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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Spillways in Nova Scotia Proven Inadequate

Record-Breaking Floods Last Month Destroyed Bridges, Dams and Roads—Hydro-Electric Plants Temporarily Put Out of Commission—Serious Failure at Grand Lake Storage Dam—Computation of Flood Discharge on Several Streams

By K. G. CHISHOLM
Assistant Engineer, Dominion Water Power Branch, Halifax

HEAVY floods occurred over the western portion of Nova Scotia on March 13th and 14th, 1920. In the district known locally as "the valley," the floods attained a severity unprecedented within the memory of the oldest inhabitant.

On Friday, March 12th, the temperature rose from a few points above freezing to 50 degs. F.; Saturday and part of Sunday remained warm, and a heavy fall of rain occurred during these three days. Table 1 gives meteorological observers' reports, in connection with which it should be noted that the recording stations at Wolfville and Kentville are subject to much lighter precipitation than the high surrounding country feeding the streams.

The winter's accumulation of snow, amounting to between 2 and 3 ft., was quickly melted and—augmented by the heavy fall of rain—ran off the frozen ground into the streams with great rapidity.

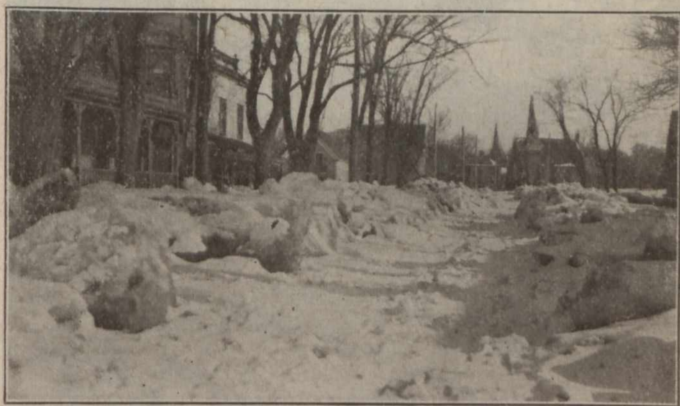
In "the valley" district the rate of run-off was expedited by the topography. This district embraces a valley from 1 to 3 mi. wide which extends from Minas Basin to Annapolis Basin, draining east by the Cornwallis River and

HIGHWAY BRIDGE AT BRIDGETOWN, N.S.

west by the Annapolis River, both tidal streams. There are high plateaus on each side of the valley, rising abruptly to elevations of 500 and 600 ft., from which descend a number of small, precipitous streams. The topographic conditions are, therefore, such as to increase the rate of run-off.

At several places, notably Kentville and Truro, the rivers were unable to clear themselves of ice, and the back-water from ice jams caused a major portion of the damage. In most cases, however, the floods were uninterrupted, open-water run-off, as the ice went out at a comparatively early stage of the flood.

The streams started to rise early Saturday morning, March 13th. Before midday, many of the streams had swept themselves clear of ice. The rise continued all day Saturday and reached a maximum early Sunday morning, after which



STREET IN BRIDGETOWN, N.S., SEVERAL DAYS AFTER FLOOD HAD RECEDED

it gradually subsided to average high water within two or three days.

The damage was heavy. Bridges were swept away, dams carried out, roads and railways submerged, orchards ruined and livestock drowned in barns which were thought to be well beyond the reach of extreme high water. There was also considerable damage to hydro-electric developments, and the inadequacy of existing spillways was clearly demonstrated.

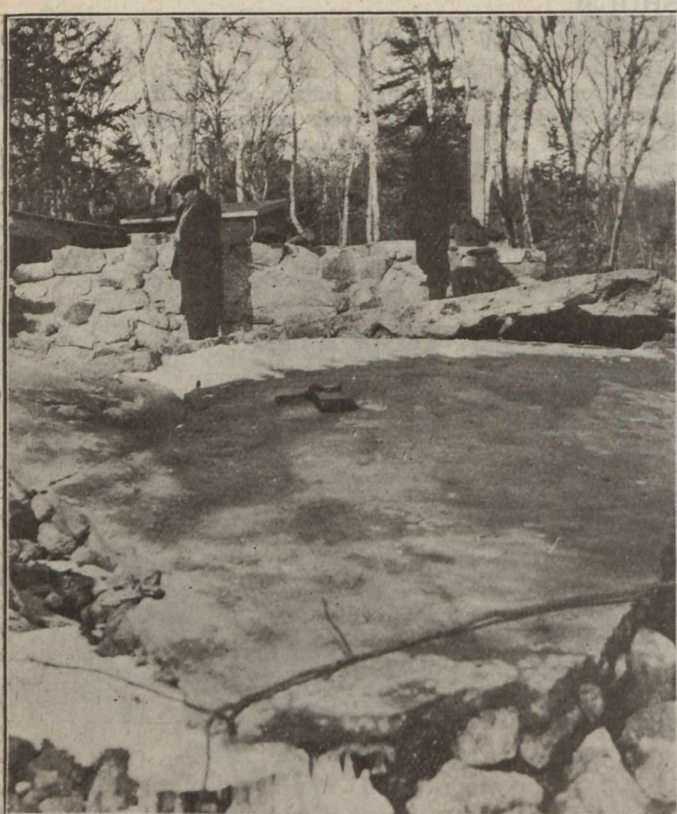
At the Gaspereau hydro-electric plant, the flood topped the bulkhead section of the dam by about 10 ins. and ran over the roof of the power-house. The solid concrete dam escaped damage, as did the temporary wooden power-house, although great anxiety was felt at the peak of the flood. It is the intention to increase the height of the bulkhead section of the dam by 2 ft. and to replace the wooden power-house with one of concrete.

At the Nictaux Falls plant of the town of Middleton, the original spillway, 132 ft. long and 2 ft. deep, had already been increased 1 ft. in depth by removing a 12-in. timber bolted to the top of the concrete. Even this increased capacity was insufficient. The flood ran over the top of the whole dam and washed out the earth from underneath the wooden intake flume. The bottom of the flume dropped out and the plant was out of commission until repairs had been effected.

The timber crib dam at Lawrencetown held although 10 ft. of water passed over it at the peak of the flood. The head was entirely obliterated. Tailwater and headwater became of the same elevation, the position of the dam being indicated only by a slight disturbance in the water surface. The power-house, which is at the base of the dam, was flooded to a depth of 5½ ft., and the machines were thoroughly soaked. In an endeavor to dry them out by running the plant after the flood had subsided, several coils were short circuited. The plant was out of commission for over a week.

The wooden power-house on the Lequille River was seriously damaged. Two sides of the building and part of the floor were carried away, and the generator and exciter were soaked. Annapolis was without lights for two weeks.

A serious failure also took place at the storage dam at the foot of Grand Lake. The dam had been built just last year, and the inpounded water would have carried the Lequille plant over the low-water period of the coming summer. The failure is attributed directly to inadequate spillway capacity. The bulkhead section of the dam was earth fill. The spillway, designed for a length of 80 ft., was actually built only 60 ft. long and 2.5 ft. deep. It consisted of a rock and gravel fill, faced upstream and down with well laid courses of heavy stone, and covered with a slab of concrete about 1 ft. thick. Fine material had been puddled into the centre of the dam, and the upstream face of stone carried about 2 ft. below the stream bottom. The head at the dam was about 12 ft. with reservoir full.



WRECKED SPILLWAY, GRAND LAKE DAM

The type of construction is, of course, open to criticism, but there is little doubt that the dam would have successfully withstood the flood had the spillway been of sufficient capacity. Over a foot of water went over the top of the embankment and a heavy current struck near the west end of the spillway, with the obvious result that the dam disintegrated at an accelerating rate. At the time of the writer's visit, more than a week after the flood, about 100 ft. of the centre of the dam, including most of the spillway, had disappeared, and a few feet of the right end of the spillway and the solid concrete sluiceway remained intact.

Following the flood, a trip was made through the district affected, and measurements and observations taken that would allow a fair approximation of the maximum rates of run-off to be compiled.

TABLE 1—TEMPERATURE AND PRECIPITATION

Date	Digby Temp. Max.	Digby Temp. Min.	Digby Rain	Annapolis Temp. Max.	Annapolis Temp. Min.	Annapolis Rain
March 12	51	35	0.05	47	34	0.35
March 13	53	42	4.12	50	36	3.26
March 14	50	22	0.05	53	25	1.21
March 15	30	20		28	17	
Date	Wolfville Temp. Max.	Wolfville Temp. Min.	Wolfville Rain	Kentville Temp. Max.	Kentville Temp. Min.	Kentville Rain
March 12	52	37	0.14	52	39	0.03
March 13	50	36	1.10	48	45	0.96
March 14	34	22	0.35	31	22	0.86
March 15	27	16		27	14	

High water marks were readily discernable, and levels were run and such other instrumental surveying and current meter work were done as was necessary. Floods were computed by extending the rating curves at regular gauging stations by the flow over dams, and in one case by the drop-off at a contracted section. The results obtained are given in the following table:—

Stream	Drainage Area, Sq. Mi.	Flood Discharge, Sec. Ft.	Flood Discharge Sec. Ft. per Sq. Mi.
Nictaux	115	2,500	21.7
Annapolis, S. Branch	35	1,200	34.3
Annapolis at Lawrencetown	414	24,500	59.2
Lequille	48	2,500	52.1
Bear, E. Branch	79	4,000	50.6
Bear, W. Branch	30	1,800	60.0
Gaspereau	143	4,150	29.0

Following are some previous Nova Scotia records:—

Stream	Drainage Area, Sq. Mi.	Flood Discharge Sec. Ft.	Flood Discharge Sec. Ft. per Sq. Mi.
Indian*	68	2,480	36.5
Margaree†	151	10,000	66.3
Philip‡	89	4,850	54.5
St. Mary‖	523	19,200	36.8

*April 6th, 1916; †May 14th, 1918; ‡October 22nd, 1917; ‖January 5th, 1918.

It is considered that the above figures should be of special value in the design of spillways, culverts and clear openings for bridges in Nova Scotia, and of some interest to engineers everywhere.

E. R. Gray, city engineer of Hamilton, Ont., has reported to the city council recommending that the city should at once undertake the construction of an artificial gas plant, preferably of the vertical retort type, of sufficient capacity to furnish the present requirements of the entire city.

W. Jackson, district engineer at Edmonton, Alta., for the Department of Railways and Canals, has completed a report on the Edmonton, Dunvegan & British Columbia Railway. The report was undertaken with a view to informing the government regarding the exact condition of the system.

Hearings on the proposal to construct a deep waterway from the great lakes to the sea, via the St. Lawrence River, and to develop power on the St. Lawrence River, will be held in a number of Canadian and United States cities in May and June by the International Joint Commission. The commission's itinerary, announced last week, includes hearings at North Bay, May 7; Marquette, Mich., May 10-11; Fort William, 13-14; Winnipeg, 16-17; Grand Fork, 18; Regina, 20; Calgary, 22-24; Billings, 26-27; Boise, 31; Cheyenne, June 2; Denver, June 3; Omaha, 5-7; Des Moines, 8; Aberdeen, 9; Minneapolis, 11-12; Duluth, 14-15; Superior, 16; Ashland, 17; Milwaukee, 18-19; Toledo, 21; Lansing, 22; Windsor, Ont., 23; London, Ont., 24; St. Catharines, Ont., 25; Hamilton, Ont., 26; Buffalo, 28-29.

THE DURATION OF TWILIGHT

By J. G. Sullivan
Consulting Engineer, Winnipeg, Man.

Being advised by a lawyer friend that the only information that he could find on the duration of twilight was contained in the encyclopedia (the only information given there being to the effect that it lasted until the sun was from 18 to 19 degs. below the horizon, and that "near the equator there is very little twilight"), the writer became interested in the question but could find very little written matter, although there is no doubt that there has been considerable written on the subject and anything that the writer may say here has, perhaps, been written before many times.

The subject is of very little economic value, so there is no justification for a long discussion, but one of the economic values that could be placed on the results, is that in high latitudes the laws re carrying lights on vehicles and railway trains between sunset and sunrise might be considerably modified for at least four months during the year.

If the statement in the encyclopedia is correct, that twilight lasts until the sun is 18 degs. or more below the

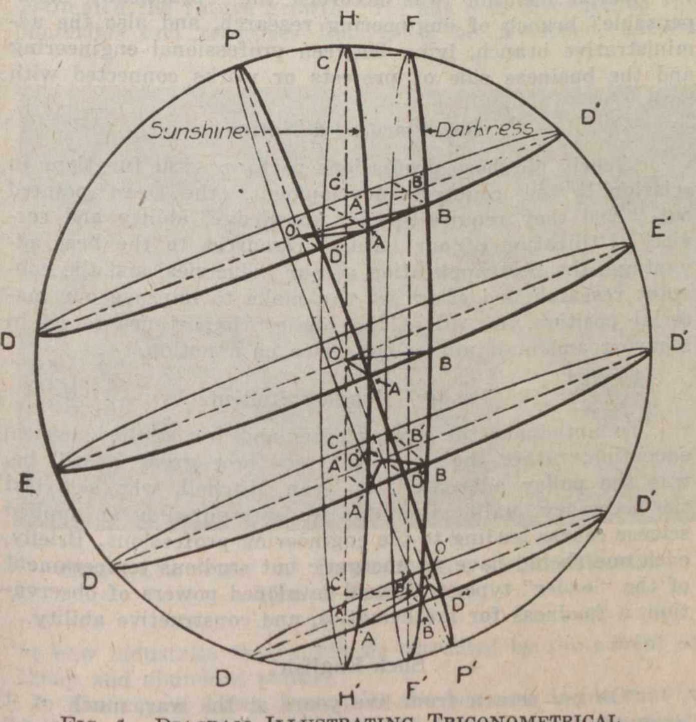


Fig. 1—Diagram Illustrating Trigonometrical Solution for the Duration of Twilight

horizon, then at the equator at the time of equinox, there would be 1 hr. 12 mins. or more of twilight. From various personal observations the writer is of the opinion that these figures are too large.

There being no absolute darkness, it is, of course, a very difficult matter to say when twilight ends and darkness begins, or vice-versa. Assuming that we are justified in believing that twilight has ended when no difference can be noticed in the brightness of the western horizon from any other portion of the horizon, and when the usual number of stars are visible (when there is no moonlight), then in the writer's opinion it would be nearer the facts to say that twilight ends when the sun is 15 degs. below the horizon.

To enable people who may be interested to judge of this matter for themselves, the writer has prepared two diagrams giving the duration of twilight at various latitudes and seasons of the year,—one on the assumption that the angle of twilight is 18 degs. and the other on the assumption that the angle of twilight is 15 degs.

For the benefit of those who may not care to take the trouble of working this problem out for themselves, the writer herewith gives his solution. The writer was of the opinion that it would be a problem in spherical trigonometry, but after a little study it was seen that it could be solved by plain trigonometry.

Let Fig. 1 represent the earth; O, the centre of same; EE', plane of the equator; HH', a plane perpendicular to the rays of the sun passing through the centre of the earth. Then, neglecting refraction and inequalities of the earth's

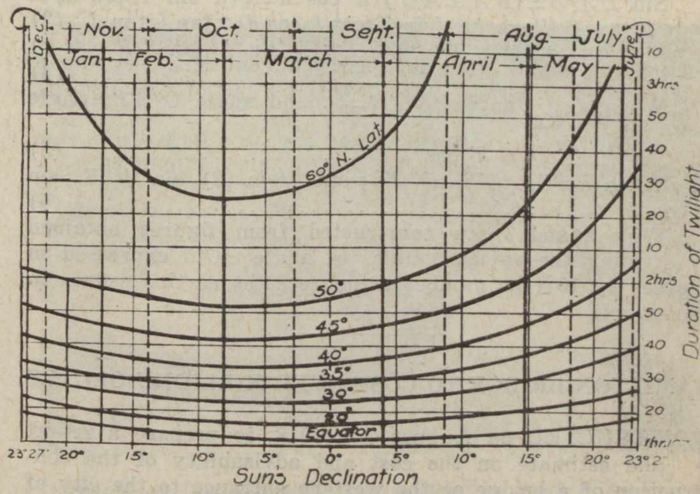


Fig. 2—Angle of Twilight, 18 Degs.

Diagram indicating the duration of twilight at various seasons of the year and at various latitudes in the northern hemisphere, assuming that the angle of twilight is 18 degs. (that is, 1 hr. 12 mins. at the equator when the declination of the sun is zero—about March 22nd and September 22nd).

surface, where this plane cuts the surface of the earth, is the loci of points of sunset or sunrise.

FF' is a plane parallel to plane HH' and marking the dividing line between twilight and darkness.

PP' is a plane through the poles of the earth and passing through the common axis of planes EE' and HH'.

DD' is a plane of any parallel of latitude.

Let R = radius of the earth.

L = angle of latitude of plane DD'.

d = angle of declination of pole PP'.

T = angle of twilight (given by some authorities as 18 to 19 degs.).

The problem is: Having given angle of twilight (T), to find the duration of twilight at various latitudes at various seasons of the year; that is to find the value of angle $AO'B$.

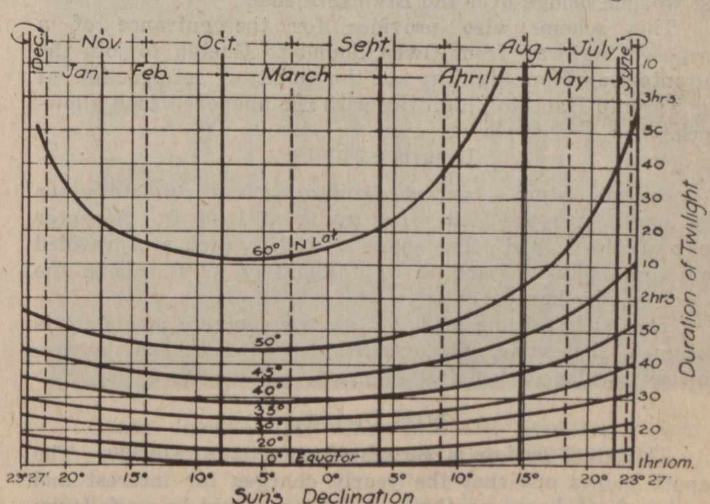


Fig. 3—Angle of Twilight, 15 Degs.

Diagram indicating the duration of twilight at various seasons of the year and at various latitudes in the northern hemisphere, assuming that the angle of twilight is 15 degs. (that is, 1 hr. at the equator when the declination of the sun is zero—about March 22nd and September 22nd).

The perpendicular distance between plane FF' and HH' is $FC = B'C' = R \sin T$. The constant distance for any given value of d between plane FF' and HH' measured in plane DD' is

$$B'A' = B'C'/\cos d = R \sin T/\cos d \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

The varying distance between plane PP' and plane HH' measured in plane DD' is $O'A'=OO'$ tan d. But $OO'=R$ sin L, $\therefore$ $O'A'=R$ sin L tan d, but as d may be plus or minus, tan d will take the same sign, and

$O'A'=\pm R$ sin L tan d .... (2)

Angle $AO'B=D''O'B\pm$ angle $D''O'A$.

Diameter of circle on plane $DD'=R$ cos L.

Sin $D''O'B=(B'A'\pm A'O')/R$ cos $L=[(R$ sin $T/$cos $d)\pm R$ sin L tan $d]/R$ cos $L=($sin $T/$cos L cos $d)\pm$tan L tan d (3)

Sin $D''O'A=O'A'/R$ cos $L=\pm(R$ sin L tan d/R cos $L)$ $=\pm$tan L tan d .... (4)

When $d=O$, angle $D''O'A=O$, and angle $D''O'B=$angle $AO'B$.

Sin $AO'B=$sin $T/$cos L .... (5)

When $L=O$, $AO'B=D''O'B$; and from (2), sin $AO'B=$sin $T/$cos d .... (6)

Figs. 2 and 3 are constructed from figures obtained by dividing the various values of angle $AO'B$ expressed in degrees by 15 (the number of degrees the earth revolves in one hour).

HAMILTON BRIDGE TO COST OVER MILLION DOLLARS

INSTRUCTED on August 7th, 1918, to prepare a report and estimate on the cost and advisability of the construction of a bridge at the western entrance to the city of Hamilton, to complete the Toronto-Hamilton highway, E. R. Gray, city engineer of Hamilton, submitted the completed document last week. It estimates the cost of a high level concrete structure at $1,419,100, exclusive of land to be acquired. A steel bridge is estimated at $1,226,590.

Of four proposals that were considered, the city engineer supports what is known as the "Mackay plan." This proposes "a diversion of the highway northerly at a point about a quarter mile east of the Valley Inn ravine, paralleling the present road and crossing the ravine approximately on a line of the present highway by a high level bridge, carrying the roadway over the G.T.R. to a point on an unopened road allowance on the western bank of the ravine."

The Route

It is then proposed to pass southerly along this road, to cross the Junction cut and Guelph branch by small structures, with a junction at York St. to be obtained on the present high level roadway a short distance southwest of the existing wooden bridge over the Brantford line.

This scheme also provides for the entrance of a proposed highway from Owen Sound to Guelph to join the Toronto-Hamilton highway at the point of intersection of the Toronto-Hamilton highway with the unopened road allowance.

Length 1,300 Ft.

In designating a concrete structure, Mr. Gray determines the length over the Valley Inn ravine at 1,300 ft. A center span of 416 ft. and other spans of 156 ft. each are provided for, the roadway standing approximately 87 ft. above the water of the harbor.

The width of the bridge, both for concrete and steel is assumed the same, viz., roadway 40 ft., flanked by two concrete walks each 6 ft.

Steel Design

The steel bridge is estimated to cost $1,226,590. The report points out that the yearly charges for interest and sinking fund, based on the cost figures, would be as follows: Concrete structure, $88,494; steel structure, $77,869.

Newman Urb, capitalist, of New York City, has acquired control of the lease of the Prince Rupert Dry Dock and Engineering Co., by buying out the interest of John Mullen, contractor, of Pittsburg. Mr. Urb states that he has opened negotiations for a contract to build 20 large oil tank steamers.

DEAN MITCHELL'S ADDRESS TO TEACHERS

IN addressing the college and secondary school department of the Ontario Educational Association last week, Brig.-Gen. C. H. Mitchell, dean of the Faculty of Applied Science and Engineering, University of Toronto, stated that the call for men and means with which to carry out the work of the country, wherein applied science and engineering knowledge and ability are required, is both insistent and universal throughout the Dominion.

"Those engaged in the work of education are vitally interested in the situation," the dean assured. "It now appears that a special effort should be exerted to direct the proper type of students into these professions."

No Overcrowding

Fear that various branches of the engineering profession may become overcrowded need not be seriously considered. The fear is rather that the present small monetary attraction in certain purely professional directions may, unfortunately, deter promising young men, and that in spite of their good education and the country's demand, they may drift from professional occupations.

Special mention was accorded the "practically indispensable" branch of engineering research, and also the administrative branch, lying between professional engineering and the business side of projects or works connected with both.

Our Place as a Nation

"Nearly all these professions perform vital functions in relation to the country's development," the dean pointed out. "And they require special knowledge, ability and service. Utilization of our natural resources to the best advantage, the best application of our industries, and the constant research and effort we can make to improve our material position, are all of the highest importance to us in securing and maintaining our place as a nation."

"Leader" Type of Students

To anticipate the growing demand for applied science education, rather than wait and see how great it will be, was the policy advocated by Dean Mitchell, who sketched the necessary qualifications for students pursuing an applied science course leading to the engineering professions. Briefly, each one should have an energetic but studious temperament of the "leader" type, with well-developed powers of observation, a fondness for mathematics, and constructive ability.

Such English!

"On my return from five years at the war, much of it amongst the various languages of Europe, I was shocked," declared the dean, "at the loose, ungrammatical, slangy and extravagant English I heard not only on the streets of Toronto, but about the precincts of the university. Let me make a plea for better English spoken and written in all our schools."

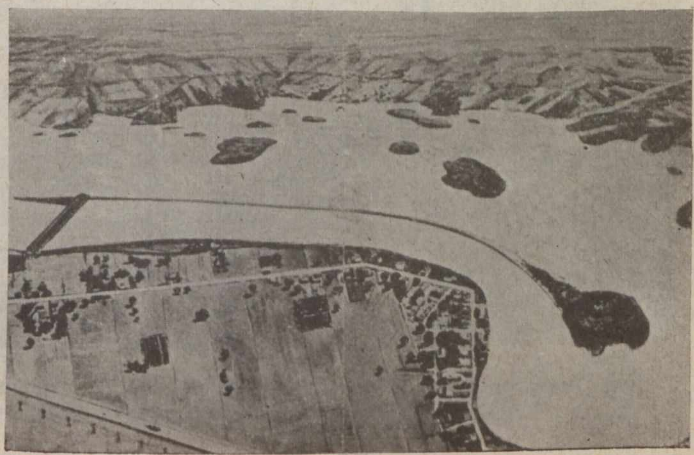
John Murphy, electrical engineer of the Department of Railways and Canals, Ottawa, addressed the Peterborough Branch of the Engineering Institute last Thursday evening, on the formation of frazil and anchor ice. In discussing the small amount of heat that is required to keep water which is near the freezing point from forming ice, Mr. Murphy described a case that occurred on a small river near Dixon, Ill., where the condensing water from a cement mill, which was at a temperature of 50 degs. F., discharged into the stream, and was proven to have prevented the formation of surface ice for a distance of two miles down-stream during five successive winters. This interfered with the harvesting operations of an ice company, and in the litigation that followed, it was shown that the condensing water, amounting to about 8 sec. ft., had prevented the formation of ice in a river which had a flow of approximately 4,000 sec. ft.

DUTIES OF A YOUNG ENGINEER ON THE CONSTRUCTION OF A HYDRO-ELECTRIC PLANT*

By H. S. Slocum
Engineer, Vielé, Blackwell & Buck, New York City

LET us assume that a group of financiers, becoming interested in a water power project, have engaged an engineer to investigate and report upon the feasibility of its development. The investigation has proceeded along two lines—the physical and the financial. The engineer has sent a party to the site to ascertain the available head and make the surveys necessary to determine the most suitable type of development and estimate the cost. He has collected and studied all the available data on the flow of the stream, area of watershed, runoff, etc., much of which is found in the bulletins of the Department of the Interior. From these data he has made his preliminary drawings and estimated the cost of development per horse power.

The most important part of the financial investigation is a survey of the power market. The investigator has tabulated the amount and cost of power used by the industries and utilities of the surrounding cities and towns; he has tabulated the population and from past records estimated the future growth. He has also investigated raw materials and resources that could be developed, as well



Bird's-Eye View of Development, Cedars Rapids Mfg. & Power Co.

as new industries that might be attracted by the advent of cheap and abundant power.

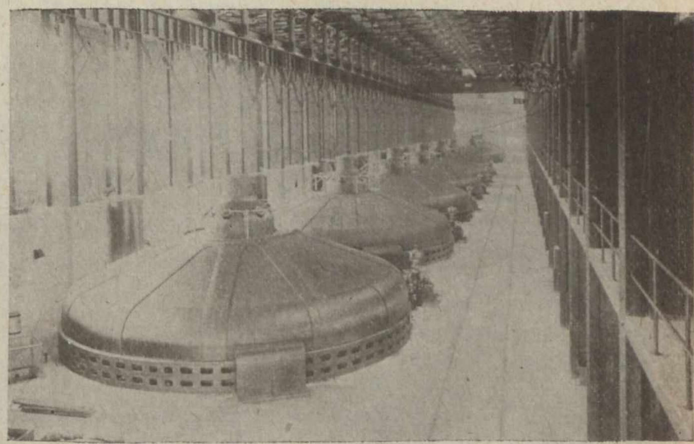
The report being favorable, the bankers decide that it will be a profitable investment and form a company which will proceed with the development. Officers and directors are elected, money raised by bond and stock issues, and an engineer with a broad experience in the design and construction of hydro-electric developments is retained.

We cannot here enter into a discussion of the design of the plant and placing of contracts, which is done in the main office and receives the personal attention of the engineer, but shall confine our discussion to the field work.

There are two general ways of handling construction: (1) Force account, by which the work is done by the company's own forces; and (2) contract, by which the work is done by an outside concern under the supervision of the company's engineers. We shall assume for the purposes of discussion that the work will be done by the former method.

The field organization will be headed by a resident engineer or manager of works and associated with him will be assistant engineers, superintendents, accountants, timekeepers, stenographers, etc.

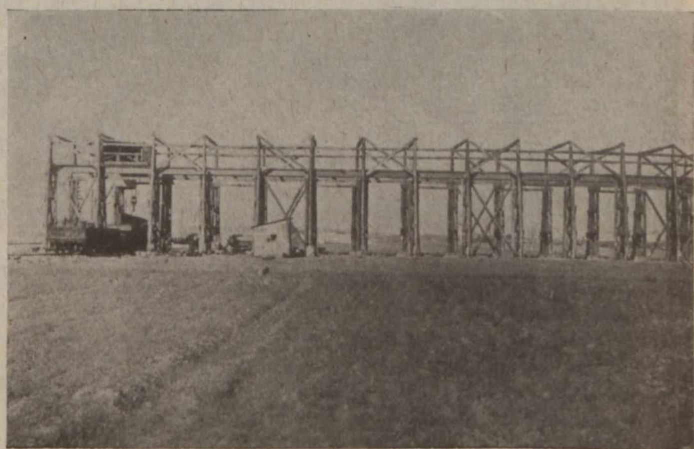
Oftentimes the site of the work is situated many miles from a railroad and the first work which confronts the engineer is the building of substantial roads of a suitable character to sustain heavy loads and continuous service during the construction period. During the early stages of the Great Western Power Co.'s development on the Feather River, California, transportation was a very serious problem, as all supplies had to be teamed twenty miles over the mountains. Later when the Western Pacific Railroad was in operation, matters were greatly simplified by the use of



Interior of Powerhouse, Cedars Rapids Mfg. & Power Co.

a cableway crossing the river, which transported materials from the railway to the work.

The layout of camps and design of buildings for housing the forces, field office, shops, storehouses, hospitals, etc., will constitute the pioneer work of the field draftsman. The technical press of late has published a great deal concerning the construction of cantonments. The construction camp is laid out on similar lines, with the same class of buildings, only on a much smaller scale. The same attention is paid to securing an adequate supply of pure water and its protection from possible contamination. Every precaution is taken to have the camp sanitary, for it is recognized that much of the success of the work depends upon the well-being and comfort of the working force. Many engineers make the mistake of huddling the buildings into a small space



Crane Runway for Handling and Storing Heavy Machinery, Cedars Rapids Mfg. & Power Co.

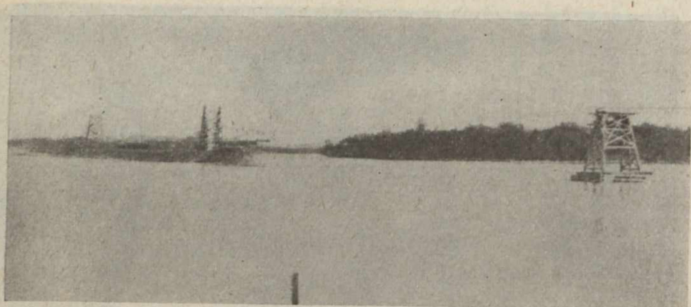
close to the work. Better results are attained by keeping the different classes of the organization and nationalities of labor widely separated. Sometimes permanent houses for the operators are built and occupied by the married engineers and superintendents. Every natural feature should be taken advantage of in order that the camp may be made attractive and homelike.

Before river work is started, the cofferdams are designed by the draughtsmen. Drawings should be made of any cofferdam of importance, as they facilitate construction and form a permanent record. There are many kinds and types and

*From the J. E. Aldred lectures on engineering practice, John Hopkins University. Illustrations by courtesy of John Hopkins University and Vielé, Blackwell & Buck.

each particular situation is studied for the one best suited to the conditions. Depth and swiftness of water, length of service, importance of work to be protected, materials at hand, expenditures justified, and variation in river levels are all factors.

The layout and design of construction plant is the most interesting work that the draughtsman will be called upon



General View of Car Dumping Cableway, Cedars Rapids Mfg. & Power Co.

to do, for on every development of magnitude conditions differ widely. The amount of the plant justified for the work is largely determined by the amount and cost of labor and the amount of work to be done. For the purpose of illustration, let us consider some of the plant designed for the Cedars Rapids Manufacturing & Power Co. on the St. Lawrence River.

This is a low head development with a first installation of nine 10,800 horse power units. The power from the rapids is developed by a wing dam extending up the river for about two miles and not across the river, as it usually

Heavy Machinery Stored on Ground—Concrete Slabs for Powerhouse Superstructure in Background—Cedars Rapids Mfg. & Power Co.

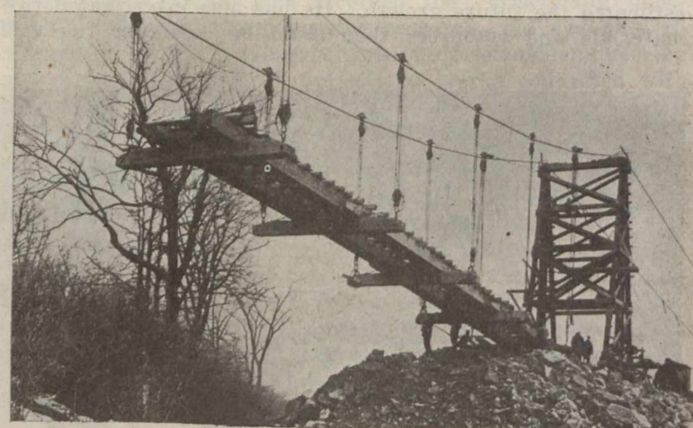
the case. The development is remarkable in that the units are the largest in physical size ever built.

As the site of the work was five miles from the railroad, it was early decided to transport supplies and materials by the Soulange Canal, which bordered the property, rather than build a branch line which would necessitate an expensive drawbridge. Car ferries and tugs were used to bring cars from the railroad ten miles away and transfer them to the company's tracks. Cement, coal and sand were brought in by barges.

As navigation was closed during the cold weather, provision was made for storing materials which would be required during the winter months. A cement storage was built capable of housing 30,000 barrels and equipped with a belt conveyor which could be extended into the hold of the barge. Twelve thousand tons of coal were stored by means of an automatic railway with a ton-a-minute capacity, served by a derrick and clamshell bucket. A temporary wooden crane runaway was built in the open field and one of the powerhouse cranes was installed thereon for handling the heavy hydraulic and electrical machinery. The cars were run under the crane, unloaded and pieces of apparatus skidded out into the field with rollers and tackle, with power furnished by the crane. When the time came for the installation of the machinery the process was reversed.

A rather unusual method was employed to extend the south bank or diverting dam from the mainland to Isle Aux Vaches across the rapids and differed from the hydraulic method sometimes used for building dams. A cableway with two high shore towers, a moving tower on wheels and a central tower to reduce the span was erected. A cradle of sufficient length to hold a train of dump cars was attached to the moving tower and suspended to the 2¼-in. standing lines. At the beginning of operations the moving tower was located next to the shore tower, and as the fill progressed it was moved along until it reached a point where it relieved the centre tower of weight. This tower was then removed and the work progressed until the fill reached the island, a distance of approximately 1,100 ft.

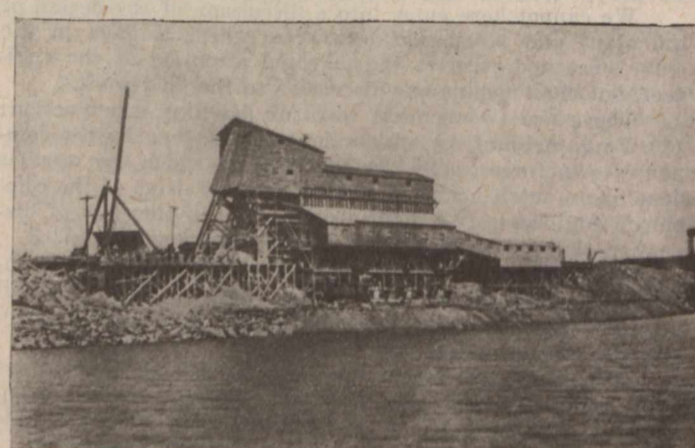
The design of the stone crushing and concrete mixing plant requires careful thought by the designer. He must



Detail View of Cradle, Car Dumping Cableway, Cedars Rapids Mfg. & Power Co.

be familiar with the equipment and be able to fit it into the general scheme of things, so that it will do the maximum amount of work with the least effort on the part of the operators. He must keep in mind that the plant will be required to turn out quantity production and a lack of coordination between its working parts and breakdowns are are serious matters, and a constant source of annoyance and expense.

The following points should be taken into consideration in designing a crusher plant: If the structure is not built on rock, the footings should be so designed as to obviate

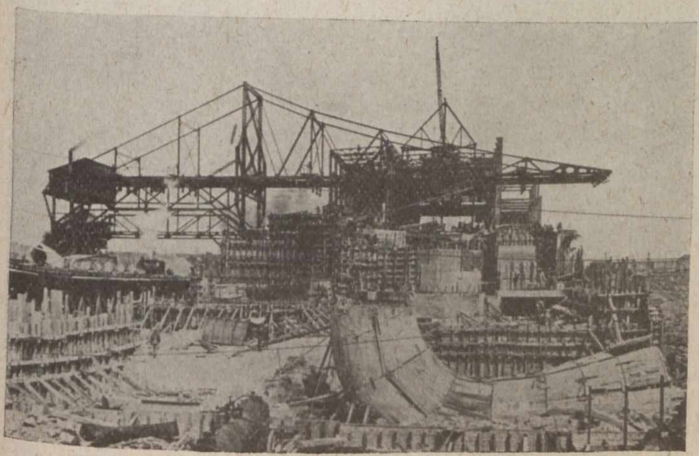


Stone-Crushing and Concrete-Mixing Plants, Cedars Rapids Mfg. & Power Co.

any chance of settlement of crushers or bins; any settlement will throw the shafting out of alignment and cause endless trouble. Strength of the supporting members of bins must be carefully worked out and liberal bracing provided. Foundation drawing are always furnished with the crushers, but the designer must see that ample clearances are provided for removing the eccentric at the bottom. It is most important that the elevator be of liberal length and at least two buckets on the tangent should be allowed below the end of chute discharging from crusher, and the same number on top discharging into the screen chute.

If the elevator is too short, stone will spill between the belt and pulleys and soon wear out the belt. Some bins are designed with flat bottoms, but those with a 45-deg. slope are better, as they save labor. Flat chutes are a source of annoyance and expense and 45 degs. is about the minimum on which stone will slide. If measuring boxes are used for proportioning the aggregate, they should be telescoping to allow the mixture to be varied, and the bottom should close automatically.

For crushing hard rock or rock containing silica, manganese steel heads are usually specified. Good heavy belts should be provided to drive the crushers. If they are too light they will stretch and slip and cause the crusher to stall on heavy loads. The mixers should preferably be



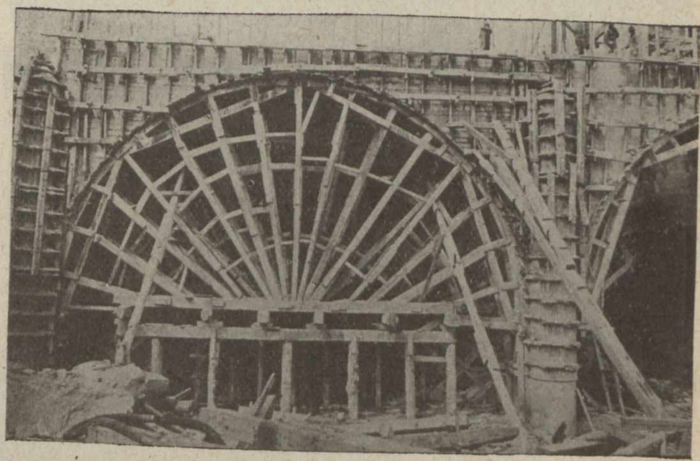
Draft Tube Form in Place, Cedars Rapids Mfg. & Power Co.

motor driven, direct connected. Sand making by swing hammer mills or rolls is usually expensive and troublesome, and should be considered only as a last resort. Care should be used in aligning the bucket elevator, for if the belt does not run true it will cause endless difficulties.

Space does not permit further discussion of the construction plant at Cedars. It was very complete, however, and consisted of 34 locomotives, hundreds of dump cars, 7 large steam shovels, locomotive cranes, derricks, shops, etc. The cost was in the neighborhood of $700,000.

Unusual forms are generally laid out by the engineer, especially those which are curved. When the scroll case and draft tubes are formed in concrete, the turbine manufacturer furnishes outline drawings and sections, from which the ribs are designed. These are drawn out full size on a laying out floor for the use of the carpenters, similar to laying out the ribs of a ship. The ribs are then set in position, using a top and bottom keel to get the correct curve, and the lagging applied. The ribs are usually spaced closely enough to allow the lagging to be made of ⅞-in. spruce cut in narrow strips. On extremely sharp bends these strips are steamed so that they will bend easily. After the forms are lagged, they are cut in pieces of a size convenient to handle (extra ribs are provided for this) and taken down and moved to the powerhouse site. Forms of this character are sometimes made collapsible so that they can be used several times. The general rule, however, is to make a set of forms for each unit, as it is seldom that a plant is large enough to allow the use of forms more than once. The reason for this is that the forms must stay for a considerable period to allow the concrete to set, and on a small or medium size development time cannot be spared for this delay.

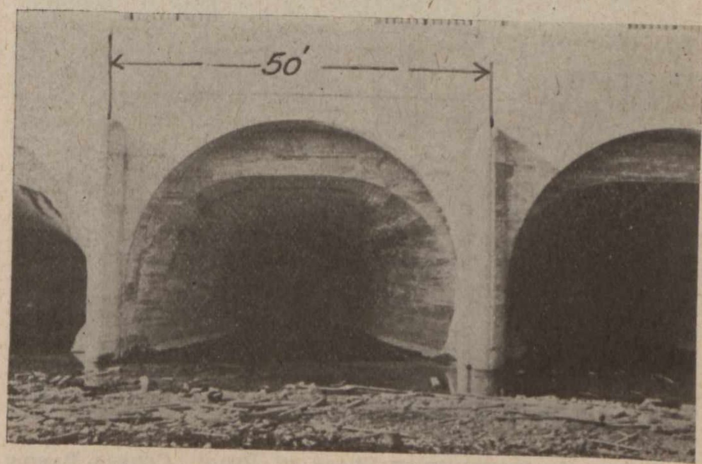
The usual shape of draft tube has a flat surface on the bottom large enough to support the form. After the excavation is completed, a pad of concrete is poured with the top to correspond to the elevation of the bottom of the tube. Rods with eyes or hooks formed in the end are embedded in the concrete to serve as anchors and to which the form is wired to prevent its floating when the concrete is



Draft Tubes Being Concreted, Cedars Rapids Mfg. & Power Co.

brought up around it. The form is then set on the pad and wired fast. The upper portion is braced with wooden struts and guyed with cables in the correct position. Added weight is sometimes given to the form by piling loose rock inside. After each lift of concrete is poured the position of the form is checked by means of the transit, both lengthwise and longitudinally. It probably will have shifted slightly, but by means of jacks and steel rope it can be easily brought back to the correct position. Especial care should be taken as the concrete approaches the top that the last lift will have the form on the centre lines.

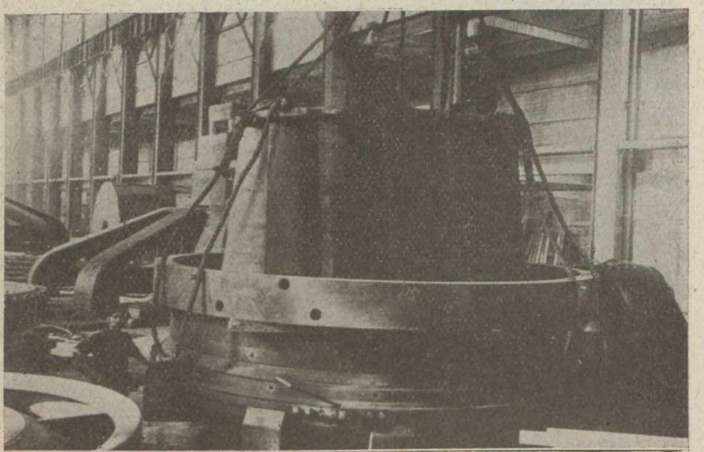
The speed ring anchor bolts are set in place by means of a templet which is bored for the exact spacing of bolts



Draft Tube Completed, Cedars Rapids Mfg. & Power Co.

and supported on the top of the draft tube form. They will extend for a considerable distance below the top of the tube and are liable to be overlooked. It is a good plan to have the anchor bolts laid out in plain sight of everyone, so that foremen as well as engineers will have them in mind.

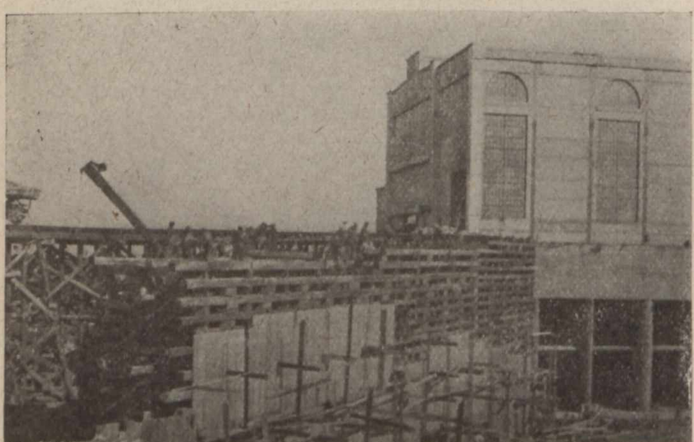
It is desirable to have the progress records in such form that the information may be quickly grasped by inspection, and for this purpose curves or diagrams are used. A graphic log may be plotted on profile cloth to show daily maximum and minimum temperatures, rainfall, number of men employed, yardages of excavation and of concrete for different divisions of work, amount of reinforcing steel placed and, in fact, anything which is considered worthy of record. The weekly average line indicates whether work is being kept up to schedule, as it shows at any time how many units of work must be done each week to complete on a specified date. As the work falls behind, this average line rises and calls for additional effort. Prints should be made and posted where the superintendents and foremen may see them, as they are a source of interest and a means of speeding up production. One single straight line may be added



Assembling Runner, Cedars Rapids Mfg. & Power Co.

to show the total units of work done by months and another line to show the percentage complete by months. This work is assigned preferably to the draughtsman and must be kept up to date. The log has proven itself to be valuable not only during construction but as a permanent record.

Unit costs are kept on developments of any magnitude, and each division of the work has its own account number for convenience in bookkeeping. When the costs are made up monthly the accountant will make up his figures on or as near the first of the month as convenient, and turn them over to the engineering department. The engineers then



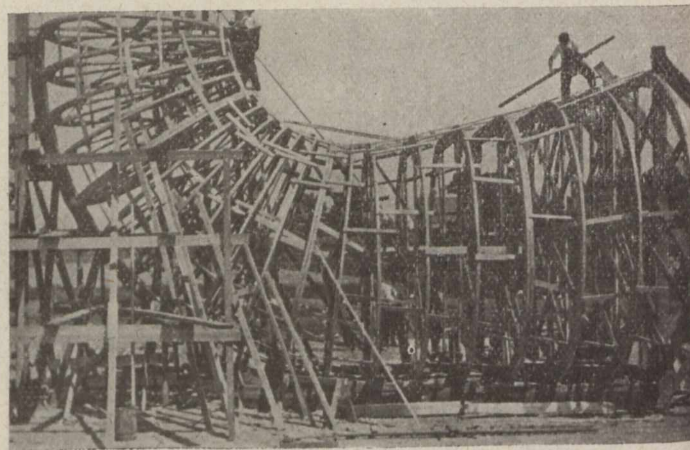
Showing Superstructure Slabs in Place, Cedars Papids Mfg. & Power Co.

divide the cost into the work done to obtain the cost per unit. Some items, such as cost of power and light, operation of shops, maintenance of tracks, roads, cost of small tools and supplies, etc., which cannot be charged directly, are written off monthly and apportioned to the accounts to which they are chargeable.

The draughtsman will many times have to devise repairs to the plant and occasional damage to permanent structures which will test his ingenuity. For instance, a welded pipe was delivered on a job, which had been damaged in transit; it would be subjected to heavy pressures in operation and presented an interesting problem in design to evolve a patch which would not weaken the pipe.

The field engineer is a very busy person. Each day he is called upon to give line and grade for excavation, line and elevations for formwork, lines for anchor bolts and later as the work progresses, he will be called upon to check the alignment of superstructure steel, give lines and elevations for setting machinery and, in general, take care of the innumerable detail that is encountered in construction. In addition to the routine work, at the end of the week he must measure up his yardages of excavation and concrete placed for the weekly estimate and at the end of the month he must make his monthly estimate from which the unit costs are computed. At the completion of the work a final estimate is made for the total yardages and the unit costs made for the whole development.

The first installation of the plant of the Great Western Power Co. on the Feather River, California, consisted of a timber dam built at the beginning of a long bend in the river and a three-mile tunnel through the mountain, from which point penstocks conducted the water to the powerhouse, with a head of 450 ft. Later a concrete dam was built which increased the head to about 530 ft. The work spread



Ribs of Draft Tube Forms Set in Position

over a large area and the field organization was divided into three parties.

Mr. K. was responsible for the engineering pertaining to the construction of dam, intake tower and a portion of the excavation and lining of the tunnel. His party consisted of four men, who gave daily line and grade for tunnel excavation, inspected the excavation to see that no point projected beyond the neat line and aligned the carriages which supported the forms before the concrete lining was poured.

This party also gave line and grade for the intake tower excavation, tested rock foundations, and laid out the forms for the structure. It checked reinforcing steel and inspected the concrete mixture used, set anchor bolts for gates and screens and also castings which were imbedded in the concrete.

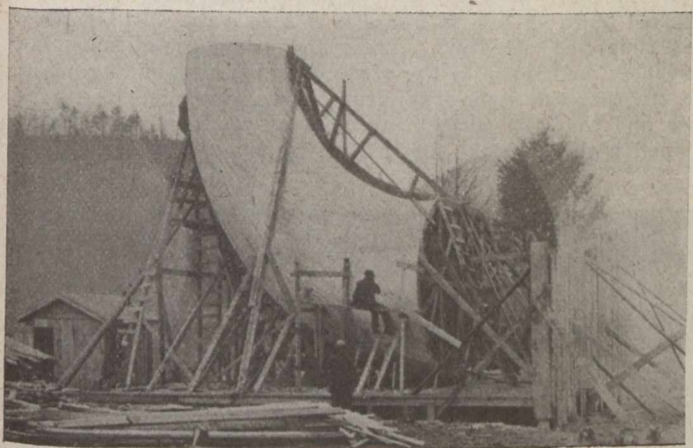
At the timber dam the same party gave the line and grade and inspected construction. In addition to this daily routine, each Saturday the party measured the excavation and concrete yardages for the weekly report, and on the first of the month made a careful estimate of the work accomplished for the monthly report.

Mr. W.'s division consisted of the remainder of the tunnel and the work performed was identical to that of Mr K.'s tunnel work.

Mr. B.'s division commenced at the south portal and extended to the powerhouse. He was responsible for setting the header pipe which was concreted into the tunnel for a distance of 75 ft., the excavation and construction of anchorages for the header and surge pipe, as well as the construction of the concrete "spew basin" at the end of the surge pipe. His party gave line and grade for concrete anchorages and supports for the 5-ft. penstocks and the line for the penstocks themselves.

The fascination of hydro-electric construction lies in the great diversity of work which the engineer is called upon to do, particularly on the construction of the powerhouse. For instance, Mr. B.'s party had first to lay out the location of the powerhouse on the ground, taking advantage of the topography that would involve the least excavation as well as the least concrete and the shortest length of penstocks.

As centre lines are laid down on paper before starting a drawing, so must the field engineer establish his centre lines by means of permanent hubs from which all lines of the construction are referred. At the same time he must establish his bench marks, running his elevations from a known bench from which all elevations are referred. When



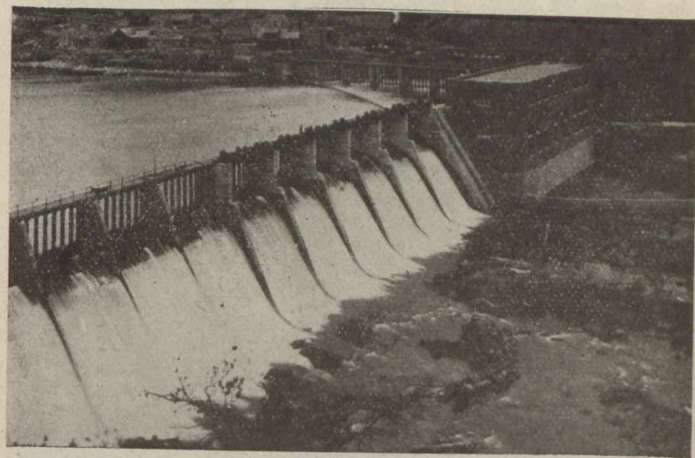
DRAFT TUBE FORM BEING LAGGED, APPALACHIAN POWER CO.

these lines and elevations are positively checked, he is ready to start actual construction.

In successive steps Mr. B.'s party laid out the cofferdams, the powerhouse excavation, gave lines and grade for getting the steel draft tubes, the points for arches and floors, the position of reinforcing steel, anchor bolts, castings, etc.. holding the centre lines both ways until the concrete reached the main floor elevation. The erection of the powerhouse steel followed, but without much attention from the engineers, aside from setting column anchor bolts and plumbing the columns. They followed the steel erector, giving grade for concrete floors, laying out the partitions, windows and doors of the superstructure. In the meantime the erector of the hydraulic machinery started his work and the party, using the same hubs, gave points to him for the centres of the turbines as well as elevations. Anchor bolts for miscellaneous machinery were set and the innumerable detail taken care of. In conjunction with this work the party made the weekly and monthly progress reports.

DRAFT TUBE FORM CUT IN SECTIONS TO FACILITATE MOVING, APPALACHIAN POWER CO.

The pioneer work of the engineer for transmission lines is similar to that of railroad location. He determines the best route to the market and furnishes necessary information to the right-of-way man who purchases the right of way

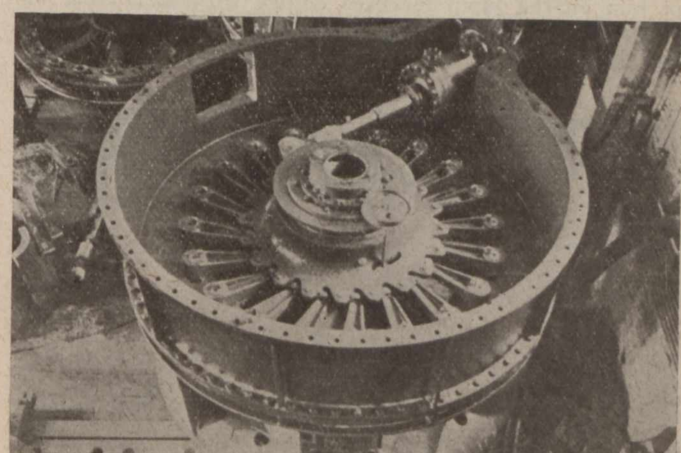


DEVELOPMENT NO. 2, APPALACHIAN POWER CO.

and makes the final maps. He then stakes out the lines on the ground, locating the tower footings.

In order to standardize the work so that the maximum amount may be accomplished in the shortest time and at the least expense, it is the custom to divide the construction force into the following small gangs: No. 1 clears the right-of-way; No. 2 excavates for footings; No. 3 places the concrete for footings.

In the meantime, steel and bolts for each tower have been checked at the railroad and distributed along the line.



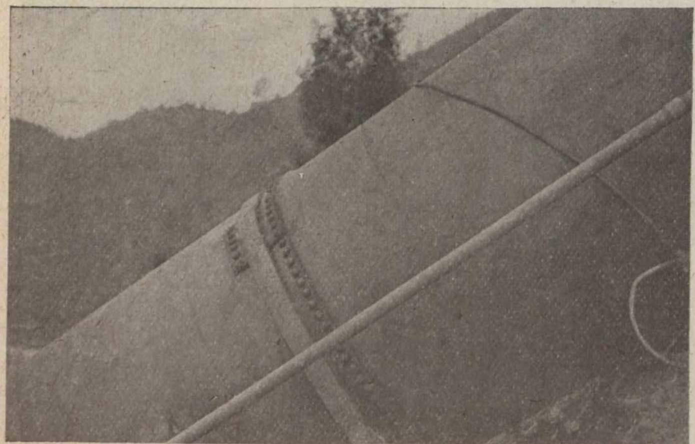
TURBINE ASSEMBLED IN SHOP, APPALACHIAN POWER CO.

Gang No. 4 assembles the towers, No. 5 bolts them up and No. 6 sets them on their bases. The line gangs follow, putting up insulators and stringing wires. Rivalry and speed records between the different gangs lend interest to the work.

On long crossings special structures have to be built which furnish the engineer with many interesting problems. It is necessary to erect at each market centre a step-down transformer station from which the power is distributed to the consumer at a voltage suitable for his use.

In connection with a hydro-electric system without adequate storage reservoir, it is almost always necessary to install an auxiliary steam plant to help carry the peak loads and augment the power supply at times of low water.

The responsibilities of the inspection engineer are many. It devolves upon him to detect errors in the work before it is too late to correct them. When I think of this branch of the work, there comes to mind the enthusiasm and energy of one canny Scotch Canadian whose sole object in life seemed to be the prevention of anyone "putting one over." He was a tireless worker, never missed a day, and on occasions stayed on the job 36 hours in order to watch a particular piece of night work. Nothing escaped his keen eye,



Patch on Defective Welded Pipe, Great Western Power Co.

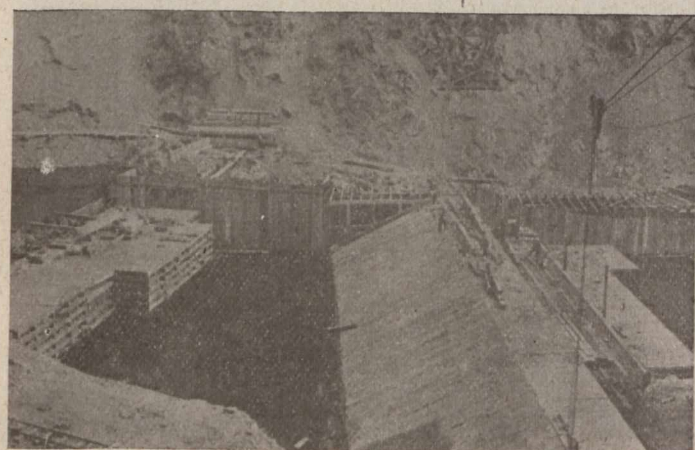
and when he passed on the correctness of a form or the placing of reinforcing steel, one could feel assured that it was right. While he knew that he was responsible to his superiors, his interest was so great, his love for his work so intense, that he felt responsible to no one but himself. It was his job, his work, and he was thereby able to put in the long hours and do the hard work that he could not otherwise have done. Needless to say "Mac" was a success.

It was a large job, with much ground to cover and it kept him on the jump to check things without holding up the construction forces—an unpardonable sin. The first thing that he did in the morning before the concrete was

Concrete Dam Under Construction, Great Western Power Co.

started, was to see that the concrete of the previous day's run was thoroughly cleaned and all laitance removed. It had to be so clean that the stone showed before it was passed. He then saw that a wash of grout was spread over the old concrete before the fresh concrete was started. The measuring boxes were then checked to insure the right proportions. After concreting was under way he stayed around awhile to see if the mixture was of the right consistency and that the foreman understood his instructions. He would then go where the carpenters were constructing new forms, check the measurements, see that boxes were left for anchor bolts, provision made for necessary openings, explain the drawings to the foreman, and in general follow the work to see that it was correct as it proceeded. He spent a good deal of time on the reinforcing steel, checking it for quantity and position, as well as giving information to the foreman.

The concrete slabs forming the superstructure were built at a distance from the powerhouse and these had occasionally to be inspected. Inspection was also necessary as they were erected, to ensure getting them in the correct position. The superstructure steel was looked over, rivets inspected, brickwork and other details gone over from time to time. He was on hand when the instrument men checked the draft tube forms for alignment, and saw that after they had been placed correctly, they were held so securely that they could not move. When he felt that he could be spared from the powerhouse, he went to the transformer station under construction and looked things over there. This did not require as much attention as the powerhouse, and it was entrusted more or less to one of his assistants. Still it took his time and attention. From the transformer house he probably went over to the stone crushing and mixing plant to see that the stone was clean before going into the hopper and that the correct mixtures of concrete were maintained with the right amount of cement and water. Here



Timber Dam Under Construction, Great Western Power Co.

also he had an assistant who did this work, but "Mac" had to satisfy himself occasionally to be sure that things were going to his liking. Many other details called for his inspection and he was never at a loss to fill in his time. In conjunction with his inspection work he kept records of concrete placed, cement used, reinforceing steel and superstructure steel placed, from which he made daily and monthly reports and plotted the graphic log.

On his way home at night he stopped at the mixing plant to see that the empty cement bags checked with the tally board, and if they did he called it a day.

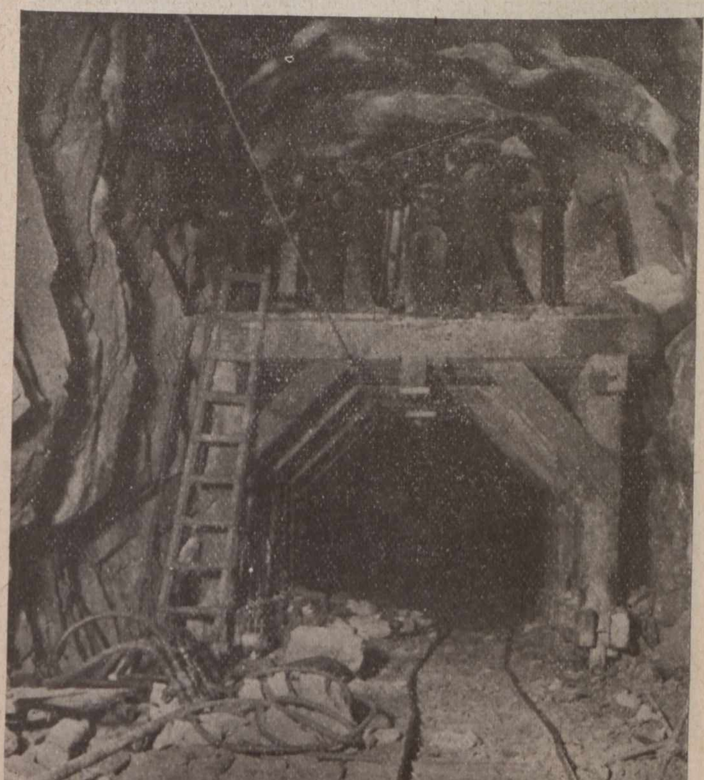
I have not space to enter into a discussion of all types of hydro-electric developments which involve the use of long pipe lines with their surge tanks, but will illustrate a low head plant which is the usual type east of the Rockies.

It will be noticed in the pictures of the Appalachian Power Co.'s plants, which furnish power to the West Virginia coal mines, that the powerhouse substructure forms a part of the dam, and the penstocks and other appurtenances used on high head plants and moderate quantities of water, are eliminated. The physical size and methods of construction of the turbine, draft tubes and scroll cases differ radically from those of a high head plant, for with low heads large passageways and massive machinery are necessary to convert the large quantities of falling water into power.

During the past couple of years we have heard and read of the remarkable speed records which have been made in building ships, industrial plants, supply bases, cantonments, etc. In war time, economy of cost was disregarded; economy of time was the essential. If capital is to be attracted or persuaded to invest in new hydro-electric developments, it will be because the engineer, by initiative and fertility of resources, can combine economy of cost and economy of time. The market price of power is kept within more or less fixed limits, and, therefore, the cost per developed horse-power cannot exceed a certain price. To-day companies paying an adequate return on the capital invested are those which, by efficient methods of construction and operation, have effected these economies. All construction expenses are capital costs on which interest must be paid.

One of the most pleasant and interesting assignments which I have had during the 18 years in which I have been engaged in the design and construction of power plants, was the installation of a low head development on the Oswego River at Minetto, N.Y., in 1915. The type was similar in design to the Appalachian and Cedars plants, with concrete formed draft tubes and scroll cases. The building was 229 ft. long and about 90 ft. wide, and contained approximately 12,000 yds. of reinforced concrete. Six main units of 2,200 h.p., with the usual equipment of transformers, high and low tension electrical apparatus, switches and lightning arresters were installed. The first concrete was poured on April 7th, and on October 1st the plant was in commercial operation, complete to the last detail,—176 days elapsed time, including rainy days, Sundays and holidays, and one month ahead of schedule.

This construction organization was the best that I have ever seen in action. The young engineers had just finished

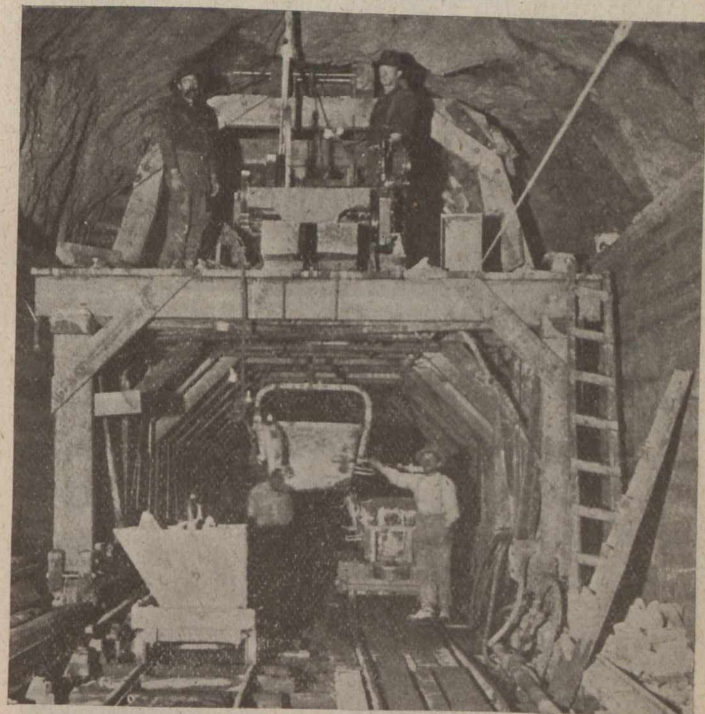


Tunnel Excavation, Great Western Power Co.

a similar piece of work and were keen to apply their recently acquired experience to improve methods formerly used. Each development shows radical improvement in the methods of construction. To illustrate one feature:—

The best method of supporting the scroll case forms had been a matter of great argument, and it was found that a method which had not been used before saved money and time. The scroll case and draft tube forms were built some distance from the powerhouse site and away from other activities and brought to the site as needed. When the draft tube forms had been set as previously noted, and the concrete brought to an elevation a foot or so from the bottom of the scroll case, a narrow concrete wall was built following the centre line of the scroll, with a slope which corresponded to the bottom of the form. This wall was left 2 ins. below the elevation of the scroll case floor, and when the form was placed, it was wedged into its correct position. Rods were left projecting on either side of the wall as a bond for the concrete which was to be later poured around it and to serve as anchors for the wire ties which kept the form from floating. The work proceeded more rapidly by this method than if each individual form were built in place.

Primarily the speed with which this undertaking was carried through was due principally to the harmonious and friendly spirit which existed on the work.



Form Carriages for Tunnel Lining, Great Western Power Co.

The plant of the Niagara Falls Power Co. was the first large hydro-electric installation on this continent, and presented many problems for the engineers to solve. Before a hydro-electric plant was decided upon, much thought was given to the form of energy into which the power of the falls could best be converted, keeping in mind that Buffalo, 22 miles away, was a probable market. Long high-tension transmission lines were then unknown, and some of the proposed methods of transmitting the power were as follows:—

1. Construct a network of canals branching from a main intake, and discharge the water into small tail-race tunnels branching from the main tunnel. (One large mill does actually purchase power in this manner and provision was made in the masonry of the forebay walls for other canals.)

2. Gear the turbines to a long line shaft and furnish power to the consumers, whose plants would be located adjacent to it, by means of belts.

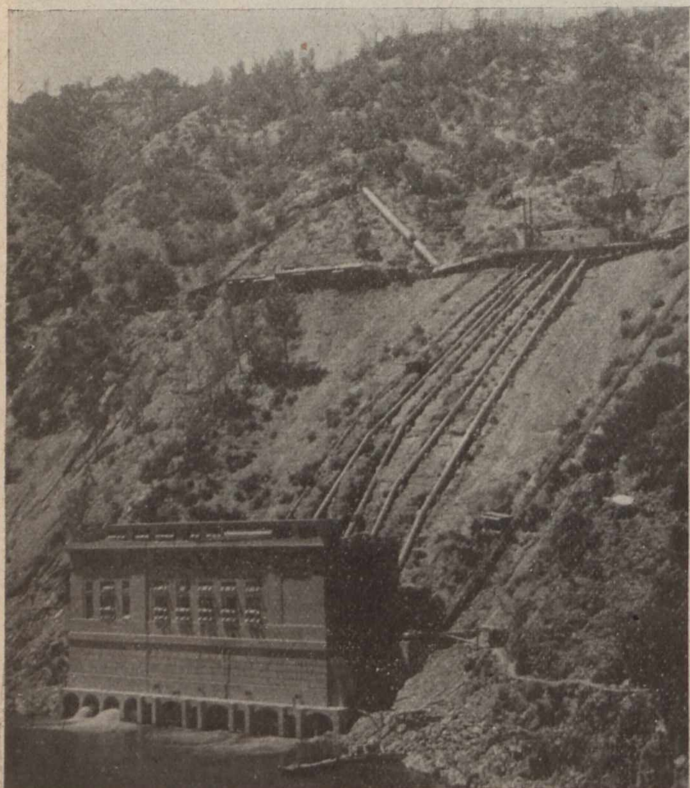
3. Convert the power into compressed air and supply the consumer by means of pipe lines.

All these methods seem strange to us now when we consider the wonderful achievements in the transmission of electrical energy.

I should like to call attention to a comparatively recent plant which converts hydraulic power into compressed air and transmits the power in this form for several miles, where it is utilized for running drills, hoists and other machinery in the Cobalt silver mines. The reason the method is feasible and commercially successful in this case is because the hydraulic power is converted into the form of energy which can be used without other conversion, thus saving many losses.

The head utilized is 47 ft. A dam was built at the head of the falls; forebay, racks and gates were installed similar to those of hydro-electric plants. After the water passes through the racks it flows through two 16-ft. diameter heads in each of which are sixty-six 14-in. diameter pipes. The water enters these pipes in swirls, drawing in with it a great deal of air which passes down the shaft with the falling water in the form of globules. As the water flows through the tunnel, the air rises to the surface and collects in the air chamber under a pressure due to a head of 325 ft., or 125 lbs. per sq. in., from whence it is piped to the mines through a 24-in. pipe. The water then passes through the tunnel and up the outlet to the river.

The plant is practically automatic and requires but one attendant. The heads telescope into the intake shaft and are set just below the surface of the water, the position being regulated by means of air hoists to conform to the



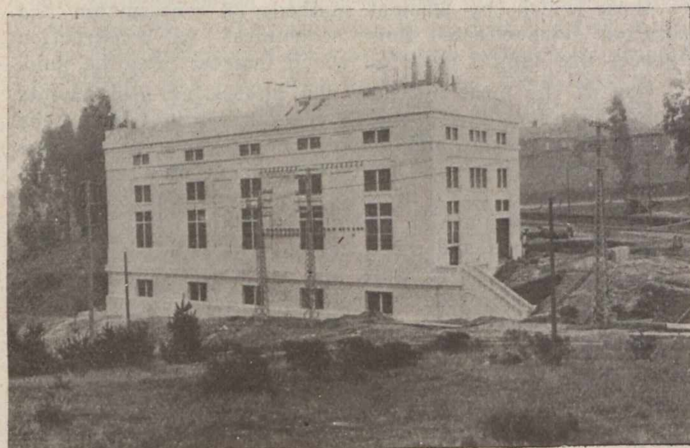
General View of Powerhouse, Great Western Power Co.

changes of river levels. Before the air in the chamber acquires a volume sufficient to cause it to discharge through the uptake shaft it is released by a 12-in. blowoff pipe which has its lower end ordinarily submerged. The superiority of air compressed by this method over mechanically compressed air is that it is free from moisture and may be transmitted in the coldest weather without condensation and freezing. It is also free from oil, which eliminates the possibility of explosion in receivers.

The making of reports, estimates and cost keeping offer an excellent opportunity for the young engineer to acquire knowledge of cost of materials, labor, etc. This knowledge is usually acquired before he takes a very advanced position in any organization. Not only does a resident engineer do considerable current buying, but his plans for plant, building methods, etc., are frequently determined by the cost of material and labor. Many engineers of highest integrity and engineering ability are so undeveloped in this respect that, while no technical irregularity can escape them, waste of material and labor go on constantly.

The young engineer should acquaint himself with as many details of the work as possible. Often older engineers find it easier to attend to many of these themselves than to take the trouble to instruct the beginner, but they are glad to be relieved by a painstaking young man. By this means the young men have access to the accounts and reports and can get all the information they wish.

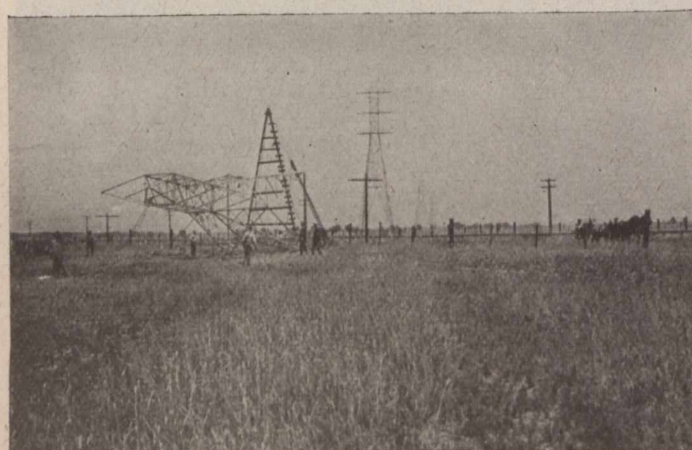
One of the compensations of living in remote places is the opportunity for saving. Living expenses are practically nothing, and with his first month's salary a



Oakland Substation, Great Western Power Co.

young man should not only start a bank account, but should interest himself in the study of profitable investments; before long he will be able to buy his first bond. By so doing he not only acquires income property, but he will take a more intelligent interest in the financial aspects of the company for which he is working.

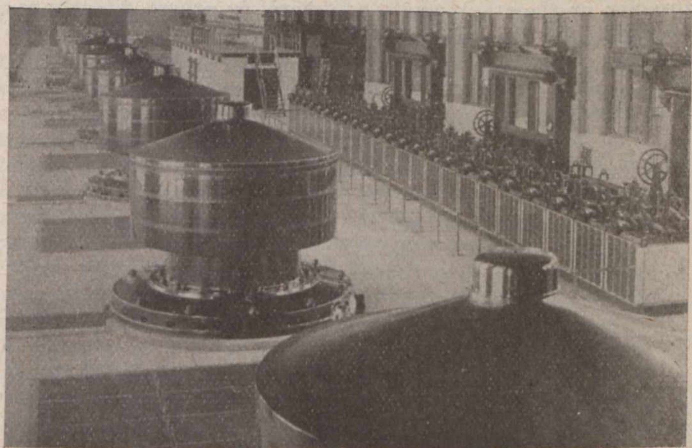
One of the things the young engineer should study is his attitude toward the construction forces. Some young engineers have a feeling of superiority over men who have worked for years at their trade, and wonder why such men should receive so much more for their services than they do



Erecting Transmission Line Towers, Great Western Power Co.

after spending four years in college. This is a natural feeling perhaps, but the young graduate should remember that he is as yet of no great value and will not be until he has gained practical experience. Take for illustration, the master mechanic on a large piece of work. He receives much larger salary than any of the junior engineers, enjoys an enviable position among his fellow workmen, and commands the respect of his superiors. He has attained his position through many years of hard work and is by nature a leader of men. Starting as an apprentice boy he has thoroughly mastered his trade. He must have initiative, resourcefulness and ability to cope with any emergency. This is also true of superintendents, boss carpenters, chief electricians, boss riggers, etc. These men are indispensable in the construction world and therefore command high pay. They have, however, unbounded respect for the engineer who has had the advantage of a technical education and the engineer retains this respect by the practical way in which he applies his knowledge. Having much knowledge of human nature, they know the limitations of the average young man and easily detect bluff. On the other hand, they are generous and will share their fund of practical knowledge with the young engineer, if they feel that he is sincere, and they will do anything in their power to help him when he is in trouble. Personally, I have a feeling of unbounded respect for some of the loyal, intelligent men of this class with whom I have been associated.

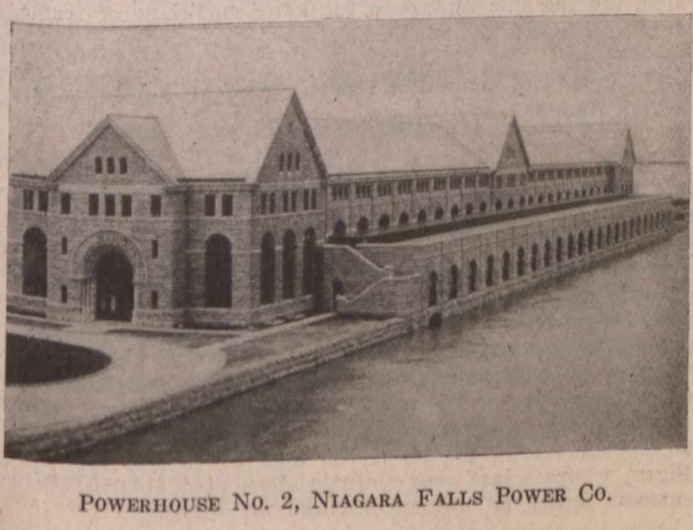
One of the greatest assets an engineer can have is the confidence of those with whom he deals. The engineers should not give out any information to the construction forces until he is sure that it is correct. If, when he does make a mistake (no one is infallible), he takes the blame



INTERIOR OF POWERHOUSE NO. 2, NIAGARA FALLS POWER CO.

on himself without trying to implicate others, he will keep the respect of his associates and his superiors.

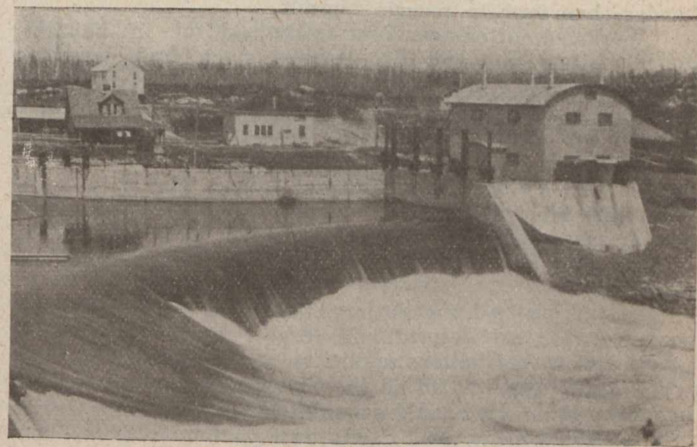
Unfortunately many young men suffer themselves and cause others to suffer through their neglect of the ordinary courtesies of life. A young engineer finds himself one of a large construction organization located, perhaps, many miles from a settlement. This usually means that he eats three meals a day and spends each evening—seven days a week—with the same group of men, many of whom are much older than himself. After many months of such close contact the best of friends and the most courteous of men get on each others' nerves, and in times of anxiety and stress are easily estranged. It at such a moment a young engineer enters the scene and freely criticisies the camp and the work and indulges in much general conversation, he is very liable to incur the dislike of nearly everyone in the clubhouse. The adage "Familiarity breeds contempt" was never more true



POWERHOUSE NO. 2, NIAGARA FALLS POWER CO.

than in a construction camp. Nowhere is punctilious observance of all the everyday courtesies more respected.

Young engineers should not only pay deference to their superior engineers, but to all older men on the work. The superintendent and foremen are accustomed to being addressed as "Mister" by their men, and I have always found all workmen, even to the humblest laborers, respond to

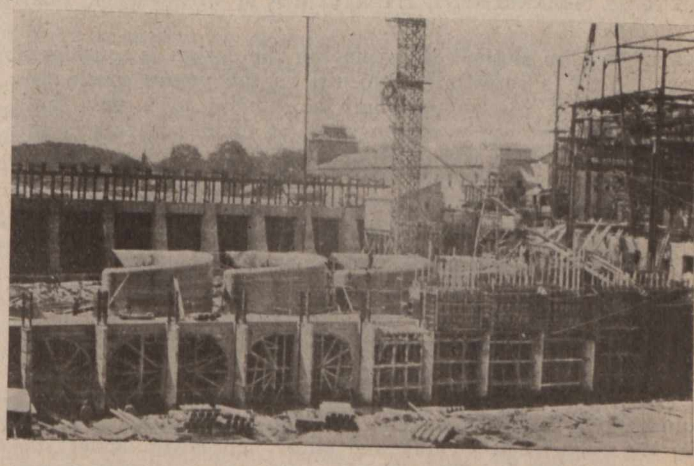


GENERAL VIEW OF COBALT HYDRAULIC AIR COMPRESSOR PLANT

courteous treatment. Conversely, our native workmen bitterly resent unjust criticism and harsh language. This is particularly true in the south, where even the humblest laborer is invariably polite. Some young men court popularity by cultivating a "free and easy" manner with workmen, which they seem to resent as much as undue harshness.

In the last analysis, the quality and quantity of work done, the time required and cost depend upon the discipline maintained throughout the organization. Harmony, enthusiasm and all the constructive forces are products of personal self-control and discipline.

In years gone by, the direction of large forces of men was often left to men whose chief qualifications were bulk, loud voices, a choice collection of oaths and reputations of being "drivers." Labor was cheap and plentiful and "turn-



SCROLL CASE AND DRAFT TUBE FORMS IN POWERHOUSE AT MINETTO, N.Y.

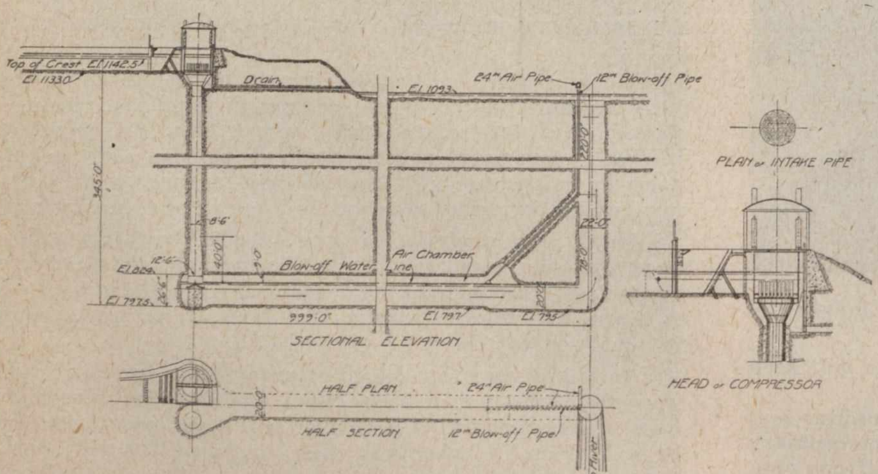
over" not the nightmare that it is now. To-day this type has nearly disappeared from positions of much responsibility and we have men who lead instead of drive, praise instead of nag; men who know the power of the right word quietly spoken. We know of superintendents and foremen who are followed from place to place by their men. In times of need they can depend upon their men to work night and day without thought of self. These foremen exact respect, implicit obedience and much work of excellent quality; they are, however, very just and appreciate what the men do.

They are sure to notice inefficiency, but ready to give praise where praise is due.

The successful executive reproves, when necessary—sometimes severely—but takes care not to leave a sulky, resentful man. A workman of the proper calibre feels his failures and mistakes as keenly as does anyone else; he expects and accepts criticisms of the right sort with a determination not to let it happen again; he probably works harder than ever to redeem himself.

Workmen often are extremely skillful in handling difficult situations, and I've learned much from watching them. One day I saw a big Irish superintendent reproving his master mechanic, a very efficient man, for neglect of a part of his work. The master mechanic was much upset and chagrined. When the superintendent had said enough, he tactfully changed to a pleasant subject and drew a big red apple from his pocket. This he gravely gave to the master mechanic, who smiled his thanks, then with an exchange of a few more pleasant remarks each went on his way.

In talking to his superiors, the young engineer should preserve both self-respect and respect for authority. He should follow instructions implicitly, and in his own province try to anticipate and to do the obvious work without waiting to be told. He should acquaint himself with the design of the development, and in his own particular department



General Arrangement, Hydraulic Air Compressor Plant, Cobalt, Ont.

learn why the method of developing the design is considered best. This is sometimes difficult, as the young graduate's knowledge of the subject may be limited to a few facts which may not apply to the work at hand. If this is the case he should, by study of drawings and intelligent questions, familiarize himself with the subject as presented in the development. If he forms the habit of analysis and care in thinking, gradually as he goes about his daily work he will begin to notice ways in which money or time can be saved or in which work may be done to better advantage. When he feels sure that his suggestion is a good one he should offer it to his superior, but should not be discouraged or angry if his suggestion is rejected by a man of broader experience. The more experienced engineer will gladly explain why it is not usable, and the young man is richer by the experience. Think and study, but never neglect the everyday routine. The valuable assistant, a future executive, is the one who assumes certain responsibilities and never under any circumstances neglects a single detail; excuses or reasons why things are not done never make things any easier for the young man; he has to produce a definite, accomplished piece of work at a given time in order to be a success.

I have tried to give an idea of some of the duties and responsibilities required of the young engineer employed on field work of a hydro-electric plant. Some may be interested in knowing what returns besides the financial the young engineer may expect from the years of hard work. First of the many compensations which may be mentioned is a practical knowledge of engineering which will be invaluable and which can be acquired in no other way; then those characteristics developed by constant contact with nature and men who work with their hands,—fortitude, human understanding and hardiness. In after years the memories of rare holidays spent on horseback on mountain trails or with a fishing rod by black pools in the swift running river are still vivid. The following line might have been said of the field engineer: "He had a heart to resolve, a head to contrive and a hand to execute."

METHODS OF SUPERVISING TIE RENEWALS*

Two general methods of annual field inspection for maintaining control of tie renewals, so that ties will remain in service for their full life but will be removed at the proper time, are recommended by the tie committee of the American Railway Engineering Association, as follows: (1) By section foremen or their immediate superiors, or others directly responsible for the safety of the track; (2) by special inspectors chosen for their experience and knowledge of the requirements of their territory and not generally connected with or responsible for the track or territory inspected.

The first method has a tendency to provide adequate renewals, thereby assuring safety within the limits of available resources. It also provides a basic knowledge of local conditions, which no other method can cover. On the other hand, there will undoubtedly be a lack of uniformity under similar conditions on various territories and the possibility of excessive and uneconomical renewals.

The second method provides for training a small number of selected men to a predetermined standard of tie renewals and consepuent conservation of ties. It presents difficulties, however, in possible inadequate renewals at certain points, inability to obtain sufficient men and difficulty in finding employment for them outside of the renewal season. Conditions on various railway systems are so different that no one method can be established, but the committee points out that consideration must be given to the local conditions in determining which method is best for any particular road.

Whichever method is used, the spotting or marking of each tie to be removed is advisable. The section foremen, however, should be allowed some latitude for removing ties, independent of the spotting, which are broken or damaged or otherwise injured. A check of ties removed from time to time is considered essential. The use of statistics for approximate determination of tie requirements in advance of field inspection will be found desirable. When the number of ties available is less than the final inspection requirements indicate as being needed, the supply should be prorated, making due allowance for local conditions of traffic, curvature, grade and roadbed.

*Abstract of committee report, American Railway Engineering Association.

In a speech in the Ontario legislature last week, Hon. F. C. Biggs, Minister of Public Works and Highways, stated that in his opinion there is no reason why motor vehicle fees could not be increased within the next two years to an average of $15 per motor car, which would give an income of approximately $5,000,000 per annum to be devoted to road improvement. Mr. Biggs stated that the money appropriated by the Dominion government as federal aid to highways is, he understands, the money that has been collected as customs duty on imported automobiles and motor-trucks. However, the province of Ontario is to receive only about $6,000,000 over a period of the next five years, said Mr. Biggs, whereas last year Ontario alone paid $14,000,000 in customs duties on automobiles and motor-trucks.

ACT INCORPORATING THE MANITOBA ASSOCIATION OF PROFESSIONAL ENGINEERS

FOLLOWING is the complete text of the Act passed March 24th, 1920, by the Manitoba legislature, incorporating the Association of Professional Engineers of the Province of Manitoba:—

His Majesty, by and with the advice and consent of the Legislative Assembly of Manitoba, enacts as follows:

1. Title

This Act may be cited as "The Engineering Profession Act."

2. Interpretation

In this Act unless the context otherwise requires, the expression:

(*a*) "professional engineer" means any person registered as a professional engineer under the provisions of this Act;

(*b*) "professional engineering" or "the practice of a professional engineer" embraces the designing, supervision, the advising on the design, or supervision and the advising on the making of measurements for the construction, enlargement, alteration, improvement, maintenance or valuation of public or private utilities, industrial work, railways, bridges, tunnels, highways, roads, canals, harbor works, harbors, river improvements, lighthouses, wet docks, dry docks, floating docks, dredges, cranes, and other similar work, steam engines, turbines, pumps, internal combustion engines, and other similar mechanical structures, air ships and aeroplanes, electrical machinery and apparatus, chemical and metallurgical machinery, and works for the development, transmission, or application of power, mining operations and apparatus for carrying out such operations, municipal works, irrigation works, water works, water purification plants, sewerage works, sewage disposal works, drainage works, incinerators, hydraulic works, and all other engineering works. The execution by a contractor or his assistants of work designed by a professional engineer, or the direction of work as otherwise defined in this clause by superintendent of construction, or superintendent of maintenance, or their subordinates when working from designs or upon advice of a professional engineer, shall not be deemed to be the practice of professional engineering within the meaning of this Act;

(*c*) "association" means the association of professional engineers of the Province of Manitoba;

(*d*) "council" means the executive council of the association;

(*e*) "president" means the president of the association;

(*f*) "registrar" means the registrar of the association;

(*g*) "secretary" means the secretary-treasurer of the association;

(*h*) "board" means the board of examiners of the association.

3. Association of Professional Engineers

(1) All persons registered as professional engineers under the provisions of this Act shall constitute the Association of Professional Engineers of the Province of Manitoba, and shall be a body politic and corporate, with perpetual succession and common seal.

(2) The head office of the association shall be at Winnipeg.

4. Financial Powers

The association shall have power to acquire and hold real estate not producing at any time an annual income in excess of ten thousand dollars, and to alienate, mortgage, lease or otherwise charge or dispose of such real estate or any part thereof as occasion may require; and all fees, fines and penalties receivable and recoverable under this Act shall belong to the association.

5. By-laws

The association may pass by-laws not inconsistent with the provisions of this Act for:

(*a*) The government, discipline and honor of the members;

(*b*) the management of its property;

(*c*) the maintenance of the association by levying fees not in excess of five dollars per annum;

(*d*) the examination and admission of candidates to the study and practice of the profession;

(*e*) all other purposes reasonably necessary for the management of the association.

6. Ratification of By-laws

All by-laws or amendments thereto shall become effective only after ratification by two-thirds majority of the votes cast by the members of the association in good standing.

7. Who May Practice

(1) Only such persons who are members of the association hereby incorporated and registered as such under the provisions of this Act, or who have received a license from the council of the association as hereinafter provided, shall be entitled, within the Province of Manitoba, to take and use the title of "professional engineer" or any abbreviation thereof, or to practice as a "professional engineer" or act as engineer in laying, advising on, constructing or superintending the construction of any railway or public work or any work upon which public money is expended, the cost of which is in excess of one thousand dollars.

(2) Any person residing in the Province of Manitoba at the date of the passing of this Act, who is at that date and has been for one year previously practising as a professional engineer, shall be entitled to be duly registered as a member of the association without examination, provided that such person shall produce to the Council satisfactory proof of having so practised.

(3) Any person who may come to reside in the Province of Manitoba, and who at that time is a duly registered member of an association of engineers similarly constituted of any other province of the Dominion of Canada, may become a duly registered member of the association without payment of fee for that year, if he shall produce to the council a certificate of membership in good standing in such province, and an application for transfer of registry endorsed by the registrar of the province in which he lately resided.

(4) Any person not otherwise qualified as hereinbefore mentioned, and who may desire to become a registered member of the association, shall make application to the council, and shall submit to an examination, or shall submit credentails in lieu of examination, whichever the council may decide, and shall be admitted to reigstry as a member of the association on payment of prescribed fees after the council shall have certified in writing that such examination or credentials have been found satisfactory to it.

(5) Any person not residing in the Province of Manitoba who is a registered member of an association of engineers similarly constituted of any other province of the Dominion of Canada, may obtain from the registrar a license to practice as a professional engineer in the Province of Manitoba, upon production of evidence of his registry in such other province, and upon payment of a fee of one dollar. In the event of such person being unable by reason of emergency or neglect on the part of the registrar, or for any good and sufficient reason, to obtain such license within three months of his making application therefor, he shall be entitled to practice as a professional engineer in the province for such period of three months without holding such license.

(6) Any person who is not a resident of Canada, but who is a member of any engineering or technical organization or society of standing, recognized by the council, may obtain a license to practise his profession in an advisory or consultative capacity.

(7) Any person who is employed as a professional engineer by a public service corporation, a private corporation, public utility or government department, whose business is normally carried on in two or more of the provinces of Canada, and who is by reason of his employment required to practice as a professional engineer in other provinces other than that of his residence, may so practice in the Province of

Manitoba, without holding a non-resident license, or payment of fee, if on demand of council, he produces credentials satisfactory to the council showing that he is a resigtered member of an association of engineers similarly constituted by some other province of Canada. It shall be the duty of such person to produce such credentials whenever so required by the council.

(8) Any professional engineer who is a resident of some other province of Canada in which there is no association of engineers similarly constituted, may obtain a license to practice, subject to the discretion of the council.

(9) Graduates or undergraduates of recognized engineering colleges or *bona fide* assistants serving under articles may during the remainder of their respective periods required for registration be engaged in professional engineering work as defined in paragraph (*b*) of section 2 under the guidance of professional engineers who assume full responsibility for their work, but shall not be classed as professional engineers until registered as members of the association as provided in this section, Such graduates, undergraduates or assistants serving under articles, shall, at the commencement of their respective engineering courses or terms of service, be registered with the association, and such graduates, undergraduates or assistants serving under articles shall be subject to the control of the council and to any by-laws passed by the association under section 5, but shall not be members of the association.

(10) The provisions of this Act shall not apply to any person employed in actual service in His Majesty's naval, military or aerial services.

(11) Engineers who were practicing in the Province of Manitoba, and who were accepted for overseas service in the war 1914-1919 in the forces of Great Britain, or any of her allies, shall be entitled to all the rights and privileges conferred under sub-section (2) of section 7, although not residing in this province at the date of the passing of this Act.

8. Partnership

Where two or more persons are carrying on practice as professional engineers in co-partnership only such members who are registered or licensed under this Act, shall individually assume the function of a professional engineer. A firm as such cannot be deemed to be a member of the association or be licensed to practice.

9. Administration

There shall be a council of management of the association to consist of a president, vice-president and five councillors, to be elected and hold office as provided by the by-laws of the association. All members of the council must be registered under the provisions of this Act.

10. Board of Examiners

A board of examiners shall be nominated and appointed annually by the council subject to such approval as the Lieutenant-Governor-in-Council may require.

11. Joint Examining Board

The council shall have power to establish conjointly with any council of any association similarly constituted in one or more of the provinces of Canada, a central examining board, and to delegate to such central examining board all or any of the powers possessed by the said council respecting the examinations of candidates for admission to practice, provided that any examination conducted by such central examining board shall be held in at least one place within this province.

12. Qualifications

(1) No person under twenty-one years of age shall be registered for admission to practice professional engineering.

(2) A candidate for admission to practice after the passing of this Act shall serve under articles with a registered professional engineer or registered professional engineers for four years, unless a graduate from some recognized engineering college in which case his term of service may include his term of instruction in such college.

13. Annual Fees

(1) Each person who is registered or licensed to practice under this Act shall pay in advance to the secretary-treasurer, or any person deputed by the council to receive it, such annual fee as may be determined by by-laws of the association, which fee shall be deemed to be a debt due by the practitioner and to be recoverable with costs in the name of the council in any court of competent jurisdiction.

(2) If any registered practitioner omit to pay the prescribed annual fee within six months of the date upon which it becomes due, the registrar shall cause the name of such practitioner to be erased from the register, and such practitioner shall thereupon cease to be deemed to be a registered practitioner; but such practitioner shall at any time thereafter, upon paying such fee, be entitled to all his rights and privileges as a registered practitioner from the time of such payment.

(3) The registrar shall not be required to issue a license to practice to any non-resident practitioner otherwise entitled to such license unless the fee provided for by the by-laws of the association shall have been previously paid.

14. Necessity of Registration

Any person entitled to be registered under this Act who shall neglect or omit to be registered shall not be entitled to any of the rights and privileges conferred by the provisions of this Act so long as such neglect or omission shall continue.

15. Right of Appeal

In the case of any refusal by the council to register the name of any person as a member of the association, or of refusal to issue a license to practice, the person aggrieved shall have the right to apply to a judge of the court of King's Bench, who, upon due cause shown, may issue an order to the council to register the name of such person, or to grant him a license to practice or make such other order upon such appeal as may be warranted by the facts, and the council shall forthwith comply with such order. Such order when so made shall be final.

16. Default of Registrar

If the registrar makes or causes to be made any wilful falsification in any matter relating to the register, he shall forfeit a sum not less than one hundred dollars.

17. False Registration

If any person shall wilfully procure or attempt to procure himself to be registered or licensed under this Act, by making or producing, or causing to be made or produced any false or fraudulent representations or declarations, whether verbally or in writing, every such person so doing, and every person knowingly aiding and assisting him therein, shall forfeit and pay a sum of not less than one hundred dollars.

18. Evidence

The certificate of the registrar under the seal of the association shall be *prima facie* evidence of registration or license, or non-registration, as the case may be.

19. Suspension for Misconduct

(1) The council may in its discretion, reprimand, censure or suspend or expel from the association any engineer guilty of unprofessional conduct, negligence, or misconduct in the execution of the duties of his office, or convicted of a criminal offence by any court of competent judisdiction, but shall not take any such action until a complaint under oath has been filed with the registrar and a copy thereof forwarded to the party accused. The council shall not suspend or expel an engineer without having previously summoned him to appear to be heard in his defence, nor without having heard evidence under oath offered in support of the complaint on or behalf of the engineer. The council shall have the same powers as a justice of the peace to compel witnesses to appear and to answer under oath in the man-

ner and under the penalties prescribed by law. The president of the council or person acting as such in his absence, or the secretary, is hereby authorized to administer oaths in such cases. All evidence shall be taken in writing or by a duly qualified stenographer.

(2) Any engineer so suspended or expelled may, within thirty days after the order or resolution of suspension or expulsion, appeal to a judge of the court of King's Bench from such order or resolution, giving seven days notice of appeal to the council, and may require the evidence taken to be filed with the proper officer of the court, whereupon such judge shall decide the matter of appeal upon the evidence so filed and confirm or set aside such suspension or expulsion, without any further right of appeal; and if the suspension or expulsion be confirmed, the cost of such appeal shall be borne by the engineer.

(3) Unless the order or resolution of suspension or expulsion is set aside by such appeal or the judge or the council otherwise order, the engineer so suspended or expelled shall not practice further, except, in case of suspension, upon expiry of the period of suspension. Pending an appeal the engineer as suspended or expelled shall not practice.

20. Penalties

Any person not being a registered or licensed professional engineer in the province or who is suspended or has been expelled as provided in the next preceding section who:

(*a*) practices as a professional engineer or,

(*b*) usurps the functions of a professional engineer, or

(*c*) assumes verbally or otherwise the title of professional engineer, or makes use of any abbreviation of such title, or of any name, title or designation which may lead to belief that he is a professional engineer, or a member of the association, or

(*d*) advertises himself as such in any way or by any means, or,

(*e*) acts in such manner as to lead to the belief that he is authorized to fulfil the office of or act as a professional engineer shall be liable upon summary conviction to a penalty of $200, and, in default of payment, to imprisonment for two months.

21. Practice Proven by Single Act

In any prosecution under the section next preceding it shall be sufficient proof of the offence alleged if it be proved that the accused has done or committed in Manitoba a single act of the kind complained of.

22. Summary Hearings

All penalties imposed under this Act, or any of them, and all sums of money forfeited shall be recoverable with costs under the provisions of "The Manitoba Summary Convictions Act."

23. Information

Any information for the recovery of such penalty or forfeiture may be laid by any member of the association or by any person appointed by the council.

24. Moneys to Association

Any penalty or sum forfeited under this Act when recovered shall belong to the association for the use thereof under this Act.

25. Limitation

No prosecution shall be commenced for any offence against this Act after one year from the date of the alleged committing of the offence.

26. Provisional Council

(1) The following persons are hereby constituted a provisional council of the association: J. G. Sullivan, W. M. Scott, Guy C. Dunn, J. M. Leamy, W. J. Dick and W. P. Brereton.

(2) The duties of the provisional council shall be to provide the register called for by this Act, to enter therein the names of those who are entitled to registration and who apply therefore under the provisions of sub-section (2) of section 7, and to call within six months from the coming into force of this Act the first general meeting of the association for those purposes and any other organization purposes of the association; they shall have the powers conferred in this Act on the council of the association. Their powers shall cease on the election of the regular council of the association.

27. Operation Postponed

No provisions of this Act restricting the practice of the profession or imposing penalties shall take effect until one year after the passing of this Act.

28. Individual Seal

Every person registered under this Act shall have a seal, the impression of which shall contain the name of the engineer and the words "Registered Engineer, Province of Manitoba," with which he shall stamp all official documents and plans.

29. Former Act Repealed

Chapter 32 of the Revised Statutes of Manitoba, 1913, being "The Manitoba Civil Engineers' Act," is hereby repealed.

30. When Act in Force

This Act shall come into force on the day it is assented to.

PRODUCTION OF STRUCTURAL MATERIALS

In a preliminary report of the mineral production in Canada for the year 1919, issued by the Department of Mines, Ottawa, the total value is estimated at $173,000,000. Included in the estimate are the following structural materials:—

	Quantity	Value
Cement, portland, bbls	4,991,340	$ 9,783,393
Brick, common, No.	293,918,891	3,723,033
Brick, pressed, No.	67,587,295	1,257,833
Fireproofing	....	359,882
Hollow building blocks, No.	2,202,000	63,275
Kaolin, tons	759	13,744
Pottery	...	187,574
Refractories, fire clay, etc.	...	380,934
Sewer pipe, tons	56,287	1,061,010
Terra cotta	......	2,861
Tile, drain, No.	19,161,718	607,792
Lime, bushels	6,999,706	2,268,432
Sand-lime brick, No.	28,219,399	377,040
Sand and gravel, tons	3,906,247	1,687,991
Slate, square	1,632	10,853
Granite	.....	968,111
Limestone	.....	2,708,625
Marble	.....	213,982
Sandstone	.....	78,327
Stone	.....	3,969,045

It is rumored that a large interest in the New Brunswick Railway Lands Co., which holds more than 1,500,000 acres of timber land in New Brunswick, has been purchased by Fraser Companies, Ltd. The latter concern is said to have applied for authority to dam the Tobique River for the development of power, with the object of erecting pulp and paper mills at Tobique Narrows. Donald Fraser, of the Fraser Companies, Ltd., when interviewed, would not deny the truth of the report, nor would he affirm it.

Mechanical analyses were recently made by the U.S. Bureau of Standards on two samples of cement received from a western portland cement company. One of the samples was taken from the tube mills and the other was a sample of the finished product of the cement mill. The object of the analyses was a comparative study of the fineness of the two materials. There was little increase of what is known as the No. 1 air analyzer flour in the finished cement, but there was an increase of 10% (from 72 to 82%) in the amount passing the 200-mesh sieve.

WATER POWER DEVELOPMENT IN CANADA

By J. T. Johnston
Chief Engineer, Dominion Water Power Branch

THE Dominion Water Power Branch, Department of the Interior, and the Dominion Bureau of Statistics, Department of Trade and Commerce, have through co-operation just completed an exhaustive census and analysis of the developed water power in Canada. The figures, which are complete to January 1st, 1920, are exceptionally interesting and are indicative of the marked manner in which the water-power resources of the Dominion are being put to advantageous use. Practically every great industrial centre in Canada is now served with hydro-electrical energy and has within easy transmission distance ample reserves of water power. Active construction in hydro-electrical enterprise is fast linking up the few centres which are still unserved, and which have water-power resources in their vicinity. In those localities where water power is not available, nature has bountifully supplied fuel reserves of coal, gas or oil.

According to a recent computation, the water-power resources of the British empire have been placed at from 50 to 70 million horse power. This does not include such territories formerly under control of the Central Powers, as will fall in future under British influence. To this total Canada contributes in the neighborhood of 20 million horse power. This figure represents the power available at sites at which more or less definite information is to hand. Continued investigation will undoubtedly add to this figure.

According to the statistics just compiled there is installed throughout the Dominion some 2,418,000 turbine or waterwheel horse power (see Table 1) of which 2,215,000 h.p. is actually and regularly employed in useful work. The larger figure includes the total installed capacity at full gate, including reserve units. It does not, however, include hydraulic exciter units. A large number of the plants now operating are designed for the addition of further units as the market demands. The ultimate capacity of such plants, together with that of new plants now under construction, total some 3,385,000 h.p.

Of the total power installed, 1,756,791 h.p., or 72.7%, is installed in central electric stations. By central electric stations are meant stations which are engaged in the development of electrical energy for sale and distribution. Central station power is sold for lighting, mining, electro-chemical and electro-metallurgical industry, milling and general manufacturing. It is apparent, therefore, that the central station total listed in Column 3 (Table 1), includes a portion of the totals listed in Columns 4 and 5 as used in other industries. In the pulp and paper industry, 473,265 h.p. is utilized, of which 381,631 h.p. is generated directly from water in pulp and paper establishments, while 91,634 h.p. is purchased from hydro central electric stations.

Hydro power used for other purposes and other industries may be listed as follows: For lighting purposes, 434,613 h.p.; in mining industry, 177,728 h.p.; in flour and grist mills, 42,736 h.p.; in lumber and saw mills, 37,918 h.p.; in other manufacturing industries, 172,955 h.p. These figures are evidence of the widespread manner in which the Do-

TABLE 1—DISTRIBUTION OF DEVELOPED WATER POWER IN CANADA BY PROVINCES AND BY USE OF POWER (JAN. 1ST, 1920)

	DEVELOPED WATER POWER							UNDEVELOPED
	Total Water-Wheel and Turbine Horse-Power Installed	Total Water-Wheel and Turbine H.P. Installed for Use in: Central Electric Stations	Pulp and Paper Industry	Other Manufacturing Industries	Total Horse-Power Actually Employed	Ultimate Designed Capacity of Plants now operating or under Construction, in H.P.	Installed H.P. per 1,000 Population	WATER POWER
1	2	3	4	5	6	7	8	9
Yukon	13,199	10,000	......	......	11,349	13,199	1,467	100,000
British Columbia	308,167	211,043	46,962	46,094	276,795	350,832	429	3,000,000
Alberta	32,992	32,580	......	17	31,754	33,070	56	466,000
Saskatchewan	......	......	......	......	......	......	...	567,000
Manitoba	83,447	71,790	......	......	75,100	297,047	135	3,218,000
Ontario	1,015,726	794,621	158,095	99,230	934,015	1,460,920	360	5,800,000
Quebec	910,029	623,088	249,332	270,961	838,071	1,146,465	391	6,000,000
New Brunswick	18,080	9,378	2,693	6,009	16,657	29,115	49	300,000
Nova Scotia	34,323	4,064	16,183	12,276	29,359	52,202	66	100,000
Prince Edward Island	1,933	227	......	1,789	1,621	1,958	21	3,000
Totals	2,417,896	1,756,791	473,265	436,376	2,214,721	3,384,808	274	19,554,000

TABLE 2—TURBINES AND WATER-WHEELS INSTALLED IN WATER POWER PLANTS IN CANADA, BY NUMBER AND CAPACITY OF UNITS AND BY PROVINCES (JAN. 1ST, 1920)

	Total Water Wheel and Turbines Installed, H.P.	Units of 100 H.P. or Under		Units Over 100 H.P. and Under 500 H.P.		Units of 500 H.P. and Under 2,000 H.P.		Units of 2,000 H.P. and Under 5,000 H.P.		Units of 5,000 H.P. and Under 10,000 H.P.		Units of 10,000 H.P. and Under 20,000 H.P.		Units of 20,000 H.P. and Over	
		No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Yukon	13,199	6	199	..	.....	3	3,000	..	.....	2	10,000	..	.....	..	.....
British Columbia	308,167	124	4,396	43	10,498	39	44,573	19	62,100	6	42,000	12	144,600	..	.....
Alberta	32,992	9	492	5	900	..	.....	2	8,000	4	23,600	..	.....	..	.....
Saskatchewan	......	..	....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....
Manitoba	83,447	..	....	1	450	2	1,000	9	35,597	8	46,400	..	.....	..	.....
Ontario	1,015,726	734	32,190	182	39,844	147	155,062	77	186,380	14	88,050	36	474,200	2	40,000
Quebec	910,029	893	31,942	189	46,626	140	151,461	51	157,825	22	151,075	20	251,100	6	120,000
New Brunswick	18,080	61	2,084	16	3,696	10	10,300	1	2,000	..	.....	..	.....	..	.....
Nova Scotia	34,323	324	8,968	38	9,605	19	13,250	1	2,500	..	.....	..	.....	..	.....
Prince Edward I.	1,933	93	1,933	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....
Totals	2,417,896	2,244	82,204	474	111,619	360	378,646	160	454,402	56	361,125	68	869,900	8	160,000

TABLE 3—CENTRAL ELECTRIC STATIONS OPERATED BY WATER POWER—PRIMARY HORSE-POWER AND DYNAMO CAPACITY INSTALLED, AND CAPITAL INVESTED IN STATIONS AND TRANSMISSION AND DISTRIBUTION SYSTEMS (JAN. 1ST, 1920)

	Installed Horse Power in			Total Installed Dynamo Capacity in K.V.A.	Capital Invested	
	Water-Wheels and Turbines	Fuel Auxiliaries	Total		Total	Per Horse-Power
1	2	3	4	5	6	7
Yukon	10,000	......	10,000	6,000	$ 3,471,678	$347
British Columbia	211,043	26,780	237,823	154,571	38,450,131	182
Alberta	32,580	2,405	34,985	24,260	6,990,972	214
Saskatchewan	......	......	......	......	....	...
Manitoba	71,790	19,400	91,190	62,313	14,340,458	200
Ontario	794,621	39,530	834,151	670,053	170,112,988	215
Quebec	623,088	28,163	651,251	522,461	133,645,655	214
New Brunswick	9,378	500	9,878	6,160	1,543,727	165
Nova Scotia	4,064	420	4,484	3,016	842,122	207
Prince Edward Island	227	......	227	346	67,230	296
Totals	1,756,791	117,198	1,873,989	1,449,160	$369,464,961	$210

minion's water power resources are being applied to the furtherance of its industrial development. In further reference to the foregoing total of water power developed in Canada, it might be noted that during the fiscal year ending March 31st, 1919, there were exported from plants included in tabulation, 175,000 h.p. years.

Tendency Toward Large Units

Table 2, analysing the number and capacity of the water wheels and turbines installed, is of considerable interest. The total installation of 2,417,896 h.p. is comprised of 3,370 units of an average capacity of 715 h.p. While 2,244 of these units are of 100 h.p. or under, they contribute only 82,204 h.p., or 3.4%, to the total. A total of 1,845,427, or 76.3% of the whole, is contributed by units of 2,000 h.p. and over; 1,391,025 h.p., or 57.6%, by units of 5,000 h.p. and over; 1,029,900 h.p., or 42.6%, by units of 10,000 h.p. and over; and 160,000 h.p., or 6.6%, by units of 20,000 h.p. and over. This table is illustrative of the modern tendency towards the installation of large units. Reference might be made in this connection to the 50,000 h.p. turbines which are contemplated for the new development of the Hydro-Electric Power Commission at Queenston.

The statistics in Table 3 refer to the developed water power used in connection with the central electric station industry. The central station industry has made great strides in Canada in recent years. A network of transmission systems, which are being rapidly extended from year to year, covers central and southwestern Ontario and southern Quebec. Other systems established in numerous centres from coast to coast are likewise rapidly extending their scope. Of the primary power used in the central stations throughout the Dominion, 91.4% is derived from water, evidencing in a striking manner the advantageous location of the water-power resources to industrial centres.

Construction Costs

The total installed water-wheel and turbine horse power in hydro central electric stations, is 1,756,791 h.p. Fuel auxiliaries installed as stand-bys to these hydro stations brings the total installed primary capacity up to 1,873,989 h.p., connected to 1,449,180 k.v.a. dynamo capacity. The total capital invested in these central stations, inclusive of transmission and distribution systems, is $369,464,961, or an average of $210 per installed primary horse power.

Of special interest to engineers is the actual cost of construction of hydro-electric power stations, exclusive of transmission and distribution systems. The figures of 70 representative hydro-electric stations throughout the Dominion, with an aggregate turbine installation of 745,797 h.p., show a total construction cost of $50,740,468 (pre-war figures) or an average of $69.11 per installed horse power. This cost includes the capital invested in construction of dams, flumes, penstocks and all hydraulic works, and of power stations and equipment. It excludes real estate and transmission and distribution equipment. The figure, in brief represents the capital cost of construction at the power site.

With a water-power development of 274 h.p. per thousand population, Canada stands well in the forefront in respect to availability and utilization of hydro power resources, being only surpassed in this respect by Norway. The enormous water-power reserves still untouched form a substantial basis for the progressive exploitation and development of other natural resources, and, if properly coordinated with the development and utilization of the enormous fuel resources of the Dominion, are an assurance of continued industrial expansion and prosperity.

PUBLICATIONS RECEIVED

POTENTIAL WEALTH OF CANADA'S NATURAL RESOURCES.—By C. E. W. Dodwell, of the public works department, Halifax, N.S.; 60 pages and cover, 4 by 9½ ins. Reprint of articles which appeared last year in the "Halifax Morning Chronicle."

NITRATE NO. 1.—Illustrated booklet, 24 pages and cover, 8 by 10½ ins., printed in two colors on coated paper. Published by the J. G. White Engineering Corporation, 43 Exchange Place New York, describing the nitrate plant built for the United States government in Sheffield, Ala.

SELLING YOUR SERVICES.—By George C. Pearson; 238 pages and cloth cover; 5 by 7½ ins.; published by the Jordan-Goodwin Corporation, Jefferson Bank Bldg., New York. A valuable treatise on selling one's own services, or making a job of getting a job, including hints on capitalizing one's experience, use of advertisements in circular letters, personal calls, employment agencies, following up personal visits, etc.

The Hydro-Electric Power Commission of Ontario is seeking to acquire a number of electric railways in Southwestern Ontario that were purchased by the Dominion government when the government took over the Canadian Northern system. Sir Adam Beck had a long interview last week with the Minister of Railways, and it was subsequently stated that a satisfactory agreement had been effected, although no details were announced.

Contract has been awarded by the Hydro-Electric Power Commission of Ontario to I. P. Morris, Philadelphia, Pa., for three 55,000 h.p. hydraulic turbines, with generators, for installation at Queenston. The Wellman-Seaver-Morgan Co., Cleveland, O., is now building two similar turbines for the Queenston plant, so there are altogether five units under contract, with a total capacity of approximately 275,000 h.p. The Canadian General Electric Co., Ltd., Toronto, has the contract for two of the generators, and the other three are being built by the Canadian Westinghouse Co., Ltd., Hamilton.

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	$1.75	$1.00	10c.

Published every Thursday by

The Monetary Times Printing Co. of Canada, Limited

President and General Manager JAMES J. SALMOND

Assistant General Manager ALBERT E. JENNINGS

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.

Telephone, Main 7404. Cable Address, "Engineer, Toronto."

Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. Goodall, Mgr.

PRINCIPAL CONTENTS

	PAGE
Spillways in Nova Scotia Proven Inadequate, by K. G. Chisholm	371
Duration of Twilight, by J. G. Sullivan	373
Hamilton Bridge to Cost Over Million Dollars	374
Dean Mitchell's Address to Teachers	374
Duties of a Young Engineer on the Construction of a Hydro-Electric Plant, by H. S. Slocum	375
Act Incorporating the Manitoba Association of Professional Engineers	385
Production of Structural Materials	387
Water Power Development in Canada, by J. T. Johnston	388
Publications Received	389
Personals	391

HYDRATION AND SHRINKAGE OF MORTARS

SOME interesting experiments have recently been conducted by the U.S. Bureau of Standards to determine whether a reduction in shrinkage of mortars can be produced by greater "hydration." The first step attempted was the production of a "hydrated" mortar by the use of a wet plaster base, but the results showed that hydration could not be readily obtained in a 1:3 mortar, if obtained at all, by the use of such a base, and was only possible when the top of the form was completely covered with metal and glass. When this was done, not only was contraction eliminated during the first 24 hours, but some expansion was produced. It was also found that by the use of a non-absorptive form with a metal and glass covering, very nearly the same results could be secured, thereby showing that very little water was given up by the wet base. As the mixes were made richer, the effects of the wet plaster base became more and more evident.

TECHNICAL MEN IN GOVERNMENT EMPLOY

TECHNICALLY trained men in the employ of various government departments at Ottawa have formed an association to advance their mutual interests. This move was made at the instance of the Ottawa Branch of the Engineering Institute of Canada. A meeting was held recently at which there were representatives of the following technical organizations: Association of Dominion Land Surveyors, Canadian Geodetic Society, Canadian Mining Institute, Canadian Society of Technical Agriculturists, Ottawa Branch of the Engineering Institute of Canada, Entomological Society, Logan Club, Ontario Association of Architects, Royal Astronomical Society of Canada and the Society of Chemical Industry.

After discussing the relations of technical men to the Civil Service Association, it was unanimously decided that all technical men in government employ should continue to be members of the Civil Service Association, but that a separate technical organization should be formed to co-operate with that association and to care for the special interests of the professional men.

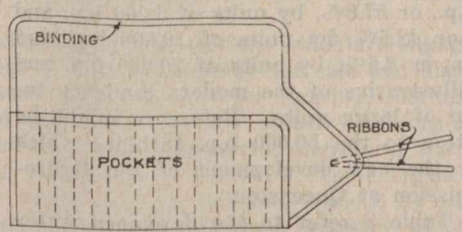
The Civil Service Association contains many thousands of clerks and others who are not technically trained and who do not always appreciate the additional remuneration that should ensue as a result of technical training. The professional men, by consolidating their interests, will be able to secure added prestige both within and without the Civil Service Association.

Letters to the Editor

A HANDY INSTRUMENT CASE

Sir,—The instrument case shown in the accompanying sketch is a home-made affair which I have carried for some 25 years, and it is as good to-day as it was when it was made. It is very much more convenient than the cases generally made, and will outwear any of them, and with an occasional washing, always look neat and clean.

The material of which it is made, is chamois leather, cut to shape, and sewn up as shown in the sketch, with a compartment of sufficient width for each instrument. When not in use, it can be rolled up and tied by the ribbons attached. When rolled up, it occupies very little space in a drawer, or can be slipped into the pocket when required for a job away from the office. When working on the board, it is simply laid out flat on the desk, and is much less in the way than the regular case.



From its shape and material it is less likely to be knocked off the table than is the regular instrument case. Even if it is accidentally dropped, the instruments are not likely to be damaged, as they do not drop out even if the case is open. A similar accident with the other types of cases is, however, usually disastrous, as the instruments fall out and scatter all over the floor, generally with damage done to one or another of them.

A further advantage is that the rubbing of the instruments on the chamois leather when they are being taken out or put in, tends to keep them clean and bright.

JOHN S. WATTS.

New Glasgow, N.S., April 2nd, 1920.

BIG DEMAND FOR ENGINEERS?

Sir,—I was very much surprised to read in a local evening paper an address, headed "Big Demand for Engineers," by Brig.-Gen. C. H. Mitchell, dean of the Faculty of Applied Science and Engineering, University of Toronto. He was quoted as saying:—

"The call for men and means by which to carry out the work of the country, wherein applied science and engineering knowledge and ability are required, is both insistent and universal throughout the Dominion." Also: "It now appears that a special effort should be exerted to direct the proper type of students into these professions. Fear that various branches of the engineering profession may become overcrowded, need not be seriously considered."

Now it seems to me, that a man in the position occupied by the general, should make himself more conversant with the true facts of the case before committing himself to such misleading statements. Any engineer will tell you that the supply of qualified engineers far exceeds the demand and always will until the number of students is restricted, similar to the medical and dental professions, and until such misleading statements as in the above address, are placed before the public in their true light. Such statements cause parents to invest a great deal of money for their children, in expensive engineering education, in the firm belief that the young men will, in a few years, enjoy a good social position and a correspondingly excellent salary. This, they consider, will be a good return for their investment. So it would if the true facts were as Gen. Mitchell is said to have stated.

At the present time there are over 800 engineering students in Toronto University alone and similar proportionate numbers in McGill, Queen's, Manitoba and others. Can Gen. Mitchell conscientiously say that there is room in the engineering profession for anything like that number of new engineers? Speaking from some experience as an engineer, I say he cannot and he ought to verify this fact before advertising for more engineering students.

It is the duty of all engineers to warn parents to thoroughly investigate the true conditions of the engineering profession before making sacrifices to pay for an engineering education for their boys, which, in most cases, will yield but a poor return for their investment.

H. P. HEYWOOD,
Assistant Engineer, Toronto Harbor Commission.

Toronto, Ont., April 9th, 1920.

PERSONALS

H. K. MORRISON has been appointed divisional engineer, Montreal division, Canadian National Railways.

A. R. ROBERTS, of Toronto, is visiting England and France in connection with export machinery business.

ARTHUR FOURNIER has been appointed vice-president and sales manager of Primeau & Co., Ltd., Quebec, Que.

JAMES A. IRVINE, formerly of Toronto, has been appointed divisional engineer of the London Division, Canadian Pacific Railway.

JAMES PENNER, of Derby, Ont., will succeed John Campbell as foreman of construction on the Owen Sound and Meaford provincial county highway.

J. ANTONISEN, formerly city engineer of Port Arthur, Ont., has again been appointed to that position, succeeding L. M. Jones, who recently resigned.

G. C. P. MONTIZAMBERT has been appointed officer in charge of building and repairs, Royal Canadian Mounted Police, with headquarters in Regina, Sask.

FRANK A. COOMBE, chief engineer of Babcock & Wilcox, Ltd., Montreal, has resigned to enter private practice, specializing in boiler plant design and operation.

E. L. TAIT, acting engineer of way, British Columbia Electric Railway Co., Ltd., has been promoted to the position of principal assistant engineer of that company.

J. R. CASWELL, formerly divisional engineer of the London division, C.P.R., has been transferred to Sudbury, where he will have charge of C.P.R. construction work in that district.

DAVID GUITELLIUS, formerly divisional engineer of the C.P.R. at Sudbury, Ont., has been appointed assistant engineer of eastern lines of the C.P.R., with headquarters at Montreal.

H. B. MUCKLESTON, formerly with the Department of Natural Resources, Calgary, has been appointed chief engineer of the Lethbridge Northern Irrigation District, Lethbridge, Alta.

W. W. MARSHALL, superintendent of the Hydro-Electric Power Commission at Orangeville, Ont., has been appointed town engineer, succeeding Charles King, who resigned recently. Mr. Marshall will fill the two positions, with offices in the Water Works Building.

GEORGE DAY, formerly sales manager of M. Beatty & Sons, Ltd., Welland, Ont., has been appointed industrial commissioner and secretary of the Board of Trade of that city, succeeding W. M. German, who has resigned.

NOULAN CAUCHON, consulting engineer and town planner, Ottawa, Ont., has been appointed Canadian representative of the Engineering Institute of Canada to the twelfth national conference on city planning, which is being held in Cincinnati, O.

J. A. H. O'REILLY, formerly associate professor of civil engineering at Manitoba University, and latterly statistical engineer for the Winnipeg Electric Railway Co., has been appointed secretary of the research committee of the Winnipeg Board of Trade.

W. H. GEORGE, assistant general superintendent, Department of Soldiers' Civil Re-establishment, Ottawa, has been appointed general superintendent, succeeding J. H. W. Bower, who recently resigned in order to become chief engineer for a construction company.

F. H. SMAIL, who for eight years has been in the employ of the Saskatchewan Highway Department, Regina, has accepted an appointment in the city engineer's office, Moose Jaw, Sask. Mr. Smail is a graduate of Queen's University, Kingston, and was overseas for four years.

A. G. BAILEY has arrived in Windsor, Ont., to take the position vacated recently by the resignation of C. W. Tarr as manager of Morris Knowles, Ltd., consulting engineers to the Essex Border Utilities Commission. Mr. Bailey was formerly in the Pittsburgh office of the firm of Morris Knowles, Inc.

W. A. BOWDEN, chief engineer, Department of Railways and Canals, has been appointed engineer representing the Dominion government in the investigation of the proposed St. Lawrence River canalization and power development. Mr. Bowden will act with Lt.-Col. Wooton, of Washington, D.C., who will represent the United States government.

JOHN A. KIENLE, formerly sales manager of the Electro-Bleaching Gas Co., has been appointed general manager of sales of the Mathieson Alkali Works, Inc. This change was brought about by the severing of relations between the Mathieson Alkali Works, Inc., and its former sales agents, Arnold, Hoffman & Co., Inc. It is now the intention of the Mathieson Alkali Works, Inc., to sell all of its products direct to the consumer instead of through sales agents. Mr. Kienle has been placed in charge of the development of a complete sales organization. E. E. ROUTH, formerly manager of bicarbonate sales, has been appointed assistant to Mr. Kienle.

BRYAN CHEVES COLLIER, general manager of the Cement-Gun Co., Inc., has been elected vice-president of that company. W. J. ROBERTS, formerly vice-president, becomes president, succeeding SAMUEL W. TRAYLOR, who becomes chairman of the Board of Directors. Mr. Roberts is also president of the Traylor Engineering & Mfg., Co., with which concern the Cement-Gun Co., Inc., is closely affiliated. Mr. Collier, who has directed the affairs of the Cement-Gun Co., Inc., for several years, previously had many years of experience as designing and superintending engineer on the construction of dams, water works, power-houses and other large structures. He is a member of the American Society of Civil Engineers.

WILLARD R. RHOADS, engineer on the staff of the Essex Border Utilities Commission, Windsor, Ont., has resigned in order to accept a position with the Sanitary District of Chicago, where he will be engaged in the design and construction of intercepting sewers and sewage treatment plants. Mr. Rhoads came to Canada shortly after graduation from the Pennsylvania State College in 1911 and joined the staff of the Canadian Northern Ontario Railway. Among other work he was engaged in the construction of the steel bridge at Thunder Bay. For the past six years he has been engaged in municipal engineering, first in Cincinnati, O., and laterly at Windsor under Morris Knowles, chief engineer of the Essex Border Utilities Commission.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

Further information may be had from the issues of *The Canadian Engineer*, to which reference is made.

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Cornwallis, Man., draining and grading	Apr. 16.	Apr. 8.	49
Dover Tp., Ont., construction of dash wheel, pump-house and concrete wheel pit, etc.	Apr. 17.	Apr. 1.	50
Granby, Que., erection of school	Apr. 26.	Apr. 8.	56
Hamilton, Ont., apparatus for fire dept.	May 15.	Mar. 18.	52
Hamilton, Ont., motor flusher	Apr. 20.	Apr. 8.	49
Kimberley, B.C., erection of school	Apr. 19.	Apr. 8.	58
Kitchener, Ont., school addition	Apr. 17.	Apr. 1.	52
Leamington, Ont., pavement	Apr. 30.	Mar. 25.	49
Little Current, Ont., rebuilding wharf	Apr. 29.	Apr. 8.	60
Moosomin, Sask., combustion engines, transformers, etc.	May 5.	Apr. 1.	58
Oakland, Man., making concrete pipes	Apr. 27.	Apr. 1.	54
Oakland, Man., grading	Apr. 27.	Mar. 25.	48
Prince Rupert, B.C., construction of bridge	Apr. 19.	Apr. 8.	50
Quebec, Que., construction of bituminous macadam	Apr. 17.	Apr. 1.	49
Quebec, Que., construction of macadam	Apr. 17.	Apr. 8.	50
Regina, Sask., construction of bridges	Apr. 19.	Apr. 8.	60
Rockwood, Man., grading of roads	Apr. 21.	Mar. 18.	316
Swan River, Man., grading	Apr. 24.	Mar. 25.	48
Toronto, Ont., centrifugal sewage pump	Apr. 20.	Feb. 26.	48
Toronto, Ont., erection of building	Apr. 26.	Apr. 8.	58
West St. Paul, Man., grading roads	Apr. 17.	Apr. 8.	50
Weyburn, Sask., construction of hospital	Apr. 21.	Apr. 8.	60
Winnipeg, Man., switchboard panels	Apr. 19.	Apr. 1.	50

BRIDGES, ROADS AND STREETS

Alexandria, Ont.—In this column in the April 1st issue it was reported that contract for the construction of "asphalt penetration roads" had been awarded by the town council. This was erroneous, in that the contract was based upon the use of Tarvia as the binder for the bituminous macadam roads.

Brampton, Ont.—Town council decided to pave the road on Nelson St., from Main to Elizabeth, and Church St., from Main to the Grand Trunk, with bitulithic pavement. Town clerk, C. Collett.

Brantford, Ont.—The city council have retained the E. A. James Co., Ltd., Consulting Engineers, Toronto, to design a reinforced concrete bridge to replace the Lorne Bridge over the Grand River. The new bridge contemplated will be two 175-ft. reinforced concrete arches. The bridge will be 60 ft. wide, and will accommodate a double-track car line. The estimated cost is $211,000. Plans are under preparation by the engineers, and it is the intention to call for tenders next winter and commence construction early in 1921.

Brantford, Ont.—The cost of building the permanent highway from Brantford to Cainsville will reach $140,000, the provincial government having received a tender for this amount. The government also received a tender to construct a 30-foot pavement from the city limits to Cainsville for approximately $200,000. The city and county councils will decide the matter.

Brantford and Ancaster Tps., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, up to 12 o'clock noon, on Wednesday, May 5th, 1920, for the construction of concrete culverts in the townships of Brantford and Ancaster. (See official adv. in this issue).

Cambridge Tp., Ont.—Tenders will be received by F. A. Senecal, County Road Superintendent, Russell County, Plantagenet, Ont., until noon, Monday, April 19th, for the construction of 3½ miles of macadam road in the township of Cambridge. Plans and specifications may be seen at the office of the Road Superintendent and on application to Y. E. A. Belanger, C.E., Hawkesbury, Ont.

Chatham, Ont.—Tenders will be called by the city council for the construction of pavements on Kirk, Duke, Seventh and Grant Streets. City clerk, W. G. Merritt.

Clinton Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, until 12 o'clock noon, on Wednesday, May 5th, 1920, for the construction of a four-inch bituminous macadam pavement in the Township of Clinton. (See official adv. in this issue).

Daly, Man.—Tenders will be received by John A. Dyer, Secretary-treasurer, Municipality of Daly, R.R. 1, Wheatlands, Man., up to 12 o'clock noon, Saturday, May 1st, 1920, for the construction of reinforced concrete bridge. Plans and specifications may be obtained at the office of the Highway Commissioner, Winnipeg, or at the office of the Secretary-treasurer.

Fenelon Falls, Ont.—The village council decided to cooperate with the county council in urging the provincial government to take over the road between Fenelon Falls and Lindsay as a provincial road.

Fitzroy Tp., Ont.—Tenders addressed to Patterson and Bryne, Engineers, will be received until noon, Thursday, April 22nd, for the concrete work on a highway bridge over the Mississippi River, township of Fitzroy. Plans and specifications may be seen at the office of the Engineers, 71½ Sparks St., Ottawa.

Guelph, Ont.—Six tenders were opened at the recent joint meeting of the public works committee of the city council and the sub-committee of the boundary line bridge committee of the county council for the construction of a new reinforced concrete bridge to replace the present Victoria Bridge. The tenders varied in price from $32,500 to $71,000. Contract was awarded to the lowest tenderer, Mr. Elson, of Toronto, at $32,500.

Halifax, N.S.—Contract let to the Bedford Construction Co. by the Highway Board for surfacing 19 miles of St. Margaret's Bay Highway, from Halifax to Indian River. The board is now receiving tenders for the construction of about five miles of water-bound macadam road on a section of the Halifax-Windsor Highway, from Mount Uniacke to a point near Lakelands.

Hamilton, Ont.—City council decided to fill in the Valley Inn ravine at a cost of $280,000 as an entrance for the To-