Brown, M.E.I.C. (N.S.T.C. '37) has been elected director of the Technical Services Council, a non-profit, industry-sponsored placement service. Mr. Brown is Assistant Co-ordinator, Management Development of The Steel Company of Canada Limited, Hamilton.

Kenneth Hallsworth has been elected a director of the Technical Service Council. Mr. Hallsworth is Director of Industrial Relations of Ford Motor Company of Canada Limited, Oakville.

Frank G. Hood has been appointed Chairman of the Board, Emeritus, **Donald C. Minard,** Chairman of the Board and **Thomas Hancock** as President at the Trane Company of Canada Limited. Mr. Hood has been an officer and director of the company since 1920. Mr. Minard, who succeeds Mr. Hood, was formerly President of the company. Mr. Hancock, Executive Vice-President and Director since 1955, joined Trane in 1934.

John H. Aitchison has been named Manager of Systems Engineering for the IBM World Trade organization. Mr. Aitchison has been Manager of Systems Engineering for IBM Canada Ltd. He joined the company in 1951 as an Applied Science Representative. He was responsible for the organization and development of the systems department at IBM Canada.



Accurately engineered to ensure perfection in building

Builders and architects will appreciate the care with which Canbar Wood Tank Company produce engineered wood products for the building trade. One of Canada's most modern woodworking plants, with over 80 years experience, is ready to go to work for you to process car-load and truck-load milling in transit, to your specifications.

Canbar Wood Tank Company can supply you with special shapes — round, rectangular, oval, half-round, elliptical or any shape to suit your requirements, including finger joint in up to 6-inch thick material. Our plant is best suited to handle quantity millwork.

Let our engineered wood product division assist you with your technical requirements.

NATIONAL WOOD TANK INSTITUTE

CANBAR WOOD TANK COMPANY
A DIVISION OF
CANADA BARRELS & KEGS LIMITED
WATERLOO, ONT. CANADA

V. L. Snow

E. Sanderson

Virgil L. Snow has been named general manager and president of General Motors Diesel Limited, London, Ont. Mr. Snow has been general manager of GM's Euclid Division, Hudson, Ohio.

Eric Sanderson has been appointed an Associate of M. M. Dillon and Company Limited, Consulting Engineers. Mr. Sanderson is Chief Municipal Engineer in charge of sewerage and water projects in the company's head office in London, Ont. He is a graduate of Manchester University and has had 20 years' experience in his field.

Emile Nenninger, JR., M.E.I.C. has been appointed an associate in the firm of Surveyor, Nenninger & Chenevert, Consulting Engineers. Dr. Nenninger has broad experience in chemical and metallurgical engineering. He has directed a large number of projects in these fields.

Fred W. Price has been appointed Executive Director of the Royal Architectural Institute of Canada. For the past two years, Mr. Price has been manager of Information and Publications for the Research and Development Laboratories of the Northern Electric Company.

Kenneth C. Mercer, M.E.I.C. (Brown Univ. '10), formerly with Keith Mercer Company Limited, has joined T. C. Chown Limited, the representative of B-I-F Industries, a Division of The New York Brake Company of Canada Ltd. The company, located in Montreal, specializes in power plant and industrial equipment, and has expended its operations to include equipment for municipal and industrial process control.

R. H. Wray, M.E.I.C. (Alberta '39), Manager of Calgary Transit System, has been elected president of the Canadian Transit Association. After serving with the RCEME in Europe during World War II, he was appointed electrical engineer and technical assistant of Calgary Transit System. He became manager in 1949.

W. E. P. Duncan M.E.I.C. (Glasgow '13) has been elected an Honorary Life Member of the Canadian Transit Association. Mr. Duncan is a Vice-Chairman of the Ontario Division of the Community Planning Association of Canada.

George Joly, M.E.I.C. (McGill '49) has been appointed associate dean of the Faculty of Engineering at Loyola College. He has been assistant dean in the engineering faculty at McGill since 1956.

Ernest A. Ford, M.E.I.C. (Manitoba '27) has been appointed to the board of directors of Dominion Bridge Company, Limited. Mr. Ford joined the company in 1927. He is vice-president of the western region.

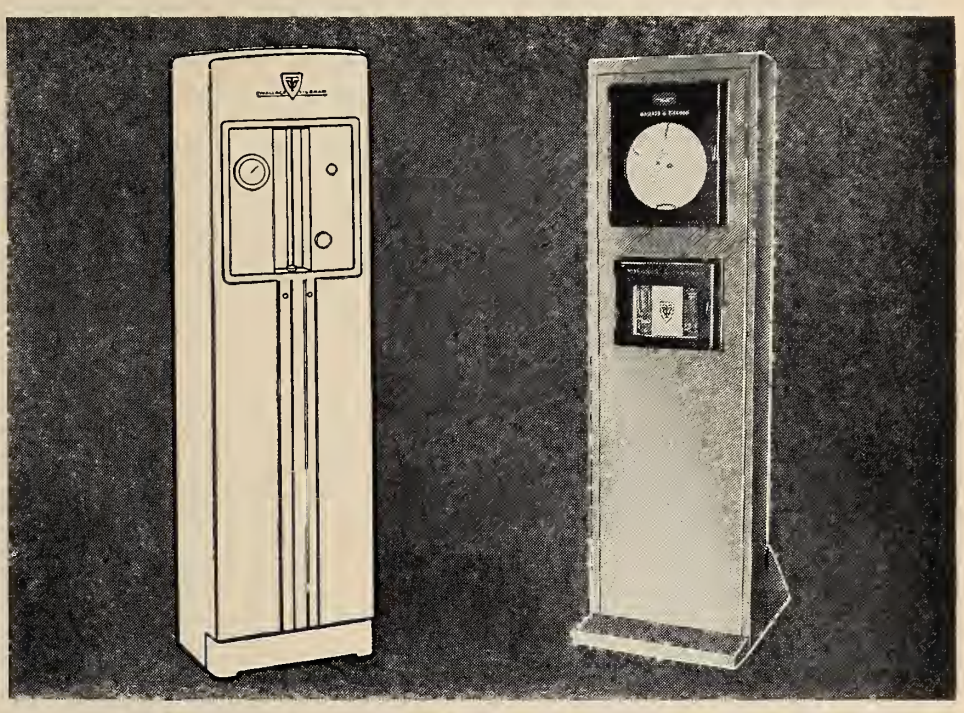
Robert J. A. Fricker, M.E.I.C. (McGill '40) has been appointed to the board of directors of Dominion Bridge Company, Limited. Mr. Fricker is a vice-president of the eastern region and has been with the company since 1941.

Maurice D'Amours, M.E.I.C. (Laval '45), assistant general manager of eastern area, The Bell Telephone Company of Canada has been named operations manager of the east division of eastern area.

William E. Dempster, M.E.I.C. (McGill '46) has been appointed Manager, Province of Quebec Region of Canadian Liquid Air Company, Limited. Mr. Dempster was previously manager of the industrial gases division.

W. E. P. Duncan, M.E.I.C. (Glasgow '13) has been named as an Honorary Life Member of the Canadian Transit Association.

(Continued on page 94)



LAST STEP TO AUTOMATED CHLORINATION... W&T COMPOUND-LOOP CONTROL

This W&T Residual Recorder-Controller brings automation to chlorination. It's going to a plant that had a V-notch Chlorinator with flow proportional control. Now, the plant will use residual control with it for W&T Compound-loop Control.

This stretches the V-notch Chlorinator's range to over 100 to 1. It allows for pin-point residual control . . . eliminates wasteful overtreatment . . . stops dangerous undertreatment.

And the best part of it is that Compound-loop Control can be built piece by piece. Starting with a V-notch Chlorinator, modest budget items over a two-year period automate any water plant's chlorination system.

For details on W&T Compound-loop Control, write Dept. S-162.35.

WALLACE & TIERNAN LIMITED

HEAD OFFICE & FACTORY: 925 WARDEN AVENUE, SCARBOROUGH, ONTARIO
MONTREAL • HALIFAX • WINNIPEG • VANCOUVER

(Continued from page 50)

Mr. Higginson said he and the General Secretary were to attend the Annual Meeting of the Engineers Council for Professional Development in Chicago.

Vice-Presidents' Reports

J. S. Waddington, Vice-President for Region V, reported on problems and progress in his area.

Vice-President J. J. Rowan of Montreal said Montreal Branch is planning an R.I. & C.C. meeting for February, 1964. Some preliminary work regarding new Branches or Sections had been done. He also noted that a Conference Room which has been provided for in the headquarters building is very much appreciated.

L. A. Bateman of Winnipeg attended the meeting on behalf of Professor J. B. Mantle, Vice-President of Region II. Mr. Bateman reported on the planning and enthusiasm regarding the forthcoming R.I. & C.C. meeting in Winnipeg.

Vice-President Gaetan Cote reported on the evidently successful technical conference being held concurrently. He said the success of the occasion was due both to the soundness of the basic organization laid down for such conferences and the co-operation, enthusiasm and hard work of the Councillors, Branch executives and conferences committees of the Eastern Townships and St. Maurice Valley Branches.

Finance Committee

Mr. Higginson, as Chairman of the Finance Committee, said significant addional strides have been taken by headquarters staff to further reduce expenditures. The entire staff now has been gathered into one building to effect rent saving and maximum efficiency, and there have been reductions in staff. Despite these efforts the deficit at the beginning of the year has grown slightly because of slightly slower payment of fees, and because the economies effected will not show their full benefits for some months.

Increased advertising rates for the Engineering Journal and changes in publication procedures have been well accepted and will be reflected in next year's accounts. The intention to hold committee meetings in the headquarters building conference room will also effect an economy.

Mr. Higginson said he feels that within two years it should be possible to clear the deficit and start rebuilding the Institute's financial reserves. The present position, he said, is the result of increased costs and a fall in advertising sales in the last four years. This decrease in advertising sales has been general, and the Engineering Journal has withstood it better than many other publications.

Special action is being taken to deal with arrears of fees. A personal letter from the President is being sent to the Vice-Presidents enclosing a list of unpaid members from their respective Regions. The Vice-Presidents are asked to ensure the co-operation of Branch Councillors and Chairmen in securing payment of unpaid fees in their rates.

Among those participating in the three-day refresher course offered by the University of Saskatchewan this September are Prof. C. Noble, M.E.I.C. and G. Watt, second and third from left standing, of the Civil Engineering Department who explain the tri-axial soils test to engineers taking the soils mechanics course.

Canadian Geotechnical Journal

It was reported that the Canadian Geographical Journal arrangements are complete, and the first copy was available at the recent Soil Mechanics Conference. The new publication will be published quarterly under the sponsorship of the Associate Committee on Soil and Snow Mechanics, National Research Council, and the Geotechnical Engineering Division of the Engineering Institute of Canada.

W. L. Haney, Chairman of the Committee on Technical Operations, reported for his committee and made several recommendations on its behalf.

The Chairman of the Publications Committee is to become, ex officio, a member of the Advisory Committee of C.T.O.

Dean Michel Normandin of University of Sherbrooke was appointed Chairman of the Civil Engineering Division of C.T.O., and Dr. R. H. Tanner was appointed Chairman of the Communications, Electronics and Automation Division.

Because the adoption of the metric system in Canada is both desirable and important to the engineering profession, a Special Committee of Council was established to study the means, timing and consequences of the adoption of this system.

Mathematics for Engineering Students

A Special Committee of Council is to be appointed to study the teaching of mathematics to engineering students, and the best means of assisting the National Research Council on this subject. This Committee is to consist of representatives of the Engineering Education Division of C.T.O., representatives of the Deans' Committee, and the Chairman of the Student Guidance Committee.

The decision to form the Committee followed a request from the National Research Council, on behalf of the Organization for Economic Co-operation and Development. The request asked whether the Institute would be prepared to organize and sponsor a suitable group to consider modern methods of teaching mathematics to engineering students.

American Association for the Advancement of Science

The E.I.C. has been invited by the A.A.A.S. to participate in its meeting in Montreal in December, 1964. The A.A.A.S., was founded 115 years ago and has met in Canada only five times, the last being in 1932. As a result of what is considered a very flattering invitation, the General Secretary was empowered to advise A.A.A.S. in general terms of the Institute's desire to co-operate in the meeting.

E.I.C. Representatives

Representatives of the Institute have attended the following conferences and are reporting: Open Conference on Building Standards for the Handicapped; National Highways Conference; Ontario Conference on Automation and Social Change; 15th Annual Dominion-Provincial Conference on Coal.

E.I.C. representatives will also attend the following: Diamond Jubilee Convention, South African Institution of Engineers; Golden Jubilee, West Pakistan Engineering Congress; Jubilee Conference, New Zealand Institution of Engineers; Tenth Annual Convention of the Institution of Engineers of Pakistan.

The E.I.C. also participated in the Inquiry into Professional Education for Town and Country Planning, sponsored by the University of Toronto.

Other major Institute appointments include: D. A. Barnum who has replaced Mr. Asplin as Councillor for the Niagara Peninsula Branch; Professor D. G. Huber who has been appointed E.I.C. Representative on the Education and Accreditation Committee of E.C.P.D.; C. E. Frost who has been appointed Chairman of the Student Guidance Committee; L. A. Bateman who has been appointed Chairman of the Membership Committee.

I. B. Sveinbjorson's appointment as A.P.E.S. Representative of E.I.C. Council has been approved; H. N. Miller's appointment as A.S.M.E. Representative to the Mechanical Engineering Division of C.T.O. has been approved; Professor John Cherna's appointment as Faculty Adviser at McGill has been approved; and the composition of the Advisory Committee of C.T.O. has been approved.

Successful Meeting For Thermal Power Division

A highly-successful joint meeting of the Thermal Power Divisions of the E.I.C. and the C.E.A. was held at Hovey Manor, North Hatley, Que., Oct. 1-2. This was the first E.I.C. function of its kind on thermal power activities. About 65 delgeates participated in the interesting program.

The meeting was arranged essentially as a field trip. On Oct. 1, tours were made of the Sherbrooke works of Combustion Engineering-Superheater Limited, and Canadian Ingersoll-Rand. At Combustion Engineering the delegates saw a number of boiler products in manufacture, ranging from high-capacity boilers for Ontario Hydro and the Shawinigan Water & Power Company, to the smaller industrial-type units. The tour included an inspection of the testing laboratories and quality control centre. Delegates were impressed with the extent of recent modernization and the potential capacity of this manufacturing plant. It was understood that most of the departments at, or near capacity during the past year to meet commitments.

The afternoon visit to Canadian Ingersoll-Rand involved a tour of the manufacturing facilities, including the foundry. CIR manufactures a wide range of equipment including pumps, paper machinery, air compressors and rock drills. The tour of the foundry was scheduled to coincide with the pouring of a number of large castings.

On the following morning a paper on the Tracy Generating Station was read by E. M. Sommerfield of U.E. & C. (Canada) Limited. Two principal discussers, H. Dick of C. A. Parsons (Canada) Limited and Dr. R. E. Vuia of Combustion Engineering - Superheater Limited, outlined the main features of the turbo-generators and boiler units. After a brief general discussion the meeting was adjourned to enable delegates to travel to the Tracy Generating Station for an afternoon plant visit.

The Tracy plant was at its most interesting stage of construction with the first boiler partially erected, and turbine erection starting. A large portion of the auxiliary equipment was also in position or being installed, thus enabling those present to obtain a complete picture of the details which make up a thermal generating station.

BIG . . .

In 1965 Canada's first nuclear fission power generating station at Douglas Point goes "on line" using a complete Graver Water Treatment plant. Generating units gulping 2½ million pounds of ultra-pure water per hour and operating at 600 p.s.i.g. are supplied by the largest Deaerator in Canada, and one of the largest Heaters in the world. A.E.C.L. got them from Graver—who also supply deaerating units with capacities as low as 2,800 pounds per hour. Big or small, Graver can handle all demands. Let us help *you!*

PROCOR

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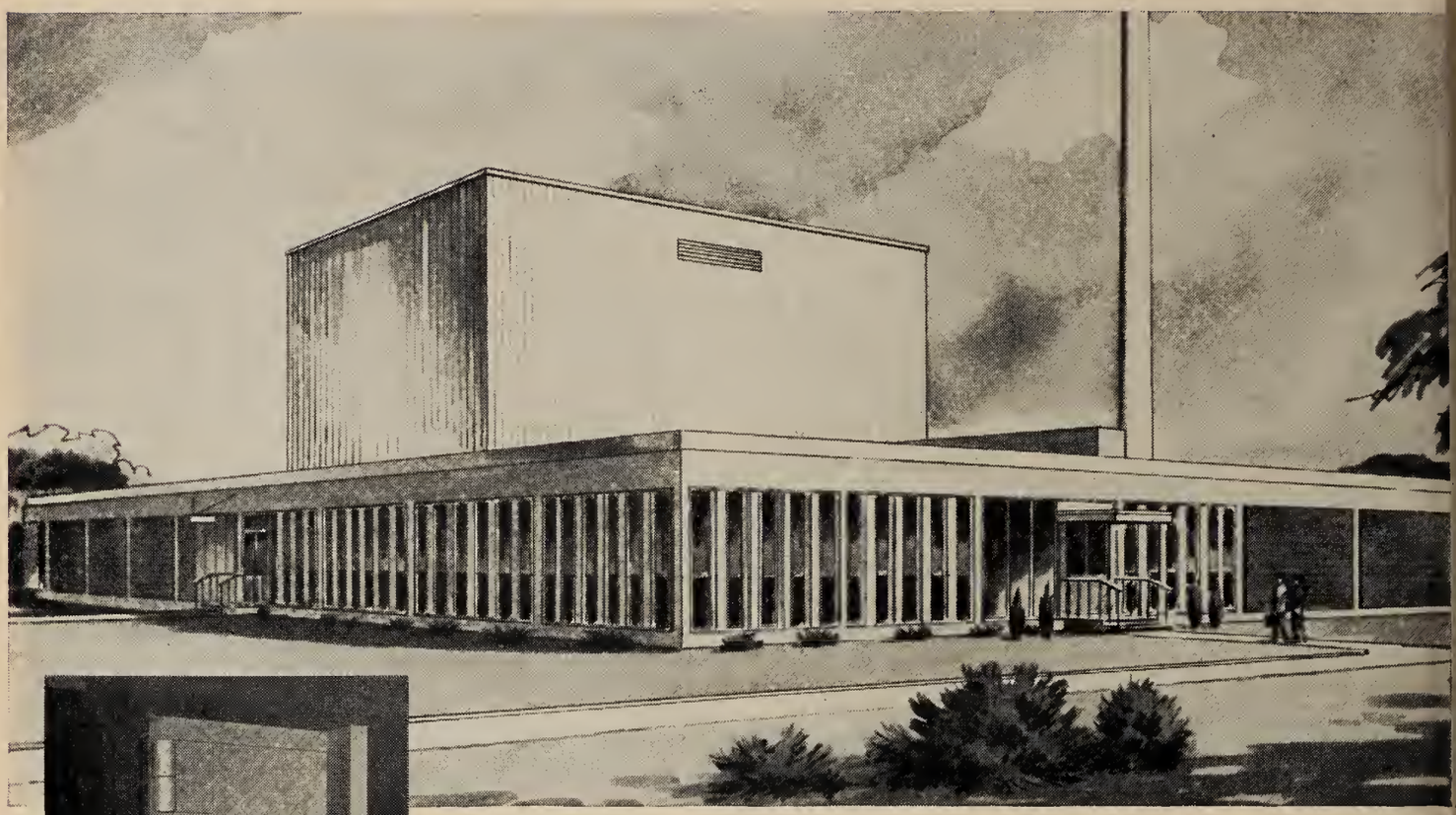
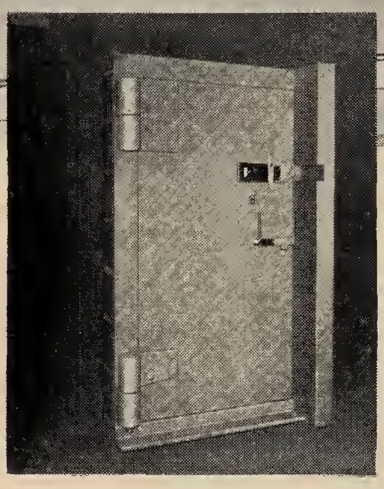
Third Line, Oakville, Ontario

WR-1... *Canada's newest nuclear research reactor*





A typical shielding door, 9" in thickness.

for which CMT has developed and is supplying eleven vital radiation shielding doors

For WR-1, pictured above . . . part of the Whiteshell complex . . . which is being built by Canadian General Electric for Atomic Energy of Canada Limited . . . CMT is manufacturing in Canada shielding and pressure doors to exacting requirements. CMT combines unmatched experience in the security field, with precision manufacturing skills to produce this equipment . . . and thus contributes importantly to Canadian nuclear progress.

NUCLEAR DIVISION

CMT

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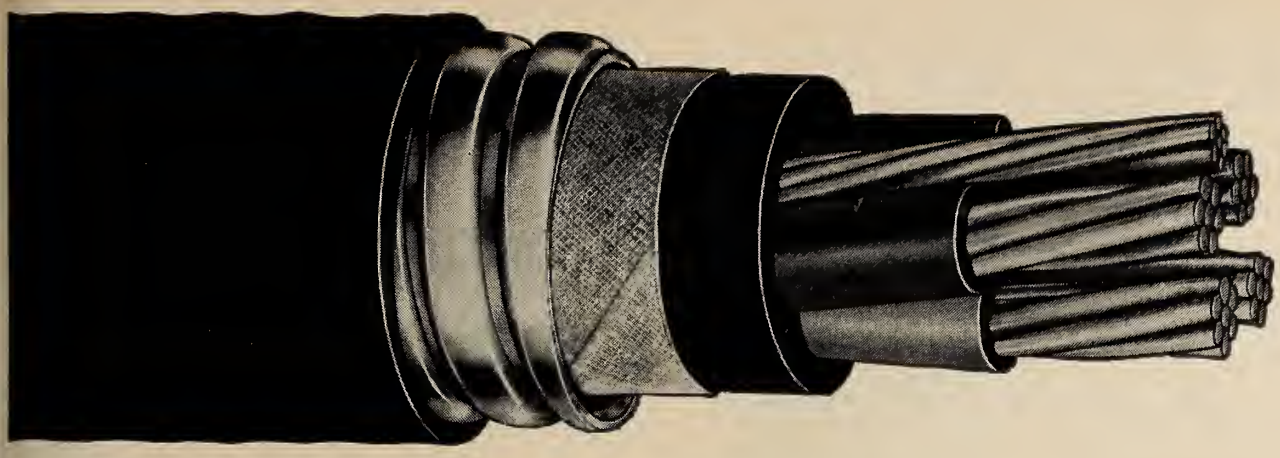
NUCLEAR SHIELDING PRODUCTS, FIRE & BURGLAR ALARM SYSTEMS, ARCHITECTURAL METALWORK, BANK SECURITY EQUIPMENT, COMMERCIAL FIRE & BURGLAR RESISTANT PRODUCTS, PRISON SECURITY EQUIPMENT



TECK is for the TOUGH jobs in industrial power distribution

(Here's the "inside" story)

AMPACITY

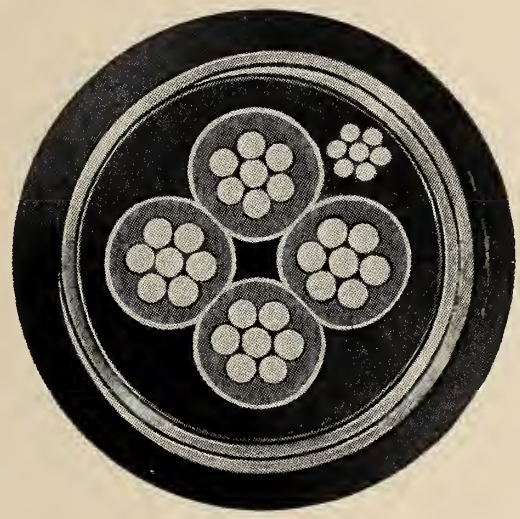
For use up to 5 kv, Teck cables meet CSA requirements for RW60 and R75; or for RW75 and R90. Can be operated at up to 90C in dry locations, 75C in wet locations.

Above 5 kv the insulation meets IPCEA specification S-19-81 for ozone-resistant butyl insulation. Can be operated at up to 85C.

CONDUCTORS

All conductors are stranded coated copper, with conductor identification by either surface colouring or coloured tapes.

Available in 2-conductor to 6-conductor configurations with built-in grounding conductor in all CSA-approved cable *at no increase in diameter.*



JACKETING

Outer jackets in either Neoprene or PVC withstand severe corrosive conditions. Both compounds are specially certified by CSA for this purpose.

The standard inner jacket is Norprene, a substance immune to high concentrations of ozone. It is flame, moisture and impact resistant. Since Norprene is not a thermoplastic, accidental exposure to high temperatures below its ignition point will not cause it to flow or melt.

An optional Butyl inner jacket is available for use where maximum heat and moisture resistance are desired.

FLEXIBLE ARMOUR

Flexible interlocked armour is normally provided in either aluminum or galvanized steel. Copper interlocked armour can be provided when requested for special applications.

SPLICING & TERMINATING

A full range of terminating and splicing fittings is available from Northern Electric. For splicing and terminating practices on the jacketed core of Teck Cable, refer to Northern Electric Engineering Instruction No. 2001—"Splicing and Termination of Norzone-Norprene Cables".

SUPPORTING & TROUGHING

Northern Electric makes available a full range of prefabricated cable troughs and supporting rack elements, in materials, finishes, sizes and accessories to meet various needs.

For full information, please refer to your nearest Northern Electric Office and request Bulletin G17-A.

3063-5

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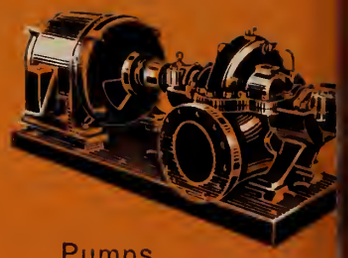
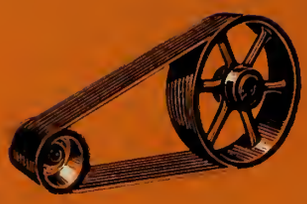
CA-C ENGINEERING IS ON THE MOVE

Motors



Pumps



Texrope Drives

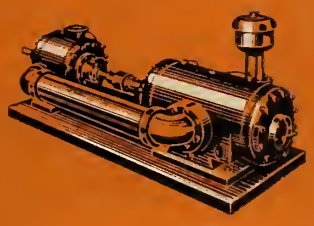
Centrifugal blow

Hydraulic Turbines

Condensers

High voltage con

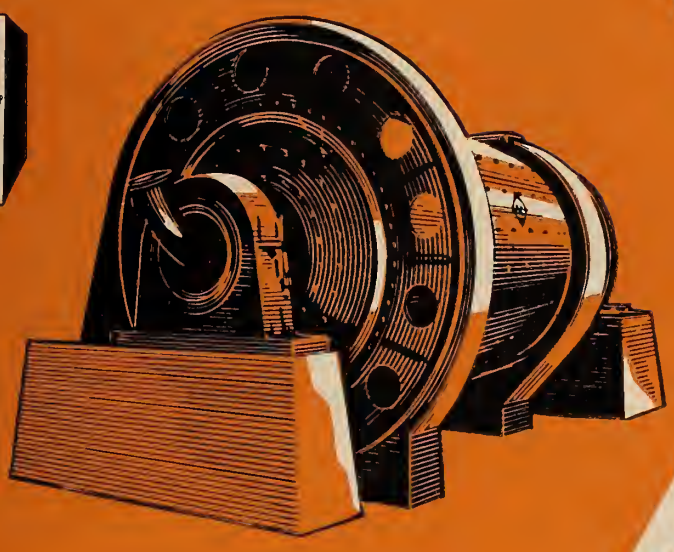
Low voltage control



Crushers

Rotary compressors

witchgear



alves

Grinding Mills

Screens

Rotary Kilns

MADE IN CANADA

...have you checked us lately?

There are new products, new functional designs, new refinements on proven ideas in Canadian Allis-Chalmers products these days. CA-C engineering is on the move . . . making good products better. Check the unusual diversity of the Allis-Chalmers line, as illustrated, then get our *latest* product facts before you specify.

62CI

CANADIAN
ALLIS-CHALMERS

Loans for businesses anywhere in Canada

If lack of suitable financing is restricting the growth of your business or if you are considering starting a new enterprise, IDB may be able to assist you.

For more information, call at the nearest IDB office or write for a descriptive booklet.

idb INDUSTRIAL DEVELOPMENT BANK

BRANCHES: ST. JOHN'S, NFLD. • HALIFAX, N.S. • SAINT JOHN, MONCTON, N.B. • QUEBEC, TROIS-RIVIERES, MONTREAL, P.Q. • OTTAWA, TORONTO, HAMILTON, KITCHENER-WATERLOO, LONDON, WINDSOR, SUDBURY, FORT WILLIAM — PORT ARTHUR, ONT. • WINNIPEG, MAN. • REGINA, SASKATOON, SASK. • CALGARY, EDMONTON, ALTA. • KELOWNA, VANCOUVER, VICTORIA, B.C.

Engineering Briefs

(Continued from page 63)

THE BATTERY "MEGGER" TESTER is a portable 500-volt insulation tester which, in addition to indicating insulation values from 0.4 to 50 megohms and infinity, measures continuity from 0 to 20 ohms, and AC-DC voltages up to 500 volts. The instrument is available from R. H. Nichols Co. Ltd., Toronto. It incorporates all ranges normally required in testing industrial and domestic electrical installations, equipment and appliances.

DORR-OLIVIER-LONG Ltd., Orillia, Ont., has announced the availability of their new vacuum drum filter. Available in a range of sizes, the filters are constructed completely of fibre-glass reinforced plastic (RFP) or other non-metallic materials except for structural members and valves. These filters are available in three or four-foot drum diameters and one to eight foot drum lengths. The plastic filter is suitable for food, pharmaceutical and fine chemical service and for processes involving severely corrosive filtrates.

A TWO-STAGE MECHANICAL vacuum pump with 106 c.f.m. free air capacity is being manufactured by Central Scientific Company of Canada Ltd., Toronto. The new unit, called the Hyvac 300, follows the recent introduction of the Hyvac 150 pump. Applications of the Hyvac 300 include backing of large diffusion pumps; fast, efficient pump-down of environmental chambers; and other research or industrial applications where high capacity and fast recovery features are required.

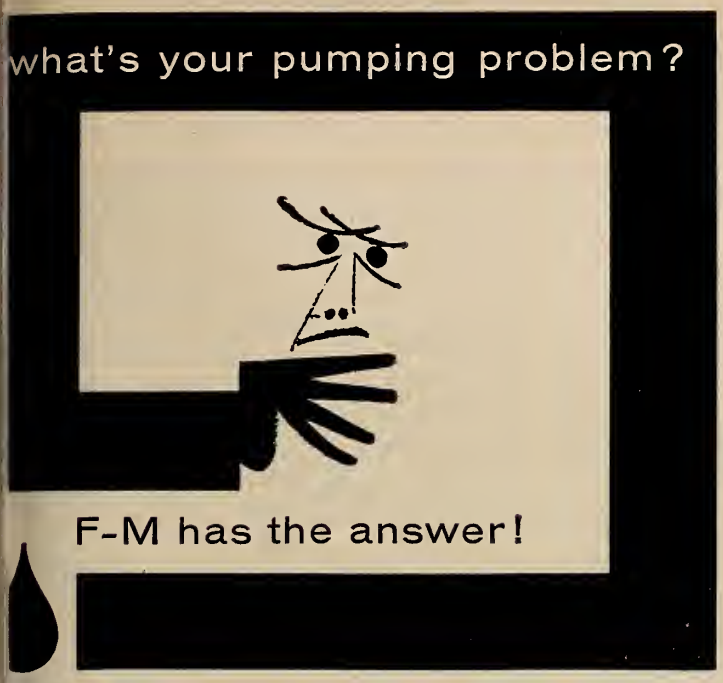
A NEW AUSTINLITE MARGINAL relay which combines improved sensitivity and streamlined design has updated the well-known unit for use in supervisory alarm equipment as an overload protector or under-and-over voltage detector in modern switch boards. The new Mark IV retains the high torque magnet system of the Mark II and Mark III, which insures that contacts close firmly without any tendency to wander from their original settings.

A VINYL FOAM PLASTISOL that provides effective strippable packaging with 50 per cent less material than conventional plastisols has been introduced by M&T Products of Canada Ltd. The material, designated Unicrome Plastisol 4417, contains a "built-in" chemical foaming agent which expands the thickness of the applied coating 100 per cent during the cure cycle. As a result, packagers have an opportunity to achieve product protection levels comparable to conventional strippable plastisols at half the cost.

A PHOTOGRAPHIC WASH-OFF drafting film that offers design engineers and reproduction specialists new speed, ease and economy in the photo reproduction of drawings and maps now is available from Kodak. Of particular appeal to design engineers is the clean, white, wet-erasable drafting surface. Extreme detail holding ability even with halftone images, blacker images for improved microfilm reproduction and superior dimensional stability for greater accuracy are added drafting room features.

A SILICONE FLUID that lends rust resistance to metal surfaces has been placed on the market by Canadian General Electric. SF-1055 is designed for industrial use as well as in the manufacture of saturated polishing cloths, aerosol protective sprays and polishes for use on guns, sporting equipment or marine hardware. Aerosol release sprays for metal molds could also effectively incorporate this fluid, which is capable of resisting the high temperatures usually accompanying metal molding.

what's your pumping problem?



F-M has the answer!

Got a pumping problem? Investigate F-M. Based on years of experience plus technical know-how, Fairbanks-Morse gives you the *widest* range of pumps for every industry and municipality — the *best* pump your money can buy! Want more information? A letter or call will bring the answers, fast.

FAIRBANKS-MORSE PUMPS
Manufactured and marketed in Canada by
Canadian Locomotive Company
Toronto — 36 Park Lawn Road, Area Code 416 — 255-0175
Kingston — Ontario Street, Area Code 613 — 548-7731
Sales, service and parts available across Canada.

"TECHNICAL ANALYSIS OF SALT (Sodium Chloride) for Ice and Snow Removal", a 61-page book, now is available from the Canadian Salt Company Limited. The first section deals with the mechanics of chemical de-icing with salt, in which the point is made that breaking the bond between ice and pavement is more important than lowering the freezing point of water. Corrosion of motor vehicles is thoroughly examined. Also discussed and defined are winter conditions in relation to air temperature, precipitation, and snow density. Included is a section of winter climate charts, giving the average daily temperature and average monthly precipitation of the major cities in Canada.

TRANE COMPANY OF CANADA has announced that a sink-bubbler unit, magazine rack, mobile shelving, tote tray unit, cubicle shelving and the standard line of shelving are available with Trane unit ventilators. Canadian-made Trane unit ventilators are used to provide heating, ventilating, and air conditioning for school classrooms. Designed to match Trane unit ventilators, the new accessories are only 11⅝ inches deep, thus saving valuable floor space. Trane offers the accessories in two heights—28 and 32 inches—to adapt to any window sill height.

AN ELECTRIC SUBMERSIBLE sewage pump model for use in municipal and industrial sewage collection systems has been introduced by Flygt Canada (1963) Ltd. The new 9 hp. model has a maximum head and capacity of 85 feet and 625 US gpm, an increase of some 18 feet and 150 US gpm. A main feature of the new model is that its external dimensions are identical to those of other units in the line, thus permitting complete interchangeability. This characteristic allows the new models to be used in existing Flygt station installations.

"CINCH" ANCHORS
"STRONGER THAN THE BOLT"

The completely reliable expansion Anchor manufactured solely in Canada. For Bolts 3/16" to 3" diameter. Data book and stress tables sent on request.

CANADIAN CINCH ANCHORING SYSTEMS LIMITED
2095 Madison Avenue, Montreal

LUMMUS
REG'D TRADE MARK

THE LUMMUS COMPANY CANADA LIMITED
OVER 50 YEARS WORLD-WIDE EXPERIENCE ON MORE THAN 900 MAJOR INDUSTRIAL INSTALLATIONS

COMPLETE PROFESSIONAL SERVICES FOR INDUSTRIAL PLANTS, FEASIBILITY STUDIES, PROCESS OPERATIONS DEVELOPMENT, ENGINEERING, PROCUREMENT AND CONSTRUCTION

CALL UN 1-9251 OR WRITE 1 PLACE VILLE MARIE, MONTREAL, QUE.

EIC CERTIFICATE OF ADVERTISING MERIT

A stark and striking single-page advertisement in the August issue of the Engineering Journal has won for Procor Limited, Sparling Division the monthly EIC Certificate of Advertising Merit. Except for the red in the Procor logo, the entire page was a white-on-black reverse. A simple line drawing depicted a large pressure vessel, a water tower and large process vessels of the type produced by Sparling. The short, effective text contains the simple statement that "Throughout the world Sparling is a leading designer, fabricator and erector of process equipment in aluminum, steels and other metals. . . ."

The ad was prepared under the direction of Paul Thompson, Manager Public Relations, Sparling Division, by Maquinna Advertising Agency Limited, Toronto, W. J. Campbell, Account Executive.

Judging for the award is done each month by an impartial jury of engineers from all parts of Canada whose only instructions were to select the best advertisement on the bases of ACCURACY—INFORMATION—ATTRACTION.

SPUN ROCK

BLANKETS
and
PIPE INSULATION
for Canadian industry

Has all the features expected of a good thermal insulation, plus these

IMPORTANT EXTRAS:

- **Long, resilient, stable fibres; no binder**
- **Non-corrosive to any metal**
- **Withstands continued vibration**
- **Maximum thermal efficiency at temperatures as high as 1200° F.**
- **Made from rock, by electric furnace process.**
- **Conforms to Commercial Standards CS-117-49**

Technical information and samples available

SPUN ROCK WOOLS LIMITED

SPUN ROCK WOOL · HEAT COLD SOUND · INSULATION

Thorold Ontario

000

depend on DART

Two Bronze Seats Ground to a True Ball Joint

DART UNION COMPANY OF CANADA LTD.

"BROOMWADE" PNEUMATIC TOOLS
chosen by leading Engineering Firms
FOR ROUND-THE-CLOCK RELIABILITY

The demand for "Broomwade" Pneumatic Tools is now greater than ever. They are tough, reliable, expertly designed and precision built to give years of trouble-free service. They are ideally suited to the requirements of engineering workshops and foundries, and are unbeatable for cost-cutting efficiency.

Write for publication No. 407 T.E.

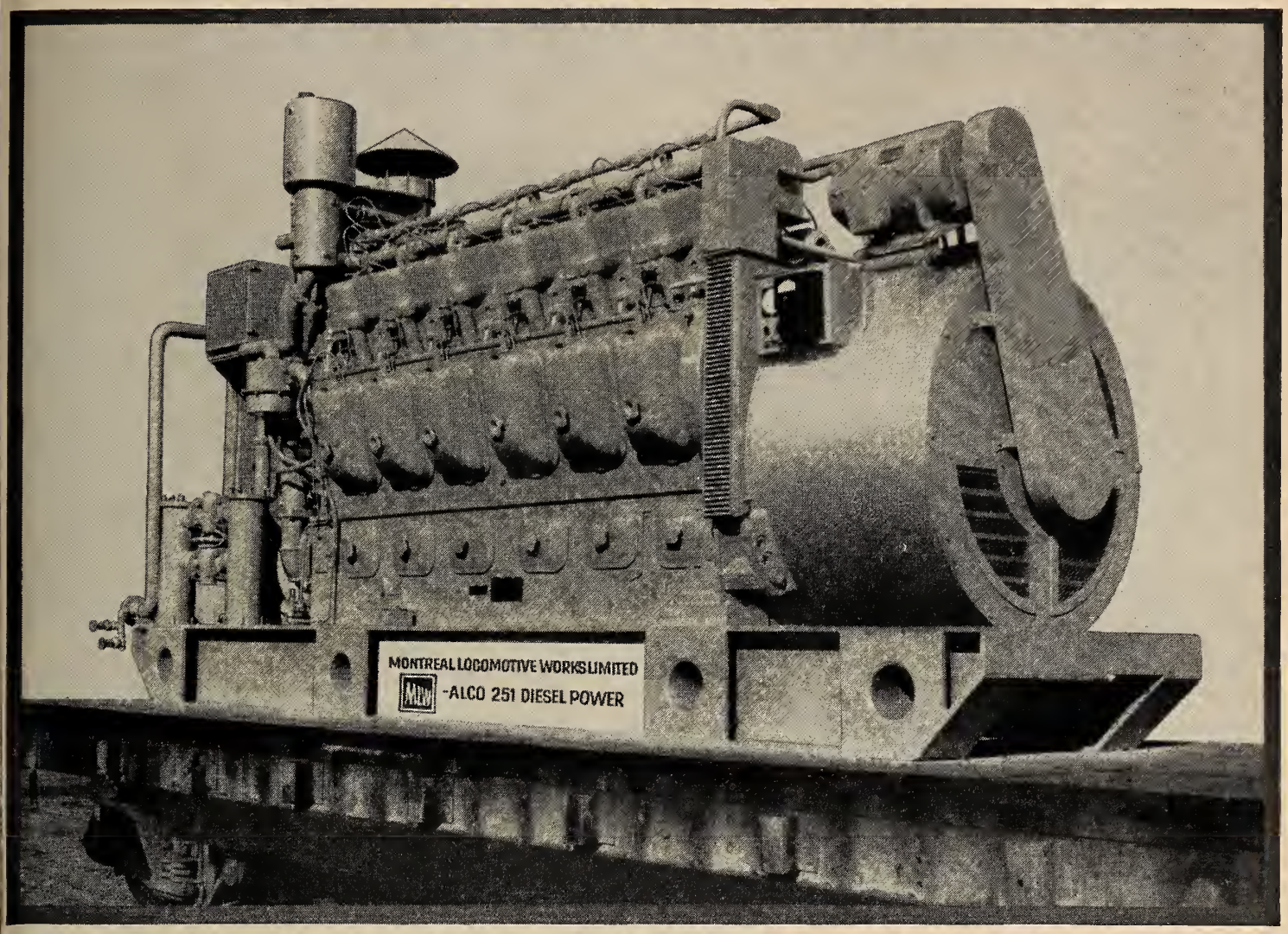
CANADIAN · BROOMWADE LTD.

Air Compressors and Pneumatic Tools your best Investment

Canadian Broomwade Ltd., Box 488, Adelaide Post Office, Toronto 1, Ont. Telephone: CRescent 4-3441

Fully represented in all major cities. 0.309 SAS

NOW FROM MLW...



Engine recently shipped to Wabush Lake, Newfoundland.

MLW-ALCO-251 ENGINE

A NEW VERSATILE PACKAGED POWER PLANT... manufactured in Canada for the domestic and overseas markets.

Here is the MLW-251 diesel—the result of twenty-six years' experience and modern advances in design, metallurgy and manufacturing—a diesel which is outstanding for its low capital cost . . . low operating cost . . . low maintenance cost . . . low installation cost...and ease of maintenance...made in Canada by MLW.

MLW

For further information write to:

Manager, Diesel Engine Sales & Service,

MONTREAL LOCOMOTIVE WORKS LIMITED

1505 Dickson Street, Montreal 5, P.Q., Phone: CL. 5-3681

(Continued from page 58)

In the afternoon and evening there were inspection and recreational cruises on the Princess Patricia.

VANCOUVER ISLAND BRANCH

J. Devlin,
M.E.I.C.

The Branch has introduced a monthly news letter which will be distributed to members, informing them of EIC and local Branch activities. In addition, the news letter will include matters of interest from Executive and Regional meetings, and will publicize meeting arrangements of the Professional Engineers of BC and other engineering societies in the area. Members of other associations are welcome to attend this Branch's meetings. Notice of their meetings, which will appear in the news letter, will permit Branch members to attend meetings of particular interest. The news letter will provide the only formal notification of scheduled Branch meetings. On September 6 the regular monthly luncheon meeting was held at the Glenshiel Hotel. Speaker was E. D. Pigott, P.Eng., of Read, Jones & Christopherson Ltd. He discussed high rise apartment design. September 18 was the date of a joint dinner meeting with the Victoria Branch of the APEBC. This meeting was held at the Tally-Ho Hotel. On October 15, a stag dinner meeting was held at the Dominion Hotel. President Higginson and the General Secretary attended.

COMING EVENTS

American Institute of Chemical Engineers. 56th Annual Meeting. Houston, Tex. Dec. 1-4.

Institute of Electrical and Electronic Engineers, Inc. Ultrasonic Engineering Symposium. Washington, D.C. Dec. 4-6.

American Institute of Mining, Metallurgical and Petroleum Engineers, Inc. 21st Electric Furnace Steel Conference. Chicago, Ill. Dec. 5-7.

Engineering Institute of Canada. Lakehead Regional Technical Conference. Port Arthur, Ont. Dec. 6.

The Institution of Chemical Engineers. National Productivity Year Symposium. Productivity in Research. London, England. Dec. 11-12.

American Society of Agricultural Engineers. Winter Meeting. Chicago. Dec. 11-14.

American Association for the Advancement of Science. 130th Annual Meeting. Cleveland. Dec. 19-21.

The Institute of Physics and the Physical Society. Conference on Electrical and Magnetic Properties of Thin Films in Relation to their Structure. Imperial College, London, England. Dec. 16-18.

ENGINEERS JOINT COUNCIL SCHEDULES COURSE IN INDEXING AND ABSTRACTING

Engineers Joint Council and Battelle Memorial Institute have announced the scheduling of a series of training courses in abstracting and coordinate concept indexing of technical literature, further implementing the EJC "Action Plan" to improve engineering information flow announced last year.

Under the plan, EJC has provided to the staffs of its societies training courses to encourage indexing-abstracting of articles concurrent with their publication. The indexing method advocated by EJC utilizes links and roles and contemplates the use of an engineering thesaurus of descriptors under development by EJC.

The courses now offered to the general public on a fee basis provide an opportunity for industry, libraries, government agencies and others to acquire training in the fundamentals of the EJC adopted system.

PUBLIC INVITED

To be given by Battelle Memorial Institute in accordance with EJC specifications, the courses will consist of week-long lecture and practice sessions under the following initial schedule:

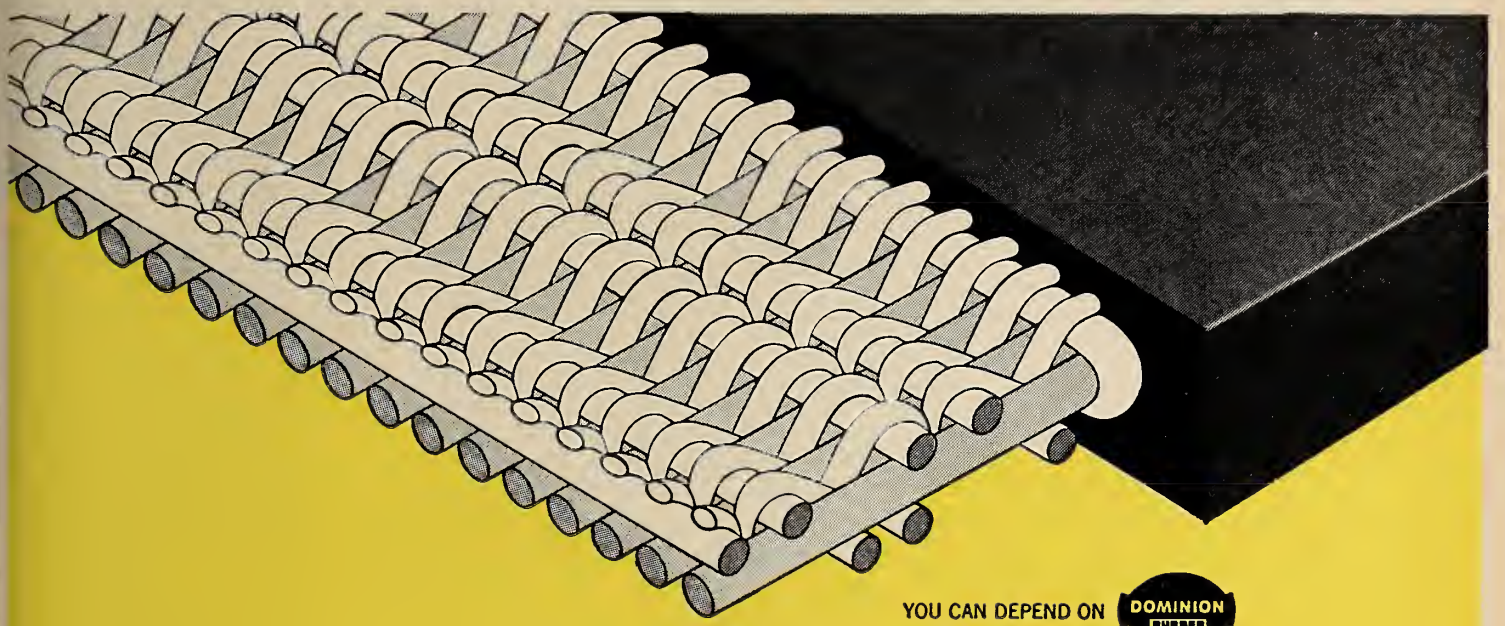
• BOSTON, MASS	December 9-13, 1963
• NEW YORK CITY	February 10-14, 1964
• MONTREAL	March 2-6, 1964
• CHICAGO	March 23-27, 1964
• NEW YORK CITY	April 27-May 1, 1964
• SEATTLE, WASH.	June 1-5, 1964
• TORONTO	June 8-12, 1964

Registration forms can be obtained from J. C. Costello, Jr., Group Director, Information Systems Research, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio.

The endorsement of this training program by EJC completes the second stage of its program to inprove storage-retrieval of engineering literature and furthering the compatability of information systems and practice.

DOMINION RUBBER ANNOUNCES

USFLEX



YOU CAN DEPEND ON DOMINION RUBBER

Key to USFLEX is lengthwise and crosswise members in parallel planes—not interwoven. Specially engineered binding enables lengthwise and crosswise members to work independently, yet cooperatively, to provide the most durable, most efficient belting ever developed.

a new concept in conveyor belt carcass construction

Another famous "first" by Dominion is USFLEX, a remarkable new conveyor belting carcass construction which increases belting strength, decreases belting weight and thickness—to make entire conveyor belt systems more efficient, more versatile, more economical, more widely applicable than ever before.

Belting applications previously requiring many plies can now be served by *one*, eliminating problems of separation and delamination. By reducing belting stretch, USFLEX requires less take-up and has unsurpassed impact and rip resistance. Internal carcass chafing problems virtually disappear.

Already proving its superior characteristics in a variety of applications, including the handling of coarse rock and on deep-trough idlers, USFLEX single-ply belting is available in working strengths up to 440 lbs. per inch ply, with a variety of covers for nearly every purpose. For your copy of our new USFLEX folder, write: Dominion Rubber Company Limited, 550 Papineau Ave., Montreal 24, Que.

DOMINION RUBBER **Dominion Rubber**
INDUSTRIAL PRODUCTS DIVISION

IP - 64 - 1

Mr. R. L. Wood, Mine Manager (right) and Mr. J. Hirsch, Plant Foreman, check twelve Goodyear HY-T WEDGE V-belts on the primary crusher drive.

HOW WEDGES SOLVED A CRUSHING PROBLEM WITHOUT A TAKE-UP

When Great West Coal Co., Ltd., Estevan, Sask., planned for the most modern coal screening plant in Canada, Goodyear Technical Service was consulted. One of the problems was that of belting the primary crusher. The drive was studied, and Goodyear Green Seal HY-T WEDGE V-belts were installed. Three years and 2,000,000 tons later, *no take-up needed . . . not one minute of down-time* due to crusher belt failure. These Green Seal Wedges are still driving and look good for many more tons. □ Dimensionally stable HY-T WEDGE V-belts (another Goodyear first) with tough, sinewy 3-T Cords handle increased Hp. as much as 30% over "super-rated" V-belts. In addition WEDGES reduce sheave widths up to 20%, with same number of belts. □ There's nothing like having an expert handy when you have an industrial rubber problem. That's where the Goodyear Technical Serviceman really shines. For the "right answers" contact the nearest Goodyear Branch or Head Sales Office, Bowmanville, Ont.

TO BE SURE CALL **GOODYEAR**

INDUSTRIAL RUBBER PRODUCTS ENGINEERED FOR THE JOB

BUSINESS REPLY CARD
No postage necessary if mailed in Canada

This card will not be processed if used for address or occupation change.

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Product/Service Information

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THE ENGINEERING JOURNAL

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MONTREAL 2, QUE.

CANADA

POSTES — CANADA — POSTAGE
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5766

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To ensure regular receipt of The Engineering Journal, please complete and return this card when you move.

Zinc metallized box beam (8′ x 11′ x 80′) for the new Richelieu River Bridge—part of the Trans-Canada Highway—near Beloeil, Que.

Box beams on new Canadian bridge protected by metallizing with zinc

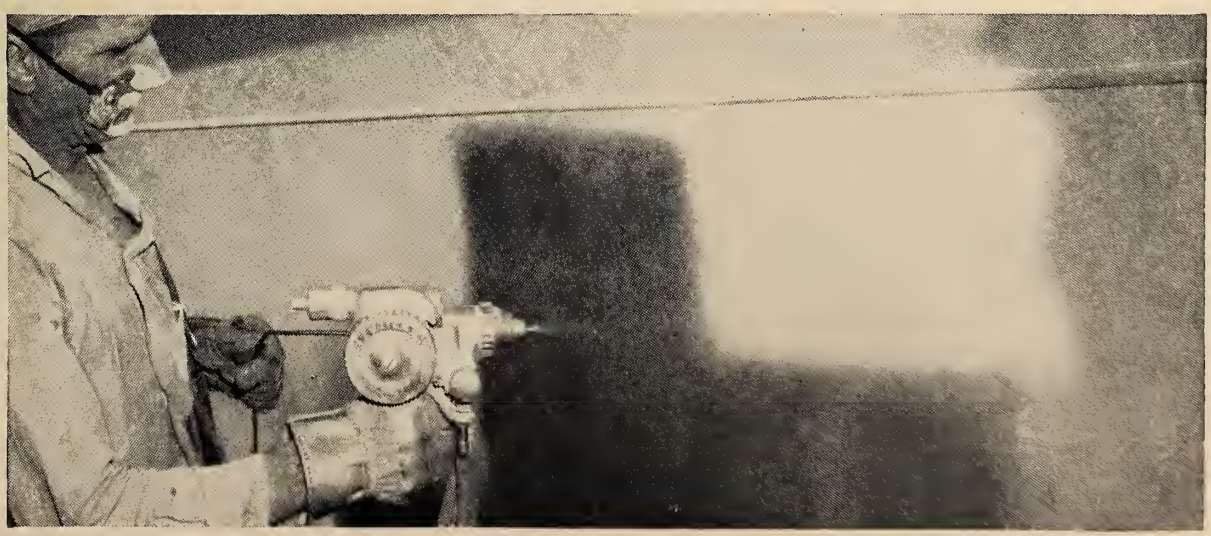
From two to ten thou of molten zinc was sprayed right onto these vital members for the new Richelieu River Bridge. The metallizing process provides a continuous adherent coating of zinc to protect the steel from the ravages of rust. Metallizing with zinc is a flexible process—it can be done in the fabricating shop or on the site—thickness can be controlled to suit protection requirements. By reducing maintenance and repair costs due to corrosion, *zinc coatings provide savings* that can run into thousands of dollars annually for many types of large steel structures. To get optimum service from any structure exposed to industrial, marine or rural atmospheres, combine the strength, versatility and low cost of steel with the protection of a zinc coating.

Consulting Engineers for the Richelieu River Bridge: Lalonde & Valois. Fabrication and Erection: Canada Iron Foundries, Limited, Structural Division. Metallizing Sub-Contractor: Lagendyk and Company Limited.

Write for information on metallizing to: Dept. SD-4

COMINCO

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED
630 Dorchester Blvd. W., Montreal 2, Que.

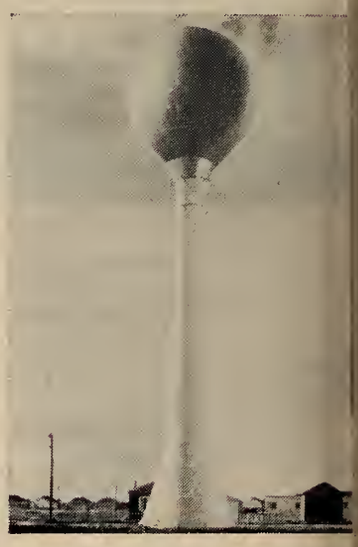


Metallizing a box beam for the Richelieu Bridge.

being First is a 50 year habit at

In 1913 Horton fabricated and erected many of these early elevated storage tanks — some of which are still in use today, after over 50 years of service.

In 1959 Horton developed, fabricated and erected the first "covered pan" floating roof tanks that conserve vapors while protecting against snow and ice under severe weather conditions. These tanks are sold under the trade name 'Weathermaster'.



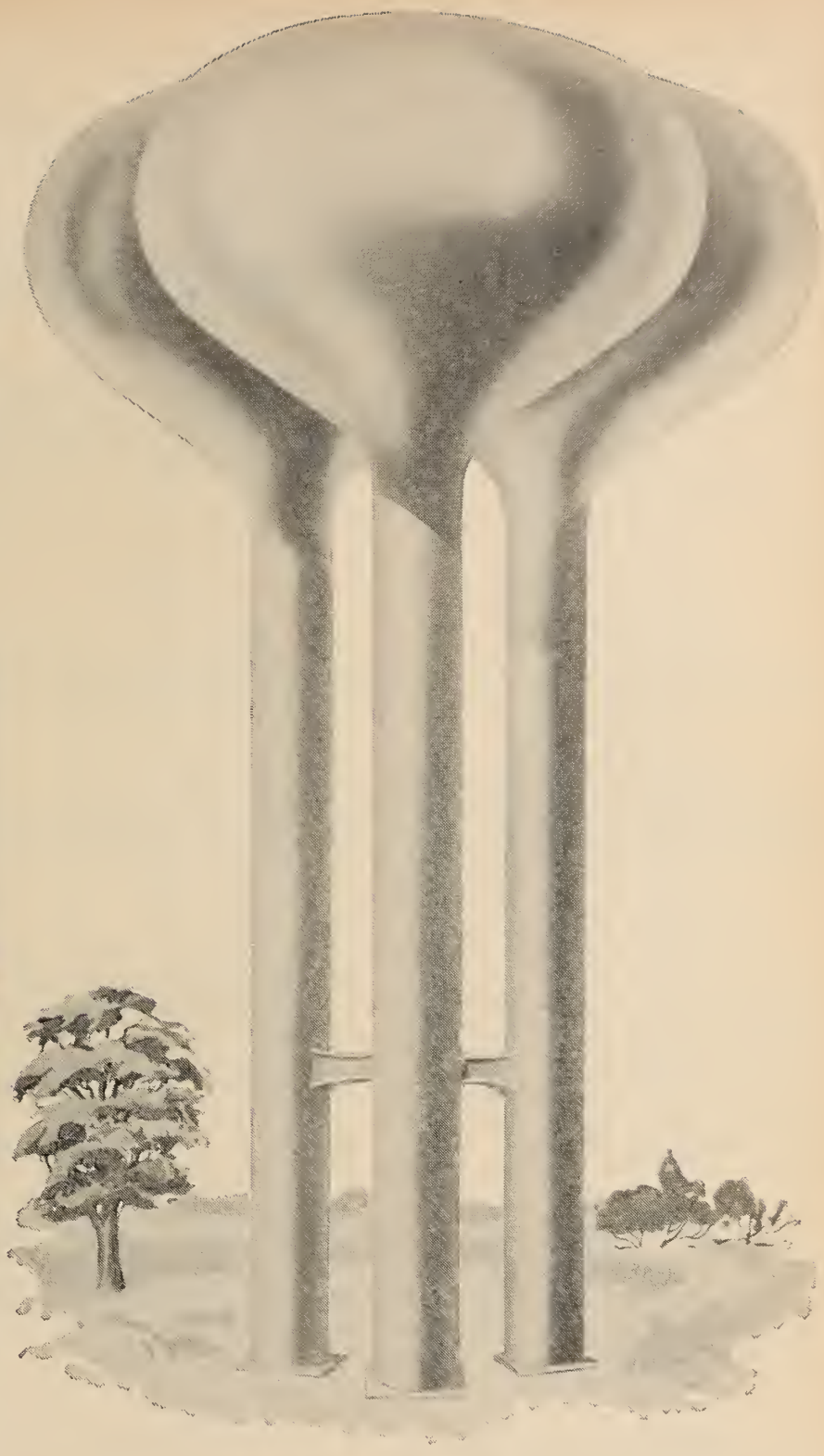
In 1947 Horton fabricated and erected the first Watersphere, creating out of strong welded steel plate a modern, landscape-blending design that is both attractive and completely efficient.

HORTON!

Fifty years of forward-thinking in the design, fabrication and erection of steel plate keeps Horton ahead!

In 1925 Horton constructed the first spherical storage vessel in Canada. Many Hortonspheres have been built in the intervening years — including ten constructed in a single, recent contract . . . five in stainless steel!

Since 1913, Canada's industrial complex has grown considerably. Horton has been equally busy — formulating and executing the most advanced new ideas in steel plate construction — keeping pace with modern industrial needs year after year. That's why today, Horton's range of services include research, engineering, fabrication and field erection. That's why today, Horton is involved in the very newest fields of cryogenics and nuclear containment vessels. That's why today, the industries served by Horton are legion and include hydro-power, gas-processing, petroleum, pulp and paper, mining, chemical processing, nuclear research and industry at large. That's why, today in Canada, there's a *name* for steel plate fabrication, Horton!



Horton's "firsts of the future" include this ultra-modern Polyspheroid — an enlightened design in elevated water storage, comprising 2, 3, 4, 5 or 6 steel plate sections, integrated to provide up to 4,000,000 gallon capacity!

CISC

HORTON SHAPES NEW HORIZONS

HORTON STEEL

WORKS, LIMITED

25 ADELAIDE STREET WEST, TORONTO, ONTARIO

Plants and Offices throughout Canada

50 YEARS HELPING TO DEVELOP CANADA

TANKS AND STEEL PLATE WORK FOR ANY INDUSTRIAL ASPECT... IN CARBON STEEL, SPECIAL METALS OR COMPOSITES

HSW-635

Employment Service

THE ENGINEERING INSTITUTE OF CANADA

This service is operated for the benefit of members of the Engineering Institute of Canada and for organizations employing engineers.

SITUATIONS WANTED

Advertisements are inserted free of charge for members of all classes. Maximum length is 60 words, and repeat insertions must be separately requested in writing for each desired appearance.

SITUATIONS VACANT

Rate: Six dollars per column-half-inch per insertion.
Replies to advertisements should be addressed to the file number, Employment Service, 2050 Mansfield Street, Montreal. Interviews with the Employment Service may be arranged by calling VI 2-8121 at the above address.

SITUATIONS WANTED

RETIRED ELECTRICAL ENGINEER — P.Eng., bilingual. Desires position either full or part time, where past diversified experience in the utility or manufacturing industries can be an asset. Broad experience in distribution and substation design, 6 years' shop experience in manufacturing. Well versed in construction, maintenance, cost estimating, studies, reports. Willing to travel. In excellent health. Do not want to stagnate. File No. 552-E.

CIVIL ENGINEER, — A.M.E.I.C., Grad. RMC 1960, U. of Toronto 1961. Age 26, married 1 child. 1 year northern construction experience as project engineer, 1½ years' experience in water and sewage, engineering studies soil surveying and testing in large soils lab, municipal and runway design across Canada. Presently located in Alberta; prefer location in Western Ontario. Available January 1964. File No. 556-C.

CIVIL ENGINEER — M.E.I.C., P.Eng., McGill '56. Age 32, married, 1 child, completely bilingual. 4 years' structural steel design, 3 years as structural design engineer of plant engineering (reinforced concrete, specifications, steel, and supervisory experience). Desires position at management or associate level. Location, Montreal area. Available on short notice. Resume on request. File No. 557-C.

RETIRED CIVIL ENGINEER — M.E.I.C., P.Eng. Languages — English, French, Polish, Russian, German. Desires any position commensurate with experience, part or full-time, Montreal area. Willing to do draughting. 18 years experience with C.N.R. in design (last 10 years mostly in steel and aluminum structures) and special project assignments. File No. 582-C.

CIVIL ENGINEER — M.E.I.C., P.Eng. (Quebec & Ontario), B.A.Sc. (Toronto), age 38, married, 3 children. 16 years' experience as materials engineer, asphalt, concrete, soils, highway design and construction, airfield construction. Presently located in Montreal. Desires challenging position with consultant or contractor. Will relocate. Available on short notice. Resume on request. File No. 581-C.

CIVIL ENGINEER — A.M.E.I.C., B.Sc. (Man.), M.Sc. (Alta.), in highways and soils. Age 37, married. Employed in supervision of highway construction, contract and construction control in drainage works. Arriving Canada from Hong Kong in February 1964. Seeks position in highway design and construction, soils and foundations in Toronto, Montreal or anywhere. Available February 1964. File No. 580-C.

ELECTRICAL ENGINEER — M.E.I.C., P.Eng. Que. McGill 1941. Married, bilingual. Experience — in the field of hydroelectric power generation and high voltage transmission — has been equally divided between the technical aspects of operation maintenance and construction and departmental management administrative functions. Wish to become associated with the management of an industrial manufacturing company in the area of general administration or plant management. Prefer Ontario location but willing to relocate elsewhere. Resume on request. File No. 579-E.

CIVIL ENGINEER — M.E.I.C., P.Eng. Age 31, married. University of Alta. 1955. 3 years Resident Engineer flood control and drainage projects. Surveying and administration. 2 years assistant construction engineer irrigation projects. 2 years hydraulic design engineer—estimating, quantity take-offs; soils and foundation analysis; hydraulic structure studies; research. Desires challenging position in related field. Locate anywhere. Available on short notice. Resume on request. File No. 578-C.

MECHANICAL ENGINEER — M.E.I.C., P.Eng., U. of Montreal '51, M.S. U. of London '60. Canadian, bilingual, married, age 34. 7 years' experience in Research and Development involving aero, structures, test equipment. 4 years' research in combustion, flame traps. Desires position in Design and Development, preferably in combustion field. Willing to travel. Will consider any location. Presently located in Ottawa region. File No. 577-M.

CHEMICAL ENGINEER — B.Sc.Ch.E. '42, M.A.I.Ch.E., Prof. Engr. 20 years' experience as research, process, job and project development engineer for oil and gas processing, and petrochemical plants. Perfect German, some Dutch and Russian. Seeks position with engineering or oil company in Eastern Canada. Available at one month's notice. File No. 6167-Ch.

MECHANICAL ENGINEER — M.E.I.C. Wide experience in managerial and supervisory capacity, including plant engineering, maintenance, design, equipment selection and purchase. Seeks position in plant maintenance or production. File No. 576-M.

MECHANICAL ENGINEER — A.M.E.I.C., P.Eng. (Ont.), Nova Scotia Tech. Age 23. Experience includes 18 months in the engineering design field, in maintenance of plant services, special studies in preventive maintenance of production equipment and inventory control of maintenance stores. Desires position in production and plant supervision. Prefer Ontario, Quebec or Maritime location. File No. 575-M.

ELECTRICAL ENGINEER — M.E.I.C., P.Eng. Presently employed by a consulting engineering concern, seeks better opportunity in the consulting engineering field in Montreal area. Age 32, graduated in 1955; married. File No. 6405-E.

ELECTRICAL ENGINEER — Engineering Officer, A.M.E.I.C., P.Eng. (Quebec), C.M.R., R.M.C., McGill, B.Eng. '61. Bilingual, age 25, married, 2 children. 1 year experience in military engineering. 1½ years experience in design and electrical engineering work relative to specific projects (accommodations & services, distribution), briefings and reviews, field inspections, assessments, estimates, preparation of briefs and reports. Desires position with engineering firm, preferably consultant. Preferred location, Montreal area or Province of Quebec. Available January 1964. File No. 549-E.

SITUATIONS VACANT

CHEMICAL

CHEMICAL ENGINEER — Preferably with some postgraduate training, to act as representative for the National Research Council's Technical Information Service and Industrial Research Assistance programs, and to represent the Research Council of Alberta to industry. Work will be varied and typical duties would include the assessment of technical problems in a manufacturing firm, working out programs for the solution of such problems, and the provision of up-to-date technical and scientific information where appropriate. A limited amount of laboratory work may be required during investigation of materials and products. A fair amount of travel throughout the province will be involved, and home location will be Edmonton, Alberta. A B.Sc. in Chemical Engineering is necessary and some postgraduate training is preferred. At least two years' experience is required. Salary $6600 and up based on education and experience. Further information and application forms are available from: Administrative Assistant to the Director, Research Council of Alberta, 87 Avenue and 114 Street, Edmonton, Alberta. File No. 532-V.

STRUCTURAL ENGINEER

A major Consulting Engineering firm located in Vancouver, B.C. requires o senior structurol engineer. Appliconts must hove o minimum of ten yeors' experience in this field with preference being given to those with experience in bridge design ond heovy industriol work. Post graduate studies in structurol engineering desiroble but not essential.

The successful applicant will hove complete charge of the structural division of the firm.

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Please reply giving detoils of experience ond academic quolificotions to:

FILE No. 544-V.

SITUATIONS VACANT

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RESEARCH AND DEVELOPMENT CHEMIST — required by large Textile Coating Company. Must be fully experienced in Vinyl Plastisol Compounding. Excellent starting salary, fringe benefits. Reply in detail to File No. 517-V.

CHIEF CHEMICAL ENGINEER — A Chemical Engineer or comparable scientific degree required to head research and development activities. Diversified programs on air and sea and space requirements. Sound company with basic consumer and expanding electronic business. Location Southern Ontario. Reply to File No. 534-V.

CHEMICAL ENGINEER — Interesting electrochemical position. Responsibilities will cover plant process and production controls and supervision of chemical control laboratory. Opportunity for development work makes this a diversified and challenging position in a sound and progressive industry. Location Southern Ontario. Reply to File No. 535-V.

GRADUATE ENGINEER

Engineer with Bachelor's or Master's degree (preferably in Chemicol or Metollurgical Engineering) ond with five or more yeors experience required for project on buried pipelines. Knowledge or experience in the field of corrosion most desiroble. Must be oble to write good comprehensive technical reports ond business cammunications. Successful condidate will be o project leoder on an investigatian which is expected to lost severol years. Please write details of qualificotions and experience to the Personnel Officer.

ONTARIO RESEARCH FOUNDATION

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CIVIL

CIVIL OR SANITARY ENGINEER — with not less than two years experience in design or construction relating to water supply and sewerage facilities, and with ability to speak fluent Spanish, required by consulting engineers with offices in downtown Toronto. This is a permanent position in which the applicant should be prepared to travel to South America as well as to work on projects in Canada. Depending on the applicant's experience his role may be that of a senior engineer varying to a position of a junior co-ordinating engineer. Reply in writing giving details of professional experience, education and salary expected. The inclusion of a recent photograph would be desirable. File No. 516-V.

NEWFOUNDLAND — DEPARTMENT OF MUNICIPAL AFFAIRS — Local Government Engineering Division. Civil Engineer with two years' experience, preferably in the municipal field. Duties, under supervision, include investigating and reporting upon design and inspection of various municipal projects, principally water and sewerage systems. Apply: Local Government Engineer, Department of Municipal Affairs & Supply, Confederation Building, St. John's, Newfoundland. File No. 537-V.

STRUCTURAL ENGINEER — required for a large firm of Architects and Engineers in Toronto, Ontario. The applicant should be a Professional Engineer, with a minimum of five years' experience in the design of structural steel and reinforced concrete buildings. Experience in the field of Structural Specifications is an asset. In replying, please give full particulars as to education, experience and salary required, to File No. 543-V.

ELECTRICAL

TELEPHONE ENGINEER — Graduate Electrical Engineer with at least three years' experience with automatic telephone switching equipment. Candidate should have a good knowledge of dial switching systems. Experience in common control crossbar systems would be an asset. Work involves systems planning and promotion, providing technical liaison with customers, and job co-ordination. Good salary and employee benefits. Apply to: Chief Engineer, L. M. Ericsson Limited, 2300 Laurentian Blvd., Montreal 9, P.Q. File No. 545-V.

MECHANICAL

MECHANICAL ENGINEER — With good thermodynamics and heat transfer background wanted for Design and Performance Engineering Group of a large steam generator and allied equipment manufacturer located in Montreal. Previous experience in steam power plants desired but not essential. Reply giving resume to File No. 540-V.

DESIGN ENGINEERS PULP AND PAPER

For Engineering Department of integrated sulphite, sulphate and graundwood pulp and paper mill located Ocean Falls, B.C.

Applicants should have Mechanical Engineering Degree and four to five years engineering experience in pulp and paper mills. Salary range $7900 - $10,000 per annum with good to excellent opportunities to advance.

Send detailed resume, personal statistics and experience. Please quote OF-2/3M-9-63.

Employment Supervisor,
CROWN ZELLERBACH CANADA LIMITED,
P.O. Box 2079,
Vancouver 3, B.C.

INDUSTRIAL ENGINEER — Required by heavy power plant equipment manufacturer located in the Province of Quebec. His activity will involve the making up of studies of work methods and procedures and recommendations regarding improvements for the establishment of time standards. Applicant should be preferably a university graduate or of equivalent education and experience. Knowledge of French desirable but not essential. Salary commensurate with education and experience. All applications will be treated in strict confidence. Reply giving complete resume to File No. 539-V.

RESEARCH ENGINEERS

WITH 1-5 YEARS' EXPERIENCE

required by our Production Research and Technical Services Department. Applicants must possess an M.Sc., or higher degree in Chemical Engineering or Engineering Physics and be interested in pursuing a career in Applied Research.

Apply to:

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Producing Department,
300-9th Avenue S.W.,
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MISCELLANEOUS

PLANT MANAGER — Required by leading metal and plastic toy manufacturing organization in Montreal. This is a key administrative position that requires top-flight management skills in an atmosphere of high speed manufacturing. While a professional engineer is preferred, serious consideration will be given to men with comparable education and practical experience. This is a very challenging position that offers complete responsibility for production, personnel and plant. Salary open. Age 30-40. Enquiries invited in confidence. Please send resume to File No. 504-V.

SMALL UTILITY COMPANY requires additional engineering staff to undertake work on system planning and board studies, planning and progress for line crews and design and supervision of small construction projects. If you are interested in any of these fields and would like to live in Newfoundland, please write the Secretary, United Towns Electric Co., St. John's, Newfoundland, giving particulars and salary required. File No. 542-V.

INSTRUMENTATION ENGINEER — Electrical or Mechanical Engineer required with experience and/or true interest in non-routine instrumentation and control projects. Work is of a very interesting nature and includes all problems in an unlimited range of process control and automation. Attractive starting salary. Liberal employee benefits including group insurances, pension plan etc., also well formulated personnel policies, and numerous other advantages. Excellent living conditions in an ideal community centrally located 100 miles from Montreal. Apply File No. 546-V.

MISCELLANEOUS

PROJECT ENGINEER — To take charge of development and research projects directly connected with developing new electro-chemical power supplies for electronic field, including fuel cells and similar programs. Applicant should be capable of helping with program work and publishing results, and do some travelling contacting government agencies and electronic industry. Location Southern Ontario. Reply to File No. 536-V.

DESIGN ENGINEER. Western Canadian Manufacturer of electrical products requires experienced design engineer, preferably with sheet metal fabricating background, to supervise development of special automotive electrical products division. Degree in electrical or mechanical engineering, or the equivalent, is a requisite. Send complete resume in confidence to File No. 538-V.

TEACHING

MECHANICAL ENGINEERING — A visiting lecturer in thermodynamics and related subjects for the academic year September 20, 1964, to May, 1965 to teach classes and laboratory. Teaching load to be light enough to allow time for other academic work such as writing. Remuneration up to $8000 including travel expense. Application with full particulars should be sent to Head, Department of Mechanical Engineering, University of Saskatchewan, Saskatoon, Sask., Canada. File No. 530-V.

ENGINEERING GRADUATE

We are looking for a graduate who presently finds his work narrow in scope and lacking in personal contacts and travel. The man selected will develop wide contacts in industry and report on up-to-the-minute developments in the power field to fellow engineers and business executives.

Preference will be given to a mechanical or electrical engineer in the 25 to 35 age group who has curiosity, a good command of English and is free to do some travelling.

Reply in confidence to:

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CONSTRUCTION ENGINEERING

Employment will be initially in field or station engineering duties — subsequent assigments will normally involve staff, supervisory and planning duties at higher formation headquarters in Canada and overseas.

Applicants must be resident in Canada and be Canadian citizens or British subjects with thce status of "landed immigrants"; not over 34 years of age, single or married. Either a short service commission of five years' duration or a permanent commission on a full-time career basis will be offered, depending on education, experience, and the applicant's choice.

Further details may be obtained from the nearest RCAF Recruiting Unit, or by writing to:

DIRECTOR OF PERSONNEL MANNING
AIR FORCE HEADQUARTERS,
OTTAWA, ONTARIO.

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TO ADVERTISERS

DEADLINE — Please note that requests far insertions must be submitted in writing nat later than the **12th of the preceding month.**
Cancellations: same as above.

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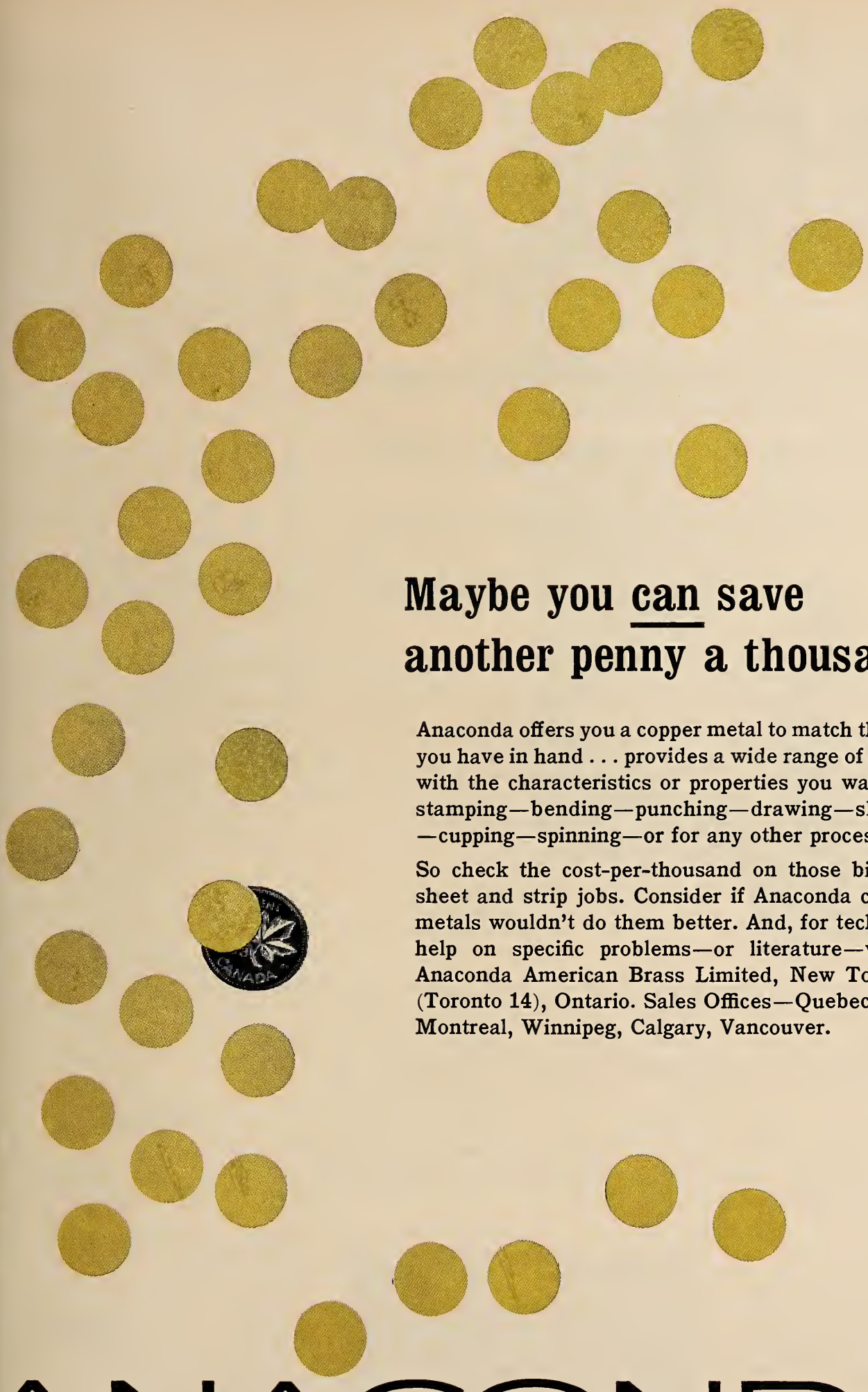
DATE IN CIRCULATION — 20th af month.

SITUATIONS WANTED — Accepted free af charge fram Members af The Engineering Institute af Canada anly.



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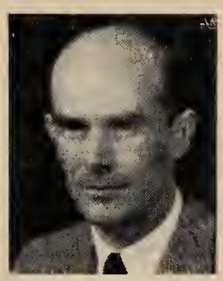
Personals

(Continued from page 71)

K. E. Patrick



P. W. Nasmyth

Kenneth E. Patrick, M.E.I.C. (U.B.C. '36) has been named Commissioner of the Greater Vancouver Water District and Greater Vancouver Sewerage and Drainage District. Mr. Patrick will be in charge of the water supply of 14 cities and municipalities in the lower mainland. Mr. Patrick has been chief engineer with the Water District for 11 years.

P. W. Nasmyth has been named Deputy Defence Research Member of the Canadian Joint Staff in Washington, D.C. Mr. Nasmyth is the Defence Research Board's Director of Maritime Research and Director of Scientific Services, RCN.

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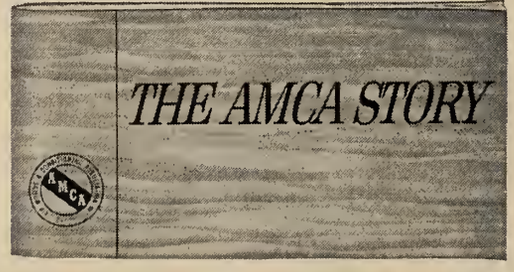


OVER 70 LEADING MANUFACTURERS OF AIR MOVING AND CONDITIONING EQUIPMENT ARE MEMBERS OF AMCA

Romeo Filiatrault, M.E.I.C. (Ecole Poly. '47) has been appointed an associate of the Consulting Engineering firm of Surveyer, Nenninger & Chenevert. Mr. Filiatrault has had wide experience in civil engineering, and has directed many projects in that field.

G. Demers, M.E.I.C. (Ecole Poly '35), consulting engineer whose office has been established in Quebec City for twenty-two years with a branch office in Montreal, has announced the formation of Demers, Bourget, Lemieux et Roy, Consulting Engineers. Mr. Maurice Bourget, M.E.I.C. (Ecole Poly. '32) is a professional engineer and Speaker of the Senate. Mr. Philias Lemieux, M.E.I.C. (Ecole Poly. '56) and Jacques Roy, M.E.I.C. (Ecole Poly. '46) have been associated with Mr. Demers for over 18 years.

W. L. Wardrop, M.E.I.C. (Manitoba '39) President of W. L. Wardrop and Associates has been appointed a Director of the Canadian Institute on Pollution Control on the Board of Water Pollution Control Federation. Mr. Wardrop's appointment is for a period of three years. He will be active in the study of pollution control problems in Canada and the United States.

Robert H. Winters, M.E.I.C. (M.I.T. '33), President of Rio Algom Mines Limited, has been elected Chairman of the Board of Directors of that company.

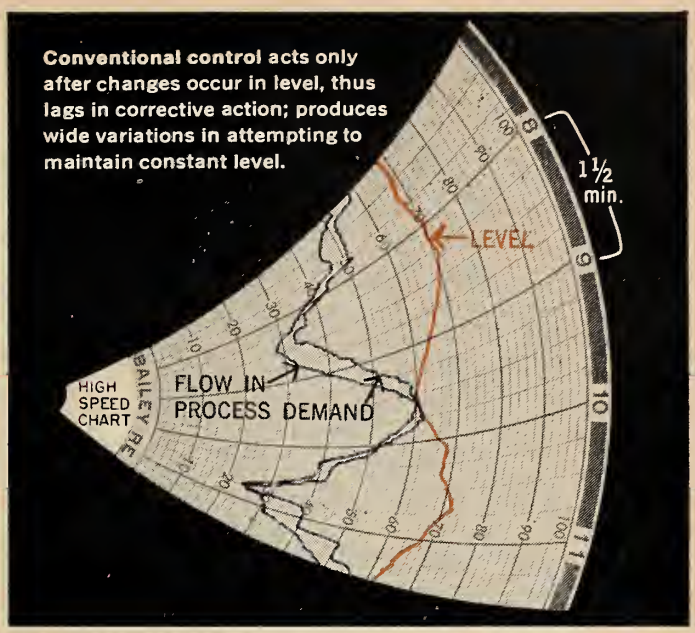
Franklyn H. Theakson, M.E.I.C. (N.S.T.C. '48) has been elected chairman of the North Atlantic Region, American Society of Agricultural Engineers. His election took place at the society meeting at the University of Maine where he presented a paper as part of a symposium on world agriculture. Mr. Theakson is only the second Canadian to be so honored. Earlier this year Mr. Theakson was awarded the Metal Building Manufacturers Award from the National Society. In June he was named secretary-treasurer of the Canadian Society of Agricultural Engineering.

EIC

Obituaries

Barnes, C. M., M.E.I.C.
Collins, W. H., M.E.I.C. (Queen's '20)
Danciu, P., M.E.I.C. (Toronto '50)
Engholm, F. G., M.E.I.C. (London, Eng. '13)
Erlebach, G. B., M.E.I.C. (U.B.C. '39)
Friesen, A., M.E.I.C. (Sask. '49)
Gore, S. J., M.E.I.C. (London, Eng. '37)
Gorman, W. E., M.E.I.C. (St Francis Xavier)
Langelier, J. M., M.E.I.C. (Ecole Poly. '10)
Medforth, G. T., M.E.I.C.
Sancton, G. E., M.E.I.C.
Stodart, J., M.E.I.C.
Waller, S. J. H., M.E.I.C. (Bristol Univ., Eng. '06)

"CAT-AND-MOUSE" CORRECTIONS?



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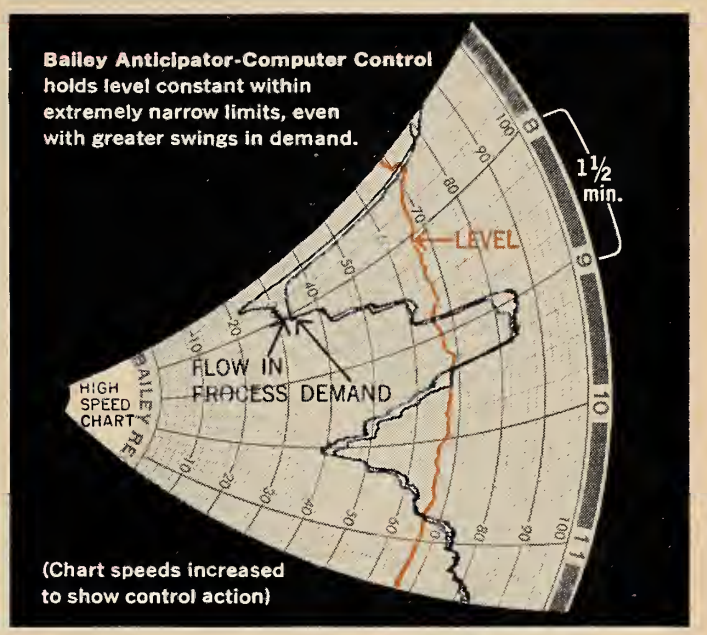

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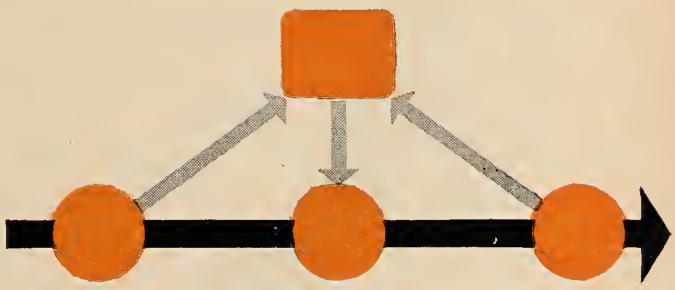

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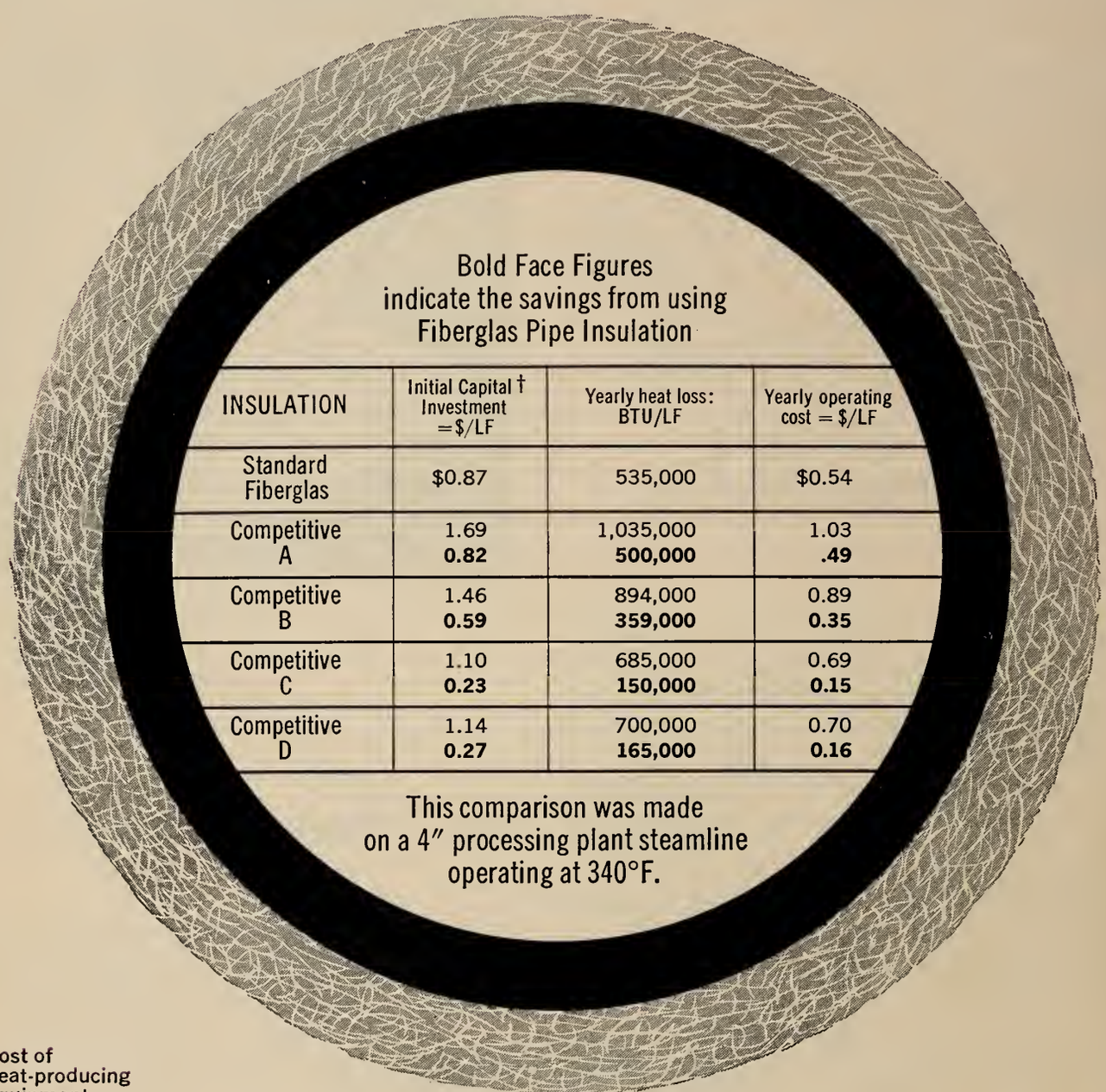

Bold Face Figures
indicate the savings from using
Fiberglas Pipe Insulation

INSULATION	Initial Capital † Investment =$/LF	Yearly heat loss: BTU/LF	Yearly operating cost = $/LF
Standard Fiberglas	$0.87	535,000	$0.54
Competitive A	1.69 **0.82**	1,035,000 **500,000**	1.03 **.49**
Competitive B	1.46 **0.59**	894,000 **359,000**	0.89 **0.35**
Competitive C	1.10 **0.23**	685,000 **150,000**	0.69 **0.15**
Competitive D	1.14 **0.27**	700,000 **165,000**	0.70 **0.16**

This comparison was made
on a 4″ processing plant steamline
operating at 340°F.

† Cost of heat-producing equipment.

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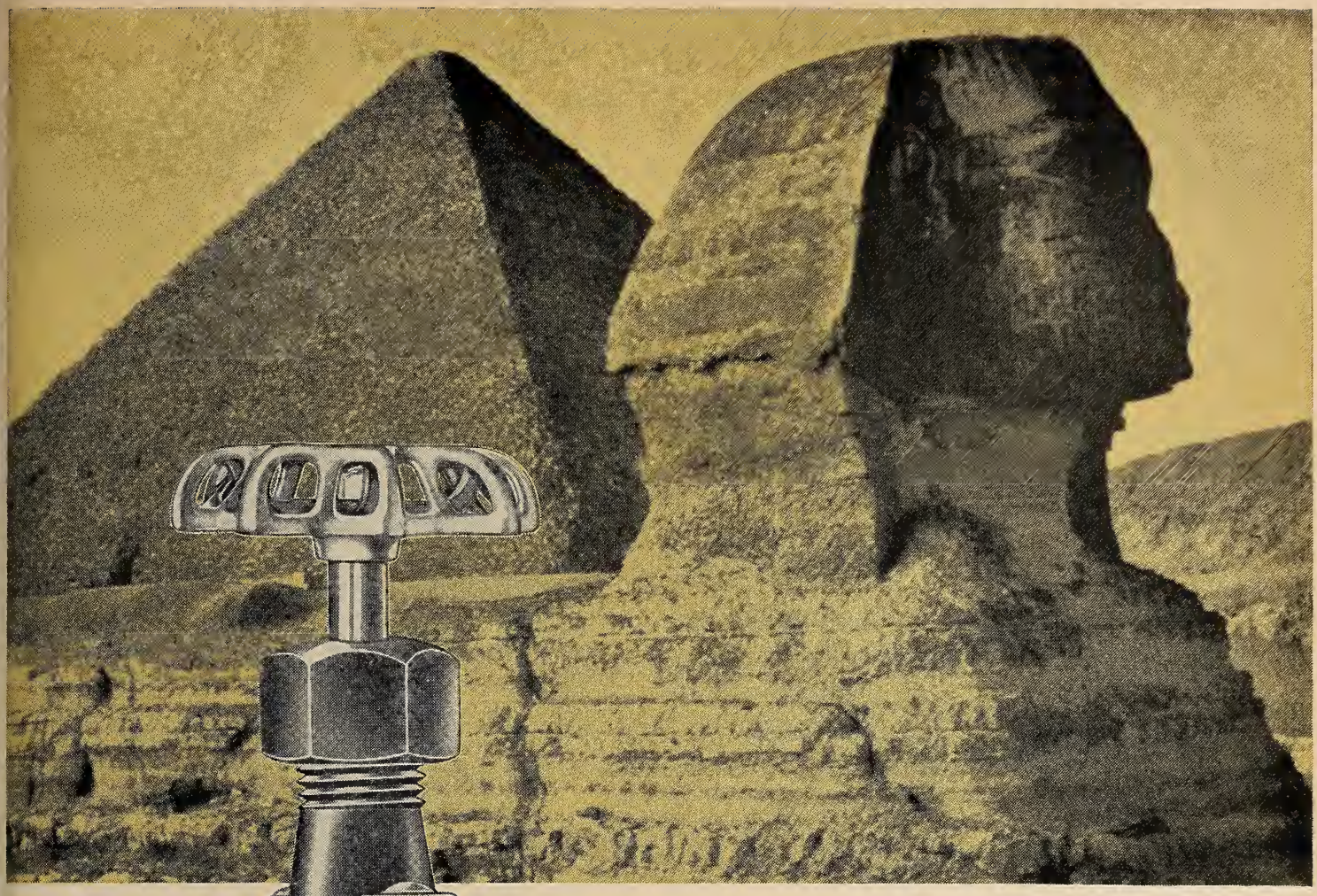

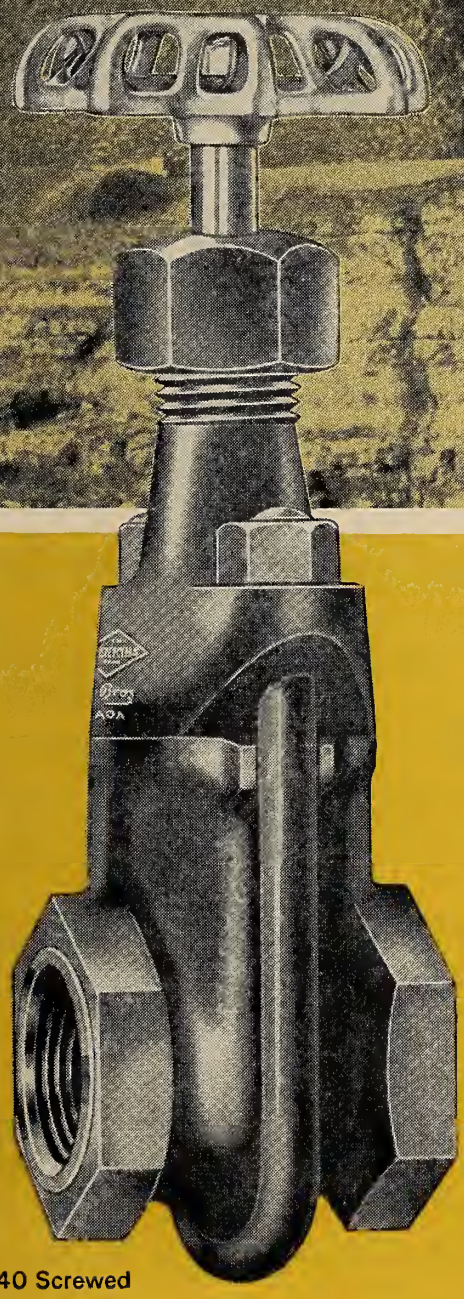

FIG. 40 Screwed

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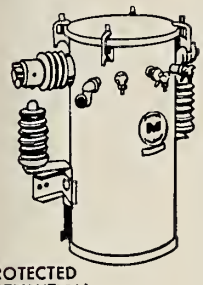

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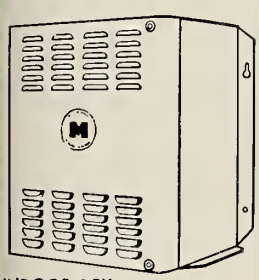

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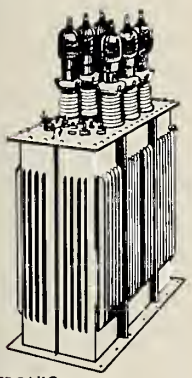

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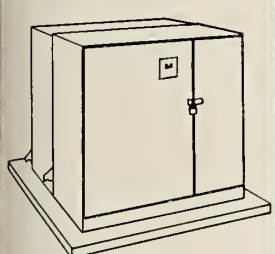

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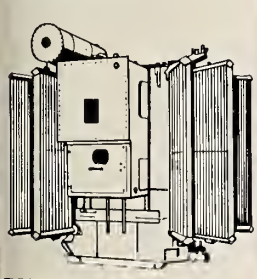

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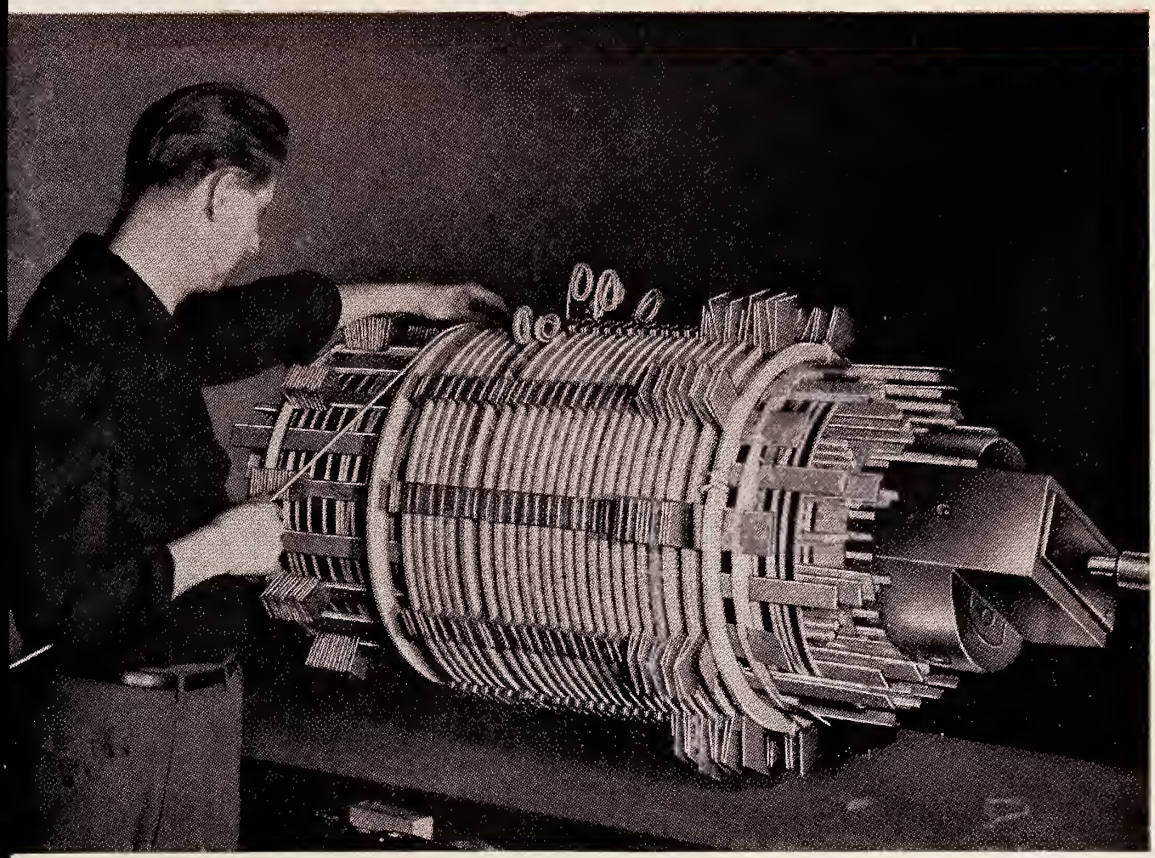

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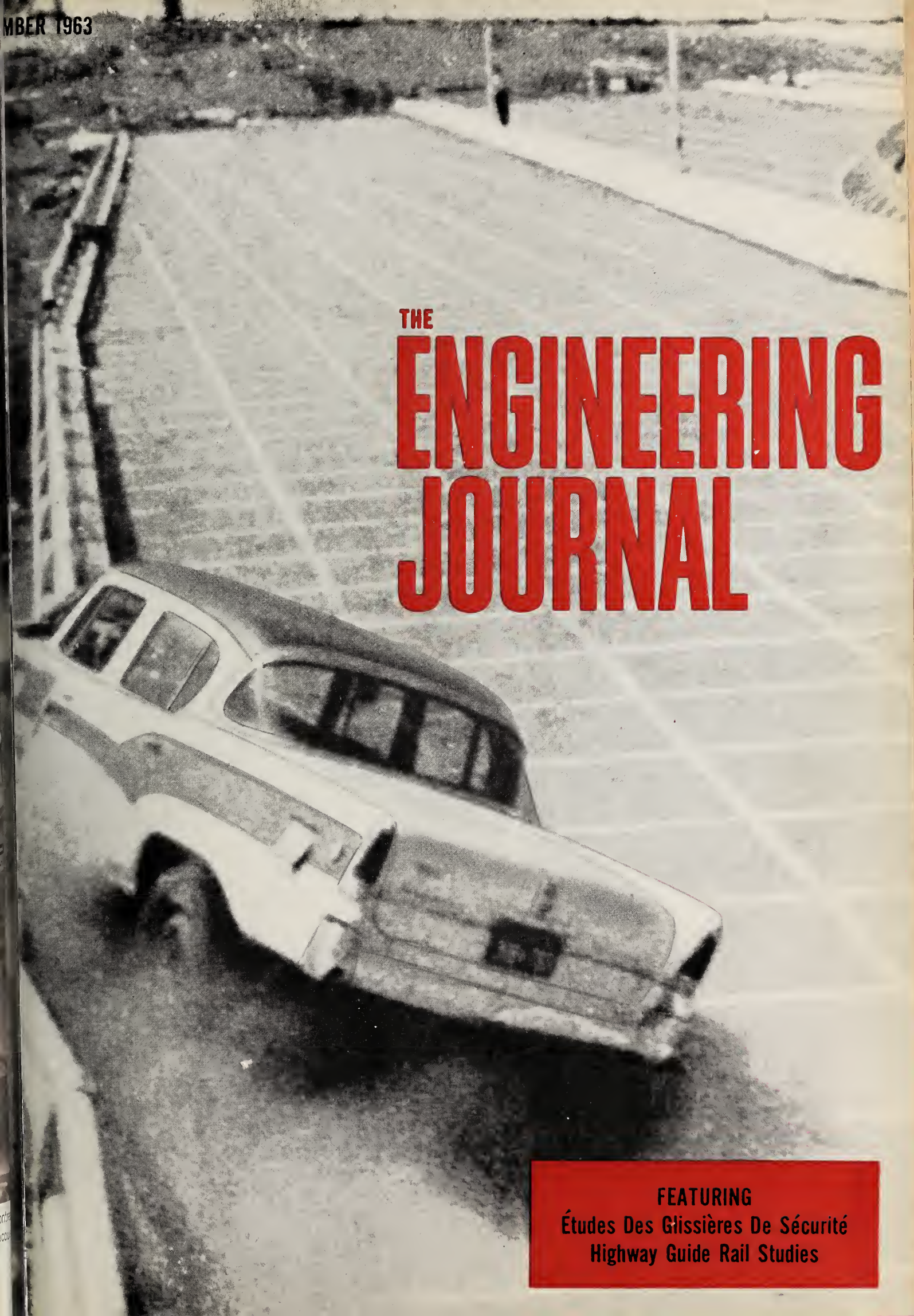

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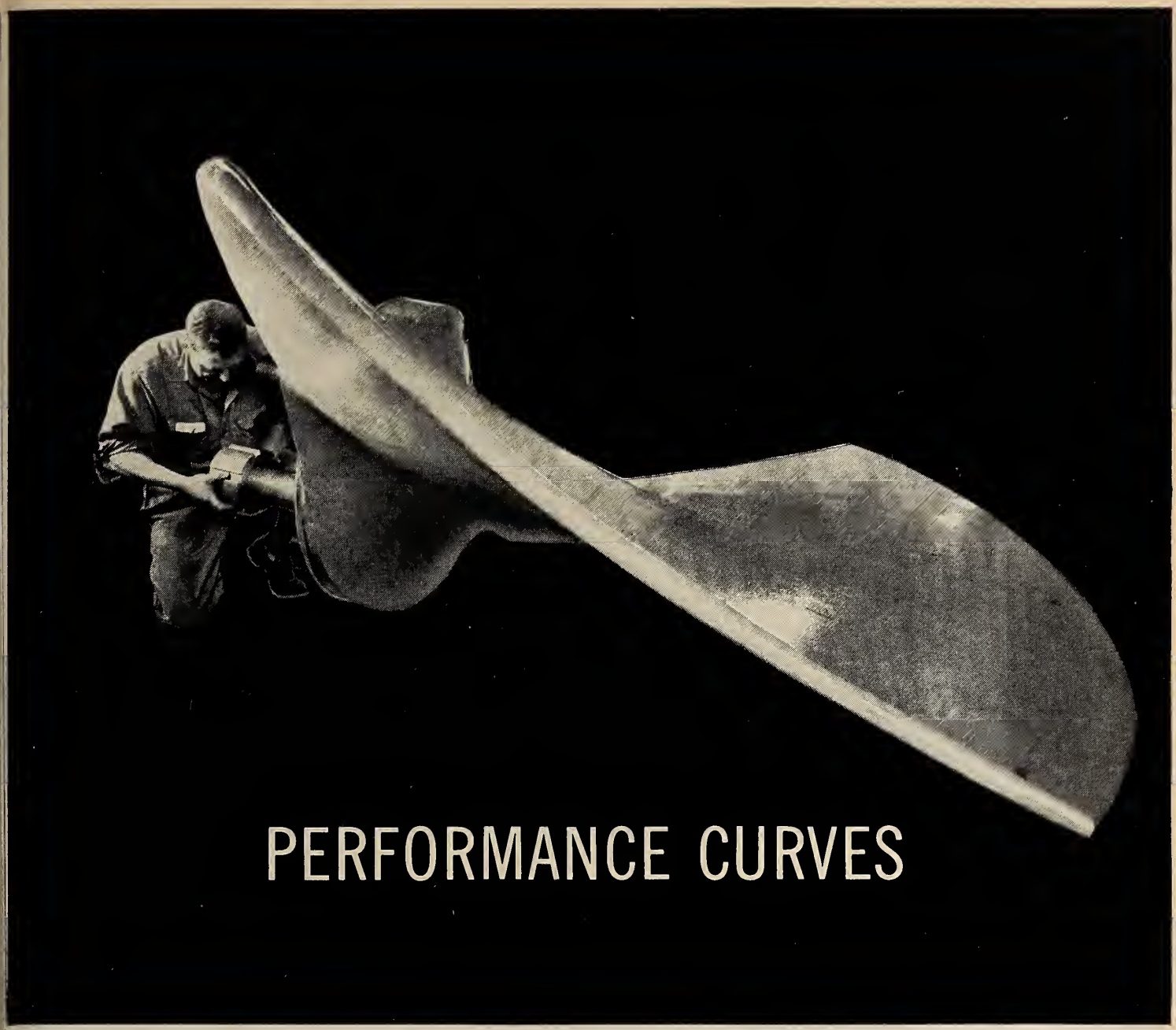

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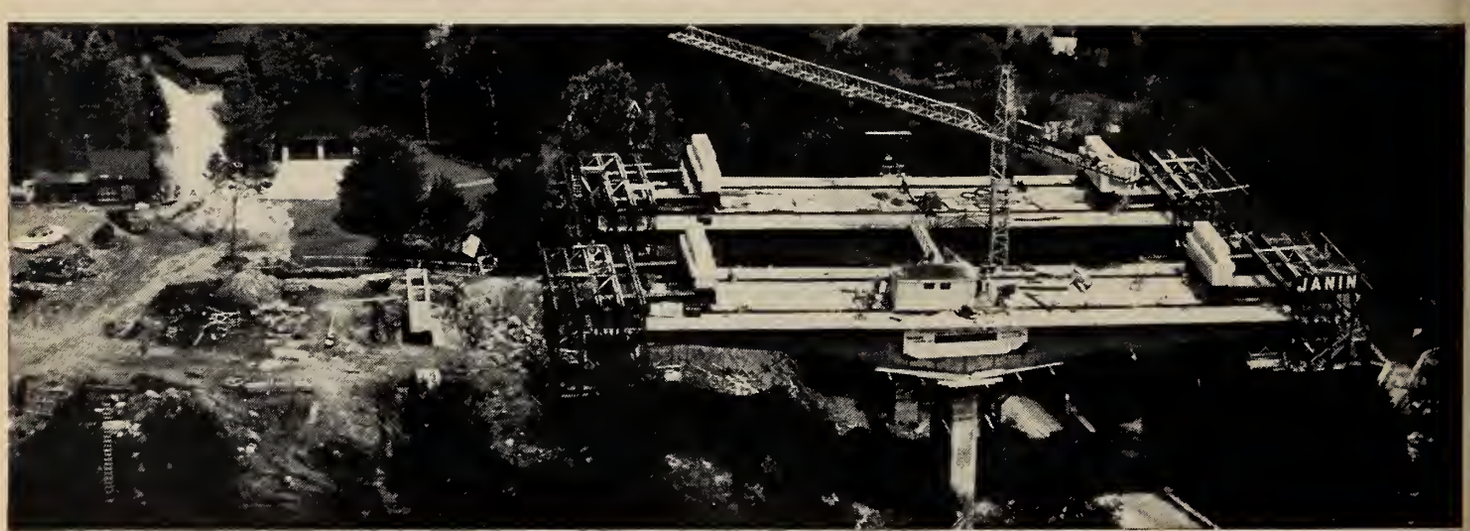

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As the result of an exclusive Canadian agreement with the internationally renowned Voith organization, Montreal Locomotive Works Limited announces the formation of the MLW-VOITH Division for the sale, manufacture and servicing of pulp and paper-making machinery.

This is a significant development. It means that many of the European-designed pulp and paper machines will now be available in Canada, and Canadian users will be enabled to take advantage of patented designs that have proved so popular in Europe and all over the World. One example: the renowned Voith headbox will now be available, *made in Canada.*

MLW-VOITH will be able to offer a wide range of equipment, from stock preparation to various types of paper and board-making machines. Since we are already working on orders for Voith designed equipment, it can be seen that MLW-VOITH now stands ready to discuss your requirements.

MLW-VOITH DIVISION:

MLW VOITH

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1505 DICKSON STREET, MONTREAL 5, CANADA

IN THIS ISSUE

COVER ILLUSTRATION

The dramatic front cover photograph of an automobile piercing a guide rail on the elevated portion of Montreal's Metropolitan Boulevard illustrates one of the tests referred to in Gilles G. Henault's paper, "Etudes Sur Différents Genres De Glissières De Sécurité — Boulevard Métropolitain — Montréal (Research on Different Types of Guide Rails on Montreal's Metropolitan Boulevard). (Photo courtesy The Warnock Hersey Company Ltd.

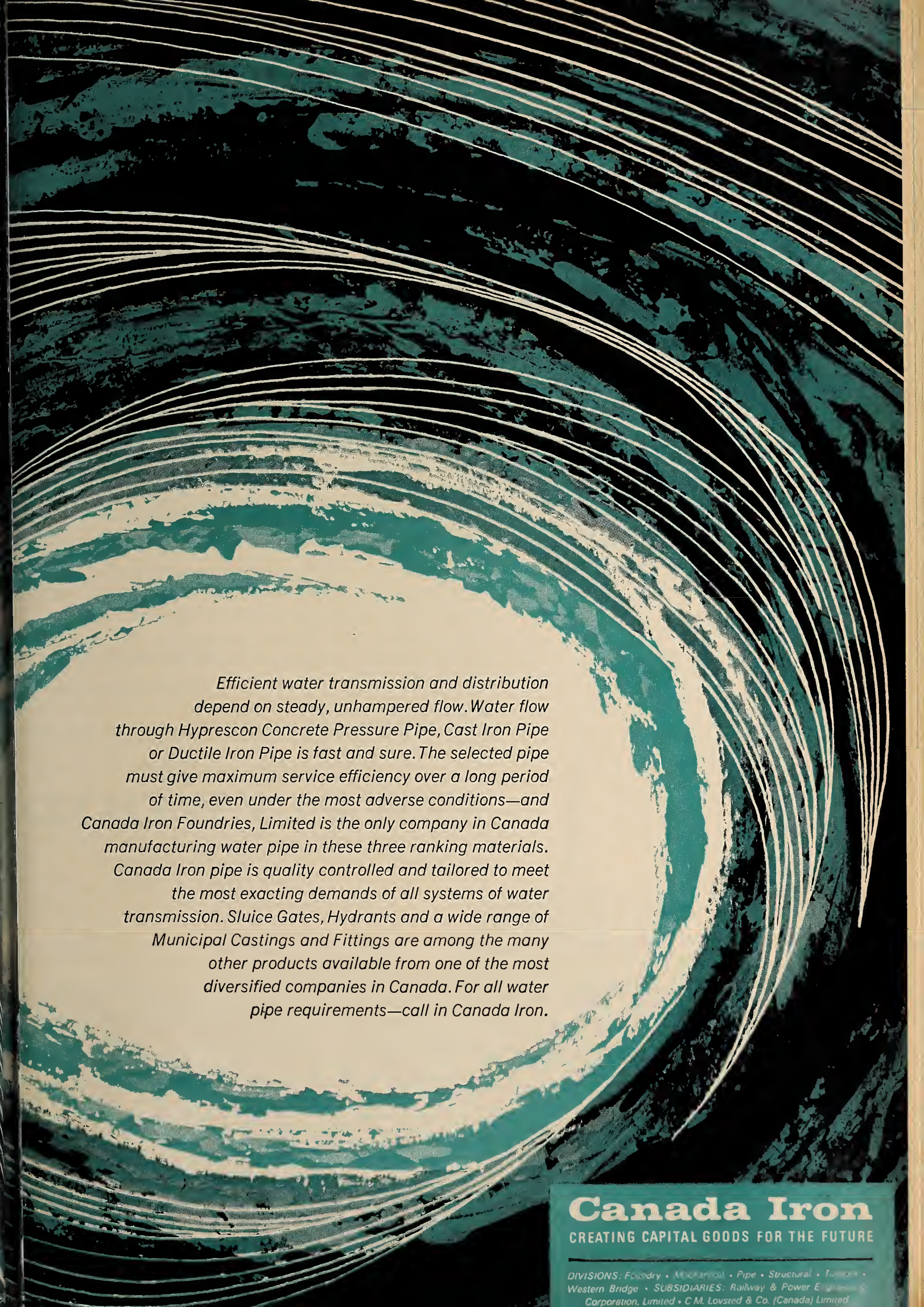
Dans son mémoire, **"Etudes sur Différents Genres de Glissières de Sécurité, Boulevard Métropolitan, Montréal"**, Monsieur **Gilles G. Hénault,** gérant du département des routes, à la compagnie Warnock Hersey Co. Ltée, déclare que la sécurité s'impose en proportion directe de l'augmentation de vitesse des voitures, de la densité de la circulation et des charges déplacées. Devant le nombre croissant d'accidents, on s'est posé la question suivante: "Les glissières offrent-elles actuellement la sécurité requise?" Le ministère de la Voirie de la province de Québec, chargé maintenant de l'entretien de la voie élévée, a confié cette étude a un laboratoire indépendant. La causerie explique le choix de la méthode utilisée lors des essais, et le pourquoi de certaines constantes: méthode de lancement, vitesse de lancement, vitesse de frappe et angle d'impact. Un film servira d'illustration de ce qui s'est passé sur le terrain, puis on indique comment il a servi plus tard dans les calculs. L'auteur conclut en donnant les résultats des treize essais sur les huit différents genres de glissières en acier, en aluminium et en béton.

In his paper, **The Future of Automation in Canada, Eric W. Leaver,** President of Electronic Associates Ltd., states that in a large country such as Canada, with a harsh environment, rich natural resources, and a low population density, a 'population multiplier' such as automation, can make a vital contribution to economic and social progress. Whether or not this will actually happen depends upon the decisions we take and those we avoid in the next few years. The areas for decisions themselves, will be based on the realities of this nation and hence, the future of automation in Canada will not necessarily be similar to that of other countries.

Manitoba Hydro is developing the Grand Rapids power site on the Saskatchewan River. The initial installation totals 345,000 kva in three units with minimum provision for a fourth unit. Output will be transmitted to the Greater Winnipeg area by two single-circuit bundle conductor lines at 230,000 volts. Initial operation is scheduled for the fall of 1964 with completion the following year. In their paper, **Some Foundation Considerations at the Grand Rapids Hydro-Electric Project, J. R. Rettie, M.E.I.C.,** Director of Engineering, Manitoba Hydro; and **F. W. Patterson, M.E.I.C.,** Director, H. G. Acres & Company Limited, discuss some of the features of the project. In their description, they include the impounding of the large reservoir over a geological formation which comprises a sequence of limestone and dolomite beds of Paleozoic age, an extensive curtain grouting program involving a single line of holes on five-foot centres to a maximum depth of 200 feet over a distance of 18 miles, consolidation grouting under major concrete structures, and special provisions to ensure stability of the intake structure.

The December issue of the Engineering Journal carries two additional features of particular interest. One is the **1963 Index.** This lists technical papers, discussion of technical papers and specific information from the many departments published since January. Technical papers are cross indexed both by authors and subjects. The other annual feature published in this issue is the **Compiled Tabulation of Student Registration in Engineering Courses.** Several significant facts are shown by the 1963 registration figures: the total engineering registration has increased, thus reversing a trend of several years; post-graduate registration is at an all-time high; and electrical engineering has just about replaced civil engineering as the basic course most popular with the students.

FLOW



Efficient water transmission and distribution depend on steady, unhampered flow. Water flow through Hyprescon Concrete Pressure Pipe, Cast Iron Pipe or Ductile Iron Pipe is fast and sure. The selected pipe must give maximum service efficiency over a long period of time, even under the most adverse conditions—and Canada Iron Foundries, Limited is the only company in Canada manufacturing water pipe in these three ranking materials. Canada Iron pipe is quality controlled and tailored to meet the most exacting demands of all systems of water transmission. Sluice Gates, Hydrants and a wide range of Municipal Castings and Fittings are among the many other products available from one of the most diversified companies in Canada. For all water pipe requirements—call in Canada Iron.

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FUSION OF BOX BEAM AND PANEL COMPONENTS

A distinctive roof design was achieved in Edmonton's St. Andrews United Church through the fusion of two basic plywood components: the box beam and the stressed skin panel. Uniting these forms allowed construction of an attractive roof system which possesses the desired acoustical qualities. The use of plywood components also contributed to the reasonable cost of the completed structure.

Box beams for the church roof were prefabricated and arrived at the site with panel flanges bolted in place. After erection of beams, rafters were added and plywood panels nailed to top and bottom of these joining members. The roof is thereby comprised of stressed skin panels on long slopes, with box beams on short slopes. Beams are 5 feet wide and 40 to 60 feet in length, serving as full width supports and finished surfaces as well.

This modern roof system exemplifies the manner in which plywood component forms can be combined to achieve original total designs. Information on many more plywood uses, for structural and aesthetic purposes, can be obtained from your Association field man.

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St. Andrews United Church is the work of D. M. Campbell & Associates, consulting architects, and Tottrum & Associates, consulting engineers.

Late Engineering News

The rock wark is practically completed on this partion of the Mantreal subway to Foundotion-Duranceau. Abaut 230,000 paunds of "Cilgel B" 70% were used.

Montreal Subway Work Is Progressing Well

Unnoticed by most Montrealers, and almost unheard, is the massive burrowing job beneath their streets which is to result in the city's first subway by the summer of 1966.

It will consist of an east-west line slightly more than four miles long which will parallel much of the mid-Montreal business and shopping district, and a looping north-south line some 10 miles long. This line begins in residential, or residential-access areas at Metropolitan Boulevard in the north, and continues across Montreal island, under the St. Lawrence River to the St. Helen's Island site of the 1967 World Fair, then further to another residential area on the South Shore. A spur of this line will swing west near the financial district to Place Victoria.

The estimated cost is $181 million.

The possibility of building a subway in Montreal had been discussed for more than half a century. A large number of factors, including the fact that the centre of Montreal was beginning to suffer from serious traffic strangulation, resulted in Montreal's administration appealing for permission to remedy the situation.

On March 21, 1962, the Private Bills Committee of the Quebec Legislature gave permission to the City of Montreal to build a subway in Montreal and, with reservations, in Westmount, Outremont, the Town of Mount Royal, and St. Laurent.

The first contract was for burrowing through rock for a little more than a mile on the north-south line, and lining the semi-circular tunnel with reinforced concrete. This contract was awarded to Foundation-Duranceau, a joint venture, and called for the removal of approximately 115,000 cubic yards of limestone. About one quarter of a million pounds of high explosives were used on this portion.

In the first year of construction, 2.4 miles of tunnel, mostly on the north-south line, were dug. Tunnel excavation work now is proceding on six of the 12 stretches in which this work is divided. Underground excavation work for five of the 20 stations planned is underway.

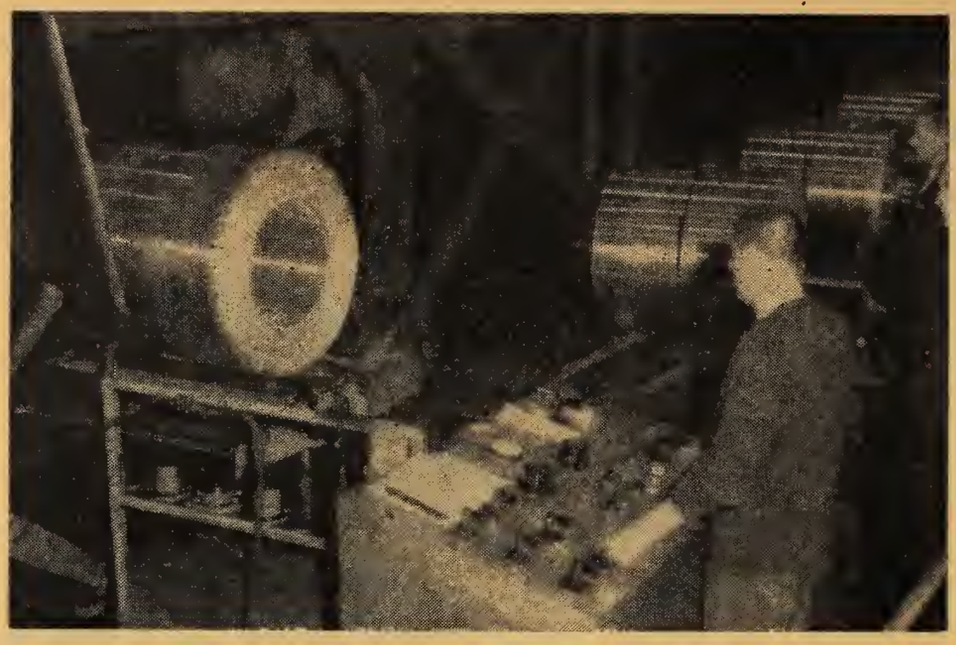
It is estimated that the entire system will accommodate 160,000 passengers an hour when it is in full operation. The first rubber-wheeled trains are scheduled to run in the summer of 1966.

At the time of this writing excavation contracts with a total value of $27,229,-711 had been awarded. Total tunneling to date is 21,388 feet.

Excovatian for the Cremozie and Berri Stotion at the narthern terminus of Montreal's subway system invalves the removal of obaut 15,000 cubic yards of rock and obaut the same amount of earth. In the background is Metropalitan Boulevard.

Begun in April, all apen cut wark on this section of Montreal's subwoy has been sub-cantracted by Jonin ta Miron Canstruction. Abaut 900 feet of the 1,265 faat open cut sectian has been cancreted.

This tunnel widens into the future Jarry Street Station. All blasting here had to be cantrolled with extreme core. The completian date far this sectian is May, 1964.



Coming from the hot mill, the aluminum sheet is fastened into a coil and removed. Shown is the control panel at Reynolds Aluminum of Canada's plant at Cap-de-la-Madeleine, Que., which controls this operation.

Reynolds Aluminum of Canada Plans $10 Million Program

Reynolds Aluminum Company of Canada Ltd. plans capital investment of more than $10 million in its Quebec and Ontario plants during the next five years. This announcement was made by Andre Piche, Executive Vice-President and Managing Director of the company following a press tour of the Reynolds manufacturing facilities at Cap-de-la-Madelcine, Que.

Mr. Piche also said Reynolds was helping to design and build a new Japanese aluminum plant.

"We completed a major modernization plan at the end of 1960," Mr. Piche said, "but since then we have seen our share of an expanding Canadian market going up, and we have had to revise our ideas about future planning and production."

"As a result of increased demands for our products we are planning a capital investment over the next year of $1.6 million. The major items of equipment will be annealing furnaces, a 4-high 64-inch foil mill and a rotogravure press. The biggest single item in our capital expenditure over the next five years will be a new cold rolling mill, capable of handling material up to 84 inches wide, costing between $3.5 million and $4 million."

Reynolds Aluminum of Canada processes aluminum from pigs to plates, coils, sheets, circles, foil and packaging materials.

Mr. Piche said that because of the wide experience of plant executives and technical staff, the company had been chosen by Reynolds International to assist in the plant layout, building and machinery specifications for a new integrated plant 90 miles from Tokyo. This plant is being built by Mitsubishi Reynolds Aluminum Company Ltd.

"One of our most important responsibilities is to train over 25 key Japanese engineers, metallurgists and other technicians, and to supply the personnel required to assist them in starting up their operation," said Mr. Piche, who is a director of the Japanese company. "Some 20 of our people will be working for short periods in Japan."

Reynolds Aluminum of Canada has also established a new division to handle its entrance into the machinery field. Specialized machinery, mainly in the laminating field, that the company has been building for its own use attracted considerable foreign attention.

"As a result we have built equipment for Reynolds International subsidiaries and affiliates in such countries as Belgium, Mexico and Cuba," Mr. Piche said. "We presently have orders for Mexico and Japan, and we expect in the near future to receive orders from Colombia and Venezuela."

Hewitt Equipment Headquarters Shifted To Suburban Montreal

The new multi-million dollar headquarters of Hewitt Equipment Limited, Caterpillar distributors for the Province of Quebec, has moved to a 33-acre site in the Montreal suburb of Pointe Claire.

Increasingly crowded conditions at Hewitt's former facilities in the Town of Mount Royal were responsible for the shift.

The main structure at the new site is a 117,000 square foot, low profile building of steel and concrete. This is the administrative and technical headquarters for a province-wide organization that also includes service centres in Quebec City, Seven Islands, and Val d'Or.

Behind the main structure is a 14-acre area with a half-mile track and work areas where all sizes of earthmoving equipment can be tested under full load conditions.

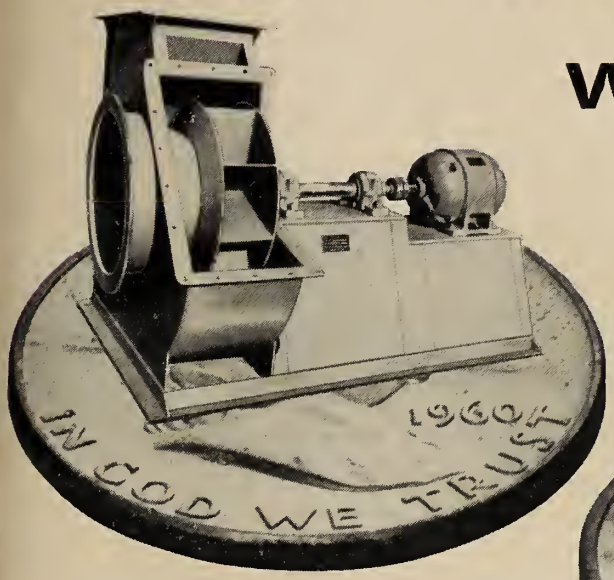
This will eliminate the need for customers to visit far-flung job sites to watch equipment at work and will provide a convenient training ground for new operators. Rebuilt and repaired equipment, in addition to the four-hour dynamometer tests on engines, will be thoroughly tested there under full load conditions.

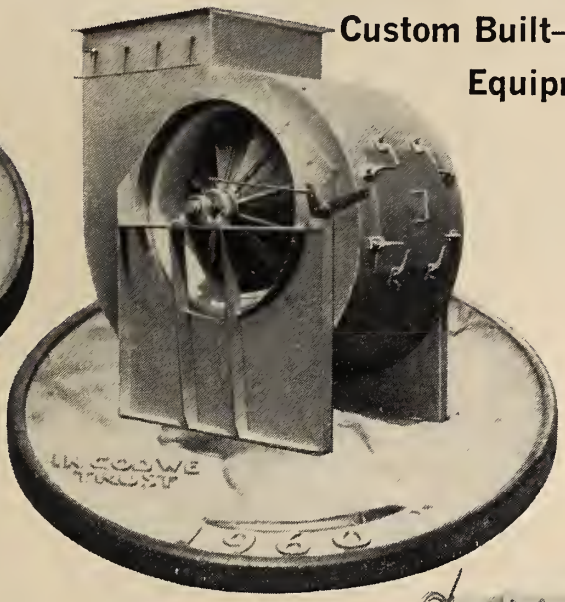
Equipment repair facilities, housed in a 50,000 square foot steel-framed concrete wing of the main building, and a separate 15,000 square foot welding and paint shop, have been laid out so that downtime on customers' equipment can be reduced sharply. Features of this area include an 800 p.s.i. high pressure water cleaning system plus an automatic paint stripping room which removes all paint down to the bare metal. This allows a detailed examination of cracks and defects which otherwise might not be detected, and improves the appearance when repainted.

Caterpillar equipment receives expert attention in Hewitt Equipment's new facilities. Hewitt is the distributor in Province of Quebec for Caterpillar.

Costs Come Back *FAST*... with WHIRLEX

Custom Built—Heavy Duty Equipment





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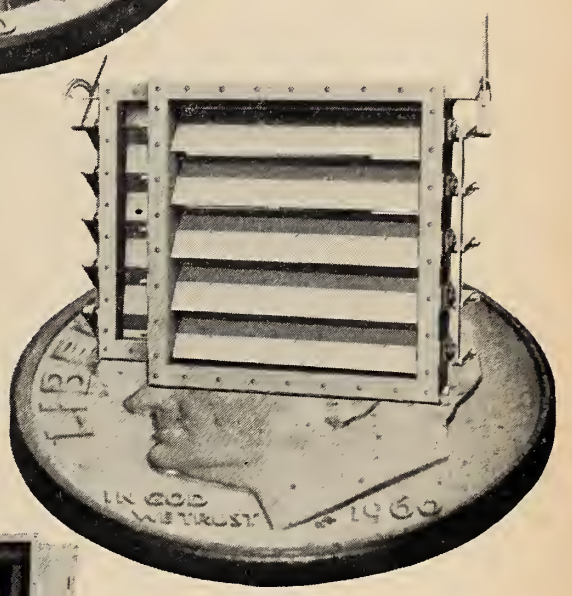

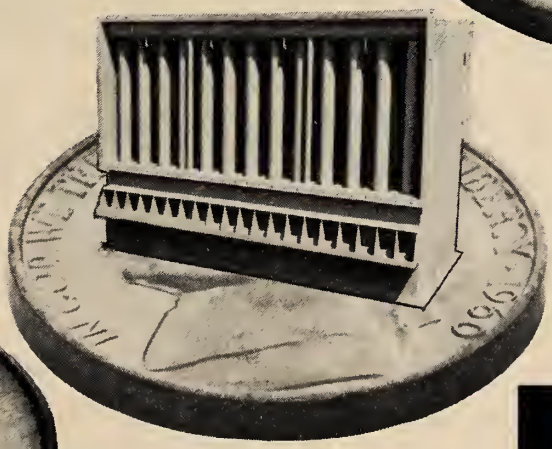

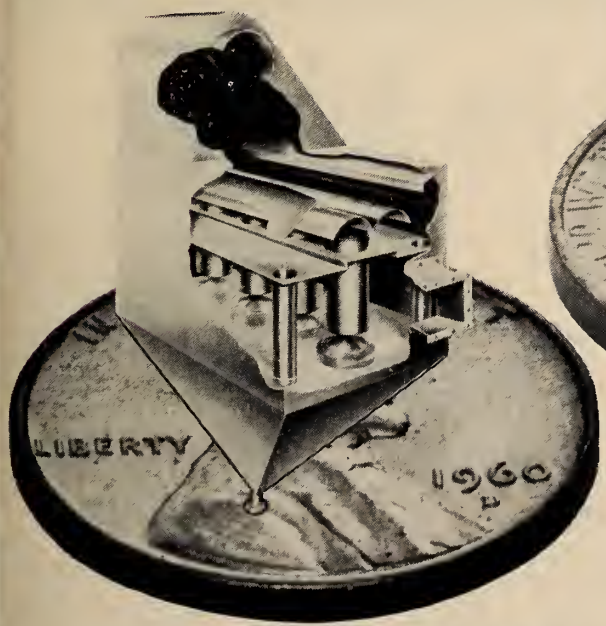

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FLY ASH WHIRLEX ARRESTOR

48 plating tanks...

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■ The plating operation pictured at top is not only big (48 tanks) but also modern in every respect — including its fume collection system (lower photo).

AAF's new high-velocity Type M Cycoils stop mists, fumes or gases *regardless of concentration*. And they offer higher cleaning efficiency at lower cost than any other collectors for this application. Millions of flooded, bubbling contact surfaces scrub and re-scrub exhaust air or gas, yet the Cycoil uses less scrubbing liquid than any other collector of this type.

For descriptive bulletin No. 286, write American Air Filter of Canada, Ltd., 400 Stinson Blvd., Montreal 9.

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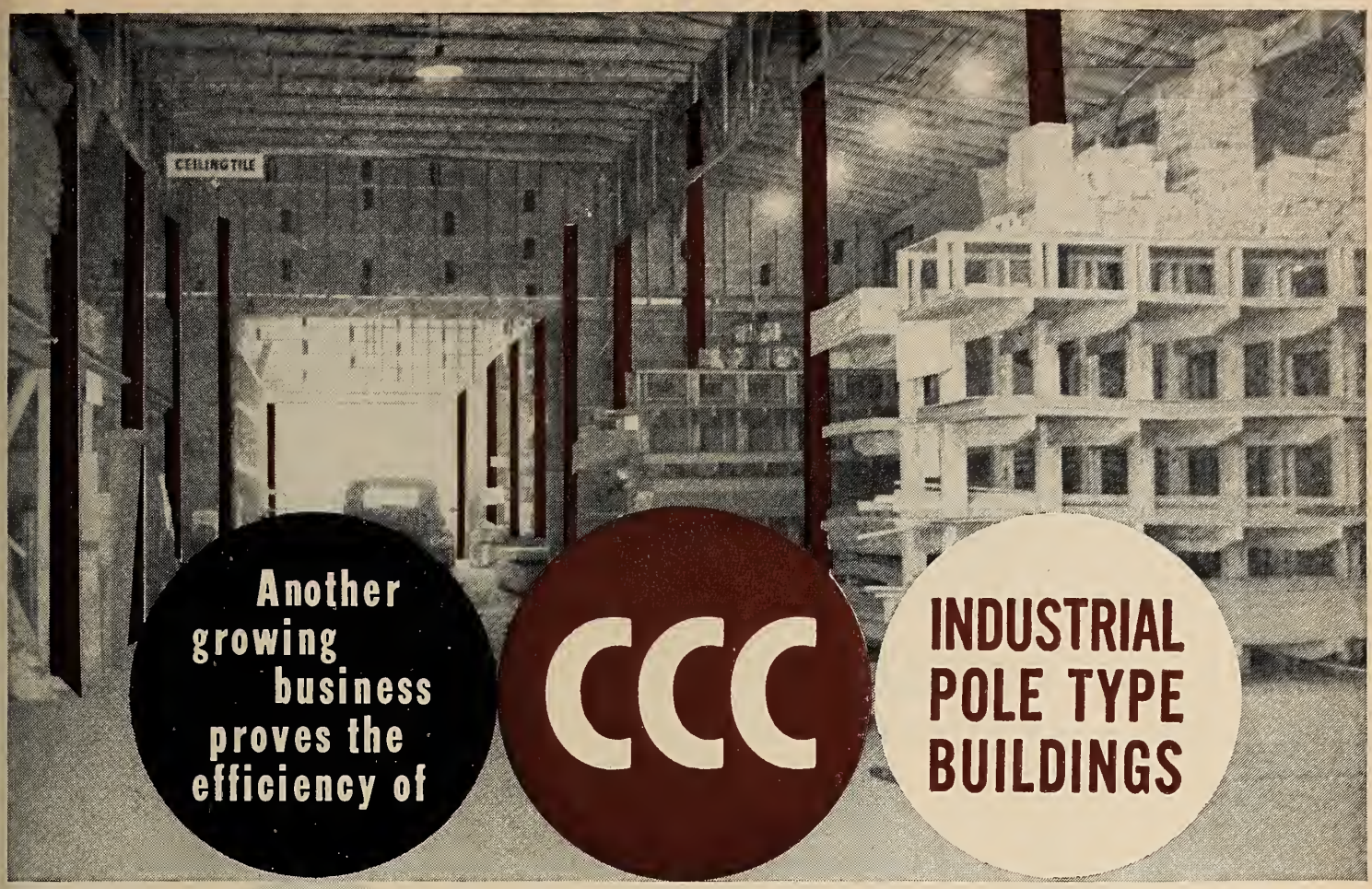
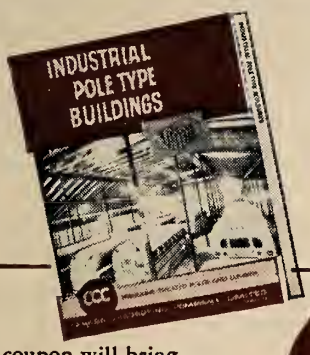


Warehouse built . . . then doubled in size . . . all at the cost of less than $2.00 per sq. ft. !

Low cost, ease of construction and flexibility that permits rapid alteration or expansion at a later date are the unique features which sold this Barrie, Ont. firm on the superiority of pole type construction with "Triple C" Brand Pressure Treated Poles and Lumber. All across Canada this versatile, economical form of construction is serving more and more businesses every year . . . for warehouses, garages, equipment storage sheds and a host of uses. Complete information from your building supply dealer, or write Canada Creosoting — plants and sales offices from coast to coast to serve you rapidly and efficiently.



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This coupon will bring you complete information, specifications, prices. Literature will be mailed to you, without obligation.

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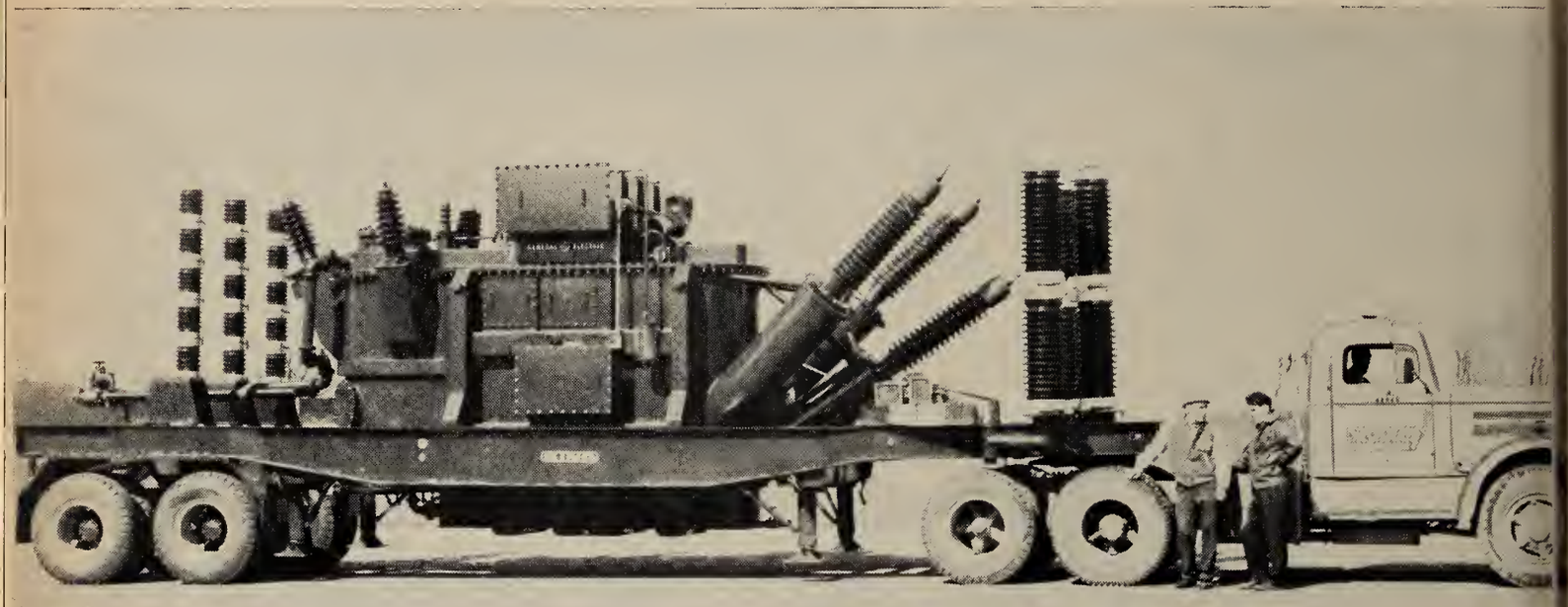
assure continuous service



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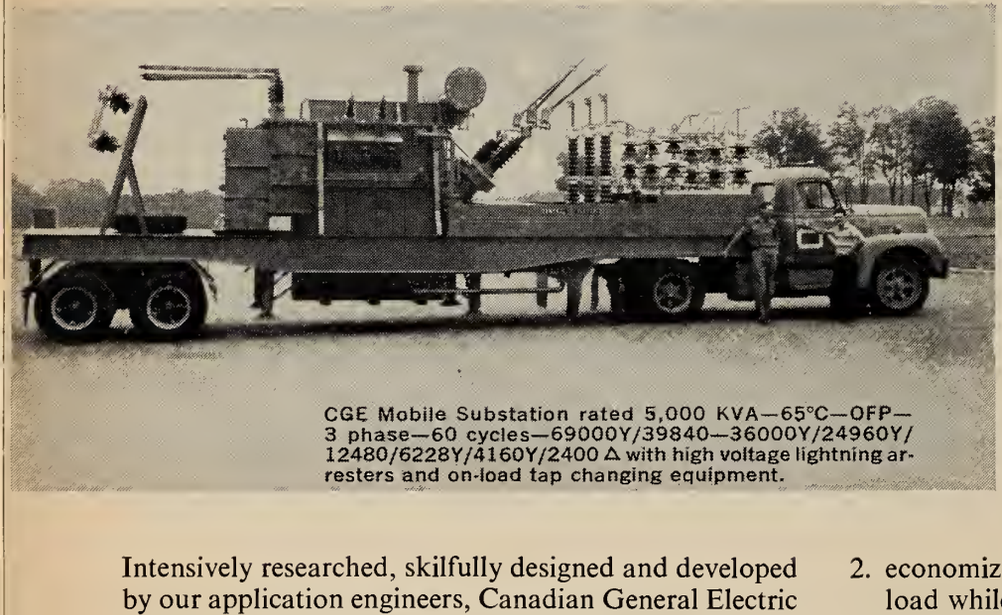

CGE Mobile Substation rated 5,000 KVA—65°C—OFP—
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1. help restore service fast in emergencies such as floods, fires, storms or other disasters.
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3. save time and money on system changeovers by carrying on while substations are being uprated or other changes made.

They can be custom-built to suit *your* special requirements.

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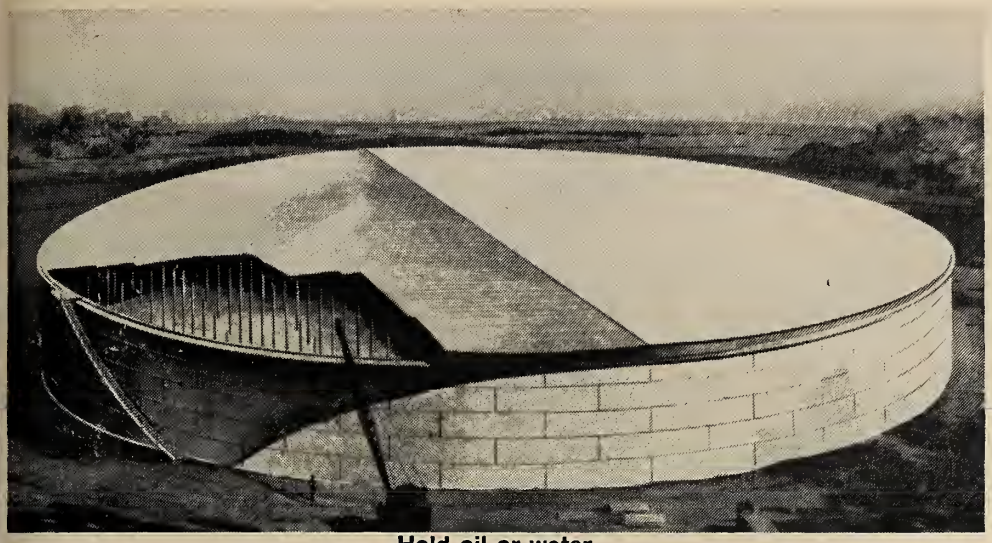

Hold oil or water

Carry traffic

Move earth

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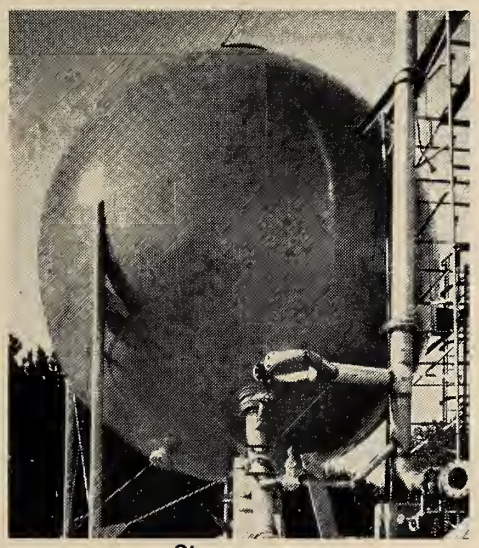
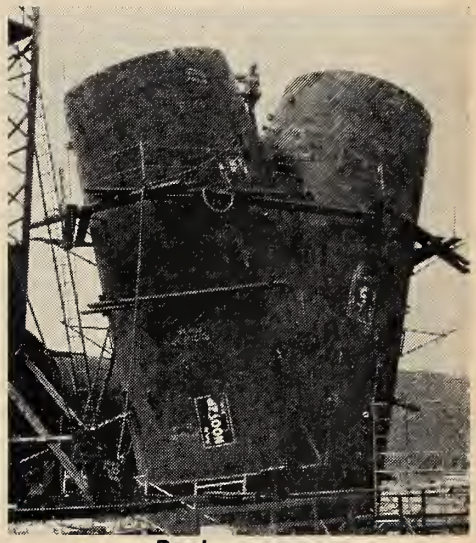


Store gases



Produce power

You can solve almost any construction problem economically with one or more of this family of USS stronger steels. Here's what they can do . . . reduce weight up to 50% . . . last 3 to 5 times as long under impact abrasion . . . increase resistance to atmospheric corrosion 4 to 6 times . . . provide 50% to 200% more strength with no increase in weight . . . reduce first cost and maintenance costs.

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Principle of the Grinnell diaphragm valve

Instead of the typical disc, or other device, for controlling flow, Grinnell-Saunders valves incorporate a diaphragm and compressor. This diaphragm completely isolates the valve bonnet . . . and seals off fluids from contact with working parts.

Product purity is safeguarded. The valve mechanism is completely protected. Flow is unobstructed . . . streamlined. And valve closure is leak-tight, even with suspended solids in the line.

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Grinnell-Saunders diaphragm valves are available in a wide range of body materials to meet virtually any requirement. You can specify cast, malleable, or ductile iron, cast or stainless steel, Durimet 20, Hastelloy A, B, C, bronze, Monel, aluminum, pvc, Saran, and Penton.

NEW . . . 48-page book on valve specifications, recommendations . . .

Operating advantages, applications, service recommendations, specifications, dimensions . . . everything you need to know about Grinnell-Saunders Diaphragm Valves is in the new Catalog SV-63. It is your complete guide to this all-inclusive line — and a must for everyone involved with valve selection, application, maintenance. A copy is yours for the asking from your Grinnell representative.

Long-lasting diaphragms

Grinnell diaphragms — many designed with sturdy backings and built-in reinforcement — reduce diaphragm replacements to a minimum. Diaphragm materials include white, natural, pure gum, and soft natural rubber, neoprene, black or white chlorinated butyl, clear Tygon, Hycar, Hypalon, G.R.S., Teflon, Kel-F, and polyethylene.

Linings

Iron body valves with flanged ends are available lined with any of the following materials: hard or soft natural rubber, neoprene, glass, lead, Penton, pvc, Saran, Hercsite, or Lithcote. Other linings — and linings for valves other than iron — can be supplied on special order.

Bonnets

Handwheel and chainwheel bonnets of various types, with or without indicating stems; lever-operated bonnets, and bonnets for any make of power operator are all included in the Grinnell-Saunders line.

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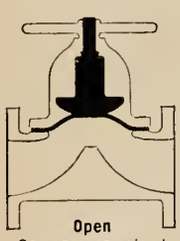
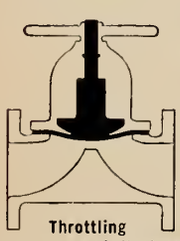
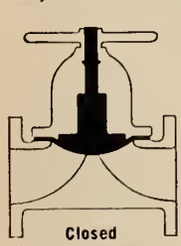


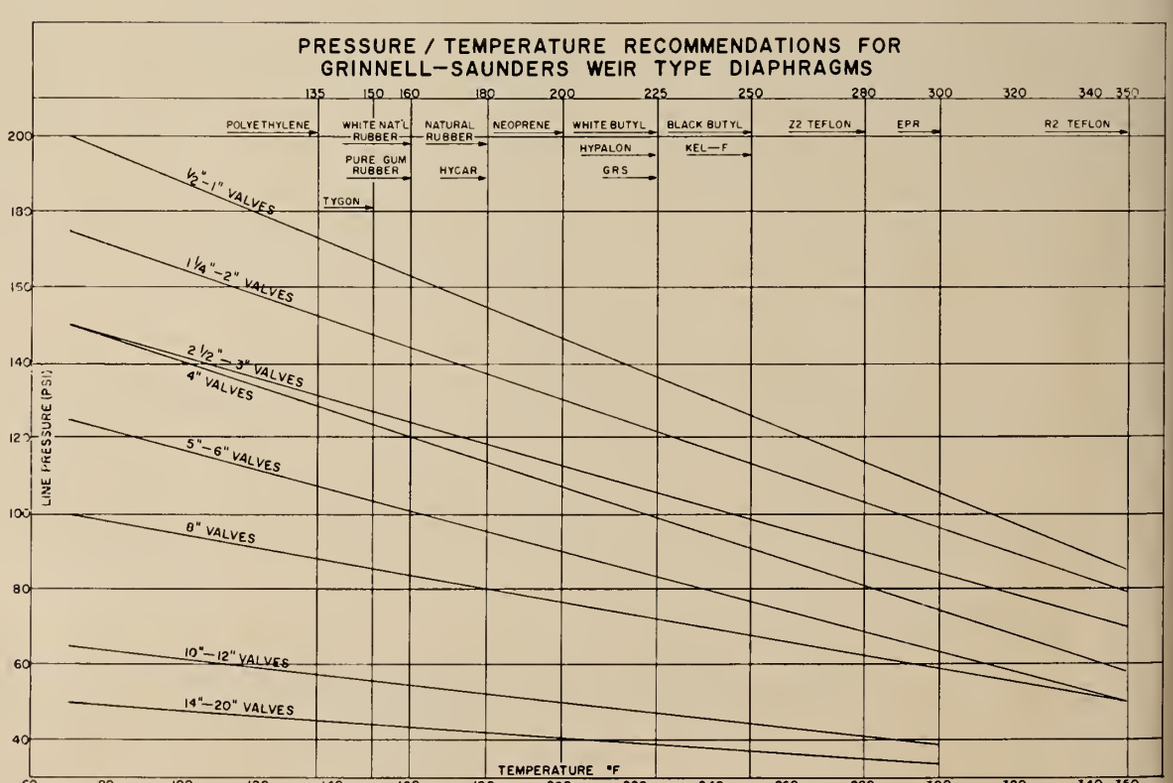
Open
Compressor raised, lifting diaphragm



Throttling
Compressor and diaphragm partially lowered

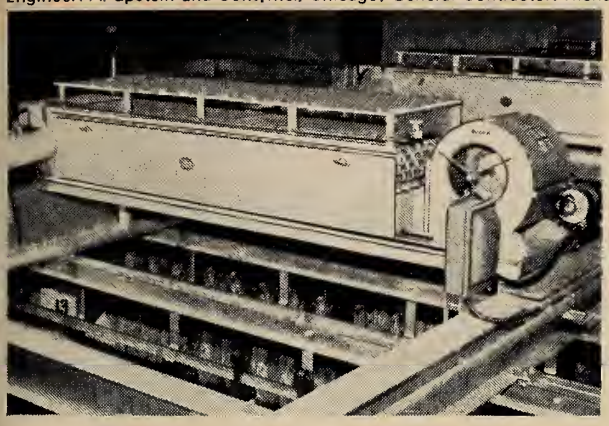


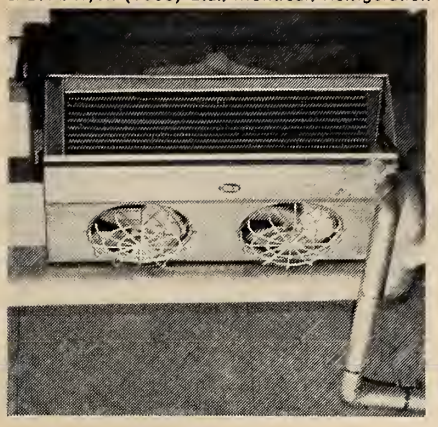
Closed
Compressor presses diaphragm tightly against weir

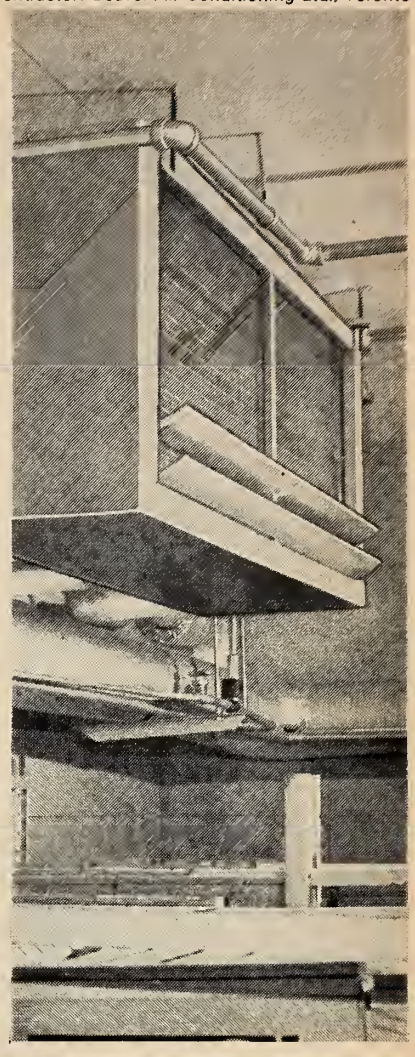


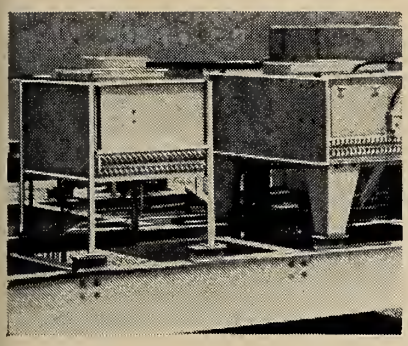
Full size (8½" x 11") copies of above chart available on request.

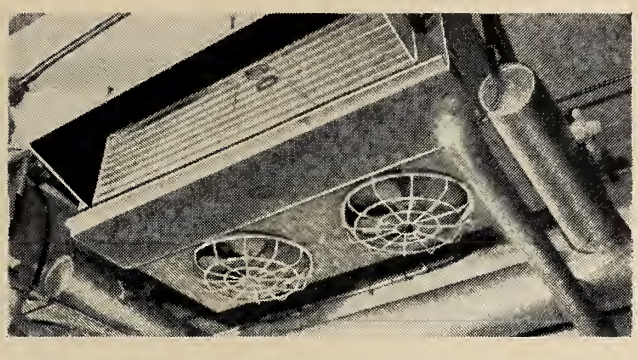
Engineer: A. Epstein and Sons, Inc., Chicago; General Contractor: Richard & B. A. Ryan (1958) Ltd., Montreal; Refrigeration Contractor: Beaver Air Conditioning Ltd., Toronto











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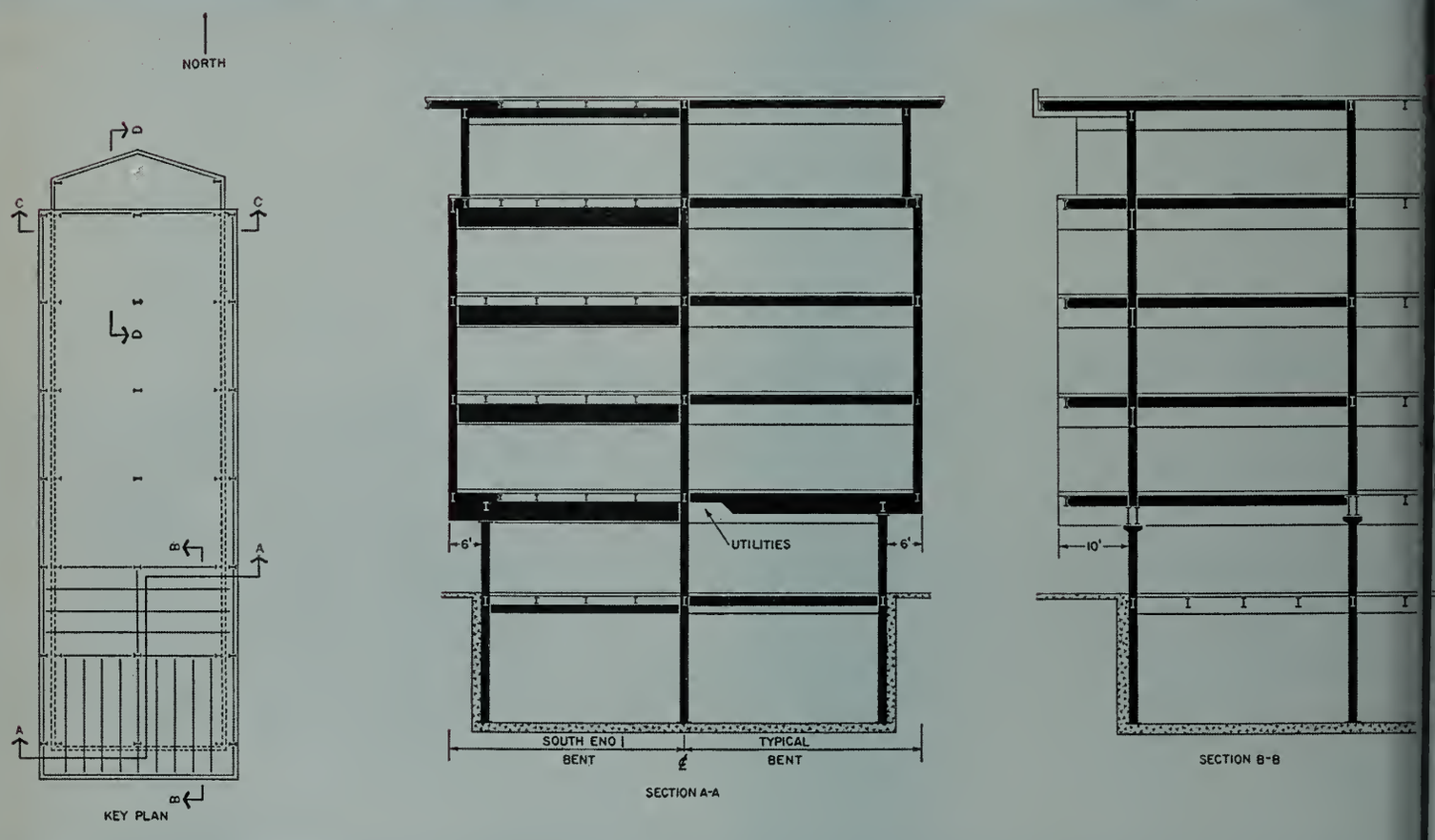

In the unique design of the Allentown City Hall and Police Building, the main tower is cantilevered at the second floor on three sides—6 feet on the east and west, and 10 feet on the south.

At first, these cantilevers looked like a natural for reinforced concrete in a waffle-slab system. But thorough study of both concrete and structural steel proved exactly the opposite.

6-ft cantilevers on east and west . . . solved by steel

In the concrete design, columns were located in the set-back exterior wall at the first floor, and carried up through the four floors above. This resulted in columns occurring in the middle of certain rooms—an undesirable feature of the concrete design.

The steel solution is shown on the key plan and Section A-A. Two parallel 30-in. wide-flange steel beams cantilever 6 ft beyond the first floor columns, and carry the exterior columns for the upper floors. This feature allows the exterior line of columns to be moved into the wall, where a line of columns rightfully belongs. In addition, to allow passage of utilities near the interior support of the cantilevered beam, the beam depth was reduced by coping the lower flange and welding on a tapered flange to replace it.

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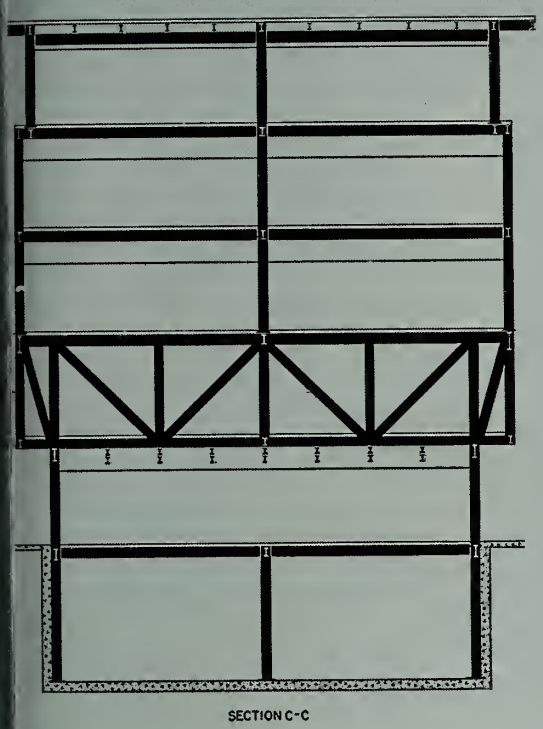

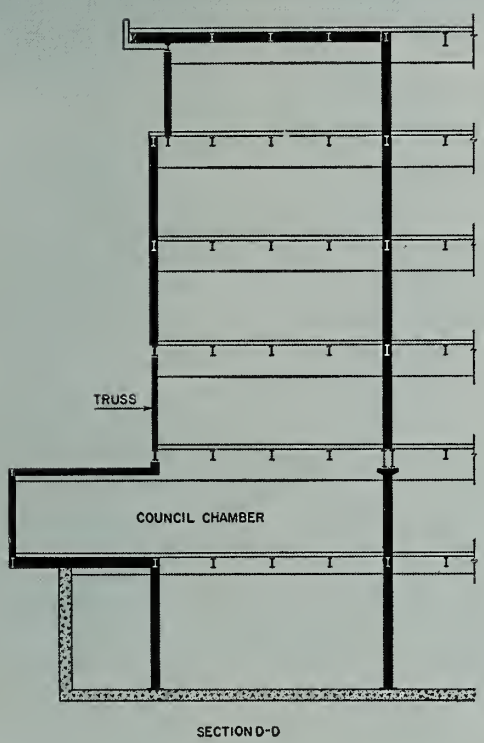

Architect-Engineer:
Everett Associates.

General Contractor:
E. C. Machin, Inc.

Steel Fabricator and Erector:
Lehigh Structural Steel Company.

All are Allentown, Pa., firms.

Bethlehem supplied 1,770 tons of structural steel for the project.

10-ft cantilevers on south . . . solved by steel

The 10-ft cantilever on the south side, and the two-way cantilevers required at the corners (see key plan) were solved by dropping the girders in the southernmost frame, thereby allowing the filler beams to pass over the girders and develop the cantilevers rather simply at each floor. (See Section B-B.)

North wall problem . . . solved by steel

The architectural concept dictated that the north wall be carried from the second to the fifth floors on a column-free support over the center of the council chamber located on the first floor at the north end of the building. Since the north wall was windowless, this problem was solved by a story-height truss, which carries the columns above, and provides a column-free council chamber at the ground floor.

Steel frame cost less than concrete

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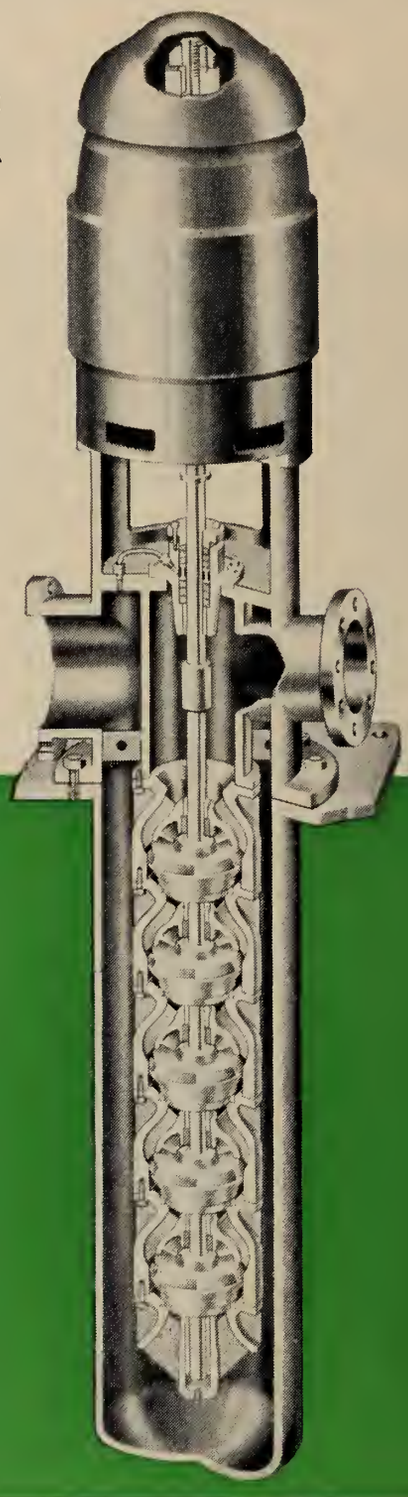

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EIC-63-CIV 14

Etudes sur différents genres de glissières de sécurité Boulevard Métropolitain Montréal

Gilles G. Henault,
Chef du service des routes,
The Warnock Hersey Company Ltd.

RESEARCH ON DIFFERENT TYPES OF GUIDE RAILS ON MONTREAL'S METROPOLITAN BOULEVARD

Conditions on the six-mile long elevated section of the Montreal Metropolitan Boulevard emphasize the need for research into the question of safety on heavily-travelled highways. The maximum speed permitted on the Boulevard was 55 miles an hour; a lesser speed would be less dangerous but would restrict traffic.

From the opening of the Boulevard in September, 1959, until November 14, 1962 a total of 33 vehicles broke through the safety barrier and fell below, resulting in six deaths. On the Boulevard as a whole during the same period a total of 15 fatalities, including the six previously mentioned, occurred.

It was, therefore, necessary to take some additional measures to ensure the public safety. After studying this problem the Department of Highways recommended that destructive tests be carried out on different kinds of guide rails suitable for installation on the existing curb. Eight models were suggested by the Department of Highways and by some of the guide rail manufacturers. The Warnock Hersey Company Ltd. of Montreal was retained to carry out these tests and to prepare a report recording the results and the conclusions which could be drawn from them.

LA VOIE SURELEVEE du boulevard Métropolitain, de six milles de longueur environ, offre le plaidoyer le plus convaincant en faveur d'ouvrages de sécurité sur les voies à grande circulation. Sur ce boulevard où la vitesse réglementaire est de 55 milles à l'heure, une vitesse moindre pourrait offrir plus de sécurité, mais aux dépens de la circulation.

Depuis l'ouverture du boulevard, en septembre 1959, jusqu'au 14 novembre 1962, trente-trois véhicules ont défoncé le parapet pour venir s'écraser en bas de la voie élevée, ce qui a entraîné six morts. Cependant, sur tout le boulevard, pendant la même période, on a enregistré quinze cas mortels, ce qui comprend les six cas précédemment mentionnés.

Il fallait trouver un moyen pour assurer plus de protection au public. Après étude, les ingénieurs de la

Voirie ont recommandé des essais destructifs sur différents genres de glissières de sûreté qui pourraient être installées sur le garde-roue actuel. Huit modèles furent proposés par le Ministère de la Voirie et par certains fabricants. La firme Warnock Hersey de Montréal fut chargée de faire les expériences prévues et de présenter un rapport contenant les résultats et les recommandations qui en découleraient.

Etude Preliminaire

Nous avons débuté par une revue de la littérature relative à la sécurité sur les voies élevées, surtout à l'endroit des parapets, et nous avons constaté que le sujet reste toujours de grande actualité. Tout récemment encore aux Etats-Unis, des comités, formés d'experts de la route, ont étudié ce problème et le "Bureau of Public Roads" de Washington, D.C., a proposé en avril 1962 de nouvelles spécifications pour les glissières, rendues publiques lors de la convention du Highway Research Board en janvier 1963.

Ces lectures ont permis de dégager les facteurs qui influencent le plus directement cette sécurité. Nous en avons tenu compte dans nos études, et au besoin, nous les avons adaptés aux conditions que nous trouvions ici.

Parmi les Etats américains qui ont fait des essais, mentionnons en particulier ceux de New-York et de Californie. La Suède a aussi entrepris des travaux de même nature. L'industrie privée à également contribué à l'étude du problème, entre autres la General Motors Co.

Caractéristiques d'un Parapet Idéal

Notre étude nous a permis d'extraire les caractéristiques d'un bon parapet, grâce à l'expérience des ingenieurs de la Voirie provinciale et à celle de nos propres experts. Les voici énumérées ci-dessous:

a) Solidité
b) Rebondissement minimum
c) Décélération modérée du véhicule tamponneur
d) Solidité de la glissière
e) Glissement uniforme sur le parapet
g) Entretien facile
h) Coût de construction
i) Dommages réduits au véhicule tamponneur
j) Apparence
k) Adaptation du garde-roue

Note:

Nous ne nous attarderons pas à décrire toutes ces caractéristiques, qui seront reprises plus tard au chapitre de la "Critique des résultats".

Photo 1.—Système de guidage des véhicules tamponneurs pour tous les essais. Départ.

Détermination de Certaines Constantes et Variables

Dans les calculs pour les glissières et les ancrages, nous devrions tenir compte des facteurs suivants:

1. Poids du véhicule
2. Vitesse du véhicule
3. Angle d'impact
4. Elasticité du véhicule à son point d'impact: pneus et carrosserie
5. Elasticité de la lisse
6. Elasticité du support et des ancrages
7. Elasticité du support de la lisse
8. Effet de freinage du pneu

Le problème n'est donc pas simple, et comme vous pouvez le constater, il est théoriquement impossible de déterminer les valeurs de ces facteurs. Actuellement, la meilleure méthode reste encore les essais destructifs comme ceux que nous avons faits.

Expérimentation Préliminaire

La recherche d'un système approprié de lancement pour que le véhicule atteigne la vitesse voulue au moment de la collision avec le parapet, et suivant un angle d'impact choisi à l'avance, s'est fait expérimentalement.

C'est sur une piste de l'aéroport désaffecté de Longueuil que nous avons appris à contrôler les facteurs qui nous intéressaient, surtout le mode de lancement. Puis nous avons passé aux essais sur le boulevard même où le premier essai fut effectué pour s'assurer de l'efficacité du système de guidage et pour vérifier si les constantes établies se maintenaient bien. Cette épreuve ayant réussi, nous avons procédé aux essais proprement dits à l'ouest du boulevard Décarie où l'on ne gênait pas la circulation.

Installation des Glissières et du Système de Guidage

Les intéressés aux glissières fournirent et installèrent eux-mêmes leurs modèles en modifiant le parapet existant ou encore en le changeant complètement.

Le système de guidage déterminé à la suite de toute une série d'expériences à Longueuil est essentiellement constitué d'un dalot dont les côtés sont solidement fixés au pavage actuel et il suit une trajectoire bien définie. Le pavage même sert de fond à ce dalot qui maintient prisonnières les deux roues du même côté de la voiture lors de son lancement, photos 1 et 2.

Système de Contrôle

Avant même d'entreprendre les essais sur le terrain, nous avions prévu la prise d'un film de façon à enregistrer clairement ce qui se passerait et de constituer ainsi un documentaire permanent auquel on pourrait se référer pour les calculs qui suivraient les expériences. Cette méthode visuelle se recommande à plus d'un titre puisque à tout moment on peut figer l'expérience et regarder à loisir ce qui se passe à ce moment précis. On peut s'assurer comment se comporte la voiture au moment de l'impact ou au moment où l'arrière frappe à son tour. Dès maintenant, nous pouvons dire que le film a été très réussi ct qu'il a permis tous les calculs désirés.

La figure no 1 montre l'installation des plateformes pour les cinéastes, l'emplacement du radar pour mesurer les vitesses et le quadrillage sur la route même pour nous aider à localiser la trajectoire du véhicule.

Analyse des Conditions Générales du Boulevard
Analyse des accidents

Nos observations se sont concentrées spécialement sur les accidents survenus à l'endroit du parapet. L'analyse a mis en lumière une grande

Photo 2.—Système de guidage des véhicules tamponneurs, pour tous les essais, à l'exception de deux des trois essais du modèle "H". Juste avant l'impact.

Definition des Termes

Lisse:
Bande généralement métallique faisant partie de la glissière de sécurité sur laquelle le véhicule peut glisser lors d'un accident.

Support:
C'est le système qui attache la lisse au garde-roue ou au sol, et qui en somme donne la résistance à la glissière.

Glissière de sûreté:
Partie de l'ensemble du système de sécurité placé généralement au-dessus du garde-roue des voies élevées et des ponts, ou simplement sur certains accotements de chaussées.

Garde-roue:
ou "Curb"—Partie de l'ensemble du système de sûreté fait d'un rebord généralement en béton et situé sur les limites de la chaussée pour ramener sur celle-ci les roues du véhicule qui s'en écarteraient.

Parapet:
Ensemble composé d'un garde-roue, d'une glissière de sûreté et constituant le système de sécurité que l'on fixe à l'extérieur des voies de circulation sur les ponts et les voies élevées.

quantité de variables, ce qui nous a empêchés de dire de façon concluante quelles étaient les causes exactes de ces accidents. Il n'en découle pas moins que les accidents semblent être dus en grande partie à l'imprudence des usagers. Nous avons aussi remarqué une concentration d'accidents aux courbes Décarie et St-Hubert, et un peu partout lorsque la surface du pavage est glissante.

Un relevé des accidents du 1er avril 1961 au 31 mars 1962 nous donne 667 accidents par 100 millions de véhicules-mille (M.V.M.), dont 282 accidents par 100 M.V.M. occasionnent des dommages au boulevard même. Nous constatons durant cette période que 50% des accidents mortels sont provoqués par des véhicules qui passent à travers la glissière. D'autre part, 50% de tous les accidents qui endommagent le boulevard sont causés par des véhicules qui vont directement ou indirectement s'arrêter contre la glissière, d'où la nécessité d'une bonne glissière.

Comme nous le disions précédemment, l'analyse préliminaire de tous les accidents à ce jour ne nous a pas donné les causes spécifiques de ces accidents, mais si nous étudions seulement celles où les véhicules ont sauté le parapet au cours de cette période, nous remarquons ce qui suit:

6 chauffeurs sur 12 avaient moins de 25 ans

9 chauffeurs sur 12 avaient moins de 30 ans

7 accidents sur 12 sont survenus sur un pavage humide ou glissant

6 accidents sur 14 sont arrivés entre 1 a.m. et 4 a.m.

4 accidents sur 14 sont arrivés entre 7 a.m. et 12 p.m.

4 accidents sur 14 sont arrivés entre 2 p.m. et 10 p.m.

De ces renseignements, il découle que l'on peut imputer les accidents à plusieurs causes, mais particulièrement à la négligence des chauffeurs et à leur jeunesse.

Pour cette période, le boulevard Métropolitain a malgré tout d'assez bonnes statistiques d'accidents si nous regardons le tableau ci-dessous qui nous donne un taux de mortalité de 4.05 par 100 M.V.M.

Si nous comparons notre taux de mortalité à celui des autoroutes américaines, nous voyons que le nôtre est supérieur. Ceci est normal, car pour le même nombre de véhicules, il y a beaucoup plus de véhicules-milles sur une autoroute que sur notre boulevard. Il y a également beaucoup plus d'accidents possibles sur ce dernier que sur les autoroutes, vu le grand nombre d'entrées et de sorties et le traffic intense aux heures d'affluence. Toutefois nous remarquons que nous sommes en-dessous de la moyenne d'accidents et de décès enregistrés sur les routes américaines, si nous excluons les autoroutes.

Angle d'impact

L'angle d'impact est simplement l'angle sous lequel un véhicule frappe un objet qui devient dans notre cas le parapet. Il est fonction de la vitesse et de la distance latérale entre le véhicule et l'objet frappé.

Nous avons cherché en analysant les rapports d'accidents, quel serait pour nos expériences, le meilleur angle d'impact en tenant compte des conditions du boulevard. Cette méthode ne nous a donné rien de concluant. Nous avons alors choisi un angle qui répondait aux pires conditions et qui tenait compte des expériences américaines.

Si nous nous référons aux études américaines et aux conditions du boulevard Métropolitain, nous voyons que pour une vitesse de 55 milles à l'heure et un déplacement latéral maximum de 28 pieds, l'angle d'impact est d'environ 28°. Ceci n'est valable que si le véhicule est en parfait état et si le coefficient de friction des pneus sur le pavage est élevé.

Les essais de Californie, entrepris en 1953, indiquent que les réactions des véhicules sont sensiblement les mêmes pour tout angle d'impact compris entre 5° et 10°. L'étude des accidents sur leurs glissières de sûreté a révélé que dans la majorité des cas, l'angle d'impact variait entre 15° et 20°. Nous avons donc choisi un angle d'impact de 21° qui tenait compte des facteurs que nous venons de décrire, ainsi que des conditions actuelles du boulevard. Nous avons aussi prévu le cas des pires accidents, par exemple celui d'un chauffeur perdant la maîtrise du volant alors que l'accélérateur est à plein gaz, même après l'impact.

Vitesse d'essai

Nous avons choisi comme vitesse d'essai celle permise sur le boulevard, soit 55 milles à l'heure. Nous aurions pu en choisir une autre, mais si l'on tient compte de l'angle d'impact, notre choix se justifie. Les facteurs vitesse et angle demeurèrent constants pour tous les essais, parce qu'en

Localisation	*Accidents 100 M.V.M.*	*Blesses 100 M.V.M.*	*Morts 100 M.V.M.*
Boulevard Métropolitain 1.4.61—31.3.1962	667	117	4.05
Autoroutes américaines			
1960	103.4	—	2.2
1961	107.5	—	2.4
Toutes les routes américaines			
1960	1500	—	—
1961	—	—	5.3
Autoroute des Laurentides	293	48	2.65

choisissant l'angle maximum pour la vitesse permise, nous produisions, au moment du choc, le maximum d'énergie cinétique qui devait se dissiper par la suite. Si nous avions varié ces facteurs, cela ne nous aurait pas aidé dans notre étude, mais tout simplement donné en certains cas, le degré limite d'utilisation de certains systèmes.

Description des différentes Glissières et Résultats

Nous avons résumé sous forme de tableau, figure 2, les résultats que nous avons obtenus. Pour les rendre plus clairs, nous avons ajouté la figure 3 qui montre les schémas des différentes glissières soumises aux essais, ainsi que la trajectorie suivie par les véhicules après l'impact. Il ne nous est pas possible de donner en détail toutes les constatations faites lors des expériences.

Modèle "A"—Leclerc et fils

Il s'agit d'une lise d'acier de calibre 12 reliée aux poteaux par des supports métalliques en acier à ressort de ½" d'épaisseur et de 6" de largeur. Sous les poteaux, une autre plaque de ½" d'épaisseur est insérée pour donner plus de rigidité au système. Ce système de support est relativement flexible et il permet une mise en place facile. Un tel système de protection peut s'ajouter au système actuel sans enlever les poteaux. Il suffit de soulever ces derniers après avoir desserré suffisamment les écrous pour y glisser la plaque de renfort. Le montage se fait facilement puisque l'on a coupé dans la plaque deux rainures qui permettent le passage des boulons et aussi d'ajuster la lisse à la distance voulue. On n'a plus qu'à serrer le tout pour terminer le travail. On peut ajuster la hauteur des lisses en se servant d'un procédé semblable.

Il est bon de noter que la plaque qui réunit la lisse au support tend à conserver la section module de la lisse sous l'impact d'un véhicule tamponneur. Ceci est important puisque la résistance sous le choc est augmentée d'autant. Les centre de la lisse se trouve à environ 20 pouces du pavage.

L'essai sur cette lisse d'acier reliée à des supports flexibles en forme de "L" a produit un grand rebondissement. Les dommages causés à la glissière sont les suivants: un poteau brisé qui tomba en bas, quatre tubes d'aluminium disjoints et la lisse fléchie.

Modèle "B"—Ministère de la Voirie, M. J. Lacroix

Ce modèle est fabriqué en acier et le support qui relie la lisse d'acier de calibre 12 aux poteaux existants est relativement flexible; il est en acier SAE 1020.

Le système a la forme d'une cornière faite d'une lame d'acier de ⅝" d'épaisseur et de 8" de largeur. La lisse se fixe directement à cette cornière, sans plaque de renfort. Sa pose exige l'enlèvement du poteau puisque à la base de la cornière, quatre trous seulement sont aménagés pour le boulonnage aux poteaux. Les trous étant ovalisés, on peut ainsi permettre un certain ajustement horizontal au support. Aucun ajustement vertical n'est prévu, ce qui empêche le maintien d'une hauteur uniforme pour cette lisse dans les courbes verticales.

Le centre de gravité de la lisse est à 21 pouces du pavage et la lisse elle-même à 5 pouces du garde-roue.

Deux essais furent effectués sur ce système, la vitesse désirée n'ayant pu être atteinte lors du premier essai.

Premier essai

Cet essai, fait à une vitesse de 42 milles à l'heure, a causé les dégâts suivants aux glissières: poteau partiellement cassé, deux lisses fléches, quelques supports courbés.

Deuxième essai

Cet essai a été fait à une vitesse de 59 milles à l'heure et les dommages aux glissières sont: un poteau tordu, un tuyau arraché, trois supports pliés, deux lisses fléchies. Le rebondissement fut important et il est montré à la figure 3.

Modèle "C"—Ministère de la Voirie

Ce modèle est une modification du modèle "B". On y a ajouté deux plaques de renfort de chaque côté de la cornière pour rendre le support plus rigide.

Lors des essais, on a constaté un assez grand rebondissement. Après que le véhicule tamponneur fut entré en collision au point désiré, il rebondit pour frapper plus loin le système actuel, le brisa et tomba en bas de la voie élevée.

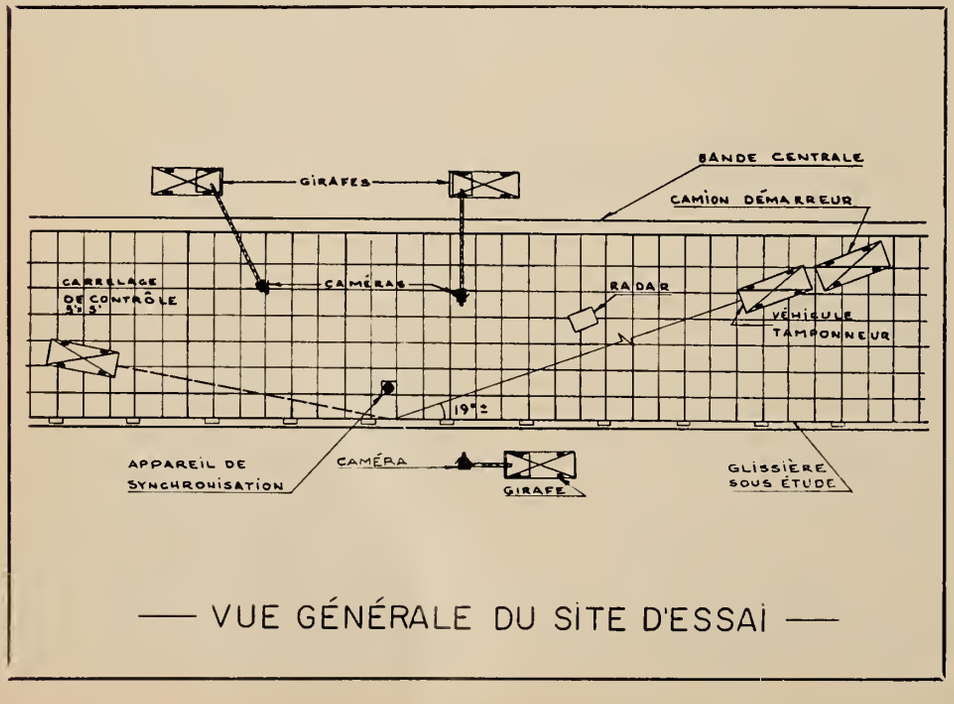
Les dégâts sur les glissières furent: un poteau et trois tubes brisés et projetés en bas, deux lisses fléches, un support partiellement arraché.

Modèle "D"—Aluminum Company of Canada

Ce modèle est composé d'une bande en alliage d'aluminuium en forme de "U" de 10 pouces de largeur qui sert de lisse. A chaque poteau, c'est-à-dire à environ tous les 7 pieds 6 pouces, l'attache de cette lisse au poteau est faite au moyen d'une bande d'acier de 12 pouces de largeur recouverte d'aluminium et en forme de cornière renforcée à sa base par une plaque supplémentaire en acier de même nature, et à sa partie supérieure par un autre "U" en alliage d'aluminium de 48 pouces de longueur. La lisse est en retrait de 2 pouces de la face du garde-roue et le centre de la lisse est en retrait de 2 pouces de la face du garde-roue et le centre de la lisse est à 23 pouces au-dessus du pavage. L'installation de ce système nécessite le soulèvement complet des poteaux existants.

Lors de l'essai, nous avons constaté un grand rebondissement. Les dommages causés aux glissières sont: un poteau brisé, deux suports déformés,

Fig. 1.



— VUE GÉNÉRALE DU SITE D'ESSAI —

le lisse fléchie et vingt-six tuyaux disjoints parce qu'ils avaient été fixés dans le mauvais sens.

Modèle "E"—Aluminium Company of Canada

Ce modèle est composé d'une lisse tubulaire en aluminium de 8⅝" de diamètre et d'une épaisseur de 0.187 pouce du type B51ST4. Elle est reliée au poteau du parapet actuel par une double bande d'acier recouverte d'aluminium de 18 pouces de largeur et de ⅝" d'épaisseur. Cette bande est constituée de deux lames de même largeur et séparée par une membrane de caoutchouc durci de 3/16" d'épaisseur. L'assemblage des tubes se fait au moyen de manchons. On doit soulever les poteaux pour installer le système. La lisse est en retrait de 3" du garde-roue et le centre du tube est à environ 24 pouces au-dessus du pavage.

Lors de l'essai, le véhicule tamponneur, après être entré en contact avec la glissière, a rebondi assez fortement et de telle manière qu'il alla frapper une autre glissière située à quelque 180 pieds plus loin. Elle résista sous le choc, mais le véhieule, après l'impact, a repris sa course sur la chaussée pour venir s'arrêter un peu plus loin. En examinant la glissière du modèle "E", on constata que les dommages avaient été relativement faibles, seule la section tubulaire avait été écrasée et quelque peu fléchie.

L'autre guissière frappée sous le deuxième impact était le modèle "G". Afin de savoir comment un tel type de glissière résisterait au cours d'une expérience normale, on décida de faire un essai dont les désultats sont donnés sous le titre "modèle G", paragraphe 9. 7.

Modèle "F"—Aluminium Construction Inc.

L'installation de ce modèle, qui est assez longue, est toutefois relativement simple, sauf à l'endroit des supports. Il est constitué essentiellement d'une lisse triangulaire rendue monolithe par l'intermediaire d'agrafes propres aux trois éléments identiques qui composent cette lisse. Chacune de ces pièces possède des nervures intérieures pour augmenter la section module. Une lame en aluminium de ⅜" d'épaisseur et de 6 pouces de largeur rattache cette lisse au poteau de support.

Le système de fixation de cette lame est très nouveau. A lar partie supérieure, c'est-à-dire à l'endroit où la lame s'appuie sur le poteau, une soudure froide est utilisée; c'est un composé de plastique et de caoutchouc. La partie inférieure est reliée à la base de béton du garde-roue par un boulon d'ancrage. La lisse à son tour est fixée à la lame par deux boulons de ⅝", l'un à la partie supérieure du triangle et l'autre à la partie inférieure. Les trous sont ovalisés à 2 pouces pour permettre la dilatation et aussi pour ajuster la lisse. Ce modèle présente une belle ligne et semble délicat. La hauteur de la lisse et la distance en retrait du garde-roue sont sensiblement les mêmes que pour les autres modèles, soit environ 22 pouces et 5 pouces respectivement.

Lors de l'essai le rebondissement fut tel que la voiture fut projetée en tranvers de la voie et vint frapper la bande centrale, pour glisser ensuite pendant quelques instants le long de cette bande, pour aller s'arrêter finalement un peu plus loin sur la voie. Les dommages aux glissières se résument comme suit: un poteau partiellement brisé, la lisse fléchie.

Modèle "G"—Aluminium Construction Inc.

Ce modèle n'est qu'une modification du système de glissière existant, et il est constitué de potcaux et de tubes. Les poteaux ACD 25 sont en aluminium profilé, plié et soudé à l'argon. Les tubes sont en aluminium de 5 pouces de diamètre, d'une épaisseur de 0.125 pouce, réunis au moyen de douilles formées par trois segments d'aluminium profilé et réunis par agrafes.

Lors de l'essai, le véhicule tamponneur a été brusquement arrêté par la glissière. Les dêgats sur la glissière sont: trois poteaux tordus ou partiellement brisés à la base et les tubes déchirés et tordus.

Modèle "H"—Ministère de la Voirie

Ce modèle, construit suivant les données du service des ponts et structures du Ministère de la Voirie, consiste en un petit mur de béton armé coulé immédiatement au-dessus du garde-roue, photo 4. On a soin, pour assurer une liaison parfaite, de fixer le mur avec des barres d'ancrage à tous les 18 pouces et de décaper de 1 à 2 pouces la surface existante du garde-roue. Ce petit mur de béton armé a une hauteur de 12 pouces et la forme d'un trapèze mesurant 6 pouces à la partie supérieure et 14 pouces à la partie inférieure. A chaque

Fig. 2.

Résultats des Essais sur Différents Genres de Glissières de Sécurité
Boulevard Métropolitain
Montréal

Essai No.	Véhicule d'essai No.	Identification	Véhicule			Vitesse (M.P.H.) Avant Impact Radar	Avant Impact Film	Après Film	Angle d'impact Prévu	Angle d'impact Film	Angle de rebond Après impact	Angle de rebond Au point maximum	Rebond maximum P'	Distance en contact avec le garde-roue	Décélération moyenne Latérale pi/sec.²	Décélération moyenne Longitudinale pi./sec.²
			Marque	Année	Poids											
3	2	Modèle "A"	Chevrolet	1956	3450	57	59	45	21°	19°	14°	20°	36′	15′	80	33
4	4	Modèle "B"	Plymouth	1956	3580	44	42	36	21°	19°	8°	9°	13′	9′	70	14
5	12		Monarch	1953	3200	57	57	35	21°	20°	9°	24°	36′	28′	69	28
6	6	Modèle "C"	Plymouth	1956	3670	55	57	44	21°	18°	11°	9°	20′	40′	124	47
7	5	Modèle "D"	Ford	1955	3570	50	53	38	21°	18°	13°	9°	28′	12′	113	67
8	8	Modèle "E"	Buick	1953	4000	50	58	44	21°	19°	10°	10°	17′	17′	210	169
9	11	Modèle "F"	Chevrolet	1952	3650	50	50	32	21°	20°	15°	25°	36′	30′	67	43
10	10	Modèle "G"	Studebaker	1957	3420	60	52	—	21°	19°	100°	100°	16′	13′	160	460
11	7	Modèle "H"	Ford	1954	3570	54	56	44	17°	15°	6°	9°	11′	37′	84	48
12	9		Mercury	1955	3980	25	29	15	21°	22°	9°	4°	7′	50′	11	10
13	9A		Meteor	1956	—	50	53	35	21°	20°	8°	7°	10′	22′	90	57

poteau, on prévoit une gouttière pour éviter toute accumulation possible, d'eau. Ce mur est en retrait de 4½ pouces du garde-roue. Sa hauteur maximum peut atteindre 24 pouces au-dessus du pavage. Ce système est de construction lente et encombrante.

Trois essais furent faits sur le mur de béton qui tenait lieu de glissière de sûreté, l'un sous un angle de 17° d'impact et deux sous des angles de 21°. Ce système produisit un très faible rebondissement. Pour obtentir l'angle d'impact de 21°, il a fallu construire un système de guidage supplémentaire, car la force centripète du véhicule aurait fait sauter le véhicule hors du dispositif de guidage ordinaire, photo 3. La pompe à gaz du premier véhicular s'étant brisée à environ 100 pieds du point de départ, deux essais à 21° furent effectués.

Premier essai—17° d'impact

On ne remarqua pas de dégâts sur la glissière.

Deuxième essai—21° d'impact—28 milles à l'heure

Cet essai n'a pas endommagé la glissière.

Troisième essai—21° d'impact—52 milles à l'heure

Au cours de cet essai, le tube horizontal supérieure entre les poteaux fut partiellement arraché, mais il n'y eut pas de dommages sur le mur, photo 4.

Autres essais

D'autres furent effectués sur le garde-roue et la bande centrale existants, mais le manque de temps et d'espace ne nous permettent pas d'en discuter au cours de cette conférence.

Critique des Resultats

Les mêmes conditions furent maintenues pendant tous les essais sur les glissières de sûreté, sauf lors des essais nos 4, 11 et 12 qui furent refaits. L'angle d'impact et les vitesses furent sensiblement les mêmes, peu importe le côté du boulevard qui fut utilisé pour les essais.

Il est à notre qu'il ne s'agissait pas de mesurer les efforts engendrés dans les composantes du parapet, mais plutôt le rendement relatif des systèmes sous épreuve.

Les vitesses et les angles d'impact ont été contrôlés avec soin et de nouvelles expériences furent refaites lorsqu'ils s'éloignaient de ceux qui avaient été choisis. Il en est de même du poids des véhicules qui fut assez constant en vue de simplifier l'interprétation des résultats. Différents types d'automobiles peuvent entraîner des variations dans les résultats, mais elles sont sans conséquence à notre avis.

Commentaires détaillés

Pour faciliter la critique des résultats, nous l'avons divisée en plusieurs sections, chacune se rapportant à une caractéristique de la glissière de sécurité idéale.

Solidité du parapet

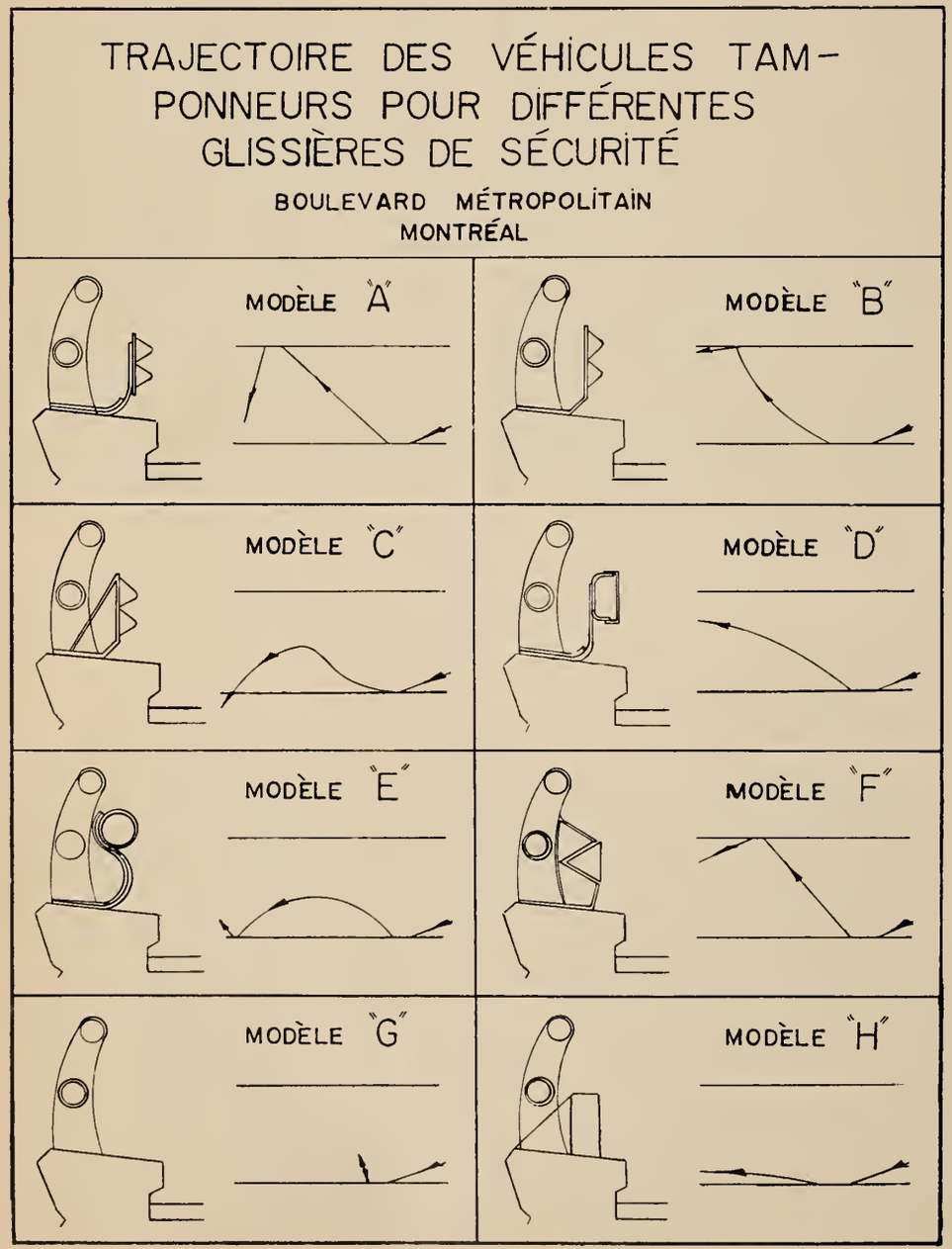
On peut toujours obtenir un parapet résistant. Il suffit tout simplement d'augmenter la résistance des éléments qui le composent.

Rebondissement minimum

Les lectures faites sur les films et l'analyse des résultats prouvent que plus le système est rigide, moins le rebondissement est élevé. Notons aussi une observation qui jette de la lumière sur nos expériences: lorsque le véhicule frappe un parapet rigide, l'avant de la voiture fait contact, et par réaction, il est repoussé sur la chaussée; mais presque aussitôt l'arrière de la voiture frappe à peu près le même endroit où l'avant a fait contact et il est repoussé à son tour, mais ce contrecoup tend à redresser le véhicule et lui aide à longer la voie près du parapet. Mais si au contraire la glissière se déforme sous le choc, l'arrière de la voiture n'est pas repoussé avec la même force, mais tend plutôt à suivre le contour de la déformation au lieu de rebondir et de redresser la voiture. Ainsi libre, cette voiture au lieu de revenir le long du parapet, continue son premier mouvement, traverse la voie médiane, et va même souvent jusqu'à frapper la bande centrale.

Parmi tous les systèmes soumis aux épreuves, le mur de béton est celui le plus rigide, aussi le rebondissement est-il le plus faible. Dans les autres cas, l'amplitude du rebondissement semble être inversement proportionnelle à la rigidité du parapet pour l'angle d'impact et la vitesse étudiés.

Fig. 3.



Le retrait de la glissière, par rapport au garde-roue, joue un rôle très important. S'il est trop fort, l'automobile a tendance à se renverser puisque seul le garde-roue entre en action à condition que le véhicule ne saute pas ce dernier. C'est d'ailleurs ce qui s'est produit lors de notre essai sur la bande centrale de béton. Si le retrait est trop faible, seule la glissière soutient le choc. Il faut que la carrosserie et la roue du véhicule frappent presque en même temps pour obtenir le meilleur rendement.

Décélération

Les décélérations moyennes durant l'impact obtenues par calcul sont approximatives, mais elles nous semblent raisonnables, sauf dans le cas du modèle "G". Il est bien entendu que pour avoir des valeurs précises, susceptibles de nous indiquer la gravité de l'accident, il faudrait avoir des accéléromètres installés à l'interieur d'un mannequin qui serait dans le véhicule tamponneur. Nos expériences prouvent que le mur de béton donne les plus faibles décélérations moyennes.

Glissement uniforme

Tous les systèmes, à l'exception du modèle "G", ont provoqué un glisssement assez uniforme le long de la lisse.

Eclatement de la glissière

La glissière actuellement en place éclat en morceaux aussitôt qu'elle est frappée par une voiture hors de contrôle, et les éclats qui volent à tout hasard, peuvent causer certains dangers, surtout sur les voies passant sous d'une seconde ligne de défense, sous forme d'une glissière additionnelle devrait-elle réduire les dégâts au minimum, spécialement s'il s'agit du mur de béton.

Entretien du parapet

Le coût de réparation du parapet lors d'un accident, varie énormément. Dans le cas du mur de béton, le coût des réparations est réduit au minimum, alors que dans le cas de l'acier et de l'aluminium, et surtout dans ce dernier cas, il est plus élevé. On peut difficilement l'évaluer, mais les chiffres obtenus à ce sujet semblent raisonnables.

Dommages causés aux véhicules

Les dommages causés aux véhicules tamponneurs varient suivant le genre de gilssière. Cependant le mur de

Photo 3.—Système de lancement avec guides additionnels.

béton a occasionné le moins de dommages.

Apparence du parapet

C'est, sans aucun doute, le modèle "F" qui a les lignes les plus harmonieuses, tandis que le modèle "H" a les plus sobres. Les autres modèles s'en approchent plus ou moins.

L'apparence du parapet a une influence sur les chauffeurs. Il est à peu près certain que ceux-ci s'éloigneront davantage du parapet modèle "H" que du parapet modèle "F".

Coût de la glissière

Le coût de construction d'une glissière varie énormément suivant le genre. Une étude comparative aurait eu son importance si nous avions eu à choisir entre deux systèmes ayant sensiblement le même rendement, mais cela ne fut pas le cas. Nous savons que l'acier est un peu moins cher que le béton, qui à son tour l'est moins que l'aluminium, mais qu'importe: ce qu'il faut avoir, c'est le système le plus économique.

En résumé, nos études prouvent que le mur de béton répond au plus grand nombre d'exigences. Cela ne veut pas dire qu'il doive être employé l'exclusion des autres types, mais tout simplement il donne les meilleurs résultats sous les conditions étudiées.

Conclusions

Le système que nous recommandons conserve le parapet actuel en lui ajoutant une seconde ligne de défense, en l'occurence un petit mur

Photo 4.—Dommages à la glissière du modèle "H" après les trois essais.

de béton reposant sur le garde-roue actuel. Nous nous basons pour cela principalement sur la faible amplitude de rebondissement du véhicule lorsqu'il frappe ce genre de mur, facteur très important pour les voies élevées. Un trop fort rebondissement peut entraîner une série d'accidents en projetant le véhicule dans les voies adjacentes où il peut en frapper d'autres utilisant la chaussée. C'est alors que se produisent les accidents en cascade.

Dans les rampes où les véhicules circulent en file simple, le facteur de rebondissement n'a pas la même importance que sur les voies élevées. Pour cette raison, nous recommandons de construire une glissière de sûreté qui retiendrait les véhicules. Le système acceptable, et qui serait le moins cher, consiste en une glissière d'acier formée d'une lisse en forme de "W" et supportée par des supports d'acier. Ce système doit résister à tout effort de tension sans la moindre déflexion, et par conséquent, doit avoir les bouts de la lisse bien ancrés. D'autre part, il est absolument nécessaire d'éliminer les dangers que pourraient causer les extrémités de cette glissière.

En résumé, les essais faits sur huit différents genres de glissières de sécurité pour une voie surélevée à circulation rapide démontrent que le mur de béton est le système qui donne le meilleur rendement pour les conditions étudiées.

Témoignages

L'auteur et la firme Warnock Hersey tiennent à remercier tout particulièrement les autorités du Ministère de la Voirie, spécialement l'Honorable Bernard Pinard, C. R., MM. Roger LaBreque, Arthur Branchaud et Philippe Bureau, ainsi que MM. Jean Lacroix et Guy Paquette de la division de Montréal, et tous ceux qui ont collaboré à ces essais d'une manière directe ou indirecte. Ils tiennent également à remercier les autorités de l'Etat de New-York et les scientifiques de l'Université Cornell, département de l'aéronautique, pour leur collaboration lors de l'établissement de l'angle d'impact maximum.

Ils remercient encore les autorités du Ministère de la Voirie de permettre la publication de cet ouvrage original.

REFERENCES

Une liste complète de toutes les références peut être obentue de notre firme, dont voici les principales: **Les volumes du Highway Research Board. Les rapports des essais sur les glissière de sûreté** des Etats de California, New-York et de la Suède.

EIC-63-CE&A 9

THE FUTURE OF AUTOMATION IN CANADA

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AUTOMATION is one of the most controversial words in modern technology.[8] It has been applied to everything from a motorized can opener to a fully automatic chemical processing plant.

The bitterest dispute, however, seems to be between those who use it to describe highly mechanized devices and those who limit it to systems employing automatic control. The advocates of computer control (even when it isn't automatic) have further confused the situation.

There has also been sharp words between those who consider automation as the result of natural evolution and those who consider the concept revolutionary. In my opinion, it is both. Certainly, it has come about as a result of a long history of developments. On the other hand, some of the aspects of the concept are so far-reaching, we seem to have "mutated" to a new plateau of understanding and competence.

The Concept

Automation spans the domains of information, energy and materials.[5,6]

Automation can and is being applied to information; its collection, translation, manipulation, storage, inter-relation, recording, and transmission.

Automation can and is being applied to energy; its development, measurement, transmission, distribution, storage and control.

Automation can and is being applied to materials; their gathering, measurement, processing, working, assembling, storage, distribution, inspection, sortation, etc.

But, the central concept, that of making things truly automatic, is tightly bound to the use of information in connection with itself and the other two domains.[5,6]

Automation as applied to handling information, involves other information, such as programs.

Automation as applied to handling energy, involves information, such as measurements and instructions.

Automation as applied to materials, involves information; in materials handling—speeds, sortation, routing; in assembly—order, orientation, timing, magnitudes; in processing—environmental measurements and control.

The mutation now taking place in the evolution of machines and their systems is due, not only to the recognition of the value of making things automatic, but the fact that to make things truly automatic requires a sophisticated way of thinking about and of handling the information required to do this.

Automation—A Hierarchial System

Every machine has organizations within itself, organization of its functions, organization of its mechanical and informational components, etc. When machines are made to operate together, then they will have to be still further organized.

Just as in every "natural" field, there are levels of organization.[9] At the lowest level will be simple reflex automata which can then be combined in various ways suitable to the environment to provide the results required. These can be "built" into higher and higher organizational forms, with greater and greater overall complexity.

One of the serious problems in extreme mechanization has been the lack of flexibility in the operation of the machines and their organization, and the resulting inability to change the product except at great cost.

In more sophisticated systems, the information is handled in a different way, and can be varied more readily. The tightness of the coupling between machines making up the organization may also be less.

Certainly in the future, a properly designed, highly automated plant, for example, must be flexible to permit product change, reliable in its components, redundant in vital areas, and consistent in its product quality.

Tomorrow's highly dynamic and competitive world will accept nothing less.

In the past, machines were coupled by workmen who provided a lot of give and take.

With the demand for higher and higher production speeds, higher quality and consistency, people are finding it more and more difficult to keep up with the machine. Inspection is a very good example of this. Imagine a man trying to find flaws in paper travelling at 2500 f.p.m. in a web 20 ft. wide!

Hence, machines must be produced to work with machines, and an organization of machines is created.

Machine organizations have their own requirements which are much different from those including people.

Because of the very complexity of such organizations, it would seem the old "management by exception" concept may be almost mandatory.

Equally mandatory, will be a rediscovery of the old concept of "elegance". We must find new approaches to old problems rather than pile complexity on complexity. A new level of creativity and ingenuity is required urgently.

Automation and the Computer

The computer has had a remarkably good "press", and there are those even in the engineering fraternity who talk as if a computer can solve just about anything.

We are being brainwashed.[4] The actual situation in relation to computers in automation is as follows:

1. Some of the claims are true—enough to make anyone sit up and take notice. Computers have, indeed, a large and valuable contribution to make, especially where high speed computation is required.
2. The word "computer", like "peace", can mean widely different things to different people. There are many highly involved informational devices that do not "compute" at all. Calling all of them "computers", can be most misleading.

3. The computer is being "pushed" as an overall supervisory control device. Many functions can best be performed on a localized reflex basis. Often, overall "supervision" is an unneeessary and costly frill. In other cases, the lessons of biology should be taken to heart. A brain that really tried to "run" every process in the human body would be ridiculously impractical. Attempting to use a computer in the way often described would be in somewhat the same category.
4. The mere generation of huge gobs of information does not neeessarily solve anything. In the final analysis, it doesn't pay to generate much more than can be used.
5. While the computer can display its skill by calculating the almost incalculable, one must always consider the worth of the calculation. Many variables in a process don't need calculating.

The Status Quo

In spite of what has been reported in the press, which gives the impression sometimes that half the industry in North America is run by Giant Mechanical Brains, the facts are remarkable modest. A few industries use a number of automatie control techniques, some are highly instrumented. But many of our industries are still using primitive methods in many areas of their operations. Even those using advanced meehanization use little automatic control. The application of true informational concepts, vital to highly sophisticated automatic systems, has just begun to be thought about, let alone applied.

Automation is generally considered to be a family of techniques for the manufacturing industry. Aetually, these techniques can be applied to any activity.

In Canada, the wider concept is of enormous economic importance because many industries not normally considered manufaeturing are vital to the well-being of this country.

A Typical Canadian Industry

According to the Dominion Bureau of Statistics' 1960 tabulation of the 10 leading manufacturing industries, the pulp and paper industries lead in sales, (nearly $1.6 billion), salaries (nearly $345 million), and employees (nearly 66,000 mill workers plus an additional number of permanent woods employees). Pulp and paper, therefore, represents a good place to start when considering automation as applied to Canadian industry. (Motor vehicles, often considered tops, actually ranks fifth.)

The "heart" of the pulp and paper business is the paper machine, a mechanical monster gulping in pulp slurry by the ton and spewing out paper by the mile. If automation were mechanization, this would indeed be automation.

The last 20 years have seen increases in machine speeds (in the newsprint end of the business), approaching 100%. What then can automation have to offer?

While the machine is a mechanical marvel, it is far from automatic. Skilled personnel hover over it like moneylenders over their last coin. Even so, quality and uniformity, as well as continuity, "get away" from the operators, and when they do, you have a situation where a machine is spitting out poor product at rates up to a mile in every two or three minutes.

Obviously, there is a real place for advanced instrumentation and control, and a great deal has already been done in this direction. But there is still a great deal more to be done to monitor the significant variables in the product and trace them to their causes in the adjustments on the machine. There will then be the problems of controls over a large number of interrelated variables.

There are undoubtedly a great many "reflex" type deviees that can be used in addition to those used now. Data logging and accumulation, just now being introduced, may eventually be followed by some sort of computer control.

Apart from the idiosyncrasies of the maehine, the raw materials, being a "natural" product, are themselves prone to large and almost unpredictable variations of their own. These too, must be taken into account for truly automatic operation. It is apparent "true" automation is not a simple problem in this case. Nevertheless, the rewards would be large and hence, economic pressure is definitely in that direction.

While automation of the paper machine presents many problems, so does the gathering of the raw material.

Most paper mills in this country "feed" on trees. This is just about as variable an input as there is. To be contended with are various varieties, sizes, shapes, locations. The standard procedure involves men going into the woods, manually cutting down the trees, trimming them, sawing them to length, stacking them for scaling, and finally, transporting them over very irregular terrain to the mill.

Even these activities are receiving serious study, and machines are in existence that can cut, trim, saw, scale, chip, and transport the material, all automatically. There is no integrated system yet in use, however, that does all of these things. But it won't be long until there is.

Pulp and paper is a typical Canadian industry. While the problems are difficult and many, the stakes are high.

The industry has been one of the most progressive in the country and I do not doubt that we shall see it make important contributions to the art and science of automation in the years ahead.

Canadian Industry—General

In the forgoing paragraphs, I have discussed a typical Canadian industry even though it is the largest.

There are hundreds of industries, of course, also important to this country, and in all of them automation can play a vital role in the years to come.

The petrochemical industries have long been known for their advanced process instrumentation. Many plants are already highly automatic and are tending to become more so by experiments toward overall end product control.

In other industries such as mining, ore transportation, ore processing, steel mills and the like, various functions and facilities have been invaded by automation. The economic rewards are so large, both in reduction in costs and improvements in quality, that this trend must continue at an ever-increasing rate.

In secondary manufacturing industries and in warehousing and distribution, materials handling seems to be the activity where automation is first taking hold. The automation of assembly operations is probably the most difficult of all, and little has yet been done in this area. (Except, measures are continually being taken in product design to eliminate as much of it as possible.)

All industry, of course, has a large and growing business information activity associated with it. In general, the percentage of this type of work in almost any industry has been mushrooming. Only the automation of much of this work can keep this in bounds. The use of various types of business machines has grown rapidly to meet this need. The increasing sophistication of information handling is indicated by the number of computers now installed, and on order.

As industry grows, becomes more diversified and sophisticated, the kinds of things that need to be done, the speed with which they need to be done, and the environments where these tasks are to be carried out, are becoming increasingly difficult to do manually.

A great deal of attention has been given to the labor saving aspects of automation but, much more important than these, there are many operations that aren't being done or can't be done at all because they are:

(a) too expensive to do with people
(b) people can't do them at all
(c) people can't do them properly

As techniques are becoming more complex and production speeds higher, more and more operations are falling into one of these three categories.

Yet, customer demands for quality, uniformity, and ever increasing speeds, are rising. Competitive pressures are increasing. Costs are increasing.

This represents a technological squeeze that only automation can resolve. In the resolving of it, rests the future prosperity of Canada.

The Canadian Environment

One of our major problems in Canada is the intellectual climate in which we live and work.

The environmental constraints in this country result in some rather unusual situations in many aspects of Canadian life, from cultural activities to the anatomies of our business and political entities. Our history is made up of a train of colonial situations in all these aspects of our society which has generated a chronic introversion and seems to have limited the horizons of our thoughts and aspirations. As possessors of one of the world's largest countries geographically, highest standards of living economically, highest political stability, and one of the world's highest standards of education, we have everything we need except the will to really make something of ourselves, and the intestinal fortitude to stand up and speak our minds.

It is in this context that we must face the impact of one of the most challenging concepts in the history of man.

In discussing Canada, one almost inevitably compares it with its powerful neighbour with which it has such a multitude of vital ties.

There are many important differences between them, and all of them will reduce the rate of application of automation in this country below that of the United States.

a. In certain industries, the market is much smaller. Smaller, in fact, than the ratio of the populations might indicate. (The U.S. manufacturing monthly output is about the Canadian yearly G.N.P.) This means that our way of doing things must be different if many kinds of production are to be economic.
b. The economy is not so well "balanced" as in the U.S. There are some things that are uneconomic to produce in Canada at all. Hence, they must be imported, and be subject to extra costs and extra delays.
c. Canada must sell more than she buys because only in that way can she balance her international accounts. This is peculiarly the case for Canada because of interest payments, dividends and the like that are a necessary part of a huge foreign investment within the country.
d. We seem to be basically more conservative than in the U.S. We, therefore, lag behind in many areas where we need not. There is quite a tendency to wait for a development to prove itself in the U.S. before even trying it here. There are, of course, some significant exceptions. Some Canadian companies have been true pioneers in a number of fields.
e. A large number of industries are controlled by parent firms in other countries. Not unnaturally, they tend to do their research and development, as well as trying out new ideas, there. This restricts the introduction of new equipments in this country to varying degrees, depending on the industry and very markedly, on the individual company. There are many exceptions to this. Some American - owned companies, for example, not only do important pioneering in this country, but bring in new techniques that we wouldn't have otherwise.
f. We, as Canadians, really haven't made up our minds as to what we are and where we want to go. This lack of a goal is hardly an inspiration for our young talented people. When they find opportunities elsewhere for more money, better facilities and hope of a better future, there is little incentive for them to stay at home. Canada has been bleeding away talent and educational investments for years.

Automation and Management

Automation has been represented as a great challenge to the engineering profession, to production people, to labor, and to the public.

But perhaps the greatest challenge is to industrial management.

Automation not only is changing the method of doing things, the kind of people who are doing things, the capital investment required to make things, but just about every facet of business.

Applications are just now showing the outline of the scope that will be achieved by the applications of these techniques. Perhaps most often overlooked are the important effects automation is going to have on the organization and philosophy of manufacturing enterprise.

Problems generated by all these changes, many of which are taking place at the same time, are a real challenge to Management.

Probably the success of automation in this country depends more on Canadian management and its skills in adapting to this highly dynamic situation than on any other single factor.

Automation Should Be "Bought"

If the people in manufacturing, raw materials industries and service industries realized it, they should be pounding on the doors of people in the automation business, because the latter can save them a lot of money by increasing their production efficiency, reducing their costs of inspection and upgrading their product quality. In today's world, an industry's very existence can depend on such improvements.

Improvements of these types can provide the incentive and cash necessary to keep more of our skilled people in this country.

The combination of high quality goods at reasonable prices, and skill-born uniqueness, could greatly help maintain Canada's posture as a world trading nation in the difficult years ahead.

Oddly enough, in the past many manufacturing people have often resisted the ideas which have offered them one of their major weapons in their fight to remain competitive.

As things are, therefore, a lot of "selling" will still be required.

Can Automation Be "Sold"?

First, it must be sold to the user industries, because these industries issue the purchase orders which represent the "moment of truth" in any business situation.

Any plant, let alone an industry, represents a highly complex situation. As in the case of a fraternity, it must be sold "in depth". Perhaps only the Vice-President in Charge of Operations can say yes, but practically anyone from one cut above the floor-sweeper to the Chairman of the Board can say "no".

Innovation, while a thrusting, exploring and indeed, an "exploding" entity, is still a fragile plant that can easily be nipped in the bud.

Within each factory, automation must have an advocate, and the most

likely candidate is one or more engineers. With their background, training and knowledge, they are most fitted to champion this cause in their own organization and carry on a continuing campaign for utilization of automation. In many cases, to their credit, they have done this. In others, regrettably, the odd one has taken the stand of "not sticking out the neck". Later, they have "got it in the neck" because production executives have taken the initiative to gain the advantages they have become aware of.

Industries operate in a social environment, and unless the "public" is sold on automation, many will be unable to use it to any important extent. Not enough has been done in this area. There has been too much emphasis on the labour saving and the "gee-whiz" aspects, and not enough on the improvements to be expected in quality, consistency and price stabilization in an era of rising costs.

In spite of all the talk of featherbedding and undoubtedly there has been some and will continue to be some, many unions, to their great credit, have taken the longer term, enlightened view on automation. They realize the larger the pot, the bigger their portion. If this continues, the future can be bright.

Automation then, must be "sold" to four important groups; the technical people who have to work it out; the production people who have to buy it and use it; the workers who have to live with it; and the public who have to accept it and its products.

Unemployment

One of the greatest potential drags on the increasing application of automation is the threat of unemployment. If too much shift in labor requirements should occur in a short time, or more importantly, if any major segment of the public thinks it has, there will be an insistent demand for a slowdown. If there should also be serious unemployment for seasonal or structural reasons, automation will undoubtedly be blamed.

If, of course, it should be found that automation had resulted in localized hardship, then society would have an obligation to temporarily cushion these effects. It is important, however, that temporary assistance not become a permanent crutch. This sort of thing has happened too often in the past.

Much more probably, it will be found, automation has little to do with unemployment. So far in this country, we had chronic and tragic unemployment for years during the Thirties with very little of what might be called automation. Even today, in Canada, the winter unemployment may peak out at 8% or more, but automation has been applied only here and there.

Obviously, other major economic factors are involved in this problem, and it is to these that we must look for solutions. If economic history means anything, increasing productivity will cause an increase in labour demand far larger than any savings in labour. It would be a disastrous error to limit automation when it could help solve the very problems it is alleged to produce.

The Future

There will come a time, when overproduction will become a problem.

We can already produce much more than the food required by our population. This, of course, is also the case in our production of many raw and semi-finished materials. This situation will spread to other areas in manufacturing. The predominant role of production in the national thinking will then begin to decline, because it will lose its urgency in the national economy.

New kinds of activities will grow and with the service industries fill some of the segments of the economy now occupied by agriculture and manufacturing. The financial machinery will continue its new trend, to do a better job in keeping the "business gears" meshed. People engaged in a "food and product" dominated community will have to get used to one where this kind of work is not the be-all and end-all of life.

One of the greatest wastes in our society, sub-employment, where a great number of our people are working at jobs far below their capabilities, will be reduced.

Children will stay in school longer, and not artificially load the ranks of the unemployed as untrained, unemployable youngsters. It will be recognized that education must continue through working life rather than stopping at the school or university gates. In the highly dynamic society that will be generated by a rapidly changing environment, this will be a job requirement.

With a better educated population employed at jobs fit for people, one can expect a reduction in the tendency so evident today to carry the attitudes induced by machine-like work over into the other areas of social behaviour. This may mark the beginning of the end of the very real and recurring threat to the kind of society we have chosen for ourselves.

As for automation, if we give it half a chance, the future looks bright.

Once given the concept of automaticity, even techniques long dormant will find new applications. The fields available for the application of its principles becomes virtually limitless. It is impossible to visualize any facet of human economic activity that can not use it. Every Canadian industry from the raw materials industries, such as the big four of agriculture, forestry, fishing and mining; process and manipulation manufacturing industries, warehousing and distribution, merchandising and entertainment, all will continue to use ever-growing numbers of automatic devices. Almost inevitably, these will be integrated into larger and larger semi-automatic and fully automatic systems.

Communications and transportation through the use of automation, will become increasingly integrated with the other aspects of our economy.

Perhaps in time, a new common informational language, "understood" by all business machines, will be developed and accepted by industry, government, and business. If later, the use of this language could become international in scope, there would be a breaking down of barriers and a stimulus given human activity only paralleled by that produced by the invention of money.

Automation will produce new types of organization in the non-biological world. It will offer totally new opportunities, but at the price of new challenges.

Sooner or later, man will have to come to terms with this kind of environment and decide whether he wants to become part of the "machine", or stand outside it, encourage it to develop to the fullest, make it do his work, and make sure he doesn't get caught in the gears!

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EIC-63-HYDEL 5

Some Foundation Considerations at the GRAND RAPIDS HYDRO-ELECTRIC PROJECT

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THE GRAND RAPIDS hydro-electric development is located in Manitoba on the Saskatchewan River where it flows into Lake Winnipeg (Fig. 1). Discharge records taken at The Pas since 1911 indicate an average flow of 24,000 c.f.s. with a range of variation between 1,7950 and 105,500 c.f.s. The scheme is based upon a head concentration averaging 120 ft. which, with a 10 ft. range of forebay regulation, will provide a storage volume in excess of 100,000 c.f.s months.

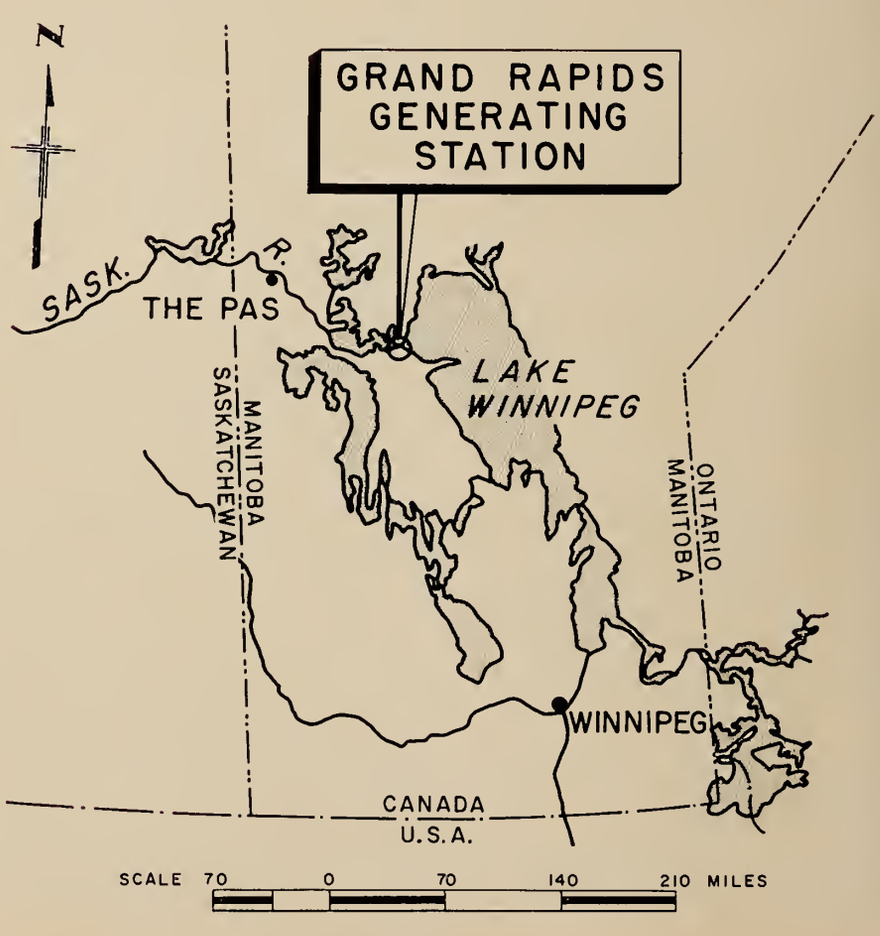
Works under construction include:[1]

(a) Six major dikes and seven freeboard dikes, varying in height up to 100 ft. and extending 16 miles, these being either of homogeneous design or having a central core flanked on both sides by supporting zones of pervious material and rockfill.

(b) Spillway comprising four openings, each regulated by a vertical lift gate 40 ft. wide by 42½ ft. deep, and having a total discharge capacity of 140,000 c.f.s. at maximum normal forebay level of 842.

(c) Intake channel 570 ft. wide and 28 ft. deep excavated through high ground to conduct water to the intake structure.

FIG. 1



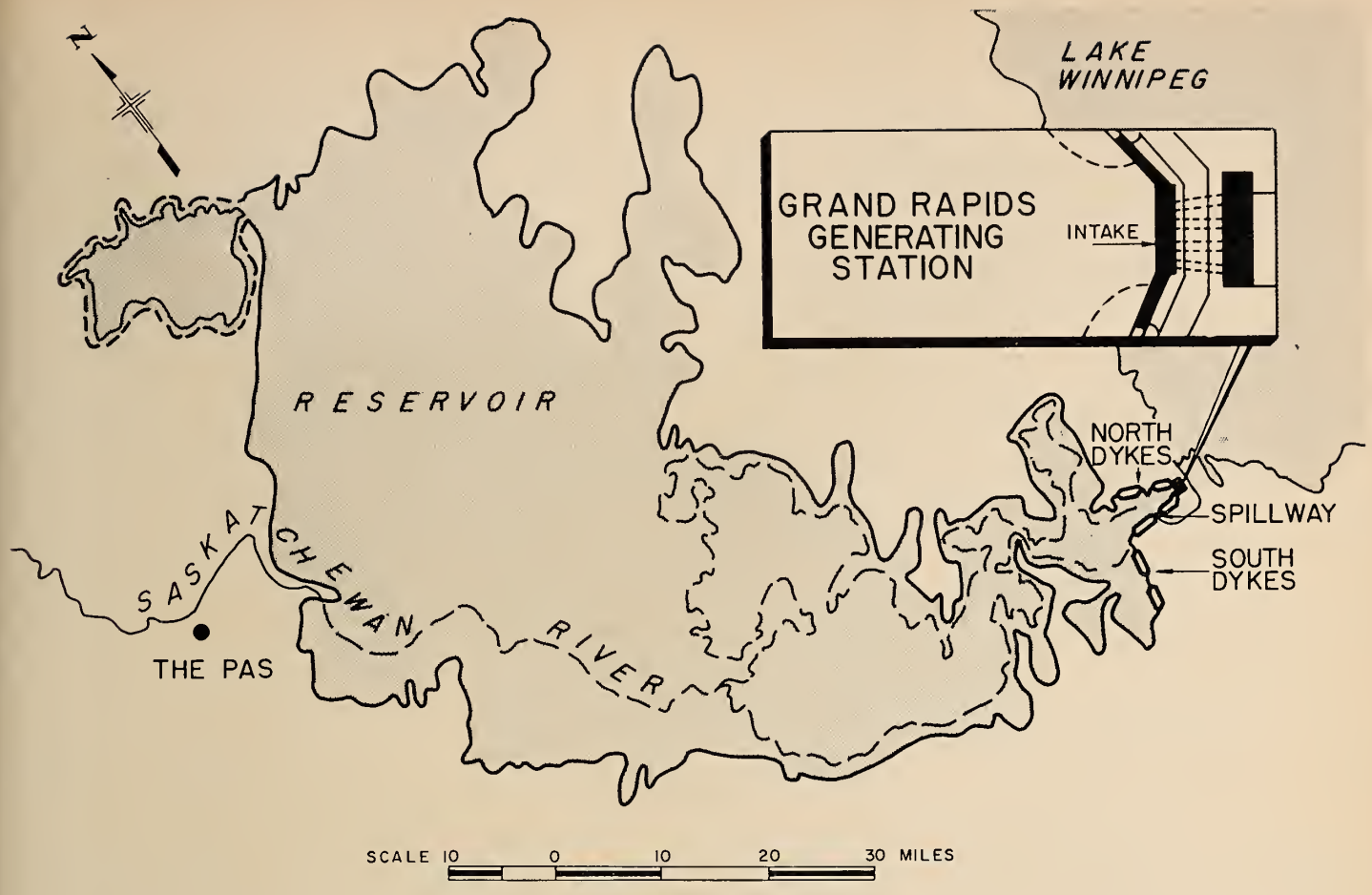


FIG. 2

(d) Intake structure of the mass concrete gravity type with hydraulically-operated vertical lift headgates. There are two gates per unit, each 16 ft. wide and 36 ft. deep.

(e) Twenty-nine-foot diameter steel penstocks, encased in concrete, each serving one unit.

(f) Powerhouse of conventional design having a total installed capacity of 345,000 kva. from three vertical shaft generators driven by Kaplan turbines, with provision for a fourth unit.

(g) Tailrace channel which follows the course of a high water channel to the Saskatchewan River.

(h) Switching station located 1,000 ft. east of the powerhouse to provide for connection of the transformers located on the powerhouse tailrace deck to the two single-circuit transmission lines leading to the Greater Winnipeg area 258 miles to the southeast.

The layout of the development is shown on Fig. 2.

Probably the most notable feature of the Grand Rapids site, and certainly the one which has created the greatest engineering problems, is the bedrock geology. It is proposed to present, herein, a brief description of the geology and a review of some associated problems of design and construction. These include the construction of a grout curtain throughout the length of major dikes; sealing of sinkholes in the headpond; construction of a grout curtain around the intake, penstock and powerhouse sites; grouting to consolidate the foundations of concrete structures; and measures to stabilize the intake structure.

GEOLOGY

The reservoir is located on a flat plateau drained by the Saskatchewan River which widens locally to form shallow lakes. Along the eastern margin of the plateau, the land falls approximately 100 ft. in a series of beaches which flank Lake Winnipeg in a belt about one mile wide. These beaches represent the shores, at various stages, of old glacial Lake Agassiz or the younger Lake Winnipeg. There are many surface depressions, indicative of sinkholes which drain underground. Numerous springs occur along the base of the escarpment and series of beaches.

During the Pleistocene epoch, the surface was overridden by glaciers which deposited till to various thicknesses. Alluvial products of recent origin are comparatively sparse, being represented by river-deposited silts and sands occurring in benches which flank the course of the river and its tributaries, and a thin veneer of granular deposits on the river bed. The project area is mostly covered with shallow overburden although a depth of 89 ft. was encountered at one location along dike No. 1 South.

The bedrock of the region consists of sedimentary deposits which were laid down under marine conditions in Ordovician and Silurian time. Pre-Cambrian basement rock was encountered at elevation 298, a depth of 470 ft. in the deepest exploratory hole in the powerhouse area. The general stratigraphic sequence is indicated in Table 1.

The site is underlain by flat-lying beds of limestone and dolomite interlayered with infrequent, but nevertheless significant, thin horizons of clayey, silty or sandy materials.

The two principal rock types present in the sedimentary deposits are fragmental or pseudo-brecciated dolomitic limestones and massively-bedded dolomites. In addition, the bedded Paleozoic succession includes poorly indurated calcareous shales and sandstones which, except for the basal sandy siltstone unit of the Winnipeg formation, represent a relatively minor proportion of the total.

The fragmental dolomitic lime stones have a mottled appearance and consist of harder fragments and

TABLE 1

General Stratigraphy

Epoch or System	*Group or Formation*	*Thickness (feet)*
Silurian	Interlake Group	242 maximum
	Possible Unconformity	
Ordovician	Stony Mountain Formation	176
	Red River Formation	168
	Winnipeg Formation	36
	Unconformity	
Precambrian	——	—

gravel-sized masses of darker coloured material enclosed in a softer limestone or dolomite matrix. Where advanced decomposition has occurred, the matrix is mostly removed, leaving a loose honeycomb-like mass of the included fragments. The psuedobreccia strata are characterized by a brownish or yellowish matrix which indicate the presence of hematite and limonite. These are stronger and show less effect of solution.

The dense, massive limestones and dolomites are strong rocks except where they are weakened locally by closely-spaced fractures or joints. Only a small amount of leaching is detectable in these beds and this is usually confined to joints and fracture planes near the ground surface.

A thin argillite layer; containing sandstone lenses and clay seams and called the "GA" bed, is present throughout the area of the site and provides a useful barrier to vertical flow, a feature which has been of considerable importance in the design of the power development.

Joints are plentiful, especially those parallel to the abundant, nearly horizontal bedding planes. Steeply dipping joints, nearly normal to the bedding, mostly strike southeast or southwest. Although the majority of the joints appear to be tight, many subsurface drainage paths and solution openings have developed along joint planes and at the intersection of joints. No faults have been identified on the ground but photo-geological studies revealed many linear features, some of which might be caused by faults. However, uniformity of dip of the bedding and the lack of any evidence of abrupt local discordances suggests that faults, if present, are of a very minor nature.

CURTAIN GROUTING

In January, 1960, when the decision was made to proceed with construction of the station, it was recognized that a considerable amount of grouting along the extensive dike system would probably be necessary for the following reasons.

1. A cutoff beneath the dikes might be required to prevent piping at the downstream toe and erosion of earthfill at the bedrock contact.

2. Due to the presence of many subsurface drainage paths and solution openings a large amount of seepage from the reservoir might be expected. While considerable drainage now occurs through subsurface passages, it is probable that this would be augmented due not only to the increased head after impounding but also to the submergence of a large number of sinkholes which will provide additional inlets to the subsurface drainage system.

Detailed investigations conducted both prior to and since commencement of construction have indicated the nature and extent of aquifers and aquicludes which govern the water transmitting characteristics of the bedrock.[2] A number of artesian aquifiers underlie the area and these have indicated slight but very significant differences in piezometric pressure. Local rainfall and snowmelt contribute to the upper artesian horizons which discharge from springs located along the toe of the escarpment. The lower artesian horizons show higher piezometric levels than the upper aquifers which indicates that their points of recharge are at higher elevations and that points of pressure relief, if they exist, are at remote distances. A typical section showing a succession of aquifers and aquicludes may be seen in Fig. 3.

The above-mentioned investigations indicated beyond a doubt that a grout cutoff should be installed to ensure stability and safety of the dikes. The problem of determining the extent of this grouting could be attacked by conventional methods. On the other hand, the determination of the amount of grouting required to reduce the volume of seepage from the reservoir to acceptable proportions was not straightforward. There appeared to be no established method of analysis which might indicate the economic limit of grouting.

At the outset, it was obvious that to carry the grout curtain far beyond the system of major dikes would make the project uneconomic. The extent of dikes and size of flooded area may be seen on Fig. 2. For the major part of the 2,400 square mile reservoir, however, the Saskatchewan River system is to be raised less than 10 ft. and, therefore, it is considered that the small increase in gradient will not cause an appreciable rise in seepage volume. In the lower end of the reservoir where it is necessary to construct dikes, the gradient will be much higher and, at the junction of the highest dikes and intake structure, the average gradient will reach a figure of approximately 0.25.

Consideration was given to the execution of a minimum program of grouting with provision for carrying out additional work as it might be indicated after impounding of the reservoir. This represented considerable risk, however, since the difficulties of grouting open channels in the bedrock would become more pronounced with increased gradients, and the act of drawing down the reservoir to perform remedial work would involve very large losses in revenue due to severely curtailed energy production from the generating station.

With these considerations in mind, and having already reached a decision to construct a grout curtain of nominal depth throughout the length of major dikes, an extension in depth was designed to tie in the grout membrane to some of the most effective aquicludes. The "GA" bed previously mentioned was found to be one of the best strata for this purpose and the grout curtain was extended at least to this horizon at about EL 730, throughout the lengths of dikes Nos. 1 North and 1 South.

The intake, penstocks, and powerhouse are located near the bottom of the escarpment at the eastern end of the reservoir and are founded below the level of the "GA" stratum as seen on Fig. 4. Although the headpond lies entirely above this horizon, the steepest gradient will be in this area as the full head of the plant is developed over a dimension of a few hundred feet from headpond to tailrace. Furthermore, the pressure in the artesian aquifers below the "GA" will undoubtedly increase somewhat due to impounding in the upper reservoir. Therefore, since the seepage from

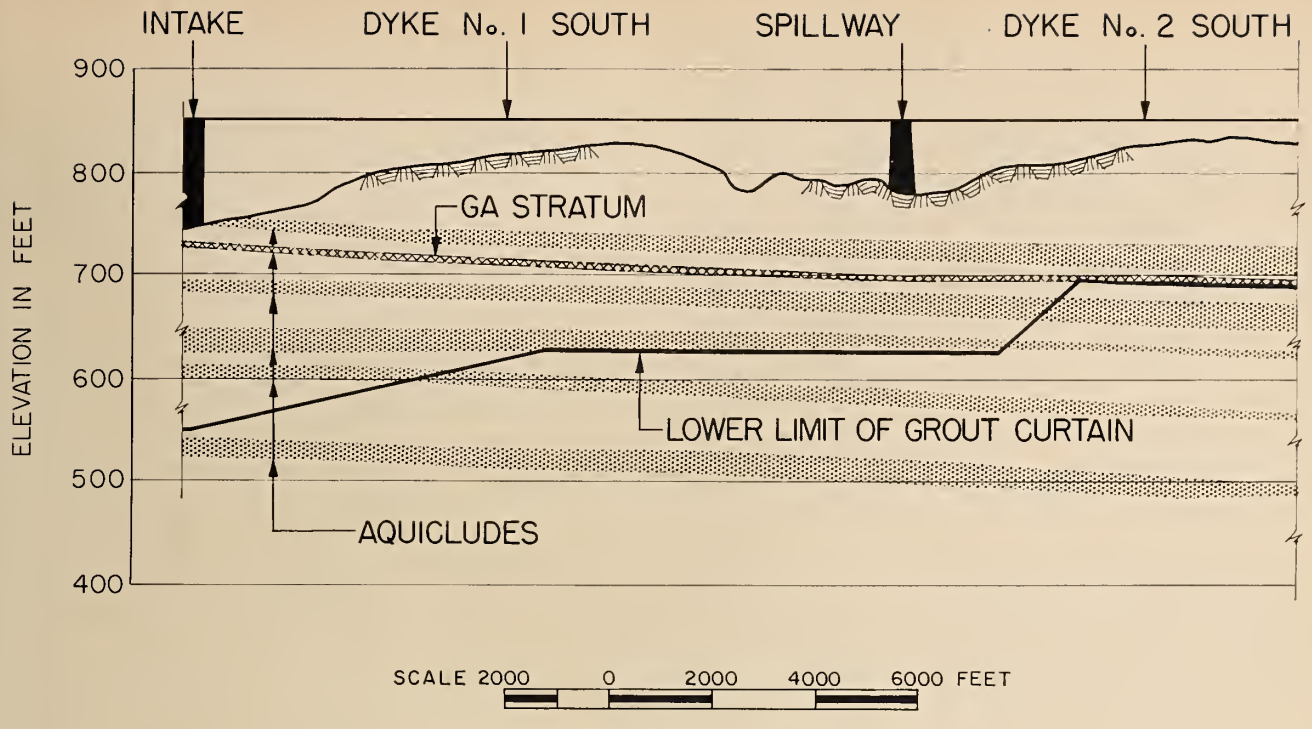


FIG. 3

these strata will tend to be greater in the powerhouse area than at present, the grout curtain has been carried down to about elevation 550. This is 180 ft. under the "GA" and well below the draft tube and tailrace levels.

Toward the western extremities of the major dikes the land is higher and a number of extensive aquicludes overlie the "GA". Here, as a measure of economy, the grout curtain has been terminated at levels above that of the "GA". It has also been carried through the high land between dikes and under the spillway to maintain a continuous membrane throughout the length of the major dike system. A partial profile of the grout curtain may be seen in Fig. 3.

This approach, of course, did not establish beforehand the optimum amount of grouting to limit the volume of seepage from the reservoir. However, since there is a need to determine the effectiveness of the program as well as to assemble data which will be of assistance on future projects, a program of observation and measurement was undertaken. A system of observation holes has been established at various locations along the dikes so that piezometric levels can be determined, both upstream and downstream, before, during and after grouting, and on the downstream side of the dikes during and following impounding. The program also includes periodic investigation of the velocity and direction of flow between aquifers, by means of a flowmeter which is suspended in the observation holes.

Correlation of all measurements is carried out regularly and the effect of the grout curtain construction along the intake and dikes No. 1 North and No. 1 South has already been observed in the rise of groundwater level in the forebay area. Should the expected gradients be not established across any section of the dikes it may be considered necessary to carry out further grouting work in that area.

A test grouting contract was arranged for the period August, 1960, to July, 1961, to develop procedures for future operations and to confirm cost estimates for this type of groating work. Satisfactory results were realized sufficiently early in the program that it was possible to have subsequent contracts under way before completion of the test work.

Approximately 18 miles of grout curtain up to 200 ft. in depth will be placed beneath and between the dikes and under the main hydraulic structures prior to the spring of 1964[3]. Generally, the curtain is a single line of pressure-grouted vertical holes on 5 ft. centres, although in some isolated areas of high grout take, the spacing has been reduced to 1.25 ft.

Drilling is accomplished using truck-mounted hydraulic type rigs to drill AX size holes (1-15/16 inch diameter) through nipples previously grouted into bedrock. The split spacing method is normally employed commencing at 80 ft. centres and proceeding until primary holes have been drilled and grouted on 20 ft. centres. Secondary holes reduce the spacing to 10 ft. and tertiary holes further reduce the spacing to 5 ft. Primary holes are advanced up to 200 ft. in depth, secondary holes to 130 ft. and teriaries to 65 ft.

Grouting is advanced vertically by zones, using packers, with all work in the upper zone being completed within the section of the contract before proceeding into the next lower zone. All surface zone grouting is done during the frost-free period. Grouting pressures employed are flexible but limited to amounts that will not result in uplift, viz: zone 1, 0-20 ft.—maximum 10 p.s.i.; zone 2, 20-65 ft.—maximum 30 p.s.i.; zone 3, 65-130 ft.—maximum 100 p.s.i.; zone 4, 130-200 ft.—maximum 200 p.s.i.

Twelve grout mixes are used on the work, the selection being dependent upon the results of pressure tests conducted on each section of hole when drilling is completed. A summary of the composition of the various grout mixes is shown in Table 2.

Effectiveness of the grouting is checked by means of NX diamond drill holes which are inclined and oriented to penetrate areas of high grout absorption or formations which were difficult to grout.

TABLE 2

Grout Mixes

Mix No.	*Cu. Ft. Water*	*Sacks Cement*	*Cu. Ft. Clay*	*Cu. Ft. Sand*	*Lbs. Bento-nite*	*Lbs.* CaCl2*	*Flowcone Reading*
4–1	16	4					
3–1	12	4					
2–1	8	4					
1–1	4	4					
0.6–1	2.4	4					
"B"	4	4		4	8		19
"C"	5.5	4		8	16		20
"D"	6.75	4		12	24		21
"E"	4.25	4	4			8	19
"F"	4	4	4	4		8	19
"G"	6.5	4	4	8		8	20
"H"	8	4	4	12		8	21

* CaCl2 is used only during winter conditions.

Table 3 shows the total quantities of grout hole drilling in overburden and bedrock and the volumes of material injected under contracts for curtain grouting that are complete or under way to December 31, 1962.

TREATMENT OF SINKHOLES

Numerous sinkholes and solution channels, many of which exhibit signs of present activity, lie within close proximity of the dykes and other structures. Remedial measures have been applied to all sinkholes under structures and within 100 ft. of the wet toe of dikes and in the immediate forebay area, as a further means of protecting dikes and other structures and of reducing seepage from the reservoir. Sinkholes or solution channels in these areas were excavated and backfilled either with concrete or with a granular filter and compacted till, depending upon the nature of the cavity and the extent of overburden in the area. One of the largest sinkholes occurred under the intake structure (Figs. 6 and 7). Here a total of 5,500 cu. yd. of decomposed limestone was excavated and backfilled with low strength concrete.

CURTAIN GROUTING FOR UNWATERING

The powerhouse excavation extends down through a zone of fragmental dolomite which was considered to be subject to wash from water under artesian pressure. To avoid the possibility that loose material would be washed out by water from beneath the more massive beds and thereby weaken the penstock and intake foundations, a grouted cutoff in the form of a horseshoe was provided to encircle these structures and the powerhouse, with the open end facing downstream. Three lines of holes were drilled and grouted through the fragmental areas with holes offset 2½ ft. in each direction, and one line of holes was extended further to a level 30 ft. below the base of the excavation. The progressive method of grouting was employed using a multiple hookup involving a six-element discharge manifold between the delivery lines and the header. The extent of drilling and volumes of solids injected in this cutoff are listed in Table 3.

CONSOLIDATION GROUTING

A program of grouting to consolidate fragmented and broken strata which underlie the foundations for the intake structure, wingwalls, penstocks and powerhouse is well advanced. Holes on 10 ft. and 20 ft. centres have been drilled to a maximum depth of 85 ft. beneath the wingwalls and intake structure. Similar treatment, generally to the same level, is under way in the penstock area and this will be followed in the powerhouse area with vertical and angle holes on 20 ft. centres to a depth of approximately 30 ft.

Consolidation grouting holes are pressure washed to obtain connections between the holes. Multiple grout hookups are employed where water and grout connections between adjacent patterns of holes are developed. Progress to December 31, 1962, on consolidation grouting is shown in Table 3.

STABILITY OF INTAKE STRUCTURE

A section through the intake, penstocks, powerhouse and their foundations is shown on Fig. 4. Although the level of the rock surface at the intake location was at approximately elevation 742, it may be seen that

FIG. 4

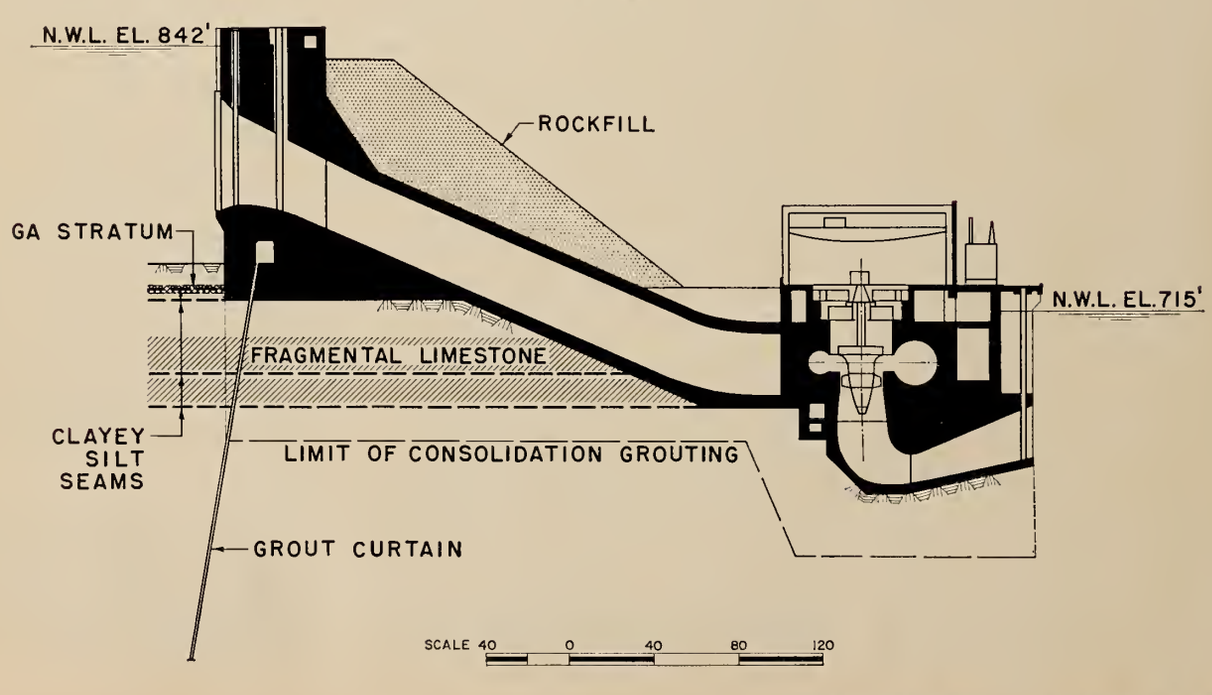


TABLE 3

Grouting Progress to December 31, 1962

Item	Unit	Curtain				For Unwatering	Consolidation
		Contract No. 1	Contract No. 2	Contract No. 3	Contract No. 3A		
Overburden drilling	Lin. Ft.	Nil	35,466	61,973	86,270	15,324	80
Rock drilling	Lin. Ft.	202,436	387,394	827,737	51,258	90,526	63,202
Cement	Cu. Ft.	178,933	390,093	715,925	51,161	92,041	22,300
Sand	Cu. Ft.	27,970	41,442	69,915	5,223	10,016	2,111
Clay	Cu. Ft.	6,742	15,182	20,864	1,691	4,574	Nil
Bentonite	Cu. Ft.	1,074	2,866	3,619	251	—	98
Calcium Chloride	Cu. Ft.	1,216	2,024	2,788	35	562	67
Grout: Rock Ratio	Cu. Ft./ Lin. Ft.	1.06	1.17	0.98	1.14	1.18	0.39

the excavation required to locate penstocks as shown would tend to reduce the support at the downstream toe of the intake structure if it was founded near the rock surface. Because of the nature of the underlying foundation rock, it was not considered advisable to apply concentrated loads in certain areas and therefore it was proposed to place the base of the intake at elevation 721.

The mass concrete wingwalls located at the junctions of dikes and intake structure could be founded at a higher level but there was some concern about the possibility of encountering continuous clay seams in the vicinity of the 2 to 3 ft. thick "GA" stratum at about elevation 730. Therefore, it was decided to delay the decision as to the base level of the wingwalls until there was an opportunity to inspect a part of the intake and penstock excavation. Consideration had been given to the drilling of calyx holes previously but it was felt that these might cave in the fragmental zones and not only disrupt the operation, but be dangerous to personnel who might attempt inspection if they were drilled successfully.

The excavations revealed clayey silt layers at elevations 279, 721, 688 and 670, some of which had not been determined as extensive strata during careful drilling at the site. As some of the layers were located at levels below elevation 721, there was then concern not only for the stability of the wingwalls, but for the intake structure itself. The clayey silt layers varied in thickness from a fraction of an inch to 8 in. and, although it was not believed that any serious total or differential settlements would occur, it was felt that the shear values in the unconsolidated materials would be insufficient to ensure a reasonable factor of safety against sliding for a major hydraulic structure. The fact that the rock surface falls away in the downstream direction serves to aggravate this problem.

Samples of the clayey silts obtained from the excavated faces were found to contain about 20% clay. Consolidation tests indicated a preconsolidation load which confirmed the opinion that these materials had been subjected to pressures during glaciation. Analysis by means of consolidated triaxial compression tests on the remolded material, led to the conclusion that a conservative value for the effective angle of shear resistance would be 29 degrees. Using these figures, it was determined that additional measures would be required to stabilize the intake and wingwall foundations against sliding failures. Methods of obtaining stability were studied and these included extension of the concrete structure to greater depth, measures for increasing the normal load on planes with low shearing resistance, provision of rock anchors, and construction of shear keys in the rock.

The main alternatives considered are shown on Fig. 5 and are described here below:

FIG. 5

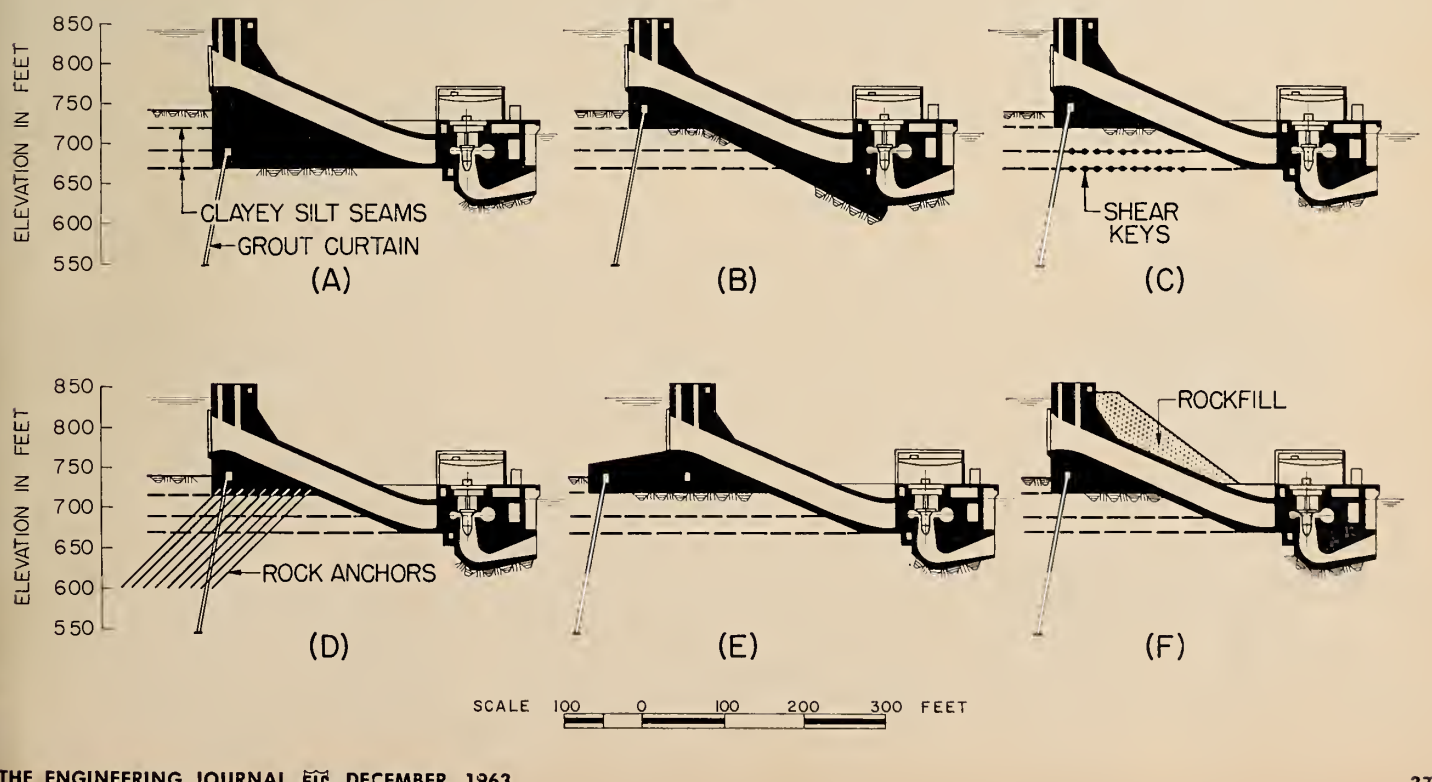


FIG. 6

FIG. 7

(a)—Founding intake at elevation 670

Here the base is sufficiently deep that the horizontal reaction from the foundation rock downstream would resist any movement along planes of low shearing retsistance at greater depth. It was estimated that the additional cost of this alternative would be $3½ million and that the delay in completion of the construction would amount to seven months.

(b)—Reinforced concrete strut

This method also carries the load to sound rock at greater depth. The added cost of this scheme would be about $2½ million and it would be necessary to extend the construction schedule by about nine months.

(c)—Shear keys in foundation

This alternative would involve the construction of concrete shear keys along each clayey silt layer in the foundation. Care would be required to ensure that all layers down to about elevation 670 were recognized and treated. The estimated cost of this scheme is in the order of $1 million and the delay in construction would be negligible.

(d)—Post-tensioned sloping anchors

This scheme provides for installation of post-tensioned rock anchors extending some hundred feet in depth. Individual anchor capacities would range from 200 to 500 kips. This method provides additional normal load on the planes with low shearing resistance and also horizontal reaction to the hydrostatic loading on the structure. The estimated cost of this alternative is $2½ million and the delay to construction would amount to about seven months.

(e)—Upstream extension of intake structure

The extension is intended to provide additional normal load on planes with low shearing resistance, by utilizing the added weight of concrete and of the water above it. This scheme was estimated to cost an additional $2 million and to delay completion of construction for about 2½ months.

(f)—Addition of rockfill

Loading with rockfill also provides for increasing the normal load on planes with low shearing resistance in the foundation. The additional cost was estimated to be $700,000 and the delay in construction was considered to be negligible.

The alternative involving the placement of rockfill offered the advantage of lowest cost, together with a minimum of interference with proposed construction operations. Furthermore, it would offer protection against sliding at any unidentified silt and clay layers of similar nature at greater depth. Therefore, this method of stabilization was adopted.

DISCUSSION

As outlined above, the solution channels and silt and clay seams often associated with limestones and dolomites have presented major problems at Grand Rapids.

In adopting measures for the reduction of seepage from the reservoir, the principal approach has been one of containing the groundwater by constructing a vertical grout cutoff to relatively impervious horizons which occur between rock strata. A secondary measure has been the closing of a large number of sinkholes which would otherwise be potential inlets to the underground drainage system.

The success of the program will depend largely on the efficiency of the grout curtain and the accuracy of assessment of the natural barriers to vertical flow in the rock. It is believed that the geological investigations and the pressure and flow measurements performed to date have provided the basis of an effective design and that further measurement and interpretation during construction and impounding may supply useful information for the refinement of this design and the repair of any major gaps in the grout curtain.

Construction of hydraulic structures on foundations containing silt and clay seams has been a subject of concern in recent years, especially since the presence of these unconsolidated materials is not always recognized before or during construction. The results of diamond core drilling at Grand Rapids bears out the belief that this method of investigation, alone, may not supply sufficient evidence of the presence or absence of continuous silt or clay seams in limestones and dolomites. In the case of the intake design, the use of rockfill to increase the normal load on planes of low shearing resistance has provided an economical means of stabilizing the foundations.

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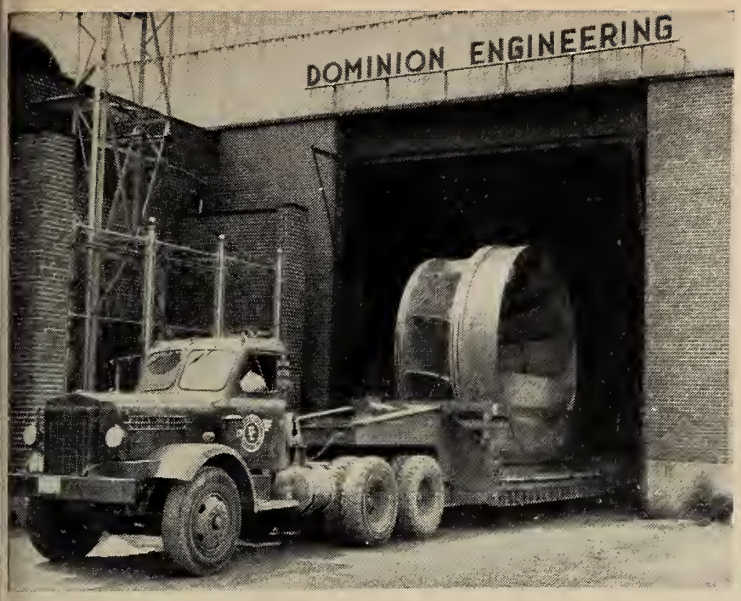

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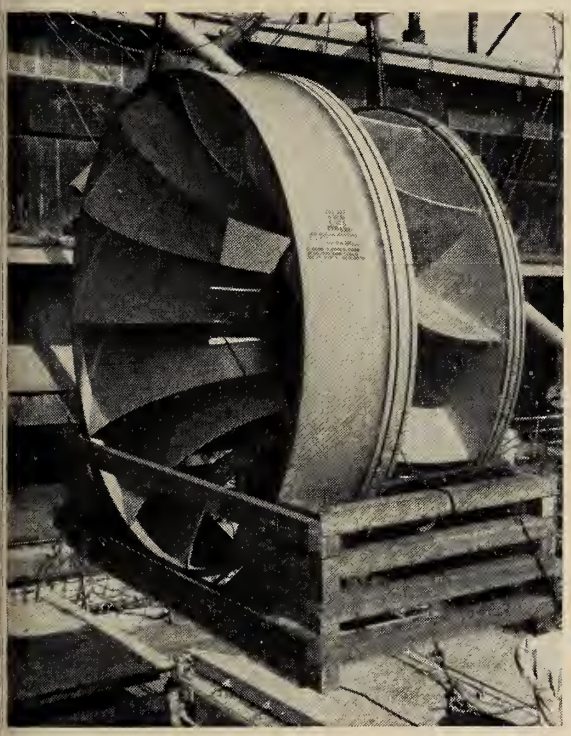

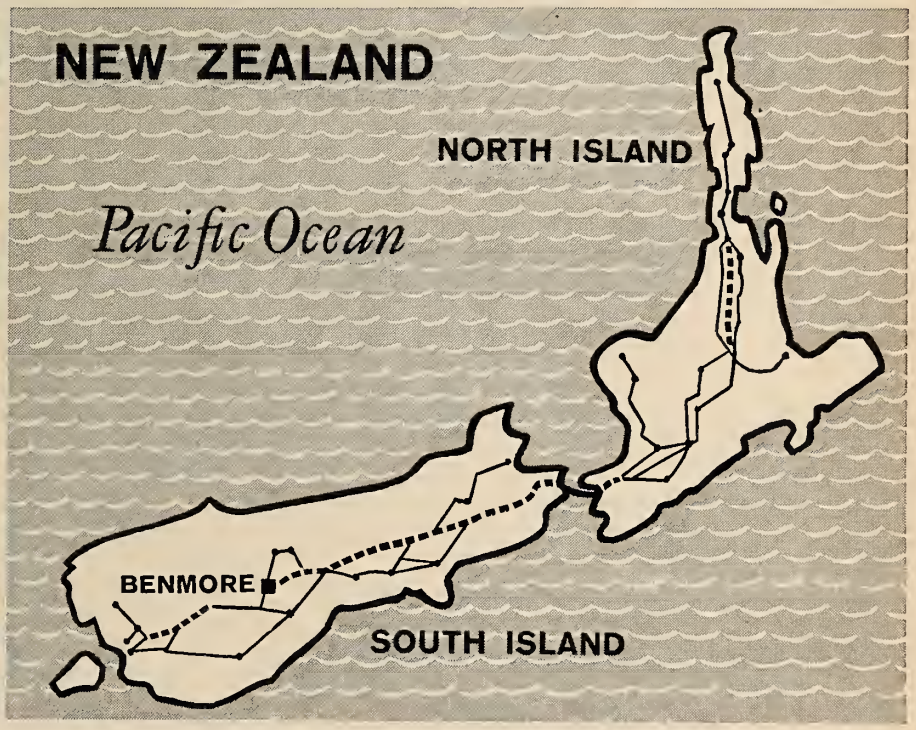

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Discussion

FOUNDATION ASPECTS OF THE RAINY LAKE CAUSEWAY

M. A. J. Matich, M.E.I.C.
Vice-President and Chief Engineer
Geocon Limited, Montreal

Per F. Andersen, M.E.I.C.
Project Engineer
Foundation of Canada
Engineering Corporation Limited

A. Rutka, M.E.I.C.
Materials and Research Engineer
Ontario Department of Highways

The Engineering Journal
November, 1963, page 23

Discussion by

A. M. Toye
Bridge Engineer
Department of Highways, Ontario

The Rainy Lake Causeway was a project of intense interest to the Department of Highways, Ontario, involving many problems not ordinarily met with in the Department. I am not a soils engineer myself and will not comment on the technical aspects of the foundation investigation, but will confine my remarks to the studies made on ice pressure.

This project presented an unusual opportunity to investigate actual pressures and movements occurring in a relatively large ice sheet and full advantage was taken of the opportunity by the consulting engineers responsible for the design of the causeway. I believe the studies were of considerable value and have contributed to our knowledge of this little understood subject.

An interesting point which was not covered in the paper is that the studies led to conclusions at variance with generally accepted theories about ice pressures. These theories are that ice acts like any other solid, expanding and contracting with temperature changes. When ice is formed at 32° F. it has virtually no internal stress. If it is cooled below this it contracts, cracks form, and water from below enters the cracks and freezes. A rise in temperature then results in expansion of the ice and consequent compressive stresses because of the added volume so that the general effect of varying temperatures would be expansion of the ice sheet as a whole and sufficient compression in a large sheet to cause ridges. The Rainy Lake studies however seemed to indicate that the ice sheet was under compression from the time it was formed. There were contraction cracks but they did not extend through the ice sheet and did not fill with water. On the other hand the ice sheet expanded during a drop in temperature and obviously had compressive stresses in it sufficient to overcome the normal contraction accompanying a drop in temperature.

Another point of interest to bridge designers deals with the actual effect of ice pressures on bridge piers. It is accepted that ice pressure against a structure can be relieved by making the structure flexible but no figures have ever been produced to say how flexible it should be, i.e. how much movement should be allowed. It has been thought that any movement of the pier would relieve the pressure to a degree. The study demonstrated that this is not the case. To relieve the pressure on a structure it must be flexible enough to move a distance equal to the actual movement of the ice. Otherwise it will still be subjected to full ice pressure.

Author's Reply

The two points made by Mr. Toye are the most important conclusions of general interest which came out of the investigation of ice conditions on Rainy Lake.

Observations of ice formation near the bridge site seemed to indicate that the origin of ice pressure has not yet been adequately explained.

Firstly we observed early formation of pressure ridges, usually within one or two days of ice cover formation. The ridge formation would often follow a period of falling air temperature and it would always precede the formation of cracks in the ice sheet.

Secondly we found that the cracks, which would develop in the ice sheet during periods of severe frost, did not extend below the upper third of the ice sheet. Inspecting the cracks near the bridge site we were not able to observe entry of water nor locate any cracks which appeared to be frozen over.

These and other observations have lead us to conclude that compressive stresses in an enclosed ice sheet result from the freezing process itself and to believe that they are caused by secondary freezing of water which is trapped between the ice crystals of the initial freezing process. This theory has satisfied all our ice observations.

ETUDES SUR DIFFERENTS GENRES DE GLISSIERES DE SECURITE BOULEVARD METROPOLITAN MONTREAL

Gilles G. Hénault
Chef Du Service Des Routes
The Warnock Hersey Company Limited
Montreal

The Engineering Journal
December, 1963, page 21

Discussion par

J. Hode Keyser
Ingénieur en chef,
Laboratoire de Contrôle et Recherche
Cité de Montréal

Je tiens à féliciter M. Gilles Hénault et son équipe de cette excellente étude, ainsi que les dirigeants du Ministère de la Voirie qui ont initié le projet.

A mon avis, cette étude, en plus d'avoir permis de déterminer le comportement relatif de différents genres de glissières de sécurité, souligne également deux faits:

a) L'importance de s'assurer avant la construction, de la conformité des structures et des matériaux;

b) La valeur des essais pratiques.

Un parapet doit normalement être construit pour assurer la sécurité du voyageur et si possible améliorer l'apparence générale de la voie.

Dans beaucoup de cas, le parapet améliore l'apparence générale de la voie, mais contribue peu à la sécurité du voyageur et même, à cause de son apparence robuste, établir dans l'esprit de l'automobiliste, une fausse impression de sécurité. L'augmentation intense en nombre, en poids et en vitesse des véhicules, exigent de plus en plus des essais routiers afin de vérifier la conformité des structures et des matériaux utilisés.

Je réitère donc mes félicitations aux promoteurs et exécutants de ce projet et je souhaite qu'on recourt aussi souvent que nécessaire aux essais pratiques dans la solution des problèmes routiers.

Discussion par

Jean Granger
Ecole Polytechnique
Université de Montreal

Comme nous avons pu nous en rendre compte, le problème exposé par M. Hénault est un probléme délicat.

Gràce a son travail ingénieux, M. Hénault a su établir des conditions d'analyse qui lui ont permis de tirer les conclusions qu'il vient de présenter.

Permettez-moi donc de le féliciter en votre nom et au mien pour son intéressant travail.

J'aimerais aussi ajouter un mot de félicitations aux autorités du Ministère de la Voirie Provinciale, pour avoir bien voulu rendre public les résultats de cette étude. A cause de ma déformation professionalle de professeur, je m'empresserai d'ajouter que cette étude, si bien commencée, mériterait d'être poussée plus avant car elle est d'une grande importance au point de vue sécurité routière.

Dans sa conférence, M. Hénault a mentionné l'aspect psychologique des glissières et j'aimerais souligner ce point de vue qui est de plus applicable à tous les systèmes de sécurité.

En effet une glissière robuste mais d'apparence déplaisante aurait comme effet d'éloigner les véhicules du parapet réduisant ainsi la largeur carossable de la chaussée, ce qui pourrait se traduire par une diminution de capacité de la route. Ainsi donc, dans le choix d'un système de sécurité, il serait bon de considérer à la fois, robustesse et apparence, ainsi que l'a fait M. Hénault.

Je terminerai ces quelques commentaires

(Continued on page 80)

Sixty tons of Steel-strapped wallboard on CNR flatcar equipped with permanent-end bulkheads. Acme heavy-duty strap is used.

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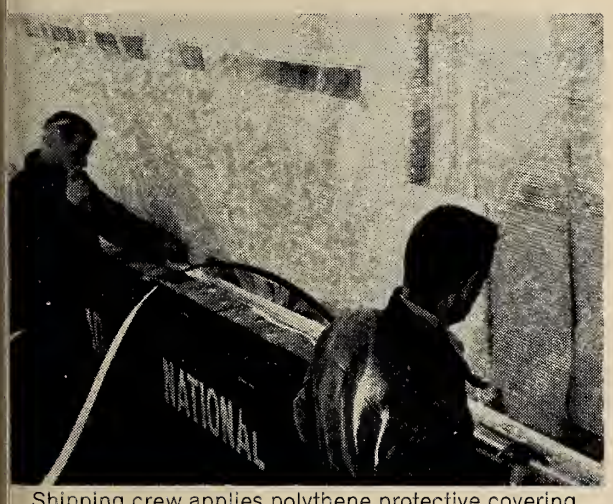

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Branch News

BELLEVILLE
M. H. McQueen, M.E.I.C.

On October 7, the Aluminum Company of Canada, Kingston Works, was host to a plant tour conducted by the Branch. L. Bandiera, Superintendent of Engineering, welcomed members and guests. An interesting description of the Works, illustrated by slides was presented by J. Noel. Alcan is the largest subsidiary of Aluminum Limited, a Canadian Corporation. It includes one of the world's largest aluminum industries, operating mines, smelters, fabricating plants, power installations, and transportation facilities. Sales facilities are found in 100 countries. The Kingston Works consists of a Foil Mill, a Sheet Mill, and an Extrusion Mill, together with a large laboratory building where research is conducted in the fabrication of aluminum. The laboratory is operated by Aluminum Laboratories Limited. Following Mr. Noel's talk, members were taken on a tour through the Sheet Mill. Here they saw a standard ingot, six feet long, 32 inches wide and nine inches thick, weighing one ton, rolled under high pressure in a hot-mill, emerge as a slab some 80 feet long and ½ inch thick. The slab was then rolled on a four-high cold-rolling mill where it was reduced in thickness to as little as fifteen one-thousandths of an inch. The original six foot ingot became a strip of aluminum about 400 ft. long formed into a coil for easy handling.

A visit to the Extrusion Mill followed. Here members saw a cylindrical ingot of aluminum preheated to a temperature of between 600 F and 900 F, then forced through a shaped opening in a steel die to make a variety of products such as aluminum trim, structural shapes, quarter-inch aluminum tubing for refrigerators and pipe up to one foot in diameter for use in oil fields.

The Foil Mill proved of great interest. This mill contains five rolling mills including the two largest in Canada, an electric annealing furnace, separators, shears and slitters. The aluminum used for foil stock comes to the mill from the Sheet Mill as coils of .021-inch thick aluminum sheet. This is finally rolled into a variety of thicknesses from .006 to .00025 inches. Foil has many applications in the packaging industry, and is a popular item in many Canadian homes.

A refreshment period followed the tour during which questions were asked regarding the various operations of the Works.

CORNWALL
G. Peter Schwarzkopf, M.E.I.C.

Guest speaker at the Branch's October 3 meeting held at the Parkway Hotel, was L. W. Gold, head of the Snow and Ice Section, Building Research Division of the National Research Council. Mr. Gold spoke on the "Properties of Ice, using a film showing ice testing in the Research Council's 'cold room', and pointed out the practical applications of this research. A question period followed the speech.

HALIFAX
D. C. Johnson

A two-day refresher program, sponsored by the Branch and the Nova Scotia Technical College, was held September 5 and 6 at the College. Courses offered were: Soil Mechanics for Civils; Analog Computers for Electricals and Mechanical Measurements for Mechanicals. The program was organized by Dr. G. W. Holbrook, President of the College, and Frank J. MacDonald, Chairman of the Branch's Program Committee. Attendance for the courses was 44.

An evening seminar on "Post-graduate Training for the Modern Engineer" was held at the end of the first day's activities. This seminar was open to the membership at large. The panel consisted of J. B. Tennan, Chairman of this Branch and Registrar of NSTC; Dr. G. H. Burchill, Dean of Undergraduate Studies, NSTC; W. A. Logan, General Manager, Maritime Telegraph & Telephone Co. Ltd.; C. F. MacNeil, Manager, Canadian Westinghouse Co. Ltd., and N. D. Weiner, Superintendent of Combustion & Utilities, DOSCO, Sydney, N.S. Attendance at this seminar was 95.

KITCHENER
W. N. Meilke, M.E.I.C.

The Branch was host to the Kitchener Chapter APEO at their October 9 meeting. Dr. D. T. Wright, M.E.I.C., Dean of Engineering, University of Waterloo spoke on "Engineering Education in Africa". Dr. Wright was a member of the delegation from Canadian universities which studied education in Africa. Dr. Wright had an excellent series of photographs showing the various universities functioning and others under construction in East and West Africa. The economic and political conditions of the continent and their impact on education was also given a great deal of attention by Dr. Wright in his talk. As emerging countries, they are aware of their need to 'catch up' to other countries in the technical field, and are doing a good basic job in their attempts. However, help is still needed from other countries in the form of teachers. English and French are the languages of the advanced students, so, people from Canada who could offer assistance, would have no difficulties adjusting to their program. Dr. Wright believes that there exists excellent potential for trade and technical exchange between Canada and Africa since Canada, when making trade overtures, would not be viewed with political suspicion as are some other countries. Secondary manufacturing of African resources by Africans for Africans, which is not developed at all, would offer great opportunities to technical personnel. Ideas and products must be adapted, however, to the African need and climate. Dr. Wright was thanked by C. G. E. Downing. The meeting was then broken down into informal discussion groups.

LAKEHEAD
W. Buryniuk, M.E.I.C.

The October 17 meeting of the Branch took the form of a film presentation and a talk by the Institute's Manager of Technical Services, Mr. C. G. Kingsmill.

SAGUENAY
P. R. Brais, M.E.I.C.

The Saguenay Branch enjoyed two highly successful meetings in October. On the first of the month, David G. Hobart, Sales Engineer with Honeywell Corporation, Montreal, outlined the instrumentation in the new Price Brothers Kenogami kraft mill. The instrumentation of the mill is complex and complete, and contains several innovations, one of which is a digital computer. A visit to the mill was held the week after the meeting.

On October 29, H. E. Brooker discussed "A Fair Day's Work." He said there is a difference between a full day's work and a fair day's work. Mr. Brooker outlined a number of factors and influences which contribute to the difference between a "full day's work," and a "fair day's work."

(Continued on page 78)

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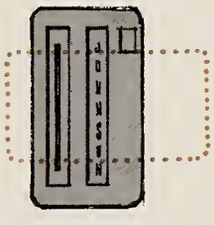

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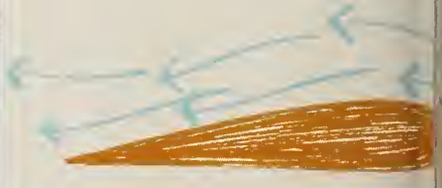
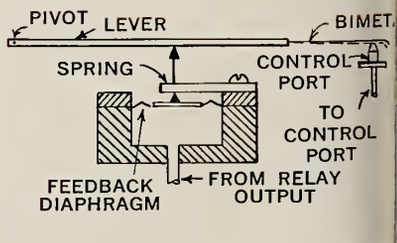


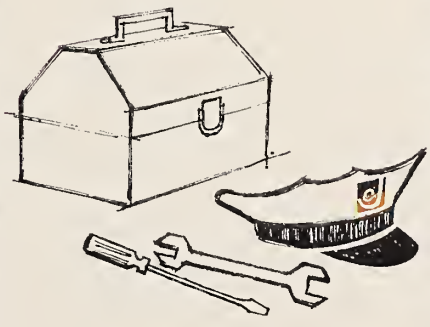


Acts Twice as Fast as any Other Pneumatic Thermostat — applying advanced principles of aerodynamics, Johnson developed new, streamlined air flow patterns for the Series T-4000. Exclusive Aerodynamic cover and body designs allow room air to circulate freely around a highly sensitive, miniature bimetal sensing element. The small mass of the thermostat body and saddle assembly also increases sensitivity. Result: unprecedented speed of response to changes in room temperature, with corrective action starting almost simultaneously with changes in demand!

Self-Adjusting for Greater Stability, Accuracy — a motion balance feedback system, as originated by Johnson for its famous "master-submaster" controllers, constantly compares and balances the thermostat output with incoming demand signals. It permits the use of a tiny cantilevered sensing element for fastest response. It assures precise, stable valve and damper operation and minimizes "hunting" and system cycling. Here, indeed, is the most technically perfect thermostat in the world!

INSTALLATION AND UPKEEP:

NEW STANDARDS OF ECONOMY



Plug-in Mounting—two flexible connectors simply plug in and secure to the pipehead with a twist. Cover snaps into place and is secured with two lock screws. Removal for servicing is equally easy. An exclusive built-in check valve prevents escape of control system air when the thermostat is removed. A special shipping cover protects the unit during construction.

Rugged, Tamperproof — factory calibration cuts installation time and errors. And the T-4000 is built to hold its set calibration regardless of shipping and rough handling. There are no weak extension springs or pivots to cause trouble. The only truly precision built thermostat of its kind, the T-4000 is made for trouble-free, lifetime service. And its tough construction and unique air flow patterns make tampering through the cover openings virtually impossible.

Maximum Adaptability — all models convert readily from direct to reverse acting, and sensitivity and throttling range are easily adjusted to match any condition encountered. Special adapter plates permit you to replace any type or make thermostat with the new T-4000.

OVER 15 MILLION TEST-HOURS PROVED THE SUPERIORITY OF THE NEW T-4000!

Actual installations in schools, offices, hospitals, factories, and other commercial and public buildings from coast to coast proved the advantages of the T-4000 Pneumatic Thermostat. Constant checking and refining over a period of more than 15 million thermostat hours of on-the-job operation have produced a thermostat that is unequalled for performance, flexibility, and economy.

MORE OUTSTANDING NEW IDEAS FROM JOHNSON...WORLD LEADER IN AUTOMATIC CONTROL SYSTEMS

PISTON TOP VALVE OPERATORS — Now the same piston-type mechanism that powers famous Johnson damper operators has been adapted for Johnson steam and water valves. This is the piston operator that has never been equalled for long life and rugged operation. It provides Johnson valves with higher lift and greater capacity, assures smooth, precise control of steam or water flow. It is ideal for ½" to 1¼" two-way and three-way valves for unit ventilators, radiators, convectors, fan coil units, and induction units. Exposed or enclosed top. A miniature oval top operator is supplied for use in confined spaces.

Valve with Exposed Top Operator

Valve with Enclosed Top Operator

Valve with Miniature Oval Top Operator

VALVE TOP THERMOSTAT — Here's a valve operator with integral thermostat that provides proportional flow control through fin-tube coils in heating or air conditioning installations. Responds fast, controls accurately! Made in both single and two-temperature models, with built-in or remote adjusting dial.

JOHNSON CONTROL

AUTOMATIC CONTROL SYSTEMS

Ask your local Johnson branch for complete details, or write to Johnson Controls Ltd., 120 Bermondsey Road, Toronto 16, Ontario. Direct Branch Offices in All Principal Cities.

Pub. No. 1048-C

Zinc metallized box beam (8′ x 11′ x 80′) for the new Richelieu River Bridge—part of the Trans-Canada Highway—near Beloeil, Que.

Box beams on new Canadian bridge protected by metallizing with zinc

From two to ten thou of molten zinc was sprayed right onto these vital members for the new Richelieu River Bridge. The metallizing process provides a continuous adherent coating of zinc to protect the steel from the ravages of rust. Metallizing with zinc is a flexible process—it can be done in the fabricating shop or on the site—thickness can be controlled to suit protection requirements. By reducing maintenance and repair costs due to corrosion, *zinc coatings provide savings* that can run into thousands of dollars annually for many types of large steel structures. To get optimum service from any structure exposed to industrial, marine or rural atmospheres, combine the strength, versatility and low cost of steel with the protection of a zinc coating.

Consulting Engineers for the Richelieu River Bridge: Lalonde & Valois. Fabrication and Erection: Canada Iron Foundries, Limited, Structural Division. Metallizing Sub-Contractor: Lagendyk and Company Limited.

Write for information on metallizing to: Dept. SD-4

COMINCO

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED
630 Dorchester Blvd. W., Montreal 2, Que.

Metallizing a box beam for the Richelieu Bridge.

Canadian Engineering

Gilles E. Sarault Named World Fair Chief Engineer

Gilles E. Sarault of Quebec City, President of the Canadian Council of Professional Engineers, has been appointed Chief Engineer of the Canadian World Exhibition (Montreal 1967).

Mr. Sarault is immediate Past President of the Corporation of Professional Engineers of Quebec.

Mr. Sarault was born in Montreal, was educated at Mount St. Louis College, Montreal, and at McGill University where he graduated with a degree in electrical engineering in 1934.

He worked with Northern Electric for three years, the Canadian Broadcasting Corporation for five years, then joined the staff of Laval University where he rose to Head of the Department of Electrical Engineering. He now is a successful consulting engineer in the electrical and mechanical fields.

Active in community work Mr. Sarault was Chairman of the Conseil Central des Oeuvres, Dioces de Quebec, and is Past Governor of the Ontario-Quebec-Maritime District of the Kiwanis organization.

Hobbies include golf, fishing, hunting, gardening and snowshoeing.

Military Engineers Association Meets

The 18th Annual Meeting and Dinner of the Royal Canadian Electrical and Mechanical Engineers Corps Association was held October 26 at the R.C.E.M.E. School at Barriefield, Ont.

Col. K. R. Ward, Commandant of the School, arranged for the Conference and welcomed the delegates.

Institute President T. C. Higginson was the guest speaker at the Annual Dinner which was attended by 150 members and guests.

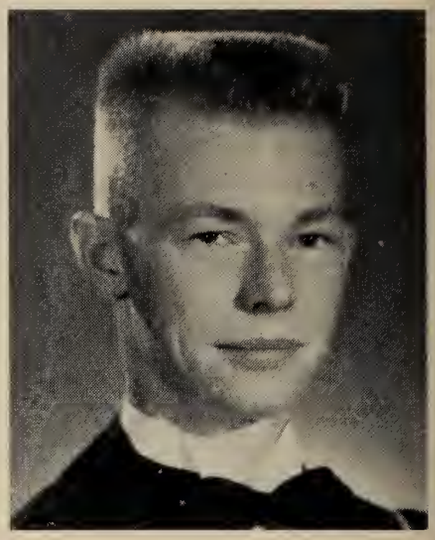
The Annual General meeting was attended by 75 members from across Canada. Col. A. Mendelsohn, CD, Director, Corps of Electrical and Mechanical Engineering, and Col. C. P. McPherson, Director of Militia and Cadets, addressed the meeting.

Five Canadian Engineering Companies Form New Group

Seventeen Canadian owner-engineers have formed a new group capable of offering a wide range of engineering services. Involved are five firms: General Engineering Company Limited of Toronto; Per Hall and Associates, Montreal; M. J. Seguin and Associates, Montreal; George Leroux and Associates, Montreal; and N. D. Lea and Associates Ltd., Vancouver.

The group is moulding a form of organizational structure designed to combine the advantages of both partnership and corporation, while discarding the weaknesses of each. Each firm will continue operating in its respective technical and geographical field, under the direction of local principals. Nationally and internationally the group will operate unitedly under the name, General Engineering Company Limited, providing a broadened range of services.

Ownership of the firm will always remain entirely in the hands of the engineers making the greatest technical contribution. Three senior principals were chosen from the initial twelve principals to act as a co-ordinator executive committee. They are: R. M. P. Hamilton, Chairman; Per Hall; and Norman D. Lea.



Stephen Nelson Memorial Scholarship Established

A scholarship has been established by the friends and classmates of Stephen Kenneth Nelson who lost his life while engaged in survey work in August, 1963. Mr. Nelson graduated in Geological Engineering from the University of British Columbia in May, 1963, and was to have returned for post-graduate work in the fall.

The scholarship pays tribute to his fine academic record and to his outstanding personal qualities. The fund is being raised by the G. M. Dawson Club, most of whose members are geology or mining students, with the help of the Department of Geology. It is hoped that $1,000 will be raised for a continuing annual scholarship which will be awarded on the recommendation of the

Meeting of the Executive Committee of the new Geco composed of the three Senior Principals, R. M. P. Hamilton, Chairman, Norman D. Lea, Vice-President, Per Hall, President

Department to a student entering his final year of Geological Engineering or Honours Geology whose over-all qualifications are considered to be the most outstanding.

Mr. Nelson was a scholar. He was also active in other university affairs, being immediate past-President of the G. M. Dawson Club. He lost his life in a plane accident while working with the Geological Survey of Canada.

Persons wishing to contribute to the scholarship fund may send a cheque to John Kerr, 1549 Western Crescent, Vancouver 8, B.C. The cheque should be payable to the University of British Columbia.

Telecommunications Film Now Available

A color movie film designed to inform students in high school and university of the scope of engineering in the Canadian telecommunications industry now is available. The film, titled "Challenge," is technical in nature but should have some general appeal.

"Challenge" is a 16 mm. film with a running time of 27½ minutes. Further information may be obtained from Northern Electric Company, Dept. 221, 1600 Dorchester Blvd. West, Montreal.

The film shows many aspects involved in a typical communications contract. This contract job is used as a vehicle to describe the many facets of engineering work in the industry. Initial sequences show the Systems man and his meetings with the customer and with other engineers. From here the film progresses through Design Control of the apparatus and planning the manufacturing and testing of typical components. Following sequences show the role of the Facilities Engineer, the Machine Designer, the Test Set Engineer and some of the equipment they have designed. The picture concludes with a recapitulation of the different fields of engineering in telecommunications and wire and cable manufacturing.

Significant Increases Shown In University Engineering Registration

Significant increases (see pages 50, 51 and 52) are shown in the enrolment of engineering students registered this year at Canadian universities.

The total number of students has increased nearly 2,000 from last year, and reverses a downward trend of several years; freshman registration shows a similar increase; post-graduate registration increased to 1,450 from 1,056.

Enrolment information was obtained by the Institute directly from registrars.

Following are some numerical highlights of this year's situation, as revealed by the E.I.C. survey:

Total undergraduate enrolment in Canadian engineering courses now stands at 16,364 compared with 14,390 last year.

The number of prospective graduates in the spring of 1964, making no allowance for wastage, is 2,342, an increase of 26.

Engineering freshmen numbered 4,968 in the autumn of 1963 compared with 4,547 the previous autumn.

There were 1,450 post-graduate students enrolled in the autumn of 1963 compared with 1,056 in the autumn of 1962.

Civil, electrical and mechanical engineering remain the most popular courses. Following are the estimates of the prospective 1964 graduates, with the previous year's estimates in brackets: Civil 611 (650); Electrical 608 (574); Mechanical 506 (505).

Readers will be able to make further detailed comparisons by study of the tables. If any questions should arise, E.I.C. Headquarters will gladly try to answer them.

Dr. J. B. Stirling, Hon. M.E.I.C. Honored by Queen's University

The almost-completed $2.8 million physics building on the Queen's University campus is to be named Stirling Hall in honor of Dr. J. B. Stirling, Hon. M.E.I.C., of Montreal, Chancellor of the University.

Dr. Stirling was President of the Engineering Institute of Canada in 1952, and in 1954 was awarded the Sir John Kennedy Medal of the E.I.C. in recognition of "outstanding service toward the development of Canada, to engineering science, and to the profession."

As Chairman of the Building Committee of the Queen's Board of Trustees for a number of years, Dr. Sterling has played a vital role in Queen's capital building program. The building is being named for Dr. Stirling in recognition of his long service to Queen's which dates from his graduation from two of her faculties, Arts in 1909, and Applied Science in 1911.

In 1951 he was elected president of the University's General Alumni Association by his fellow graduates of that year, and Queen's awarded him an honorary Doctor of Laws degree.

In 1955 Dr. Stirling received the Montreal Medal of the Alumni Association, the organization's highest award to "a maker of Queen's."

Nova Scotia Engineers To Hold Banquet And Dance

The Association of Professional Engineers of Nova Scotia (APENS) will hold a Banquet and Dance in the Commonwealth Room at the Nova Scotian Hotel, in Halifax, on January 17, 1964, following the Annual Business Meeting.

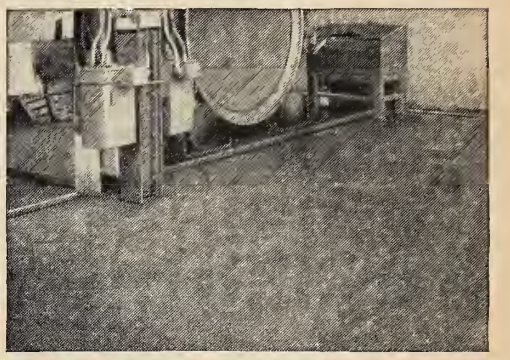
The ladies have again been invited to attend this portion of the Annual Meeting.

(Continued on page 76)

ROCK-HARD FREEZE-PROOF
CONCRETE
in hours!

Here's the perfect 'emergency' concrete:

CIMENT FONDU



Food Plant in full operation 24 hours after pouring Ciment Fondu concrete

This machinery foundation was taking its full load 10 hours after the concrete was placed

In one day, **CIMENT FONDU** is as hard as ordinary concrete in 28 days.

Wherever speed or special conditions are factors, specify **CIMENT FONDU.** Not only does it provide quick bearing strength, but it's also frost-proof within 24 hours and corrosion resistant overnight. Write for details.

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ALUMINOUS CEMENT

CIMENT FONDU LAFARGE (CANADA) LIMITED
150 Beaubien St. West, Montreal, Que.
611 King St. East, Toronto 2, Ont.

CIMENT FONDU LAFARGE CORPORATION
122 East 42nd Street, New York, N.Y.

REGISTRATION IN ENGINEERING AT CANADIAN UNIVERSITIES 1963-64

University	Year	General Course	Agricultural	Chemical	Civil	Electrical	Industrial	Geology and Mineralogy	Mechanical	Metallurgical	Mining	Engineering Physics	Surveying	Forest	Aeronautical	Total
Memorial	1st	96	...	....	....	....	...	...	....	...	...	...	...	...	...	96
	2nd	54	...	....	....	....	...	...	....	...	...	...	...	...	...	54
	3rd	53	...	....	....	....	...	...	....	...	...	...	...	...	...	53
Total		203	...	....	....	....	...	...	....	...	...	...	...	...	...	203
Dalhousie	1st	68	...	....	....	....	...	...	....	...	...	5	...	...	...	73
	2nd	78	...	....	....	....	...	...	....	...	...	5	...	...	...	83
	3rd	46	...	....	....	....	...	...	....	...	...	7	...	...	...	53
	4th	....	...	....	....	....	...	...	....	...	...	3	...	...	...	3
	5th	....	...	....	....	....	...	...	....	...	...	3	...	...	...	3
Total		192	...	....	....	....	...	...	....	...	...	23	...	...	...	215
St. Mary's	1st	46	...	....	....	....	...	...	....	...	...	...	...	...	...	46
	2nd	20	...	....	....	....	...	...	....	...	...	...	...	...	...	20
	3rd	14	...	....	....	....	...	...	....	...	...	...	...	...	...	14
Total		80	...	....	....	....	...	...	....	...	...	...	...	...	...	80
St. Francis Xavier	1st	70	...	....	....	....	...	...	....	...	...	...	...	...	...	70
	2nd	45	...	....	....	....	...	...	....	...	...	...	...	...	...	45
	3rd	30	...	....	....	....	...	...	....	...	...	...	...	...	...	30
Total		145	...	....	....	....	...	...	....	...	...	...	...	...	...	145
Nova Scotia Technical College	4th	....	...	17	62	45	...	...	35	1	3	...	...	...	...	163
	5th	....	...	17	50	35	...	...	37	4	3	...	...	...	...	146
Post-Graduates		....	...	6	29	18	...	...	8	1	2	...	...	...	...	64
Total		....	...	40	141	98	...	...	80	6	8	...	...	...	...	373
Acadia	1st	....	...	8	13	14	...	...	8	...	...	...	...	...	...	43
	2nd	2	...	4	13	5	...	...	7	...	...	...	...	...	...	31
	3rd	1	...	5	7	14	...	...	6	...	...	...	...	...	...	33
Total		3	...	17	33	33	...	...	21	...	...	...	...	...	...	107
St. Dunstan's	1st	26	...	....	....	....	...	...	....	...	...	...	...	...	...	26
	2nd	15	...	....	....	....	...	...	....	...	...	...	...	...	...	15
	3rd	8	...	....	....	....	...	...	....	...	...	...	...	...	...	8
Total		49	...	....	....	....	...	...	....	...	...	...	...	...	...	49
Mount Allison	1st	59	...	....	....	....	...	...	....	...	...	...	...	...	...	59
	2nd	57	...	....	....	....	...	...	....	...	...	...	...	...	...	57
	3rd	30	...	....	....	....	...	...	....	...	...	...	...	...	...	30
Total		146	...	....	....	....	...	...	....	...	...	...	...	...	...	146
New Brunswick	1st	....	...	31	40	44	...	...	26	...	2	...	1	...	...	144
	2nd	....	...	21	39	52	...	...	17	...	...	...	2	...	...	131
	3rd	....	...	17	35	29	...	...	15	...	1	...	4	...	...	101
	4th	....	...	9	39	45	...	...	28	...	...	...	5	...	...	126
	5th	....	...	6	42	33	...	...	20	...	...	...	3	...	...	104
Post-Graduates		....	...	13	14	20	...	...	2	...	...	...	2	...	...	51
Total		....	...	97	209	223	...	...	108	...	3	...	17	...	...	657
Moncton (formerly St. Joseph's)	1st	21	...	....	....	....	...	...	....	...	...	...	...	...	...	21
	2nd	15	...	....	....	....	...	...	....	...	...	...	...	...	...	15
	3rd	6	...	....	....	....	...	...	....	...	...	...	...	...	...	6
Total		42	...	....	....	....	...	...	....	...	...	...	...	...	...	42
Laval	1st	115	...	....	....	....	...	...	....	...	...	...	...	...	...	115
	2nd	331	...	....	....	....	...	...	....	...	...	...	...	...	...	331
	3rd	....	...	23	64	57	...	8	51	11	7	26	...	...	...	247
	4th	....	...	16	33	37	...	9	24	14	5	17	...	...	...	155
	5th	....	...	11	32	36	...	2	22	9	2	16	...	...	...	130
Post-Graduates		....	...	16	22	28	...	12	16	2	5	19	...	...	...	120
Total		446	...	66	151	158	...	31	113	36	19	78	...	...	...	1,098
Ecole Polytechnique	1st	282	...	....	....	....	...	...	....	...	...	...	...	...	...	282
	2nd	388	...	....	....	....	...	...	....	...	...	...	...	...	...	388
	3rd	282	...	....	....	....	...	...	....	...	...	...	...	...	...	282
	4th	....	...	14	75	44	...	5	43	14	4	13	...	...	...	212
	5th	....	...	19	101	63	...	5	50	19	10	8	...	...	...	275
Post-Graduates		....	...	7	16	3	...	2	5	6	4	7	...	...	...	50
Total		952	...	40	192	110	...	12	98	39	18	28	...	...	...	1,489

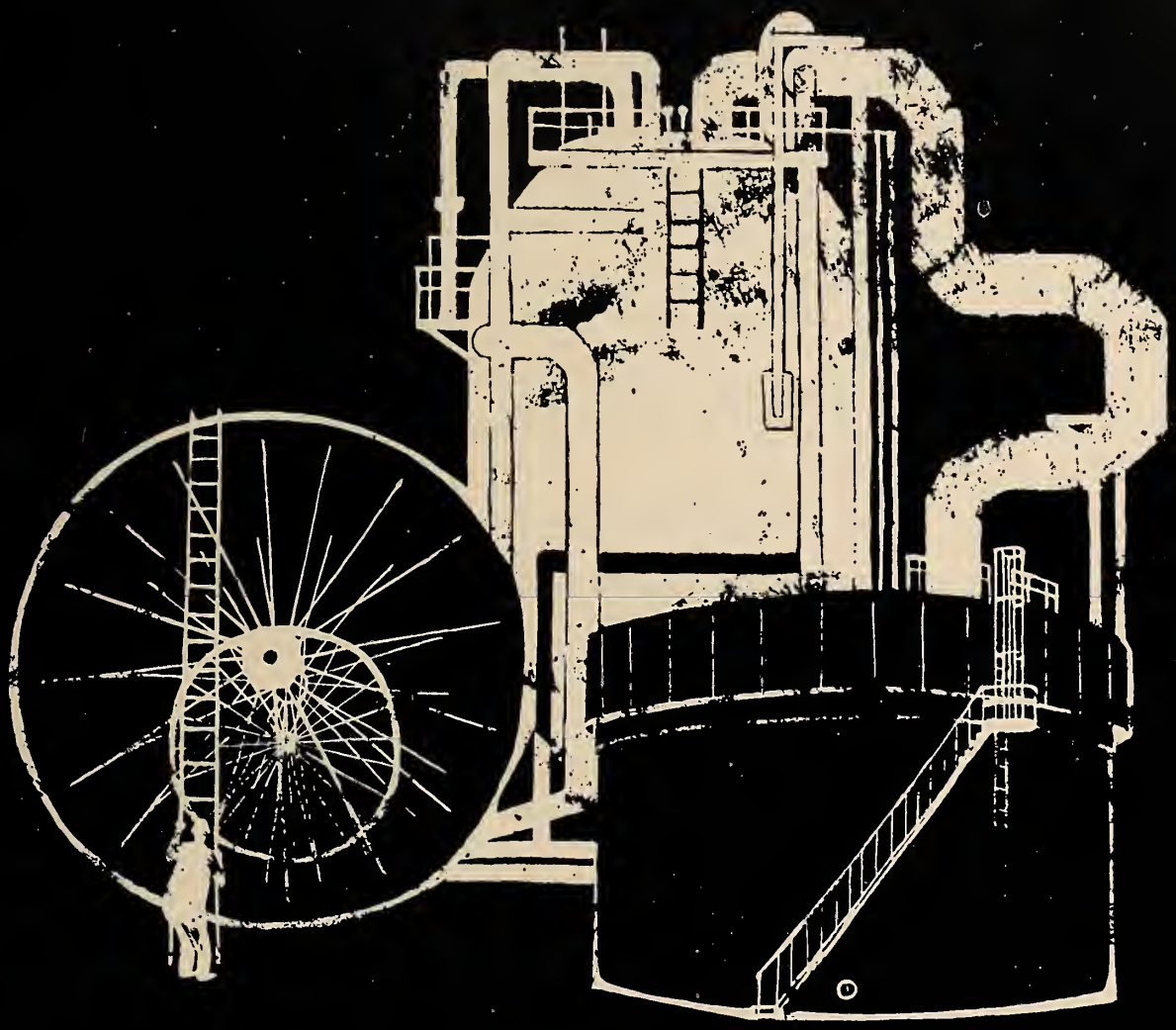
REGISTRATION IN ENGINEERING AT CANADIAN UNIVERSITIES 1963-64

University	Year	General Course	Agricultural	Chemical	Civil	Electrical	Industrial	Geology and Mineralogy	Mechanical	Metallurgical	Mining	Engineering Physics	Surveying	Forest	Aeronautical	Total
McGill	1st	263	...	....	....	....	...	...	....	...	...	...	...	...	...	263
	2nd	208	...	....	....	....	...	...	....	...	...	...	...	...	...	208
	3rd	....	...	20	18	53	...	...	42	9	2	11	...	...	...	155
	4th	....	...	16	26	71	...	...	36	12	1	6	...	...	...	168
	5th	....	...	14	38	56	...	...	32	6	1	3	...	...	...	150
Post-Graduates		....	...	15	33	35	...	...	45	12	12	...	...	...	...	152
Total		471	...	65	115	215	...	...	155	39	16	20	...	...	...	1,096
Sir George Williams	1st	204	...	....	....	....	...	...	....	...	...	...	...	...	...	204
	2nd	107	...	....	....	....	...	...	....	...	...	...	...	...	...	107
	3rd	....	...	....	10	21	...	...	12	...	...	...	...	...	...	43
Total		311	...	....	10	21	...	...	12	...	...	...	...	...	...	354
Loyola	1st	107	...	....	....	....	...	...	....	...	...	...	...	...	...	107
	2nd	56	...	....	....	....	...	...	....	...	...	...	...	...	...	56
	3rd	....	...	7	13	15	...	...	11	...	...	2	...	...	...	48
Total		163	...	7	13	15	...	...	11	...	...	2	...	...	...	211
Sherbrooke	1st	111	...	....	....	....	...	...	....	...	...	...	...	...	...	111
	2nd	34	...	....	....	....	...	...	....	...	...	...	...	...	...	34
	3rd	....	...	....	13	15	...	...	7	...	...	...	...	...	...	35
	4th	....	...	....	13	13	...	...	6	...	...	...	...	...	...	32
	5th	....	...	....	11	11	...	...	8	...	...	...	...	...	...	30
Total		145	...	....	37	39	...	...	21	...	...	...	...	...	...	242
Ottawa	1st	**50	...	....	....	....	...	...	....	...	...	...	...	...	...	50
	2nd	39	...	6	8	20	...	...	8	...	...	...	...	...	...	81
	3rd	....	...	6	7	17	...	...	....	...	...	...	...	...	...	30
	4th	....	...	7	....	13	...	...	....	...	...	...	...	...	...	20
	5th	....	...	7	....	15	...	...	....	...	...	...	...	...	...	22
Post-Graduates		....	...	19	....	21	...	...	....	...	...	...	...	...	...	40
Total		89	...	45	15	86	...	...	8	...	...	...	...	...	...	243
Carleton	1st	87	...	....	....	....	...	...	....	...	...	...	...	...	...	87
	2nd	54	...	....	....	....	...	...	....	...	...	...	...	...	...	54
	3rd	35	...	....	....	....	...	...	....	...	...	...	...	...	...	35
	4th	....	...	....	7	8	...	...	9	...	...	2	...	...	...	26
Post-Graduates		....	...	....	....	4	...	...	3	...	...	...	...	...	...	7
Total		176	...	....	7	12	...	...	12	...	...	2	...	...	...	209
Queen's	1st	233	...	....	....	....	...	...	....	...	...	...	...	...	...	233
	2nd	....	...	40	46	41	...	3	38	17	9	13	...	...	...	207
	3rd	....	...	45	48	32	...	4	36	15	4	16	...	...	...	200
	4th	....	...	21	38	22	...	1	25	12	6	20	...	...	...	145
Post-Graduates		....	...	10	26	26	...	3	11	6	4	3	...	...	...	89
Total		233	...	116	158	121	...	11	110	50	23	52	...	...	...	874
Toronto	1st	....	...	122	85	98	37	10	75	8	8	117	...	...	...	560
	2nd	....	...	70	52	80	30	7	52	17	5	50	...	...	...	363
	3rd	....	...	42	54	54	20	5	29	11	6	48	...	...	...	269
	4th	....	...	45	41	58	21	3	55	5	5	56	...	...	...	289
Post-Graduates		....	...	45	42	76	30	...	26	29	...	...	...	...	46	294
Total		....	...	324	274	366	138	25	237	70	24	271	...	...	46	1,775
McMaster	1st	91	...	....	....	....	...	...	....	...	...	...	...	...	...	91
	2nd	....	...	23	16	13	...	...	14	4	...	9	...	...	...	79
	3rd	....	...	9	10	15	...	...	9	2	...	7	...	...	...	52
	4th	....	...	6	7	9	...	...	9	1	...	2	...	...	...	34
Post-Graduates		....	...	20	8	9	...	...	4	7	...	...	...	...	...	48
Total		91	...	58	41	46	...	...	36	14	...	18	...	...	...	304
Ontario Agricultural College	1st	30	...	....	....	....	...	...	....	...	...	...	...	...	...	30
	2nd	25	...	....	....	....	...	...	....	...	...	...	...	...	...	25
	3rd	12	...	....	....	....	...	...	....	...	...	...	...	...	...	12
	4th	14	...	....	....	....	...	...	....	...	...	...	...	...	...	14
Post-Graduates		10	...	....	....	....	...	...	....	...	...	...	...	...	...	10
Total		91	...	....	....	....	...	...	....	...	...	...	...	...	...	91
Waterloo*	1st	511	...	....	....	....	...	...	....	...	...	...	...	...	...	511
	2nd	....	...	68	99	101	...	...	97	...	...	...	...	...	...	365
	3rd	....	...	22	47	74	...	...	66	...	...	7	...	...	...	216
	4th	....	...	9	22	26	...	...	26	...	...	12	...	...	...	95
Post-Graduates		....	...	6	20	21	...	...	8	...	...	...	...	...	...	55
Total		511	...	105	188	222	...	...	197	...	...	19	...	...	...	1,242

REGISTRATION IN ENGINEERING AT CANADIAN UNIVERSITIES 1963-64

University	Year	General Course	Agricultural	Chemical	Civil	Electrical	Industrial	Geology and Mineralogy	Mechanical	Metallurgical	Mining	Engineering Physics	Surveying	Forest	Aeronautical	Total
Western Ontario	1st	87	...	....	....	....	...	...	....	...	...	...	...	...	...	87
	2nd	62	...	....	....	....	...	...	....	...	...	...	...	...	...	62
	3rd	....	...	12	14	11	...	...	11	...	...	...	...	...	...	48
	4th	....	...	4	11	17	...	...	8	...	...	...	...	...	...	40
Post-Graduates		....	...	4	4	....	...	...	5	...	...	...	...	...	...	13
Total		149	...	20	29	28	...	...	24	...	...	...	...	...	...	250
Windsor	1st	25	...	11	9	10	...	...	12	...	...	3	...	...	...	70
	2nd	....	...	9	12	13	...	...	10	...	...	5	...	...	...	49
	3rd	....	...	10	15	12	...	...	9	...	...	6	...	...	...	52
	4th	....	...	4	7	19	...	...	2	...	...	4	...	...	...	36
Post-Graduates		....	...	8	5	4	...	...	3	...	...	...	...	...	...	20
Total		25	...	42	48	58	...	...	36	...	...	18	...	...	...	227
Laurentian (Nil this year)		....	...	....	....	....	...	...	....	...	...	...	...	...	...	....
Lakehead College of Arts, Science & Technology	1st	19	...	....	....	....	...	...	....	...	...	...	...	...	...	19
Total		19	...	....	....	....	...	...	....	...	...	...	...	...	...	19
Manitoba	1st	229	...	....	....	....	...	...	....	...	...	...	...	...	...	229
	2nd	178	...	....	....	....	...	2	....	...	...	7	...	...	...	187
	3rd	....	...	....	52	47	...	4	49	...	...	5	...	...	...	157
	4th	....	...	....	56	33	...	...	32	...	...	5	...	...	...	126
Post-Graduates		....	...	....	37	37	...	...	11	...	...	...	...	...	...	85
Total		407	...	....	145	117	...	6	92	...	...	17	...	...	...	784
Saskatchewan	1st	425	...	....	....	....	...	...	....	...	...	...	...	...	...	425
	2nd	154	...	19	1	12	...	5	4	...	...	8	...	...	...	203
	3rd	....	19	18	42	37	...	6	52	...	...	8	...	...	...	182
	4th	....	6	13	35	44	...	9	51	...	1	10	...	...	...	169
Post-Graduates		....	6	‡21	28	10	...	‡11	§22	...	...	‡20	...	...	...	118
Total		579	31	71	106	103	...	31	129	...	1	46	...	...	...	1,097
Alberta (Edmonton)	1st	213	...	....	....	....	...	...	....	...	...	...	...	...	...	213
	2nd	146	...	....	....	....	...	...	....	...	...	...	...	...	...	146
	3rd	....	...	36	33	52	...	...	48	12	...	8	...	...	...	189
	4th	....	...	41	53	53	...	...	52	6	2	3	...	...	...	210
Post-Graduates		....	...	30	40	19	...	...	6	18	...	...	...	...	...	113
Total		359	.....	107	126	124	...	...	106	36	2	11	...	...	...	871
Alberta (Calgary)	1st	116	...	....	....	....	...	...	....	...	...	...	...	...	...	116
	2nd	72	...	....	....	....	...	...	....	...	...	...	...	...	...	72
Post-Graduates		4	...	....	....	....	...	...	....	...	...	...	...	...	...	4
Total		192	...	....	....	....	...	...	....	...	...	...	...	...	...	192
British Columbia	1st	292	...	....	....	....	...	...	....	...	...	...	...	...	...	292
	2nd	88	...	29	....	90	...	...	....	...	...	...	...	...	...	207
	3rd	....	2	19	30	63	...	8	34	25	9	12	...	4	...	206
	4th	....	2	25	39	49	...	11	52	22	2	12	...	1	...	215
Post-Graduates		....	...	12	31	38	...	6	8	16	...	6	...	...	...	117
Total		380	4	85	100	240	...	25	94	63	11	30	...	5	...	1,037
Canadian Services Colleges																
Royal Military College (Kingston)	1st	66	...	....	....	....	...	...	....	...	...	...	...	...	...	66
	2nd	....	...	7	5	8	...	...	11	...	...	7	...	...	...	38
	3rd	....	...	22	22	29	...	...	24	...	...	8	...	...	...	105
	4th	....	...	17	21	21	...	...	16	...	...	8	...	...	...	83
Total		66	...	46	48	58	...	...	51	...	...	23	...	...	...	292
Royal Roads	1st	**100	...	....	....	....	...	...	....	...	...	...	...	...	...	100
	2nd	....	...	14	6	21	...	...	15	...	...	10	...	...	...	66
Total		100	...	14	6	21	...	...	15	...	...	10	...	...	...	166
College Militaire Royal de St-Jean	1st	129	...	....	....	....	...	...	....	...	...	...	...	...	...	129
	2nd	55	...	....	....	....	...	...	....	...	...	...	...	...	...	55
Total		184	...	....	....	....	...	...	....	...	...	...	...	...	...	184
Grand Total		6,999	35	1,365	2,192	2,514	138	141	1,766	353	125	668	17	5	46	16,364
Post-Graduates		14	6	232	355	369	30	34	183	97	27	55	2	...	46	1,450
Prospective 1964 Graduates		14	8	259	611	608	21	31	506	84	32	164	3	1	...	2,342

*Figures shown are for the Co-operative Engineering course and represent actual enrolment in first year and combined enrolment of Fall '63 and Winter '64 (est.) for advanced years. Rearrangement of the course at University of Waterloo now makes it possible to grant the first degree in four academic years, instead of five as previously shown. **Estimated. ‡Students doing post-graduate work in Chemistry, Physics or Geology, who are known to hold undergraduate degrees in Engineering. §Includes one student doing post-graduate work in Biochemical Engineering.



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TRANSACTIONS

Transactions of the Engineering Institute of Canada had been published quarterly, with each issue consisting of two to four papers. Beginning this year Transactions were published in five Series: Series "A" covering Civil, Geotechnical, and Bridge and Structural engineering; Series "B" for Mechanical, Welding, and Thermal; Series "C" for Electrical, Communications Electronics and Automation, and Hydroelectric; Series "D" for Management, Research and Education; and Series "E" for Chemical, Mining, and Oil and Natural Gas.

Subscribers to a Series received all the papers in the Series as and when they were available.

DIVISION PAPERS

This new category of technical paper was instituted to cover gaps which might have existed for papers which mightn't qualify for publication either in Transactions or the Engineering Journal. The same qualifications of quality were insisted upon for these papers but slightly different terms of reference applied regarding length and technical scope.

Division papers were published as and when available, and were distributed on an individual order basis.

THE ENGINEERING JOURNAL

Greater opportunity for publication of papers elsewhere permitted the publication of shorter, and more topical papers in the Engineering Journal.

NUMBERING SYSTEM

All papers published during 1963 carried a distinct number. Each of the 15 engineering disciplines represented by a Division on the Committee on Technical Operations was assigned its own series of numbers. All Civil Engineering papers, for example, were designated: EIC-63-CIV . . . . Numbering within a series was consecutive only as papers were approved for publication. Thus paper number EIC-63-CIV 1 was published in the Engineering Journal, numbers EIC-63-CIV 2 and 3 were published as Division papers, and EIC-63-CIV 4 was a Transactions paper.

The following list includes papers published in all three media. Papers are listed consecutively, by engineering discipline in each of the media.

A few gaps were caused by papers approved for publication and assigned a number, but subsequently withdrawn.

BACK ISSUES

Copies still exist of most Transactions and Division Papers published in 1963. Anyone wishing individual copies or complete Series may use the order form.

1964 PUBLICATIONS

After a year of experience in the broader publications scheme, even more ambitious plans have been made for 1964.

Excellent papers are being written, and some now are in production to ensure availability in January. The quality of the production of these papers will also be improved substantially.

Further information concerning 1964 publication plans, and of specific papers, will appear in the January and subsequent issues of the Engineering Journal.

Take the opportunity now to fill the gaps in your own technical library with copies of the 1963 Transactions and Division papers you may have missed.

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AUTHORS AND PROSPECTIVE AUTHORS

For the benefit of engineers wishing to submit papers to the Engineering Institute of Canada, a comprehensive Guide For Authors has been prepared and is available free from EIC Headquarters.

Personals

Frank R. Badger has been appointed general factory manager of Massey-Ferguson Limited's North American Combine Assembly Plant. Mr. Badger was formerly general project manager. Mr. Badger joined the company in 1937.

William B. Campbell has been appointed Sales Manager, Edmonton for Canadian Liquid Air Ltd. Mr. Campbell joined the company in 1941. In 1959, Mr. Campbell was Assistant Manager of the Province of Quebec Region, the position he held until his recent appointment.

Rinaldo Folli, M.E.I.C. (Milan '47) has been named General Manager of Pirelli Cables, Conduits Limited, St. Johns, Que.

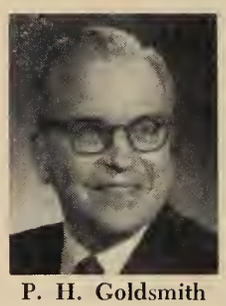
R. Folli

S. Sillitoe

Sydney Sillitoe, M.E.I.C. (Alberta '31) has been promoted by Northern Electric Company Limited. Mr. Sillitoe, Chairman of the Institute's Committee on Technical Operations in 1961-62, has been moved from Belleville to Head Office in Montreal as Assistant Manager – Patents. He was one of the original Commissioners of the Belleville Transit Commission appointed in 1960, and was Chairman in 1962. After receiving his Bachelor's degree Mr. Sillitoe earned his Master's degree from University of Alberta and subsequently took courses at McGill, Queen's and the University of Western Ontario, from which he obtained a diploma in Business Administration.

Robert J. Urlocker, has been appointed Assistant Regional Manager, Ontario Region for Canadian Liquid Air Ltd. Mr. Urlocker, a metallurgical engineer, joined the company in 1955. Prior to his present appointment, he was Sales Manager in Toronto. Bertram L. Walsh has been named Manager of Industrial Gas Equipment Sales, Head Office, Montreal. Mr. Walsh, a civil engineer, joined the company in 1956, and has served most recently as Sales Manager in Hamilton.

J. B. Stirling



P. H. Goldsmith

J. B. Stirling, M.E.I.C. (McGill '52) has been appointed Sales Manager, Paper Machinery for the North American market of Dominion Engineering Works Ltd. He succeeds **P. H. Goldsmith** who is now responsible for the export sales of paper machinery as well as handling liaison with Werkspoor, N.V. of Amsterdam, Holland, manufacturers of Dominion Paper Machines for European countries.

G. S. Hamilton, M.E.I.C. (McGill '57) has been appointed to assist P. H. Goldsmith in the export markets of Dominion Engineering Works Ltd.

Keith D. Landell has been appointed President of W. K. Davidson and Co. Ltd., the company acquired by Montreal Locomotive Works. Mr. Landell retains his position as Commercial Vice-President of MLW.

R. J. Chrisholm has been appointed Manager of I-T-E Circuit Breaker (Canada) Limited's Western Division. In May 1961, Mr. Chrisholm was appointed Product Manager, Power Apparatus Equipment, Eastern Power Devices Division. In addition to the overall management of the company's western division, he will head the Western Region Field Marketing organization.

G. S. Hamilton

R. J. Chrisholm

Dr. R. M. Quigley, M.E.I.C. (Toronto '55) has been named Assistant Professor of Engineering Science at The University of Western Ontario. Dr. Quigley, who obtained his doctorate at M.I.T., was previously Senior Soils Engineer-Geological Engineer with Geocon Ltd., a subsidiary of the Foundation Companies of Canada.

Robert St. Arnaud has been appointed special representative for The James Morrison Brass Manufacturing Co. Ltd. For the past 15 years, Mr. St. Arnaud has been active in the field of valve, instrument, control and hydraulic industrial sales.

R. St. Arnaud

J. K. Taylor

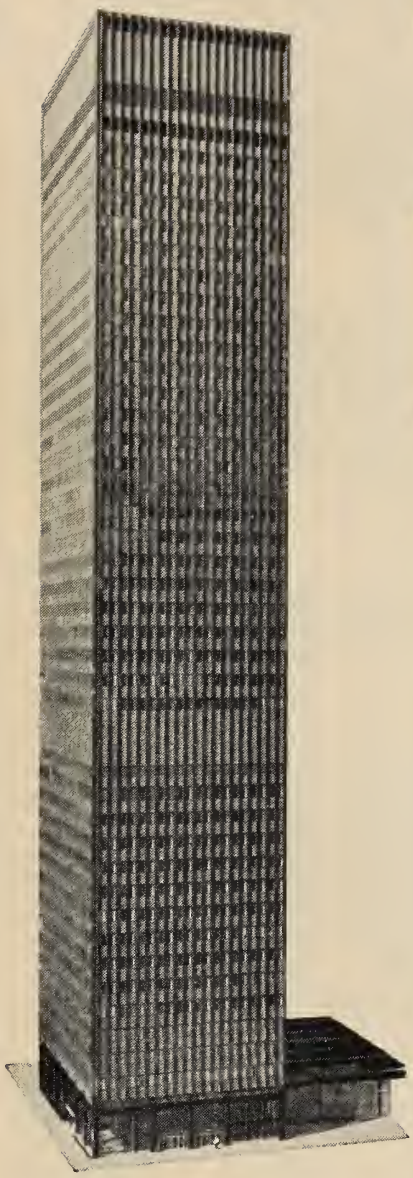
J. K. Taylor, M.E.I.C. (McGill '54) former Product Engineer for Dominion Engineering Works Ltd., has been appointed Sales Engineer. He will be responsible for contact with Eastern Canadian paper mills.

Dean D. Ramstad has been elected Assistant Vice-President of the International Nickel Company of Canada ,Limited, and its United States subsidiary, The International Nickel Company, Inc. Mr. Ramstad joined The International Nickel Company, Inc. in 1957 as a member of the General Solicitor's staff. He has been assistant Secretary of both companies and has been active particularly in the company's exploration activities.

George Oksiutik has joined the staff of Sinclair Radio Laboratories Ltd. as an Engineering Physicist. His duties include assisting in the development of a new telemetering antenna for the Alouette II Satellite programme.

(Continued on page 78)

La Grande Salle de La Place des Arts. Installation: 3 DK10-10 35,000 PPH Steam Boilers. Consulting Engineers — Mech: and Elec: McDougall & Friedman, Montreal.



Canadian Imperial Bank of Commerce Building. Installation: 3 DK10-7 29,000 PPH Steam Boilers. Consulting Engineers — Mech: G. Granek & Associates, Toronto.

Standard Life Assurance Company Building. Installation: 2 TJW, 10 x 10^6 BTU/HR High Temperature Water Generators. Consulting Engineers — Mech: Wiggs, Walford, Frost and Lindsay, Montreal.

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Engineering Information Service

The following books have recently been received.

THE ECONOMICS OF HIGHWAY PLANNING, David M. Winch, University of Toronto Press, Toronto, $3.95

SPECIFICATIONS FOR OIL BURNING EQUIPMENT, British Standard 799, Part 1-1962, British Standards Institution, London, 20/net

STEEL GIRDER BRIDGES, British Standard 153: Parts 3B & 4,-1958, British Standards Institution, London, 15/ net

SPECIFICATIONS FOR STRUCTURAL STEEL SECTIONS, British Standard 4: Part 2-1963, British Standards Institution, London, 5/net

SPECIFICATIONS FOR FLANGES AND BOLTING FOR PIPES, VALVES AND FITTINGS, British Standard 10-1962, British Standard Institution, London, 15/net

SPECIFICATIONS FOR STEEL PIPES AND TUBES FOR PRESSURE PURPOSES, British Standard 3601 and 3602-1962, British Standards Institution, London, 10/net

SPECIFICATIONS FOR MICROSCOPE OBJECTIVE AND NOSEPIECE THREADS, British Standard 3569-1962, British Standards Institution, London, 4/6 net

SPECIFICATIONS FOR BRAKE SHOES AND BRAKE SHOE HOLDERS, British Standard 3565-1963, British Standards Institution, London, 12/6 net

METHODS OF TESTING WATER TURBINE EFFICIENCY, British Standard 353-1962, British Standards Institution, London, 20/net

THERMODYNAMICS FOR ENGINEERS, A. C. Walshaw, Longmans Canada Limited, $5.50.

CRYOGENIC ENGINEERING, J. H. Bell, Jr., Prentice-Hall Inc., $16.00.

MECHANICAL VIBRATIONS: AN INTRODUCTION TO MATRIX METHODS, J. M. Prentis & F. A. Leckie, Longmans Canada Limited, $4.20.

PROFESSIONAL ACHIEVEMENT FOR ENGINEERS AND SCIENTISTS, Tyler G. Hicks, McGraw-Hill, $9.40.

MECHANICAL ENGINEERING DESIGN, Joseph E. Shigley, McGraw-Hill, $13.55.

POWER HYDRAULICS, A. B. Goodwin, Cleaver-Hume Press Ltd., 42s.

PROFESSIONAL ENGINEERS AND THE COMMON MARKET, The Engineers' Guild, 10/-

L'ELECTRONIQUE DANS LES APPAREILS DE CONTROLE NUCLEAIRE, Tome 1, Geroges Nicolo, Eyrolles, 112, 30F.

ENGINEERING MECHANICS OF DEFORMABLE BODIES, Byars and Snyder, International Textbook Company, $8.50.

NEW SOURCES OF ENERGY, PROCEEDINGS OF THE CONFERENCE, ROME, 21-31 August 1961, United Nations, $2.50.

THE ECONOMICS OF HIGHWAY PLANNING, David M. Winch, University of Toronto Press.

L'ORGANISATION DU TRAVAIL, P. Leroy & J. E. Rollet, Eyrolles, 110,15F.

ASTROPHYSICAL QUANTITIES, C. W. Allen, Oxford University Press, $11.35.

ULTRASONIC DELAY LINES, C. F. Brockelsby, J. S. Palfreeman, R. W. Gibson, Iliffe Books Ltd., 65s net.

LE LAMINAGE DES PRODUITS PLATS, E. C. Larke, Dunod, 88F.

LA METHODE DES CAS ET LA FORMATION AU COMMANDEMANT, P. Arbousse-Bastide, Dunod, 18F.

INTRODUCTION A LA THEORIE DES SYSTEMES ECHANTILLONNES, J. Tschauner, Dunod, 26F.

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Discussion

(Continued from page 40)

en demandant à M. Hénault quelques informations supplémentaires relatives a cette étude.

1. Telle que proposé, la glissière en béton empêchera le véhicule de franchir le parapet, et le redressera dans la direction de la route. La violence du choc peut-elle causer la mort, ou du conducteur ou des passagers?

2. Quelle protection une telle glissière peut-elle accorder aux véhicules lourds, tant au point de vue retention que capotage.

Reponse de L'Auteur

Je remercie Monsieur Hode Keyser pour ses bonnes paroles et je tiens à souligner que je suis entièrement d'accord avec les points qu'il a mentionnés.

J'aimerais ajouter à ses remarques que les lignes d'une glissière de sécurité ont leur importance et il faut traiter le sujet avec soin, car ici il faut tenir compte des réactions psychologiques des usagers de la route. Si nous ne soignons pas l'aspect de nos glissières, on peut détruire le sens de sécurité qu'il devrait développer chez les gens. Tous les effets sont possibles—de l'irritation la plus nerveuse au laisser-aller voisin du sommeil. C'est un sujet bien nouveau et peu de recherches ont été faites dans ce domaine.

Toutefois, nous savons que le problème existe et ainsi nous devons le traiter en nous basant sur nos connaissances actuelles assez limitées cependant.

Je remarque qu'il attache aussi une grande importance aux effets psychologiques chez les usagers de la route lorsqu'ils ont à circuler près de différents genres de glissières de sécurité.

En réponse à la première question, j'aimerais bien affirmer que la vie des occupants des véhicules frappant la glissière fabriquée de béton armé ne serait pas en danger, mais je ne puis aller si loin car l'expérience telle que poursuivie ne permet pas de tirer une conclusion aussi vigoureuse. Il aurait fallu installer un accéléromètre dans la poitrine de mannequins, qui auraient représenté le chauffeur et même les passagers, mais malheureusement nous n'avons pas eu le temps de pousser nos expériences aussi loin que cela.

Toutefois, nous avons calculé les décélérations moyennes lors de l'impact, lorsque le véhicule était en contact avec la glissière, et nous pouvons voir dans le tableau de ce rapport que les valeurs dans le cas du mur de béton sont inférieures à celles trouvées avec d'autres genres de glissières, dans les mêmes conditions d'étude Cette décélération moyenne est certainement inférieure à la décélération lors de l'impact, mais nous avons raison de croire que les valeurs peuvent nous aider à tirer certaines conclusions.

Ainsi pour une vitesse d'impact d'environ 55 m.p.h., il semble, d'après les décélérations moyennes calculées, qu'il n'y a pas de danger pour la vie des occupants, mais des essais plus poussés seraient nécessaires pour donner une réponse conclusive. Le danger de mortalité lors de l'impact pourrait être réduit considérablement si les occupants des véhicules employaient des ceintures de sécurité. Nous avons remarqué que dans plusieurs essais une ou plusieurs portes des véhicules s'ouvraient sous le choc.

En réponse à la deuxième question, le genre de glissière que nous avons recommandé peut résister à l'impact de camions de catégorie moyenne. Il est fort possible que, grâce à son armature, elle retiendra les véhicules plus lourds sur les voies de circulation, à la condition qu'ils ne sautent pas par-dessus le mur. Ce dernier phénomène peut se produire en vertu du centre de gravité des camions qui est relativement très élevé en comparaison des automobiles.

Quant au capotage, le même raisonnement est valable, à la condition que les composants du centre de gravité ne deviennent pas impossibles.

En résumé, on peut dire que le mur recommandé protégera la majorité des camions. Il aurait été économiquement impensable de construire le mur pour protéger tous les genres de camions.

COMING EVENTS

The Iron and Steel Institute. Autumn General Meeting. London, England. Nov. 25.

American Institute of Chemical Engineers. 56th Annual Meeting. Houston, Tex. Dec. 1-4.

Institute of Electrical and Electronics Engineers, Inc. Ultrasonics Engineering Symposium. Washington, D.C. 4-6.

American Institute of Mining, Metalurgical and Petroleum Engineers, Inc. 21st Electric Furnace Steel Conference, Chicago, Ill. Dec. 5-7.

American Institute of Aeronautics and Astronautics. Heterogeneous Combustion Conference. Palm Beach, Fla., Dec. 11-13.

American Association for the Advancement of Science. 130th Annual Meeting. Cleveland, Ohio. Dec. 26-31.

Society of Automotive Engineers Inc. Annual Meeting and Engineering Display. Detroit, Mich. Jan. 13-17.

American Chemical Society. 146th National Meeting. Denver, Colo. Jan. 19-24.

Australian and New Zealand Association for the Advancement of Science. 36th Congress. Canberra, Australia. Jan. 20-24.

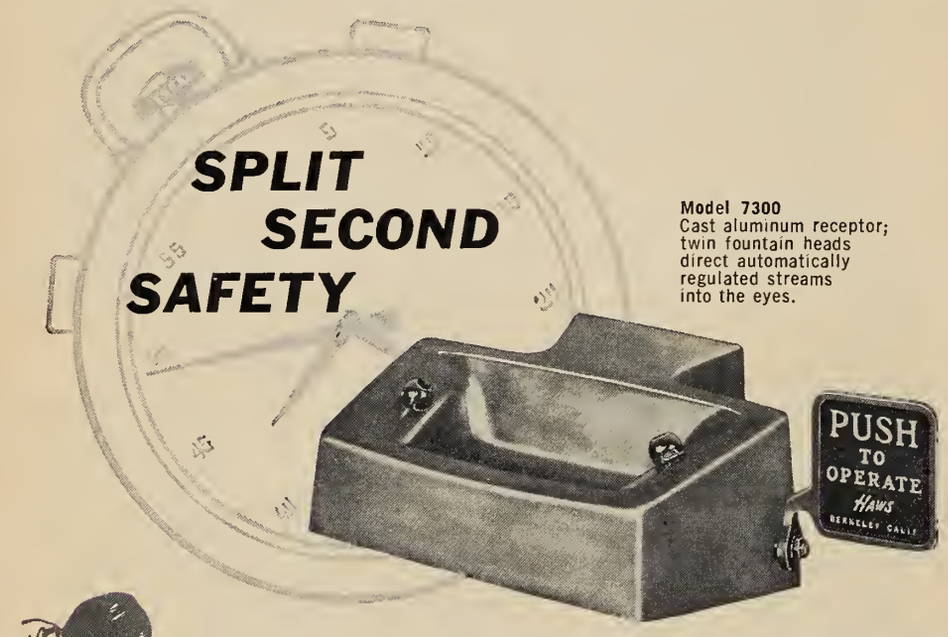
American Society of Heating, Refrigerating and Air Conditioning Engineers. Semi-Annual Meeting. New Orleans. Jan. 27-29.

Canadian Pulp and Paper Association. Technical Section. 50th Annual Meeting. Montreal, Que. Jan. 28-31.

American Meteorological Society. 44th Annual Meeting. Los Angeles. Jan. 29-31.

Canadian Section of American Water Works Association. Association Quebecoise des Techniques de l'Eau. 2nd Annual Meeting. Quebec City, Que. Feb. 10-11.

Eastern Snow Conference. 21st Annual Meeting. Utica, N.Y. Feb. 13-14.



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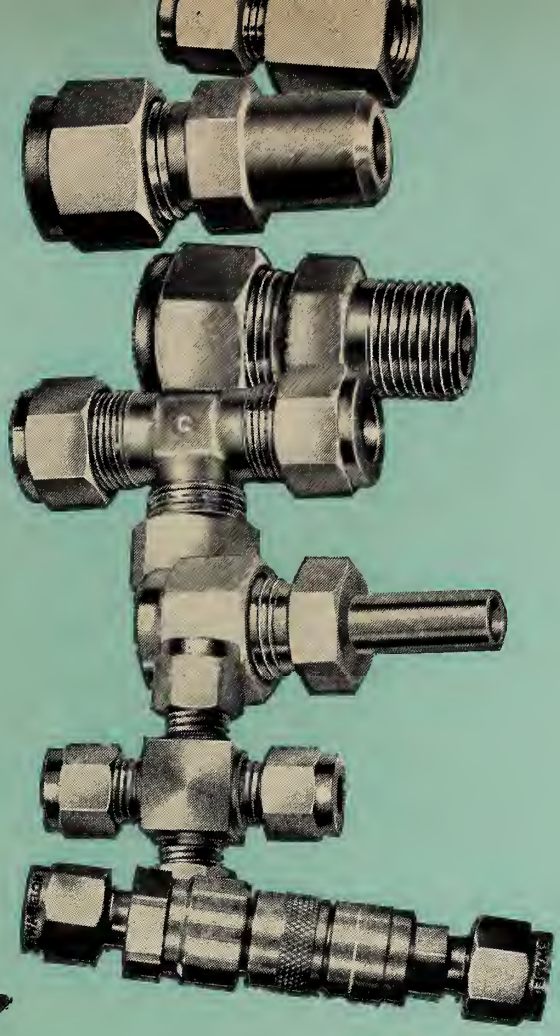

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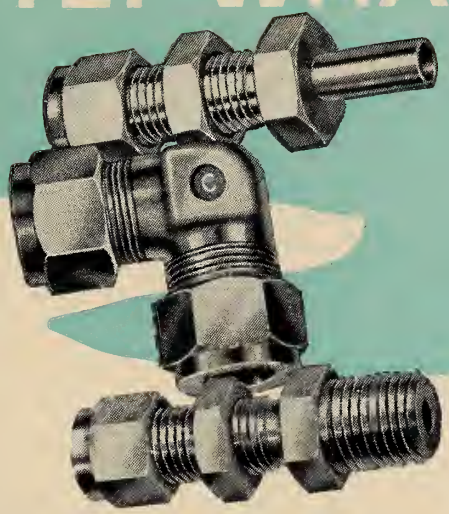

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Engineering Briefs

A ONE-INCH VANE METER designed specifically for corrosive waterflood applications, has ben developed by Rockwell Manufacturing Company of Canada, Ltd. The new meter operates on a magnetic drive principle which is magnetically linked to a hermetically sealed register. Incoming water impinges tangentially on roto vanes, and this action moves the one-piece rotor element. The integral register-magnetic drive unit eliminates the need for a stuffing box and gear train.

CANADIAN INGERSOLL-RAND Co. Limited has announced the availability of their line of Type 30 air compressors in 3 to 20 HP with diesel engine drivers. The units, self-contained with compressor and driver, and mounted on an extended baseplate, provide air power for isolated plant locations, or other areas where air is regularly required. Air-cooled construction eliminates the danger of freezing and the cost of water and water piping. Compressors are furnished with either finger valves, concentric ring valves or channel valves. The units are supplied with automatic stop control, constant speed control or manual operation. A totally enclosed centrifugal device unloads the compressor every time the unit stops. Diesel drivers supplied feature electric starting, manually operated clutch and safety device equipment for temperature and oil control.

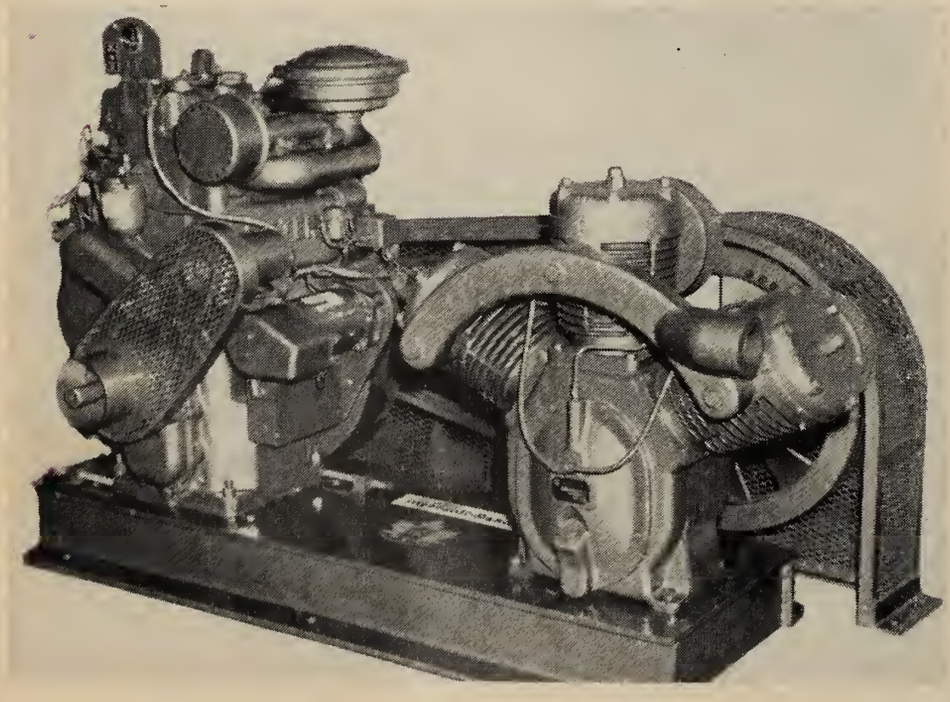
INTERNATIONAL BUSINESS MACHINES Company Limited has introduced a new programming system which enables the 7070/7074 computer to automatically "draw" a flowchart in about 15 seconds. The new system called "Autochart", has three primary advantages—it saves programmers many hours in the original manual preparation of a flowchart; it speeds the changes on a flowchart; and it provides a permanent retrievable documentation of a program.

THE SERIES MCV, adjustable speed programming cam timer is available through Sperry Gyroscope Ottawa Limited, Canadian agents for Industrial Timer Corporation. The eight models in the MCV series feature variable cam shaft speeds which are easily changed by the use of a simple thumbwheel on the side of the unit. Time cycles range from 30 seconds up to 24 hours. Models have a one to four adjustment ratio, can be equipped with five gear racks, and two to ten isolated load switches.

Engineering Briefs

Information contained in this section has been obtained from press releases. Mention of products and services does not imply endorsement by the Institute.

Diesel Driven Compressors



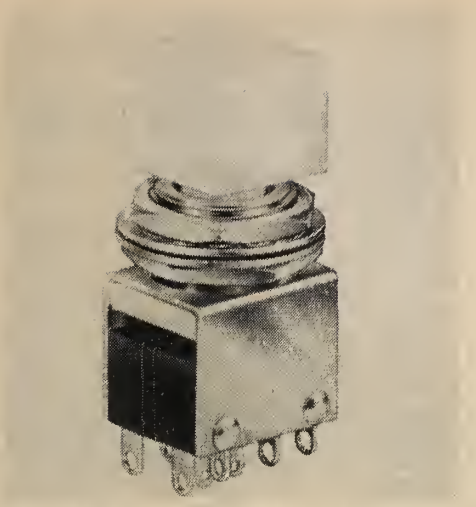
Trepel Hydraulic Lift

TREPEL TYPE K Hydraulic lifting tables from Trepel-Pathex Automations Ltd., are available in capacities varying from 200 lbs. to 50 tons. Special foundations are not required. Platform sizes up to 33 ft. provide lifts up to 14 ft. Semi or fully automatic controls and complete accessories are provided.

THE CANADIAN MINING INDUSTRY has been introduced to a new jet chambering process developed by Union Carbide Limited, Linde Gas Division, and Gardner-Denver Company (Canada) Limited. The equipment used is a Gardner-Denver percussion for drilling the primary pilot hole, and a Linde jet piercer for enlarging or chambering the hole. The Linde jet piercer utilizes an air-fuel jet piercing burner. The new air-fuel burner does not require oxygen for burner operation when drilling or chambering. The burner uses fuel oil, such as diesel fuel, and air from a Gardner-Denver SP900 "Roto-Screw"(R) compressor to produce the hot combustion gases which spall the rock.

A NEW 32-PAGE CATALOGUE describing the Hot Process Feedwater Systems is available from Graver Water Conditioning Division of Procor Limited, Toronto. The Graver Hot Process System permits reduction of dissolved and suspended impurities to prescribed low values regardless of variations in flow or chemical composition of the incoming feedwater. The Hot Process softener has proven successful under widely varying plant conditions in producing a boiler feedwater of uniform quality. The cataloque WC-102C features charts, diagrams, and photographs illustrating this process, and is available without obligation.

(Continued on page 68)

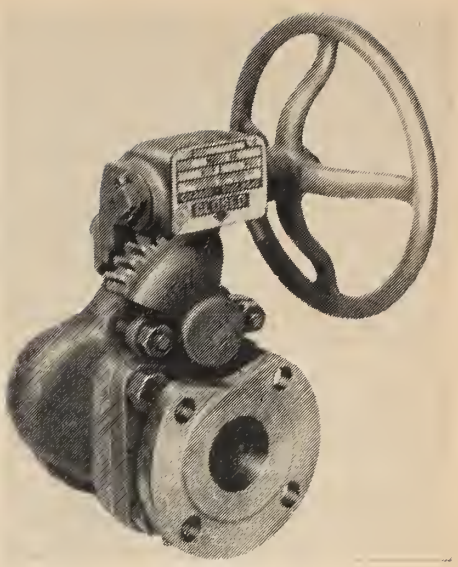


Lighted Pushbutton Switch

LICON DIVISION OF CANADA ILLINOIS TOOLS LTD., has introduced the O1 series of lighted pushbutton switches. These miniature components combine panel indicating and switching functions in a single package. O1 switches are available in momentary contact, maintained contact, selenoid held and indicator units. The miniature incandescent bulbs come in 6, 12 and 28 volt styles and are rated to 10 amps. 28 VDC/250 VAC. Indicator buttons are either 5/8 inches square or 5/8 inches diameter.

COMPUTING DEVICES OF CANADA Limited, Ottawa, have developed a new navigation device, the Tactical moving map display. This moving map provides the pilot with a continuous projection of the complete topographical details surrounding the aircraft's present position. The maps for any area are photographed and placed on 35 mm color film. These are projected on a brightly lit screen so the aircraft's position is always in the center of the display. Map movement is fully simultaneous with the plane. The film magazine contains maps covering an area 1800 x 1800 nautical miles. A look-ahead feature enables the pilot to view the approaching area. The map returns to present position automatically. To overcome cockpit space limitations, course, track and range to destination information are displayed on the same indicator.

A 1200-AMPERE, MN-FRAME molded case circuit breaker has been announced by I-T-E Circuit Breaker (Canada) Ltd. The new breaker, 9 inches wide, 22 inches high, and 5¾ inches deep, is designed for switchboards, panelboards, motor control centers and individual enclosures. The unit is listed in ratings from 800 to 1200 amperes, 600 volts a-c, 250 volts d-c. Interrupting ratings is 25,000 amperes, asymmetrical, at 600 volts a-c; 50,000 amperes, asymmetrical, at 240 volts a-c.



Okadee Valve

THE OKADEE flanged valve for liquid or gases has been announced by Canadian Meter Company Limited. The non-lubricated valve is designed for straight through flow with a full opening. The Okadee is available in either cast steel in single or double seat design in sizes from 1½" to 12". Okadee valves are applicable to a wide variety of industrial applications where low maintenance is an important factor.

(Continued on page 68)

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Engineering Briefs

(Continued from page 67)

CANADIAN GENERAL ELECTRIC has introduced a new, clear, silicone material which can be used to form an elastomeric coating on electronic components and assemblies in as little as one-sixth the time as presently available materials. Identified as SS-4090 silicone electrical insulating coating, it forms an elastomeric coating on a substrate which will make it suitable for use on flexible printed circuits as well as wired and unwired conventional printed circuit boards, memory circuits, modules, capacitors and resistors.

AN IN-LINE SOLIDS SEPARATOR for the product pipe line has been introduced by Dorr-Oliver-Long Ltd., Orillia, Ont. The unit is permanently installed in-line, and produces a small fixed pressure drop that will not vary. Collected solids are stored for intermittent discharge, and are discharged without affecting the continuous operation of the separator. It is designed for horizontal or vertical operation, and can be supplied for in-line mounting with minimum offset of the pipe.

JOINT RESEARCH EFFORTS by Dominion Tar and Chemical Company, Ltd., and the Canadian and United States technical staffs of The Bauer Bros. Co., have resulted in a new concept in cleaner design. The new model is designated as the No. 606-110 Centri-Cleaner® and offers several operating advantages over the conventional 606 design, which the company still will manufacture. In addition to improved cleaning efficiency, the new unit operates with a pressure drop of only 35 p.s.i., compared with the 45 p.s.i. used formerly.

WAJAX EQUIPMENT LIMITED has announced that Austin-Western self-propelled hydraulic crane models 210 and 409 now can be supplied with high-speed and free-drop lines. Driven by a planetary cable hoist, the high-speed line gives speeds up to 244 ft./min. The free-drop line is available for machines fitted with the high-speed line; and, when so equipped, the cable may be powered up or down or lowered by gravity.

A 24-PAGE ILLUSTRATED booklet, "KaMeWa Controllable Pitch Marine Propellers", now is available from A. Johnson & Co. (Canada) Limited. The booklet includes a short history of the development of the hydraulically-operated, controllable pitch marine propeller as undertaken by AB Karlstads Mekaniska Werkstad (KMW) of Sweden, from the company's first installation in a small 150 hp. coaster in 1937 to the 20,000 hp. propellers of today.

A REVOLUTIONARY MOULD core baking procedure employing infrared light is part of the mould making process at Sovereign Castings Ltd., Calgary. This iron and non ferrous metal foundry was founded in May, 1963, and production started in mid-June. The new core baking process was developed by the company to save on capital investment required for the usual baking oven. The process is reported to be proving very successful.

AN ADDITION TO THE Atlas Asbestos Company line of building materials has been announced by the company. The product, "Atlas-Turnall' Promenade Tile, is designed for use in patios, porches, roof gardens, verandahs, sun-decks, recreation and swimming pool areas. Composed of asbestos and cement, it wears like stone, is fireproof, vermin proof, and will not rot.

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NOVA SCOTIA ENGINEERS TO HOLD BANQUET AND DANCE

The Association of Professional Engineers of Nova Scotia (APENS) will hold a Banquet and Dance in the Commonwealth Room at the Nova Scotian Hotel, in Halifax, on January 17, 1964, following the Annual Business Meeting.

The ladies have again been invited to attend this portion of the Annual Meeting.

OUTSIDE HELP WITH INSIDE KNOW/HOW

MEET THE ARMCO MAN

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OF THE ENGINEERING INSTITUTE OF CANADA

Forthcoming separate papers comprising "Transactions of the Engineering Institute of Canada" are:

SERIES "A" CIVIL; GEOTECHNICAL; BRIDGE & STRUCTURAL

EIC-63-BR & STR 11 "The Rational Design of Beam to Column Connections" by A. N. Sherbourne

SERIES "E" CHEMICAL; MINING & METALLURGICAL; OIL & NATURAL GAS

EIC-63-CHEM 11 "On The Thermodynamics of Reactions Involving Isomers: The Dehydrogenation of n-Butenes" by R. W. Missen

THE ABOVE PAPERS WILL BE SENT AUTOMATICALLY TO THOSE WHO HAVE SUBSCRIBED TO THE SERIES IN WHICH THE PAPER APPEARS. OTHERS WHO DESIRE A COPY MAY ORDER IT FROM HEADQUARTERS ON THE FORM ON THE FOLLOWING PAGE.
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ABSTRACTS

EIC-63-BR & STR 11
"The Rational Design of Beam to Column Connections"
A. N. Sherbourne

The paper discusses the problem of beam to column connections and critically reviews the recommendations affecting the plastic design of bolted and welded connections.

EIC-63-CHEM-11
"On the Thermodynamics of Reactions Involving Isomers: The Dehydrogenation of n-Butenes"
R. W. Missen

Equations are given for calculating the equilibrium conversion for various cases involving a reactant and/or product in two or more isomeric forms. These equations are applied to the dehydrogenation of n-butene to show that the conversion is a minimum when all isomers are present at equilibrium. Conversely if all isomers of butadiene were formed at equilibrium, the conversion would be a maximum. Generalized statements of these results are given, and the relation to kinetic considerations are discussed.

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AUTHORS AND PROSPECTIVE AUTHORS

For the benefit of engineers wishing to submit papers to the Engineering Institute of Canada, a comprehensive Guide For Authors has been prepared and is available free from EIC Headquarters.

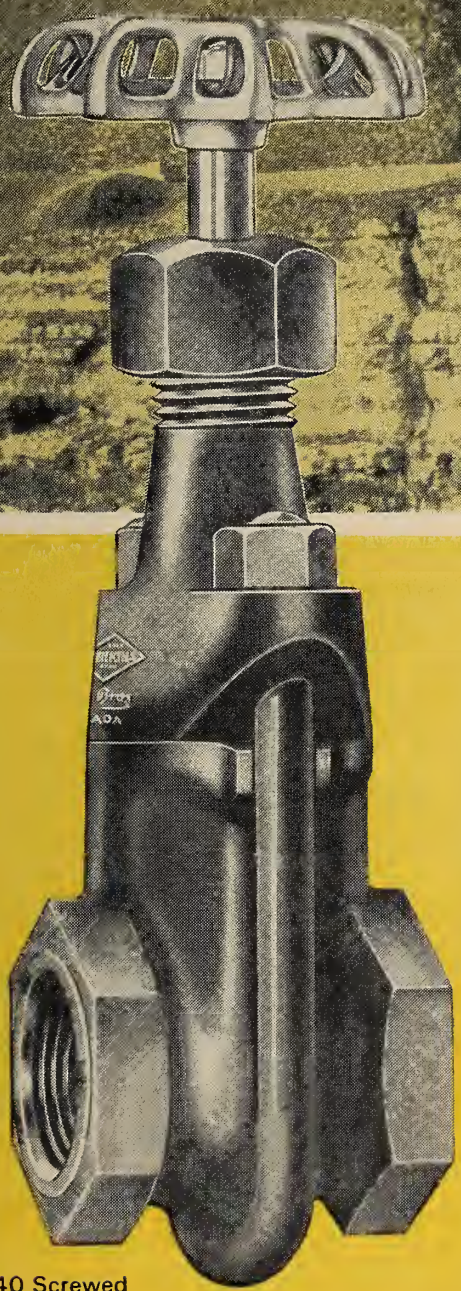

FIG. 40 Screwed

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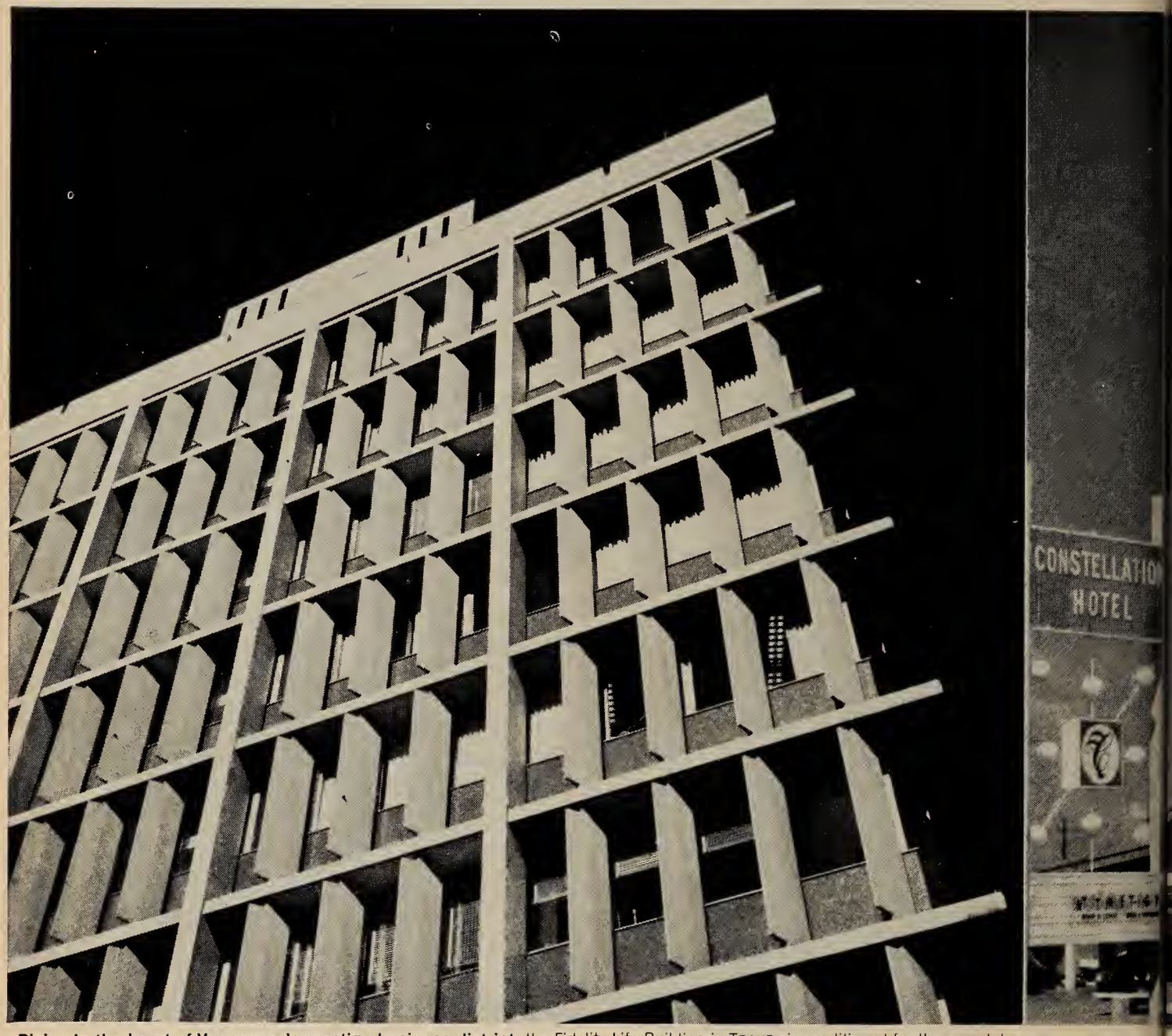

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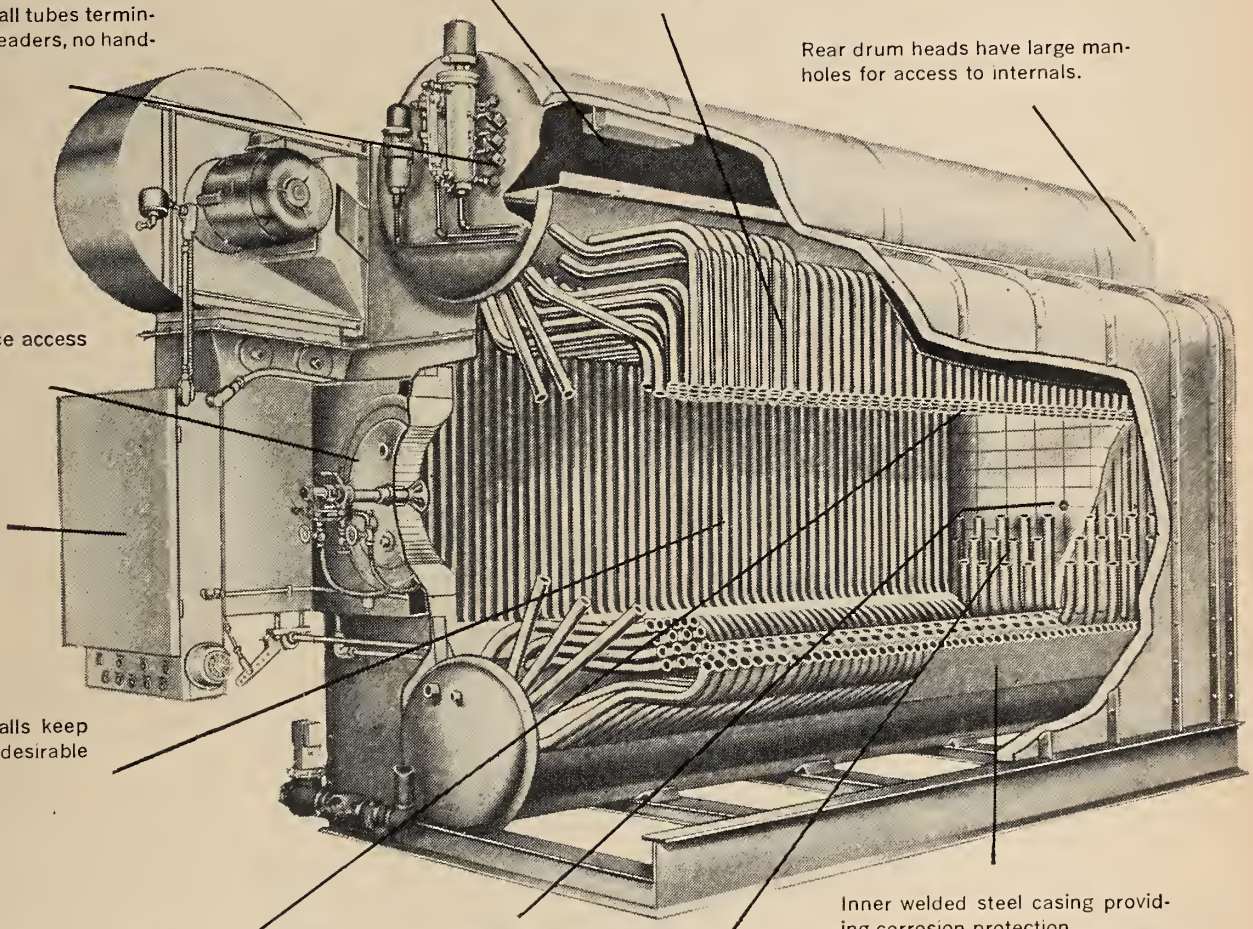

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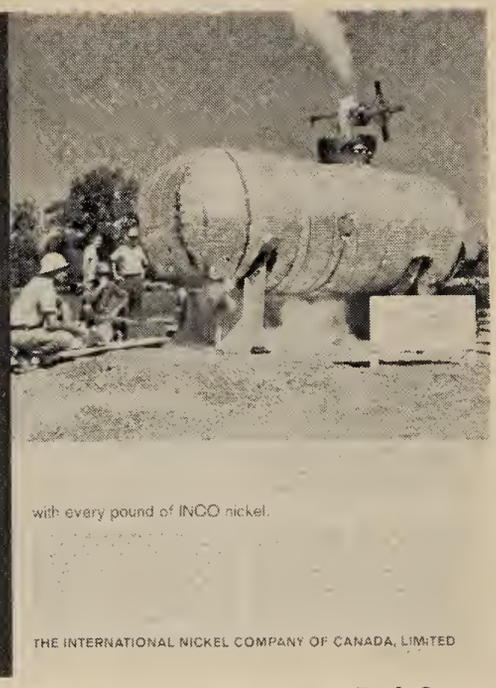
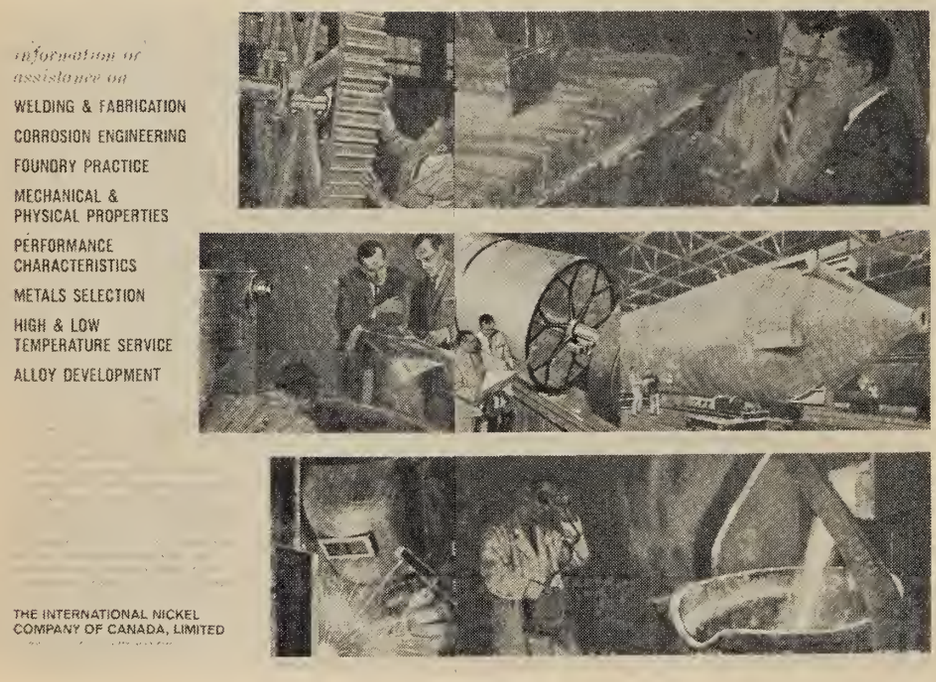


Back Cover



Centre Spread

A striking four-page insert gaining maximum effect from color, art work and photographs won for the International Nickel Company of Canada, Limited, the EIC Certificate of Advertising Merit for September. The first page, essentially the outside cover, is simple and highly effective. A square of nickel with the INCO trademark is alone against a colored linen-like material. The words "with every pound of INCO nickel you get" lead to the inside pages which feature text and seven drawings illustrating metallurgical information, fabrication assistance, welding information, corrosion engineering service, aid in metals selection, advice on mechanical and physical properties, and foundry practice. The back cover contains more text telling of the services and assistance which come "with every pound of INCO nickel" and a four-color photograph of a nickel steel test tank.

For INCO, K. H. J. Clarke is Manager of Canadian Sales and Market Development and J. E. Totten is in charge of Advertising. The advertisement was prepared by Cockfield, Brown & Co. Ltd. (Toronto), R. W. Booth, Account Supervisor.

Judging for the award is done each month by an impartial jury of engineers from all parts of Canada whose only instructions were to select the best advertisement on the bases of ACCURACY—INFORMATION—ATTRACTION.

Canadian Engineering

(Continued from page 49)

EIC Represented At ECPD Meeting

The Engineers Council for Professional Development met September 30 and the Institute was ably represented by its three appointed members, Dr. J. J. Green, Dean D. T. Wright, and Col. W. A. Capelle.

A major portion of the Council's time was spent on reviewing the Report of the Education and Accreditatation Committee. The basis for accrediting engineering curricula is on both qualitative and quantitative criteria which have been established. Each curriculum at each American institution is accredited individually.

Also discussed were finance, admissions, and constitution and rules. ECPD Vice-President for 1962-63, W. Scott Hill, was elected President for 1963-64.

ECPD meetings from 1964 through 1969 will be held in the early autumn at, respectively, New York, Florida, Denver, Toronto, New Orleans, Detroit.

A definition of a technician was accepted by the Recognition Committee.

Courses Offered By Quebec Organization

Le Centre D'Organisation Scientifique de l'Entreprise (COSE), formed on the recommendation of a special committee sponsored by the Economic Council of Quebec, is a special work study and scientific training centre designed to fulfill a recognized need in Quebec. It is an independent non-profit organization.

The COSE is offering a basic comprehensive work study course for engineers or technicians actively engaged in the field. The course is theoretical and practical, lasts 240 hours, and is given one or two days a week during a five or ten month cycle.

An initiation course totalling 24 hours is directed to managers, supervisory personnel, foremen and others who direct or co-operate with work study analysts, but who need not apply these techniques directly.

Future courses are planned in office work study (O & M), quality control and other subjects related to industrial engineering. Courses, given normally in French, can be given in English.

Services include a documentation centre containing French and English periodicals, reference books and films.

For further information write to the COSE at 685 Cathcart Street, Montreal 2.

Colonel William Capelle Retires

Col. William A. Capelle, M.E.I.C., of Ottawa, completed a 29-year military career when he retired from the Regular Army this month.

He had been seconded to the office of the Assistant Deputy Minister of National Defence (Construction and Properties Division) since April, 1962.

Col. Capelle had been active and effective in the E.I.C., having served as Chairman and as Councillor of the Ottawa Branch.

He began his career in the Army shortly after earning his Bachelor of Science (Civil Engineering) degree at the University of Manitoba in 1932. His first appointment was as a second-lieutenant with the 12th Field Company, Royal Canadian Engineers, Non-Permanent Active Militia.

In September, 1939, he assumed command of the 1st Canadian Corps Field Park Company which was mobilized in Winnipeg, and which he took overseas. He served in England and in France until his return to Canada in the summer of 1945, at which time he retired from the Active Force.

Col. Capelle rejoined the Regular Army in January, 1947, and was appointed Assistant Director of Works and Accommodation at Army Headquarters in Ottawa. He subsequently headed this directorate until appointed command engineer at Ceneral Command in Oakville, Ont., in November, 1950.

Following promotion to rank of colonel in October, 1952, he served in the capacity of Director of Works, and later as Director of Engineering Development, both at Army Headquarters. From September, 1957, until September, 1958, he was in command of the Canadian Base Units of the United Nations Emergency Force in the Middle East.

On his return to Canada, Col. Capelle was Director of Quartering at Army Headquarters, a position he held until April, 1962.

Canadian Association Of Management Consultants

The Canadian Association of Management Consultants, which came into being officially earlier this year, has issued a brochure which states its objectives and explains the broad range of services offered by its members.

Although management consulting has been practised in Canada by Canadian firms for more than thirty years, there had not been any form of professional association of management consultants in this country.

The new association aims at fulfilling, in Canada, the functions now being performed in the United States by the Association of Consulting Management Engineers, and in the United Kingdom by the Management Consultants Association. Like these older bodies, the Canadian Association of Management is designed to become the recognized Association for professional management consultants in Canada.

Member firms offer a wide selection of specific services under the general classifications of general management, production, finance and control, marketing, and personnel.

Keystones of the new Association are its statement of professional objectives, and its code of ethics. Requirements for admission to the Association are:

The firm must have been engaged in management consulting in Canada for at least five years;

Throughout this period it must have maintained a minimum full-time staff of eight professional consultants. (In both these cases the period of five years is reduced to three years for firms of known reputation previously established in other countries);

The firm must serve clients in at least two areas of management, production, marketing, finance and controls, and personnel administration;

Persons employed in the direction, control and execution of consulting assignments must be recognized by the Association as experienced and competent in their particular fields of management consulting;

The firm must have recognized standing in the field of management consulting, as evidenced by its activities in a number of spheres toward the advancement of the profession;

The firm must provide evidence to the Association of a record of competence, ethical conduct, high standards, independence and stability.

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PORTER'S 20" HYDRAULIC DREDGE "SHUNIAH" DURING REMOVAL OF 550,000 CUBIC YARDS OF SAND, SILT AND RUBBLE, FOR DEPARTMENT OF PUBLIC WORKS, CANADA, AT SHIP CHANNEL EXTENSION, TORONTO.

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THE J. P. PORTER COMPANY LIMITED

Personals

(Continued from page 58)

George MacDonald Haliburton, M.E.I.C. (N.S.T.C. '43) has been appointed Manager, Production and Engineering, Atlantic Region by Canadian Liquid Air Ltd. Mr Haliburton joined the company in 1946, and managed the Atlantic Provinces as District Manager until appointed Manager of Technical Development in 1960.

Morton R. Angus has been appointed production control manager; **J. F. Braithwaite,** personnel and industrial relations manager; **John Busk,** production manager; **John Simpson,** safety manager; **Norman W. Slaughter,** quality control manager; **Brian G. Hickey,** factory accounting manager and **Reginald J. Weaving,** facilities manager at Massey-Ferguson's North American combine plant at Brantford, Ontario.

Peter Squarrie has joined the Canadian Welding Bureau as its Western representative. He will serve the area from the Lakehead to the Alberta border. Mr. Squarrie, a Civil Engineering graduate from the University of Manitoba, has been employed by the Truscon Steel Works as District Engineer. He has a wide background in the design and development of structural steel.

M. Burtyk

Dr. C. S. Lord

P. Nicolle

H. Fernberg

Michael Burtyk has been elected President of Acme Steel Company of Canada, Ltd. He was formerly Vice-President — Production. Mr. Burtyk joined Acme Steel in 1929, and in 1952 was promoted to superintendent of manufacturing in the company's Toronto plant. He was named Vice-President in 1959.

Dr. Clifford S. Lord, chief geologist of the Geological Survey of Canada, has been loaned to the External Aid Offices by the Department of Mines and Technical Surveys to assist in a Colombo Plan survey of the need for major land use studies in the newly-formed state of Malaysia.

E. G. DeWolf, M.E.I.C. (N.S.T.C. '44) has been appointed sales representative for the Smith & Loveless division of Procor Limited for the Maritime Provinces.

Phillip Nicolle has been appointed to assume responsibility of the re-organized mid-western operations of Atlas Copco Canada Ltd. Mr. Nicolle joined the company in 1959. In 1961 he was appointed district manager in Winnipeg.

Harold Fernberg has been named manager of the newly-created service division of Atlas Copco Canada Ltd. Mr. Fernberg studied Mechanical Engineering at Helsinki College, Finland. His Canadian experience includes engineering design, maintenance and mining. He will be located at the company's headquarters in Montreal.

R. R. McIntyre, M.E.I.C. (Sask. '49) has been appointed Chief of the Soil and Water Conservation Section of the Agricultural Rehabilitation and Development Administration, Ottawa. Mr. McIntyre has been assistant chief engineer with the Maritime Marshland Rehabilitation Administration at Amherst, N.S.

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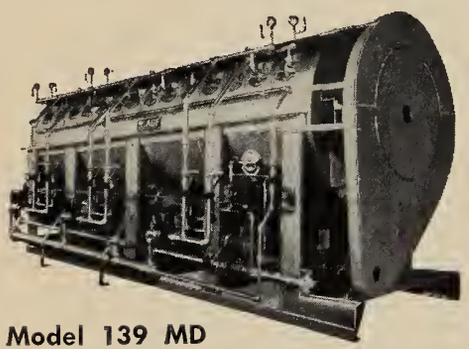
In the VERSATILE AGF rotary retort furnace



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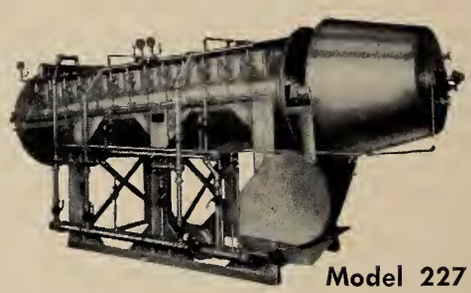

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W. J. Horner

J. R. Williamson

W. J. Horner, M.E.I.C. (Sask. '45) has been appointed Manager, Joy Alpha Fan Division. He will be located in Winnipeg, the Alpha division headquarters.

J. R. Williamson has been appointed manager, Marketing Department, in the Canadian Westinghouse Power Transformer and Circuit Breaker Division. Mr. Williamson joined the company in 1948 following graduation from Nova Scotia Technical College.

Dr. J. M. Douglas, M.E.I.C. (Michigan '58), Associate Professor of Chemical Engineering, McGill University, has been elected Chairman of the Chemical Engineering Division of The Chemical Institute of Canada for 1963-64. Dr. Douglas joined the staff of McGill in 1958. Prior to that time he spent three years at Polymer Corp., Sarnia as a process engineer and later as a development engineer.

Max Drouin, M.E.I.C. (Laval '51) has been appointed Manager of Canadian General Electric's Meters and Instruments Section in Quebec City. Mr. Drouin joined CGE in 1951. In 1957, after a number of engineering and manufacturing assignments, he was named Manager-Sales, Meters and Instruments.

Charles F. Atcheson, M.E.I.C. (Manitoba '53) has been appointed Plant Superintendent, Scarborough Works of Acme Steel Company of Canada, Limited. Prior to joining Acme Steel, Mr. Atcheson served eleven years with Canadian Westinghouse Co. Ltd. in Hamilton.

Obituaries

MacAulay, K. P., A.M.E.I.C. (N.S.T.C. '61)

Nathanson, J., M.E.I.C. (McGill '50)

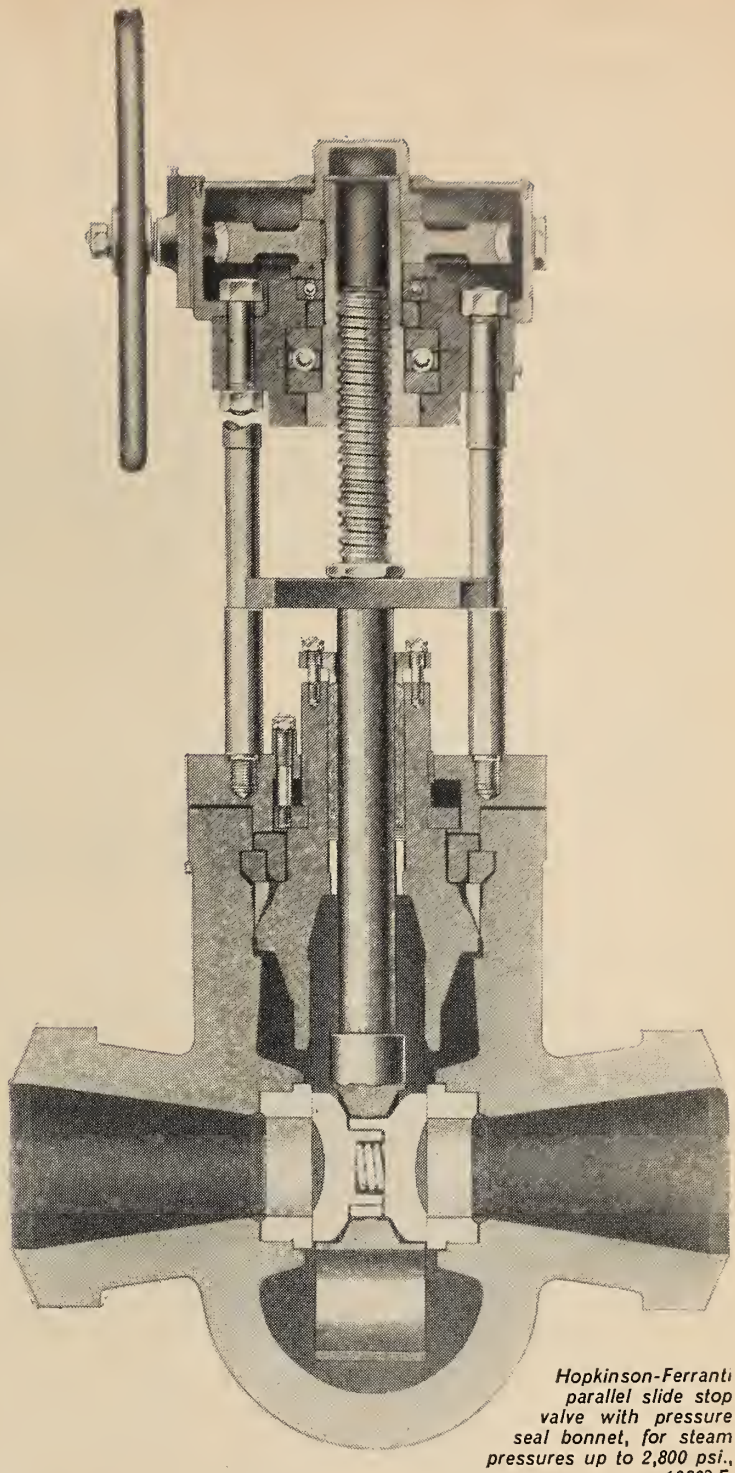
Nelson, S. K., S.E.I.C. (U.B.C.)

Nohr, L. H., A.M.E.I.C. (U.B.C. '60)

Roberts, T. B., A.M.E.I.C. (Toronto '62)

Stewart, A. L., M.E.I.C. (Toronto '20)

Vinet, Eugene, LIFE M.E.I.C. (McGill '11)



Hopkinson-Ferranti parallel slide stop valve with pressure seal bonnet, for steam pressures up to 2,800 psi., 1060° F.

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Hopkinsons' name is well represented in every major thermal power generating station in Canada. A complete line of steam valves, safety valves, soot blowers and boiler mountings is available for all temperatures and pressures. To keep maintenance and shut-down costs at a minimum and to ensure the maximum in dependability, Hopkinsons' is the name to specify.

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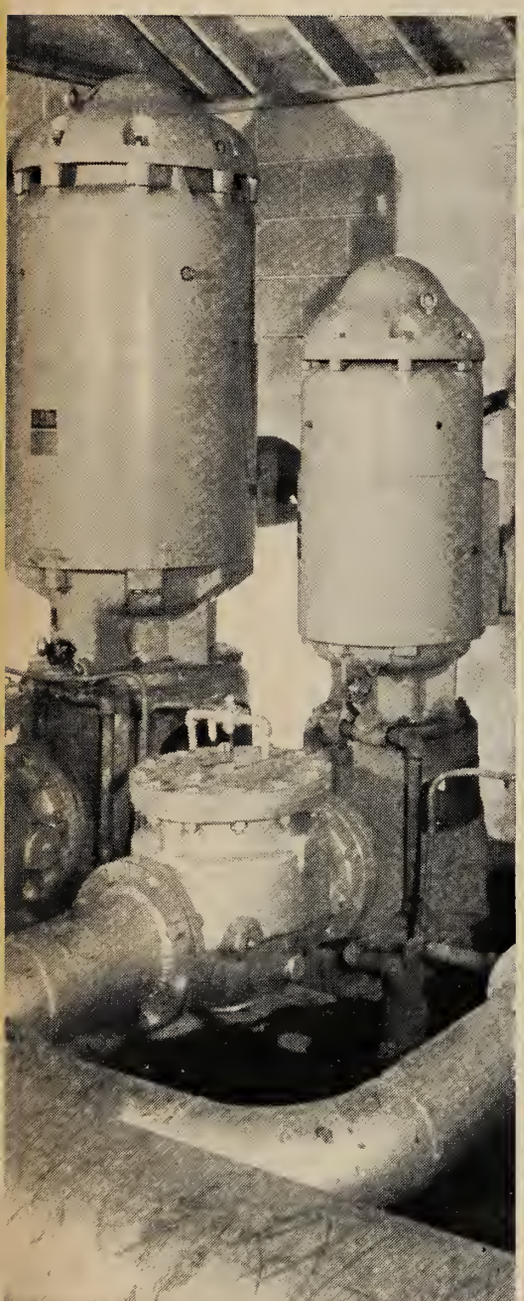
clean it up...

change its character..



Southern—Deming Pumps

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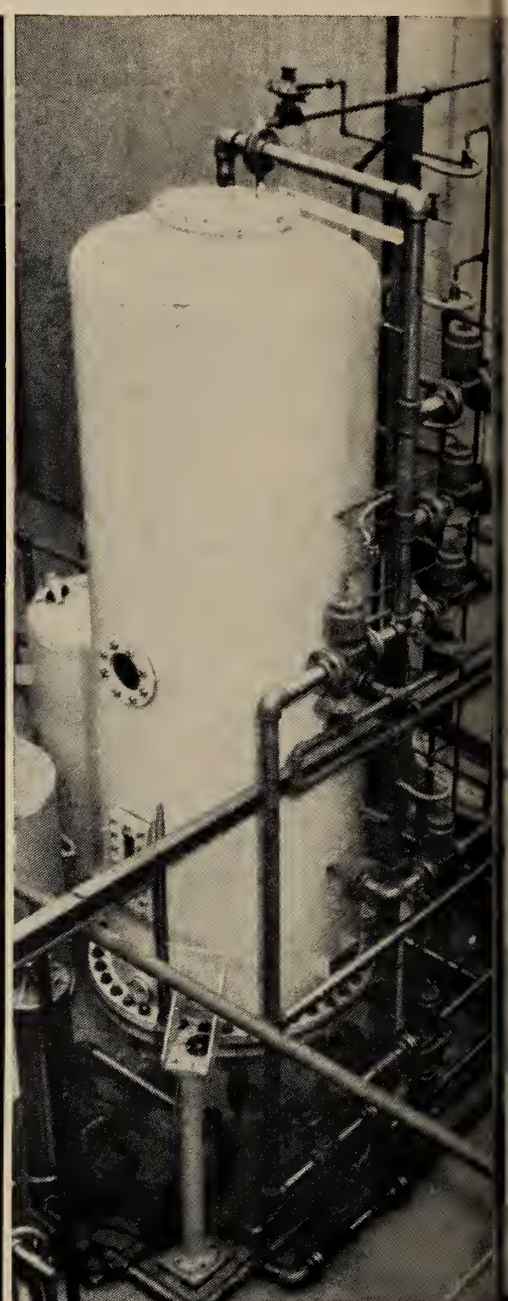

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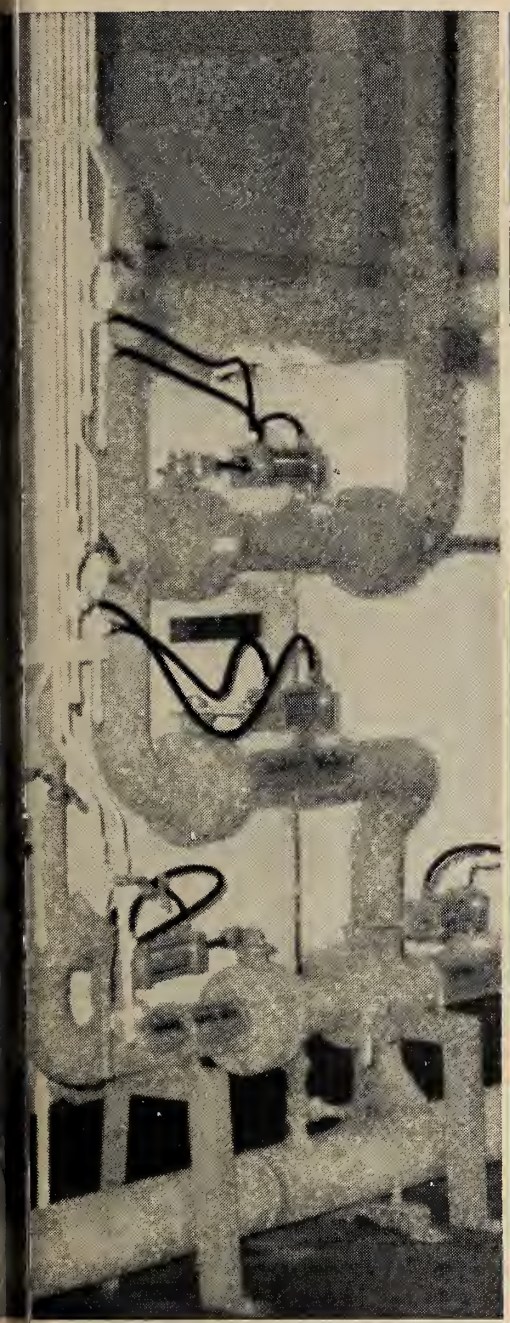
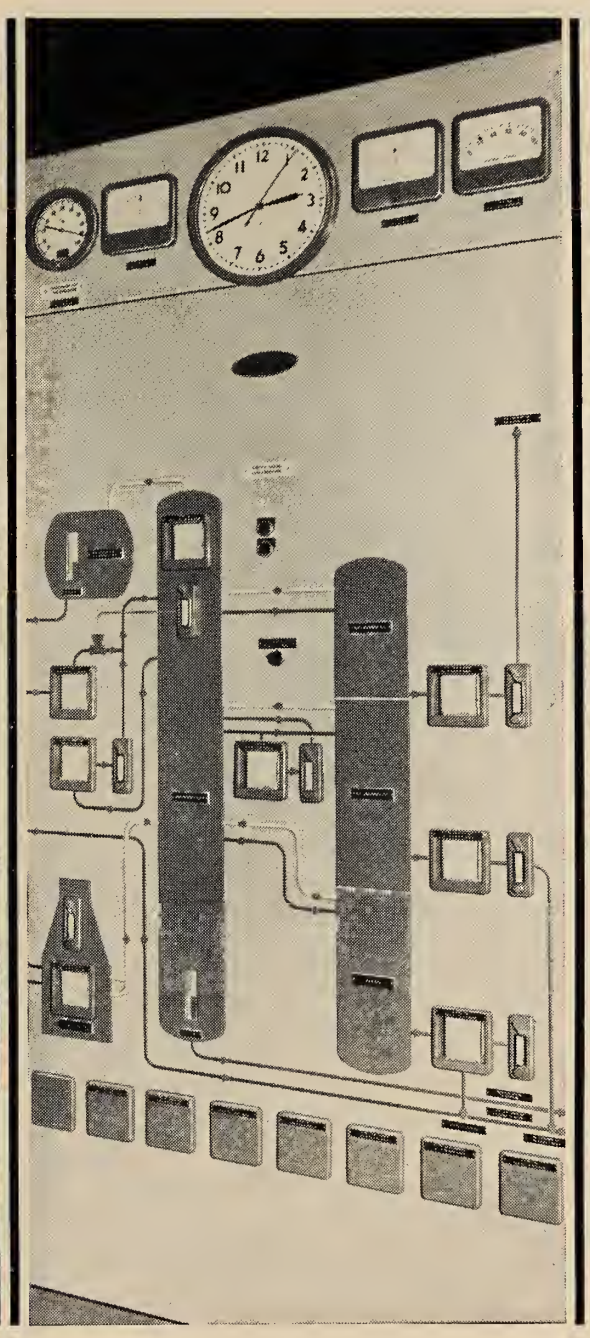
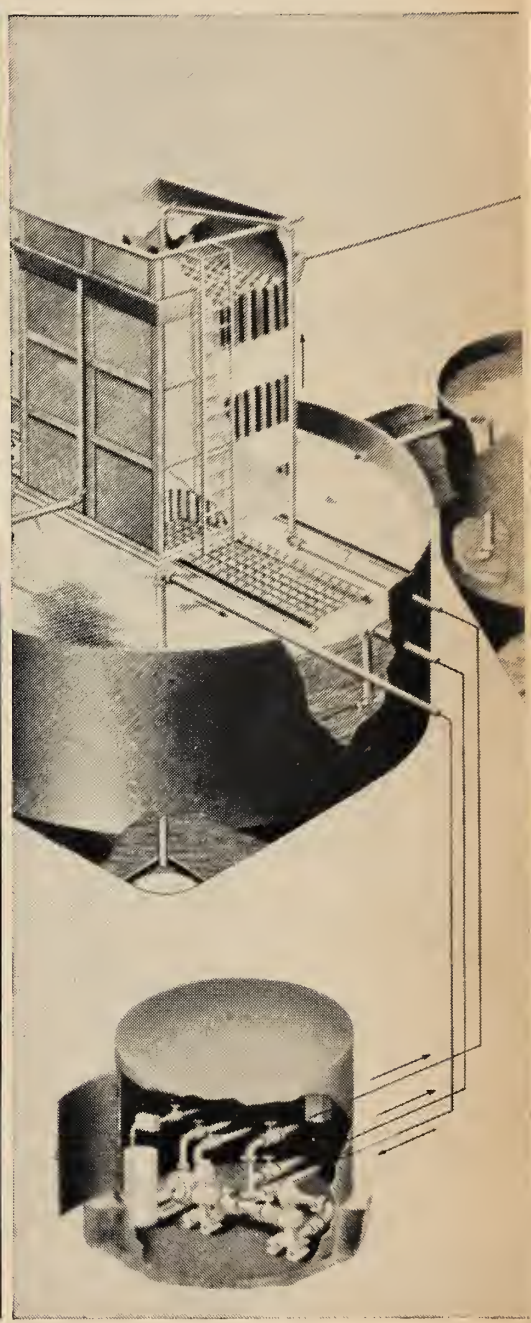


Crane Monogrammed Piping



Swartwout Electronic Controls



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Branch News

(Continued from page 42)

U.B.C. STUDENT SECTION

Brian A. Van Snellenberg, S.E.I.C.

E. G. W. Bush, M.E.I.C., Field Engineer with the Master Builders Company in Vancouver, and membership chairman of the Vancouver Branch, EIC, was the guest speaker at the Student Section's meeting of October 25. In his talk, Principles and Applications of Grouting, Mr. Bush outlined the various ways in which homogeneous spheres can pack, the void spaces resulting, and the configuration of smaller spheres which would be required to fill the void. This type of packing was compared with the packing of unconsolidated materials, and the different types of grout which would be required to fill them, Water sealing for dams, support for settling foundations, and solidification of subsoil to minimize transmitted vibration were applications illustrated by slides.

VANCOUVER

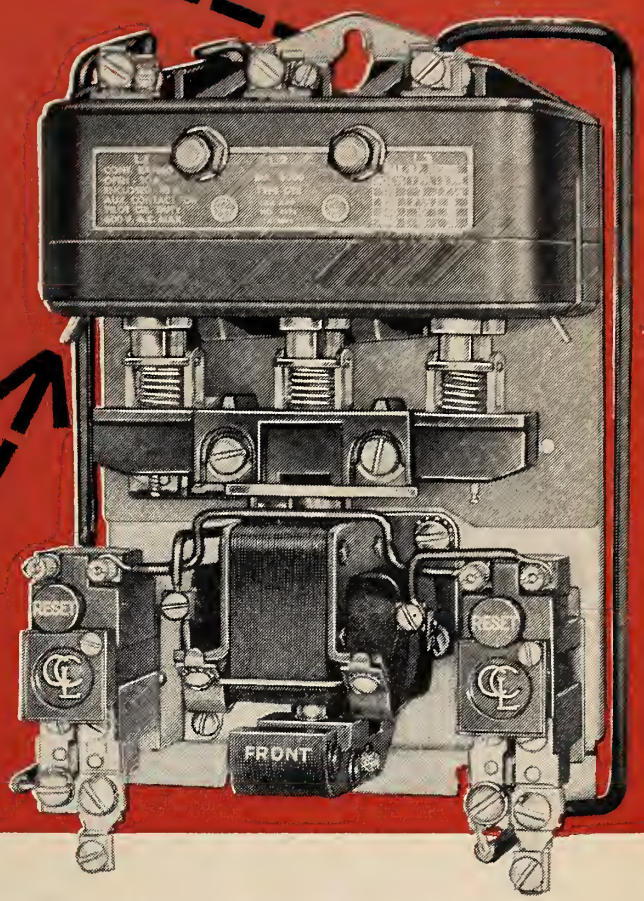
L. B. Davies, M.E.I.C.

The Branch's technical program for the 1963-64 season has been organized by Keith Henry, M.E.I.C., Technical Activities Chairman, around the theme of "Power in British Columbia". The program was inaugurated on October 2, by Dr. Gordon M. Shrum, Co-Chairman of the B.C. Hydro and Power Authority, when he delivered an address entitled, "Power in British Columbia". Dr. Shrum reviewed the power situation in B.C. at the present time, and predicted that power from the Peace River development would be required to meet the growth in load requirements, and to replace obsolete and expensive generating equipment.

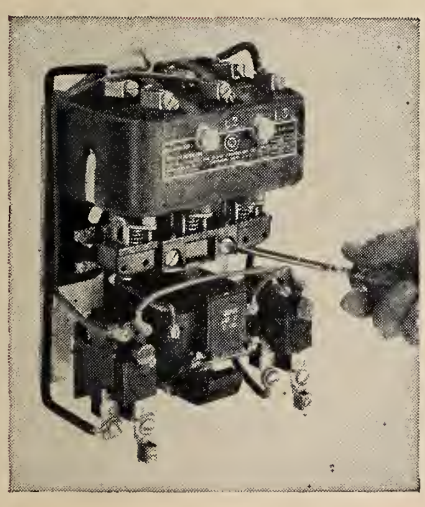
On October 8, Dr. Anthony D. Scott of the Department of Economics and Political Science, University of British Columbia, presented a talk on "Economic Considerations in the Development of Hydro Power in British Columbia". Dr. Scott explained how the earlier concept of evaluating hydro projects by the estimated cost of power produced has been supplanted in United States Corps of Engineers practice, by the broader concept of benefit-cost analysis. In this type of analysis, the benefits of a hydro project are considered to include not only the revenue earned from power, and that earned from other direct uses such as navigation, irrigation and water supply; but also intangible benefits such as flood control and recreation. The ratio of these benefits to the cost of the project constitutes a measure of the true economic worth of the project and permits comparisons to be made between alternative projects. Dr. Scott pointed out that benefit-cost analysis has yet to be applied on a large scale in Canada, and showed that the failure to analyse projects in this way may lead to uneconomic utilization of resources.

EIC

to the front...



with C.C.L. Type "CY" STARTERS



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of the

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BANFF SPRINGS HOTEL, BANFF, ALTA.

May 27-29, 1964

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Davie is building, transporting and erecting the penstocks for Calgary Power Limited's Big Bend Power Development Project on the Brazeau River. Industries served by BIG DAVIE include those associated with Hydro-Electric and Irrigation Developments; Petro-Chemical Processing; Mining; Defence Research and Development; Bulk Storage, etc.

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SITUATIONS VACANT

Rate: Six dollars per column-half-inch per insertion.
Replies to advertisements should be addressed to the file number, Employment Service, 2050 Mansfield Street, Montreal. Interviews with the Employment Service may be arranged by calling VI 2-8121 at the above address.

SITUATIONS WANTED

CIVIL ENGINEER — A.M.E.I.C., B.Sc. (Man.), M.Sc. (Alta.), in highways and soils. Age 37, married. Employed in supervision of highway construction, contract and construction control in drainage works. Arriving Canada from Hong Kong in February 1964. Seeks position in highway design and construction, soils and foundations in Toronto, Montreal or anywhere. Available February 1964. File No. 580-C.

CHEMICAL ENGINEER — B.Sc.Ch.E. '42, M.A.I.Ch.E., Prof. Engr. 20 years' experience as research, process, job and project development engineer for oil and gas processing, and petrochemical plants. Perfect German, some Dutch and Russian. Seeks position with engineering or oil company in Eastern Canada. Available at one month's notice. File No. 6167-Ch.

ELECTRICAL ENGINEER — M.E.I.C., P.Eng. Que. McGill 1941. Married, bilingual. Experience — in the field of hydroelectric power generation and high voltage transmission — has been equally divided between the technical aspects of operation maintenance and construction and departmental management administrative functions. Wish to become associated with the management of an industrial manufacturing company in the area of general administration or plant management. Prefer Ontario location but willing to relocate elsewhere. Resume on request. File No. 579-E.

CIVIL ENGINEER — A.M.E.I.C., B.Eng. (N.S.T.C.) 1961. 1 year experience in municipal engineering as resident engineer and 1 year in sales engineering. High academic standing and good employment record. Desires position with consultant in design and/or supervision in municipal and traffic engineering. Future plans include full or part time post-graduate studies depending on employer. Location Ontario or Quebec. File No. 6467-C.

CIVIL ENGINEER — A.M.E.I.C., P.Eng. (Que), R.M.C. 1957, B.A.Sc. Toronto 1958, M.Sc. in hydrodynamics M.I.T. expected June 1964. Experience includes 3 years R.C.A.F., 1½ years with consulting firm in field and office positions, 2 years' research experience in hydrodynamics at M.I.T. Desires position in design and/or research in hydrodynamic field. Married, 3 children. Available June 1964. File No. 592-C.

MARKETING MANAGEMENT OR ADMINISTRATION — Civil Engineer, M.E.I.C., P.Eng., B.Sc. Alberta 1957. Candidate for Master of Business Administration Degree (U.W.O.) May 1964. Age 29, married. 5 years' experience in metal products field in sales and promotion to Government agencies, consultants, and industry. Experience in dealer selection, training, and supervision. Major interest in durable goods, available May 1964. Location open. File No. 591-C.

MINING ENGINEER, SALES — M.E.I.C., P.Eng. (Que.), C.I.M.M. 12 years in sales and sales management mining and construction equipment. Present location Western Canada, seeks position as western representative for manufacturer of equipment or products for the mining industry. Mature dependable representation assured with established contacts in coal, metallic and non-metallic mines. File No. 590-S.

ELECTRICAL ENGINEER — S.E.I.C., P. Eng. (Ont), N.S.T.C. 1959. 4 years' outstanding industrial experience on diversified projects. Industrial, processing, commercial, and institutional, power distribution design. Desires responsible and challenging position in industrial or consulting field. File No. 522-E.

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CHEMICAL

RESEARCH AND DEVELOPMENT CHEMIST — required by large Textile Coating Company. Must be fully experienced in Vinyl Plastisol Compounding. Excellent starting salary, fringe benefits. Reply in detail to File No. 517-V.

CIVIL

DESIGN ENGINEER — Required by the City of Regina, to be responsible for the preliminary design of sewer and water systems, including sewage treatment plants and water-pumping stations. Qualifications: Graduation in Engineering from a recognized university; eligibility for professional status with the Association of Professional Engineers (Saskatchewan); at least five years' experience in responsible engineering work, preferably in the sewer and water field. The salary range for this position is from a minimum of $7,212 to a maximum of $9,168 per annum. Applications and enquiries should be directed to the Personnel Department, City Hall, Regina, Saskatchewan. File No. 572-V.

NOTICE TO ADVERTISERS

DEADLINE — Please note that requests for insertions must be submitted in writing not later than the **12th of the preceding month.**
Cancellations: same as above.

SITUATIONS VACANT — Classified rate: $6 per column-half-inch per insertion. Display rates: Per insertion — 1/12 page — $100; 1/8 page — $120; 1/6 page — $195; 1/4 page — $215; 1/3 page — $285; 1/2 page — $345.

DATE IN CIRCULATION — 20th of month.

SITUATIONS WANTED — Accepted free of charge from Members of The Engineering Institute of Canada only.

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Chief Superintendent, Naval Research Establishment, c/o Fleet Mail Office, Halifax, N.S.

OR

Chief of Personnel, Defence Research Board, Dept. of National Defence, Ottawa 4, Ontario.

and refer to file 63-NRE-2A.

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MECHANICAL ENGINEER — Recent graduate with one to three years' general engineering experience, to serve as junior engineer in the Plant Engineering office of an expanding company. This company is located in the Annapolis Valley area of Nova Scotia. Duties will consist of working on varied projects under the supervision of the Plant Engineer. Applications should be in writing with full resume, and will be treated in confidence. Apply in writing to File No. 568-V.

MECHANICAL ENGINEERING GRADUATE required by leading manufacturer of industrial instruments, for the Production Engineering department. Duties would include general engineering assistance to the manufacturing process, some factory project supervision, occasional travel to the U.S.A. factory, organizing manufacturing information on revisions. Position offers scope for an energetic person. Applicant must have manufacturing experience and be capable of working with limited supervision. Apply in writing only to Personnel Department, The Foxboro Co. Ltd., 707 Dollard Avenue, La Salle, Quebec, giving age, experience, salary requirements, and other pertinent information. File No. 566-V.

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McMASTER UNIVERSITY — Applications are invited for appointments in the Department of Electrical Engineering. Candidates should have an interest in one or more of the following: Network Theory; Non-linear Circuits; Communications; Control Systems; Digital Systems. A Doctorate in Electrical Engineering is required and industrial research or development experience would be an advantage. Duties include teaching at undergraduate and graduate levels, conducting research and supervising graduate students. Salary according to qualifications and experience. Floor Salaries: Assistant Professor $7,250; Associate Professor $9,250; Professor $12,-500. Additional stipends for summer research work. Applications and inquiries should be addressed to The Chairman, Department of Electrical Engineering, McMaster University, Hamilton, Ontario. File No. 555-V.

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For Engineering Department of integrated sulphite, sulphate and groundwood pulp and paper mill located Ocean Falls, B.C.

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Support is provided by a group to install instrumentation at field sites, and groups for development, calibration and maintenance of transducers. Facilities include multichannel magnetic tape recording and data presentation; semi-automatic data digitalization equipment; a digital computer; shock tube; laboratories for development, construction and maintenance of electronic equipment; model shop and large machine shop.

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CITIZENSHIP:

Candidates must be Canadian citizens or British subjects.

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Please apply in writing, enclosing curriculum vitae to:

Chief of Personnel
Defence Research Board
National Defence Headquarters
Ottawa, Ontario.

and refer to File 63-SES-1E.

THE NOVA SCOTIA TECHNICAL COLLEGE invites applications for the position of head of the Department of Electrical Engineering, which will become vacant in May 1964. The position calls for leadership in teaching and administration as well as offering the opportunity of developing a rapidly expanding group of graduate students. Candidates should have a higher degree, an established field of research and a number of years of university teaching experience. Salary will be commensurate with a senior appointment. Applications should be sent to the President, Nova Scotia Technical College, Box 1000, Halifax, N.S. File No. 556-V.

MECHANICAL ENGINEERING — Assistant Professor required with Ph.D. to do research and teach at the undergraduate and graduate levels in applied mechanics, vibrations, stress analysis, machine design or related fields. Excellent facilities and working conditions. Good salary range with summer research stipend available. Duties to commence July or September 1964. For further information apply to Chairman, Department of Mechanical Engineering, McMaster University, Hamilton, Ontario. File No. 565-V.

THE UNIVERSITY OF BRITISH COLUMBIA — HEAD OF THE DEPARTMENT OF CIVIL ENGINEERING. The University of British Columbia is proceeding to the appointment of a Professor to be Head of the Department of Civil Engineering in succession to Professor J. F. Muir, who will retire on June 30, 1964. The Department of engaged in research and teaching in most areas of civil engineering, and it is not proposed to specify a particular area in which the Head of the Department should be primarily qualified. He will be encouraged to develop the broader aspects of civil engineering without being unduly bound by past traditions. Accordingly, the Selection Committee would like to receive from each applicant a statement of his views on desirable trends in civil engineering research and teaching, and on the proper relation of civil engineering to allied engineering and other disciplines. Applications are invited for this position and should reach the undersigned (from whom further particulars may be obtained) not later than January 10th, 1964. They should contain appropriate details of the applicant's career and the names of several referees. —Dean D. M. Myers, Faculty of Applied Science, The University of British Columbia, Vancouver 8, B.C. File No. 564-V.

MARITIME REGIONAL TECHNICAL CONFERENCE

Fredericton, N.B.

January 30, 31, February 1, 1964

Sponsored by the Fredericton Branch EIC-APENB. Technical papers will be presented on the afternoon of January 30 and the morning of January 31. Field trips have been planned for February 1.

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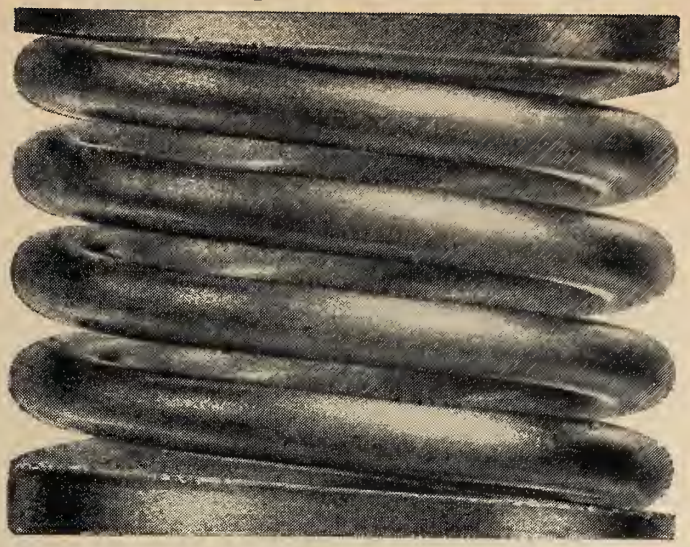

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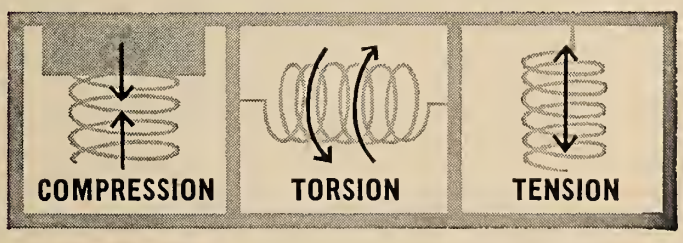

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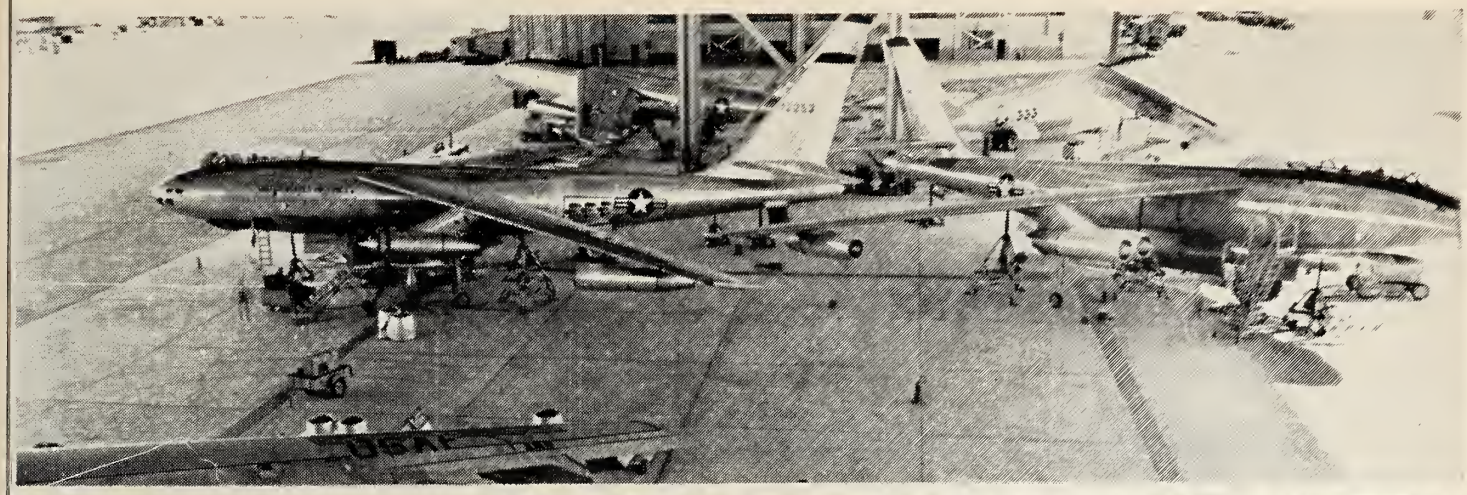

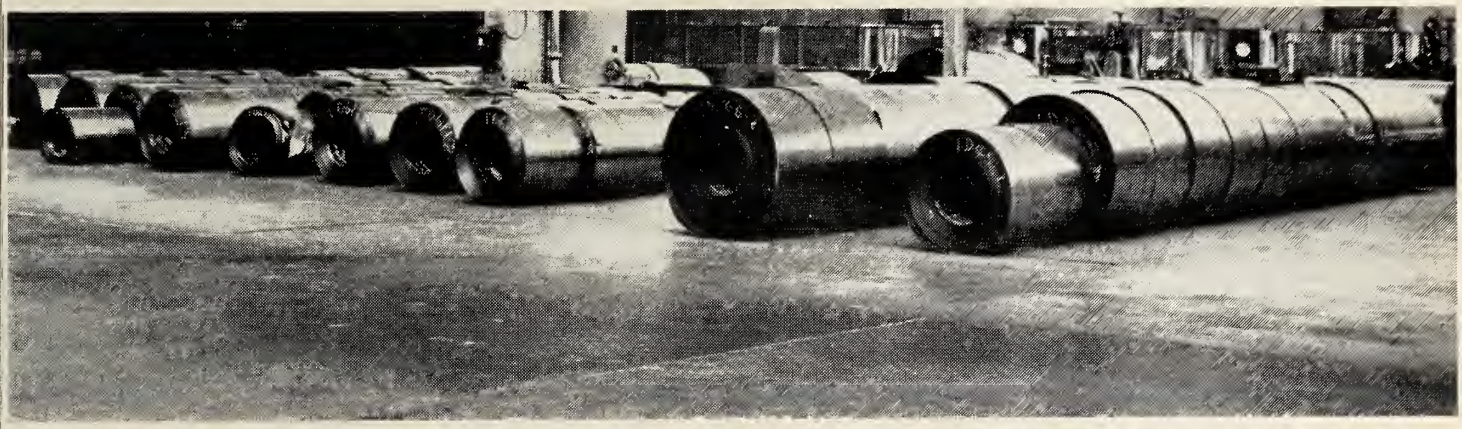

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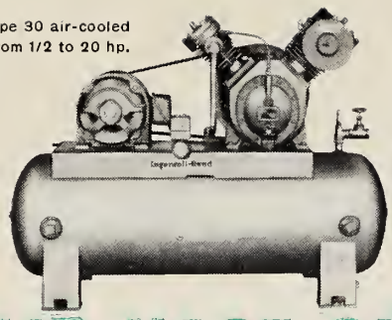

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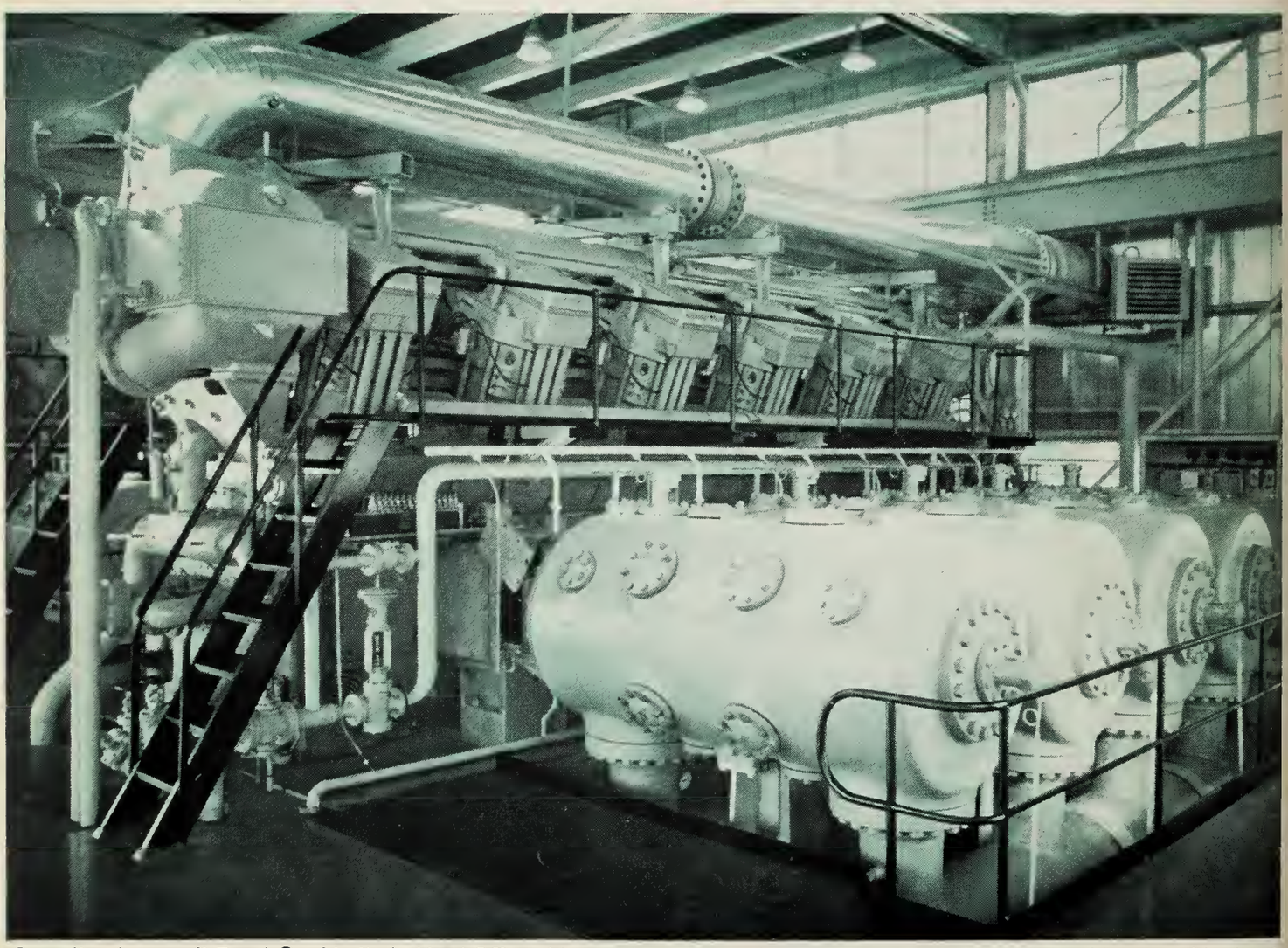

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