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The Canadian Engineer

ESTABLISHED 1893.

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MEDICAL ATTENDANCE IN CONSTRUCTION CAMPS.

Reports from certain sections along the G.T.P. indicate the existence of an epidemic of typhoid fever. Every autumn the disease is more or less prevalent among the men in railway camps or other large construction works.

The outbreak of any infectious or contageous disease in out-of-way places brings into the limelight the antiquated methods too frequently adopted by short-sighted contractors in dealing with men in times of sickness. The law allows the contractor to deduct from the men's pay a limited fee, for which in return he must provide medical attendance, etc. Some contractors do better for their men than the law requires, but frequently it would be better for the men and more satisfactory to the contractor if the medical attendants on railway construction work, in lumber camps and large public works were under the control of the Provincial Board of Health. Every doctor on such work would then become an officer of the Board of Health. A regular inspection by such an official would reveal conditions—conditions that could be much improved with very little expense, and sickness would be prevented, the spread of disease checked, and the men would take more kindly to those engaged as camp doctors.

As it is now, men have a horror of the "contract doctor's" hospital. No matter what is done, they look upon it as a money-making scheme, and when they take sick they make every effort to reach civilization rather than go to the hospital provided, and frequently, when they reach the outside world, they are a hopeless case, as far as the doctor is concerned.

With the same fee collected and returned to the Provincial Board of Health a complete central organization would be established, better doctors could be provided, more precautionary measures taken, and the men would be better satisfied.

THE GEORGIAN BAY SHIP CANAL.

Recently the interim report on the Georgian Bay Ship Canal has been printed and distributed, and, although many summaries of this report have appeared, yet we think the subject of sufficient importance to deal with at some length, in view of the fact that the Premier of Canada mentioned it as Canada's new great public work.

The projected waterway is designed for vessels 600 feet long, 60 foot beam, and a draft of 20 feet. This would necessitate a waterway at least 22 feet deep and canal locks 65 feet by 650 feet.

The route surveyed is some 440 miles long, of which from 410 to 420 miles follows the course of rivers and lakes, leaving about 28 miles for cut canal. Leaving the Georgian Bay, the route follows the French and Pickerel Rivers and enters Lake Nipissing. From Lake Nipissing a cut three-quarters of a mile long is made into Trout Lake, thence into Turtle Lake, the Little Mattawan River and Talon Lake, and from Talon Lake a canal is cut into the Mattawan River, which is utilized until the Ottawa is reached, which river is used to Two Mountain Lake, and from there to Montreal.

Leaving out the question of cost of construction, the next great consideration is time of transit. The canal, if built, will be constructed with the view of shortening the water route between Lake Superior ports and the ocean, and, unless it can cut some time off the present route, it will not be considered as a national highway. Compared with the present water route from Lake Superior to Montreal, this canal would only at best cut one and a half days off the present time, but should the St. Lawrence and Great Lakes canal system be enlarged to a 22-foot canal and the number of locks reduced, just as good time could be made by this system, and no practical benefit in time would be secured. At a probable cost of $100,000,000, it is doubtful if the Georgian Bay Canal will be built. One-half that amount would complete the St. Lawrence system as a 22-foot canal, and this system would serve a large water front.

In the development of water power the canal would be a large factor. Under present conditions some 150,000 horse-power might be developed along the route. This may be increased to 1,000,000 horse-power by improved methods.

The construction would likely take ten years, involving an expenditure of some $10,000,000 annually. In a summary of quantities to be moved we find the submarine rock excavation placed at over 8,250,000 cubic yards, and estimated at $3.50 per cubic yard. The dry rock excavation is placed at 18,500,000, and estimated at $1.25 per cubic yard. The next large item of cost is concrete, over 1,750,000 cubic yards, estimated at $7.50 per cubic yard. Some of the other estimated prices are of interest, as second class concrete, $4.50; granite masonry, $50; rock-fill behind cribwork, 50 cents.

The Georgian Bay Canal completed in less than twenty years is not an impossibility. It is a greater possibility to-day than the G.T.P. was six years ago. It would be a more daring venture. The G.T.P. has every indication of being a successful commercial venture from the opening of the road. The Georgian Bay Canal would be for many years a charge on the country's exchequer. As a commercial venture it would be a doubtful undertaking; as the plaything of a nation builder it is a possibility.

THE CURRICULUM OF THE ENGINEERING COLLEGE.

For over a month the student at the engineering college has been attending lectures. To the freshmen the various courses appear fearfully and wonderfully made. It is all a strange combination, this calculus and geology, dynamics and chemistry, algebra and surveying, drawing and statics. The relation of these subjects to a course in engineering is hard for him to recognize, the absence of instruction in English literature he cannot understand.

To a man in the final year the irregularities of the combinations of courses of instruction in the Faculties of Applied Science of Canadian Universities are real, and are an evidence that frequently college courses are arranged to suit the whims of university professors rather than the requirements of the engineer.

The curriculum of our engineering colleges should be framed and modified to prepare the graduate for his professional work. Subjects that may be termed culture studies, and purely academic, should not be included in such courses. The increasing professional demands upon the engineer in all fields of work require a corresponding broadening in the engineer's training, and necessitates many modifications in his college course. The technical qualifications required have extended, and the professional man to-day must meet demands not exacted a generation ago. But aside from his professional work the engineer becomes affiliated with work requiring administrative ability, and he frequently finds himself engaged in such work requiring a more liberal education than usually afforded by engineering colleges. This training he should receive before entering upon his course in engineering. No attempt should be made to crowd such work in a four years' course. Twenty years and more ago a four years' course was adopted, and, although the subjects first taught have been amplified and new subjects introduced, the period of college training remains the same. Both instructor and student realize the impossibility of doing good work under such conditions. Either the engineering college course must be lengthened or a much higher standard of entrance must be required.

CANADIAN NORTHERN RAILWAY.

The report of the Canadian Northern Railway for the year ended June 30th, 1908, deals with larger figures than the previous one. In a year, which has witnessed heavy depression in all branches of industry, the company has been able to earn bigger earnings, both gross and net, than ever before in its history. This was the first complete year that the company operated the Qu'Appelle, Long Lake and Saskatchewan Railway, between Regina and Prince Albert. Part of the increased receipts was doubtless due to that fact, but reports from the system generally show a steady and progressive advancement.

The following table compares the principal figures for the two years:

	1907	1908	Per cent. inc.
Miles	2,509	2,850	13
Gross	$8,350,198	$9,709,463	16.28
Per mile	3,328	3,388	1.8
Maintenance of way and steel	$1,260,960	$1,486,030	17
Maintenance of equipment	1,033,369	1,330,067	28
Traffic expenses	90,787	120,284	32.6
Transportation	2,820,782	3,486,639	23.6
General expenses	218,266	253,756	16
Total expenses	$5,424,164	$6,676,776	23
Ratio to gross	73.49	74.10	

	1907	1908	Per cent. inc.
Net	$2,926,034	$3,032,687	3.64
Per mile	1,166	1,058	– 9
Fixed charges	$1,882,489	$2,353,757	25
Surplus	1,043,545	678,929	–34

It will be observed that the increases in gross earnings generally proportionately exceed the increased mileage operated. Perhaps the most striking feature of the improvement is the gain from passenger receipts, being $381,831, or 26 per cent.

	1907	1908
Passenger	$1,464,258	$1,846,087
Freight	5,941,729	6,824,722
Mails	58,231	72,919
Express	85,124	107,266
Miscellaneous	1,000,856	858,407

Heavier expenditure in bringing up the standard of the roadbed and track and enlarging station accommodation, freight sheds, sidings, and other necessary facilities to meet the increasing demands of traffic account for the increase in working expenses. The shops and yards at Fort Rouge at Winnipeg, involving an outlay of a million dollars, are in part completed and have already proved of benefit. The new engines houses at Brandon, Dauphin and Saskatoon have been completed. The Fort Garry station, Winnipeg, it is hoped, will be completed in about eighteen months. This will be the property of the company, with the Transcontinental and Grand Trunk Pacific as tenants.

SOME COMMON MISTAKES IN THE CONSTRUCTION AND MAINTENANCE OF WATER SYSTEM.

W. C. Yorston, C.E.

In attempting a paper of this kind the writer does not wish to be understood as making a criticism of existing water systems. During an experience of some years in municipal work in the Province of Nova Scotia, one could hardly fail to notice some defects in the construction and maintenance of the water supply systems of the different towns, and it is more with an idea of bringing these deficiencies to the notice of the members of the Nova Scotia Society, in order that conditions may be gradually bettered, than a critical arraignment of the civic fathers of the different towns. My experience has been that in making provision for water supply and fire protection our civic authorities are imbued only with the very best intentions. The unfortunate thing is that their knowledge of engineering matters is not large enough to permit of their appreciating the best points of an engineering problem, and the result is that the point which has the greatest weight is the cheapness of first cost of anything, and all other considerations are apt to be lost sight of when there are dollars in question. The ordinary town council is quite satisfied when it is demonstrated that water is delivered in the streets of their town under good pressure, and they do not stop to reflect that they may want at some time a **very large quantity under good pressure,** and usually it is only when some entirely unforeseen occurrence happens, such as a large fire in the business district, that they are forced to the conclusion that the water service is not all that is desirable and necessary. I think that one of the most pitiable occurrences that one can imagine is to see a heavy fire well started in a row of wooden buildings, and a company of firemen around it almost helpless because of insufficient water supply to quench the fire with. At first thought one would say that this was almost impossible in any of our Nova Scotia towns, and yet practically this very thing has happened in two of our towns within the memory of all of us.

The question of adequate fire protection, too, I consider has not been dealt with altogether justly by the fire insurance companies, in that they have rated the efficiency of fire systems on the basis of the ordinary fire, instead of insisting on a demonstration of their efficiency for conflagrations, which, after all, is the real test for usefulness.

I do not intend either to criticize the manufacturers of waterworks goods for providing goods of light and cheap grades. After all, a manufacturing concern will provide just the goods most in demand by their customers. As a rule, they make light, medium and heavy goods of all kinds. It is only human nature, when goods are put up to tender, for any firm to want to quote as low a figure as possible, and to do this they often make a grade which they are fully aware is light for the service demanded of it; and if the purchaser is not as wideawake as he should be, he is only too apt to select the material he requires, judging it solely by its cheapness in price.

I purpose discussing briefly the different parts of a water system, and pointing out the usual mistakes made in construction.

Main Pipe Line.—Perhaps the most common error in the construction of water systems is the size of the main pipe line. This is usually the most expensive part of the system, as the pipe must often be of large size, and the temptation to use the smallest size possible is, therefore, correspondingly great. What I want to emphasize is that we do not look far enough ahead and provide pipe capacity enough, both for increased domestic consumption and ample fire protection. The tendency is to plan our water systems as regards fire pressure for the ordinary fire, while it is the **extraordinary** fire which ought to be considered. The size of the main pipe is really governed by the amount of water to be delivered for fire purposes, since the domestic consumption is small in comparison. Every small town of 1,500 to 2,000 inhabitants has some few blocks where the buildings are situated close together, and, as in all our small towns practically all the structures are of wood, there is almost as much danger of a conflagration as in a place many times as populous, since in the larger towns and cities brick structures are much more numerous.

* Read before the Nova Scotia Society of Engineers.

The writer can recall at least three occasions on which he has seen eight fire streams used on a single burning building, and I think it would, therefore, be safe to assume that at least that number would be required in every town. Now, a good fire stream requires a pressure at the nozzle of 40 pounds, and, with hydrants as usually placed in our maritime towns, the streams on the average would be passed through 300 feet of hose. None of our departments would use less than one-inch nozzle for each of these streams, and to maintain a nozzle pressure of 40 pounds, while using 300 feet of hose, would require a hydrant pressure of 66 pounds, when best quality rubber-lined hose is used, and the amount of water used by each stream would be 160 imperial gallons per minute.

The total water used with eight fire streams would, therefore, be $160 \times 8 = 1{,}280$ gallons per minute. As the main in addition must be capable of keeping up the domestic consumption, they should be able to furnish a further amount of, say, 220 gallons per minute, thus making the total required capacity of the main 1,500 gallons per minute.

A 10-inch main supplying 1,500 gallons per minute would lose, in friction, 22 feet head per 1,000 feet of its length.

A 12-inch main supplying 1,500 gallons per minute would lose in friction 9 feet head per 1,000 feet of its length.

A 16-inch main supplying 1,500 gallons per minute would lose in friction 2 feet head per 1,000 feet of its length.

To put this in a little more comprehensive form, let us suppose that the main pipe line is exactly one mile in length, and that the conditions are as outlined above, namely, that the pipe is to deliver 1,500 gallons per minute and at the same time maintain a hydrant pressure of 66 pounds.

A 10-inch main, one mile long, would require a static head of 268.6 feet, equal to 116.3 pounds static pressure.

A 12-inch main, one mile long, would require a static head of 200 feet, equal to 86.6 pounds static pressure.

A 16-inch main, one mile long, would require a static head of 163 feet, equal to 70.6 pounds static pressure.

Eighty pounds per square inch is considered the best hydrant pressure for general use, and should not be exceeded very largely on account of the difficulty of managing fire hose under such heavy pressure and the danger of rupturing the mains by shutting off the water too quickly.

As very few of our towns have a less length of main than one mile, it can easily be seen that the main less than 12 inches is not large enough to give sufficient fire protection. It must be borne in mind that there is a further friction loss in the distribution mains, which cuts down the pressure considerably; and also, it must not be forgotten that the above calculations are for clean, smooth pipes, and that in actual practice after a few years' use the mains will not deliver anything like the above amounts. Discharging capacities of cast-iron pipes as usually tabulated are based on formulæ derived from experiments, in which the conditions, particularly as regard the smoothness of the inside of the barrel of the pipe, are much superior to those attained in average practice. The interior surface of cast-iron pipe, after a few years' use, becomes much rougher in character, due to the corroding and incrusting action of the water, and this tends to greatly impede the flow of water through the pipes. Hence, the necessity of selecting diameters of pipes capable of delivering quantities much in excess of apparent actual need.

As the pipe increases in size the discharging capacity increases very much more rapidly than the cost of installation, because the area of the circle increases "as the square," while the ring of metal constituting the pipe increases only in direct proportion to the increase of diameter. In a growing community, where the demand on the water supply is larger every year, such increased cost, compared with the subsequent trouble and expense, and often positive danger of a deficient water supply, is very small. Thus, a 10-inch pipe costs but 26 per cent. more than an 8-inch pipe, while its discharging capacity is increased 75 per cent. A 12-inch pipe costs but 23 per cent. more than a 10-inch pipe, while its discharging capacity is 58 per cent. greater. A 16-inch pipe costs but 41 per cent. more than a 12-inch pipe. while its discharging capacity is 105 per cent. greater.

In making the above calculations of the amount of water used for fire streams, I have taken the amount of water delivered through a 1-inch nozzle, as this is the smallest size that can be used for an effective fire stream. For a very heavy fire a larger nozzle than 1-inch would be more effective, and I think most fire departments are equipped with several nozzles of large size.

Distribution Mains.—My remarks as to the main pipe line apply also to the distribution pipes through the streets, in that they are apt to be built of too small pipe. Four and 6-inch pipe cut down the pressure very quickly when passing a large quantity of water. Take for example, the amount of water required for two fire streams at 160 gallons per minute each, equal to 320 gallons per minute, and suppose it to be passed through a 4-inch pipe. The loss of head from friction in the pipe will amount to 110 feet head per 1,000 feet in length. Under the same conditions a 6-inch pipe would lose from friction 20 feet per 1,000 feet of length. Considering the enormous friction loss in 4-inch pipe, it must be apparent that for fire purposes a 4-inch main is entirely too small, and that its use should be confined to large services. **It should never be used as a part of the distribution system.** As illustrating how quickly cast-iron pipe deteriorates, the writer was shown some years ago a section of 4-inch pipe, cut out in installing a hydrant branch. This pipe had been laid about fourteen years previously. It was manufactured by R. D. Wood & Co., of Philadelphia, and was as good a specimen of pipe originally, as regards both metal and coating, as the writer had even seen. When this pipe was cut out and examined carefully, it was found to have only 65 per cent. of its original area. All water mains can, of course, be cleared of incrustations by scraping, which increased their capacity by enlarging the orifice again. This process is, however, expensive, and in the majority of our Nova Scotia towns has not been resorted to so far. The only difference in cost between 6 and 4-inch mains is in the cost of the pipe, since the cost of excavating and laying both sizes is practically the same. As illustrating the advantages of using 6-inch instead of 4-inch, I may say that a 6-inch pipe costs only 46 per cent. more than a 4-inch, while the capacity is 176 per cent. greater than that of a 4-inch.

Cast-iron Pipes.—Cast-iron pipes are often made needlessly heavy. The writer believes in heavy weight pipe, but thinks at the same time that manufacturers take advantage of the customer and send too much overweight. A 5 per cent. variation in weight, up and down, is quite sufficient, and the manufacturers should be quite content with that amount of leeway.

There is no valid reason why any town requiring cast-iron pipe for use in its water system should have to accept pipe 10 per cent. and over in weight, and pay for the excess in metal, when the proper amount of material would give equally good results, and yet our different towns are buying pipe in carload lots, and almost invariably do this very thing. The coating of pipes properly is very important, and the manufacturers are apt to shirk unless closely looked after. All foundries use a tar bath for coating pipes, although the composition varies greatly. Very often the crude tar as it comes from the gas works is used, and the lighter products of distillation are driven off, either by the heating of the tar in the dipping-tank or by the heat of the pipe itself. The temperature of the material in the bath, and that of the pipe itself, are the important things; if both these are right, the coating will be good. The tar coating in the bath will not dry if applied to a cold pipe, and if the pipe is too hot when it is dipped the distillation has been carried too far, and the coating is brittle.

This coating of the pipes does not seem to be done with enough care, and the matter is so vital to the life of the pipe that it should be looked to carefully. It is usual for pipe specifications to contain a clause requiring good coating of the pipes, but as far as the writer's knowledge goes it is never rigidly enforced, and the result is that pipe are used in many systems that should not properly be put in.

Special Castings.—These are usually made by the local foundry, and are paid for by the pound. The result is that there is a great temptation to put in as much metal as possible, and it is not uncommon to find these castings 40 per cent. over weight. In all specials the branches and changes of direction should be made with easy curves, so as to lessen the friction of the water. A great many patterns for special castings are not of ideal design as regards the shape of the waterway, and almost universally the thickness of them is such as to make the casting needlessly heavy. The unfortunate thing is that any extra metal put in a pipe casting must be put on the outside, since the inside diameter cannot be interfered with, and the extra thickness often causes trouble. How many water superintendents are there who can vividly remember attempting to get a special casting into the bell end of a pipe of standard dimensions, only to find at the last moment that the extra metal put in at the foundry prevented its entering unless the end of the special was first chipped off with a cold chisel to make it fit.

Besides the useless metal usually paid for in special castings, there is another defect that is almost universal, namely, the protective coating applied to them. Usually special castings are made in such small quantities that the expense of fitting up properly for coating the specials is prohibitive, and the result is that a make-shift bath is prepared with which it is wholly impossible to apply a proper, tough coating. In some cases even, instead of dipping the heated casting in a prepared bath of proper temperature, the makers attempt to apply the coating with a brush, with the result that nothing is accomplished in the way of protecting the pipe.

A mistake is often made of having specials cast of unusual pattern so as to fit particular cases. This is particularly true of "Y" branches, and it would seem to be unnecessary, as all cases can be met with standard branches and sixteenth bends, and the cost of such special patterns saved to the town.

Hydrants.—As regards fire protection, these are, of course, of very vital importance. They must always be in order and ready for instant use, and, since such onerous duties are imposed on these parts of the system, great care should be taken with their manufacture and maintenance. My belief is that we do not bestow enough care on the selection and maintenance of fire hydrants, and not nearly as much as their importance demands. In the hurry and excitement of a fire, hydrants are very apt to receive rough usage, and to withstand this they require to be made very strong and heavy; spindles and packing nuts especially should have ample strength to withstand abuse. They should have large valve opening and good sized barrel, and easy curves at the bottom and at nozzles, to prevent loss of head by friction. They should drain quickly, and the drip should be completely closed while water is being drawn from the nozzles. The drip orifice should be of good size and bushed with composition, and each hydrant should be drained so as to take off the water escaping from the barrel of the hydrant when the drip is opened. The brass hydrant nozzles should preferably be screwed into the post of the hydrant, instead of being leaded in as at present, and if there could be a coarser thread adopted for the hose coupling, I am of opinion that it would be a great improvement, as I see no reason why the firemen should be obliged to take four or five turns to couple hose when one and a half turns of a coarser thread would be quite as good and amply strong.

The design of the hydrant post does not necessarily affect its efficiency, nor yet would a more artistic design add very materially to the cost of the hydrant. On the whole, I think a better designed post would add materially to the appearance of the streets, and that the improved appearance would be well worth the small extra cost.

Valves.—Like other waterworks goods, valves are made good and bad, light and heavy. It is always poor policy to buy these goods solely because they are cheap. Hardly any of our systems have enough gate valves, and in most towns, too, one can find both right and left-hand valves, valves with babbitt seats, and others with composition seats. As in the case with other parts of the water system, they are liable at times to get rough handling, and they must be heavy to withstand the rough usage; in particular the valve spindle and packing nuts should be heavy and the composition valve seats perfectly true, and preferably screwed in.

Valve boxes for main valves should be good and strong, and the cover in particular should be heavy, and at the same time capable of being easily removed.

Services.—In nothing, perhaps, is there more difference of opinion than with regard to the material to be used for services. Galvanized iron services are, perhaps, the most common in use, and in the writer's opinion they are the poorest of any, the only quality which recommends them is the extremely low first cost, a quality which seems to appeal unfailingly to the average councilman. The average life of a ¾-inch galvanized pipe is about twelve years, and after that length of time in use they will be found practically filled with rust and mud. The weak points are, of course, the ends where pipes are joined, as there is no protective coating at these places to prevent the water attacking the iron.

The writer's preference is for heavy lead service, as this kind has good lasting qualities and gives good satisfaction wherever used. Unfortunately, lead service cannot be used in all places, as some waters attack the lead, and thus render their use dangerous. However, it does not often happen that a water of this kind is used for domestic consumption, and in case of any suspicion an analysis of the water by a capable chemist will determine beyond doubt whether lead services can safely be used or not.

Various other services are sometimes used, such as cement-lined, lead-lined, block tin-lined, enamelled, etc., all of which have their special advocate, but the average superintendent would do well to satisfy himself thoroughly before adopting any kind of patented service pipe for general use.

Cocks should be used both at the main and the sidewalk, and this is often not done, one cock either at the main or the sidewalk being made to do duty for both. However, I think the advantage gained in case of accident to the service in having a cock next the main will well repay any town for the extra expenditure, and the convenience of having a cock in the sidewalk will be appreciated by any superintendent who has much turning off and on to do. The cocks should be of heavy pattern and good finish.

Service boxes should be fitted tight to the cocks so as to prevent mud entering the box and filling over the top of the cock. A simple telescope pattern is best, and the top should be fitted with a neat and strong cap, held on by a brass bolt.

General.—Water pipes can be laid on as crooked a cow-path as ever existed, provided the supply of short pipe and sleeves is ample. It is bad practice nevertheless, for it is hard to keep any record of such pipes, and nothing is more exasperating than to lose track of the location of any part of the system of pipes.

Not enough attention is paid to the location of distribution mains in the streets. They should be a uniform definite distance from the boundary of the street, and the valves should be installed in some position capable of being easily found.

Where at all possible, water pipes should be laid to grade. By doing this, air pockets are avoided and the flow in the pipe is better. This applies to the distribution pipes as well as the main pipe line. As a usual thing not enough air cocks are used; every summit should be fitted with an air vent, and they should be automatic in their action. Enough blow-off pipes should be installed to completely empty the pipe lines, and in the distribution system it is a decided advantage to have blow-off branches placed so as to scour the pipes and clean out all mud and sediment thoroughly.

Maintenance.—Records.—I have before spoken of the necessity of laying all water mains on definite lines, so that their location may be known exactly. It is even of more importance that the location of all valves should be known beyond a shadow of a doubt, as they may be wanted in a hurry, and it is most exasperating to require to use a valve and find that its location is uncertain. This, of course, applies to all cocks on service, and, in fact, to any part of the system which is underground.

When a water system is first installed it seems a simple matter to keep a record in a blank book of each valve and fixture as it is installed, but after a time, when the number of services increases, this method is apt to become cumbersom, and soon the book becomes intelligible only to the one who made it. Now, I do not want to reflect at all on the correctness of the records, for I know full well that all good superintendents take a pride in having as accurate information regarding their system as can be obtained, but I do think that each town should have records that can be readily understood by any person, whether he is very familiar or not with the system. There are several methods of keeping records that are good, but the writer's preference is for the card system, in that it is, perhaps, more flexible than any other, and permits of the records being arranged in any one half dozen ways. As regards the records of service branches, there would be a card for each premises connected, and on it a diagram showing the relative position of the water main and the building, with measurements taken to locate the cocks. It is most convenient generally to file these cards by "streets," and when arranged in this way it takes but a moment to find any card required. These card records should be kept in the vault, where they cannot be lost by fire, and as each service is added the superintendent has only to make out the proper card and put it in its proper place in the box. Thus a duplicate set of records is really kept, for the superintendent has his book of notes, taken on the ground, and besides there is a complete record filed in a safe place, which are intelligible to anyone looking them up. Records of main valves can be kept in much the same way.

Water Charges.—In writing this paper I have no intention of discussing the means of raising revenue, and yet, perhaps, it can well be given a passing notice. Of course, it cannot be expected that all towns can have the same water rates, since the charges must be dependent in large measure on the cost of installation of the system, and also on the cost of maintenance. It is apparent that a town which has to go many miles for its water supply must charge more to its citizens than another town which has a supply almost within its limits, and also a place which gets its water by gravity can afford to charge less than any other town which is compelled to pump its supply, and consequently has large maintenance charges.

One can find flaws in any method of assessing all kinds of rates and taxes, but a person who studies the water rates of the Nova Scotia towns must be struck with the great variance of the charges and the ingenuity displayed in trying to overcome the defects of flat rates. The majority of the Nova Scotia towns make a fixed schedule of prices for all classes of buildings, without regard to the quantity of water consumed; others, again, base the rates on the assessment of the property and add a schedule for extra fixtures, while still another group try to overcome some defects in the first two methods by making a sliding scale of charges, dependent on the number of rooms and the number of inmates. Again, some places assess a fire rate, while the majority do not do so. Since the first result of installation of a water system anywhere is to reduce the fire insurance premiums, it would seem only fair to charge a fire rate on all properties on streets in which water mains are laid, thus reducing considerably the amount to be charged for water for domestic consumption. The fair way to charge for water is to have the payments in direct proportion to the amount consumed, and this can only be done by using meters on the services. I do not intend to discuss the question of meters further than to say that, in my opinion, the cost of meters should be provided for in the estimates for the system, as my experience shows that flat rates are conducive to the grossest waste. The act of installation of a water system makes water an article of merchandise, and it should be disposed of in a business way.

Care of Hydrants and Fixtures.—I do not know that the care of hydrants needs to be enlarged upon, as these are generally well looked after. They need the greatest care in winter time to prevent their freezing, but if a hydrant is well drained the trouble is much lessened, and the superintendent who is fortunate enough to have no ground water near his hydrants can rest easy, for his cares are light.

One of the greatest bugbears of a water superintendent is the watering-cart man, for, after the hydrants have been used for a while to fill watering-carts, the hydrants are apt to be found out of order. Of course, if the town can afford the expense, it is nice to have special watering-carts, the hydrants are not molested, but since most small towns cannot afford to have two sets of hydrants, the remedy seems to be to make the fire hydrants so strong that they cannot be broken, however roughly they may be used.

All blow-off valves should be operated frequently enough to prevent any sediment being deposited in the mains, and packing on all valves should be examined at intervals to make sure it is tight.

Motors.—Some towns have flat rates for motors, and generally the flat rate charges for this service are ridiculously low. As water systems are not installed for power purposes, it would be better not to allow motors to be attached to the mains, and, if they are allowed, the supply should be furnished through a meter at meter rates.

I feel bound to admit that much of this paper is old ground for many in our society, and yet I feel constrained to emphasize some of these points in order that we as engineers, who are best fitted by training and experience, may be sufficiently impressed by the importance of some of these points to urge us to make an honest endeavor to have water supply conditions made as good as possible. A layman is too apt to confound the maximum delivery of a pipe with its capacity for fire purposes, neglecting the fact that water for fire purposes must be delivered **under pressure** to be of any use. Almost any one of our local towns can make a good showing when one, two, or even three streams are used at a time, and they will point with pride to the height to which water can be thrown. If, however, instead of one or two streams, a total of six or eight streams are used simultaneously, the result is far different from the first, and the extra stream added will have cut down the pressure so far that the streams are not effective, and it may even happen that a less number of streams would throw more water on the fire, and the streams themselves would be so much better that much more might be accomplished by the smaller number than by the larger. A fire is never put out by playing into the flames; it is only put out by cooling off the burning coals themselves, and when the water from a small stream falls in the condition of fine spray, it is evaporated and turned into steam before reaching the fire, while with a good stream the spray is less, and a sufficient volume of water reaches the burning coals themselves to cool them off.

It is very hard to get the average citizen of any town to fully appreciate the value of the fire protection system as a usual thing. He either does not, or is not able to discriminate between good and bad fire streams, and commonly he is quite content if the local fire department are able to make a good showing with two or three fire streams, using small nozzles. He will be reluctant to credit the water system with the saving effected in insurance. He will investigate carefully the financial standing of insurance companies, and pay cheerfully the amount demanded by them for insuring his property, but at the same time will be quite ready to accept almost anything in the way of evidence of fire protection, and as long as hydrants are in sight and reasonably near his property will feel quite secure.

In getting up the data contained in this paper regarding fire streams I have made free use of a paper by John R. Freeman, read before the New England Waterworks Association in 1890. This paper, the title of which is, "Some New Experiments and Practical Tables relating to Fire Streams," is a most valuable addition to engineering literature on the subject of hydraulics.

WHY INDEPENDENT TELEPHONE COMPANIES HAVE BEEN A FAILURE.*

. . . The whole history of the independent telephone movement demonstrates that the very great majority of independent companies have been furnishing service at rates much too low to make the business continuously profitable, and at the same time provide for future growth and replacement. Indeed, it can be positively stated that every attempt to cut telephone rates to a lower figure than that justified by the experience of companies having outlived the reconstruction period has ended or must end disastrously.

Not only have the rates been too low to pay fair returns on the actual money invested, but too often the companies have been financed in a manner that from the start precluded the possibility of profitable operation. Fortunes have been made in the building of competing telephone plants, and fortunes have been lost in operating them.

In considering the organization of a new telephone company, one must never lose sight of the fact that the construction, maintenance and operation are so linked together as to be inseparable, and an honest telephone company must be all these three things in one. The construction of a telephone plant is never complete. Every new subscriber entails fresh construction. The plant must be maintained and cared for out of the money received for services rendered by the operating department. The three departments are interwoven and interdependent, and must stand or fall together.

But one of the reasons which have brought about so many failures of independent telephone companies is that promoters have found that the best way to get quick returns is to make a profit on the construction of the plant, and they certainly deserve great credit for the clever manner in which they secure their end.

An application is made to the city council for a franchise, which the investing public generally regards as something of great value, but which after all is merely the permission to do business. The rates proposed to be charged, always lower than the prevailing charges, are limited in the franchise, and the promoters claim that under them they will be able to make liberal profits.

Sometimes the plant is good; sometimes bad. To the public it always looks good because it is new. Operators are keyed up to "top notch," and not infrequently the new concern gives extraordinarily fine service from the start. The public is called upon to witness that the promoters have made good and kept all their promises.

But as soon as the construction company has unloaded its securities and taken its profits, the service begins to fall off and the profits begin to dwindle. If the number of subscribers increases at all rapidly, rates have to be raised, but it is rarely that more than the operating expenses can be met. By the fifth year the reconstruction period has arrived, and the holders of the securities realize that the so-called profits of preceding years were not profits at all, but should have been spent on maintenance or put aside for reconstruction. Besides, no depreciation fund has been formed, and one of three things is bound to happen. The property goes to the bondholders, or preferred stock is issued, or a receiver is appointed. Within ten years every cent invested by local capitalists has been lost, and the plant has either been lost also, or enough new capital has been invested to double the original cost.

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* From the report of Henry Noble Hall, employed by the New Orleans Board of Trade.

THE DESIGN OF CANAL DIVERSION WEIRS ON A SAND FOUNDATION.

W. G. Bligh, M. Inst. C.E.

(Continued from last week.)

Before leaving the subject of the particular type of weir under discussion, viz., the direct overfall (which will subsequently be designated as type B), we will give the section of the Narora weir (Fig. 5), which is a most instructive example of how a weir should not be designed.

As originally built the rear apron extended for only 30 feet behind the drop wall, and the impervious apron continued for 42 feet beyond the very deep fore curtain which terminated the masonry floor. The length of l, or of the effective base line, is the total horizontal length plus the contour of the vertical depressions. In this case the horizontal length of impervious base is 123 feet, to this must be added 10 feet vertical depth at the weir wall, 17 feet down one side of the fore curtain and 18 feet up the other, total 168 feet. This is the distance measured along the line of the floor surface to the point B, from a vertical drawn through A at the termination of the impervious rear apron. The line AB drawn from the summit level at A is then the actual hydraulic gradient of the water pressure and has an inclination of 168÷13=1 in 13. Now from B, the vertical lengths, which, as we have seen are 10, 17, and 18 feet, respectively, are measured back in reverse order, and lines drawn from the points thus obtained parallel to BA, up to their several positions on the section, will give the outline of the trapezium of pressures. Thus the line AB runs from A as far as C where the vertical depressions aggregating 10 feet are situated. A vertical step there occurs which is equal to the loss of head occasioned by the length 10 feet, i.e., 10÷13 feet. The second slope is intercepted at D, where another step takes place at the commencement of the vertical curtain. This last is formed by the intersection of a gradient line drawn from the end of the 17 feet measured back from B. Similarly at the further side of the curtain wall another step takes place down to the interception of a third gradient line. This point must correspond with the termination of the impervious floor. The space enclosed between the horizontal floor surface and the stepped slope will now correctly represent the hydrostatic pressure area on the floor of the work.

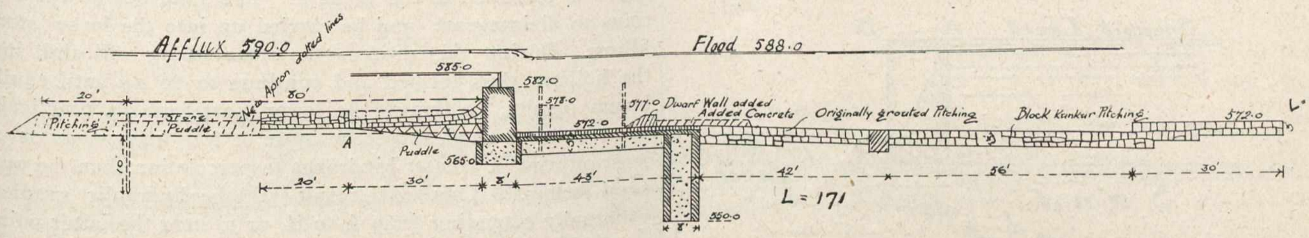
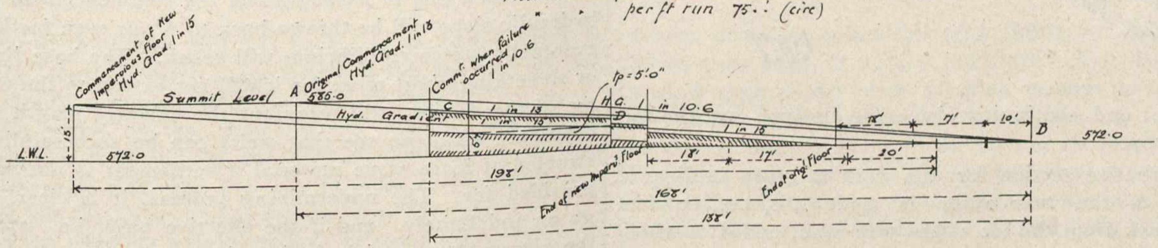


Fig. 5. NARORA WEIR Type B. Class I.

Flood Discharge 300.000 Sec ft — Ganges River — per ft run 75.: (circ)



Inspection of the diagram, Fig. 5A, on which the depth of t p is marked (t being thickness of floor) shows that the area of the trapezium of pressure over the first part of the floor is nearly double that of A p or of the area of the section multplied by its effective S.G., which is unity. The floor at its commencement should, therefore, be twice as thick than actually constructed. When failure took place, the rear apron was non-existent, having been washed away. The effective base length would then be reduced to 168–30=138 feet=10.6 H, and this fact, added to the further increased deficiency in the value of A p (i.e., the weight), is quite sufficient to account for the failure. With a gradient of 1 in 13 the work stood for several years in spite of the deficiency in weight, although hollow actually existed below the floor, which was practically supported by the hydrostatic pressure.

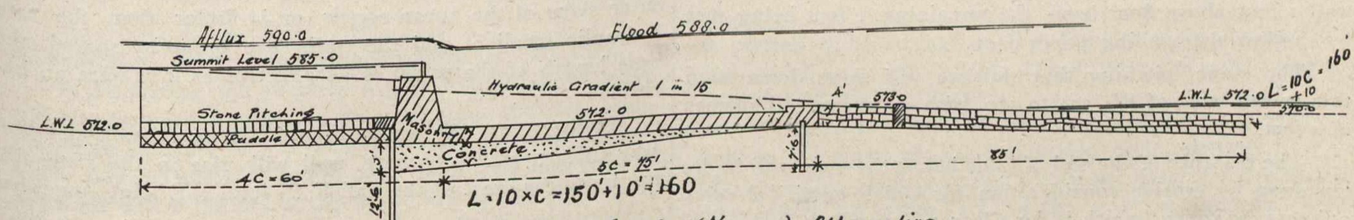


Fig. 6 (Narora) Alternative

C = 15 f = 2 f-1 = 1

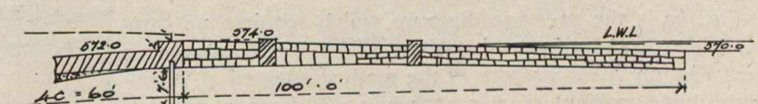


Fig. 6B

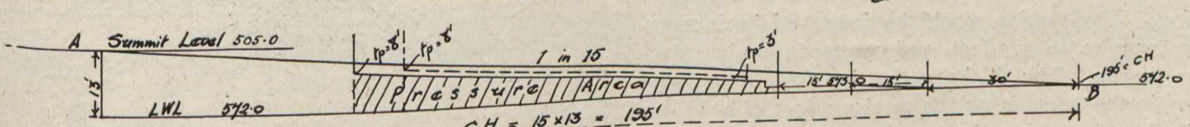


Fig. 6A

Mr. Bligh, while in Canada, addressed the Engineers' Club, Toronto, and the Engineering Society of Toronto University on this subject.

If the heavy fore-curtain had been placed underneath the drop wall, the work, although overstrained, would probably have lasted out without failure.

The repairs to this work consisted, as shown on the section Fig. 5, of a considerable extension of the rear apron from the original 30 feet to 85 feet, this reduced the pressure on the floor to 5 feet, which is just sufficient (vide diagram Fig. 15A). Further, the grouting of the rip vap was not renewed as an impervious continuation of the floor, this reduced the triangle of pressure. With the object of further assisting the stability of the floor, which was probably already more or less undermined, a mass of concrete 2 feet deep was thrown over its lower end, continuing also some distance over the following rip vap.

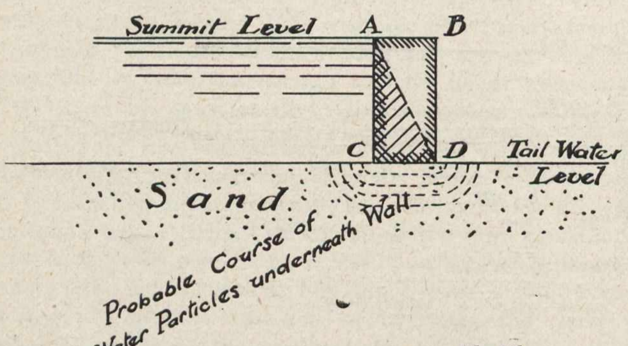


Fig. 7

An alternative section for this work is given in Fig. 6. The length of the rear apron is made=4 c, i.e., 60 feet measured back from the toe of the weir wall, added to which is the vertical obstruction of sheet piling, having a value of 2c., total 6c. The neutralization of head effected (h) will thus be 6 feet, leaving (H–h)=13–6=7 feet upward pressure at this point. This is provided against by a floor 8 feet thick with p=unity. The floor is made 5c., or 75 feet long and tapers to a thickness of 3 feet. This effects a further reduction of head of 5 feet, leaving 2 feet head to be disposed of. As this would necessitate a further length of 2×15=30 feet of impervious floor, which is hardly necessary for anti-erosive purposes, the masonry floor will be cut short here and the 2 feet head still remaining accounted for by a raising of the end wall 1 foot above floor level, the remaining 1 foot being met by shallow sheet piling 7 feet deep.

The stone pitching that follows will slope down from this raised level of RL 574 to 570, with an average thickness of 4 feet.

The distance of the end of talus below the weir wall is determined by erosive consideration for which empirical rules only can be given, which is for Class 1 Types B & D, L=15H =150. It is actually 160 feet.

Fig. 6a is the pressure diagram which requires no comment after the lengthy explanations given in the preceding case. Fig. 6b is explanatory of the method adopted of retaining the hyd. gradient of 1 in 15, while still further reducing the length of the masonry floor, and disposing of a balance head of 3 feet. The section would be improved by increasing the rear apron to 5c.=75 feet, and correspondingly reducing the fore apron. The thickness at the foot of the weir wall can remain the 8 feet it now is or else 1 foot of head can be knocked off by deepening the curtain.

The previous examples have all been cases where the weir has as appendage an impervious floor which is subjected to hydrostatic pressure, and we will now endeavour to show that the principles of length of base causing effectual neutralization of head and consequent reduction of the velocity in the passing current to a safe limit, apply also in the case of a weir, the material of which is not impervious.

Fig. 7 represents a wall upholding water to its crest, the hydraulic gradient is AD and the pressure area on the base in the triangle ACD. Unless CD equals at least 10 times AC failure will result by the substratum being washed out, i.e., by piping. Now, as in Fig. 8 let a mass of loose rubble stone be deposited below the wall. The weight of this stone will evidently have an appreciable effect in preventing the disintegration and removal of the sand below the foundation. Besides which the water will not have a free egress consequently it will rise in the interstices of the mass to a certain height, EE, which is indeterminate as it depends on the obstruction caused to the flow. The resulting hydraulic gradient will then be AE, flatter than AD in Fig. 7, but still not flat enough to prevent disintegration.

In Fig. 9 a rear apron is shown and the loose stone fore-apron is extended to the point F. The sand below will continue to disintegrate and be carried up into the loose stone filling. During this process the stone filling will sink into the hollows thus formed and continue to do so until equilibrium results, i.e., until the lower part forms a practically close mass of sand and stone more or less impervious or at least offering a greater hindrance to percolation than the pure sand below. This will result in the hydraulic gradient eventually extending from A to H, or to near the latter point.

In the mean time the resistance thus afforded will give time for the rear apron to be silted up by deposit from the river. When this is accomplished, the commencement of the hydraulic slope will be thrown back to A^1, or even further and eventually stable equilibrium will result. The base line GF, or something short of it, for it will not extend to the extreme toe of the section, will represent the effective length of percolation. Thus we see that weirs can be successfully constructed of loose stone material if settlement is allowed and provided for. The undermining process, it is clear, cannot go on indefinitely, and if the effective base, i.e., excluding the extreme toe, and including the rear apron is made the proper ratio to H, i.e., l=cH, stability will be insured. The depths of the loose stone filling in the fore must, however, be such that its weight when immersed, or when dry, is at least equal to the head of water to which at any time it may be subjected.

In this figure a further development is effected by the introduction of vertical body walls of masonry in the pervious mass of the fore-apron.

These impervious obstructions materially assist the statical stability of the foundation, so much so that if the outer slope of the apron equals or is flatter than the safe hydraulic gradient and the walls are properly spaced, the base length of the prism is as effective as if it were an impervious floor.

In the figure the water through the rear apron and passing underneath the breast wall will rise in the stone filling up to the crest of the wall F, its level at E being somewhat

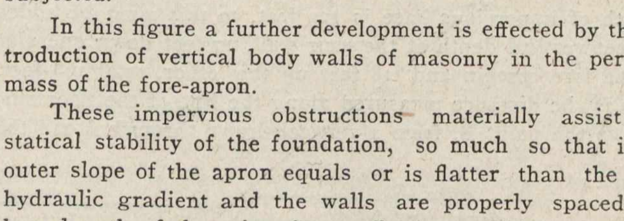


Fig. 8

higher. A similar case must accur in each bay, with the practical result, that enforced percolation through sand is assured just as much as if the superstructure were impervious. The same proviso applies in this as in the latter case, viz., that the effective weight of the mass of stone when empty of water must equal the upward pressure caused by the head, or if the full head be counted when the bays are full of water, the combined weight of the loose stone plus that of the water per foot run must exceed that of the full head neglecting the internal rise of water level. In this section the head is reduced gradually in steps, but when the river is at low level and no water passes over the crest, a freshet might throw a

N.B.—The letter p is used for the Greek letter roe in formulae.

sudden stress on the sand foundation, which it could only resist by being supported by an equally great superincumbent load of stone filling.

In all loose stone weirs of triangular section a rear apron of loose stone is provided as shown by the triangle AGC in Fig. 9. Until this rear apron is rendered stanch by silt deposit it possesses no appreciable statical value. When, however, it is provided with layer of impervious material, or else when the same consummation is effected by external silt deposit, it can justly be considered as forming an integral portion of the weir body and the incidence of the water pressure due to the head will then be removed as in Fig. 2 from the rear of the breast wall AC, back to a vertical through G, thus the length of creep is increased by the distance GC and the hydraulic gradient flattened from AF to A'F.

The value of the stanchness of the rear apron is so marked that it should be rendered impervious by a thick under-layer of clay, and not left to more or less imperfect surface silt stanching as has usually been the case.

As the effective weight, or S.G. of stone filling forms an essential factor in design, its exact value should be a subject of investigation. When such material is immersed, the solid parts displacing water are subject to loss of effective weight by buoyancy, and the interstices are filled up with water.

In estimating the effective weight of the porous mass it will be necessary to ascertain the percentage the voids bear to the whole, we shall then be enabled to assume one SG for the whole area. Thus with 50 per cent. voids and with rock having a SG of 2.6 the SG of the whole will be $(2.6+0) \div 2 = 1.3$. When the mass is immersed the loss of effective weight in the half solid part will be as $p:(p-1)$, i.e., will be reduced as 2.6 to 1.6. The reduced SG of the porous mass will then become $(1.6+0) \div 2 = .8$. In cases wherever the weight of the water filling the interstices above the base be considered as an asset to the value of A p, the SG of the water being unity, that of the mass half full of water will be .5, and that of the whole, including the immersed stone, will be $(.5+.8) \div 1 = 1.3$. The value thus obtained happens to be identical with the S G of the mass when free.

In cases where the stone filling or pitching is situated below the LWL it is clear that it is immersed and thus the S G of the solids in the mass is considered as reduced by unity, at the same time the water filling the interstices of the loose stone lying below that level, which limits the depth of the head, cannot be counted on as an asset against the pressure caused by the head.

The reduction in open spaces can be effected by the judicious mixture of small sized stone and gravel with the ordinary filling.

Fig. 11 is a section of the Okhla weir over the Jumna River. It is remarkable among its type, from not being provided with any lines of curtain walls projecting below the base line hitherto invariably adopted. Its stability is consequently dependent exclusively on its weight and horizontal base width. As will be seen, the section consists of a masonry breast wall 10 feet deep and 4 feet wide (above which are collapsible crest shutters 3 feet deep) founded on river sand, at normal bed level. To the rear of the wall, a slope of dry stone pitching extends to an inclination of 1 in 4. In front of the breast wall, the fore apron consists of a long slope of stone filling having an inclination of 1 in 20, which runs down till normal bed level is reached, where it terminates in a deep talus of loose material. The base is horizontal up to a little beyond the 3rd body wall, where the depth is reduced to 4 feet. It then runs in a line parallel to the surface slope up to its termination. This apron is crossed by three longitudinal body walls of masonry, the first of which is carried right through to the foundation, while the other two, which were put in later, do not quite reach the horizontal base line of the structure.

The maximum statical head occurs when the water is upheld to the crest of the collapsible weir shutters, i.e., at 662.30. This level is 13 feet above the base of the structure. The actual low water level of the river is somewhat lower, but if this level were considered as that of the lower reach the head would be increased by the difference. The effect of this increase in the head and of the water pressure is, however, more apparent than real. The sand below the base line being pervious, the water will rise through it, practically annulling this increase of head. The effective base length of this weir is taken as 200 feet, i.e. = 15.4 H.

The flood discharge at the Jumna at this weir is 150,000 cubic feet per second, the depth above crest 8 feet, length about ¾ mile.

In Fig. 12 another example of Type A is given, viz., of the Dehri Weir, constructed on coarse sand of Class II. The head is 10 feet so that adopting a value for c of 12, the base length should be $10 \times 12 = 120$ feet,

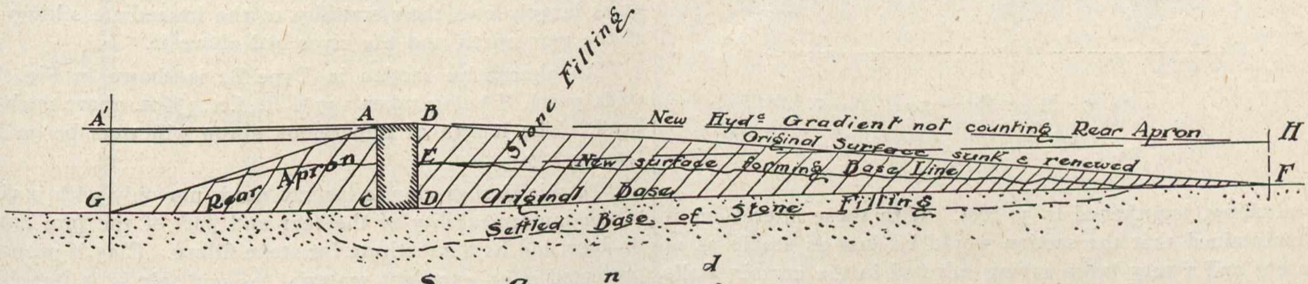


Fig. 9.

Fig. 10.

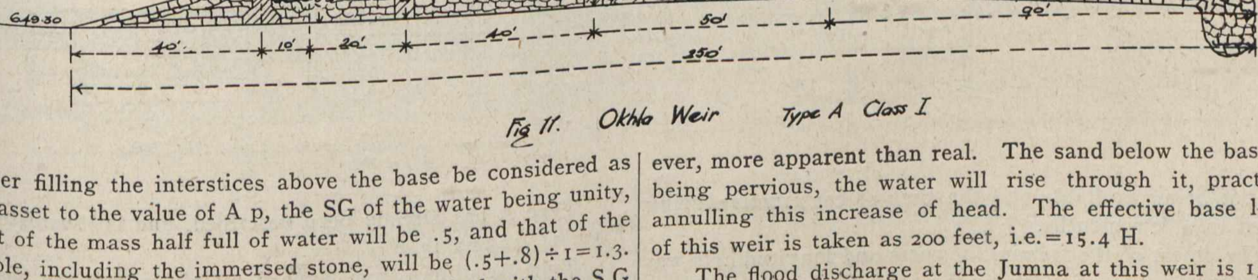


Fig 11. Okhla Weir Type A Class I

which it exactly measures. Thus if the rear slope were rendered impervious by a layer of clay puddle, the existing base width would be sufficient without the two lines of curtains. Excluding the rear slope and including the curtain walls the value of c works out to 12, (vide Table post). The stability of the fore apron would be improved by the insertion of another body wall dividing the total fall of 10 feet into 3 instead of 2 steps, as it is at present, and the rear slope should consist of a rectangular mass of puddle protected

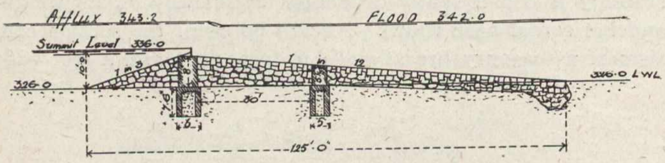


Fig. 12 - Dehri Weir - Type A - Class II. Sôn River
Flood Discharge 830,000 Sec ft Length 12500 ft
per ft run 66

by pitching, lengthened to 30 feet. With these alterations it is maintained that the section would be just as stable as at present and a very large saving effected in the curtain walls which have a combined length of 5 miles.

To stop leakage a single row of sheet piling 10 or 12 ft. deep beneath the breast wall would be a desideratum in all river sands of Class II. The coarser the quality of the sand the better its resistance to disintegration under pressure, but on the other hand percolation is naturally in inverse proportion to the fineness of the particles. The discharge of the Son River is 836,000 second feet, the length of the weir is 12,500, and the depth of water above crest, 9 feet; afflux, 1 foot, The weir is of record length.

One further example will be given of a weir of Type A, which is exemplified in Fig. 13, of a crib weir designed by the author which was constructed in Upper Burma over some intermittent torrents with deep sandy beds belonging to Class II. This type of construction was necessitated by the exigencies of the situation, skilled labor and lime not being available and the time of construction being limited to a few months.

The object of the framing of posts and longitudinals was mainly to act as a support for the covering boards. These are essential to prevent the loose stone filling, which was not even packed at the surface, being washed out. The foreslope of the apron is 1 in 15, formed by steps of 1 ft. at every 15 ft. of length. An improvement in the design would have been to continue the longitudinal boards at each step, right down to the sand foundation. They would then act in the same way as the vertical body walls used in Fig. 11 and 12, that is, as dampers to percolation through the stone filling; the value of l works out to over 12 H. These weirs answered well as long as the fore slope was retained at 1 in 15. Where this latter was increased to 1 in 10, leakage and settlement took place. The talus required constant renewal for the two first seasons, a large amount of material was thus absorbed which sank out of sight. This was undoubtedly due in a large measure to the A Type adopted. The streams in question were some 200 ft. wide with a bed slope of over 1 in 1,000, and consequently the velocity of approach was very high. Had longitudinal body walls or rather vertical barriers been adopted, the settlement would have been much less. These weirs largely owe their stability to the immediate silting up of the rear apron and the river bed above it.

An alternative section in Type B2 is shown in Fig. 14, (vide post), H being taken as 7½ ft., i.e., 1½ ft. above the bare head. The length of impervious apron will thus be 90 ft., i.e., 12 × 7.5.

In this design clay is largely used, not only with a view to the impermeability of the rear and part of the fore apron or floor, but as a substitute for stone filling. Clay if properly protected is an excellent material, as not only is it stanch to percolation, but its specific gravity whether in water or air is often higher than that of loose stone filling, vide Fig. 23 (post).

The design of the crib weir work is very similar to that of the last example and in the fore apron consists simply of 2-inch covering planks screwed down to wailings 6-in. x 3 in., which in turn are spiked to hard wood posts. These are spaced 5 ft. apart in both senses. The drop wall is enclosed by a double row of sheet piling.

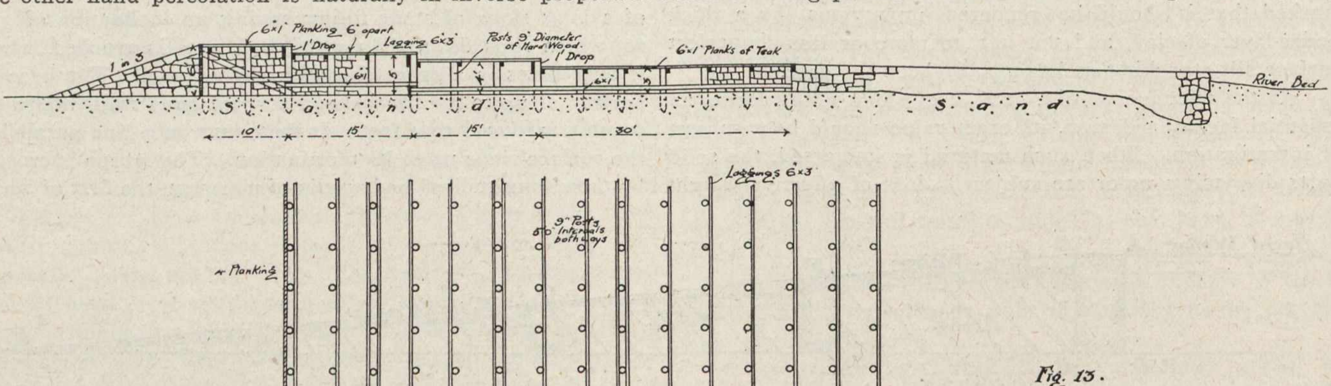


Fig. 13.

The comparative quantities of material are as below:—

	Fig. 4.	Fig. 4a.	Remarks.
Stone filling 500		380	Inclusive of rear apron and deep talus in Fig. 4, and 10 ft. talus in Fig. 4a.
Clay filling ....nil.		290	

The different types of weir sections will not be explained.

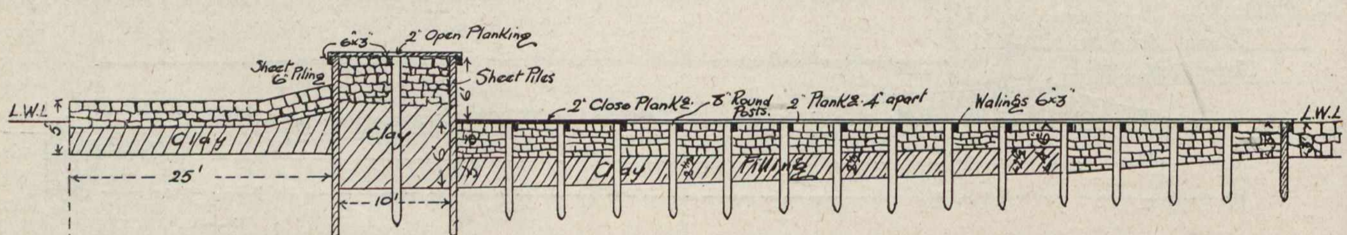


Fig 14.

Type A has already been described, and is illustrated in Figs. 11, 12 and 13.

Type A2 differs from Type A mainly in that the base of the fore apron instead of being horizontal is inclined parallel to the surface slope, as far as the latter extends. It is thus rectangular not trapezoidal in section. Another point of divergence from the older type is that this rectangular sloping apron is rendered impervious to upward hydrostatic pressure either by a layer of concrete below the dry pitched surface or else the whole apron is formed of masonry. In later examples the drop wall is kept low and is provided with exceptionally high shutters. Examples of this type will be given in Figs. 15, 17, 18, 19 and 20.

Type B is similar to Fig. 2, i.e., it consists of a vertical drop wall, which is generally surmounted by collapsible iron shutters, provided with a rear apron, either a rectangular horizontal floor, or a pitched slope. The fore apron consists of a horizontal impervious floor at low water level, followed by a

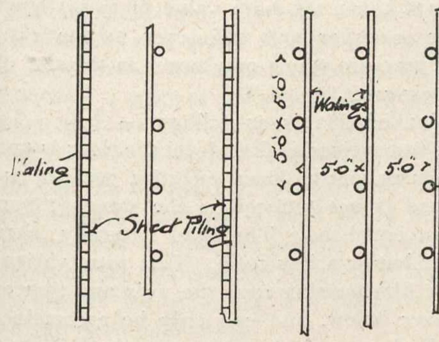


Fig. 14a

length of pitching or riprap. Examples given in Figs. 4 and 5.

Type B2.—This type is similar to B, being a direct overfall with horizontal floor, the only difference being in the foundations, which are dredged out, the material of the drop wall and apron being deposited in the water of the pool thus formed, no pumping being resorted to. (Figs. 14 and 22).

Type C.—Similar to type B, but with floor raised above LWL. A pitched slope connects the two levels. It is thus a compromise between Types A and B. (Vide Fig. 16.)

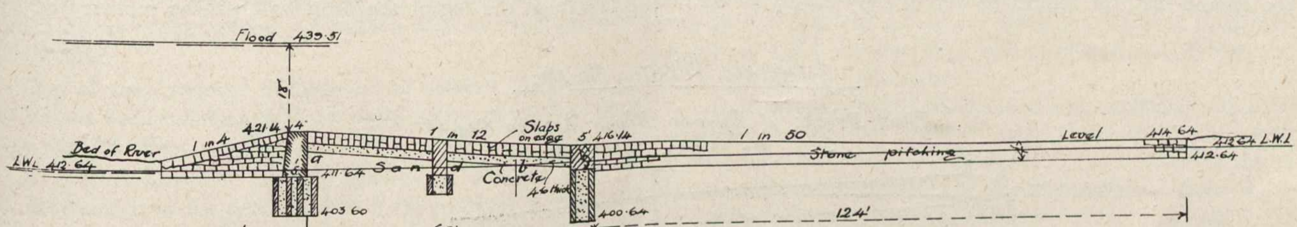
The disadvantages inherent in Type A are solely due to the fore slope which causes the congestion of the water of the river due to the obstruction of the weir to be very gradually reduced, the destructive velocity of passage is therefore maintained unimpaired for a considerable distance beyond the breast wall, and its action on the talus is consequently very severe, necessitating, particularly after first construction, constant yearly addition of material to the talus in order to maintain the section. These large masses of stone filling sink below the surface out of sight and are not shown on the record sections.

In types B or B2 this objectionable slope in the fore apron is non-existent, an undersunk impervious floor of high specific gravity being substituted, its surface level with the normal river bed or with LWL. The breast wall of type A is thus converted into a drop wall, a direct overfall being substituted for the rapid. This arrangement has the manifest advantage of greatly increasing the section of the waterway where such increase is most wanted; that is, immediately below the breast or weir wall. By this means a corresponding diminution of the velocity of the current is effected.

In Fig. 11 the area of the flood water way from the breast wall up to the 2nd body wall is 435 sq. ft., whereas, if the section were converted into Type B the same area is 1,015 sq. ft.

The velocity of the current during floods passing over Okhla weir has been ascertained to be no less than 18 ft. per second at a point 20 ft. beyond the crest. This destructive velocity would be reduced in a section as in Fig. 9 or 10, to 18 × 435 ÷ 1,030, or to 7.6 ft. per second. This point should tell strongly in favor of Type B.

Some examples of Type A2 will now be given. Fig. 15 is the section of the Adimapali anicut over the Penner River in the Madras Presidency. The river sand is of Class II., with c = 12. The head or H being 8.5 ft., the requisite length of creep will be 8.5 × 12 = 102 ft. The actual length as exhibited in Fig. 17, including the vertical depression of the 3 lines of curtain walls is 122 ft., giving a hydraulic gradient of 1 in 14.3. If either the first or last be omitted from consideration the resulting hydraulic slope will be about 1 in 12. In this count the rear slope, as usual, is omitted and the loose stone talus is likewise ignored. As this latter lies for half its depth above LWL the outlet of percolation at the termination of the impervious apron cannot be considered as absolutely



ADAMAPALI WEIR Fig 15 Flood Disch of Penner River 413000 Secft
Do Do per ft run of weir 184

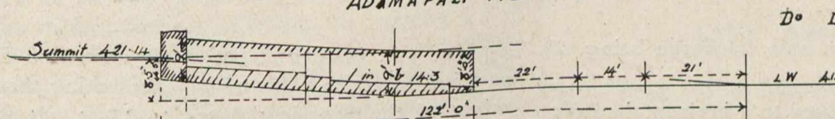


Fig. 15a

free, and the result will probably be that the escaping water will rise part way in the pitching and form a continuation of the slope. This rise of level will have the effect of decreasing the inclination of the hydraulic gradient. The fore apron as in all weirs of this sub type is rectangular in section and is rendered impervious by a layer of concrete over which stone slab surfacing is built.

Fig. 15a is the graphical pressure area diagram. The full head is as we have seen 8.5 ft. Owing, however, to the raised position of the apron with regard to LWL, the pressure acting on the base at the point a, Fig. 15, is that due to the difference of level between a and the summit level, which is 4.5 ft., diminished also by loss of head due to creep between the rear of the wall and the point a. The base of the trapezium of pressume will, therefore, be an inclined, not a horizontal line, and will run from a point 4½ ft. below the summit at the

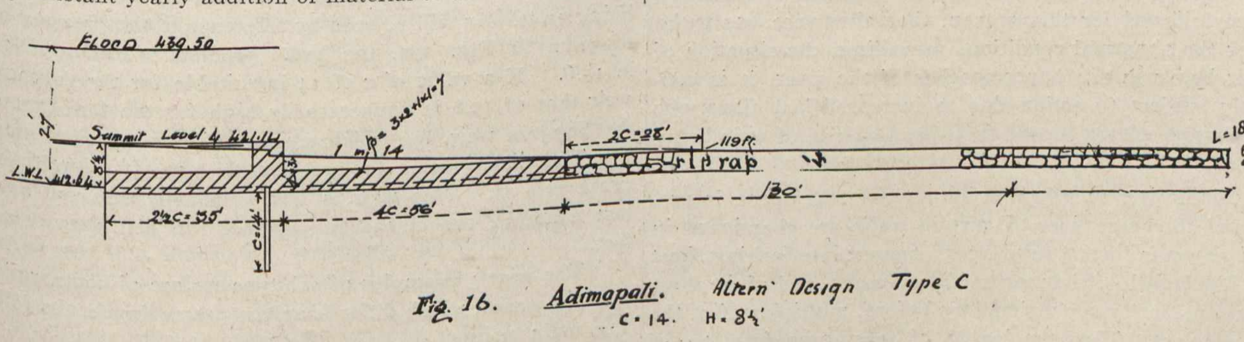


Fig. 16. Adimapali. Altern Design Type C
C = 14. H = 8½'

rear of the breast wall to the point marked b on the diagram, where the base line of the apron coincides with LWL.

The upper surface of the trapezoid of pressure is not necessarily parallel to this base line but is obtained in the ordinary way already explained of measuring out the total contour length of impervious base which gives the ruling gradient and then measuring back along the base the several vertica' depths. From the points thus obtained lines drawn parallel to the ruling gradient up to their proper relative positions, give the upper outline of the pressure area.

With regard to the weight area or Ap, taking the specific gravity of the material as 2, the depths tp at the point a and b will be 4.5 × 2 = 9 ft. . Beyond b the apron falls partly below LWL, at its termination, one foot in depth is immersed, the thickness tp will therefore be 3.5 × 2 + 1 × 1 = 8 ft. These dimensions are marked on Fig. 15a.

In Fig. 15a if the head of 8.5 could be considered as acting right through as is sometimes convenient to assume, the base line of the areas of weight and of pressure would then be horizontal while the stepped surface line would not be altered in any way. The area of pressure would thus become, by addition of the triangular strip at the bottom, larger than before. The weight area, however, would also be enlarged in the same degree. It is evident that if the actual reduction in head at the point a be ignored, the weight of water lying between a and LWL will have to be added to that of the apron. When this is done the upper outline of the area representing weight will coincide with that previously obtained. The flood discharge of the Penner River here, is 413,500 second feet, the length of weir is only 2,250, the action on this weir must be excessive, the unit discharge being 184 second feet.

If the apron were bodily depressed to a horizontal surface of level 416.14, it would still be amply thick enough to withstand the increased head, and be nearly as easy to construct as its base line would be only 1 ft. below LWL. The type would then be converted from A2 to C.

The conversion as thus indicated has been effected in Fig. 16. In this design the floor level is placed at RL 415.64, i.e., at 3 ft. above LWL. With a floor 4 ft. thick, the base will lie only 1 ft. below LWL, and with this exception the whole of the masonry work can be constructed in the dry. A safe hydraulic slope of 1 in 14 has been adopted, this is in excess of the 1 in 12 usually considered sufficient for this class of river sand, but the precedent of the original construction has been followed for this reason, that allowance has to be made for the abnormal conditions prevailing, the situation of this weir being in the upper reaches of the river, it is consequently subject to action due to increased bed slope, the unit discharge, of 184 second feet, per foot run of weir being very high.

In this design an effective impervious rear apron is provided, and the three lines of curtain walls are abandoned in favor of one rear line of reinforced concrete interlocking sheet piling. The length of the rear and fore aprons, and of the sheet piling are made for convenience as before, multiples of c, the river coefficient. Thus the length of rear apron from toe of drop wall is 2½c = 2½ × 14 = 35 ft., the sheet piling is c or 14 ft. deep, and the length of the fore apron is cH—4½c = (8.5—4½) 14 = 56 ft.

The depth of the apron and talus throughout is 4 ft. Under the conditions of maximum statical head, as occurs when the summit level is at weir crest level and the tail water at LWL, this depth affords more than ample margin of security as regards weight at the critical point of the section, i.e., at the toe of the drop wall.

This is marked on the section Fig. 16, where the upward hydrostatic pressure is equivalent to 4 ft., while the value tp is 7 ft. This latter is composed of 3 ft. of material of specific gravity 2 = 6 ft. of water plus 1 ft. of material of specific gravity, unity; total, 7 ft.

In weirs of type C, not provided with crest shutters a margin of about 1½ times the bare value of tp is, however, required in order to cover any deficiency in the ratio of weight to upward pressure which may occur in the rise of the water above the weir crest.

The explanation of this is as follows:—

When the tail water rises to floor level the floor is entirely immersed and consequently loses effective weight at the same time the head is not reduced in the same proportion, so matters are not equalized. The head naturally increases with the tail water but in a less ratio. This ratio varies with the velocity of the film passing over the weir and that of the current in the river below, and can only be ascertained by calculating the discharge of the river per foot run at the floor level and then finding from tables or by calculation that depth of film which will pass this known discharge. This ratio of rise of the head and tail water varies from about 1:3 to 1:2. Assuming the larger ratio, when the tail water reaches the floor level in Fig. 16 it will have to rise 3 ft., the head water at the same time will rise half this distance or 1½ ft., the head on the work will then be reduced from 8.5 to 5.5 + 1.5 = 7 ft. With this reduced head the upward pressure at the toe of the drop wall will be represented by a depth of 3 ft. instead of the 4.5 ft. shown on Fig. 16a. On the other hand the value of tp representing the counteracting weight of the floor is reduced to 4 × 1 = 4 ft. only. This proves that with the lesser head of 7 ft. the floor is subjected to a greater proportional stress. It is evident that with any further rise of the tail water above floor level the head is still further reduced without any corresponding diminution of weight in the floor. Thus the depth of floor should be determined from the head occurring when tail water rises to floor level, while the length as before is dependent on the maximum statical head, i.e., the difference between summit level at weir crest and LWL.

SANGAM WEIR Fig. 17.

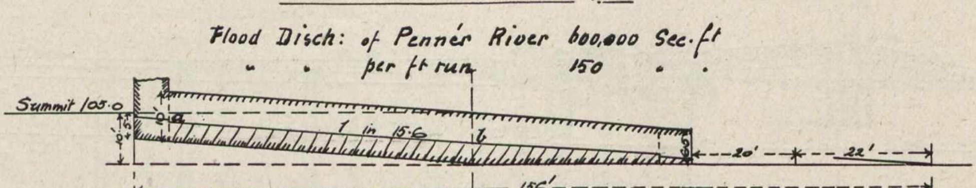


Fig 17a.

The Sangam weir (Fig. 17), is on the same river but situated in the delta, is of similar construction being also of Type A2. The head is greater than in the last example being 10 ft. As will be seen by reference to the pressure area diagram in Fig. 17a, the hyd. gradient works out to 1 in 15.6. If a value of c of 14 is suitable for the Adimapali weir that of 15.6 is unnecessarily high for the fore apron of the Sangam weir, for which a value of 12 is deemed ample.

The discharge is 600,000, length 4,100 ft., depth above crest 12½ ft. This weir is not so heavily strained as the last example, the discharge per foot run being 150 second feet.

The next 3 examples of sub-type A2 are of comparatively modern works, which differ from the preceeding in the following main points.

Firstly:—They are provided with exceptionally high weir shutters, so that half, or nearly half, the total closure above LWL is effected by this means, the solid weir can thus be kept very low, presenting but comparatively slight obstruction to the water-way of the river.

Secondly:—The level of the talus is often placed below LWL, not level with it, or above it as in most older examples.

(To be continued.)

PAINTING CEMENT SURFACES.

By P. W. Nelson.

It is only in comparatively recent years that cement has come into more extensive use as a building material, and it is but natural that the majority of us are as yet undecided about how to proceed in the painting over cement, because we have not had sufficient time in which to make our experiments, note the results and arrive at a positive conclusion. A great many experiments have, of course, been made, but most of them without a trace of scientific reasoning back of them. As an example, I will relate what an Eastern painting contractor told me recently in regard to painting on cement.

He said he always had more or less trouble with cement surfaces until he found a method which he could rely upon. His method was to give the surface a coat of strongly glued calcimine before applying the oil paint; this might have helped him out at the time, but it is certainly no method which can be safely recommended.

Many hastily conducted experiments have led to wrong conclusions, and it has even happened that two men, experimenting along the same lines, have come to opposing conclusions. The reason for this is that there is a difference in cement and cement surfaces, and our aim is to find, if possible, a method which will give satisfactory results in all cases.

It has long been the popular opinion that linseed oil is hurtful to cement, and also that no oil paint would endure if applied direct to the cement. I believe both of these opinions to be wrong.

One of the foremost authorities on cement assures me that he has been painting with oil paint over cement for many years with the best results.

It is true, however, that all non-drying oils are more or less destructive to the cement, and if the cement wall should be saturated with raw linseed oil there is no doubt about the outcome, as the oil would slowly disintegrate the cement. But for painting we do not use non-drying oil, and our oil paint will dry on the surface without affecting the cement, a fact which has been fully demonstrated. As for the cement affecting the oil paint, so is that more apparent than real. It is held by experts that cement surfaces properly executed, clean and dry, are no more dangerous to oil paint than the modern wall plasters.

Undoubtedly most of the trouble is caused by the painting being done before the cement is dry. Cement dries very slowly. The opinion of men who are experts in the use of cement say that a cement wall must stand at the very least over one summer before painting with oil paint can be commenced.

The first thing required is to wash the surface thoroughly with a weak solution of muriatic acid, followed with a good wash of clean water. The strength of the acid solution should be about 7 or 8 per cent. This wash will clean the surface, neutralize to a large extent the alkali, and thus make on the smooth cement surface enough of an impression to give the paint a proper hold. The surface must then be given time to dry perfectly.

In painting it is well to use considerably more turpentine than is ordinarily the case, and very little dryers. In fact, boiled linseed oil is considered preferable to raw. For priming, the paint should be used thin, and contain so much turpentine that it is almost flat, increasing the amount of oil for succeeding coats. Each coat must be given ample time to dry before the next one is applied.

For water color or calcimine, washing with muriatic acid solution, followed by clean water, should be done if first-class work is to be expected. When the surface is thoroughly dry it should be given a coat of alum size, or, still better, a coat of flat paint, and when the size is dry the surface is ready for calcimining.

*A paper read before the Ohio State Association of Master House Painters and Decorators.

One painting contractor, who does a great amount of work in our Eastern sky-scrapers, tells me that he makes a size of equal parts of acetic acid and alum. His formula is one pound of acid, one pound of alum and two gallons of water. I have not tried this size, so I give it for what it is worth.

If the treatment suggested should prove not to be all we expect, it is at least the best I have, through diligent search, been able to obtain, and one that I believe is the best so far put forward.

So far so good, but in this method there is one thing which nearly everybody is opposed to using in paint nowadays, namely, time. Time is the great sesame for all painting. Give the surface time to dry and let one coat dry thoroughly before another is applied, and we will have far better work than is usually the case.

In our modern rush the painter is, however, often forced, against his protest. to paint over a surface long before it is dry enough to receive the paint. This is true not only of cement, but also of plaster and sand finish. We all know there will be trouble when painting is done over a wet surface, and with cement the main difficulty is that it dries so very, very slowly that it is invariably painted before it is half dry. It may appear dry on the surface and still contain a large quantity of moisture.

To meet this demand for rush, inventive minds have set to work to make a paint which can be applied over cement as well as plaster surfaces while the same are still damp. There are a few such paints on the market to-day; some are manufactured in paste form to be thinned down with turpentine and benzine. They dry out perfectly flat, have great covering power and will adhere to the damp cement or plaster by virtue of the fact that they will permit the moisture in the wall to evaporate through.

It must be plainly understood that ordinary oil paint or enamel cannot be applied over them until the wall is thoroughly dry, because such coating will close up the pores of the wall, so to speak, prevent the moisture from escaping and force it to accumulate behind the paint, causing the paint to blister and come off.

CITY AND TOWN LOTS.*

By S. Bray, Chief Surveyor, Department of Indian Affairs, Ottawa, Ont.

By a Provincial Act passed about fifteen years ago it was provided that no municipal council except the council of a city or town, shall lay out any roads or streets more than 100 nor less than 66 feet in width, except where an existing road or street is widened, or unless by the permission of the council of the county in which the municipality is situate; but any road when altered may be of the same width as formerly. And it further enacts that no highway or street of a less width than 66 feet shall be laid out by any owner of land without the consent of the council of the municipality by a three-fourths vote of the members thereof. This enactment has proved to be a very wise one.

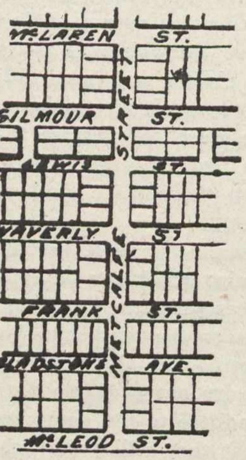
No action appears to have been taken to regulate the depths of lots. This would appear to be a matter of great importance, both from an economical standpoint and on account of the public health. If lots are laid out with a depth so small that the back yards, where houses are built, are continually in the shade, the general health of the residents will certainly be more or less affected. And again, if the lots are laid out of too small a depth, the city or town in which they are situated has too great a proportion of street area to maintain for the amount of assessable land area. This point may be especially illustrated in the sketch below.

This sketch shows a portion of Metcalfe Street, in the city of Ottawa, and I may say there are parts of the said city similarly laid out. Between Gladstone Avenue and Frank Street, as shown on the said skech, there is a depth of only one lot. I may here say that the very great majority

* Read before the Ontario Land Surveyors.

of lots in the city are only 99 feet in depth, and this is a depth very commonly adopted in many cities and towns. Again, between Lewis Street and Gilmour Street there is a similar depth of only 99 feet. In both of these cases the houses in many instances front on one street and their back yards are on the other. It is evident that the city has to construct and maintain two streets where one would be ample, and in addition to this has not only less land to assess, but on account of the fronts of the opposite lots facing on back yards, they are necessarily depreciated in value.

It may be contended that this is a state of affairs that should have been attended to by some proper officer of the municipality, who should have refused to accept the subdivision. This does not appear to be the duty of any officer.



Scale. 10 chains = 1 inch.

The lands were laid out, the plans filed, and the lots sold, and the city saddled with an extra street, and a large number of lots unduly diminished in assessable value.

It is also to be noted that when a city has progressed with ordinary success, that a store 99 feet in depth is very shallow. In fact, the building cannot be built with this depth, as it is necessary to keep back from the rear line a sufficient distance to admit light at the back of the building. I think it should be admitted that 99 feet is too shallow a depth for a city or a town lot. It would, in my opinion, be a wise measure to have an Act passed limiting the depth of a block, that is to say, from one side to another in both directions, to 250 feet, thus making the lots 125 feet deep; of course, subject to variation where the shape of the land or the inequality of its surface requires it.

LIFE OF MANGANESE STEEL RAIL ON CURVES —FROM SERVICE TESTS MADE ON THE ELEVATED DIVISION OF THE BOSTON ELEVATED RAILWAY COMPANY.*

By H. M. Steward, Roadmaster, Boston Elevated Railway Company, Boston, Mass.

Within a few months after the elevated division of the Boston Elevated Railway Company was opened for traffic (June, 1901), it was found that the rails on the curves were wearing out at an unprecedented rate. As about 40 per cent. of the entire length of the line is curved, the question of maintenance and the cost of rail renewals became, and still is, a serious problem.

The tracks on the elevated division were first laid with Bessemer rail having a low carbon element (about 0.45 per cent.), and the life of the outer rail on the sharp curves was very short, averaging about sixty days. On account of this excessive rail wear, the railway company determined to make a trial of manganese steel rail, and a curve in the subway near Park Street Station, having a centre radius of 82 feet, was selected for the trial. In 1902 the outer rail of the curve was relaid with manganese rail. These rails were cast in 20-foot lengths, conforming as nearly as possible to the A.S.C.E. 85-pound section, and were purchased of William Wharton, Jr., & Company, Inc. The Bessemer rail, which was in the track immediately preceding the installation of the manganese rail, wore down 0.065 foot in 44 days, as shown in Fig. 1. The manganese rail remained in service up to August, 1908, when it was removed on account of an accident. It will, however, be replaced in the track within a short time and will be allowed to wear out completely. Fig. 2 shows the result of this experiment after the manganese rail had been in service 6 years, 3 months and 7 days, or 2,291 days. The amount worn from the top to the rail, only 0.046 foot, is certainly remarkable and illustrates the great resistance this metal offers to rolling friction. The comparative wear of ordinary as against manganese steel for a period of 2,291 days is graphically shown in Fig. 3.

* Read before the American Street and Interurban Railway Engineering Association, Atlantic City, N.J.

The traffic over this piece of track in 1902 was, of course, much less than at present, averaging probably 1,000 cars, or 36,000 tons, per day, as against 1,700 cars, or 62,000 tons per day, at present. Consequently the manganese rail, on account of the constant increase in traffic, has given even better service than the comparative result show. Other instances could be cited, but in these cases the manganese rail has not been in service such a long period of time, although the comparative results are equally as good. This one example, however, is probably sufficient to illustrate the long life and value of rails made from this metal.

In 1902 and 1903 the railway company purchased about 700 feet of manganese rail at an average cost of $5 per lineal foot. The cost of Bessemer rail to this company averages about 0.39 cents per lineal foot.

From time to time we have made other experiments with special rollings of Bessemer, nickel and open-hearth rails. In 1903 the Cambria Steel Company furnished us with some Bessemer rail having a carbon element of about 0.78, the wearing qualities of which were very satisfactory when compared with ordinary Bessemer rail, and were far better than the nickel and open-hearth rail which we have obtained up to the present time. None of these rails, however, approached the manganese rail in length of life.

Comparative Life of Several Kinds of Steel Rails on Typical Sharp Curves. Speed of Trains from 8 to 10 M.P.H.

Location of Curve.	Radius.	Ordinary Bessemer Rail Mo.	Ds.	High Carbon Bessemer Rail Mo.	Ds.	Nickel Rail Mo.	Ds	Manganese Rail Mo.	Ds.	Opent Hearh Rail Mo.	Ds.
Park St., S. B., (subway)	82 ft.	2	3	8	18†	3	12†	76	4*	1	11
Adams Sq., N. B. (sub'y)	89 ft.	2	17	10	15	4	4†	80	10†	1	27
Park St., S. B., (subway)	90 ft.	2	16	10	11†	4	3†	66	15*	1	20†
Haverhill St., N. B.	100 ft.	4	3	11	13	6	19	128	9†	2	21
Sullivan Sq. loop	106 ft.	3	7	13	8	5	7†	101	5†	2	7

*Still in service. †Estimated life from actual results on curves of similar radii.

As it is of interest to compare the life of different brands of rails under the same conditions, I have selected five curves of short radii, and have prepared a tabulation showing the comparative life of five different kinds of rail.

We have not been able actually to test all of these rails on each of the curves, but from the actual results obtained on curves of similar radii we are able closely to estimate the life of the rails. In the preceding table these comparisons will be found.

The general use of manganese steel on tangents does not seem to me to be advisable. Even under the severe traffic of the elevated division ordinary rail has given fairly satisfactory service for over seven years. Our tangent rail does not, of course, receive such hard usage as that on steam roads, and the joints do not suffer from the pounding of heavy locomotives. Manganese steel, while offering great resistance to grinding friction, will not, in my opinion, offer as great resistance to heavy blows on account of its ductility. Under heavy locomotive service I should say that the joints would batter and bend down some time before the rail would otherwise wear out. Its high cost also prohibits its use for this purpose.

In our service we find that manganese rail will not withstand side wear equally as well as top wear. The grinding friction from the flat of the tire does not seem to have the same effect on manganese steel as the cutting action of the flanges and we have found it advisable to protect the side of the head of the manganese rail, holding the flanges away from it by means of a check or guard-rail fastened securely to the inner rail of the curve. As the guard-rail can be readily lubricated, it does not wear out particularly fast, and we can afford to allow it to take the side wear, and in this way protect the manganese rail.

On account of the excellent results obtained from manganese steel, the railway company purchased during the last two or three years about 4,700 lineal feet of this rail at an average cost of $6.70 per foot.

All the manganese rail used by the company up to the present time has been cast in lengths not exceeding 20 feet. On account of its having been necessary to cast the rail, the cost has been exceedingly high, due not so much to the cost of the metal as to the labor involved in making the patterns, casting, and especially in finishing the rails. As it is not possible to machine the metal, the only way it can be finished to form is by grinding.

Recently the question of rolling manganese rail has been taken up by two companies in this country, and at least one in England. It is proposed to roll manganese rail in lengths up to 33 feet and of any section desired. The Boston Elevated Railway Company has not as yet obtained and made a trial of rolled manganese rail, but is about to do so, and has already placed orders for a limited quantity. When the rolled manganese rail is received the company proposes to make a comparative test with cast manganese rail of the same quality as was used on the Park Street curve. If the rolling of manganese rail is found to be successful and the metal is equally as good as when cast, the cost ought to be very much less than at present and the use of the material for track purposes should increase.

We have also used manganese steel extensively in frogs, swith-points, etc. The difference in life between manganese steel and rolled rail frogs and switch-points is great enough to warrant its use, and will more than pay for the difference in first cost alone, while if the cost of maintenance is taken into consideration manganese steel is the cheapest metal that can be used.

As to the comparative cost of maintenance, the general maintenance of track, outside of rail renewals, should not vary appreciably, whether the track be laid with manganese rail or Bessemer rail. Taking the curve at Park Street as a basis, and assuming that the life of manganese rail at this point would be eight years and that of Bessemer rail about two months, I should say that the following figures would be a fair estimate of the comparative cost of maintenance per linear foot of single rail for a period of eight years:—

Cost of manganese rail per foot	$ 6 70
Bonds, spikes, etc.	09
Labor	22
Total cost of maintenance	$ 7 01
Cost of Bessemer rail per foot (fifty renewals)	$19 50
Spikes, bonds, etc.	3 25
Renewal of ties, account "spike killing"	2 90
Labor	15 50
Total	$41 50

This comparison, you will understand, is made from one specific case in which the costs can be very closely estimated. The same proportions might or might not apply in other instances.

The results we have obtained from the use of manganese rail on the elevated division have been very satisfactory, and our experience would seem to show that railways operating under similar conditions should make liberal use of this material.

THE INSPECTION OF STRUCTURAL STEEL.*

P. S. Hildreth.

In the construction of iron railway bridges it was early recognized by engineers that such structures must not only be correctly designed and properly erected under competent supervision, but that the intermediate stage of manufacture of material at the rolling mills and fabrication of the material into members at the shops should also be supervised. This was considered important in order to determine the quality of the material and workmanship by testing and inspection and their strict compliance with the specifications.

The advent of steel increased the importance of such supervision, because of the frequent extreme brittleness of steel, the several processes of its manufacture and its lack of uniformity. Certain knowledge of its quality was also considered important because of its higher tensile strength, and the fact that larger and more important structures could be built.

When steel began to be used for buildings it was several years before the desirability of supervision at the points of manufacture began to be realized, and it was only when the services of skilled structural engineers were found necessary in designing an important steel-frame building, and they insisted upon tests and inspection, that it became firmly established. To-day it is the general custom to have the cast-iron or steel frame of a building so supervised, and it is provided for in every complete building specification. Such supervision determines the character of the material and workmanship as much as expert knowledge does the character of a design, although in each case a contract and specification may call for the best. Like the receiving of money, it is not only necessary to ask for it, but to see that one gets it and counts it.

The complete supervision herein referred to requires representatives at the several points of manufacture, the choice and making of tests, the examination of material for mechanical defects, including scantness of section, cracks, seams, ragged edges, lamination, piping, etc., at the mills, the general control of fabrication, the accuracy and neatness of work, a careful comparison with approved plans, an independent estimte of weights and a supervision of painting and shipment. Perhaps the most evident value of such supervision is the accurate knowledge it gives of the progress of manufacture and prospects for shipment, and the tendency to secure the prompt delivery of the several members in the order required.

Important delays in the construction of a building generally occur in the steel work, and from three causes—failure on the part of the manufacturer to keep his promises, shipment of necessary parts late and out of order and of defective parts which at the building site require time-consuming correction or condemnation and replacing. Assuming a building costing $600,000 on property of the same value, or a total value of $1,200,000, and a rental value of 10 per cent., it is evident that the time of construction is worth $10,000 per month, or about $400 for each working day. Competent supervision of manufacture cannot force a contractor to live up to his promises, but it tends to do so, and can advise the purchaser of the fact and establish the responsibility. It can more certainly secure orderly shipments and can generally prevent and certainly correct errors and defects.

The most competent supervision at the building site cannot determine the quality of material, improve the character of shop work or prevent the delays noted above. It frequently cannot secure the proper correction of evident defects, as the loss of time to make proper correction is often of greater value, and inferior work is accepted with no other satisfaction than protest and threats of not having future business relations.

It is not necessarily to be assumed that the management of a great steel corporation or of a large bridge shop intentionally violate their contracts or generally turn out defective

*P. S. Hildreth, in Journal of Technology.

material or inferior shop work, but it is to be considered that workmen are no longer paid by the day or have an interest and pride in their work. They are only a small part of an enormous and complicated mechanical process; they are paid by "piece"—the number of tons rolled or rivets driven—and their constant incentive is to turn out the greatest quantity without regard to quality. In every large rolling mill there is a percentage of defective material—inferior ore has been used, a melt has been overheated, material has been too hot and squeezed too close, or if cold rolled, the rolls are rough, or any one of a hundred possible variations from perfect results. Such material no longer goes back to the furnace; the scrap heap has ceased to exist. It is worked off on someone who does not know the conditions, and it generally goes into the building trade and to the purchaser who is not represented at the mill.

Similar conditions pertain at the shops. To secure well-riveted, straight members, it is necessary that punching be accurate, members be carefully assembled with holes opposite and faired by reaming, and pieces held close together and straight by ample bolts, and finally that properly heated rivets be driven and the machine held for a second. All of this means care and time, and is contrary to the selfish interests of the workmen. Many rolling mills and shops have inspectors in their own employ, but they are chosen from among the workmen and have little knowledge or spmpathy with high-class engineering requirements. They are too close to the workmen, and such departments are too frequently used for purposes of deception and the getting rid of inferior materials and work rather than securing the strict compliance with specifications. It is therefore essential that testing and inspection should be done by independent men, preferably with wide experience and some technical knowledge of materials and design and the general principles of engineering.

Ten years ago an engineer would send one or perhaps two of his employees to the mill and shop and have them supervise he manufacture of an important structure. To-day one or two of the large railway systems who deal with manufacturers along their line maintain an inspecting corps in their engineering department, and can do so economically because of the large amount of work, the minimum travelling expenses and the fact that the men can be used in the field or office at times when manufacture is not progressing. Such a course is not feasible for the average architect or engineer. Manufacture is complicated, and is carried on at several mills and frequently at several rolls at once, and often at more than one shop; it is intermittent and progresses actively for several days or weeks, and then slacks off until other rollings or other classes of shop work are undertaken. One or two men cannot be at the several places at the same time, and the commercial conditions are such that the processes of manufacture cannot be delayed pending the presence of an inspector. The work therefore requires an organization of a number of men, and such men should be thoroughly experienced in their work and with full knowledge of all of the intricate methods of manufacture. They should be under direct and intelligent control of principals with full experience in the special line of work and structural engineering.

These conditions have been met by several firms or associations of enginers making a specialty of the supervision, testing and inspection of mill and shop manufacture. They are enabled to perform the work efficiently through the constant employment of a large organization of skilled assistants, and economically because of the number of clients and the performing of a large amount of such work, whereby employees are permanently located at the points of manufacture, thereby saving time and expense of travelling, and because each employee may be used on portions of the work for several clients.

The economy of such methods is shown in the reports of the Rapid Transit Commission of New York City. With a large tonnage of steel work, the engineers in charge established their own inspection department and employed from fifteen to twenty inspectors, covering from twenty to thirty points of manufacture. During one year about 50,000 tons were inspected at a cost of between 90c. and 95c. per ton for inspection at mills and shops. Subsequently the tonnage fell to about 10,000 tons in a year; the force was reduced to twelve men, and the cost was about $1.50 per ton. Had the work been equally well done by one of the well-established firms of inspecting engineers, who annually inspect over 100,000 tons of steel, it could undoubtedly have been done for from 70c. to 80c. per ton.

Like many other branches of professional work, the supervision of manufacture of iron and steel work has become a specialty, and is best accomplished by the employment of reputable and experienced inspecting engineers. To judge of the value of the services of such specialists, they should be weighed in the same scales as other experts; experience, judged from years and variety of work; facilities, by the number and location of assistants; methods, by the character of records furnished, and reputation, by the class of work done and references. Least of all is the charge for services. The value is dependent largely upon the conscience and thoroughness of the principal and assistants, and is not a commercial product to be bought from the lowest bidder; in fact, low terms can mean nothing else than poor service. Terms, by custom, are made per ton, and there is a proper variation in cost of inspection of a light, complicated structure, or a heavy, straight one. They may properly vary from $1 to 70c. per ton for mill and shop inspection, and from $150 per month to 25c. per ton for inspection of erection when desired.

Inspection of the manufacture of iron or steel work is not a part of an architect's services, particularly as it is of marked value to both the general and the steel contractor in the information it furnishes the former and the delay and expense it saves to both. It is therefore customary for leading architects to specify that the general contractor shall employ inspecting engineers, but as he may defer to the steel contractor, and it is important that they should be absolutely independent, a clause about as follows is generally used:—

"The material of all members under calculated stress shall be tested and all materials and workmanship shall be inspected at the original points of manufacture by inspecting engineers appointed by the architect, and subject to his removal. The cost of such inspection shall be paid by the general contractor at the rate of ——— cents per ton of structural iron and steel required for the building. The inspectors shall represent and report to the architect and general contractor with the view of securing the prompt and orderly delivery of members of material and workmanship specified."

In addition to this clause there should be others requiring the steel contractors to furnish proper facilities for testing and inspection without charge, and to promptly replace rejected material or workmanship; also; that, such inspection or lack of inspection shall not relieve the contractor from responsibility under the contract and specifications.

Part II.

The details of good inspection of structural steel during manufacture are stated below, and are supplemented with a few examples of the value of such inspection.

As a general principle, it is essential that the manufacture of cast-iron and steel and the fabrication of steel shapes in the shops should be supervised during their entire progress, rather than merely passed upon after portions of the work are completed. It is only by such supervision that errors and defects can be prevented, the general character of workmanship improved and delays necessary to make corrections avoided. Some defects, if not discovered until work is finished, can never be entirely satisfactorily corrected unless the entire member is rejected and replaced, which is often impracticable. When inspection is intelligently conducted on these lines it is welcomed by the best manufacturers, and is of assistance to them in promptly and properly getting out their work.

During the rolling of steel at the mills or casting of iron at the foundries, inspectors should be present and have knowledge of the stock used. They should personally choose representative test specimens and personally make the tests, in order to be able to testify in court if necessary. They should see that chemical analyses are the specified determination and personally take drillings for check analyses when desirable. As the material is cut, straightened and handled for loading, they should inspect it for accuracy of section, weight and all classes of physical and surface defects. Particular attention should be given to castings by sounding, striking edges and examination. They should report as to the tonnage of material cast or rolled and shipped, and send a list of the material accepted and rejected with corresponding detailed records of tests identified as applying to certain material. The bending test is best reported by an outline of the actual bend. Every piece of material should be accounted for. They should also report as to the prospects of securing material, and advise purchasers as to when material may be expected from the foundries or mills, and expose the falsity of statements frequently made by shops that they cannot secure material when such statements are untrue.

During shop manufacture, inspectors should be familiar with the plans and check them for clearance and compliance of shop-working plans with general plans as to main sections. They should supervise the shop work from its start, carefully watching the material for mechanical defects, particularly during punching and other manipulations, assembling of members, including preliminary comparisons with plans, matching of holes, painting of surfaces in contact and surfaces inaccessible after erection (two coats), straightness of members, riveting, facing, boring and finishing. After members are finished, and before painting is done, they should make a careful final inspection and detailed comparison with plans. They should finally see that members have all scale and rust removed and are thoroughly painted with specified paint on dry surface, are correctly marked, and are so loaded upon cars as to prevent injury during transportation. They should report weekly as to the progress of the work in the shops, showing in detail the number of pieces required, those being manufactured and those shipped. In special cases they should report the progress of manufacture and shipments daily by wire.

When work is let at a pound price, and when required, the inspecting engineers should estimate the weights of members, and in all cases inspectors should watch the scale weighing, and when weights are estimated, make a comparison of each member with its estimated weight.

When inspection is finished there should be rendered a complete final report giving a brief history of the work and describing the inspection. It should include the records of all material inspected, with the corresponding tests, rejections, variations from specifications, errors, methods of correction, statement of weights and dates of shipment, and other matters of interest, and should be a convincing certificate of the character of materials and workmanship, and all records should be original papers signed by the inspector in charge, rather than copies, in order that, if necessary, such records may become competent evidence in court, and under any circumstances will demonstrate to the architect and owner the actual performance of the work rather than the making up of results in a general office or the copying of mill or shop records.

On important contracts the individual men on the work should be known to the architect, and subject to his discipline or discharge. All reports should be rendered to the architect, with copies to the contractor and copy of final report for the owner. In general the inspection should be absolutely thorough, honest and complete. There is no man but makes mistakes, and commercial conditions of manufacture and the best methods of testing do not give absolute assurance; nevertheless, honest and competent inspection is of established value.

The following examples of errors or defects rejected or corrected under competent inspection are of interest.

Of an order of cast-iron bases for a fourteen-story office building, 12 of the first 17 cast cracked in cooling or when struck by a sledge, and showed dangerous initial strains caused in cooling; three showed open spaces inside. All were rejected and built steel bases substituted.

In a large department store cast-iron columns were used. At the foundry a considerable number were found with lugs, on which floor girders rested, hollow—apparently sound, but merely shells. The defect was apparently caused by the fact that in casting, these lugs were uppermost and the sand slightly green; when the metal was poured steam formed and the hot metal was blown up into the lug, forming a perfect surface, but stopping the vent and making an air pocket. The unsound lugs were discovered by careful sounding with a hammer. Had the columns gotten into the building a serious failure would no doubt have occurred.

The shifting of the core in casting columns frequently occurs and gives an eccentric distribution of metal and an element of danger. It is discovered by measuring through test holes.

There are many cases of beams, channels, or other shapes which are extremely brittle and break into two or more pieces under slight shock, such as unloading from a truck. This is a frequent defect of Belgian material, but not uncommon in this country, and is due to an excess of phosphorus or overheating. It is discovered in chemical analyses, in the action of the material under punching and often in cracked metal at rivet holes; it is sometimes indicated on the surface by fine cracks or ragged edges. All such material is extremely dangerous under important live loads, such as machinery, and would probably be a source of failure in the event of earthquake shocks, even if slight.

A large brewery stock house, with exceptionally heavy loads, had built columns of latticed channels heavier than the minimum section. They were ordered and rolled scant 15 per cent. in weight, and rejected at the shop on comparison with the general plans. The defect was rectified by substituting plates for the lattices, and a delay of over a month avoided.

A 24-inch I-beam, to be used as a track girder for a large travelling crane in a power-house, was rolled with ragged edges. It was rejected by the mill inspector, and shipped in spite of his rejection. The cracks were neatly puttied up, and it was offered to the shop inspector, who, being advised and on his guard, discovered and again rejected it. The suggestion of the shop to rivet on cover plates was declined, as the beam itself was defective. It was seen to be properly replaced.

Many defects of punching, assembling and fitting occur in the shops. Many thousand loose and burnt rivets are driven, and rivets are frequently omitted; many errors of dimensions occur.

A building had over 50 columns in the basement tier; the first one was found to be one foot too short, due to an error in the templates. All subsequent columns were made of correct length, and a serious delay and large loss to the steel contractor avoided.

On heavy and long columns the heat of the rivets driven in a long single or double row tends to cause a twist which makes good connections difficult and, if the error multiplies, tier upon tier, impossible. It can always be discovered by a competent inspector, and avoided by driving rivets for short distances around the column.

In a 21-story building the shop ordered the material for the exceptionally heavy columns a trifle short; it did not face to a full bearing, and the defect was rectified by using additional splice plates. In the same building errors of length of columns occurred as much as ½-inch, and were corrected by carefully planed filler plates or compensated by increased length in upper stories. Many connection brackets were misplaced and built up or correctly relocated. The inspector in charge handled the work so well as to be subsequently employed by the shop as assistant superintendent; he undoubtedly saved many days' time and large expense to the steel contractor, compared with the necessity of correcting such errors at the building site, even in cases where corrections were possible there.

Many cases occur of ends of columns not faced square to the axis of the column; in abutting column sections the error may double. It is readily discovered by a competent inspector, and corrected by milling off square and using a well-fitting filler plate.

Some exceptionally heavy-built girders were specified to have reamed holes; the shop punched them full size. They were required to be reamed for 1-inch rivets, and additional cover plates used to develop the full strength.

In a number of important roof trusses there were two sets of members of the same length and shape, but different cross-section; in the shop they were reversed in place with a reduction of strength of 25 per cent. The error was found and corrected by cutting the trusses apart and correctly placing the members.

Many connecting angles of beams are incorrectly placed, either not square or so as to give greater or less length than designed. They can be readily discovered and corrected at the shop, but give great annoyance at the building, and generally are forced in place and materially reduce the strength and stiffness of the frame.

The lack of thorough painting or substitution of a cheaper paint for a specified brand is of constant recurrence in the shops. The life of steel work in a building is undetermined, yet architects agree it should be well protected, and if a good brand of paint is specified, it should be used.

The knowledge that material is loaded and shipped in good order is a matter of importance in fixing the responsibility for injury during transportation or subsequently.

Knowledge of the actual weights, certified to by an independent inspector, is of importance in adjusting "extras." Many errors or misstatements occur. Similarly, knowledge of delays and time of starting work or making shipment is important in adjusting penalties for delays, and the information secured by an inspector is of special value as tending to prevent improper claims and disputes.

ELECTRIC EQUIPMENT OF THE CANADA TIN PLATE COMPANY'S WORKS, MORRISBURG, ONT.

The works of the Canada Tin Plate and Sheet Steel Company, Limited, at Morrisburg, Ont., are the first of the kind erected in Canada for the production of black and galvanized sheet steel, tin, terne, black and Canada plate. Tin, being proof against ordinary rust, or corrosion by acids, is most useful for culinary purposes, but, as in its pure state it is both soft and expensive, it forms for commercial purposes merely a coating over copper or iron. At Morrisburg the metal plates are rolled to the requisite weight and then go through a process of immersion in baths of the pure tin. The equipment for hot and cold rolling, pickling, annealing, tinning and galvanizing are all arranged for continuous operation with a minimum of labor.

These tin plate works have the distinction of being the first in the world to be driven entirely by electric power. The current is supplied from the plant owned by the town of Morrisburg. The electrical equipment, induction motors, switchboards, transformers, etc., was built by Allis-Chalmers-Bullock, Limited, of Montreal. The motors are of the wound rotor type, and of specially heavy construction in order to give satisfactory operation under working mill conditions.

Figure No. 1 shows a 350-horse-power, 3 phase, 60 cycle motor running at 200 revolutions per minute directly off the town mains at 2,000 volts, and operating the cold roll equipment. Starting torque is provided by switching grid-iron resistances in the rotor windings and gradually cutting out as the motor comes up to speed. The slip rings are shown on the motor shaft on the side opposite the pulley, the connecting cables beneath the floor to the grids which are not shown in the view. The motor is provided with a step cone pulley grooved for nine 9 x 7–1¾ ropes. The driven wheels are each 22 feet in diameter and the two at present in use weigh 20 tons each and revolve at 45 and 47½ revolutions per minute. The third will be lighter in weight and revolve at 50 revolutions per minute. Each wheel is designed to run direct connected 3 stands of 22-inch cold rolls and the conveyors between them.

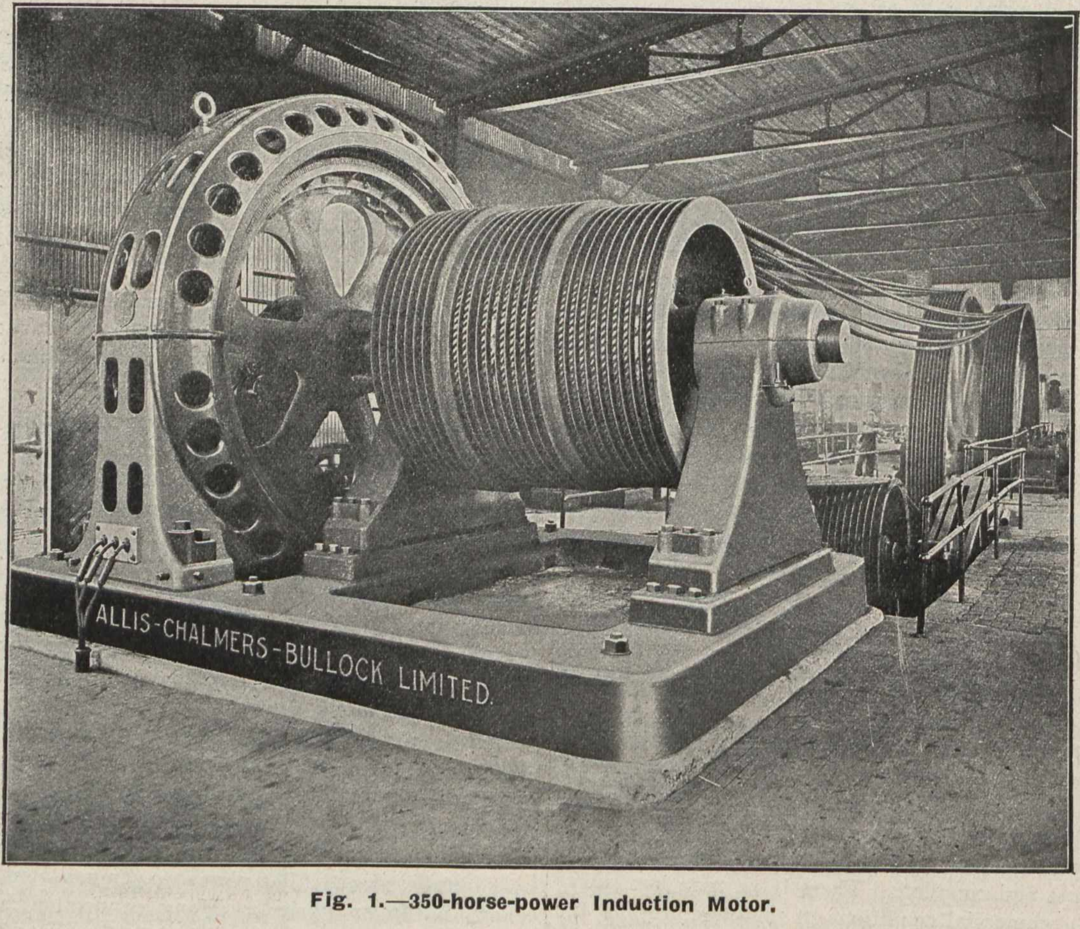


Fig. 1.—350-horse-power Induction Motor.

There are also two motors each 650-horse-power, three phase, 60 cycle running at 200 revolutions per minute directly off the town mains at 2,200 volts and operating the hot mills. The starting torque is obtained by an arrangement of resistances connected similar to those of the cold roll motor. Twenty-two 1¾-inch cotton ropes connect each motor with a 30-foot flywheel which weighs 75 tons. Each of the motors is designed to carry four sets of 26-inch hot mills. These mills are connected in train direct to the large wheel by means of 18-inch spindles and loose coupling boxes.

The buildings are of steel, concrete and stone, spacious, well lighted and ventilated. The plant is of the most improved design and constructed with a view to economical production. Mr. N. D. Lewis, the general manager, together with Messrs. Peacock Bros., engineers, Montreal, designed the lay-out. Mr. Lewis, together with Mr. B. B. Tucker, resident engineer, personally supervised construction.

HYDRAULIC MINING IN THE YUKON.

R. E. W. Hagarty, B.A. Sc.*

The pre-eminent thing in the Yukon territory, Canada, and in Alaska is, of course, gold. Commencing with south-eastern Alaska, at Juneau, is situated the famous Tredwell mine, mining the lowest grade quartz ore in the world at an average rate of about $2.60 per ton. Near the Yukon boundary, at Atlin, B.C., gold occurs to a considerable extent. Continuing down the Yukon River, we have Dawson city, once the "most celebrated camp of the North." Here gold occurs, both in quartz and free in sand. Fairbanks represents the placer mining district of central Alaska, while Nome, on the north-west coast of Alaska, is the scene of an extensive placer district, which closely resembles Dawson and its surrounding creeps in many ways.

The latest "rush" is up the Koyukuk River, Alaska, well inside the Arctic Circle. From what the writer could ascertain in Nome last August this district promises to be very rich in placer gold. It may be of interest to note the total gold productions up to 1906:—

Alaska	$ 99,650,830
Yukon	118,959,800

The gold occurs almost entirely in the free, or "placer" state. For the past twenty-eight years in Alaska and twenty-three years in the Yukon the major occupation has been the separation of this metal from the sands and gravel with which it is associated. The various processes involved are all spoken of as gold "mining"; although this term is somewhat misleading, since in few cases does anything exist which resembles a mine as usually concerned.

The "pay" sand or gravel may be found in the bottom of creeks and small rivers, in their valleys or along the hillsides. At Nome gold is also found on the sea beach, as well as along the creeks of the surrounding district. The typical gold-bearing sand is of a dark bluish-black color, and is known as "black sand." But there is also found a yellow sand. In Bonanza and Eldorado and some other creeks near Dawson it is generally acceded that this variety is richer than the black sand.

The pay sand is usually found just above bed-rock, which exists along Bonanza Basin at an average depth of about seventeen feet. At Nome rock is found to be at a much greater depth, although "colors," or indications of gold, may be found anywhere from the surface to bed-rock. In the Yukon, therefore, any method of obtaining the metal must necessarily include disposing of the ground, which, by the way, is frozen, and overlies bed-rock throughout the entire district.

The manner of occurrence of the pay sand governs the system of prospecting. The most natural places to expect gold are the bottoms of creeks, which have cut their way to almost bed-rock through this frozen ground. If such streams are shallow or dry the mining is a comparatively simple matter. Prospect holes are sunken in the valleys of such creeks, and also the contiguous hillsides are tested, and have been found to yield pay sand similar in all respects to that found in the creek bottoms. Hence, it is probable that the deposit of placer gold was of glacial origin. However, the two geological conditions which constitute the engineering problems of mining in the Yukon are the occurrence of the pay sand at bed-rock depth, and the existence of frozen ground.

Experience has developed several systems of mining, but every method depends to a greater or less extent upon the use of water. Hence, the term "hydraulic mining" may be taken to include all gold mining operations in the Yukon, although there is a special application of the term which will be referred to later. The comparative simplicity of the mineralogical aspect of placer gold also renders the term mining somewhat of a fallacy. Especially is this the case since the hydraulic portion of this unique department of engineering known as "hydraulic mining" is by far the more important, from both scientific and financial standpoints. At least, the foregoing statement is true of operations as carried on at the present time, when the ground is being worked at a cost of millions and the entire country virtually controlled by large corporations.

Fig. 1.—A Yukon Gold Dredge.

It is the intention of this article to deal with the several methods of gold mining employed in the Yukon the arrangement being in logical order of development, and in a subsequent article to describe the complete hydraulic and hydro-electric installation of the Yukon Gold Company, which has been necessitated by the vast extent of their gold mining project, and recently constructed on this account. Certain statistics will be introduced which have been assimilated during the writer's connection with the work. However, much of the information, and also any opinions expressed in both articles, are the result of personal observation, and are in no way intended to relate to financial or speculative interests connected with stock manipulation.

The Placer Mining.

The fall of 1906 saw the beginning of the great Klondike gold rush. Thousands of prospectors tramped over the hazardous White Pass route from Skaguay to White Horse and floated down the Yukon River in small boats to the junction of the Klondike River, where the city of Dawson sprang into existence. This new town became the metropolis of the world-famous gold district, which comprises Bonanza, Klondike, Eldorado and other creeks bearing familiar names. The average annual production of this district has been $12,000,000.

* With Hazen & Whipple, consulting engineers, New York.

The host of derelict miners from California and fortune-hunters from all parts of the earth had not travelled to the perilous North for any other purpose than getting gold, and as a result there was instituted an almost socialistic tendency for personal independence, which spirit pervaded the entire aggregation. For example, it was (and is yet in certain quarters) considered decidedly "infra dig." to work for any other than one's self. The great richness of the ground lent

Fig. 2.—The Bucket Line.

itself admirably to this condition, inasmuch as the dust was easily separated by washing the gold-bearing sand in flat pans, the operation being known as "panning." The general system, where claims are worked by one or two individuals, according to the panning or other simple process, is known as "placer mining." To illustrate the ease with which gold was obtained by this method the words of an old placer miner may be quoted from a conversation with the writer:—

"Gold! Why, gold was the cheapest thing in the country. One time I needed the price of a couple of meals, so washed my working clothes, and upon panning the refuse obtained $11."

To doubt the honesty of this statement would be a misdemeanor against the unwritten law of the Yukon. Can there be any wonder, then, that there existed this spirit of personal freedom which permeated the country, and which reigned supreme until three or four years ago, when corporation interests invaded the Yukon? The advent of the capitalist, needless to say, was the cause of strife, and was entirely in opposition to the Yukon idea as entertained by these freeborn men of the North, who considered it an unpardonable offense to "work for the Guggs" (as Guggenheim brothers are popularly termed) at four dollars per day and board. However, it is only fair to explain that the large mining companies are working ground which has been largely abandoned by the placer men as being of too low grade to be profitably handled by their primitive methods.

Method of Sluice Boxes.

The crude system of panning gold is only applicable where pay-sand is easily obtained, such as the bottoms of creeks; but even in this case it is an advantage to use "sluice-boxes" as a means of separation. A continuous open channel, made of lumber and of cross-section, about two feet by one foot, with "riffle blocks," constitutes a sluice-box. The riffle blocks are strips of wood, usually, about one inch by one inch, nailed across the floor of the box, with a space of about one-half inch between strips. The boxes are from fifty to several hundred feet in length, and are placed on grades not less than about two per cent. Water carrying the sand, etc., is run through the boxes at such a velocity that the pebbles and particles of sand are carried away with the water, while the gold sinks and is safely deposited in the openings between the riffle blocks. Every few days a "clean-up" is made, when the gold is recovered.

There are several methods by which the gold-bearing sands are moved, but in every case, except that of panning, the sluice-box in some shape or form is the ultimate means of separating the gold. The variation in the methods of operation lies in the diversity of ways in which the sand is obtained ready for sluicing. For instance, there are several ways to dispose of the frozen ground; also, there are two possible locations, hillside and valley. The latter situation requires the sand to be elevated before sluicing.

After the foregoing remarks the reader is probably in a position to better understand the various engineering problems by specific descriptions of the several distinct methods of dealing with certain difficulties. Throughout the entire Yukon the ground is frozen to bed-rock, and remains so permanently, with the exception of from one to three feet on top, provided the overlying moss is not disturbed. The moss is about one foot thick, and covers both hillside and valley. The somewhat surprising thing with regard to it is that all through the summer the moss, even on the hillsides, is wet, and presents a boggy tendency under foot. From the layer of thawed ground underlying the moss arises a vegetation which is almost tropical in its luxuriance. But in spite of this delusionary condition of the surface, everywhere frozen ground can be found. It is this condition with which an engineer finds himself face to face. There are two ways of thawing ice: by heat, or by running water. Consequently, there are the following ways of disposing of the frozen ground:—

(a) If the moss is stripped off the sun will thaw the ground to a depth not exceeding seven feet during the summer season of about four months. However, if the resulting "muck" is removed continually the thawing may proceed to a greater depth at a rate of about from six inches to one foot per day.

(b) Another method is to place fires on the surface of the ground; but this method is uneven in its effect and otherwise uncertain.

(c) Still another system is to run water over ground which has been stripped of the moss; thus the ground is

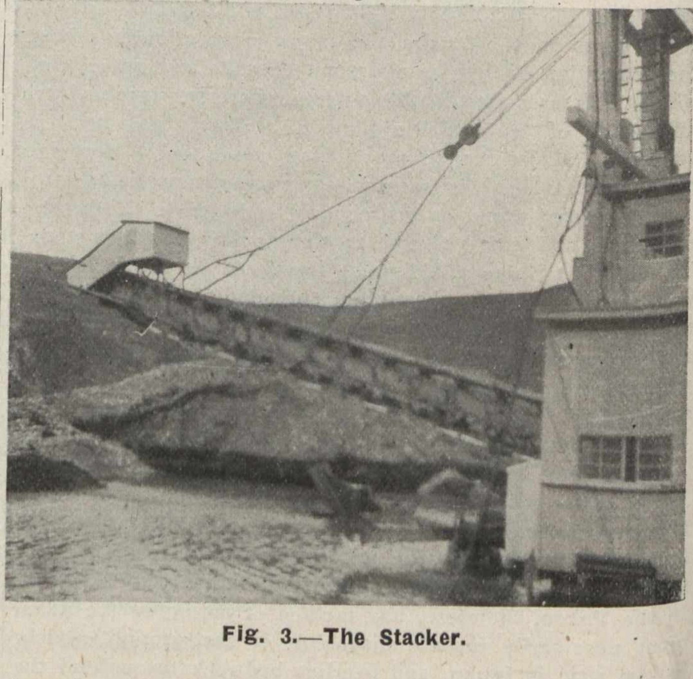


Fig. 3.—The Stacker.

thawed and removed at the same time. This will be dealt with under "hydraulicking."

(d) A fourth method involves the use of steam.

Thawing by Steam.

This is one of the most unique, ingenious, and scientific operations in connecion with Yukon mining. Steam is supplied by a main boiler through feed-pipes and branch pipes, and finally through rubber tubes to "steam points," which are driven into the ground at regular intervals. The "points" are merely iron tubes, with a steel-pointed shoe on one end, by means of which the tube is hammered down to near bed-rock. The steam is emitted from the tube horizontally through holes in the side, close to the point. A description of a thawing plant which the writer saw in operation may convey a more complete idea of the process. A 90 horse-power boiler supplied steam for eighty points, which were driven to an average depth of about fifteen feet on eight-foot centres. The points consisted of ⅜-inch and ¾-inch diameter iron pipes, with steel shoes. Steam was delivered to the points at an indicated pressure of twenty pounds. The points remained in the ground from two to three days. The operation kept five men shifting points and one man in the boiler-house.

After the foregoing outline of the frozen ground problem it may be well to continue with the description of the various mining methods. The first advance on the original placer mining by panning was the introduction of sluice-boxes, used wherever sufficient water was available. Following this came the introduction of machinery. Claims were worked by the open-cut, or by the drift and hoist method. The open-cut system merely entailed excavating to pay-sand, either by the hydraulic method or by thawing and removing the earth and sand by hand labor, by steam shovel or by a bucket elevator.

The drift method consists of sinking a mine shaft in the usual way and "drifting" or running underground cuts,

Fig. 4.—Operating a Hydraulic Plant.

the sand, etc., being elevated as before and sluiced. These two methods, while improvements on the original process, were more or less crude. The cost of equipment in these cases never exceed about $8,000, and included the following: One 6-inch discharge centrifugal pump for elevating water for sluicing; one 40 or 50 horse-power boiler, with an 8 or 10 horse-power engine, working a hoist and self-dumping bucket; a small pump of 3-inch discharge and 1-inch nozzle, used for thawing, or else a set of steam points. Such a plant has a capacity of about fifty cubic yards of material sluiced per day. Of recent years mining has been attempted on a much larger scale. In general, the three systems employed by large companies are:—

(a) Dredges for creeks and valleys.
(b) Hydraulicking for the hillsides.
(c) Hydraulic and mechanical elevators.

The Dredging System.

Externally, a dredge (see Fig. 1) is similar in appearance to the usual type, except that instead of the familiar arm and dipper the excavating is done by a series of dippers connected to a continuous chain belt arrangement known as a "bucket-line" (see Fig. 2).

The dredge is floated primarily in a creek. The buckets are caused to dig from the bottom of the creek to near bed-rock, where pay gravel is found, and excavation is gradually carried into the bank. Thus the dredge literally "eats its way," forming its own channel. The gold-bearing sand and gravel is mechanically sluiced inside the dredge, and the refuse, known as the "tailings," is carried out of the back of the dredge by a conveyor or "stacker" (Fig. 3).

The main points in the distribution are to get the conveyor long enough to stack the coarse material to a height sufficiently great, and far enough behind the dredge, so that it will not run back; also, the fine tailings must leave the dredge at an elevation which will ensure storage room.

The disadvantages of this system are, first, that the place of excavation is not visible; and second, the dredge only operates to bed-rock. Frequently gold is found four or five feet down in the rock crevices, jointage and bedding planes.

It will be seen from the system of dredging briefly described that the original course of a stream does not limit the field of working of the gold-dredge, since its operation permits of excavating anywhere in the valley, or, technically speaking, on the "benches" contiguous to the river on which the dredge was originally floated. In this lies one of the chief advantages. A most concise description of a "gold-ship," to use popular parlance, is given by Mr. F. W. Griffin, M.E., of San Francisco, Cal.:—

"The dredge of the present day is the endless chain elevator type. An endless chain of buckets is carried on rollers resting on a steel ladder. The upper end of this ladder is hinged on a gantry frame, about twenty feet above the deck of the dredge. The lower end of the ladder is suspended by cables, which pass over sheaves to a drum on a winch, so that the ladder may be raised or lowered to feed the buckets. The buckets pass over tumblers at the upper and lower ends of the ladder. The power to drive the bucket line is applied at the upper tumbler through gears. The material as excavated by the buckets is dumped into a hopper, and from this hopper is fed to revolving or shaking screens. Water under pressure is forced from spray pipes over the screens on to the travelling gravel. The gold-bearing material passes through the screens into a distributor, which feeds this material and water to tables provided with riffles. These tables in turn discharge into side or tail sluices, which deposit the fine tailings well behind the dredge. The coarse tailings, after being washed on the screens, pass from the screens to a conveyor, which carries these tailings 30 to 50 feet behind the dredge and stacks them 20 to 30 feet high."

The capacities of dredges vary from 40,000 to 70,000 cubic yards per month, figured on the basis of a 20-hour day. This limit of size is considered economical, although 100,000 yards have been handled. This rated horse-power of a dredge approximately from 185 to 260, although no definite law can be established for accurately determining this requirement, owing to the continual occurrence of sudden over-loads, due to the buckets striking heavy boulders, etc. Steam has been used as a driving power, but a modern equipment will include an electric installation for running the dredges. In this case it will readily be seen that the motor must be designed for variable speed.

Figs. 1, 2, and 3 illustrate a Bucyrus dredge, made in South Milwaukee. The actual capacity varies from 2,000 to 2,500 cubic yards per 20-hour day. The rated horse-power is 250, distributed as follows:—

(a) Bucket line, 100.

(b) Cenrifugal pump, used in elevating water for sluicing, 75.

(c) The stacker, 25.

(d) The rotary screen, 30, (used for preliminary sifting of large stones).

The remaining 15 horse-power is utilized in shifting the bucket line and in sundry small requirements. The gold, sand, gravel and water enters the dredge by the bucket-line and receives a preliminary sifting in the rotary screen, in which the meshes are ¼-inch diameter on ½-inch centres. Subsequently, the remaining slurry of gold and sand is run over a series of metal sluices, the gold being deposited between the riffles and the sand being carried out by the stacker.

Hydraulicking.

Figs. 4 and 5 illustrate the general system of excavating sand and earth, known as "hydraulicking." This method of moving ground is more or less in the experimental stage, but is a unique engineering digression, unfamiliar to many members of the profession, and more especially easterners.

In brief, the process is as follows: Water under considerable pressure is discharged through large nozzles, called "giants," for the purpose of tearing away earth, sand or gravel from the side of a hill which for some reason is to be either excavated or entirely removed. The water, after disintegrating the particles of sand, etc., carries them away in suspension. Consequently, the chief topographical requirement for hydraulic excavating is to secure natural grade sufficient to carry away the water at a rate exceeding the scouring velocity of the particular material to be moved. The operation applies, then, essentially to hillsides.

The frequent occurrence of hydraulic methods in the Pacific West may be partially due to the prevalence there of high-pressure gravity water supply. However, in many places throughout the West hydraulicking is carried on where the pressure has to be supplied by mechanical means; even in this case the cost of excavating enables the methods to be called cheap. The latter is the case in the city of Seattle, which is built on hilly ground. The process of levelling off the hilltops, and also of transporting the same material to "fill" the valleys, is done by hydraulicking, in

Fig. 5.—The Effect of Hydraulicking.

which the water pressure is supplied from an electrically-driven pumping installation. The operations are eminently satisfactory.

In Fig. 4 there is shown a "giant" nozzle, which is mounted on a swivel pivot, enabling the operator to change the direction of the stream horizontally and vertically. This nozzle is 3¾-inch diameter size. The head on the nozzle is 110 feet. The water is supplied through the 16-inch diameter wood-stave pipe shown in the illustration. The range of the jet is about 50 feet. The capacity of this giant is about 2,500 cubic yards in twenty-four hours.

Fig. 5 shows clearly the jet and the flow of the water shortly after leaving the cut, and just before it is collected in a sluice-way and transmitted a distance of 2,000 feet or more.

In the Yukon this principle, it will be seen, is readily applicable to mining purposes, the main problem being the source of water supply.

The effect of running water on the frozen ground has a thawing tendency; consequently where water is available hydraulic giants may be used to advantage. Both excavating the ground to bed-rock, and also sluicing the pay sand are accomplished by the method which has been described as hydraulicking.

Hence, we have the specific application of the term, "hydraulic mining." Successful results have been obtained in the Yukon in connection with this important subject. Mr. Coffee, at present hydraulic expert for the Yukon Gold Company, made a report to the Anglo-Klondike Company in 1902, in which he stated that 29,000 cubic yards were sluiced in twenty-two days. The cost of hydraulicking was only 15 cents per cubic yard. The total operating expense was 35 cents per cubic yard, or $1.96 per square yard of bed-rock. It is also stated that the average cost of mining and sluicing by the ordinary drifting method amounted to $5.85 per square yard of bed-rock.

Hydraulic and Mechanical Elevators.

It will be readily seen that a certain lower portion of the hillside is not available for hydraulicking, since some drop is necessary for the usual method of sluicing.

In some portions of Bonanza district it is fortunate that the pay gravels occur on comparatively narrow benches cut into the sides of the valley at elevations of from 150 to 300 feet above the present valley bottom. Speaking generally, however, the ordinary hydraulic and sluice-box method will have the disadvantage referred to; and for the purpose of eliminating these deficiencies an ingenious method has been tried and proven by recent experiments to be successful.

The system involves practically a combination of the two methods previously described, viz., dredging and hydraulicking. A large sump hole is excavated 12 or 14 feet below bed-rock at its lowest elevation in the valley. Channels are cut to rock at desired places from top to bottom of the hill. Hence, it is possible to create a network of these small canals, which are hydraulicked into the common cesspool, from which the sand and water is elevated to a sufficient height (about 70 feet) for sluicing.

The "hydraulic elevator" consists mainly of a system of centrifugal pumps." In the "mechanical elevator" the lifting is done by a chain-bucket line similar to that used on a dredge, but connected with a rigid steel framework, placed on a hillside preferably, so that the bucket line is at a slight incline.

The Yukon Gold Company have acquired large holdings in the vicinity of Dawson City, and are planning very extensive dredging and hydraulic operations. The scheme, which includes water supply and power development, is one of the largest of its kind ever attempted. In a subsequent article, "Hydraulic Engineering in the Yukon," the writer will describe the complete hydraulic and hydro-electric installation, which is nearly completed at a cost which can only be figured in millions.

CANADIAN ISSUES IN 1908.

Nearly $143,000,000 New Capital Has Been Supplied Since Beginning of the Year.

From the commencement of the year to the end of last month, new capital was supplied to the extent of nearly $143,000,000 for the development of Canada. The figures, which have been compiled by Mr. E. R. Wood, vice-president of the Central Canada Loan and Savings Company, are as follows:

Government issues	$43,500,000
Railway issues	64,000,000
Municipal issues	20,270,000
Miscellaneous issues	15,075,000
Total	$142,845,000

A press telegram from Pittsburg of 27th, speaking of a further decline recently in price of steel-making pig iron, says this makes it more probable that finished steel prices will have to be reduced. And instead of any advance in price of structural steel at once after the election, this advice declares the belief of some authorities to be that the question of a general reduction will be considered seriously.

IDEAL RELATIONS BETWEEN THE CENTRAL STATION AND THE CONTRACTOR.

George Lewis.

The relations between the central station and contractor should be co-operative in character; both are depending upon the sale of electrical energy for their livelihood and prosperity, and more can be accomplished when both are pushing than when they are antagonizing each other.

Unfortunately, there exists in many places about the country a lack of this harmony, a working at cross-purposes, that cannot be helpful in its effects upon this industry.

The contractor suffers because the central station invades his legitimate field by competing with him in construction and repair work, and by selling apparatus at profit that is ruinous to the contractor.

I presume the central station justifies such a policy, because they desire to create a sale for their product, and they think the contractor cannot do much for them in this capacity. Whatever their reasons are, this kind of policy is responsible for much of the bitterness which now prevails between these two branches of the electrical business, a friction as foolish as it is harmful.

From my point of view an opposite policy would be more conducive to the greater good for both.

"In union there is strength" is more than a platitude, in business as well as politics. The truth must be recognized that the greatest measure of success must depend upon the prosperity of each, and the success of each must promote the interest of all; that principle is established beyond cavil, and no intelligent man in this day and age has the temerity to hold up his hands and say, "The Millenium," when some one proposes to work along these lines.

The primary feature of the central station's business is the sale of "juice," and, all other parts of it being secondary, and, therefore, of less importance, it would seem to me that the most profitable policy for them to adopt is the one that will yield the greatest results to the primary purpose.

The most essential thing for the central station is to first create a friendly public sentiment, and, after having obtained it, to keep it. This requires the maximum of harmony and diplomacy, and to have this every firm and individual engaged in the electrical business must be considered.

If the contractor is a competitor, he is a disturber, and, therefore, a source of irritation so far as his influence for or against the central station is concerned.

The central station should do no construction work, except on very small jobs, where they come into close competition with the gas company and want to displace a gas arc or something of this nature. Their solicitors should obtain house-wiring and other contracts and turn the work over to one of the local contractors, being careful not to show any partiality to anyone. In return for this consideration the contractor should establish a schedule of prices for wiring houses and other small buildings that would be equitable to all concerned, and this schedule should be used by the central station solicitors, in going after all work, as it would enable them to estimate almost any job quickly and intelligently, thus saving time and not arousing a suspicion in the mind of the prospective customer that someone is trying to rob him, as is too often the case when this co-operation is lacking, and bids of varied amounts are submitted. This schedule plan has been attempted in some quarters with more or less success, and has attracted some attention by becoming the subject of comment in a congratulatory way by the electrical press in many parts of the country. By turning this business over to the contractors on this schedule plan the central station would be enabled in a great degree to regulate this class of work. They have a record of the transaction, they maintain a uniform price, and thus secure justice to the customer, and the contractor secures his legitimate profit; the latter is, therefore, a satisfied "booster" instead of a "thorn in the flesh" to rankle and burn, because he helps create a sentiment unfavorable to his natural ally.

The contractor, in turn, should use his influence in every way to create satisfied customers for the central station, and it would be possible for him to allay much criticism that is unjustly directed at the central station. Too often the contractor takes a negative position so far as the central station is concerned in advising the customer to cut down his connected load and reduce his bills. It would be much better for him to not emphasize a reduction of bills, and, therefore, less consumption of current and a reduction of profit to the lighting company, but, instead, to advocate more light. The customer is not so much concerned about the amount of his lighting bills as he is about the quality and quantity of the illumination he is getting for the money expended; a co-operative policy of this kind would do much to eliminate this source of annoyance, and the contractor would thus become a positive instead of a negative factor in his relation to the central station.

The central station could go further than this: they could make it possible for the contractor to purchase various heating devices, fans, fixtures, etc., by combining their requirements, and thus buy in such quantities as would secure the minimum cost. This would enable them to mutually establish a re-sale price representing a fair margin of profit, and every one could sell the same article at the same time and at the same price; this, with simultaneous advertising and window display, would yield better results. Another good feature of such an arrangement would be, one manufacturer's flat iron, toaster, heater, etc., could be used, which would reduce the annoyance of the customer in procuring renewals, occasioned by the use of many different brands of the same device. The possibilities in this line are almost limitless.

The central station should show consideration for the contractor by giving the latter a list of their prospective motor and apparatus customers, that all might be solicitors for the man who wants to sell his current. It should be impossible for anyone to sell any apparatus at cost or below retail prices, and the central stations should place themselves in a position not to do anything to reduce the contractor's profits, or in any other way belittle him. The contractor would, therefore, have greater consideration for the central station, would exercise more care in not selling a customer a motor to use on a direct current lighting circuit when he ought to have an A C. motor or a 60-cycle motor when he should purchase a 30-cycle or a three-phase motor for a single phase circuit, etc. All these cause great dissatisfaction and irritation, and may be reduced to a minimum.

This policy would give the central station a restraining power that no other policy could possibly give. If the contractor is tempted to introduce and push the sale of some new device or product that for some technical, engineering or other reason the central station deems inadvisable to adopt, the fact that this co-operation is so beneficent in its results would restrain the contractor from yielding to any temptation that would embarrass his ally and friend.

The foregoing and many other things growing out of this policy must appeal to the central station man who wishes to exercise some regulation over the prices, sales and methods of associated interests affecting public opinion and the sale of his product, as he wants the best results and can obtain them in no other way. It must appeal to the contractor, because it is his "bread and butter"; it is his chance to associate with larger interests, to develop greater business and larger business capacity.

Moreover, it is not only the ideal relation, but, in the light of the best knowledge of this generation, it is the only relation that will give these kindred interests their full degree of development.

* Read before the Michigan Electrical Association.

SOME PARTICULARS OF THE MUNICIPAL PURIFICATION PLANT AT LINDSAY, ONT.

First municipal ozonizing plant to treat the entire water supply of a town on the American continent.

Constructed under contract with the town of Lindsay by J. Howard Bridge, the inventor and patentee.

Daily capacity, 1,500,000 gallons.

Cost, including pre-filter, $7,250.

Cost of operation, 8 horse-power, for which the town pays $35 a horse-power year. This equals $280 for the treatment of 547 million gallons yearly, or 51c. per million.

There are no other costs, the plant being operated by the regular employees of the pumping station.

Besides breaking all waterworks records for cost of installation and economical operation, Mr. Bridge broke all records for rapidity of construction, which in the purification of a public water supply is of almost equal importance. Mayor Begg, of Lindsay, turned the first sod on August 24th. The plant, including a pre-filter of reinforced concrete, was completed and in operation on October 23rd—a little over eight weeks.

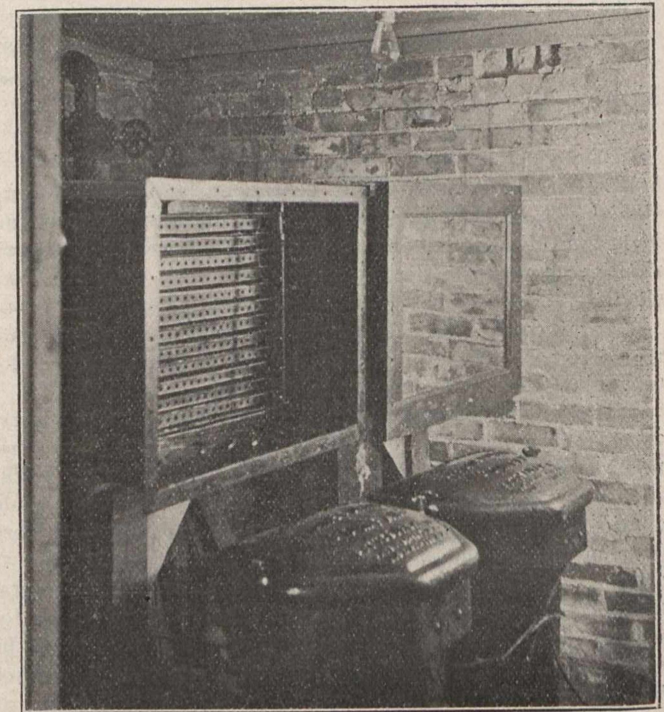
Plant Under Construction.

The ozone-purification plant is located at the city pumping station, on the banks of the Scugog River, from which the town supply is taken. The Scugog is a sluggish stream running from a shallow lake of the same name into Sturgeon Lake. The water is strongly charged with vegetable matter derived from the lake and surrounding swamps, and this, besides affording a rich pabulum for bacteria, imparts an unpleasant odor and taste to the water. As a result the citizens have had recourse to well-water, which in itself has not always been above suspicion, and typhoid fever has been quite prevalent in the town.

Prior to the installation of the ozone plant, a rough and ready sort of filtration was practised which did little more than strain out the grosser particles of suspended matter. The new system includes a modern rapid filter of reinforced concrete, a sterilizing well forty feet deep and about six feet square, and a purified-water basin from which it is pumped directly into the mains of the town. The system is so contrived that the water passes entirely by gravity from the river through the filter and sterilizing well to the suction pipes of the pumps; while in the electrical part of the plant there is a similar absence of mechanical means, so that with the exception of a small blower of ¼ horse-power there is not a wheel turning anywhere. By an ingenious automatic device the graded opening of a single valve admits varying quantities of water to the apparatus as required by the needs of the town. At ordinary times the pumpage is five hundred gallons per minute. During fires this may be doubled; in either case the rate of filtration and ozone sterilization is simply regulated by the operation of a raw-water valve, and no other attention is required. So too, when the pumps are completely stopped, provision is made by which the ozone produced is automatically drawn from the ozonizers, so that these may safely run continuously should the attendant neglect to turn off the electric current supplying them.

To come to details. A twelve-inch pipe leads from a crib sunk in the river to a raw-water basin, holding fifteen to twenty thousand gallons. From this the water flows into a rectangular tank of reinforced concrete, some 12 feet by 15 feet, where it passes through three feet of coarse sand, to strain out the suspended matter. This pre-filter is cleaned by simply reversing the current, the wash-water coming from the city main under a pressure of 60 to 100 lbs. to the square inch. The cleansing process occupies about three minutes, and is practised every day when the river is especially foul. At other times the filter may run several days without washing. The waste-water after washing the sand escapes into the river through two eight-inch pipes furnished with check valves. After rough filtration the water under treatment flows through an eight-inch pipe into another chamber, in which its height is automatically regulated by a butterfly-valve and float. Here it passes into an air-tight box built of concrete, which is directly connected, by means of a two-inch pipe, with the ozonizers, in a small building adjoining. The water now falls down a number of four-inch pipes leading to the bottom of a well, thirty feet deep, and in doing so passes the ends of a great many small brass tubes, through which, by suction, the ozonized air is drawn and thoroughly mixed with the water. An arrangement of baffle-plates prevents the too rapid escape of the ozonized air from the water, and the two fluids, thoroughly commingled, flow slowly up the well into a pure-water basin, where the non-exhausted ozone separates from the water. When thus freed from the purifying gas, the water is allowed to pass to the suction pipes of the pumps, which send it at once through the city mains and to the stand-pipe.

The ozonizers occupy a brick building only 8 feet by 10 feet, built against the pump-house. They consist of two iron boxes, each containing 26 separate units. Each unit has its own fuse, so that, if by any chance, a short-circuit should occur, the unit affected would be the only one to go quietly out of commission, while the remainder would continue operative. These units are so constructed that a workman can remove or replace them in a few moments.



Ozonizers—One with Glass Front off to show the Twenty-six Separate Electrodes.

The city current is brought into the building at 1,040 volts, and is raised by step-up transformers to 10,000 volts. Each of the two ozonizers has its own transformer, and independent air inlet and outlet, so that they may be operated together or separately. The air is sucked into the apparatus by the movement of the water through the sterilizing well, and no air-pump is used, as is the custom abroad. Nor, contrary to European usage, is anything done to free from moisture the air admitted to the ozonizer. Mr. Bridge has found that while a larger output of ozone results from drying the air admitted to the ozonizer, the difference is not enough to justify the cost of operating a refrigerating machine, or even of installing any of the chemical dryers used elsewhere. It is by the cutting out of an air-pump, which costs twice as much to operate as does the ozonizer, and the elimination of an air-dryer, that the Howard Bridge system has demonstrated its superiority to that tested by the officials of New York City, who showed that the cost of ozone in water purification is only 25 per cent. of the whole, the remaining 75 per cent. being used up by the air-pump and refrigerating machine.

In regard to the efficiency of the Lindsay plant, there can be no question as to its having already met the chief conditions called for in the contract made with the town—that the plant "will successfully purify to an absolutely safe extent, from a sanitary and public health standpoint, the water to be supplied through the said waterworks system, and will remove all objectionable color, taste and smell from the said water, and will destroy all germs or constituents which shall prove dangerous or shall be liable to prove harmful to the health of the people using the same, and shall be bright and clear and palatable to the taste, and shall not be rendered in any way injurious to the waterworks system, or the piping thereof by reason of passing through the said process." The effluent of the plant is clear, bright and palatable, and it is free from objectionable color, taste and smell. Presumably it is also free from noxious germs, as the bactericidal properties of ozone have been so abundantly demonstrated as now to be accepted as a matter of course. An elaborate series of bacterial tests are about to be conduced at the Lindsay plant by Dr. Amyot, official bacteriologist of the Province of Ontario, which will be made public in due time. In the meantime the eyes of sanitarians and hygienists throughout the United States and Canada are directed to this first municipal ozone purification plant on the American continent, which, if it fulfils its present promise, may revolutionize all accepted ideas of the purification of public water-supplies and its costs.

SOCIETY NOTES.

Engineer Society, McGill University.

The importance of the business end of engineering is becoming constantly of greater importance, and, recognizing this, the Faculty of Applied Science of McGill University has added to its curriculum a course of lectures dealing with that topic. The lectures will be delivered by Mr. Robert A. Ross, E.E., of Messrs. Ross & Holgate, of Montreal. Mr. Ross will deal with the relation of engineering to business, with money and credit as applied to engineering, with the business organization and the operation of companies, the purchase and sale of material, with the booking and accounting of engineering, and with estimates, specifications, contracts and reports. Mr. Ross has had an extensive experience in the branches upon which he will lecture.

Engineering Society, Toronto University.

On October the 31st the Engineering Society of Faculty of Engineering, Toronto University, held their annual excursion. This year they visited the large manufacturing plants and extensive engineering works of the city of Buffalo. Dean Galbraith, Prof. C. H. C. Wright, Prof. H. E. T. Haultain, and R. Marshell, president of the Society; Mr C. H. Mitchell and Mr. E. A. James accompanied the two hundred and seventy members who took in the excursion.

Buffalo is an ideal city for engineering students to take an excursion to, as large works connected with every branch of engineering are in operation there.

By far the most popular place to be visited was the Lackawanna Steel Company's plant. The visitors were taken through these works in parties of twenty, and were able to follow the complete steel process, from the ore-dump through the blast furnace, open-hearth furnace, rolls, etc., until the finished rail or angle bar was turned out.

Other points of interest were the city harbor works, city pumping plant, Buffalo General Electric transformer station, International Railway power house, and the Thomas Motor Works.

Toronto Branch, Canadian Society of Civil Engineers.

The regular meeting of the Toronto Branch was held on October 29th, and a large number of members were present. Mr. C. H. Mitchell, chairman of the Branch, presided. Some time was taken up in discussing various suggestions that were made as to what might be done to increase the influence and usefulness of the Society. Dr. J. Galbraith, president of the Society, suggested that, perhaps, the Society was attempting to cover too large a field, and in so doing some of its usefulness was lost. Other members took part, and, although the discussion lasted for an hour or more, no definite stand was taken on any question.

Following the discussion Mr. Stanislas Gagné, B.A.Sc., read a paper on "Notes on Canadian Forestry." We will give more space to this paper later. Additional interest was added to this subject because of the many lantern slides used. Dr. Fernow, Dean of Forestry, and Mr. T. Southworth, formerly director of Forestry for Ontario, also took part in the discussion.

ORDER OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee.

5442—October 16—Granting leave to the Dunnville Consolidated Telephone Company to erect, place, and maintain its wires across the track of the G.T.R. at Cedar Street, Forks Road, Dunnville, Ont.

5443—October 16—Granting leave to the Dunnville Consolidated Telephone Company to erect, place, and maintain its wires across the G.T.R. at Canfield Junction, Ontario.

5444—October 14—Authorizing William Brown of Lennoxville, P.Q., to lay water pipe under track of G.T.R. at a point 1,047 feet south of mile post 106 from Montreal, or 359 feet from where the line between Lots 6 and 7, in the 6th Range, Township of Ascot, crosses the railway.

5445—October 20—Granting leave to the Central Barbed Wire Telephone Company of Alberta, to erect, place, and maintain its wires across the C.P.R. 600 feet north-west of Nanton Station, Alberta.

5446—October 20—Granting leave to the Bolton Telephone Company, Limited, to erect, place, and maintain its wires across the track of the C.P.R. between Concession 6 and 7, Lot 23, Township Albion, Ontario.

5447—October 20—Authorizing the C.P.R. to construct, maintain and operate branch line of railway to and into the premises of the Cranbrook Sash and Door Company, Limited, Kootenay District, B.C.

5448—October 20—Authorizing the C.P.R. to construct bridge No. 41.8 on Boundary Section, B.C., of its line.

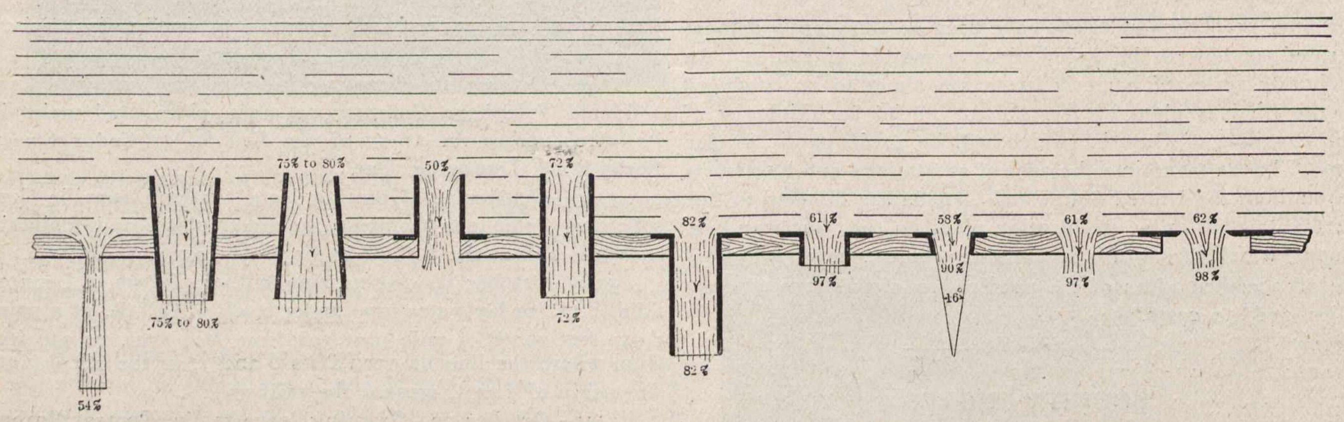
ENGINEER'S LIBRARY

ORIFICES FOR THE MEASUREMENT OF WATER.

F. VanWinkle in Power.

The discharge of water from orifices varies greatly according to the location and form of the opening. When placed in the side of the reservoir, the upper edge of the opening should be completely submerged, and generally speaking, the head on the orifice should be three or four times its vertical height; otherwise, there will be interference in the formation of complete contraction. Contraction causes only the inner corners of an orifice in thin plate to be touched by the escaping water, and the issuing jet for some distance beyond the contracted portion retains the form of the aperture. When the orifice has uniformly sharp edges, the issuing stream from a round, square, rectangular or triangular orifice presents the appearance of a beautiful crystal bar.

The most carefully conducted experiments indicate that the smallest orifices under small heads give submerged discharges of less than 1 per cent. below free discharge into the air, and that when the orifice is as large as one square foot, excepting for very small heads, the difference is not appreciable. For all practical purposes a sharp-edged orifice with submerged discharge may therefore be regarded as having the same per cent. of theoretical discharge as though discharging freely into the atmosphere with a head due to the difference in level.



Many different forms of aperture have been devised with the purpose of increasing discharge, but those which concentrate the outflowing jet most nearly to the form of the natural curve assumed by the contraction of the jet from an aperture in thin plate come nearest to imparting as high a velocity as the thin-plate aperture does to its most concentrated portion of the issuing jet. It would seem, however, that the form and properties naturally assumed by the vein from the aperture in thin plate should not be expected to be surpassed when we take into account the fact that it concentrates as much as 98 per cent. of all the velocity due to gravity in its discharge, leaving only 2 per cent. of the theoretical 100 per cent. for overcoming the friction of approach to the aperture and the reacting resistance of the atmosphere. Paths of particles approaching the aperture are parallel almost all the way back to the entrance and create less contraction; and in addition to atmospheric pressure on the surface of the water tending to increase the velocity of particles toward the vacuum space, atmospheric resistance opposing the discharge combines to increase the size of the issuing jet. This results in less velocity of jet, but it increases the discharge. An ajutage of this kind, if made only large enough for the suppression of the contraction and without increasing its length to that point where it becomes a pipe which would offer frictional resistance, will increase the capacity of discharge of the entrance orifice more than 25 per cent., so that its actual discharge will be about 82 per cent., in place of 62 per cent., of the theoretical discharge due to the head.

If the tube projects into the reservoir, the discharge will be 72 per cent. of the theoretical, a reduction of about 12 per cent. of the net discharge.

But if the inward-projecting tube is so short that the entrance acts as an aperture in thin plate with natural contraction, it is found to have a coefficient of discharge of only 50 per cent., as against 62 per cent. obtained by placing the aperture directly in the vertical side of the vessel. It may be said generally of inward-projecting tubes of various forms, that they yield less discharge than when the entrance end is flush with the side of the reservoir. The contraction is smaller than the ordinary orifice in thin plate, indicating a greater convergence of the lines of direction of filaments.

BOOK REVIEWS.

Industrial Electrical Measuring Instruments.—By Kenelon Edgcumbe, A.M. Inst. C.E., M.I.E.E. Published by Archibald Constable & Co., Limited, 10 Orange Street, Leicester Square, W.C., London; pp. 227, illustrations 126. Price, 8s. net.

This book is a practical treatise, dealing with the details of construction, theory and working of the various types of electrical measuring instruments in general use, together with their relative merits, sources of error and the practical means of compensating for same. A chapter on Accuracy of Measurements deals with the relative value of error in instrument readings to the records of measurements, and points out the importance of not recording a greater number of figures than can actually be relied upon. Chapters are devoted to constructional details, of the general parts of instruments, measurement of resistance, potentiometers, galvanometers, measurement of current, measurement of potential, moving iron, moving coil, hot wire and induction types of anemeters and voltmeters.

Power measurements and the various types of watt meters is fully discussed, with vestor diagrams and diagramatic illustrations of the windings and connections. Power factors and synchronous meters are dealt with in detail.

A chapter is devoted to instrument transformers, with vector diagrams and curves of characteristics; also the sources of error under different conditions of load is discussed. Pyrometers, oscillographs and relays are briefly dealt with, and the author ends up with a short description of high-tension lightning arresters and surge gaps. A noticeable feature of the book is the entire absence of trade cuts. The illustrations in most all cases are diagrams showing the working principles rather than views of actual apparatus, thus emphasizing the essential features. Vector diagrams and curves have been used freely in place of formulæ. The book contains much useful data relating to the design and selection of measuring instruments, and its freedom from higher mathematics will appeal to the practical man.

F. A. G.

The Ventilation of Public Sewers.—By John S. Brodie, member of the Institution of Civil Engineers, the Incorporated Association of Municipal and County Engineers, and also a Fellow of the Royal Sanitary Institute. This book is published by The St. Bride's Press, Limited, 24 Bride Lane, Fleet Street, E.C., England. Pages 170. Size 6 x 9.

The ventilation of sewers is without doubt one of the most vexed questions of sanitary engineering, and it is safe to say that there has been the least progress made in it of any of the engineering problems.

This book is a compilation of the opinions of the most eminent sanitary engineers, and also giving a discription of many of the past and present systems of sewer ventilation. Chapter I. gives a brief history of sewer ventilation. Chapter II. discusses fully the question, "Is the Ventilation of Sewers Necessary." Chapter III., the ventilation by natural air currents is very thoroughly dealt with, giving special attention to house traps, open manhole tops and ventilation shafts. It also gives the review of conclusions and recommendations of the prominent city engineers. Chapter IV., sewer ventilation by artificially produced air currents. The methods discussed are Gas Burning Vents and Electric Fans; also giving illustrated drawings of each. Chapter V. contains an interesting discussion on Deodorization of Sewer Gas, giving a description of two successful types. Chapter VI.: This chapter deals with the comparative costs of the various systems of ventilation now in use. Chapter VII. reviews all the other chapters.

The appendix consists of extracts from the best English sanitary journals, setting out the pros and cons of the different methods of ventilation.

From the perusal of this book one gets a clear and brief idea of the experiments on sewer ventilation and the results are well worth noting. W.R.W.

Concrete System.—By Frank B. Gilbreth, M. Am. Soc. M.E. Published by the Engineering News Publishing Co., 220 Broadway, New York. Bound in full flexible morocco, 8½ x 11 inches, 184 pp. 220 illustrations. Price $5 net.

This is one of the best works of its kind that we have seen. The subject of systems in concrete work has been arranged by the author in the form of printed instructions. As is stated in the preface, it is neither a text-book nor a treatise. The various subjects have not only been arranged in a convenient and easily accessible manner, but the information is of such a practical nature as to be found useful and instructive, chapter by chapter. The publishers' preface says: "The question of cents and dollars to gain or lose and a business reputation to preserve or injure dominated every line drawn or written in this work." The work is an accumulation of good, practical knowledge along lines pertaining to concrete buildings. There is no set order of classification or arrangement of the subjects in hand, the instructions being arranged almost like a report, in which the subject is arranged in a manner that should be much appreciated by the practical concrete contractor. The author in addition has added standards for testing cement, the most used specifications for cement, code of rules for conducting fire tests of concrete constructions, with a specimen test report, and other practical information of this nature. The work, which is profusely illustrated, handsomely bound and printed, is the best of its kind we have yet seen. A. E. U.

Calculator.—Designed by Major B. Baden-Powell. Published by Knowledge Office, 27 Chancery Lane, W.C., London. Price, $1.00.

While not professing to be an absolutely exact calculating machine, this simple appliance ought to prove of the greatest use in everyday life. It is so simple in action, so compact, and yet so reliable, that it should find a place on the writing table of all those who have frequent calculations to make.

Not only does it enable one to very rapidly obtain approximate results, even with large figures, in multiplication and division, but for those who have to deal with foreign measures and wish to know, almost at a glance, the equivalent in English measures, this should prove unequalled. One advantage of this form of apparatus may be noted, that any special measures which have to be converted, such as Roubles to Pounds, Carats to Grains, or Kilowatts to Horse-power, can be temporarily marked on the card.

The equivalent fractions of decimals, proportions, and square roots are also easily found.

It is made of heavy white cardboard and the press work is well done. Size, 8 x 8.

PUBLICATIONS RECEIVED.

Major Hodgins' Charges.—Proceedings of the Special Committee appointed to investigate Major Hodgin's charges regarding over-classification of materials in the construction of the National Transcontinental Railway. Size, 6 x 9, pages 500.

Conrad and White Horse Mining District.—By D. D. Cairnes. A report on the mining possibilities of the district, with contoured topographical and geological maps accompanying. Size 6 x 9, pages 38.

Landslide.—A report by R. W. Ellis, LL.D., on the landslide at Notre Dame de la Salette, Lievre River, Quebec. Map. Size 6 x 9, pages 20.

Quebec Bridge.—Report of the Select Committee appointed to investigate the conditions and guarantees under which the Dominion Government paid moneys to the Quebec Bridge Co. Thos. B. Flint, Clerk of the House. Size 6 x 9, pages 200.

Rolling Lift Bridges.—The Scherzer Rolling Lift Bridge Co., Chicago, U.S.A., send a book which is more than a caalogue. The book is well illustrated, and gives views of many designs of lift bridges, also outline drawings showing the main members and dimensions of many of their bridges. Size 6 x 10, pages 120. Fully illustrated.

Report on Steel Rails.—Bulletin No. 102 of the American Railway Engineering and Maintenance of Way Association, being the preliminary reports of Committees on Rail, specifications for drop-testing machine and specimen rail record blanks. E. H. Fritch, secretary, 962 Monadnock Block, Chicago, Ill.

CATALOGUES.

Boiler Compound.—The Bird-Archer Co., 90 West Street, New York, are distributing a 50-page booklet for steam users. It gives concisely the cause and effect of boiler troubles, and points out the Archer method of prevention.

Coal Tipples.—The Jeffrey Manufacturing Co., of Columbus, Ohio, in Bulletin No. 22, give illustrations and line drawings of a large number of coal storage plants; also their conveying and elevating machinery. Size 6 x 9, pages 50.

Chain.—The Weldless Chains, Limited, of 62 Old Broad Street, London, E.C., in their booklet, "The Very Last Word on Chains."

Perforated Metal.—The Allis-Chalmers-Bullock, Limited, Montreal Que., in Bulletin 1425 tell of the superior qualities of their metal over wire as used in screens of all kinds. Illustrations given of various patterns and sizes.

Reinforced Concrete Pipe.—The Reinforced Concrete Pipe Co., of Jackson, Mich., send a handsome catalogue of some eighty pages illustrating various installations of their reinforcement. They also give the results of several tests. Size 9 x 12.

Boiler Troubles and Their Prevention is the title of a 48-page treatise just issued by the Bird-Archer Co. This book will interest all who own or operate steam boilers, for it explains, corrosion, scale, oil and grease deposits, and what harm they may do. It tells what scale consists of, how it collects, resulting loss in fuel and steaming capacity, dangers from overheating, cost of mechanical cleaning and the advantage of boiler compounds in preventing scale, oil deposit or corrosion. It further discusses every method of water and scale treatment, gives valuable advice on feeding boiler compounds, the care of blow-off valves, etc. Copies may be had free by addressing the Bird-Archer Co., 90 West Street, New York.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS.

Nova Scotia.

DEVIL'S ISLAND.—Tenders for extension of breakwater, Devil's Island, will be received at this office until 4.30 p.m. on Thursday, November 19th, 1908, for the construction of an extension to the breakwater at Devil's Island, Halifax county, N.S., according to a plan and specification to be seen at the offices of C. E. Dodwell, Esq., resident engineer, Halifax, N.S.; E. G. Milledge, Esq., resident engineer, Antigonish, N.S., on application to the postmaster at Eastern Passage, N.S., and at the Department of Public Works, Ottawa. By order. Nap. Tessier, Secretary, Department of Public Works.

WEST ADVOCATE.—Tender for West Advocate Breakwater, N.S., will be received at this office until 4.30 p.m. on Friday, November 13th, 1908, for the construction of a breakwater at West Advocate, Cumberland County, N.S., according to a plan and specification to be seen at the offices of C. E. W. Dodwell, Esq., resident engineer, Halifax, N.S.; E. G. Millidge, Esq., resident engineer, Antigonish, N.S.; on application to the postmaster at West Advocate, N.S., and at the Department of Public Works, Ottawa. Nap. Tessier, secretary, Department of Public Works.

New Brunswick.

HAVELOCK.—Tender for Havelock village culvert, will be received at the Department of Public Works, Fredericton, until Monday, 30th day of November, 1908, at noon, for rebuilding Havelock village culvert, Parish of Havelock, King's County, according to plans and specifications to be seen at the Public Works Department, Fredericton, N.B., and at the office of Mr. J. A. Murray, M.P.P., Sussex, N.B., and at the office of Mr. H. A. Keith, Havelock, N.B. John Morrissy, Chief Commissioner, Department of Public Works.

LEPREAU.—Tenders for brickyard cove retaining wall will be received at the Department of Public Works, Fredericton, until Monday, 30th day of November, 1908, at noon, for rebuilding brickyard cove retaining wall on Little Lepreau Road, parish of Lepreau, Charlotte county, N.B., according to plans and specifications to be seen at the Public Works Department, Fredericton, N.B., and at the store of Oscar Hanson, Sr., Little Lepreau, on and after Monday, November 16th, 1908. John Morrissy, Chief Commissioner, Department of Public Works.

LEPREAU.—Sealed tenders, marked "Tender for Mill Pond Bridge," will be received at the Department of Public Works, Fredericton, until Monday, 30th day of November, 1908, at noon, for rebuilding Mill Pond Bridge over Little Lepreau River at Hanson's, parish of Lepreau, Charlotte county, N.B., according to plans and specifications to be seen at the Public Works Department, Fredicton, N.B., and at the store of Oscar Hanson, Sr., Little Lepreau, on and after Monday, November 16th, 1908. John Morrissy, Chief Commissioner, Department of Public Works.

Quebec.

POINTE à BROUSSEAU.—Tender for Pointe à Brousseau Wharf will be received at this office until Monday, November 16, 1908, for the construction of a Wharf at Pointe à Brousseau, Gaspe County, Que., according to a plan and specification to be seen at the office of Ph. Beland, Clerk of Works, Post Office Building, Quebec, on application to the Postmaster at Little Valley, P.Q., and at the Department of Public Works, Ottawa. Nap. Tessier, secretary, Department of Public Works.

RIVIERE BLANCHE.—Tender for Riviere Blanche, Pier Head Extension, will be received at this office until 4.30 p.m., on Monday, November 16, 1908, for the construction of an extension to Head Block of Pier at Riviere Blanche, Rimouski County, Province of Quebec, according to a plan and specification to be seen at the offices of Mr Chs. Desjardins, Clerk of Works, Post Office, Montreal; Mr. A. R. Decary, Resident Engineer, Post Office, Quebec; on application to Mr. Hermel Parent, Postmaster, Tessierville, Que., and at the Department of Public Works, Ottawa. Nap. Tessier, secretary, Department of Public Works.

ST. EMELIE.—Tenders for roadway and enlargement of block at St. Emelie will be received at this office until 4.30 p.m. on Monday, November 23rd, 1908, for the construction of a roadway and enlargement of block at Ste. Emelie (Leclercville), Lotbiniere county, Province of Quebec, according to a plan and specification to be seen at the office of A. Decary, Esq., resident engineer, post-office, Quebec, on application to the postmaster at Leclercville, Lotbiniere county, Que., and at the Department of Public Works, Ottawa. Nap. Tessier, Secretary, Department of Public Works.

THREE RIVERS.—Tenders for dock and ice-breaker, Three Rivers, will be received at this office until 4.30 p.m. on Friday, November 27th, 1908, for the construction of a timber dock and ice-breaker at Three Rivers, St. Maurice county, Province of Quebec, according to a plan and specification to be seen at the office of A. Decary, Esq., resident engineer, post-office, Quebec; Charles Desjardins, Esq., Clerk of Works, post-office, Montreal; F. X. Berlinguet, Esq., resident engineer, Three Rivers, and at the Department of Public Works. Nap. Tessier, Secretary, Department of Public Works.

Ontario.

KINGSTON.—Tenders for floor, Kingston Drill Hall, and addressed to the Secretary of the Militia Council, Headquarters, Ottawa, will be received until noon, November 12th, 1908, for the renewal of the floor in the Drill Hall, Kingston, Ont. E. F. Jarvis, Secretary.

PELEE ISLAND.—Tender for the Pelee Island Wharf Extension, will be received at this office until 4.30 p.m. on Monday, Nov. 23rd, 1908, for the construction of an extension to the west wharf at Pelee Island, Essex County, Ontario, according to a plan and specification to be seen at the offices of J. G. Sing, Esq., resident engineer, Confederation Life Building, Toronto; H. J. Lamb, Esq., resident engineer, London, Ont., on application to the postmaster at Pelee Island, Ont., and at the Department of Public Works, Ottawa. Nap. Tessier, secretary, Department of Public Works.

CONTRACTS AWARDED.

Ontario

TORONTO.—Baker and Jordall, Manning Chambers, Toronto, are making the foundation test pits for the new Bell Telephone Building, Toronto.

Manitoba.

FORT WILLIAM.—The contract for the new 4,000,000 bushel elevator here has been awarded to James Stewart & Co., of Chicago, the price being about $2,000,000. The equipment is to be the most modern and the house is to be absolutely fireproof. It is to be completed by November 1st, 1909.

British Columbia.

VICTORIA.—The tenders for the 3,500 water meters for the waterworks system were received and opened. The prices tendered showed a wide range. The tenders were referred to the water commissioner and the city purchasing agent to report to the streets, bridges and sewer committee.

The tenders submitted are for 3,400 five, eight; twenty, one inch, fifteen one and one- half inch; ten two inch three three inch and two four inch meters, the prices for which are submitted as follows: Glenford & Kennedy, $75,371; John McDougall & Co., $32,645 and two alternative bids of $30,137 and $33,185; J. A. Johnson, $38,518.30; Walter Fraser & Co., for the Union Water Meter company, $30,041; Hinton Electric company, per J. E. McIldeeny, $30,632.79; Baltimore Meter company, $30,076; Dyer, Field & Co., $30,990; Drummond, McCall & Co., $30,947.19. The Thampson Meter company, of Brooklyn, N.Y., asked for an extension in the time for tendering of two weeks but the request was not granted.

Foreign.

BOSTON.—The Alberthaw Construction Co., of Boston, just received the contract for replacing the old log crib dam at Saxton's River, Vermont, with a modern dam of concrete construction. The work is to be done for Sidney Gage & Co.

RAILWAYS—STEAM AND ELECTRIC.

New Brunswick.

MONCTON.—Great progress has been made during the season on the Moncton-Chipman section of the Transcontinental Railway, so much so that in a year's time Corbett, Floesch & Company, who have the contract for this portion of the work, expect to turn the section over to the Government. This portion of the work is divided into sections one, two, three and four, and on the first section all is in readiness for the laying of the rails. On sections two, three and four some 400 men are at work. Ten miles of rails have already been put down, and the distance is being daily added to. The erection of telegraph poles has only recently been started, and it is hoped by the middle of December to have the telegraph line in operation between Moncton and Canaan River. Four steam shovels are engaged on this end of the section, while five others are employed in the vicinity of Chipman.

Quebec.

MONTREAL.—The Grand Trunk have under consideration new terminal scheme for Montreal, involving a cost of some millions of dollars. The new scheme, which is being planned under the direction of the new chief engineer, Mr. R. G. Kelly, is of a twofold character, one feature of it being the construction of an air line from the bridge to Bonaventure station, with an appropriate terminal structure there, and the other the quadrupling of the track from beyond St. Henri to give a double track for both passenger and freight traffic from the west

Ontario.

LONDON.—The Southwestern Traction Company have asked the City Council for permission to extend their tracks along Simcoe to Talbot, and it is rumored that the new St. Mary's Traction Company will apply for a charter to run on Talbot street, in which connection would be made between St. Mary's and other northern points and St. Thomas. Such a scheme would be strongly opposed by the Street Railway Company.

PORT COLBORNE.—Mr. E. F. Seixas, general manager of the N., St. C. & T. electric railway, and a party of prominent railway men were in town last week. They had driven over the route of the proposed belt line railway around the Niagara district, starting at Niagara Falls, and from there to Fort Erie, then from Fort Erie to Port Colborne. From here they drove to Welland. This is the route that will undoubtedly be covered by an electric line in the not far distant future.

PORT ARTHUR.—The friction between the officials of the Port Arthur Railway Commission and the Joint Commission will have to be settled by the courts. The latter applied for possession of the books and papers this morning, necessary to operate the road, but were refused. They are going to apply at once to the Provincial Railway Board for an order to compel the old officials to hand over these papers and retire from the active management.

Alberta.

CALGARY.—A sub-committee of the city council reported the terms of the offer of the Montreal Engineering Company to the city and the city's offer to the company. The company agreed to construct six miles of railway. They would pay the city as follows: First five years, nothing; second five years, taxes on regular assessment; third five years, taxes and 2½ per cent. of gross receipts; fourth five years, taxes and 5 per cent. of gross receipts, if the city has reached a population of 60,000; taxes and 10 per cent. of gross receips if city has reached a population of 75,000.

The committee were unanimously of the opinion that the offer was not good enough, and looked with particular disdain on the "six miles of line" proposal.

The committee's terms are: First fiive years, taxes only; second five years, 3 per cent. of receipts and taxes; third five years, 7 per cent. and taxes; fourth five years, 12 per cent. and taxes. And approximately eleven miles of line at the outset.

British Columbia.

VANCOUVER.—The Canadian Pacific train No. 96 going east met with an accident on Oct. 16th, at Bear Creek. A split rail caused the accident, three sleepers going off the track.

SEWERAGE AND WATERWORKS.

Ontario.

GUELPH.—Acting under instructions from Dr. Hodgetts and the Attorney-General, Col. McCrae, chairman of the Guelph Township Board of Health, has sworn out an information against the corporation of the city for creating a public nuisance by running sewage into the River Speed, endangering the public health. The case is to be heard on Tuesday next, and Provincial officials will give evidence. The matter has been hanging fire for some months, and since the complaints were made a new septic tank has been built, which, it was thought, would relieve the nuisance, but the authorities say it will not and demand filter beds. Engineer Shipman advised that another tank would do the work, but Dr. Hodgetts says the money might as well have been thrown into the river, unless the beds are constructed.

British Columbia.

VANCOUVER.—Tests were made to a pressure of 185 pounds to the square inch on the high-pressure salt-water main on Government Street. As the mains, when in use during a fire will not have to withstand a pressure of more than 150 pounds to the inch, this test is a satisfactory one. The main was tightly plugged at both ends and filled with water, and then the fire engine "Deluge" pumped more water in until the gauge showed 185.

TELEPHONY.

Quebec.

MONTREAL.—Mr. J. Kent, manager of the C.P.R. telegraphs, who has returned from a trip to Winnipeg, states that telephone lines are now being strung on the telegraph poles with a view of establishing a complete telephone service between Montreal and Winnipeg for train despatching. A circuit has already been established from Montreal to North Bay and from North Bay to Whitemouth. By the time the operating department takes over the new double-track between Fort William and Winnipeg the telephone circuit with Winnipeg will be ready. The C.P.R. has already utilized the telephone very largely for this work, and besides, all passenger and freight trains are now provided with a telegraph apparatus, which enables a train at once to communicate with the nearest operator in the event of an accident.

Ontario

PORT ARTHUR.—Fort William has asked Port Arthur to agree to increase the telephone rates. The system has not been paying at Fort William, though profitable here.

LIGHT, HEAT, AND POWER.

Ontario.

ST. CATHARINES.—The city council has concluded the negotiations with the Lincoln Electric Company for a five-year contract for the lighting of the city streets at $50 per arc light, the city agreeing to take not less than one hundred lights after January 1st, 1910. The city has the power to renew the agreement at the expiration of the contract for a period of fifteen years. A clause inserted in the agreement giving power to the company to transfer or assign the agreement and the contract to the Cataract Company was struck out before adoption.

RECENT FIRES.

Nova Scotia.

HALIFAX.—The starch factory at Hunter River, P.E.I., was totally destroyed by fire November 1st during a fierce gale. The loss was $8,000, and insurance $4,000.

Quebec.

QUEBEC.—A disastrous fire visited the Lake St. John district on October 31st, when the bridge spanning the Assouapmouchouan River was completely destroyed. The bridge, which was built of wood, was covered, and was constructed by the Provincial Government some ten years ago. It was 1,800 feet in length and cost $20,000, and was used solely for vehicles.

MISCELLANEOUS.

Ontario.

WOODSTOCK.—The London Western Counties Pipe Line company have written the city council asking for a franchise to supply the place with natural gas from Port Dover.

TORONTO.—City Engineer Rust has recommended to the Committee on Works an additional hydraulic dredge, at an approximate cost of $76,000. He states that sand pump No. 1 has been in commission for about sixteen years, and will require extensive repairs. He also recommends the purchase of another tug to cost about $10,000.

PERSONAL.

MR. F. S. FERGUSON has been appointed manager of the Canadian Iron and Foundry Company; office at St. Thomas, Ont.

MR. A. BYRNE, of the Garlock Packing Company, of Toronto, Montreal and Hamilton, has returned from an extended European tour.

MR. E. L. MILES, formerly assistant engineer on Toronto-Sudbury branch C.P.R., is now locating for C.N.R. in the Moose Mountain country.

MR. A. FRONHOEFER, formerly division engineer on C.P.R. double tracking, Smith's Falls to Montreal, is now district engineer, Division 4, District D, N.T. Railway.

MARKET CONDITIONS.

Toronto, November 5th, 1908.

In metals, the week has witnessed a good deal of "toning up," and the whole metal list of prices is either quotably improved or stiffened in tone. There was a broadening demand last week for pig iron both in the United States and Canada, and to-day the enquiry keeps up, with more transactions certain in the States as a result of Taft's election over Bryan. American advices say that the next two months are sure to see a good many orders for structural material p'aced across the line.

This week's cold snap has stimulated what may be called cold weather hardware. And it has given a fillip to galvanized sheets and also tin. Building has been active in Toronto during last month. City hall statistics show that there were 552 permits granted during October, as compared with 334 during the same month last year, while the estimated value reached $1,019,492 as compared with $776,555 for the same month last year.

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:—

Antimony.—Price unchanged at 8¾c., with more enquiry.

Axes.—Standard makes, double bitted, $8 to $10; single bitted, per dozen, $7 to $9.

Bar Iron.—$1.95 base, from stock to the wholesale dealer.

Boiler Plates.—¼-inch and heavier, $2.40. No special activity. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Demand limited. Lap-welded, steel, 1¼-inch, 10c.; 1½-inch, 9c. per foot; 2-inch, $8.50; 2¼-inch, $10; 2½-inch, $10.60; 3-inch, $12.10; 3½-inch, $15.30; 4-inch, $19.45 per 100 feet.

Building Paper.—Plain, 30c per roll; tarred, 40c. per roll. Business brisk.

Bricks.—Common structural, $9 per thousand, wholesale, and the demand moderately active. Red and buff pressed are worth, delivered, $18; at works, $17.

Cement.—The market is lower; cement can be had in 1,000 barrel lots at $1.80 per barrel, including the bags, which is equal to $1.40 without bags. Overproduction is evident, and demand is not brisk in a wholesale way. The smaller dealers, however, are busy selling small quantities.

Coal Tar.—In improved request; $3.50 per barrel the ruling price.

Copper Ingot.—Market active and higher here at 14½ to 14¾c. The United States market has been variable during the week but is now higher.

Detonator Caps,—75c. to $1 per 100; case lots, 75c. per 100; broken quantities, $1.

Dynamite, per pound, 21 to 25c., as to quantity.

Roofing Felt.—There is much more demand and a better feeling. Price $1.80 per 100 pounds.

Fire Bricks.—English and Scotch, $32.50 to $35; American, $28.50 to $35 per 1,000. Demand, moderate and steady.

Fuses—Electric Blasting.—Double strength, per 100, 4 feet, $4.50; 6 feet, $5; 8 feet, $5.50; 10 feet, $6. Single strength, 4 feet, $3.50; 6 feet, $4; 8 feet, $4.50, 10 feet, $5. Bennett's double tape fuse, $6 per 1,000 feet.

Galvanized Sheets—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.05; 12-14-gauge, $3.15; 16, 18, 20, $3.35; 22-24, $3.50; 26, $3.75; 28, $4.20; 29, $4.50; 10¾, $4.50 per 100 pounds. Fleur de Lis—28-gauge, $4.30; 26-gauge, $4.05; 22-24-gauge, $3.50. Queen's Head—28-gauge, $4.50; 26 gauge, $4.25; 22-24-gauge, $3.70.

Iron Chain.—¼-inch, $5.75; 5-16-inch, $5.15; ⅜-inch, $4.15; 7-16-inch, $3.95; ½-inch, $3.75; 9-16-inch, $3.70; ⅝-inch, $3.55; ¾-inch, $3.45; ⅞-inch, $3.40; 1-inch, $3.40.

Iron Pipe.—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ½-inch, $2.63; ¾-inch $3.56; 1-inch, $5.11; 1¼-inch, $6.97; 1½-inch, $8.37; 2-inch, $11.16; 2½-inch, $17.82; 3-inch, $23.40; 3½-inch, $29.45; 4-inch, $33.48; 4½-inch, $38, 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.86; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.71; 1-inch, $6.76; 1¼-inch, $9.22; 1½-inch, $11.07; 2-inch, $14.76. Colder weather causes more movement.

Lead.—An active market at unchanged figures, say $3.90.

Lead Wool.—$12 per 100 lbs. f.o.b. factory.

Lime.—In adequate supply and moderate movement. Price for large lots at kilns outside city 22c. per 100 lbs. f.o.b., cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

Lumber.—Dressing pine we quote $32 to $35 per thousand for usual lengths (12, 14, and 16 ft.), and stock sizes of boards, and $38 to $40 for special lengths, common stock boards, as to grade, $24 to $28; Cull stocks, $20; sidings, $17.50; Southern pine, moderately firm; Norway pine rather easy. Hemlock moves steadily in small quantities. British Columbia shingles still $3.20; lath, No. 1, $4; No. 2, $3.50, with perceptible stiffening; spruce flooring, $25. No quotable change in price anywhere, but a more settled feeling.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3. There is a fair supply and no especial activity.

Pitch.—An active trade at unaltered prices, at 70c. per 100 pounds.

Pig Iron.—More enquiry has developed within the past ten days. Meantime we do not alter prices. Clarence quotes at $19.50 for No. 3; Cleveland, $19.50 to $20; in Canadian pig, Hamilton quotes $19.50 to $20.

Plaster of Paris.—Calcined, wholesale, $2; retail, $2.15.

Putty.—In bladders, strictly pure, per 100 lbs., $2.

Rope.—Sisal, 9½c. per lb.; pure Manila, 12½c., Base

Sewer Pipe.—

	4-in.	6-in.	9-in.	10-in.	12-in.	24-in.
Straight pipe per foot	$0.20	$0.30	$0.60	$0.75	$1.00	$3.25
Single junction, 1 or 2 feet long.	.90	1.35	2.70	3.40	4.50	14.63

In good demand; price 70 per cent. off list at factory for car-load lots; 60 per cent. off list retail.

Steel Beams and Channels.—Quiet. We quote:—$2.50 to $2.75, according to size and quantity; if cut, $2.75 to $3; angles, 1¼ by 3-16 and larger, $2.50; tees, $2.80 to $3 per 100 pounds. Extra for smaller sizes of angles and tees.

Steel Rails.—80-lb., $35 to $38 per ton. The following are prices per gross ton; Montreal, 12-lb. $45, 16-lb. $44, 25 and 30-lb. $43.

Sheet Steel.—Market steady, with fairly good demand; 10-gauge, $2.50; 12-gauge, $2.55; American Bessemer, 14-gauge, $2.35; 17, 18, and 20-gauge, $2.45; 22 and 24-gauge, $2.50; 26-gauge, $2.65; 28-gauge, $2.85.

Tool Steel.—Jowett's special pink label, 10½c. Cyclops, 18c.

Tank Plate.—3-16-inch, $2.50.

Tin.—An advance has been declared and demand is good at 31½ to 33c.

Wheelbarrows.—Navvy, steel wheel, Jewel pattern, knocked down, $21.35 per dozen; set up, $22.35. Pan Canadian, navvy, steel tray, steel wheel, per dozen, $3.30 each; Pan American, steel tray, steel wheel, $4.25 each.

Zinc Spelter.—Business very good at better prices, $5 to $5.50.

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Montreal, November 4th, 1908.

On the other hand, the situation in England is quite unsatisfactory. The market for Cleveland warrants is very flat and irregular. Prices have declined considerably owing to the news that the German syndicate, which controlled the price of pig in that country, has been dissolved, and that after the first of the new year individual makers will be at liberty to sell at open prices. It was generally hoped that at the last moment the syndicates agreement would be renewed, so that the news of the contrary reacted unfavorably upon the English market, as export from England will now be considerably curtailed. Owing to the weaker state of the warrant market, makers prices are also lower and there is less disposition on the part of consumers to purchase ahead. Stocks in store have again increased 6,500 tons. Notwithstanding the above, the market for steel and finished material has improved, prices being firm and demand for home consumption being better. The local market was very steady during the week. Practically everything required for fall and winter has now been ordered, and shipment will proceed actively from now till the close of navigation.

There were no changes of consequence throughout the market this week, prices being as follows:—

Antimony.—The market is easier, at 9 to 9½c.

Bar Iron and Steel.—Prices are steady all round, and trade is decidedly dull. Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $2.00; sleigh shoe steel, $1.90 for 1 x ⅜-base; tire steel, $1.95 for 1 x ⅜-base; toe calk steel, $2.40; machine steel, iron finish, $2.10.

Boiler Tubes.—The market is steady, quotations being as follows:—2-inch tubes, 8½c.; 2½-inch, 10c.; 3-inch, 11½c.; 3½-inch, 14¾c.; 4-inch, 19c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $1.50 per 100 pounds; felt paper, $2.25 per 100 pounds; tar sheathing, No. 1, 50c. per roll of 400 square feet; No. 2, 35c.; dry sheathing, No. 1, 40c. per roll of 400 square feet, No. 2, 26c. (See Roofing; also Tar and Pitch).

Cement—Canadian and American.—Canadian cement, $1.65 to $1.75 per barrel, in cotton bags, and $1.90 and $2.05 in wood, weights in both cases 350 pounds. There are four bags of 87½ pounds each, net, to a barrel, and 10 cents must be added to the above prices for each bag. Bags in good condition are purchased at 10 cents each. Where paper bags are wanted instead of cotton, the charge is 2½ cents for each, or 10 cents per barrel weight. American cement, standard brands, f.o.b., mills, $1.85 per