PAGES

MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Britain's Concrete Shipbuilding Program

Twenty Firms Have Been Awarded Contracts Totalling About $25,000,000 for the Construction of Barges, Tugs and Mine Sweepers—Barges Are Flat-Bottomed and Will Be Floated, Not Launched—Some Are Self-Propelled and Have 1,100 Tons Carrying Capacity—For Service in the English Channel

TWENTY firms located in various parts of England, Ireland and Scotland are now building concrete ships. So far as is known, the first concrete boat of any description built in the British Isles was launched on Good Friday of this year; it was a 500-ton barge. Up to a month ago no other concrete boat had been launched in the British Isles, but a large number of them will be finished within the next month, and possibly some have been floated since the departure from England of the engineer to whom we are indebted for the following information and who is connected with one of the twenty firms above mentioned.

The designs for the boats that are being built have all been prepared by just six designers. In some cases a contractor or a group of contractors obtained the services of a naval architect and secured designs satisfactory to the admiralty. In other cases a firm of consulting engineers or naval architects prepared a design, secured for it the approval of the admiralty, and then allowed various firms of contractors to use that design upon a royalty basis. All contracts were awarded upon a cost-plus basis, a fixed estimated cost being agreed upon for each boat. If the cost exceeds that amount, the contractor is paid only the percentage of the fixed amount; if the cost is less than the estimated amount, the contractor nevertheless receives his percentage on the whole of the fixed amount.

The construction of the concrete ships is under the jurisdiction of Lord Pirrie, Controller-General of Merchant Shipbuilding. The contracts were awarded in the spring of this year and amount to approximately $25,000,000, including barges, tugs and drifters (mine sweepers). The largest of these are the barges, each of which has about 1,100 tons carrying capacity. The admiralty has not awarded any contracts for large freighters such as are being built by the American government, which has awarded contracts for $40,000,000 worth of concrete ships, including a considerable number

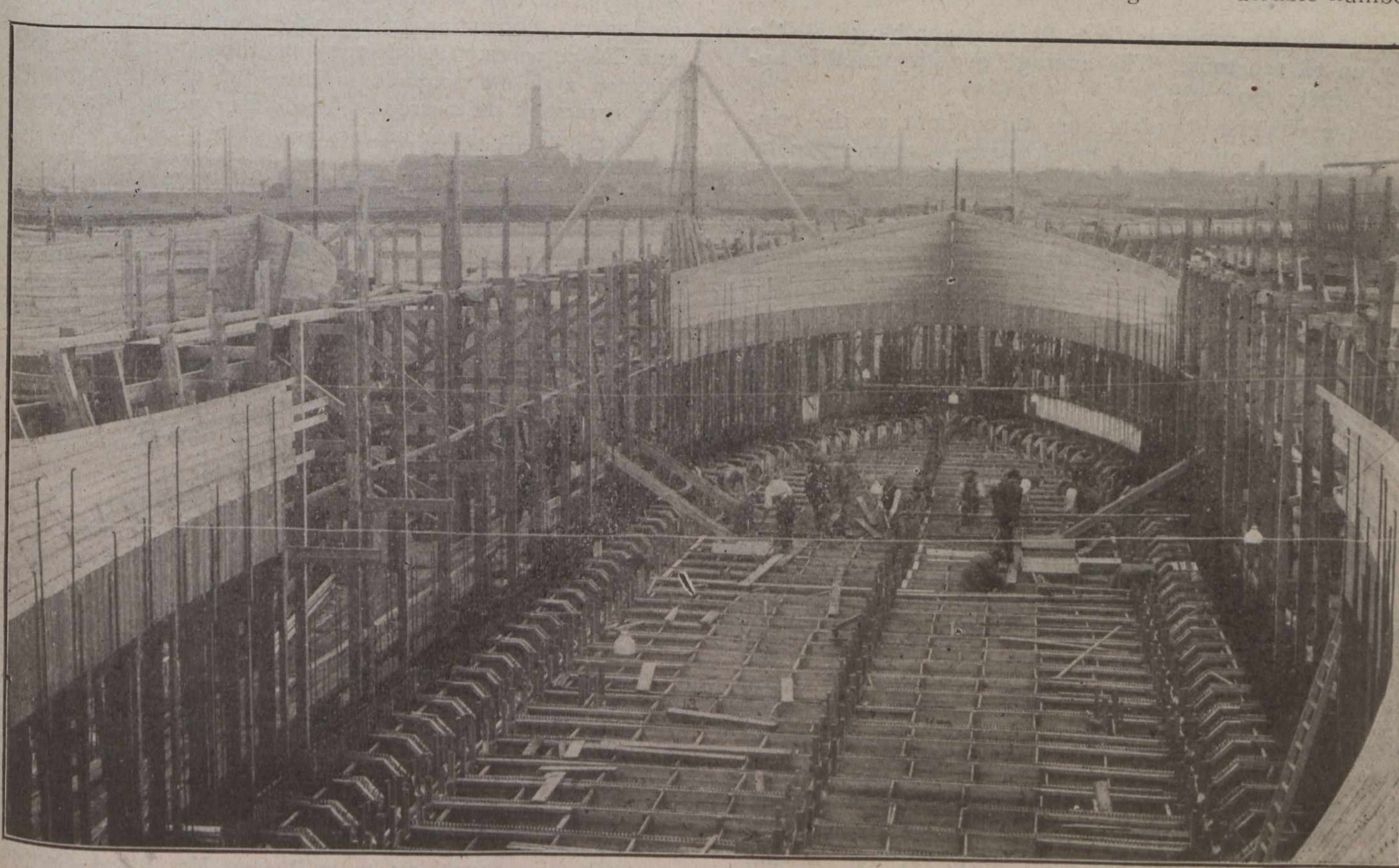


Fig. 1—Recent Photograph of Concrete Barge Now Under Construction in England

of freighters of several thousand tons carrying capacity. Whether the admiralty will build large freighters will not be decided until at least some of the present contracts have been successfully completed; then the cost, time of construction and general satisfaction given by the barges will be reviewed, and the further policy of the admiralty in regard to concrete ships will be based upon the results obtained and also upon the success attained in the meantime by the American government in the construction of the larger vessels, some of which will no doubt be launched at an early date.

The only specifications given out by the admiralty in regard to these barges were that they should be 170 ft. long, 33 ft. broad, 18 ft. deep, with a draught of not more than 14 ft. when loaded, and a carrying capacity of from 1,000 to 1,100 tons. The entire design to fulfil these conditions was left to the individual designers, with the result that the six designs which are being used vary considerably. The quantity of steel being used by the

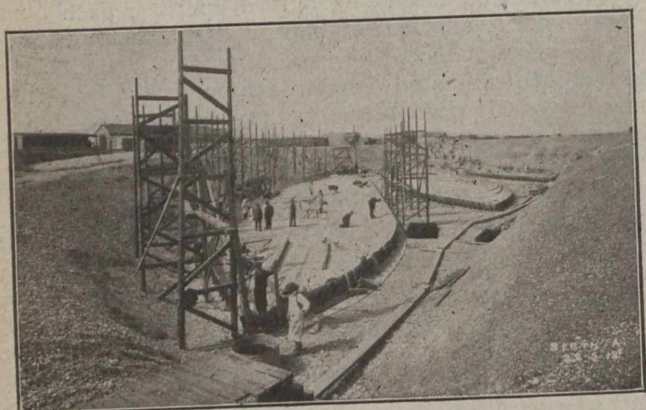


Fig. 2—Building Bottom Forms for Three Barges

various designers varies from 85 tons per barge all the way up to 129 tons. The average quantity used is approximately 100 tons.

Some designs stipulate bars throughout as the reinforcing, while others use much more expanded metal than bars. Fig. 1 shows one of the boats in which most of the reinforcing is expanded metal. The ends of sheets of expanded metal can be seen sticking out between the forms for the ballast tanks.

The mix used for this boat, as for most of the others being constructed, is 1 : 1⅛ : 2¼. The concrete is mixed much drier than is the general practice in Canada. Each barge contains about 400 cu. yds. of concrete. Gravel, washed and graded and crushed where necessary, is being largely used as aggregate. Quite a few of the firms, however, are using crushed whinstone, and at least one or two of them are using crushed granite, although this material is not popular on account of the added weight which it gives to the boat.

The average weight of these barges, not loaded, is 1,800 tons. Some of them are self-propelled, but most of them are not, as they will be towed across the channel. All of them are for use in English Channel traffic. The equipment on each of the towed barges costs about $35,000, including pumps, boilers, anchors, life-boats, ventilators, derricks and other loading and unloading devices, etc. The equipment of the self-propelled barges, of course, costs considerably more. All of the equipment is being built in England.

The tugs are launched from slipways; but the flat-bottomed barges are floated, not launched. Fig. 2 is a view of one of the building basins in Southern England. The bottom form work for three barges can be seen in place. The basin is dug out alongside a river bank, leaving a wall of earth (on the right-hand side of the photograph) between the basin and the river. When the three boats are finished, a 40-ft. channel will be cut through this wall, so that the boats will float and can then be towed through the channel to the river. After the boats are out of the basin, sheet piling will be driven across the channel and the basin again unwatered.

The bottom form work is built so that it will not float with the ships. After the basin was excavated, timber posts were sunk, embedded in concrete. Transverse battens were then nailed to the tops of these posts and the timber flooring, or form work, was laid longitudinally across the battens. Several small trap doors, about 2 ft. x 3 ft., are arranged in the bottom form in such manner that they can be lowered by levers after the barge is built, thus allowing the water to come up through the trap doors and relieving the upward pressure on the form work, also helping to float the barge from the form work. The basin is from 8 ft. to 9 ft. lower than high water in the river, but the bank surrounding the particular basin shown in Fig. 2 is very solid and no difficulty has been experienced from infiltration. The depth of the river just beyond the bank is about 25 ft. at high water.

COST OF THAWING SERVICES WITH ELECTRICITY

During the past winter the Baltimore County Water & Electric Co., of Baltimore County, Maryland, thawed 332 services with electric outfits at an average cost of $10.97 per service. Three trucks were employed in this work. One truck carried the thawing equipment, consisting of thawing transformer, switches and instruments. Accompanying this truck were two linemen and one groundman from the electric company that furnished the current. The driver was an employee of the water company. Two other trucks were in service, one of them carrying the reels of wires and the other carrying the digging tools, connecting up stocks and dies for putting in short pieces if the meters were burst or damaged by the plumbers trying to thaw them. The foreman in charge of main extensions and the foreman in charge of services were employed with the thawing outfit. The total cost to the water company of thawing the 332 services was $3,641, distributed as follows:—

	Total.	Per service.
Water company labor, 4,553¼ hours at 29.4 cents	$1,339	$ 4.03
Water company trucks, 1,405½ hours at $1	1,405	4.24
Current, linemen, etc.	897	2.70
Total	$3,641	$10.97

The water company employees were paid by the month. The figure given in the table is the average rate of wage per hour. It was necessary to excavate for some of the services. The actual cost for the excavation was $1.50 per lineal foot.

"Coal is everything to us," says Mr. Lloyd George. "Coal is the most terrible of enemies and it is the most potent of friends."

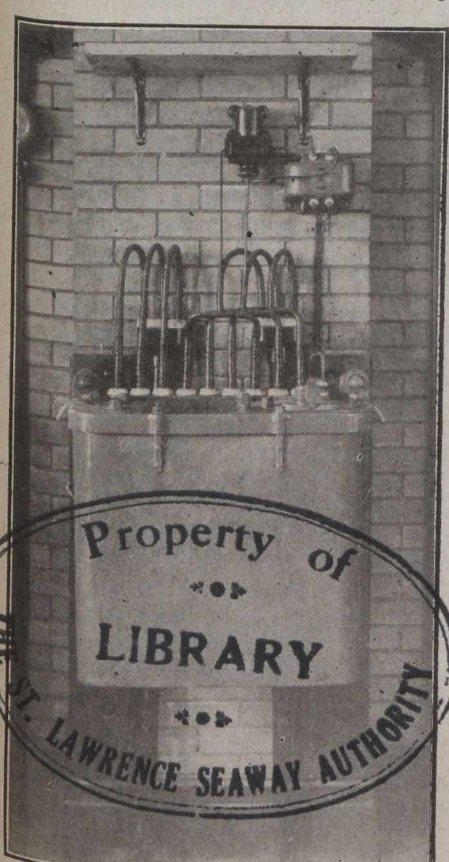
PUMPING EQUIPMENT AT THOROLD

By W. L. Adams
Consulting and Constructing Engineer, Niagara Falls

INCREASED industrial activity generally due to the acquisition of several new plants, has necessitated extensions to the water supply system for domestic, commercial and fire protection purposes in the municipality of Thorold, Ont.

This new installation consists of a two-stage 1,500-Imperial-gallon turbine pump, directly connected to a 250-horse-power induction motor, with the necessary control and auxiliary apparatus.

A 3-phase, 2,300-volt transmission line supplies the equipment terminals on a pole structure about 100 feet from the pump house on which are mounted three S. & H. primary cutouts, fused with 150-amp. link fuses, and one 3-conductor, form L, 3,000-volt, outdoor type L.S. Cat. No. 82, G. & W. pothead. From this pothead a three-core, 2,300-volt, No. 2 varnished cambric lead-covered underground cable was run to the basement, terminating in a similar indoor type cable end bell and S. & H. cut-outs, fused with 100-amp. link fuses.



Mounting of Compensator for Turbine Pump

Two 3-phase circuits branch from these fuses, one feeding the old pumping and lighting equipment and the other supplying power for the new pumping unit.

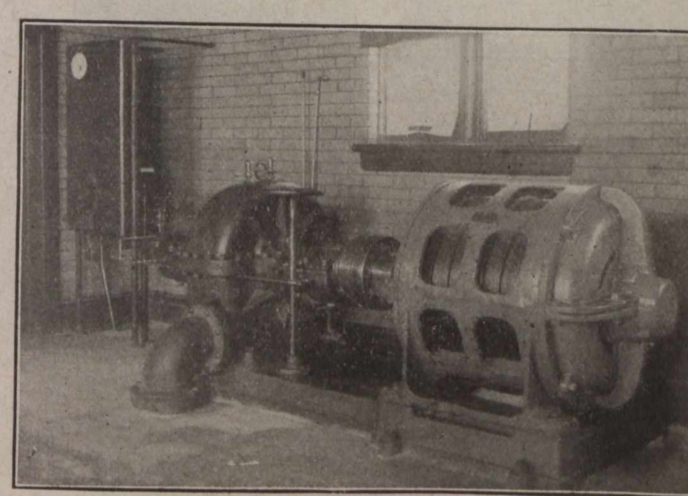
The control equipment for the motor consists of a 300-amp., 2,500-volt, 3-pole, single-throw, Westinghouse type F1, hand-operated oil switch, complete with two 100/5-amp. current transformers, inverse time limit over load trip double coil relays and one 100 amp. scale ammeter all mounted on a marine finished slate panel, also one Crocker-Wheeler 250-horse-power, type P.D., 3-phase compensator with five taps ranging from 33 per cent. to 80 per cent. supplied with push-button switch and oil immersed, no voltage release energized by means of a 2,200/220-volt potential transformer protected by plug fuses on the primary side. The compensator is mounted on the brick wall near the oil switch and motor. All connections between switch board and motor are 3-conductor No. 6 paper-insulated lead-covered cable run in 1½-inch galvanized conduits.

The 250-horse-power, 2,200 volt, 58-amp., 3-phase, 25-cycle, 1,500-r.p.m., squirrel-cage induction motor is directly connected to the pump by means of a flexible coupling fitted with eight adjustable rubber buffers on turned steel pins to compensate for any possible unequal wear between pump and motor bearings.

The pump is of the 2-stage turbine type with horizontally split case so constructed that the impellers and shaft may be lifted out by simply removing the top half of the casing without disturbing any pipe connection.

Thorold Pumping Station

The impellers are of bronze and are fitted with seal rings so arranged that the hydraulic pressure at all times balances the end thrust. However, should the hydraulic balance in any way become affected, the full end thrust would be taken care of by a liberally proportioned water jacketed marine type thrust bearing which holds the impellers central with the discharge channels. The thrust collar is a solid forging and is adjustable on the shaft.



Motor-Driven Turbine Pump

The 2 15/16-inch steel shaft is brass-covered at the stuffing boxes, and all bearings are babbitt lined.

The pump is capable of delivering 1,500 Imperial gallons per minute against a head of 350 feet when running at 1,500 r.p.m.

The base plate is of box section extending the full length under the pump and motor and is secured to the floor by six 1⅛-inch anchor bolts and cement grouting.

The water supply is taken from the Welland Canal to a settling basin located about one mile from the pump house and is conducted through a 12-inch pipe line to the pump house, where an 8-inch N.R.S. gate valve controls the suction end.

The 8-inch discharge line from the pump is provided with an 8-inch N.R.S. gate valve and an 8-inch horizontal swing check valve connecting through an increaser to the 10-inch city main.

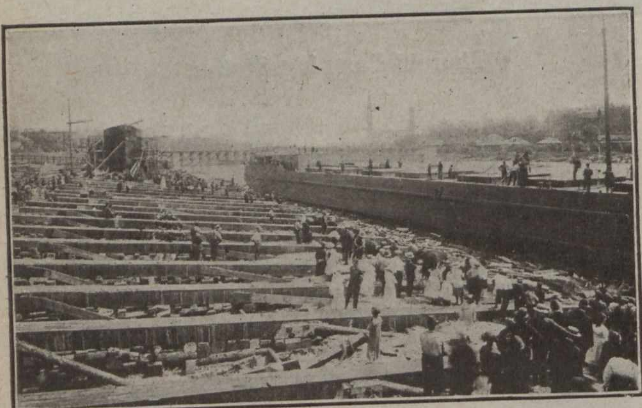
The stem for the discharge valve has been extended up through the floor adjacent to the pump so that the unit may be conveniently operated from the main floor.

SHIPBUILDING AT THREE RIVERS

By Romeo Morrissette
Dept. of Public Works, Three Rivers, P.Q.

THE Tidewater Shipbuilding Company, Limited, launched their first steel vessel on Saturday, July 27th. The launching took place in the eastern branch of the St. Maurice River, at Cap de la Madeleine. The company is a subsidiary of the Canada Steamship Lines, Limited.

John J. Collins, B.A.Sc., of Three Rivers, has been retained by the company to supervise the construction of



"T. P. Phelan," Launched at Three Rivers, P.Q.

wharves. The company is now building a 300-ft. quay, composed of twelve rows of 40-ft. piles, driven at 3-ft. centres longitudinally and at 4-ft. centres transversely. The cribwork between the piles will be filled with dredged material. From the wharf to the C.P.R. bridge a sea-wall will be built, extending the full length of the property. At the bridge, 12-in. x 30-ft. spruce piles will be driven and a B.C. fir cribwork built.

Contract has been awarded to the Laurin & Leitch Construction and Engineering Company, Limited, of Montreal, for the dredging of 182,000 cu. yds. of clay and sand, in order to open a 15-ft. channel from the company's property to the St. Lawrence River. The company will dredge the material needed for fill with their own suction dredge.

The manufacture of tin-plates in Germany has recently increased to such an extent that Germany hopes to be able to export that product on the conclusion of peace. Before the war the greater bulk of Germany's supply was imported from England. In view of the scarcity of tin, new processes have been brought out to recover this metal from old tin-plates, and the tin deposits of Germany that were formerly considered as too poor to work are now being exploited so far as possible.

OTTAWA'S MAYOR LIKES SASKATOON'S FILTER PLANT AND METERS

"SASKATOON has taught a lesson to Ottawa, or at least to the mayor of the latter city," says the last issue of Engineering News-Record, of New York, "and has thus shown once more that the smaller and more progressive cities of the western part of the continent can teach the larger and more conservative cities of the East, if the latter are only willing to learn.

"As many of our readers know, Ottawa has been backing and filling with its very pressing water-supply questions for many years. It has turned down projects for slow-sand filters, for mechanical filters and also for gravity supplies from sources which were supposed not to require filtration. Journeying westward, Mayor Fisher of Ottawa on approaching Saskatoon noted the very muddy character of the water of the Saskatchewan River. On reaching his hotel he was apprehensive of the quality of water he would find, but was pleased with its tasteless and colorless condition, and found on investigation that a 'small, inexpensive filtration plant' worked the transformation. Promptly he wrote back to his home city urging that 'we forget that there ever was a water question in Ottawa,' and saying that a filtration plant would be a good investment even if it were scrapped after ten years on account of the introduction of one of the proposed gravity supplies.

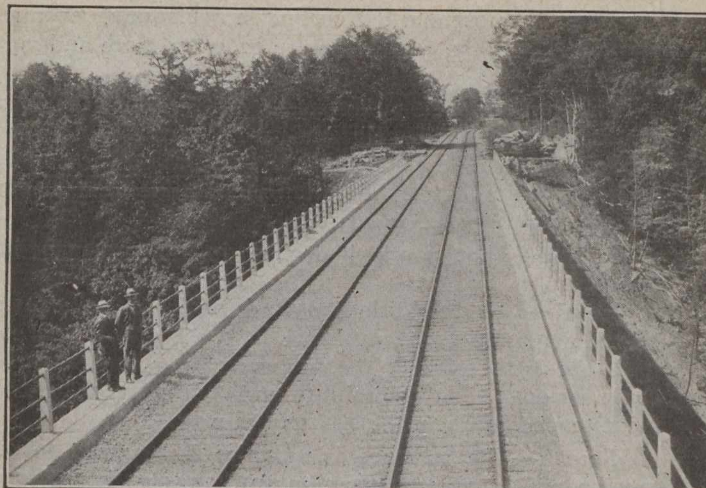
"A further contrast in water supply matters was found by Mayor Fisher at Saskatoon. His letter home states: 'For a long time last winter, Ottawa pumped daily from 250 to 300 gallons for every man, woman and child in the place. The maximum pumped in Saskatoon during the same period was 72 gallons per capita. This is all the more remarkable in view of the fact that for weeks at a time the thermometer stands at —20° F. in Saskatoon.' Every service in Saskatoon is metered, Mayor Fisher reports. The lesson is obvious. Unfortunately, Ottawa is not the only city that prefers to pump and waste an immense quantity of muddy or otherwise unsatisfactory water, rather than curtail consumption by the use of meters and thus make filtration a comparatively inexpensive proposition."

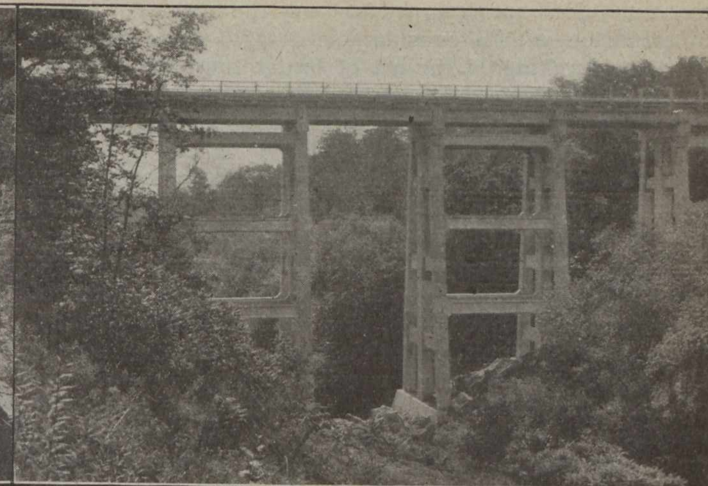
The development of this country is indicated by the annual report of the Postmaster-General, which shows that last year over 700,000,000 letters were posted in Canada, or three times the number handled in 1907.

Amongst the novelties produced by the war is a machine invented by Thomas Marshall, of Stanningley, England, for collecting barbed wire scrap in war-destroyed areas. The machine, which has a remote resemblance to a straw and hay elevator, is carried on caterpillar chain tracks. The wire scrap is picked up and cut into lengths, and then dumped into cars or pressed into bales.

In shipbuilding, says "The Engineer," of London, Eng., one of the effects of wood shortage is the increased use of substitutes for sheathing on steel decks. The chief drawback of some of these compositions, particularly those in which sawdust is bound together in a stone-like mass, is that they retain a quantity of chloride of magnesium which, in solution, is powerfully corrosive to steel, and may accumulate between the composition and the steel deck.

"Many users of the Patent-office Library," says "The Engineer," of London, Eng., "will hear, with the highest satisfaction, that the Library is at last to possess a complete photostat apparatus, the offer of one from Sir Robert Hadfield, as a mark of his 'appreciation of the unfailing courtesy and kindness he has received from the department,' having been accepted. The laborious copying of drawings and texts will now be obviated, and it may be hoped that for a slight expense photo-copies of pages from books will be available at a few hours' notice."





Canadian Pacific Railway Viaducts at Toronto

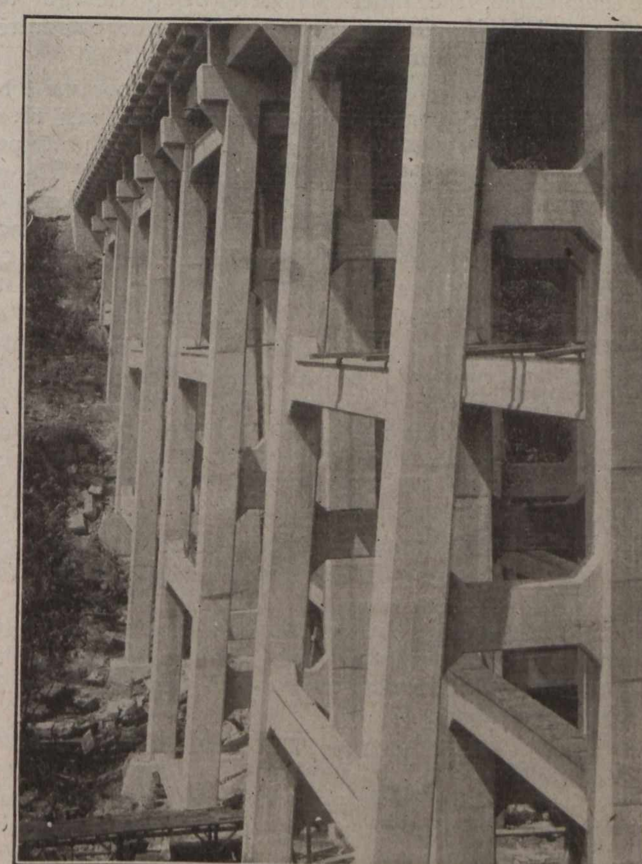
Premoulded Beams 35 to 37 Ft. Long—Construction Details Unprecedented Says the C.P.R. Press Bureau

IN the April 25th, 1918, issue of *The Canadian Engineer* appeared an article by Arthur F. Wells, B.A.Sc., of Wells & Gray, Limited, engineering-contractors, Toronto, on the reinforced concrete railway trestle which his firm was then building at Toronto for the Canadian Pacific Railway Company. Another similar trestle was then under construction for the railroad by the Dominion Construction Co., Limited, Toronto. Both of these trestles have now been practically completed and the following "write-up" of them, prepared in popular style, has been sent to the daily newspapers by the C.P.R. Press Bureau:—

"The double tracking of the North Toronto subdivision of the Canadian Pacific Railway between Leaside and North Toronto is now nearing completion, and involved the replacement of bridges (known as 0.9 and 1.8) which heretofore had been trestles constructed of steel. Owing to the high price of steel and the difficulty of procuring it since the war began it was found that reinforced concrete competed successfully against steel.

"The bridges were therefore constructed of this material and are a triumph of railway construction work, No. 0.9 being 386 feet long and 90 feet high, carrying two tracks, and No. 1.8 of similar dimensions, but a three-track structure. The length of the individual spans and the details of their construction are unprecedented in the engineering world. Previous to this no reinforced concrete beam with a length of more than 25 feet has been attempted; the spans of these two C.P.R. structures are each from 35 to 37 feet long. These spans have been made possible by the employment of unit construction by which each span was designed as two T-beams which after being manufactured near the work were laid side by side on the previously built reinforced concrete towers. The towers themselves are really reinforced concrete buildings constructed in the usual manner by means of wooden forms built around a steel reinforcement which was previously assembled and securely wired together. When all was in readiness the concrete was poured by means of long spouts which led in several directions from the main mixing tower. The pouring of the concrete was maintained as continuously as possible until a whole tower was completed. This work was done during the winter at a time when the temperature was below freezing point; it was performed inside of what was virtually a building erected to maintain a suitable temperature around the newly deposited concrete until it was out of danger by being damaged by frost.

"These two structures are provided with narrow sidewalks, and hand-rails which enable trainmen to move conveniently alongside standing trains. The hand-rails add considerably to the aesthetic appearance of the structures which are extremely artistic in appearance and at the same time satisfactory from a general and utilitarian point of view besides being absolutely per-



Concrete Bents

manent. Both are designed to carry the heaviest engines in existence with a considerable margin of safety, and are epoch-making in the art of bridge engineering in as much as they have demonstrated that reinforced concrete can take the place of steel for a large number of permanent bridges.

"These two structures are so solid that when passing over them on a train one gets the impression that he is on a solid fill instead of on a bridge.

"The method employed in the erection of the reinforced concrete spans is a specially interesting feature of the structures. Each slab, as a unit, weighed 55 tons, which was the limit load that could be handled by the C.P.R. 100-ton standard wrecking cranes. The crane engaged handled no less than 110 slabs each 55 tons in weight, or in all something like 6,000 tons, and all this was done without a single mishap to either men or material. Another remarkable feature is that both structures were built without interruption from the beginning of June, 1917, to the beginning of July, 1918, which was a shorter period than would have been required to manufacture and erect similar structures in steel. Passenger and freight traffic on the C.P.R. main lines was continued without interruption during the progress of these interesting works."

WAR BURDENS OF WATERWORKS

RECORDS have been received from fifty typically important waterworks in the United States by a committee appointed by the American Water Works Association for the purpose of investigating the effect of the war upon the costs of construction and operation of waterworks systems. Leonard Metcalf is chairman of the committee, the other members being George W. Fuller and Major George A. Johnson. The committee reports that the records received indicate:

(a) That the advance in the cost of labor used by waterworks in construction work during the past three years was approximately 13 per cent. in 1916 and 27 per cent. in 1917, over the pre-war costs in the United States. These pre-war costs were fairly reflected by prices prevailing in the year 1915. Material decrease in efficiency of labor has also been observed in all parts of the country, the consensus of opinion indicating an approximate loss in efficiency of from 25 to 35 per cent.

(b) The important waterworks construction materials, pipe, valves, hydrants, etc., have more than doubled in cost. The more important operating materials, such as coal and fuel oil, have also more than doubled and chemicals for the treatment of the water have advanced from 50 to 100 per cent. and more.

(c) The normal annual increase in revenue of the waterworks has in general decreased, except where war activities have materially increased the local market for water.

(d) The operating and maintenance expenses have increased approximately one-third, the increase in gravity works being of less serious moment generally than in the pumping plants.

(e) The net revenues applicable to depreciation allowance, fixed charges, dividends, and surplus have, in general, remained about stationary, instead of increasing substantially from year to year, thus indicating that the new investment is not being taken care of, and that the divisible revenue is declining. The conditions vary markedly at individual plants and in groups, the eastern group showing the most marked decline in net annual revenues. Unfortunately, the conditions are growing more and more serious.

The committee has summed up the results of its investigations in ten conclusions, which are as follows:—

First—That the waterworks of the United States have suffered, through war conditions, large increase in construction and operation costs.

Second—That marked decline in net revenue has resulted.

Third—These conditions did not begin to make themselves generally felt until late in 1916, and it was not until the latter part of the following year that they became serious. The desirability and continuity of employment tended to delay the advance in wages.

Fourth—The advance in cost of labor used in extension and minor construction work has gathered force in the last six months, and it is the general opinion of municipal and corporate managers that additional increases are certain to come during 1918 and thereafter, if labor is to be held.

Fifth—It is undesirable to replace old, well-trained forces, familiar with these waterworks properties, with other labor not having this familiarity, in the effort to hold the wages at a point below the general local standard for similar service. The character of the service would suffer and it would not be fair to labor.

Sixth—Serious and conscientious effort has been made by waterworks operators generally to reduce construction and operating forces to a minimum. These reductions have in many cases already gone beyond desirable limits, even to reducing the working efficiency of the properties. In other cases still greater economies are possible in better consumption of coal; waste reduction by increased use of controlling meters, pitometer surveys, and more frequent house-to-house inspection, and in quarterly instead of monthly meter readings of small meters.

Seventh—The general situation is a very serious one and has shown itself in increasing difficulty of attracting capital for necessary betterments. While extension of service is likely to be increasingly limited with the conditions of war, it would be unfortunate, if the activities of important industrial and commercial centres, particularly those concerned in governmental activities, should be thus circumscribed.

Eighth—The menace of the situation lies in the increasing difficulty under such conditions of maintaining constantly a water service safe from a sanitary standpoint, necessary for good fire protection service, and adequate for industrial, commercial and domestic needs.

Ninth—Public Service Commissions and other regulatory bodies have already recognized the danger of the present situation to the public as well as to the utilities, and are likely at least to afford such relief as may seem to them necessary to maintain credit, but it is imperative for waterworks operators to keep clear records, showing the actual change in conditions and prices of materials and labor, that these bodies may have uncontestable proof upon which to pass judgment as to the necessity for relief.

Tenth—It is imperative, in the interest of good service, that waterworks operators of municipally as well as corporately owned plants, should anticipate their construction and operation needs, as far as possible, and should be careful to obtain the necessary priority orders, that the quality of the water and the service rendered may not be seriously impaired in the future for want of construction and operation materials and supplies.

NOTES ON FRENCH CANALS.*

In France the canals have received much attention from the Government, in the opinion of certain economists more than their share, considering that as rivals to railways they are inferior in speed and accessibility. In 1879 the French Chamber voted (from extraordinary funds) a large sum for canal improvement and construction. At that time 870 miles of new waterway were cut, towing-paths paved or gravelled, relays of horses and mules provided for public service, and other means of traction by steam and electricity advanced; swing bridges were also built and telegraph lines run alongside, but nevertheless the canals were not a success. Tolls were then abolished, preferential rates (20 per cent. lower) over the railway granted, with a monopoly of the transport of foreign and special goods.

English coal and building materials had to travel via Rouen by water to Paris; wine in casks and agricultural produce in bulk were reserved for canal transport, while the railways were restricted to the carriage of home products. It is French policy that one agent shall not monopolize. Still, with all this fostering care and a staff of underpaid officials, canals did not pay their way except in the north-east, where transport of every kind has always been in keen demand. Though better use is made of the canal in France than in England, before the war most of the freight borne over there was riparian on account of the cost of transhipment. But since the outbreak of hostilities canal traffic has increased wonderfully. In England the possibilities have been noted, and the Canal Control Committee, with Government aid, are pushing the advantages of water transport. In France the shortage in coal has made canals a necessity, and now even the unfinished Canal du Nord is overburdened with traffic. It is in the future, when coal is scarce, however, that France will appreciate her waterways and the political wisdom of having two strings to one's bow.

Form a Perfect Network

The French canals are planned systematically, and in the north-east form a perfect network, occupying one-fifth of the area of the country. They connect all the great rivers running lateral at unnavigable parts and having branches and terminals as close as possible to railway centres. In the war zone they are important enough to have particular military protection—the Canal Defence. The larger canals, such as the Centre, Rhone and Rhine, etc., have a depth of over 7 ft. on an average, a lock width of not less than 5.20 metres, and some are of great length, extending in several cases to hundreds of miles. As to physical difficulties, the Canal Marne-Rhine has 113 locks in 128 miles of way, three tunnels, and aqueducts over the Meuse, Moselle and Meurthe. The Canal du Centre, from the Loire at Dijon to Chalons, a distance of 70 miles, has 63 locks; the Canal de l'Est, again, has 99 locks in 91 miles on the southern branch, while on the northern branch it is tunnelled for 48 yards under the celebrated fortress of Verdun, and has three other longer underground sections. The diminutive Givors Canal, too, runs underground for a distance of nearly one-eighth of a mile. Yet the traffic is now increasing, and in some places a lateral canal has had to be cut.

The Marseilles-Rhone Canal, now in course of construction, runs through the Rove' tunnel, which is 4½ miles long, 72 ft. broad, and from summit to canal bottom 46 ft. deep.

*From "Water and Water Engineering," England.

France has 4,170 miles of navigable rivers and 3,110 miles of canals, and her ton-mile traffic on canals is something like 500,000 greater than on the rivers, though the latter cost the country over 30 per cent. per annum more for maintenance.

A canal, as proposed, from the Upper Rhone to the Rhine in Switzerland, with Geneva as a terminal port, would be of great economic importance to the Swiss, as by it the heart of their country could be linked via French rivers and canals with the sea. The canal under consideration would be 287 kilometres in length, and extend through high land to the Rhine near its source, passing through a rich provisioning district.

The Rhone and Rhine are connected further north by a canal which passes south-east of Belfort, the great French fortress on the Franco-German frontier, while the Marne-Saône links up the Rhine with Paris.

Marseilles is connected with the Rhone by the Canal d'Ales à Bouc and a new extension. Cette, another seaport on the Gulf of Lyons, and an important one, is served likewise by a Rhone canal. St. Etienne, the great coal centre, has been promised a canal service. At present it has only the little Givors Canal, an extension of the equally small River Gier.

Caen Canal Enlargement

The Canal du Centre is a "first-class" canal—that is, over 7 ft. in depth. This connects the Saône and its lateral canal with the Loire; some branches to this waterway, however, would prove of great utility.

Two canals of special interest to the English just now are the Nord and the Caen. The unfinished Canal du Nord, connecting Paris with the manufacturing districts of Northern France through the Seine and Oise, is just behind our fighting line, and is a good specimen of modern French engineering skill. It describes a fairly straight line by cutting through the Canal de la Somme to that of La Sensée, and is lateral to the Canal de St. Quentin. Its dimensions are: Depth 8 ft., width 70 ft., and locks to the number of 19, with an average lift of 20 ft.—greater by 5 ft. than the ordinary canal lock in England, and by 3½ ft. than any one on the Manchester Ship Canal. Electric towage was to have been adopted, and telephone as well as telegraph lines fixed, but the war has stopped completion for the time being.

The Caen Canal was designed to substitute an unnavigable section of the River Orne, which falls into the English Channel almost opposite the proposed new port at Portsmouth. The canal occupies the former bed of the river; its depth reaches 18 ft., but when the works in connection with the new dam are completed, it will measure nearly 20 ft. It has all improvements—gravelled towing-paths, swing bridges and telegraph line. The boats now using the canal are steamers and cargo boats of 1,600-2,000 tons burden. However, a decree has been issued declaring the widening and deepening of this canal a matter of public utility.

Foreign Tenders Invited

The chief engineer of the Department of Calvados has informed the British vice-consul at Caen that foreign firms will be allowed to tender for work in this connection. The conditions of tender have not yet been drawn up, the preliminary acquisition of land having not yet been effected; nevertheless, foreign contractors who in due course may wish to tender are invited now by the engineer-in-chief to get into touch with him, informing him on what terms they would be able to undertake the construction of the whole or part of these works.

REPORTER NOW CITY MANAGER AT ONE DOLLAR PER ANNUM

MAYOR ARCHIBALD JOHNSTON and the city council of Bethlehem, Pennsylvania, have selected Winton L. Miller, of St. Augustine, Fla., to be city manager and the city solicitor has been instructed to prepare the necessary ordinance creating the office of city manager, defining his powers and duties, etc. It is understood that the salary of the city manager will be one dollar per annum, payable out of the funds of the city! The remainder of the city manager's salary, said to be $10,000, will be paid through the liberality of the mayor and members of council, as they have voluntarily established a fund sufficient to pay same.

For ten years Mr. Miller was city hall reporter on a Dayton, O., newspaper, and then on the staff of the Dayton Bureau of Municipal Research. He was appointed executive secretary to the city manager of Dayton and on August 1st, 1915, he was appointed city manager of St. Augustine. Under the provisions of that city's charter he acted as director of safety and public works. The entire administrative branch of the government under the charter of St. Augustine was under the direction of the manager. The proof that Mr. Miller's administration was a successful one is the fact that the commission manager form of government was adopted by a bare majority of 18 votes in 1915, while in November, 1916 (after Mr. Miller had been in office for one year), the electors of that city voted to retain the managerial form of government by a majority of more than two to one, and since that time the two commissioners elected annually have been re-elected without opposition.

Mr. Miller had charge of the entire reorganization of the fire department of the city of St. Augustine, and under his supervision the development and extension of the water system of that city was improved; also a new sewerage system was installed. Of course, Mr. Miller had the co-operation and services at all times of an able city engineer. Mr. Miller then accepted a position at Hog Island offered by the United States Government. Having completed the work assigned to him there, the mayor and city council of Bethlehem were able to persuade him to go to that city. The mayor of Bethlehem is a mechanical engineer, having graduated from Lehigh University in 1889. He is better known as the vice-president of the Bethlehem Steel Co. than as the mayor of Bethlehem, to which latter position he was elected last year without opposition.

GOOD ROADS INCREASE VALUES*

IN the state of Indiana, the average selling price of land has been increased about $6.48 per acre by improved roads. The Indiana farmers estimate that improvement of all roads would increase average land values $9 per acre. They estimate, also, the average annual loss due to poor roads at 76 cents per acre, which, capitalized at 6 per cent., represents a depreciation of $12.67 per acre. Another enquiry, carried on by the Office of Road Inquiry at Washington, shows that the increase in land values due to good roads ranges from $5 to $20 per acre. Nothing can show better than these figures how valuable an asset good roads are.

*From "Conservation," issued by the Commission of Conservation, Ottawa.

One of the first things the prospective purchaser of a farm wants to know about a district is the distance from the railway station and the character of the road from the station to the farm. Some branches of agriculture are much more dependent upon good highways than others. The man who is engaged exclusively in the raising of cattle which can be driven for long distances to a shipping station, is, in a measure, independent of the condition of the roads. The grower of corn and any other crops which can be stored for a time without deterioration, can manage to get along, even though the road to his shipping point be impassable at times.

He is greatly hampered, however, by the necessity of doing his hauling in good weather regardless of market conditions and of whether or not his farm operations are seriously retarded by the absence of himself and his team. For the dairy farmer, the fruit and vegetable grower, and for the producer of perishable commodities of all kinds, ability to get his products to market at all seasons of the year and in all kinds of weather is undoubtedly indispensable to success. For all kinds of general farming, therefore, a good country highway is essential to the most profitable operation of the farm and to any considerable development of agriculture at a distance from a market town or shipping station. Other advantages it confers are better school facilities for the children, better rural free delivery service, greater attractions for pleasure-seekers and touring clubs, better attendance at country churches and an improved social life on the farm and in the villages.

Primarily, the benefits of good country highways go to the farmer, but less directly they go to the merchants and manufacturers by giving them wider markets for their goods and by decreasing the cost of distribution. In road improvement lies one of the greatest opportunities for general advancement, and farmers' associations, good roads committees, automobile associations and others can do much to further this work.

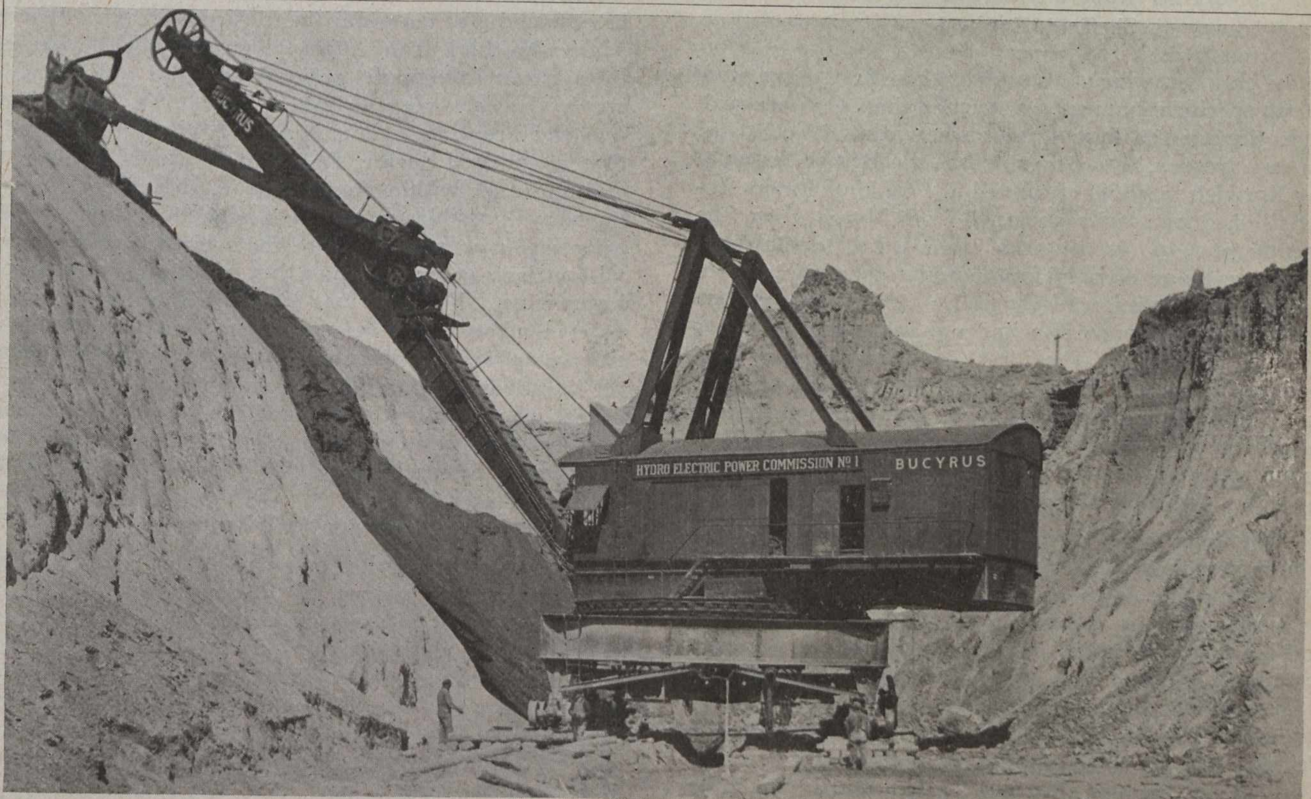
The International Joint Commission will meet in Montreal on Monday next, for consideration of an application of the New York and Ontario Power Co. for approval of its plans to reconstruct its dam and water-power properties at Waddington, on the St. Lawrence River. Opposition has been filed to the company's application by the Canadian Government and the Dominion Marine Association.

Serious protests have been made to the Board of Control regarding the Morley Avenue sewage disposal plant in Toronto. It has been alleged by residents of the east end of Toronto that they have to stay indoors during the warm weather on account of the odor. The Board of Control has instructed Dr. Hastings, the officer of public health, and R. C. Harris, the works commissioner, to submit a report on the plant.

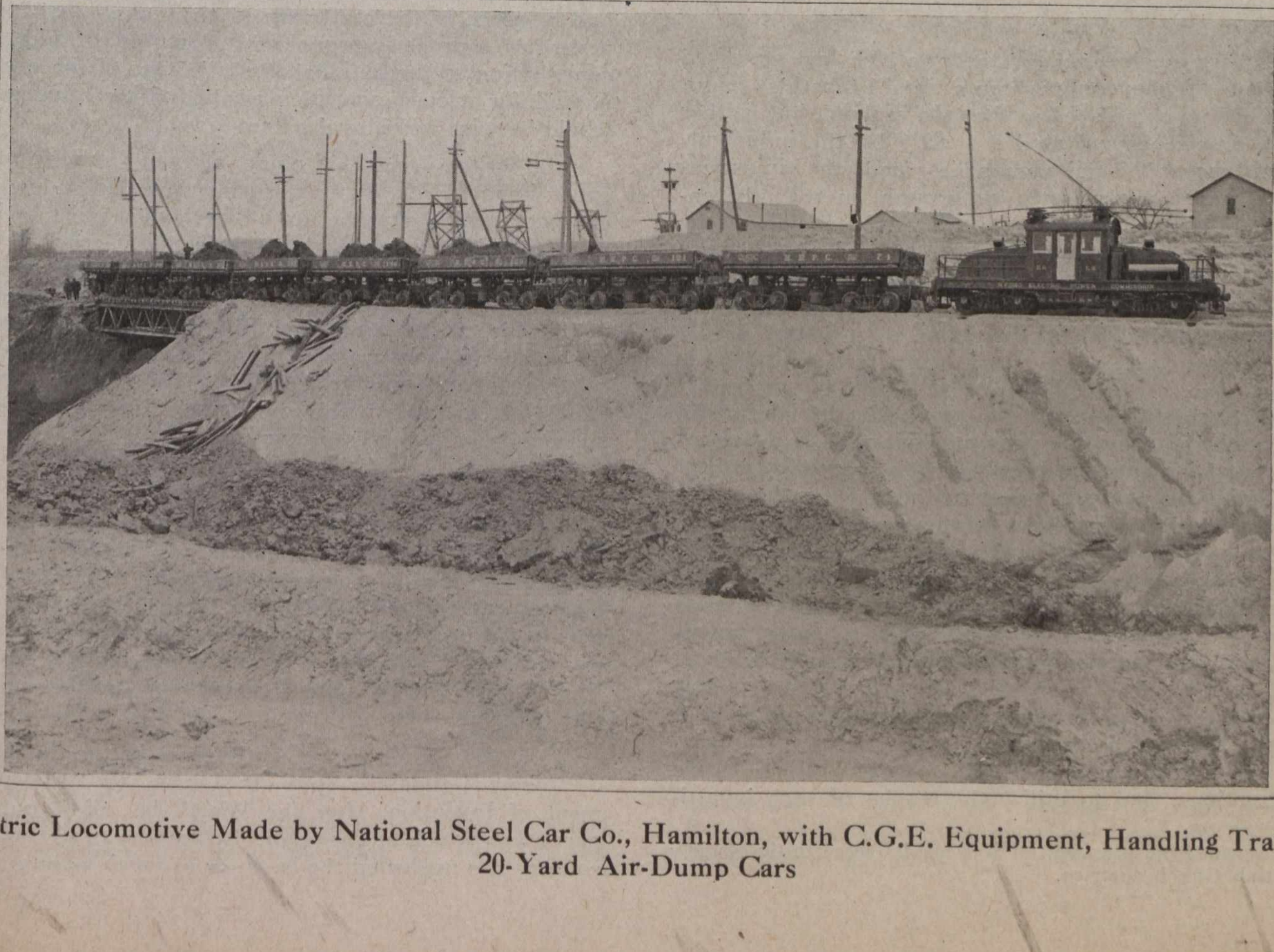
Sir William Gage, of Toronto, has suggested the opening of a new street from Front to Queen Streets, Toronto. He would locate the street midway between York and Bay Streets and parallel to those streets. He suggests that the people of the city might contribute $1,000,000 toward the cost if the street be considered a monument to the Canadian soldiers. The suggestion has been forwarded by the Board of Control to the city officials for report.

On the recommendation of Works Commissioner Harris, the Board of Control of the city of Toronto this week authorized the payment to the John ver Mehr Engineering Company of half of the $209,000 drawback on account of the new filtration plant constructed by the company. "The plant has been completed and accepted as satisfactory," stated Mr. Harris. "It has been in operation since March, 1918. The city's total obligation in conection with the plant was $1,077,000."

Two Construction Views, Chippawa-Queenston Power Canal



The World's Largest Electrically-Driven Shovel; 8 Cu. Yd. Bucket When in Earth, 5 Cu. Yd. in Rock; 90 Ft. Boom, 58 Ft. Dipper Stick; Capacity 3000 Cu. Yds. Daily; Weight, over 400 Tons; Can Load Cars Standing on a Track Which Is 62 Ft. Above Tracks on Which Shovel Stands



Electric Locomotive Made by National Steel Car Co., Hamilton, with C.G.E. Equipment, Handling Train of 20-Yard Air-Dump Cars

PATENTS*

By Sir Robert Hadfield, F.R.S.
Sheffield, England

IT may be interesting to state that the first descriptive patent specification was not earlier than October 3rd, 1711, though the first statute was granted in 1623. Mr. Henry Derdes, in a paper before the British Association at Norwich in 1868, exhibited a "Table of Patent Inventions" chronologically arranged from March, 1617 (the fourteenth year of the reign of James I.), to October, 1852. An average of only four patents per annum were granted during the reign of James I.; 62 per annum during the reign of George II.; and not more than 297 per annum up to 1853. The first American patent was granted in Massachusetts in 1641. To the end of 1917 about 1¼ million patents have been granted in America, a fact which shows the importance attached to them in that country.

Inventor's Rights Established

In 1603 there came before the English courts the test case in monopolies (Darcy vs. Allen, Noy, 178), which established the principles of absolute but limited monopoly as the right of an inventor. In this case a decision was handed down by the judges which clearly defined the conditions under which a right to a monopoly would be upheld. Henceforth patentability depended upon (1) priority of claim, (2) novelty of invention, and (3) usefulness of the device. In the words of the judges:—

"Where any man by his own charge and industry or by his own wit and invention doth bring any new trade into the realm, or any engine tending to the furtherance of a trade that never was used before, and that for the good of the realm; that in such cases the King may grant to him a monopoly patent for some reasonable time until the subjects may learn the same, in consideration of the good he doth bring to the commonwealth; otherwise not."

This case emphasized the theory which had governed the grant of monopoly patents in Elizabeth's reign. Judges had so opined before the case in hand, but neither King nor subjects had abided strictly by the judgment. The existence of illegal monopolies and the injustices practised under their protection brought in 1623 the enactment of the so-called "Statute of Monopolies," by which all previous illegal monopolies for once and all were abolished and the definition of the judges in the Darcy vs. Allen case as to priority, novelty, and usefulness, established as the patent law of the realm.

Wise Patent Laws Needed

The successful patentee is much like the successful boy at school; the state presents him with a monetary prize. As his protection is only for a comparatively short time, surely no one can object to this. In pushing forward a patent its owner must develop considerable acumen and business knowledge, which in themselves are of benefit to the state. The reward of pure science is on a higher plane, but it is hardly probable that its votaries confer more benefit on mankind. The inventor, moreover, holds his monopoly only for a comparatively short time. At any rate, it can safely be said that no country can become truly great, nor can it advance as it should, unless it has wise patent laws.

A well-known writer has said, "To encourage scientific investigations, and to utilize the results of such investigations for the benefit of the community, are problems of deepest concern." These are wise words, and the writer would like to add that better stimulation by our patent laws would still more aid this desirable result. There are some who think it unworthy to protect new developments by a patent monopoly granted by legal authority. But surely this is a very mistaken idea. We are all human, and the granting of a patent—so wisely originated and first introduced during the reign of James I.—is a great stimulus and, within proper reason, should be encouraged in every possible way. It is true that there are many scientists who nobly devote themselves to pure research without any other aim than that of aiding the progress of knowledge. Faraday was such an example, but it must be remembered that he was in a specially favorable position as permanent lecturer to the Royal Institution, with all its advantages, which no money could buy. In such cases where individuals have an assured position or occupy some permanent post, with all the means of experimental research found for them, then it is quite another matter.

Faraday's Discovery

Moreover, the writer cannot but think that if Faraday had protected by patent, his discovery relating to the invention of what afterwards proved to be the first inception of the modern dynamo—for the world freely admits it was to him and to him alone that this stupendously important advance was due—then under such a stimulus this modern device would probably have developed at a much earlier period. Not only is inventive genius required to originate a new idea, but there is a genius of probably equal value, namely, how to translate discovery and invention into practical application.

The leading article in "The Engineer" of February 22nd, entitled "The Foundations of Reconstruction," stated: "The Minister of Reconstruction, Dr. Addison, pointed out that there is a wealth of inventive ingenuity and resource in the craftsmen of this country which has never had a properly organized opportunity of adding its contribution to the national stock." One of the greatest stimuli for encouraging this wealth of inventive genius would be wise and liberal patent laws.

The writer urges this point of view because of the great importance of making our new patent law of a character which must be up-to-date, and it must be if we want to hold our own with countries like Germany. We seem to try to make our patent laws as cumbersome as possible, and steadfastly to reject modern development of this branch of our national life—that is, compared with the encouragement we find granted to inventors in some other countries, notably America. Yet inventive genius exists just as much within the British Empire, but is not sufficiently or properly encouraged.

Antediluvian Policy

As an example of the antediluvian policy of our Empire on this question, it is difficult to imagine that an Englishman in this country cannot get a copy of a Canadian patent without sending to Canada, and even then only a typewritten one, as patent specifications are not printed there! Fie upon you, Canada, in this respect! This is only one of quite a number of shortcomings on this question.

In an excellent paper recently given before the Society of Chemical Industry by A. P. Laurie, on "Encouragement of Invention After the War," he points out in a paragraph which might readily be termed an axiom, "No country has neglected the inventor as much as ours in the

*Excerpt from presidential address delivered to the Society of British Gas Industries.

past, and yet no country has had a more brilliant series of inventors." This is indeed true, for, as shown in the valuable lecture by Sir Dugald Clerk, F.R.S., before the Royal Society of Arts, on "Discovery and Invention," in December, 1917, our country has more than held its own in this respect. With further wise encouragement and modern patent laws, we shall continue to maintain our position if British legislators will only grasp the idea that invention must be stimulated by patent laws of reasonable character. Our present system is in many ways old-fashioned and out-of-date. This may seem strong language, but it can be proved up to the hilt.

Assistance for Inventors

Mr. Laurie makes the suggestion that inventors might be encouraged if there was closer touch between the Patent Office and the new Department of Scientific and Industrial Research, so as to make further development of the Patent Office possible, and that if a special department existed for doing this, it might prove a centre for the advice, encouragement, and assistance of inventors. In other words, the Department of Scientific and Industrial Research ought to be made the means of supplementing and assisting inventors. There is just reason for believing this, because in the government department already established, the Munitions Inventions Department, much assistance has already been given to inventors. This is a definite fact to which the writer can bear testimony, because he happens to be on the panel and has seen its methods of working. Whilst these may not be perfect, they have without doubt been of the greatest value to the nation in this time of crisis. Over and over again the writer has seen inventors assisted, whilst in other cases an unfortunate individual whose invention is worth nothing has been gently and courteously handled—and it is not an easy matter with some inventors to show them that their ideas are impracticable. For the inventor presenting something worth investigating, experiments have been carried out, and not necessarily at his own cost. Where there has seemed to be a germ of an idea which would prove of utility, every possible stimulus has been afforded.

Workshop and Laboratory

This Munitions Inventions Department, whilst now dealing only with inventions bearing on the war, might be amplified for post-war conditions. It has already an expert staff, composed of men of considerable ability, most of them taken from the Patent Office. It has a proper head, or comptroller, also a personnel of men on its board representing both pure and applied science. These members of the board subdivide their work into committees, to each of which it attached an expert secretary. If this could be continued after the war there is no doubt such a centre would prove of the highest value and service to the nation.

A. P. Laurie, in the paper above mentioned, would go still further and have both a workshop and a laboratory under the direct control of the Inventions Department for dealing at the initial stages with subjects brought before their notice. He also suggests that an inventor whose inventions have been approved of by the board should be afforded facilities for the carrying out of experiments, making of models, and receive other assistance, and that where necessary, and in case of poverty of the inventor, these facilities should be given free of charge.

With reference to the Munitions Invention Panel, which is doing such admirable work for the state and which may probably prove of great service and be made use of after the war, it may be interesting to mention that at the building in Princes Street, Westminster, devoted to this work, there is a large staff of officials headed by a comptroller, and aided by an Advisory Panel of nearly fifty experts specially selected. Colonel H. E. F. Goold-Adams has in the past rendered excellent service as comptroller, this post now being occupied by Admiral Sir Reginald Bacon.

Munitions Advisory Panel

There are ten main committees and some six sub-committees of the Advisory Panel; these, with the accredited *liason* representatives and officers of the American, French, Italian and other governments, form a strong combination.

The subjects dealt with cover: Ordnance and Ammunition; Gunsights and Rangefinders; Instruments; Fortifications; Field Service; Transport; Chemical Inventions; Machinery and Metals; General Purposes. In addition the important subject of Nitrogen Products is dealt with, covering: Processes; Experiments; Power; Gas-firing; Economics; General Purposes.

As regards the staff of the Munitions Inventions Department, there are altogether 217 civil members and 33 military members. Many of these are, of course, engaged in carrying out important experimental work at Rochford, Orfordness, Claremont, Imber Court and the research laboratory at University College, where there is also a large civilian staff, some 40 in number. From this will be seen the extensive nature of the examination of inventions and the actual research and other work being carried out.

Examined 40,800 "Inventions"

To show the vast amount of work the Department has to get through, it may be stated that already 40,800 inventions have been examined. Unfortunately, not more than 10 per cent. are found to be even worthy of an in-investigation; on about 5 per cent. of them, experimental work is carried out, and, finally, not more than 1 per cent. are found suitable for adoption and of practical service. In other words, out of some 36,000 inventions, many of them not really worthy of this term, about 120 really excellent ones have emerged, and 60 to 70 small inventions have also proved useful. Roughly speaking, the final percentage does not mean more than about 0.60 per cent. It should be mentioned that a fair number of the ideas submitted have been put down for post-war consideration.

It must not be forgotten that the National Physical Laboratory will, after April 1st, become vested in the Imperial Trust for the Encouragement of Scientific and Industrial Research, though the Royal Society will still exercise scientific control over the laboratory. At the present time its staff numbers upwards of 500, and its income for the year closing at the end of March will be well over $500,000, which shows the magnitude of the work carried on. Under Sir Richard Glazebrook's able guidance it is proving of the utmost importance. There seems to be no reason, therefore, why it should not join hands with the Munitions Inventions Board in regard to a scheme such as that referred to in the foregoing remarks.

As showing how patents for inventions strike a "new" nation, it may be mentioned that the Japanese Government, when considering the establishment of a patent system on the lines of that created by the American Patent Act of March 1st, 1899, appointed Mr. Takahashi their special commissioner to Washington, D.C. On being asked why the people of Japan desired to have a patent system, he replied:—

"It is only since Commodore Perry in 1854 opened the ports of Japan to foreign commerce that the Japanese have been trying to become a great nation, and we have looked about us to see what nations are the greatest, so that we can be like them, and we said, 'There is the United States not much more than one hundred years old, and America was not discovered by Columbus until four hundred years ago.' We said, 'What is it that makes the United States such a great nation?' and we investigated and found it was patents, and we will have patents." The writer in every way agrees with this wise statement by the Japanese representative, and wishes his countrymen would insist upon the British Parliament giving to the British Empire a patent law as liberal and as equitable as that of the United States.

Germany Encourages Inventors

Germany has recognized the importance of invention and has spent a very large sum upon a new Patent Office of palatial proportions.

There is great credit due to our own country for having been the first to introduce possible remuneration to inventors by means of patents. Even if the mercenary stimulus only be regarded, it can be safely said that the world at large has derived much benefit from the work of the patentee. Many of our great intellectual men of modern times have conferred benefits of the highest order upon the world, whilst they themselves have profited by their inventions.

In the writer's opinion the rapid progress made in America has been largely due to their wise encouragement of patents. A cheap patent does not mean a nasty one at all. Low fees stimulate patent activity, and should be encouraged here much more than in the past. It is a crying shame that in a great Empire like ours we do not have one Empire patent to cover the whole of our Dominions. If America can do this for her forty-eight separate states and her eighty millions of white population, why should we lag behind?

American vs. English Practice

An American, or for the matter of that an Englishman too, for the small fee of some $35, including all the government taxes, can obtain patent protection for 17 years from the date of issue of the patent—not merely from the date of application or lodging the specification. This patent monopoly for a new idea, which will indirectly benefit not merely the patentee but the users of the invention, holds good throughout the whole of the forty-eight American states, covers the whole of a country representing an area of some three million square miles, and operates for a nation of about 100 million people. In fact, it is really more than this, as the American patent can even be extended to the Philippines on payment of a merely nominal extra fee.

Why, too, allow the American citizen to protect his invention for a term of seventeen as against our fourteen years, with all the consequent advantages to the American citizen? This, however, is not all. The term of the British patent begins to run from the date of application, whereas an American patentee has two years or more in which to complete his specification, this time not counting against him, so that the real life of an American patent is nearer twenty years as against our fourteen years. As pointed out by Sir Charles Parsons in one of his papers a few years ago, at least one-third, often one-half, of the life accorded to a British patent is necessarily occupied in developing and overcoming the many difficulties and obstacles met with. In fact, it may be truly said that in the case of the majority of successful patents obtained in this country the patentee has only about seven or eight years in which to recoup himself for the great amount of capital expenditure and time devoted to his invention.

Forty Patents; Cost, $10,000

At the present time, within the Empire and within the region where the Union Jack floats, to get full protection requires no less than forty separate patents, the total cost of which, for a much smaller term of years—only fourteen in Great Britain and Ireland—is about $6,700. This total charge, what with special government fees, agents' expenses, patentee's expenses, would probably increase the cost of one patent to something like double this amount. In other words, to sum up we have a total charge for a patent within the great American Republic of the ridiculously small sum of $35, covering, as already stated, an area of more than three million square miles and a population of not far short of 100 million people. Against this, to cover our Empire we have the very heavy figure of probably over $10,000—that is, for one patent—including government fees, also general expenses and charges. It seems impossible to imagine that this country, with its business acumen, should continue such a foolish policy. Incidentally, it may be mentioned that Canada and Australia seem the only sensible members of the British Empire in this respect—Canada granting an eighteen-year patent, and Australia a fourteen-year patent, for the moderate sum of $65.

Is there any wonder, therefore, that with American patents obtainable for about $35, and for 20 per cent. longer time, as compared with the $6,700, or not far short of $10,000 to cover all the expenses paid by a member of this Empire, America goes ahead and develops her material welfare and industry in the way she has done? Without doubt, the mainspring of this enormous development of our American cousins has been their government's wise encouragement of this system of cheap patents. The writer is speaking of what he knows personally, or he would not lay such emphasis upon this important subject. Take, for example, the great General Electric Company, with its enormous pay-roll of between 50,000 and 60,000 people at its various works. This corporation has largely developed its present proud and strong position by the wise employment and encouragement of patents, and the annual balance sheet generally refers to the amount of money spent in patent protection. This is a very large sum, and yet it is money well expended. In time it brings literally a return of hundreds—in fact, probably thousands—per cent. for the expenditure and capital so invested. Only this one instance is mentioned, but it is within the writer's personal knowledge that nearly all big successful corporations in America have been largely founded upon important patents, which enable such corporations, at any rate for the time being, to be in a position of great advantage. By its wise policy America, without doubt, indirectly benefits in a thousand ways. Invention is stimulated and the smallest members of its great federation are encouraged to try and progress in the various arts concerned.

Classification of American Patents

There is another point regarding the American patent system which might be emphasized, and that is its admirable classification, enabling the division and subdivision of subjects to be made in a simple and yet effective manner. The division in which the writer is specially interested, that of metallurgy, furnishes an excellent example, with its various classes and sub-classes. A visitor to America should never leave Washington without going through the Patent Office and seeing the splendid routine work, which the examiners there so courteously allow.

The number of patent applications in the United States has now reached the enormous total of over 70,000 per annum. In 1870 the number was 19,200, and in 1890 it was 41,000. At the present time over 40,000 patents are issued and classified yearly. It is also interesting to note that the field of search by the Patent Office examiners in that country is a very wide and thorough one. In 1870 there were 106,000 searches made, and in 1911 this had reached the enormous total of 1,034,000.

Number of Patents Granted

The total number of patents granted in Great Britain from the year 1870 to the end of 1917 was about 500,000. In the United States up to the end of 1911 this was 1,023,000; in Germany, 260,000; in Austria-Hungary, 83,000; in Italy, 107,000; in Belgium, 248,000; in Russia, 27,000; and in Spain, 47,000. All these cover the period since patents were first issued in the various countries named up to the end of 1911.

As W. J. Rich, of the Patent Office, Washington, D.C., says in his recent valuable article on "American Patent Legislation and Its Application to Alloy Patents" —the words relating to patent statutes based on a provision in the constitution of the United States are indeed worth quoting—"When the framers of that grand document prepared it they had more prescience than is realized by many. In Section 8 it was enumerated in the powers granted to Congress that it shall have power amongst other things, 'To promote the progress of science and useful arts by securing for limited times, to authors and inventors, the exclusive rights to their respective writings and discoveries.' "

In some cases the owner of a patent is very much like the man who throws the proverbial stone into a pond, the ripples from which extend and circulate in a manner which cause no little astonishment. In the same way it is difficult to say when and where the benefits obtained from a successful patent, whether to the patentee or the consumer, begin and end.

To Fight the Hun

The writer firmly believes that the time will come when it will be possible to obtain one patent for the whole of the Anglo-Saxon speaking race in this terrestrial globe. *A better and more excellent way of fighting our enemies with whom we are at war could not be devised.* The claim would not be at all an impracticable one, and with the hearty co-operation (which it is believed would be readily obtained) of the Great Republic, our own Dominions, and this country, a step forward in the world's history for advancement and progress in the art of invention would without doubt be obtained.

The writer is glad to say that the powerful organization known as the Federation of British Industries is vigorously taking up this important question. They have for some time past had a special committee at work on proposed patent law reform. The writer strongly urged that the question of an "Empire" patent should be brought to the front, and is glad to say that this is one of the planks in their platform. The Federation urges: "A patent granted in the United Kingdom, or in any Dominion, Commonwealth, or Colony, should be deemed to be in force throughout the whole of the British Empire."

It would add greatly to the strength of the efforts being made by the Federation of British Industries if all the Scientific and Technical Societies would unite and assist the Federation on this and other important points regarding patents. If we do not knit our Empire together with modern conveniences, we shall most certainly fall apart and disintegrate.

SAND STREAKS IN CONCRETE*

By D. A. Watt
Assistant Engineer, Troy Dam

IT has probably been noticed by most engineers who have been connected with the building of concrete structures that there is a tendency for sand streaks to appear upon the face of the finished work, and that these appear to be more prevalent where the concrete is very wet than where it is of a moderately dry mixture. This peculiarity was noticed on the work at Troy, where steel forms were used for a considerable portion of the structures.

Inquiry was made of several engineers and superintendents as to what was the probable cause of the disfigurement, and in all cases the answer was that they believed it to be due to the excess of water in the concrete working its way to the face of the form and then percolating downward, thus carrying the cement away from the face. This belief, however, did not seem to be borne out by a close examination of the work at Troy, since there was no deposit of cement at the lower end of the streaks, such as must have been the case if the foregoing theory were correct. There being no possibility for the cement to escape outside of the form it would necessarily have collected at the bottom of the streak or along the sides, and have shown itself distinctly. This was not found to be the case, and no trace of collected cement could be found anywhere along the streak. Moreover, the streaks were usually much wider at the top than at the bottom, whereas it seemed probable that water percolating downward would tend to spread out as it found its way down the form.

The puzzle was solved by one of the concrete foremen whose attention had been directed to the matter, and who discovered that the water, instead of percolating downward, percolated upwards, and carried the cement with it. The process was not confined to the face of the forms but appeared at various points in the mass of the concrete, and was apparently due to the weight of the concrete gradually forcing out the excess water, and the latter naturally followed the easiest path of escape, which was upwards. The escape of the water was through very small fissures or holes not larger than a pin head. The flow would continue for a minute or two and when it stopped there would be left upon the surface a small flat cone of cement. This would account for the fact that no cement appears at the bottom or along the sides of such streaks when the forms are removed, since it is all carried up to the surface.

The process was much more noticeable with steel than with wooden forms, since the former, having a very smooth face, offered practically no resistance to the seepage of water.

*From "Professional Memoirs."

EFFECT OF TIME OF MIXING ON THE STRENGTH OF CONCRETE

By Prof. Duff A. Abrams

(Continued from last week's issue)

TESTS now completed do not enable us to analyze the factors which control the values of the constants in equations (12) and (13). It will be of great interest to determine how these terms are affected by such factors as age of concrete, character of aggregate and other factors. A series of tests is now under way which will throw considerable light on certain phases of this problem.

The interrelation of wear, strength and water content may be shown on one diagram, as in Fig. 18. This diagram is made up by superimposing Figs. 13 and 16 with certain modifications in position. The dotted line with arrows indicates the method of solving the following problem. What wear will be given by a concrete having a compressive strength of 2,800 lbs. per square inch? What is the water ratio for this concrete? The diagram shows a wear of 0.72 in. and water ratio of 0.84. A great variety of other problems may be solved in this way, as: What compressive strength and wear will be given by concrete of a given water ratio? Certain features of these tests suggest that the relation between strength and wear indicated in equation (10) is independent of the age and other properties of the concrete. This, however, cannot now be stated as a definite conclusion.

The Talbot-Jones rattler has proven entirely successful as a method of studying the wear of concrete. The abrasive charge, the rate and number of revolutions used in these tests have been found to give a wearing action suited for a wide range in the properties of concrete. A very poor concrete may be entirely destroyed, a high-grade concrete will show a wear of ½ in. or less.

Comparison of Hand and Machine Mixing

In Series 93 parallel tests of hand-mixed concrete were made for comparison with the machine-mixed specimens.

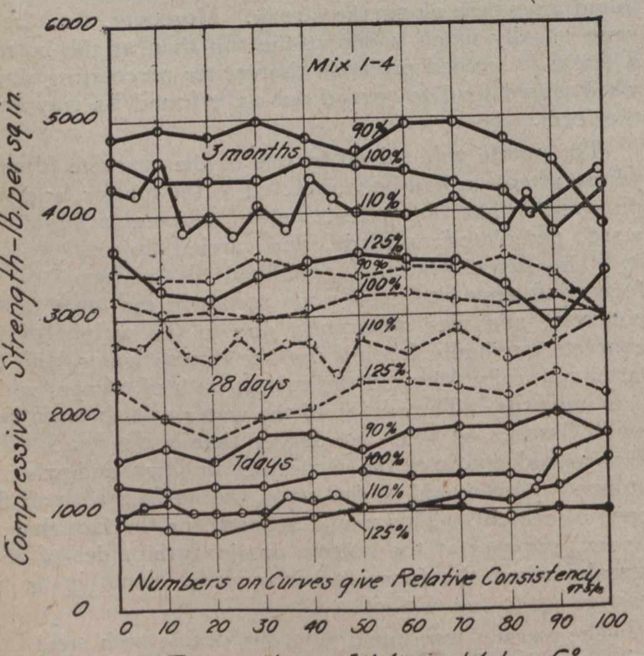


Fig. 49—Effect of Temperature of Mixing Water on the Strength of Concrete

Series 97—Each value is the average of 10 tests; 5 from each of 2 batches mixed on different days.

The two sets of tests were made from the same materials under the same conditions. The hand-mixed specimens were mixed separately; the four cylinders in a set were made on different days. It has already been noted that the strength is influenced by the water content in the same way for both machine-mixed and hand-mixed concrete.

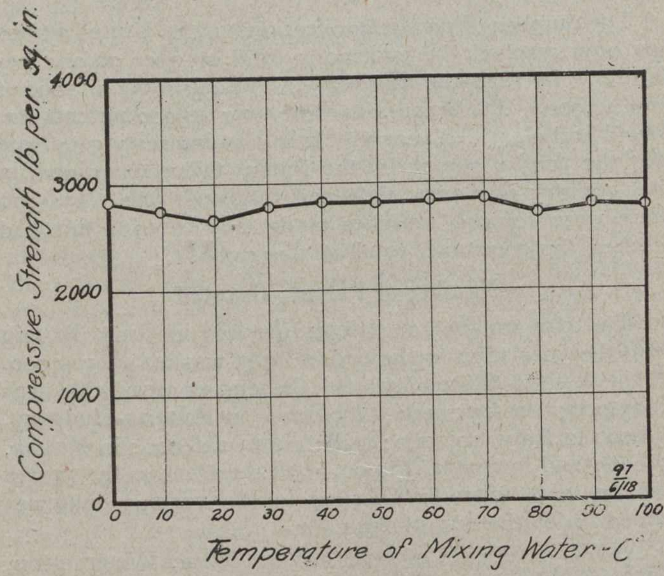


Fig. 50—Effect of Temperature of Mixing Water on the Strength of Concrete

Series 97—Each value is the average of 120 compression tests of 6 by 12-in. cylinders. This curve is the average of the 12 curves in Fig. 49.

The tests show that in general the method of hand-mixing, by means of a bricklayer's trowel, which has been used in most of our research work, gives results sensibly equivalent to that found by mixing concrete in this series for a period of 1½ minutes.

The concrete made by using fine sand for aggregate gave a strength for hand-mixing more nearly equivalent to 2 to 5 minutes machine-mixing. Whether this indicates a relative excess in the hand-mixing for the finer sands, or a difference in the performance of the mixer, it is impossible to state; probably both of these factors affect the result.

The mean errors of the tests show about the same variation in four machine-mixed specimens from the same batch as for four hand-mixed specimens made from separate batches on different days. The average mean errors for the 14 sets of 28-day tests in Series 93 are:—

Machine	10.4 per cent.
Hand	11.9 per cent.

The mean errors are greatly reduced if a larger number of specimens are made for a given condition. In most of our experimental work five specimens constitute a set; in some instances this number is increased to ten or even twenty.

Effect of Rate of Rotation of Mixer Drum

In Series 96 tests were made on 1 : 5 mix, aggregates graded 0-1¼ ins. for four different consistencies in which the rate of the rotation of the drum was varied from 8 to 30 r.p.m. Tests have been completed in this series at ages of 7 and 28 days and 3 months. The 1-year tests are not yet due. The results of these tests are given in graphical form in Figs. 31 to 46. In Fig. 43 all consistencies have been averaged for each age. It is seen that the rate of rotation of the mixer drum exerts only a slight influence on the strength of the concrete for rates between about 12 to 25 r.p.m. For the low and the very high rates there is generally a slight reduction in strength. The rate of 18 r.p.m. recommended by the manufacturer for this machine corresponds closely to the rate for maximum strength. This rate gives a peripheral

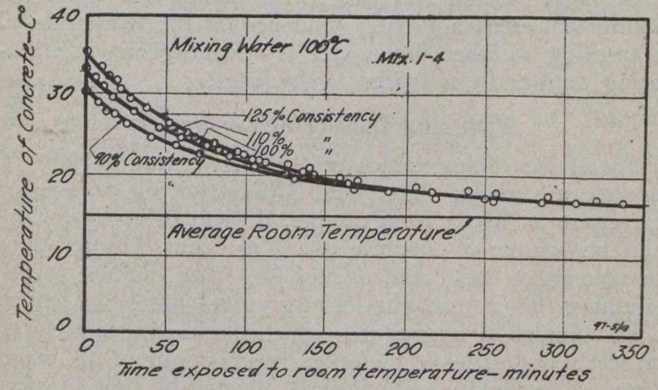


Fig. 51—Temperature of Concrete Immediately After Molding Specimen

Series 97—A similar set of curves may be constructed for other temperatures of mixing water.

speed of 150 ft. per minute for the maximum diameter of the inside of the drum.

In studying these series of tests particular weight should be given to the 110 per cent. consistency, since these tests are the average of three batches for each rate mixed on different days. However, there seems to be little difference in the behavior of concretes of different consistencies with reference to the effect of the rate of rotation.

Effect of Age on Strength

In Series 89, 93, 96 and 97 compression tests were made at ages of 7 days, 28 days and 2 or 3 months. Other tests will be made in Series 93 and 96 at the age

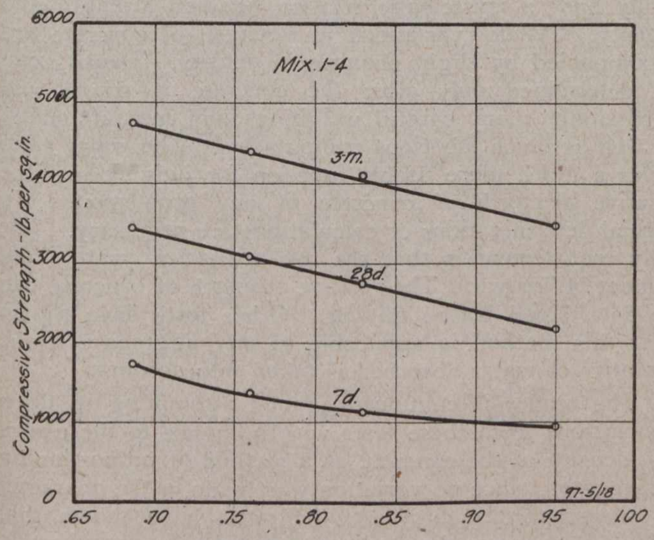


Fig. 52—Influence of Water on the Strength of Concrete

Series 97—Each value is the average of 110 tests; 10 tests for each of 11 different temperatures. These curves approximate straight lines due to the narrow range in the water content. Compare Figs. 7, 9, 31, 33 and 44.

of 1 year. The data in the tables enable us to make a study of the increase in strength with age. It should be borne in mind that all the specimens were stored in damp sand until tested.

Figs. 19, 21, 35 and 38 show the relation of age to strength platted to a direct scale of ages in days. Corresponding diagrams are given in several instances in which the age is platted to a logarithmic scale. It is seen that the relation can be expressed by an equation of the form,

$$S = C \log. A - D \qquad (14)$$

where S = compressive strength;

A = age at test; and

C and D are constants which depend on mix, consistency, time of mixing and other conditions of the test. For concrete of usual quality as used in these tests, this equation becomes

$$S = 2{,}200 \log. A - 1{,}200 \qquad (15)$$

where the age at test (a) is expressed in days.

Equation (15) is based on tests of 1 : 4 and 1 : 5 mixes, 110 per cent. consistency, mixed 1 minute.

An equation of a somewhat similar form is used by Unwin* for expressing the effect of age on the tensile strength of cement and mortars, as follows:—

$$y = a + bx^n \qquad (16)$$

where y = strength of cement or mortar;

x = age at test;

n = an exponent; and

a and b are constants.

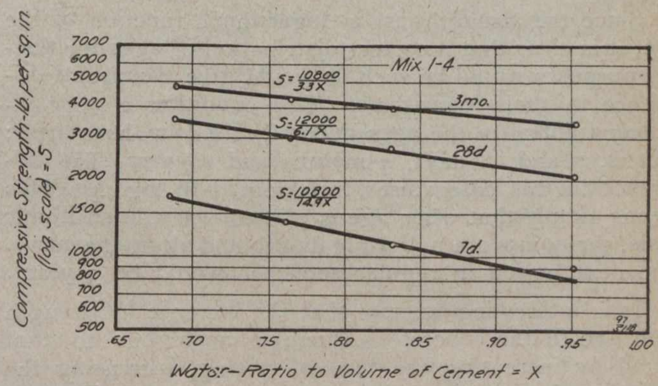


Fig. 53—Influence of Water on the Strength of Concrete

Series 97—Same data as in Fig. 52, except strength is platted to logarithmic scale. Compare Figs. 8, 10, 32 and 34.

For neat cement he found

$$y = 363 + 48 \sqrt[3]{x - 1} \qquad (17)$$

where x = age in weeks.

Equation (15) seems to represent more nearly the relation for concrete tests. This equation also is of the same type as those found in other relations. Compare equation (6).

The important thing is that at no time is there any falling off in the strength of the concrete. The erroneous opinion held by many that concrete decreases in strength is based on the results of briquet tests of cements and mortars. This reveals a fundamental objection to the briquette. A retrogression in strength of concrete has not been found in any group of tests made in this laboratory. Hundreds of groups have been tested at ages from 7 days to 1 year or older. This increase in strength persists regardless of mix, size of aggregate, consistency of concrete, time of mixing or other variables. Reports of published tests show that a similar relation exists up to periods of nine years. It is not known how long this increase in strength continues, but there is no apparent reason why it should cease, so long as the concrete does not dry out and we do not exceed the strength of the aggregate.

*See "The Materials of Construction," by W. C. Unwin, 1910, p. 459.

According to equation (15) we should expect the following strengths for concrete of the quality used in these tests at the ages shown:—

1 week.	1 month.	3 months.	1 year.	2 years.	5 years.	10 years.
660	2,050	3,100	4,440	5,100	5,900	6,600

Using the 1-month strength as a basis of comparison, we obtain the following percentages:—

32%	100%	183%	240%	250%	288%	322%

The relatively low strengths shown at the earlier ages are probably due to the fact that the tests were made in mid-winter. The specimens were stored in the basement where the temperature was somewhat low. Tests made under normal atmospheric conditions show a strength at 7 days of from 40 per cent. to 50 per cent. of the 28-day strengths.

There is no further increase in strength after the concrete has thoroughly dried out. The fact that increase in strength continues so long as the concrete is kept damp, and ceases as soon as it becomes dry, emphasizes the necessity for protecting concrete from too early drying and for continuing the curing in a damp condition as long as possible.

Since the strength is a logarithmic function of the age, it is clear that a correct distribution of ages for testing purposes would be such as would give a constant difference in their logarithms. This condition is approximately fulfilled in the ages generally used in these tests; that is, 7 and 28 days, 3 months and 1 year. The difference in this case varies from log. 3 to log. 4. This means simply that when age is platted to a logarithmic scale, the points are uniformly distributed along the curve. The next period in regular sequence would be 3 years.

It is interesting to note that the increase in strength with age (if the concrete is damp) is analogous to that found by increasing the time of mixing, increasing the quantity of cement or using coarser aggregate. The last two items, of course, may be combined in the one item of reducing the water ratio in the mix. It appears that proper curing is by all odds the cheapest method of getting full value from the cement used.

Effect of Temperature of Mixing Water

In Series 97 compression tests were made on concrete of 1:4 mix in which the temperature of the mixing water ranged from 0 to 100° C. Duplicate batches were mixed on different days using four different consistencies. Fig. 49 shows the average strengths obtained at 7 and 28 days and 3 months. An average curve for all consistencies and all ages is shown in Fig. 50. It may be surprising to find that such a wide range in temperature should make no more change in strength. The reason for the uniformity in strength is found in Fig. 48 and 51.

Fig. 48 shows how the temperature of the concrete is influenced by the temperature of mixing water. The temperature of the concrete was determined by inserting a thermometer in the fresh concrete immediately after molding the specimens. For average consistency the temperature of mixing water must be changed about 5° in order to produce 1° change in the temperature of the fresh concrete. There is only a small difference for wide range in consistencies.

Fig. 51 shows that, regardless of the consistency, the concrete rapidly approaches room temperature. The most favorable condition is platted—100° C. mixing water. The concrete probably reaches room temperature before initial setting of the cement occurs.

It is important to note that the mixing water near the boiling plant has no injurious effect. It has been reported recently that certain concrete was defective on account of being "corked" by using boiling water for mixing.

In large masses of concrete the use of hot water for mixing will exert a greater influence on the temperature. In freezing weather, hot water is advantageous in eliminating danger from frozen aggregates.

Yield and Density of Concrete

In all the tables values of "density" and "yield" of concrete are given. The yield is based on the volume of aggregate as used; for example, a yield of 1.025 means that the volume of concrete is 2½ per cent. greater than the volume of the mixed aggregate. The method of determining the unit weights of aggregates described before gives volumes of aggregates which correspond closely to the actual quantities of materials in a concrete of the usual mixes. The yield is only slightly affected by time of mixing; the longer mixing times giving slightly lower values than the short.

The term "density" is used to express the total volume of solid material in the fresh concrete. It is based on the specific gravities of the cement and aggregate, the proportions of the materials and the yield of the concrete. The density is only slightly affected by time of mixing of the concrete; it is more influenced by variations in consistency, mix, grading of aggregate, etc. There is in general no definite relation between strength of concrete and density. The relation is sometimes direct and sometimes the reverse if we consider all possible proportions of given materials. The maximum density for these materials was found in the 1:7 and 1:9 mixes. It will be noted (Table 8) that the rich mixes give lower densities than the leaner ones. With a systematic variation in some one factor in either the proportions of given materials or in the manipulation of the concrete, we generally find a systematic relation between strength and density. Wide variations in strength of concrete are accompanied by slight changes in density. Density can be determined only after the concrete is mixed and necessitates many careful weighings and measurements, as well as much laborious computation. The water ratio gives a much more usable function for judging of the relative strength of concrete of any proportion. No special determinations or calculations are necessary. The only requirement is that the quantities of water and cement be known. The relative strength of concrete can be determined before mixing. Other tests have shown that this method is applicable to any aggregate if the quantity of water absorbed is taken into account.

The reader is cautioned against attempting to draw conclusions from these tests with reference to the use of the density of the concrete as a method of proportioning aggregates, since no variation was made in the character of sieve analysis curves. Other tests have shown that wide variations in density may occur due to variations in the grading of the aggregate without any change in strength.

A company may be formed in Victoria for the purpose of carrying on shipbuilding, in which the shipyard workers will be asked to take stock. The board of trade of the city recently considered the question and a company with a capital of, say, $400,000, was proposed.

The United States now has upward of 120,000 soldiers in training in technical schools throughout the country. The courses include electrical construction, gas engine and automobile engineering, blacksmithing, plumbing and gas-fitting, tool-making, cabinet work, carpentery, etc.

SOME TESTS ON THE EFFECT OF AGE AND CONDITION OF STORAGE ON THE COMPRESSIVE STRENGTH OF CONCRETE*

By Harrison F. Gonnerman
University of Illinois, Urbana, Ill.

THIS paper presents the results of some tests on the development of compressive strength of concrete with age and on the effect of condition of storage on the compressive strength. The results show little increase in strength in the air-stored specimens after an early age and a marked increase in strength in the specimens stored under moist conditions up to an age of three years and little change in strength between 3 and 5 years. A decided increase in compressive strength was also found when specimens which had been stored in air for 2 years and 7 years were transferred to moist storage conditions.

The specimens of Series A, D, P, S and W were made at the University of Illinois in the months of March and April, 1913. The test specimens were 6-in. x 6-in. cylinders. The concrete was 1 part Universal portland cement, 2½ parts sand, and 3½ parts broken limestone. The sand was screened through a ¼-in. sieve and was dry when used. The broken limestone was screened to pass a ¾-in.-mesh sieve and be retained on a ½-in.-mesh sieve. Several determinations showed that the stone, which was thoroughly damp when used, contained 4 per cent. of water and the water contained in the stone was taken into account in the calculation of the water used in the mixture. The concrete for all of the specimens was mixed by hand with a trowel, only enough concrete being mixed at one time to make one specimen. The specimens were molded in cylindrical metal molds. To distribute accidental differences the four specimens of each series tested on a given date were made on different days with the specimens of other series and ages.

The amount of water used to give concrete of the consistency designated as "normal" was 9.3 per cent. by weight of the total materials (cement, sand and limestone); the concrete of normal consistency was drier than that ordinarily used in reinforced-concrete construction. In the mix of "dry" consistency 8.4 per cent. of water by weight of total materials was used; for this mix water could be brought to the surface of the concrete with vigorous tamping. In the concrete of "wet" consistency 10.2 per cent. of water was used; this consistency was not very wet as 13 per cent. of water was required to give a mix which could not be used without considerable water separating from the concrete.

After three days the forms were removed and the specimens stored in damp sand or left exposed to the air of the laboratory until the date of test. The temperature of the storage room ranged from 60° to 75° F. during the months of March and April when the specimens were made and the temperature of the storage room throughout the year was usually about 65° to 75° F. The air of the storage room was more moist than would generally be found in an ordinary enclosed room. The temperature of the damp sand was generally about 6° lower than atmospheric temperature. In order to prevent absorption or loss of water so far as possible during the period of storage, the specimens of Series P were coated with paraffin before they were stored in the damp sand. The specimens were removed from sand storage 1 to 3 days before testing.

*Paper presented at the annual meeting of the American Concrete Institute, July, 1918.

The results of the tests are given in Table 1 and Figs. 1, 2 and 3. It will be noted in Table 1 and Fig. 1 that the specimens of Series S (normal consistency, 9.3 per cent. water), P (normal consistency, 9.3 per cent. water, paraffined), D (dry consistency, 8.4 per cent. water) and W (wet consistency, 10.2 per cent. water), which were stored in damp sand, increased rapidly in strength up to an age of 1 year. The ratio of the strength at 1 year to the strength at 28 days averaged 1.94 for Series S, D and W; the ratio for Series P was 1.58. At ages greater than 1 year the rate of increase in strength for the specimens of Series W and P was relatively small, there being

Table I.—Compressive Strength of Concrete at Different Ages for Various Consistencies and Conditions of Storage

EACH VALUE, UNLESS OTHERWISE INDICATED, IS AN AVERAGE OF FOUR OR MORE 6 x 6-IN. CYLINDERS. PROPORTIONS, 1 : 2½ : 3½ BY WEIGHT.

Series.	Consistency.	Water Used in Mixing, per cent.	Storage Condition.	Compressive Strength in lb. per sq. in. at Age of									
				7 days	14 days	21 days	28 days	2 mo.	6 mo.	1 yr.	2 yr.	3 yr.	5 yr.
D	Dry	8.4	Damp sand	1751	2140	2058	2615	3332	3934	3945	4890	5340	4540
S	Normal	9.3	Damp sand	1390	1775	1816	1820	3063	3431	3765	4042	5116	5174
W	Wet	10.2	Damp sand	1103	1354	1623	1657	2410	3281	3757	3914	4278	4295
A	Normal	9.3	Air of lab.	1481	2061	2126	2116	2232	2049	2350	2189	2780 3455*	2774 4058*
P	Normal	9.3	Coated with paraffin, damp sand	....	....	....	2314	2521	3329	3071	4235	4340	4472

* Stored in damp sand when 2 years and 4 months old.

practically no increase in strength for these specimens from the 3-year to the 5-year age. At the age of 5 years the strength of the specimens of Series W and P was 2.6 and 1.9 times the strength at 28 days, respectively.

The specimens of Series S and D showed a considerable increase in strength from an age of 1 year up to an age of 3 years. The strength of the specimens of Series S, like that of Series P and W, remained nearly constant from the 3 to the 5-year age. The strength of the specimens of Series D, which, up to an age of 3 years, had been greater than that of the other series, fell off con-

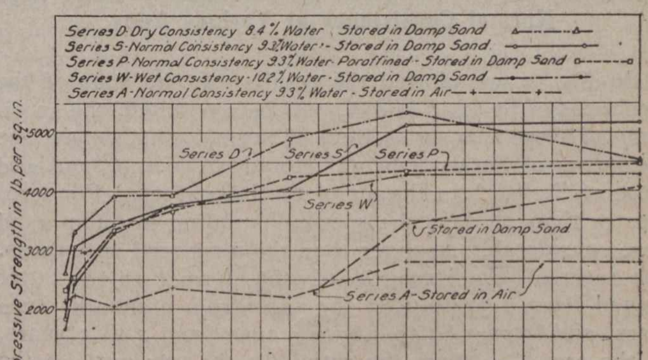


Fig. 1—Effect of Age on Compressive Strength of Concrete of Different Consistencies and Storage Conditions

siderably at the 5-year age; no reason for this drop in strength is apparent and it is believed that the result is accidental. The strength of the specimens of Series S at an age of 5 years was 2.85 times the strength at 28 days.

The specimens of Series A (normal consistency, 9.3 per cent. water) stored in air attained nearly their maximum strength at the very early age of 14 days. From an age of 14 days up to an age of 2 years they gained but little in strength, the compressive strength over this period of time ranging from 2,051 to 2,350 lbs. per square inch. At an age of 3 years they showed some gain in strength and the strength at an age of 5 years was the same as that at 3 years. The strength at 5 years was 1.3 times the strength at 28 days.

When it was found that the strength of the specimens of Series A had not increased with age up to the 2-year age, one-half of the remaining specimens of this series was stored in damp sand when 2 years and 4 months old, to find the effect of damp storage at this advanced age. In Fig. 1 it is seen that at an age of 3 years the strength of the specimens so stored for the last eight months had increased considerably (675 lbs. per square inch) over that of similar specimens stored in the air of the laboratory, and that at an age of 5 years the increase in strength of specimens so stored for the last 2 years and 8 months was 1,284 lbs. per square inch—the strength of these specimens being 1.46 times the strength of similar specimens stored in the air of the laboratory. It is evident, therefore, that when the air-stored specimens were changed to storage under moist conditions further hydration of the cement occurred and the strength of the concrete increased markedly with the lapse of time and was approaching the strength of the specimens which had been stored in damp sand throughout the 5-year period.

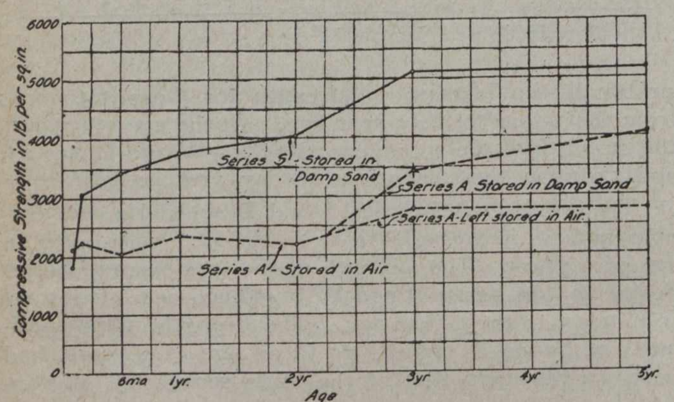


Fig. 2—Effect of Storage on the Strength of Concrete of Normal Consistency at Various Ages

In Fig. 2 are plotted the results of the tests of the specimens of Series S and A. As before stated, the specimens of these two series were of normal consistency, the specimens of Series S being stored in damp sand and those of Series A in the air of the laboratory. For ages greater than 28 days the specimens stored in damp sand were considerably stronger than the air-stored specimens. The ratio of the strength of the former to the latter ranged from 1.37 to 1.85 for ages from 2 months to 2 years, and from 1.85 to 1.87 for ages from 2 to 5 years. At the age of 5 years the ratio of the strength of the specimens of Series S to the strength of the specimens of Series A which were stored in damp sand when 2 years 4 months old was 1.28. It seems probable that with the lapse of time the strength of the latter specimens would approach more closely the strength of the specimens of Series S. A set of specimens stored in air and two sets stored in damp sand, having normal consistency but made under conditions somewhat different from the specimens of Series A and S, gave results at the various ages which tend to corroborate the results of Series A and S.

In Fig. 3 the average strength of the specimens of Series D, S and W stored in damp sand, and the strength of the air-stored specimens of Series A, are expressed in terms of the strength at an age of 28 days. For the sand-stored specimens the strength at 7 days is about 0.7 of the strength at 28 days, the strength at 1 year is about 2.0 times the strength at 28 days and the strength at 5 years is 2.5 times the strength at 28 days. For the air-stored specimens the strength at 7 days is 0.7 of the strength at 28 days, the strength at 1 year is 1.1 times the strength

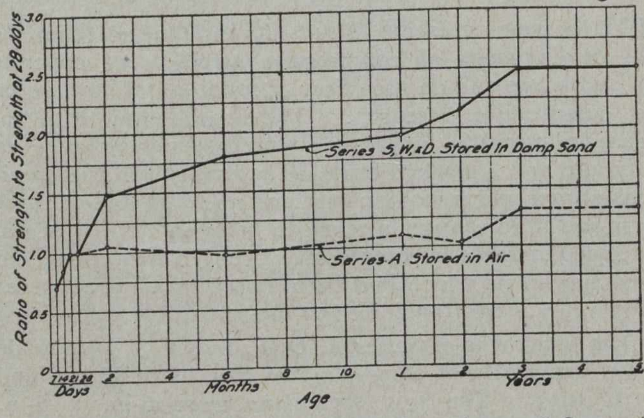


Fig. 3—Relative Strength at Various Ages of Concrete Stored in Damp Sand and in Air

at 28 days, and the strength at 5 years is 1.3 times the strength at 28 days. It is seen that the condition of storage has a marked effect on the strength of the concrete at ages greater than 28 days.

It is probable that the strength of the stone aggregate itself affected the strength of the stronger specimens, for in these the stone aggregate was found to be fractured, while in the specimens of lower strength fractures of the stone were not common.

The specimens of Series Q were made under the direction of the late C. H. Cartlidge, bridge engineer of the Chicago, Burlington and Quincy Railroad Company, in March and April, 1910, and were stored in air in the company's laboratory at Aurora, Illinois. The tests at

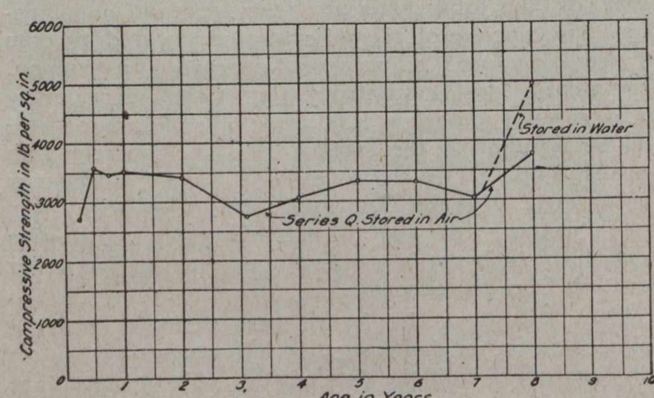


Fig. 4—Effect of Age on Strength of Concrete of Series Q

an age of 3 months were made at the company's laboratory; the tests at other ages have been made at the University of Illinois, shipment of each lot of ten specimens being made two or three weeks before time of test.

The test specimens of this series were 6-in. x 10-in. cylinders. The concrete was 1 : 4 mix, a bank run gravel being used as aggregate. The consistency of the concrete was reported to be similar to that ordinarily used in reinforced concrete construction. The results of this series of tests are plotted in Fig. 4. It will be seen that at the age of 6 months the concrete had attained nearly its maximum strength, only the test at 8 years giving a greater strength. In May, 1917, one-half of the remaining specimens of the series were stored in water and the other half was left stored as before, exposed to the air of the room. The tests made in 1918 when the concrete was 8 years old showed for the air-stored specimens a slight increase in strength over the strength at an age of 6 months. The specimens which were stored in water for 10 months showed an increase in strength of about 30 per cent. over the air-stored specimens of the same age and an increase of 38 per cent. over the specimens tested at an age of 6 months. It should be noted that for this series, as was the case with Series A, the growth in strength of the specimens stored under moist conditions is marked, even though the specimens were of considerable age at the time the change in storage was made.

Summary of Tests

The tests of the specimens made at the University of Illinois may be summarized as follows:—

1. The strength of the concrete which was stored in contact with moisture increased rapidly up to an age of 1 year; the increase in strength at ages greater than 1 year, although considerable, took place at a much less rapid rate.

2. The air-stored concrete attained nearly its final strength at a comparatively early age and gained little strength with the lapse of time.

3. The concrete which had been stored in air for a considerable time increased in strength greatly after it had been stored in contact with moisture so that further hydration of the cement could take place; the strength of the specimens stored in damp sand 2 years and 8 months after they were 2 years and 4 months old was 1.46 times the strength of the specimens which remained stored in air for 5 years.

4. The strength of the concrete at an age of 7 days for both damp sand storage and air storage was about 70 per cent. of the strength at 28 days; at an age of 1 year the strength of the concrete stored in damp sand was about twice as strong as at 28 days and the air-stored concrete was only 10 per cent. stronger than at 28 days. At an age of 5 years the strength of the concrete stored in damp sand was about 2.5 times the strength at 28 days and the strength of the air-stored concrete about 1.3 times the strength at 28 days.

5. At ages of 3 and 5 years the strength of the concrete stored in damp sand was about 1.9 times the strength of the air-stored concrete.

The tests of the specimens made by the C., B. and Q. R. R. may be summarized as follows:—

6. For the specimens stored in air the strength at an age of 8 years was slightly more than that at 6 months.

7. The strength of the specimens stored in water for 10 months after they were 7 years old was 1.3 times the strength of the specimens which remained stored in air for 8 years.

It seems apparent that concrete in structures exposed to air which is not damp will gain little strength beyond that attained at the earlier ages, in the portions where loss of moisture takes place, while concrete in contact with moisture or dampness will continue to gain in strength for some years.

The aluminium industry of all countries has been considerably developed since the war started. The annual report of the Swiss company at Neuhausen shows greatly increased output and large profits during the past year. A sum of about $1,000,000 has been set aside from the gross profits of the year to provide further hydro-electric power to extend operations.

COST OF LAYING WATER MAINS

THE report of the Board of Water Commissioners of Detroit for 1917 states that work on the construction of new extensions of water mains was materially hampered during the year by shortage of labor and excessive rains, and that in an effort to overcome the difficulties due to the former, use of machinery was resorted to so far as possible. Four mechanical trench excavators were purchased, one operated by steam and three by gasoline, and also four backfillers operated by gasoline and one portable air compressor for caulking. The use of these machines throughout the year resulted in the laying of a larger quantity of pipe and with a considerably smaller force than would have been possible by the use of hand labor only, the result being that the total length of water mains laid was the greatest of any year in the history of the Board.

The total quantity of pipe actually laid during the year was 70 miles, of which 9.5 miles consisted of main feeders 12 inches in diameter or larger. Costs of laying the several sizes, for material, labor, overhead expenses and total, were as follow:

Cost Per Foot of Water Mains

Size, ins.	No. of feet.	Material, etc.	Labor.	Overhead expense.	Total.
4	379	$ .95	$1.09	$.13	$ 2.17
6	153,296	.71	.46	.05	1.22
8	72,898	.98	.55	.06	1.59
10	4,311	1.38	.69	.08	2.15
12	15,762	1.79	.86	.10	2.75
16	7,574	2.33	1.20	.14	3.67
24	2,007	4.68	2.25	.26	7.19
36	2,077	7.42	3.28	.38	11.08
42	13,112	10.35	5.67	.65	16.67

The unit cost of pipe laid, as shown in the table, is higher than previously. This is due to the higher cost of material; to shortage of labor resulting in gangs too small for good economic results; to higher wages paid; and to unfavorable weather conditions, all of these being contributory factors in raising the cost, which was offset in part only during a portion of the year by the utilization of trenching machines, and by the adoption of the method of laying longer extensions, regardless of whether any houses have been built or started on the line of proposed extensions.

An interesting item in the report concerning consumption shows that the maximum rate of consumption occurred on July 26th, when it reached 55 per cent. above the average for the year. The fire department reported that the total used for fire protection service during the year amounted to but one-seventeenth of one per cent. of the quantity pumped.

The Government Railway in Alaska will not be finished before 1921, or considerably later than the date calculated when the work of building the line was begun. The line is now 65 per cent. completed, but more time may be required to build the unfinished third than was required for the completed two-thirds. About 6,000 men were employed in the field last year, but it is expected that not more than 3,000 men can be obtained this year. The chief efforts will be directed to completing the main line between Seward and Anchorage, and to laying the lines towards Fairbanks. It is hoped to open the line from mile 215 to mile 265. The government had, up to the end of May, spent on this railway an aggregate of $23,670,000. The original estimate of the cost of the line was $35,000,000, but on account of the increased cost of labor and materials the present estimate is $40,000,000.

THE TRAINING OF ENGINEERS*

By E. J. Silcock, M.Inst.C.E., F.G.S.

THE above title does not indicate the whole field which it is proposed to cover in this discussion. Obviously the training of water engineers can only be considered in relation to the more general question of the education of all civil engineers as distinguished from mechanical manufacturing engineers.

It is proposed to consider the subject under two heads: First, the broader question of the education of civil engineers; and second, the amount of specialization necessary for those who intend to practise as waterworks engineers.

In the first branch of the subject the writer confines himself to the training of civil engineers who are intending to practise as consulting, official or executive engineers in connection with railways, harbors, docks, canals, waterworks, sewerage, gasworks, municipal engineering and mining. It is submitted that these branches of the profession should be separately considered and provided for, and should not be included in the mechanical and electrical branches.

Hitherto the engineering departments of the British universities and technical schools have endeavored to make their courses cover all sections of engineering, but there has been a general tendency to make the mechanical side predominant. This no doubt arises from two causes —*viz.*, first, the number of students intended for mechanical work is larger than that of those intending to follow civil engineering; and, second, mechanical engineers have, as a body, been more liberal in their financial support of the modern universities and schools, and have therefore quite rightly been more largely represented than their civil engineer confreres on the governing bodies who appoint the teaching staffs and direct the courses of study.

Early Training

The general sequence of the training of a youth intended to follow the profession of civil engineering should, in my opinion, consist of:—

(1) A good general education at a public school.

(2) Education at a university in the theoretical side of the profession for a period of two years.

(3) An apprenticeship for a period of three years with a civil engineer in active practice.

Dealing with these in the order named: The public school selected should be one having a good "modern side." This is most important. Most public schools still cling to the old idea of a classical education with a modern side as a "side show" and to it are relegated many of the incompetents from the "classical side," together with a few brilliant boys who have gained scholarships but who are intended for a commercial career.

For a boy to be successful as a civil engineer he must have a good general education and, whilst agreeing that Latin and Greek should not be excluded in his early school years, it is in my opinion imperative that those two subjects should be dropped during the last year or two of the boy's school life and his whole energies for that period concentrated on natural science, mathematics (which should be continued at least to include the calculus and the solution of triangles) and two modern languages.

With regard to age limits, it is suggested that the boy should be sent to a good preparatory school at the age of eight or nine, and that the public school training should begin when he is about twelve years old and should continue until he is about seventeen years of age. He should then be capable of passing a matriculation examination at a university.

Technical Theoretical Training

Turning to the technical theoretical training at a university, it is submitted with some confidence that a period of two years should be sufficient to give an average youth a good grounding in the general principles of the subject which are likely to be of use to him in his profession, but this will involve a radical alteration in the system of education at present in vogue. To begin with, the time actually occupied in attending lectures, laboratory work, private study, and preparation of work must be considerably increased. The youth, who would now be over seventeen years old, and at an age when, if not still at college, he would be going to work, must be taught to regard himself as no longer a schoolboy, but a man who has really commenced his life's work, just as much as if he were in an office. To this end ordinary office hours of 9 a.m. to 5.30 p.m. (with an hour for lunch five days a week, and 9.30 a.m. to 1 p.m. on Saturdays), should be kept and strict punctuality and regular attendance should be observed and insisted upon. Evening work of preparation or writing up notes should be imposed at times as a form of overtime, but need not be a regular requirement. The holiday periods would have to be very substantially reduced and brought more into line with the time given to youths in offices. Probably a month in the summer, with a week at Christmas and Easter respectively would be as much time as could be spared if the necessary work is to be accomplished. Further, the time occupied in examinations should be cut down to a minimum, and it is suggested that the course of instruction may well include, as a prominent feature, test-papers on the various subjects taught. This would effect a twofold object—*viz.*, to train students to express their knowledge in writing, and, at the same time, enable the teaching staff to ascertain what progress had been made. By adopting such methods it would not be necessary to hold more than two formal examinations during the course, and these should be of not more than a week each in duration. One such examination should be conducted by the university staff at the end of the first year and the other by examiners appointed by the Institution of Civil Engineers at the completion of the course. The latter body might, with advantage, divide the associate-membership examination into two parts, one theoretical and the other practical. The student should be capable of passing the theoretical part of the examination at the end of his two years' college course.

Scope of Theoretical Instruction

The scope of the theoretical instruction should cover, *inter alia*, the following subjects:—

(1) Chemistry. Elementary, as affecting the materials likely to be used and to enable the student to understand a chemical analysis or formula.

(2) Physics. Elementary, to enable the student to appreciate the meaning of physical expressions.

(3) Geology, as affecting engineering with special reference to hydro-geology.

(4) Surveying instruments, their uses and adjustments.

(5) Strength of materials and methods of testing.

(6) Hydraulics—to be very fully treated.

*Paper submitted in introduction of discussion by the Institution of Water Engineers, England.

(7) Calculations of stresses in structures and graphic methods.

(8) Dynamics.

(9) General principles applicable to various forms of prime movers.

(10) Instruction in the selection of types and testing of prime movers and machinery, with information as to the limitations of same.

(11) Transmission of power.

No attempt should be made to teach drawing; this can be better done in the office, and, in my opinion, it is unnecessary to teach the students mere manual dexterity with machine tools. The various processes which can be carried out by different types of tools and the limitations to which they are subject should be fully described and illustrated by the instructors in the laboratory, or by visits to works, but it is not imperative that the student should learn to use the machines himself.

Surveying and levelling can be better taught after leaving the university, provided the student has been instructed in the construction, use and adjustment of the principal instruments which he will have at his command and the theoretical basis on which various types of surveys are founded.

As an illustration of the sort of training required it is much more important that the student should have been instructed in the general capabilities of different types of prime movers and their application under various circumstances than that he should be able to appreciate the intricacies and the niceties of a special valve-gear, however ingenious and interesting it may be.

So far as is known, there is no university or technical school curriculum which covers the ground suggested above, and if there were it would be quite impossible to do justice to it in two years without modifying the usual time-table. On the other hand, two years is as much time as should be allotted to the theoretical part of the training, provided that it is supplemented subsequently by evening work. The addition of a third year to the practical training would be, in my opinion, of far more value than a third year at the university, even if that year were properly utilized. Under the system advocated it is contended that as much useful information could be acquired in two years as is now obtained in three years. The system proposed is a radical change which would upset the whole holiday arrangements of existing universities. It is probable that the number of students would not justify the establishment of many civil engineering courses such as those outlined, but if three or four could be equipped at the Universities of, say, London, Birmingham, Manchester and Leeds, so that the students could share the corporate and social life of those universities, they would be more likely to succeed than would separate engineering schools such as the late Cooper's-hill establishment.

Articles Period

After taking the two years' university course, the student should be articled for a period of three years to a civil engineer in practice, who should be a corporate member of the Institution of Civil Engineers. The first two years of this period should be chiefly devoted to drawing-office work, interspersed with visits to works in progress and practical field work, with qualified assistants on surveys and levelling. Draughtsmanship is of the greatest importance and can best be acquired in an office. It is the groundwork of the designing part of the work, and is essential to the first step after completion of articles—*viz.*, that of obtaining a footing in an office as a paid assistant. The better a man can draw and express his own and other people's ideas on paper, the better the work the pupil will be entrusted with, and the more he is likely to come in touch with his principal. During his first two years the pupil should make himself familiar with all drawings and work going on in the office and should occupy his spare time in making tracings for himself of standard drawings. Such tracings are the best means of impressing on his memory the details of construction, and would form also a valuable fund of information for reference in future years. He should also accumulate a collection of reports, specifications, tenders and bills of quantities, and in the latter should fill in the prices from two or three actual tenders. The more of these he has the better, and the greater amount of labor he puts into them in copying and filling in prices the more complete his knowledge will be.

The third year should be devoted more to out-door work, and the pupil, who should now be able to make surveys or take levels, would be entrusted with this class of work. While a pupil, he should also be sent out for short periods as assistant to a resident engineer or clerk of works. This would enable him to acquire practical knowledge of the quality of materials and workmanship, setting out, measuring up, the management of men, methods of timbering excavations, dealing with water, lifting heavy weights, testing engines and machinery, and other details of actual construction.

During the whole of the three years he should in the winter months devote at least two nights per week to attendance at continuation classes, if possible at the university at which he took his two years' course, or, failing this, at some good technical institute or school. At the end of his third year (say at the age of twenty-two) the embryo engineer should be able to earn a salary sufficient to keep him. He will have his foot firmly placed upon the first rung of the ladder, and it will depend upon himself and the way in which he takes advantage of his opportunities how far and how fast he will go in his profession.

His final step in training will be to take the second part of his associate membership examination of the Institution of Civil Engineers at the age of twenty-three or twenty-four. This examination should, in the writer's opinion, be of a more practical character than the present examination and should be partly *viva-voce* and accompanied by tests in the use of surveying instruments, engine-indicator, etc., and an exhibition of drawnigs, made by the candidate, of works on which he has been engaged.

Specialization

Turning now to the more specialized subject of the training of water engineers, it is submitted that the school—and college—training previously described should be the course followed by those intending to take up water engineering, and the main point to be considered is the period in the training at which specialization should commence. The author suggests that it is most desirable that an intending water engineer should commence to specialize immediately after he has finished his university course. He should become articled to a member of the Institution of Civil Engineers who either holds a public appointment as engineer to a waterworks undertaking, or one who, if in consulting practice, is mainly engaged in the design and construction of works of water supply. Of the two, probably the best general result would be obtained if the intending engineer were articled to an engineer holding an official position as a waterworks engineer. This would give greater insight into distribution and management of waterworks, but should, if possible, be combined with constructional work of as varied a character as possible. On the other hand, the young man who is articled to an engineer in consulting practice would probably see a greater variety of work than one articled to an official engineer and would be more likely to eventually become a designing and constructive engineer rather than adopt an official position. The relative advantages of the two methods are probably about equal, and both can be recommended.

If, however, the young engineer does not article himself to a waterworks engineer he should at least become the pupil of some engineer who is engaged in works of a similar character, such as sewerage, land drainage, irrigation, canals or dock works. After serving his time he should in this case at once endeavor to obtain an appointment in the office of an engineer of a water undertaking, in order to familiarize himself with the routine work of a waterworks engineer's practice.

A Waterworks Diploma?

Connected with this subject is a further question of whether or not it is desirable that there should be a special qualification or diploma in waterworks engineering. In the writer's opinion it is desirable that such a diploma should be instituted, but it should in the first instance be looked upon as a purely voluntary test submitted to by the candidate of his own free will. It should be regarded as supplementary to, and not a substitute for, associate membership of the Institution of Civil Engineers. The case of medical officer of health may be taken as an analogy; thus, a medical man who intends to take up public health work, after obtaining his ordinary qualifications to practice in medicine and surgery, usually takes the D.P.H. qualification as a further indication that he is capable not only to act as a medical man, but is specially well qualified in public health matters. A diploma such as this has obvious advantages, one of the most important of which is that it gives the young engineer a definite goal to work for, and compels him to study more deeply than he otherwise would do the special subject in which he is interested.

If, as the result of this discussion, there is a general feeling in favor of a special diploma, it is suggested that this institution is the proper body to act as the examining authority and that it behoves the council to take steps to that end. If hereafter such a diploma became compulsory, the institution, being already in the field and equipped with suitable machinery for carrying out an examination, would most probably be accepted as the proper medium for continuing the examination and granting the statutory diplomas.

The following discussion took place after the presentation of the above paper:—

H. C. Head (Winchester) apologized for the unavoidable absence of H. C. Adams, the chairman of the Joint Committee on the Status of Water Engineers. He knew it was that gentleman's intention to be present if it were possible. He would like to say that the committee was absolutely at one with the views expressed by Mr. Silcock. At the last meeting of the committee, on May 22nd, the members had no inkling of what Mr. Silcock was going to say in his paper, but the minutes of that meeting contained the following item: "It was unanimously resolved to invite the council of the Institution of Water Engineers to consider the advisability of establishing a standard examination for water engineers on the lines already suggested for the final (practical) examination, but also including a *viva voce* test, the chairman accepting the committee's invitation to draft the terms of the letter." He (Mr. Head) believed that the institution had not yet received that letter, but, if so, it would receive a definite request in due course. He thought it was nothing short of cruelty to take a boy from a public school at seventeen or seventeen and a-half years of age and expect him to listen to lectures from 9 a.m. to 5.30 p.m. every day of the week and half-day on Saturdays. That excluded workshop practice and so-called practical work which was common in the technical colleges at the present moment, and which he (Mr. Head) regarded as valuable, not so much as teaching a boy, but as a means of giving him some mental relaxation. It was imperative that a boy who was going to live an outdoor life should be a good sportsman. What chance would a lad have of taking part in sports who was at work from 9 a.m. to 5.30 p.m.? His summer holiday was to be limited to four weeks, and in the sporting seasons he was only to have one week at a time. He was rather afraid that if they followed Mr. Silcock's advice they were going to overdo the poor boy. He was very glad that Mr. Silcock included *viva voce* examinations. If he might go a little outside the scope of the paper, he would like to say a word or two on the question of qualifications of engineers generally. The Institution of Civil Engineers seemed to have taken up the education and training of civil engineers fairly well up to a point. They had a school for studentship which was excellent, providing

(Continued on page 142)

COST OF THAWING WATER SERVICES WITH ELECTRICITY

At the recent convention of the American Water Works Association, considerable information regarding last winter's experiences with frozen water services was brought out in the discussions. The costs of electrically thawing services in several of the cities are shown in the following table:—

	Per service.	Remarks.
Paterson, N.J. ....$	8.20	Includes all expenses and overhead.
Madison, Wis.	10.00	Charge for thawing.
Kitchener, Ont. ...	2.00	Current 50c. per service.
Peterborough, Ont.	2-2.50	
Niagara Falls, Ont.	10.00	Charge by electric company.
Green Bay, Wis. ..	3.50-12	Electric Light Company charged $1.50 per hour for current and $3 per hour for man.
New Rochelle, N.Y.	15.00	Charge by electric light company.
Trenton, N.J.	7.50	Water Department.
Gary, Ind.	3.00	By city; electric light company charged $10.
Lawrence, Kan. ...	3.25	Current 10c. per hour; 1 man at 60c., 1 man at 35c. and 1 man at 25c.
St. Louis Co., Miss.	6.58	Current $1 per connection and 75c. per hour for man.
Minneapolis, Minn.	5.00	City outfit.

The Canadian Engineer

Established 1893

A Weekly Paper for Canadian 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

JAMES J. SALMOND, *President and General Manager* — *ALBERT E. JENNINGS*, *Assistant General Manager*

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1208 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr.

Principal Contents of this Issue

PAGE

THREE-YEAR TECHNICAL COURSES

ONE of the leading universities in the United States has announced, as a war measure, three-year courses in all branches of engineering in place of four years as heretofore, with a view to enabling students to earn a degree in the shorter time. To accomplish this properly will impose a large additional amount of work on the teaching staff and a considerable added cost to the university, but the student will gain one whole year of time in his life's work, and will save the cost of living expenses for one year without his being subjected to any really serious additional strain in his studies. By substituting three terms a year in place of two terms, and by shortening the summer vacation to one month, the university will be able to give to the student the same course in three years that is now given in four. The price of tuition for the three-year course will be the same as it was formerly for the four-year course.

Under the four-year course the university yearly had two terms of 17 weeks each, or 34 weeks in the year, which, in the four years, amounted to 136 weeks, of which two weeks yearly, or eight weeks in the course, were devoted to examinations, leaving 128 weeks for instruction. The president of the university declares that the full present course can be given in three years, without lessening the thoroughness of the different studies, by introducing three terms of 14 weeks each, devoted entirely to instruction. There would thus be 42 weeks of study to the year, or 126 for the course, only two less than are now included in the four years.

This change involves the elimination of the final examination periods. The examinations will be taken care of by tests throughout the term. The proposed plan allows of one week's vacation at Christmas and one week's vacation in the spring, with eight weeks in the summer, three or four weeks of which will be devoted to the required summer schools in the practical work of the technical courses, leaving the men from four to five weeks for rest and vacation.

"This is certainly an ample provision in this time of war strain," says the president of the university, "and perhaps at any time. Our faculty feel that by the elimination of one of the existing spring vacations, the fixing of vacations at the end of the first and second terms, and the concentration of student social functions into one week at Christmas and in the spring, we shall greatly benefit by continuous work, and with the two rest periods of one week each, with classes closing not later than three o'clock on Wednesday and Saturday afternoons, will give sufficient rest.

"It is believed that this change will appeal alike to students and parents. With the introduction of military training and the shortened course, a student can feel that he is preparing in the shortest time possible for efficient servce, and that in pursuing his studies to their completion, with the addition of military training, he is gaining his education and professional diploma, and also receiving the military training desired by the war department, and has a distinct status in national service."

McGill University, the University of Toronto and many other Canadian universities are still observing the four-year course of technical studies. Whether the new idea of crowding the four years' work into three years will appeal to the heads of the Canadian universities or not, the experiment is well worth watching. If successful, the idea will appeal strongly to those students who are ambitious to get into useful work so soon as possible, and also to those whose supply of funds is limited. While announced as a war-time measure, it will no doubt be retained as a permanent policy if it proves successful.

The conservation of a year during war-time, enabling the quicker training of engineers for use at the front should the war last long enough to need their services, is an important consideration. The Canadian universities might well follow the lead of this enterprising American university in the war-time experiment. It should not be difficult to revert to the four-year course if for any reason the three-year course be found impracticable.

RAILROAD EFFICIENCY

EASTERN Regional Director Smith, of the United States Railroad Administration, has reported to Director General McAdoo that the following measures for efficient operation have been adopted since January 1st:—

Elimination of 2,200,000 non-essential train miles.
Reassignment of 365 locomotives.
Transfer of power from one road to another.
Diversion of traffic to less congested routes.
Handling company fuel and material by direct routes.
Common use of terminal facilities.
Interchange of labor.

Urgent traffic moved first.

Classification of freight to prevent reswitching.

Co-ordination of harbor facilities at New York.

Institution of sailing days for less than carload lots.

Routing to tidewater via delivering line.

Diversion of traffic to roads with favorable grades.

Repairing in best situated shops.

Running locomotives over more than one road.

Moving coal and equipment through the Pennsylvania tubes.

Other minor measures are also noted and a final assurance is given that the outlook is favorable for transportation service. The government is securing the earnest co-operation of all of the railroad heads in solving the many problems, and no doubt the freight situation will be much improved within a few months, although a rather pessimistic professor of political economy whom the writer met recently in the United States, could not "see how the government is ever going to get out of the hopeless economic muddle into which it plunged when it took over the railroads."

PERSONALS

JOHN MORRICE ROGER FAIRBAIRN, who last month was appointed chief engineer of the C.P.R., was born June 30th, 1873, in Peterborough, Ont. He began his professional career in 1890 on Otonabee River surveys, and in the same year became a civil engineering student at the School of Practical Science, Toronto. During the summer of 1892 he was a leveller and topographer on the preliminary and local surveys for the Peterborough, Parry Sound and Sault Ste. Marie Railway, under the late W. A. Ramsay, chief engineer of construction for the C.P.R. In May of the following year he graduated in civil engineering and for the next two years was engaged on work for the Department of the Interior, the Department of Militia and Defense and the Department of Railways and Canals. In 1896 he had charge of the construction of the Lachine and St. Laurent lines of the Montreal Park and Island Railway Company. He then located in British Columbia, and in 1897-8 was engaged in mining work. On passing as a provincial land surveyor, he went into private practice at Greenwood, B.C. August, 1900, saw Mr. Fairbairn back with the C.P.R. as leveller on the grade reduction surveys between Winnipeg and Port Arthur. After a short period as engineer in charge of a section of the Simcoe-Balsam Lake division of the Trent Canal, Mr. Fairbairn was in 1901 appointed as an assistant engineer of the C.P.R. at Montreal. He subsequently occupied the following other positions with the railway: Resident engineer at Ottawa, 1902-4; division engineer, Ontario division, Toronto, 1905-7; division engineer, Eastern division, Montreal, 1907-8; principal assistant engineer, Montreal, 1908-10; engineer of maintenance of way, Montreal, 1910-11; assistant chief engineer, 1911-18; and now chief engineer. Mr. Fairbairn joined the Canadian Society of Civil Engineers as associate member in 1899, and became a full member in 1908. He is now vice-president of the Engineering Institute of Canada and is a member of the American Society of Civil Engineers and of the American Railroad Engineering Association.

Lieut. CYRIL HOUSTON, son of W. R. Houston, secretary of the Toronto Stock Exchange, is reported missing. After studying at the University of Toronto, Lieut. Houston went to France with the Royal Air Force. His elder brother, Allen, is with the 9th Canadian Engineers in France.

Lieut. MARVYN MORROW, grandson of the late Senator J. W. MacDonald, of Toronto, has been awarded the Military Cross for bravery. Lieut. Morrow is a graduate of McGill University and at the beginning of the war enlisted with the Canadian Engineers at Vancouver. He is at present serving with the 3rd Battalion, Railway Troops.

CHARLES HENRY RUST, who has been city engineer of Victoria, B.C., for the past six years, has resigned. Mr. Rust has accepted an appointment with a private corporation in Toronto. Before going to Victoria he was for many years the city engineer of Toronto. Mr. Rust was president of the Canadian Society of Civil Engineers for the year 1911, and was vice-president for 1901 and 1910. He was a charter member of the society and is very well known in civil engineering circles in this country.

CHARLES GARRETT, contractor, and A. E. DOUCET, civil engineer, of Quebec, have been appointed as temporary advisors to the administrative commissioners of Montreal. After severing connections with the Sudbury Dynamite Works and the Hamilton Powder Co., Mr. Garrett was engaged for some time on railway construction in West Africa and later in Canada. Mr. Doucet until recently held the position of district engineer of the Transcontinental Railway and chief engineer of the Lake St. John Railway.

THE TRAINING OF ENGINEERS

(Continued from page 140)

students' meetings where the members were encouraged to know one another. That culminated in examination for associate membership which each student hoped to pass, but when he had passed, the institution took no further interest in him whatever. The man was turned out and was told that he was qualified as a junior in the profession, but there was no definite help in order to secure his becoming a senior. He had got to obtain any further experience at the expense of clients or employers, and it was not until the man had learned his profession at somebody else's expense that the institution was prepared to take him up again and recognize him as a fully qualified member of the profession. One did feel that if possible there should be some means for carrying on the education and training of the junior engineer who had qualified as an associate member, so that he might come forward at a later date, with the assistance and knowledge of the governing body of some recognized professional organization—either the Institution of Civil Engineers or one of the sectional institutions dealing with special branches, like their own institution, for election as a full member of the institution.

(Concluded in the next issue.)