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The Canadian Engineer

ESTABLISHED 1893

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TORONTO, CANADA, DECEMBER 6th, 1907.

CONTENTS OF THIS ISSUE.

INDUSTRIAL EXPANSION.

With the closing of the year 1907, as we scan our broad Dominion with its vast developed, and even greater undeveloped resources, we see the mark of industry on every hand. As we turn back over the pages of another industrial year we find still greater and more extensive achievements recorded in our vast fields of engineering. It is hard to say in what line Canada has excelled. The Dominion to-day presents a most remarkable story of growth, expansion, and development. It has been a memorable year, for recorded during the past twelve months are some of the greatest engineering works Canada has yet undertaken. Perhaps the most striking example of Canadian development is seen in the network of railway lines which now traverse the country throughout its length and breadth. We have seen extensive improvements made to all railway lines, and many remarkable achievements in railway bridge building. The Grand Trunk Pacific is finding plenty of room, and still there remains vast areas of untraversed land. The mileage of steam railways in Canada has increased from 2,695 miles in 1871 to 23,018 miles at the present time. It has been interesting to watch the rapid growth of the Grand Trunk Pacific, which was incorporated in 1903 to build its railway from Winnipeg to the Pacific Ocean. We have watched the progress of the Canadian Pacific Railway, whose charter dates from 1881, the Canadian Northern and other railways, including the enormous expansion in electric railway development, all of which have added their quota to Canada's expansion for 1907. Associated with this expansion is an increased demand for construction supplies, which has been almost illimitable. Letters from all parts of the Dominion have been received by the Canadian Engineer telling the story of this remarkable increase.

The past year has been a remarkable one in the development of waterpowers, and there yet remains almost incalculable power to be developed. All the Provinces of Canada have experienced the same call for power, a demand which will increase as the years go by. The question of Niagara power, of forty years' duration, has become a reality, and power has been transmitted from this great source to our towns and cities. We have seen it developed, transmitted and utilized in our very midst. We have watched with interest the development of electrical power in the West, and the live interest taken by this section of Canada in their illimitable natural resources.

The Canadian mining industry has experienced a real boom, and an unusual amount of machinery has been required to unearth the rich mineral deposits of our lands. The famous Cobalt district has been a wonderful centre for mining activity, notwithstanding the great amount of speculative imaginary ore.

The shipping industry of Canada, including our inland and coasting trade, and numerous trans-Atlantic, Oriental, and foreign markets, has made a noted advance during the past year, and many vessels have been added for the increased traffic. We have seen Thomas A. Edison's prediction realized, since electric power has been developed at the mouth of a coal mine, at the plant of the Maritime Coal, Railway and Power Company, Nova Scotia, situated on the bank of Chignecto Mine. During the past year the hundredth anniversary of the introduction of steam navigation in America was celebrated; 1907 holds the record for the largest boat ever built in Canada, the "Midland Prince," which was launched at the yard of the Collingwood Shipbuilding Company. It was constructed for the Midland Navigation Company, and chartered for the grain business between Port Arthur, Fort William, Duluth and Chicago. The Trent Valley Canal, which has been before the people of Canada for many years, added another notable achievement in July, when the hydraulic lift-lock at Kirkfield, overcoming a level of about fifty feet, was opened. We have seen the Georgian Bay Canal question again under consideration, and at the closing of the year find it somewhat of a more feasible undertaking.

The St. Andrew's locks on the Winnipeg River, fifteen miles below the city of Winnipeg, presents many exceedingly interesting and unique features. The work of construction was commenced during July. It was not long ago that the transportation from the Atikokan Iron Works of Port Arthur of the first cargo of Canadian pig iron east for the purpose of manufacture was recorded; also the first set of tubes for the subaqueous portion of the Detroit River Tunnel, which were sunk into position on October 1st. Great improvements have been made in our harbors and shipping facilities. New terminals, extensive changes and improvements in every line from coast to coast have added their quota to Canada's development for the year 1907. The Independent telephone movement, the Marconi telegraph development, municipal works of great proportions, and endless industrial achievements in every line have marked the year's undertakings.

TORONTO'S WATERFRONT PROBLEM.

It is plain to anyone who will seriously consider Toronto's waterfront question that the time has arrived when the occupancy of the waterfront by railways must be firmly and decidedly dealt with, in order that the rights of others than the railways may not be permanently destroyed. Many complications will undoubtedly arise in any case in the efforts to properly conserve all the interests involved. In the United States the foremost solution of traffic congestion and inconveniences suffered by Toronto is the viaduct. Relief obtained from overhead bridges could not be other than temporary. The growth of population and of railway traffic would soon make this situation so intolerable that relief from it would be demanded at any cost. The financial aspect of the problem should not be the primary consideration. Some day or other the railroad tracks along Toronto's waterfront will have to be elevated. When the environs of Toronto are considered part of the city's commercial heart, then the railroad companies and the city will be glad, if their foresight stands them in good stead now, that a substantial and useful viaduct runs along their waterfront. If the knack of looking into the future is not cultivated, the dirge of the viaduct that is not will be as continual and mournful as the chirp of the persistent sparrow. There is a strange hesitancy in dealing with improvements which involve the demolition of things that "have always done." Considerable opposition has been shown from some sources to the building of this viaduct, although the railroads say that the opposition is not theirs. This being so, the viaduct seems to be emerging from its theoretical blue-print shape into something that looks more substantial. From somewhere or other have emanated all sorts of fanciful and insuperable objections to elevated tracks. Such elevation is but a matter of mutual agreement and money. If hard-headed railroad directors, a persistent Board of Trade, and a determined city council cannot agree on the merits of an undertaking which is a necessity and a desirable improvement, one can have little regard for this trinity of authorities. A viaduct for Toronto's railroad traffic is an obvious necessity.

RAILWAY FATALITIES.

The epidemic of serious railway accidents, which seems to have struck Canada during the past few months, continues to swell the appalling list of fatalities. America holds two unenviable records. One, the annual amount of its fire loss; the other, the sacrifice of human life on the altar of its railroads. The following is the record since 1896:—

Year.	Passengers.	Employees.	Others.	Total.
1896	11	46	104	161
1897	7	76	130	213
1898	5	98	167	270
1899	20	119	145	284
1900	7	123	195	325
1901	16	118	183	317
1902	19	146	165	330
1903	53	186	181	420
1904	25	192	178	395
1905	35	206	227	468
1906	16	139	206	361

In 1896, one hundred and sixty-one persons lost their lives on the Canadian railroads. Ten years later the number had increased to three hundred and sixty-one. In the United States alone, for the year ending June 30th, five thousand persons were killed in railway accidents and 76,286 injured, which represents an enormous and appalling increase over the figures for the preceding year. These figures include only accidents to passengers, and to employees while actually on duty, and do not include electric lines, on which casualties are increasing at a rapid rate. The large number of accidents on the American roads, compared with the few in Great Britain, is frequently a subject of comment. Two reasons exist for the happy dearth of fatalities there. Great care is exercised in every way, and a railroad accident in Great Britain is a serious thing for the railroad. It is not forgotten with the verdict of the jury. The Imperial Board of Trade thoroughly investigates the causes of each accident. If the railroad company is neglectful, the company suffers. If reforms are suggested, the company would find it unwise to refuse to carry out desirable improvements.

Mr. M. J. Butler, Deputy Minister and Chief Engineer of the Department of Railways and Canals, says that the return of accidents on Canadian railways is the dark side of the business of transportation. "The danger accompanying the movement of trains is always very great, and when to this is added negligence and carelessness on the part of both employees and those who suffer, we have the factors which roll up annually a regrettable record of sacrifice. While these accidents are apparently inseparable from railway traffic, they nevertheless are nearly always avoidable. Unless someone blunders, or something breaks, such disasters as usually occur could not happen. The strengthening of equipment, the elimination of risky methods of handling trains, the introduction of safeguards in many forms, and the enforcement of rigid inspection, are all steps in the right direction. These agencies are now being applied with more or less care on practically all our railway lines; and still the waste of life goes on." The circular in respect to defective equipment which the Railway Commission is sending to all Canadian railways will draw attention to recent reports of inspectors to the effect that over thirty per cent. of the engines and cars in use, the total running into thousands, have defective safety appliances, and that many of the cars have defective air brakes. The circular will express the hope that within a reasonable time these defects in equipment will be rectified, and that it will not be necessary for the board to take further action.

It is not long since the investigation of the train wreck at Caledon, in which the driver and conductor were acquitted. The fact was clearly shown that the accused had received no definite instructions touching the grade and curves and peculiarities of this particular section of the road. It might be judged from the evidence presented that so long as no accidents occur employees have assurance of immunity, and feel safe in disobeying orders. The Railway Commission should be required to use full power in providing means to detect violation of train orders, to carefully investigate safety appliances designed for the prevention of accidents, and to punish the railroad companies responsible.

EDITORIAL NOTES

A Western engineer in sending in a subscription to the Canadian Engineer during the week strongly endorses an article which appeared therein in the issue for November 1st p. 374, an extract from which reads: "Canadian money should be paid to Canadians for Canadian effort, especially if the result of that effort is as good as, if not better than, that of a foreign competitor." The writer is strongly of the opinion that this principle should be enforced, not only in the case of the Quebec Bridge, but in a great many of the engineering enterprises throughout the Dominion.

* * * *

What untapped sources of wealth exist in British Columbia will be known only when the transportation companies' steel rails have been laid in the fertile valleys of the Province. The railroad is the pioneer of civilization and prosperity. The people of British Columbia have suffered from the lack of labor and of railroad facilities; there are signs of a change in both directions. Visits of prominent Canadian Pacific officials to the coast would indicate that the company will assist soon in the opening up of a country, the extent of whose vast resources is but largely a matter of guesswork. The completion of the Kootenay Central too, will mean much for the north-eastern part of that district and for the Province as a whole.

* * * *

The question of the duty and responsibility of a consulting engineer towards his clients, and also that of inspectors who are employed to see that the work is properly executed, naturally arises from the clear and voluminous evidence of the engineer, Mr. Theodore Cooper, before the Canadian Commission in the recent investigations of the failure of the Quebec Bridge. It is not an uncommon practice on this continent for consulting engineers to entrust the actual detailed design of bridges in accordance with their specification, to the bridge companies, who in many cases have a staff employed for this purpose. If these powers are exercised properly there is no reason why the work, as the making of drawings, details of connections, and calculations, when entrusted to responsible manufacturers, and when afterwards subjected to rigid scrutiny by conscientious consulting engineers, should not be successful. Now that most of the facts are known, it will be shown whether the implicit faith Mr. Cooper appears to have had in the experience of the bridge company was fully justified or not.

* * * *

A letter appears in this issue from Mr. W. H. Booth, M. Am. Soc. C.E., of London, England, who visited the Quebec bridge shortly before it fell. It is the opinion of Mr. Booth that the mistake has been made of attempting to employ merchant sizes of material, that in all engineering work it is usually the best commercial practice to employ ordinary commercial material in construction. The question of a serious overrating of compression members and incorrect formulæ as a basis for their calculation is an uncomfortable thought suggested by the writer—formulæ that, so far have stood the stress of traffic, but when applied to a too large step as to size of bridge members result in failure. The case of the growth of various machines is cited—the gas engine, steam turbine, etc., where the progress has been comparatively slow, but followed by disaster in each case where immediate steps became too great and growth too fast. The experienced engineer should never let himself be caught too far off precedent. He should not allow himself to assume that things which hold good for smaller sizes will necessarily hold good for proportionately larger designs.

AN ENGLISH ENGINEER'S OPINION ON THE QUEBEC BRIDGE FAILURE.

Editor Canadian Engineer:

Considerable interest has been felt in England in respect to the failure of the Quebec Bridge. American engineers have so long been regarded as peculiarly experienced in long-span bridge construction that it is thought the present disaster must have arisen from some strange oversight in the design. The fact that one of the members of the lower rib of the cantilever was found doubled into an S bend has by some been taken to show that the damage sustained by this piece at the maker's yard, in transit through New York, and when unloaded at Quebec was responsible for the failure. The fact that the same member on the opposite lower rib was afterwards found to be similarly bent is no evidence against the view, for it is certain that if one rib began to buckle it was likely to cause the other side rib to buckle in the same place.

But the damaged member was probably but the first piece to fail, and if bridge parts have a factor of safety of five it is argued that this particular member could scarcely have been so damaged as to fail had it been really able to carry five times the load before failure. It could not have been reduced to one-fifth its strength of any damage that could have been overlooked. Then, if reports be true, many other compression members in the bridge showed signs oı weakness, for they had lateral deflections, though "not to the same extent as the member that was thought to have failed first. The uncomfortable thought is thus raised that all the compression members were extraordinarily overrated, that the formula by which they were calculated must have been very seriously wrong. Let the formulae generally accepted have the imprimatur of the best bridge engineers. So far these formulae have given results in bridges that have stood the stress of traffic. Then a big step is made in advance as regard the size of bridge members and a failure ensues. Is it because the recognized formulae have given results which, for moderate dimensions, would plot along a curve apparently of the straight line order, but actually one that, like many of the curves of performance with which engineers have to deal, is nearly straight for a long range and then suddenly falls away to a quite sharp curvature.

To the writer, who saw the bridge in July, just before it fell, it appeared that the mistake had been made of attempting to employ merchant sizes of material. In all engineering work it is usually the best commercial practice to employ ordinary commercial material in construction. And usually the structures which are built from such commercial materials are themselves structures from ordinary kind. As structures such as bridges have developed in size the rolling mills have fitted themselves step by step to produce rolled shapes from which the bridge members could be built up. But when a huge step forward in the dimensions of a bridge is suddenly taken it finds the rolling mills unprepared to meet the deman' foı proportionate material. The huge compression members of the Quebec bridge are probably a case in point. They have been built up to a supposed sufficient section by the superposition of a supposed sufficiency of small sections. It seems extremely probable that such built up sections are inherently weaker than has been supposed and that for all abnormal structures there must be abnormal methods of construction.

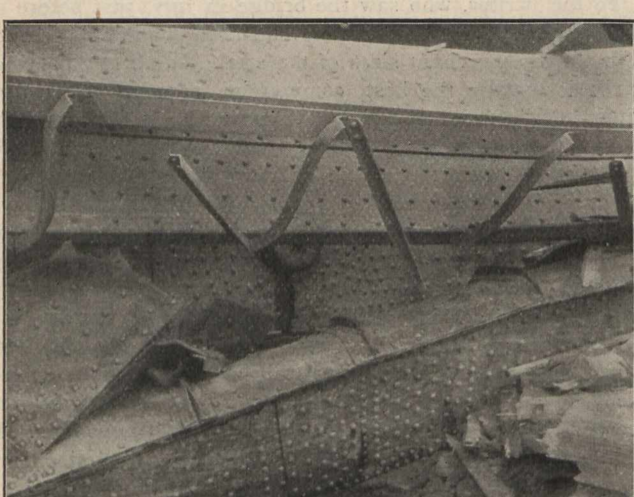
In the Forth bridge, which had spans of only 1,710 feet or 90 feet less than the Quebec bridge, and carried nothing but a double-track railway, such abnormal methods of construction were adopted, for the compression members were all tubular and were built hard by the site of the bridge. No attempt was made to employ ordinary commercial sizes of rolled sections, but plates were used with section stiffeners and butt strap jointing. The result has justified the means for the bridge apparently possesses ample stability. It has been severely criticized as wasteful and clumsy, but after all those faults are on the right side. All the material works to the best advantage, for it is disposed at a maximum distance from the axis. It is a pity that the Quebec bridge failed, for it throws doubts on the method of construction. It must be admitted that American bridge designers have done excellent work; they have been compelled by the engineers of the country to find out how to make great bridges from merchant material, and they have taught the world much on stresses that only close designing could have found out. It has been said by an experienced engineer that the engineer should never let himself be caught too far off precedent; that is to say he must not allow himself to assume that things which hold good from size 1 to size 2, and so on to size 3 or 5, will necessarily hold good if proportionately designed for, say size 20. The jump is too great. If we look back on all engineering, whether civil or mechanical, we shall find ourselves confronted constantly with failures like that of the Quebec bridge. Some man takes a big forward step and differences step in that have not been apparent in the earlier stages.

Thus it is that all machines have grown slowly. The gas engine to-day is a sample of slow growth. Apparently it is very like a steam engine, yet with all the experience of the large steam engine to guide designers the large gas engine has advanced along a wreck strewn path. The steam turbine grew slowly, but in the new Cunarders a big step was taken, but the Cunard Company took good care to build the "Carmania" first as an intermediate step. The success of the "Lusitania" is a proof of the singular engineering ability employed in the big shipyards. The greater success of the "Mauretania" on her trial trips seems to point to something having been learned from the "Lusitania." Ordinary engineering is one long record of failures, but they have not perhaps destroyed much life. When a disaster kills men we hear of it, but in principle the failure of a bridge is no worse than the failure of some abnormal engine or dynamo.

W. H. BOOTH,
London. M. Am Soc. C. E.

CANADIAN SOCIETY OF CIVIL ENGINEERS VISITS QUEBEC BRIDGE.

Upwards of 100 members of the Canadian Society of Engineers paid a visit to the ruins of the Quebec Bridge on November 9th. Transportation was very kindly provided by the Intercolonial Railway. The party was met by Chief Engineer Hoare of the Quebec Bridge Company, along with



Broken Chord Joint of Quebec Bridge Between Panels, Showing Lacing.

a number of other Quebec engineers. Mr. Hoare had placed at the disposal of the society the services of Inspector Kinloch, of the Quebec Bridge Company, who spared no pains to point out the more interesting features of the wreck.

The trip afforded an opportunity to a great many students as well as practising engineers to visit the site of the greatest modern bridge disaster, and in the light of what has developed in the inquiry, to observe the results of the collapse of one of the greatest steel superstructures ever erected. In all there were present 115 officers and members of the society, some 55 of those who made application for transportation having failed to be present.

The following officers and members were present:—W. McLea Wallbank, president; P. Johnson, vice-president;

President Walbank, and Chief Engineer Hoare of Quebec Bridge Company.

Professor C. H. McLeod, secretary; Messrs J. A. Jamieson and W. F. Tye, members of council.

Messrs. F. W. Anderson, J. L. Allison, A. Arsenault, T. C. Allum, editorial representative, "Canadian Engineer," G. E. Bell, C. Brandeis, J. B. Brophy, J. A. U. Beaudry, A. Birch, F. P. Buchanan, M. C. J. Beullac, N. F. Ballantyne, E. E. Brice, E. Bregent, A. Buteau, O. Baudouin, J. J. Collins, P. Chevalier, S. B. Code, U. Chopin, A. Chausse, R. de B. Corriveau, W. P. Copp, P. E. De la Cour, N. P. Dalziel, A. H. Dion, K. W. Dowie, H. P. Dwight, C. W. Drysdale, J. Duchastel, L. A. Dufresne, J. Ewing, J. H. Edgar, W. M. Everall, G. H. Ferguson, A. Gray, C. E. Goad, A. J. Grant, R. M. Hannaford, L. Hurubise, N. M. Hall, H. Hadley, Jr., H. M. Haughton, F. C. Jewett, W. A. Kennedy, E. C. Kirkpatrick, F. T. Kaolin, W. D. Lawrence, W. A. Logan, R. Lesage, W. L. Leslie, G. L. Law, B. Leman, O. Lefebvre, F. G. MacLeod, F. O. Mills, N. M. McLeod, H. V. Morris, B. D. McConnell J. E. A. McConville, A. W. K. Massey, J. L. Michaud, J. L. Millar, W. B. McLean, D. L. McLean, A. McCulloch, G. E. McCuaig, P. B. Motley, M. Neilson, T. J. Norton, W. E. O'Brien, C. E. Osler, H. H. Pinch, P. L. Pratley, J. H. Parent, O. Poissant, D. Renaud, H. W. Read, L. N. Rheaume, A. Roberts, J. W. Le B. Ross, J. A. Roy, E. A. Rhys-Roberts, G. Sproule, A. T. Spencer, H. E. Sutherland, T. G. Sherwell, R. O. Sweezey, S. W. Smith, L. Sherwood, R. Steckel, J. H. Sullivan, W. G. Scott, J. B. Spence, F de Sieyes, F. R. Smith, W. J. Sproule, A. Bromley Smith, D. C. Tennant, W. V. Taylor, W. Chase Thomson, J. H. Trimmingham, I. A. Vallieres, H. E. Vautelet, J. P. Watson, H. A. Whitley, W. T. Wilson, E. T. Wilkie, E. J. Walsh, N. de C. Walker.

President Walbank of the Canadian Society of Civil Engineers and Chief Engineer Hoare of the Quebec Bridge Co. may be seen discussing the accident from the bank overlooking the bridge. The accompanying cut, taken while the party were at the wreck, shows the broken chord joint betweer panels, also style of lacing.

RAILROAD ENGINEERING IN THE EARLY DAYS IN CANADA.

By George Hawkesworth Armstrong.

In June, 1851, I left school, being then fourteen years of age, and one day while taking a walk found myself near the spot where the Hamilton Stuart Street Station of the Grand Trunk Railway now stands. At that time the contour of the ground was undulating. The Great Western Railway had made a commencement near Burlington Heights, and the navvies were engaged in cutting rock of the nature of concrete. A party of engineers (most of them were from the United States, with a sprinkling of Canadians) were engaged with the transit, level, rod, and chain in the survey. The resident engineer, with whom I was well acquainted, asked me to join the crew, and I took the chain. The work seemed suited to me, and on my arriving home I importuned my father to allow me to become a regular member of the survey party. He was well acquainted with Mr. Benedict, the chief engineer (from New York), and that gentleman very readily gave me a situation as chainman at a salary of $32 a month.

A party of engineers had in the meantime surveyed the road to Toronto, and had placed stakes every hundred feet. Marcus Smith, lately deceased, was a Government engineer at Ottawa, and along with the writer was ordered to follow those gone before and take a topographical description of the line. We started by the steamer "Magnet" (Capt. Sutherland) for Burlington, our starting point being there, he having in the meantime taken the topographic description of the country between Hamilton and Burlington. We landed at the pier, and trudged our way through the deep sands to Burlington village. Having had dinner at a tavern there, we settled down to our work, and the axeman and I took many measurements, both sides of the line, Smith mapping them down. The country then was a magnificent sight, and I have seen acres of the noblest trees of all varieties burned so as to clear the land. The same trees to-day would be worth a fortune. What we require in Canada now is more planting of trees, and I hope the Dominion Government, in conjunction with Provincial Governments, will press that home to our people in the strongest way.

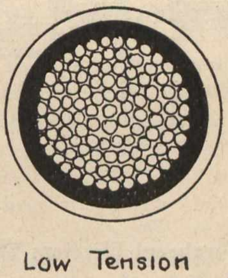
From Bronte to Oakville the contour of the country was of a rolling nature, and the creeks we passed over were deep and transparent streams, not as they are now, with their fountain heads all cut away by the avarice of the husbandman. Before we reached Port Credit a cedar wood full of swamp had to be passed through, and to this day I am at a loss to know how we ever managed to come out. The densest of shade, miry water, and the climbing ove of decayed and mossy cedar logs taxed me to the utmost, so much so that on arriving at our hotel in Port Credit I was stricken down with an attack of fever and ague, compelling me to leave for home and recuperate. My eldest brother had for some time been an engineer in a surveying party at Ekfrid, near Delaware. The resident engineer was a Boston man named Pettingell, his brother Andrew being leveller, and my brother rodman. I was ordered to join the party, going from Hamilton by stage. The country at that time was very wild, indeed, and the work in that locality was attended with much difficulty, due to the swampy nature of the land. Not far off was the battlefield of the Thames, where the gallant Indian chief, Tecumseh, was killed.

My health having suffered from so much exposure, I, after a six months' sojourn, returned home, and upon recuperating was ordered to join a party of engineers at Paris, Ont. The resident engineer was Charles L. McAlpine, from Newburgh, N.Y. Including myself, there were seven in the party, as he had charge of the section from Paris to Woodstock. The work there was splendid to me; and I really feel sure that it was more efficiently done than such work is done to-day. I know that the cross-sectioning, the measurements of cubic yards, and the surveys made, including the laying of the track, was perfect in every detail. A piece of work we had to perform near Mudge Hollow, some four miles west of Paris, was an extremely difficult one to perform. We had to use the trees of over a hundred acres of wood, 150,000 cubic yards or more, to fill up the peat bog there, which was bottomless. Mr. Finkham, one of our assistants, and I had to survey a large hill, using a spirit or level-board. That hill furnished nearly 100,000 cubic feet of earth in addition, and was used in this sinkhole as well. In track-laying we took the levels every five or eight feet, and the line from Paris by that operation was at that time the best on the road. The road being finished about January, 1854, the celebration of its completion was fully carried out. A great many Toronto and Hamilton people attended the celebration, while others came from Detroit. There are very few alive now who were present, and I know full well that a very few of the engineers are. After the road was completed I returned home.

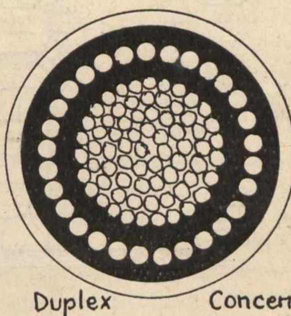
UNDERGROUND DISTRIBUTION OF LIGHT AND POWER.

By E. D. Tillson.

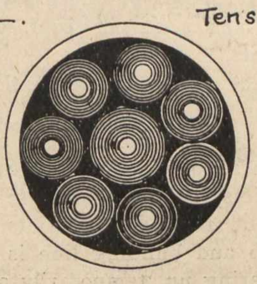
In general, lighting and power companies keep all lines overhead until compelled to change, when the "underground ordinance," if it comes (and, incidentally, it is quite sure to come), entails a more or less complete redesign of their entire distribution system—certainly complete within the "underground district" specified in the ordinance. A map is first drawn of the district, and to sufficiently large scale to show every individual piece of property in it. A complete canvass is then made of the area to determine



Low Tension Rubber Insulated Cable.



Duplex Concentric Rubber Insulated, Low Tension Cable.



8 Conductor Arc Lighting Cable.

accurately the present, and, if possible, the immediate future current consumption on each of the premises. This, with the class of receiving apparatus, whether incandescent or arc lights, elevators or small motors, etc., is now marked on the map opposite each property.

Hence, distribution areas, with their centres of distribution, equivalent current consumption and power factor of, and voltage to be applied to each one of these centres, may be determined, and finally, feeder routes and location of distributing mains and service connections. These locations are marked on a series of detail sheets, each sheet taking in only one or two blocks of the district. In addition to the above, they have noted upon them the kind of pavement, location and sizes of manholes and service boxes, position of foreign pipes in street, as far as known, etc. These sheets are primarily contractors' drawings, and upon them the contract price of the work is figured. They may be used subsequently, however, in connection with cable records.

Returning to the consideration of distribution centres: These we will suppose connected directly to the power station by feeders, usually medium potential, when the centre, if located in an area of fairly dense distribution, becomes a transforming point, supplying radial low-tension mains, spread over an area, say, two blocks square. Otherwise, as in residence districts, where these distributing mains become of too great length to be considered or in central business districts, where heavy currents entail, in even short secondary mains of 250 to 300 feet, a wasteful amount of copper, then these distribution centres simply remain points, supplying a series of comparatively small transformers, each delivering its current to several, or even, as in many instances, to but one consumer.

These distributing centres are either connected with the station by pressure wires incorporated in the feeder cables, or the feeder panel is equipped with a compensating voltmeter. By either of these devices the potential difference at a centre is constantly known, and may be kept at a certain point by automatic field regulation, or by manually operated devices of the auto-transformer or induction type. Where the expense of such apparatus is not justified, and when, upon extending the mains, their voltage falls below a certain limiting value, the original potential difference may be restored by the use of multiple taps in the transformer primaries, or by interposing kick-up transformers of small capacity in the mains.

Close regulation in lighting is important, as with the ordinary incandescent lamp 1 per cent. variation in the voltage applied to its terminals produces a 5 per cent. variation in candle-power, and a 10 per cent. variation in the latter brings complaints.

Because of the wide and rapid fluctuations produced in circuits delivering current to motors, all such apparatus consuming over 4 or 5 kilowatts is best supplied from a separate network, either polyphase or multiple wire D.C.

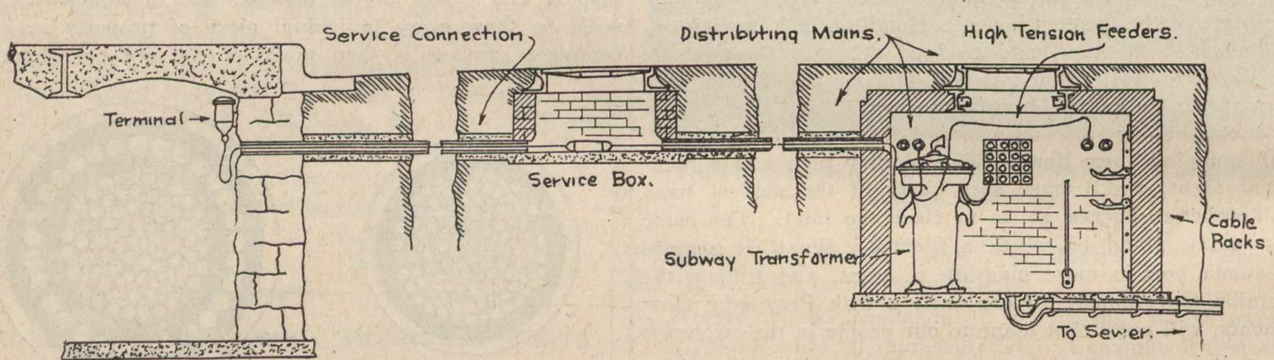
In business districts, conduit runs are located outside the curb. Throughout residence districts, however, that area between the curb and building line is often available, and the expense of tearing up, temporarily and permanently repairing the street is thus avoided, an item that may easily amount to 30 per cent. of the total cost of a particular run. Probably the type of duct most used in America is the well-known cam-single type. The objections to the multiple duct are found in the inflexibility of a conduit run constructed with them, difficulty of handling and of making joints. Fibre duct is coming into extensive use. It is extremely light; hence, cheaply transported and quickly laid. Furthermore, such material does not abraid cables drawn through it. In regard to encasement: Standard practice encloses all runs in three inches Portland concrete. At times, however, for suburban work, the sides of a conduit are left unprotected and the top covered with boards. The average cover over completed conduit may be taken as 2½ feet.

Manholes are built of brick or concrete. Where the soil is such that outside forms are unnecessary, and where a large number of similar manholes are to be built, concrete may show a saving over brick holes. Otherwise, brick construction is from 5 to 5 per cent. cheaper than concrete. The delay to the whole work occasioned by the many distinct operations and waits incident to all concrete construction is considerable in this class of work.

Service connections are made radially from shallow service boxes placed in intervals between manholes, intercepting the top row of ducts only. These services are run direct to consumer's basement. Armored cables laid in the ground without other encasement are used for this; also lead cable in single duct runs. Where distributing mains are on one side of a street only the expense of individual services may become excessive when it is usual to run a lateral to one property only, and hence through basement walls to several others.

Where the underground system connects with overhead leads, or for street lighting, the conduit is run to a point three feet from the pole, and iron or fibre bends connected to it through conduit castings. These bends, encased in concrete, rise to the surface in an easy curve of three feet radius, and either attached to lengths of exterior vertical pipe, or enter the interior of a built-up pole.

Turning to the consideration of underground cables: American practice is tending towards the universal use of paper-insulated lead-covered cables for all voltages. Not only is paper much cheaper, but for many purposes makes a better insulation than the 30 per cent. fine Para compound. The paper is wound spirally upon the conductor in layers of successively reversed lay. This core, after baking, is saturated with an oil of high insulating qualities, and finally enveloped in a lead sheath. Ordinarily, both legs of a single phase and all legs of a polyphase circuit, unless it be for arc lighting, are incorporated in one cable, with "split" insulation; i.e., suppose an insulating wall 10-32 in. thick be required between two conductors or between conductor and ground. Each conductor is covered to a thickness of 5-32 in. These cores are then assembled and wrapped with a belt 5-32 in. thick, the interstices so formed being filled with impregnated jute.



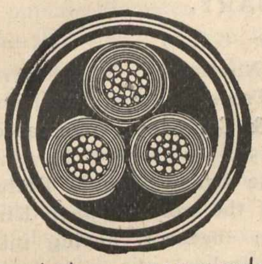
Sectional Elevation Showing Details of Distribution.

Armored cables to be laid in direct contact with the earth on the "solid system" have their lead sheaths served with a layer of prepared jute. This is followed by an armoring of iron or steel, strap or wire, a layer of jute saturated with a chemical and animal proof compound being added over all.

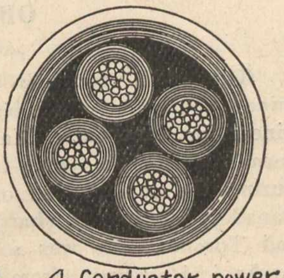
Joints on low potential cables may be of the patent or clamped connector type. The splice now most used, however, employs split tube connectors sweated to the bared ends of the wires. These joints are then taped, boiled out, and encased with a lead sleeve joined to the sheath by wiped solder joints. The intervening space is filled with hot insulating compound.

High potential underground cables we find in the form of substation feeders, which may run through conduit for their entire length or connect with an overhead transmission. To protect such cables from surges, caused either by lightning or by switching operations, it is customary to bridge the conductors at each terminus through a very high resistance, composed of air gaps and carbon rods in series, when an abnormal potential difference between any two conductors results in a discharge across this bridge rather than in a puncture to the cable insulation. Cumulative charges on the sheaths are prevented by thoroughly grounding the lead at several points.

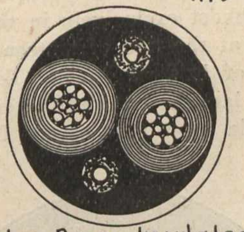
Disastrous burn-outs occur at times on high potential feeders, caused most often by the insulation between conductor and sheath breaking down at some point of severe mechanical injury to the lead. To decrease the charging current through a fault from conductor to sheath, and hence the destructive violence of the ensuing short between conductors, the plan of grounding the neutral point of the transmitting apparatus through a suitable resistance has been tried, and with success in some instances. These burn-outs seriously concern the underground distribution of the future, and this method of suppression has been the



3 Conductor, paper insulated leaded and armored Cable.



4 Conductor power cable with split insulation



Duplex Paper Insulated Cable with Pressure Wires.

subject of several A.I.E.E. papers and discussions recently.

As to the cost of an underground system, and in comparison with the cost of overhead construction, it is impossible to give any general statement that could be made use of in even the roughest estimate. The first cost of subway installations is admittedly high, especially as it is advisable to build most of the conduit in duplicate. However, it is reasonably urged that their maintenance cost is practically nil, and that all considerations of safety and sightliness demand that wires be placed underground.

REINFORCED CONCRETE AND ITS APPLICATIONS TO ENGINEERING CONSTRUCTION.

By J. S. de Vesian, M. Inst. C.E.

The object of the present paper is to present some notes upon the characteristics of reinforced concrete and its constituent parts, to describe briefly the principal systems employed in Great Britain, and to give particulars relative to applications of the material to various classes of engineering construction.

I.—Definition of Ferro-Concrete.

Ferro-concrete, or reinforced concrete, is a combination of concrete and steel, in which the steel takes the tension stresses and the concrete the compression. It may rightly be termed a new material, conforming to laws of its own.

For instance, if a beam of concrete alone will extend under tension for, say, 1-10th of an inch, a similar beam reinforced properly with steel will extend 1 in., or ten times as much, without showing signs of cracking or distress. The more the steel can be subdivided throughout the tension area of the concrete the better; or, in other words, small round bars are preferable to rolled sections of considerable area. By the suitable employment of such bars the designer is enabled to secure monolithic construction, in which all parts are connected absolutely without joints, and the reinforcement extends throughout the concrete, imparting the necessary resistance to tensile and other stresses to individual members, and by passing from one member to another the bars perform a most valuable duty by helping to distribute the forces over the different parts of the structure.

II.—The Durability of Reinforced Concrete.

The durability of concrete need hardly be entered upon after the experience we have had from olden times. Many old works give us instances of the preserving effects that good concrete has on iron.

Sewer pipes with steel reinforcements have been lately replaced in Europe after forty years' use, and the steel was found to be in good condition. As an instance, coming under the author's personal notice of the preservation of steel when embedded in good concrete, the case of some piles at Southampton may usefully be mentioned. As these piles were originally made too long, the tops were cut off and thrown upon the foreshore, where they have remained for more than eight years, being covered and uncovered by the tides four times a day by the double tides prevailing in Southampton Water. Some of these stumps have been examined by various eminent engineers, as well as by the author, and in every case the steel was found to be perfect ¼-in. only below the surface, while the bars which had been protruding where they were cut off were, of course, completely rotted away. Another very common example of the preservation of steel and iron by Portland cement is furnished by old ships, whose bottoms have been coated inside with cement when built. In such cases the places have always been found in a state of perfect preservation under this coating when replaced in after years on account of corrosion from without.

III.—The Selection of Steel for Reinforcement.

It is very important that the steel used in ferro-concrete should be of suitable quality for its intended purpose. Most experts in this class of work are now agreed that mild steel produced by the basic open-hearth process, with a tensile strength of from 28 tons per square inch to 32 tons per square inch, and an elongation of 20 per cent. in a length of 8-in., is the best for general employment. High carbon steel is unsuitable, as is also any metal of variable quality, such as some kinds of Bessemer steel. Apart from the fact that high carbon steel is apt to break unless bent with great care after suitable heat treatment, there is no economy in such metal because, as its co-efficient of elasticity is not higher than the co-efficient for mild steel, the higher elastic limit cannot be utilized fully without causing excessive stresses in the surrounding concrete, resulting in the cracking of the material and the consequent corrosion of the metal. It is immaterial what form the steel takes, but, of course, the most economical form, and the easiest to arrange, is the round bar. This section can be obtained from many different works of the requisite quality, and at competitive prices. Some patentees advocate special bars squeezed into various forms, or twisted, with the idea of giving a greater hold on the concrete. Corrugated bars of several different shapes are sometimes recommended by makers in this and other countries, on the ground that the steps or indentations so formed give an absolute mechanical bond, in addition to the natural adhesion between the concrete and the metal. In the opinion of the author, all deformed bars necessitate a greater weight of steel being used for the same loads. The process of forming the bars injures the metal, and it may well be doubted whether such bars would pass the tests which must be rigorously enforced for any reinforcement in order to ensure the proper security of the structure when completed.

In the Hennebique system nothing but round bar is used for tension members. Flat steel is used for the stirrups to resist the shearing forces. The adhesion of concrete to steel, which is an undoubted factor, is ignored. The bars are always flattened and opened at the ends to form a secure anchorage. The adhesion varies from 200 pounds per square inch to 570 pounds per square inch of surface in contact, so that as long lengths of steel are buried in the material there would be, as a rule, more than ample adhesion even if the bars were perfectly straight and not anchored into the concrete at all. Moreover, in the Hennebique system, even in

Extracts from a paper read recently before the Civil and Mechanical Engineers' Society.

the most straightforward beams and floor slabs, at least half the bars are bent upwards from the points of contraflexion and carried over the supports. The polygonal form so obtained ensures the most secure anchorage possible.

IV.—Portland Cement.

The quality of Portland cement used in ferro-concrete is of the greatest importance. The author prefers cement of the finest grinding, giving not more than a 20 per cent. residue on a 180 by 180 mesh sieve. The fineness of grinding after calcination is not a very conclusive test by itself. It would be better to have evidence of a very intimate mixing of the chalk and clay before calcination, but such a test would be very difficult to supervise, and in practice the best one can do is to see that the cement is delivered to the requisite fineness. The permissible expansion specified by the author under the Le Chatelier test is only half of that allowed by the British standard specification—viz., 6 mm. and 3 mm. fresh or seven days old. The time of setting should be from fifty to ninety minutes initial, and from seven to nine hours final.

Test blocks of 4-in. cube are required to stand the compressive stress of 600 pounds per square inch at the age of twenty-eight days.

V.—Sand.

The sand to be used for cement mortar and concrete is specified by the author to be sharp and coarse, of all sizes from ⅛-in. downwards, and to be washed perfectly free from all traces of chalk, lime, clay or earth matter. Sand of even size like "standard" sand is undesirable.

VI.—Aggregates.

The aggregate for the concrete should consist of the hardest local stone obtainable other than limestone, which is not admissible owing to its disintegrating under heat. Brick, cinder, coke breeze or slag concretes should be avoided for reinforced concrete work, as the concretes made with such materials are porous, or, as in the case of many slags, corrosive, owing to the sulphates and similar impurities in the material itself. Judging a slag from a chemically pure sample is not safe, for, as the nature of the charges in the furnaces vary, the slag from the same ironworks may not be the same quality for many hours together.

In the choice of stone, a rounded shingle or gravel of hard stone is preferable to broken stones, as so many stones have a flaky cleavage, and the rounded pebbles make a more even and sounder concrete than these flaky pieces owing to the ease with which the sand and cement can fill the voids.

For ferro-concrete construction the author is in the habit of specifying that the aggregate shall be of all sizes from ¾in. down to ⅛-in. As in the case of sand it is highly important that the aggregate should be perfectly free from earthy matter of any kind.

VII.—Proportions of Concrete.

The proportions of the materials for reinforced-concrete necessarily vary with the character of the work to be executed.

In all engineering construction strength and durability are the most important considerations, but it is very often necessary, as in the case of pipes, reservoirs and marine constructions, to pay special attention to the question of impermeability. For resistance to fire it is well-known that iron and steel are adequately protected when embedded in good stone or gravel concrete.

The voids in the sand should be ascertained by filling a receptacle with perfectly dry sand, and measuring the amount of water it is possible to add without overflowing; then it is easy to calculate the voids as a percentage of the sand. The percentage of voids in the aggregate can be determined in a similar manner. As the proportion of voids differs very much with the class of sand and stone, and the size and shape of the particles, it is desirable to test the percentage of the voids before arranging the exact mixture to be used in any work.

The average mixture adopted in reinforced concrete construction is as follows:

Portland cement	6	cwt.
Sharp sand	13½	cubic feet
Washed gravel	27	cubic feet

These quantities when properly rammed yield about 31 cubic feet of concrete.

VIII.—Concrete Mixing.

The proper mixing of the concrete is of the greatest importance, and as good concrete may be improved 100 per cent. in strength by thorough mixing, it is preferable to employ a good machine mixer than to attempt to do this work by hand. The machine is certain to do it all alike, whereas no workman, however much he is looked after, can perform the operation so effectively. The concrete mixture should be just plastic, and must always be well rammed.

OBITUARY.

The death occurred on November 28th, following a minor operation, of Robert Frederick Tate, resident engineer for Mackenzie, Mann & Company. Deceased was born in Belleville, Ont., in 1854, his father's headquarters during the construction of the Grand Trunk Railway in Canada, who was in charge of the work between Kingston and Toronto. He was a born engineer, having inherited mechanical instinct from his father, who was a trained civil engineer. He started his career in railway civil engineering, and his thirty-seven years of actual professional life were spent almost exclusively in that branch. He commenced business at the age of sixteen with a contractor in the construction of bridges on the Toronto and Nipissing Railway. A year later he entered the employ of the Midland Railway of Canada (now part of the Grand Trunk system)

R. F. Tate.

as a chainman on surveys. Five years later he was appointed chief engineer, and held that position for five years, when he retired to seek a wider field for experience. In 1893 he located the line of the British Columbia Southern Railway from the summit of Crow's Nest Pass to Tobacco Plains in East Kootenay, on the international boundary. He was also engineer in charge of a portion of double track of the Grand Trunk Railway in their Sarnia tunnel, connecting from Blackwell to the east end of the tunnel yard. In 1899 he was appointed resident engineer for MacKenzie, Mann & Company, with headquarters at Toronto, which position he held up to the time of his death. He was fifty-three years of age, was a charter member of the Canadian Society of Civil Engineers, was president of the Engineers' Club, Toronto, during 1905, and was a member since its inception.

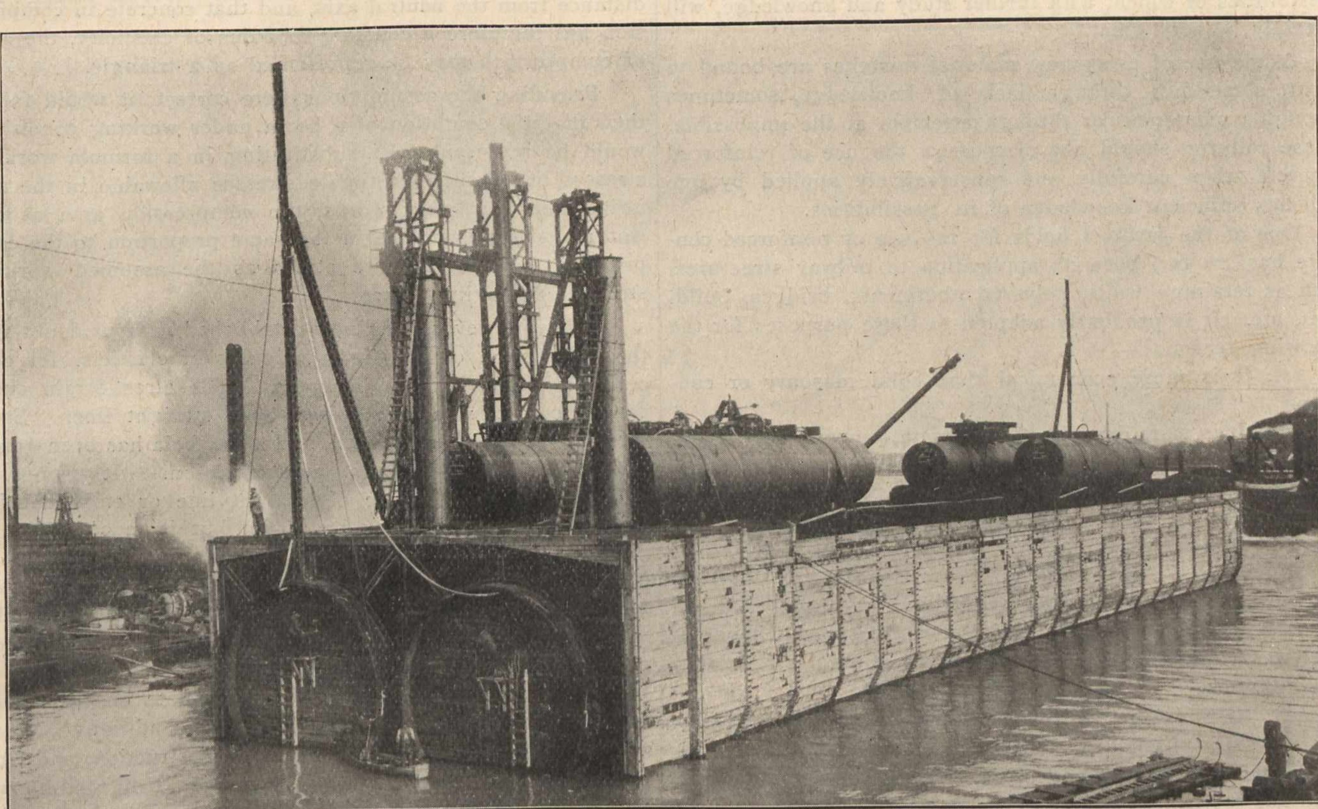
DR. BERNARD J. HARRINGTON, director of the Macdonald chemistry and mining building of McGill University, died on November 29th. He was a graduate of McGill, and had been connected with the teaching staff of that institution for 36 years.

LOWERING SECTIONS FOR THE DETROIT RIVER TUNNEL.

The accompanying illustrations show the manner in which the sections are floated down the St. Clair River, and the systems of lowering these, in the construction of the Detroit River Tunnel for the Michigan Central Railway service connecting Windsor and Detroit across the Detroit river. These sections are constructed at the St. Clair yards of the Great Lake Engineering Works, Detroit, there being ten sections similar to those shown in the accompanying views. Each section is 260 feet long, and each tube is 23 feet 4 inches outside diameter.

The subsequent portion is 2,624 feet in length, westerly of the open cut, 1,540.07 feet; westerly approach, 2,128.97 feet; easterly approach, 3,193.14 feet; easterly open cut, 3,500 feet, making a total distance of excavation of 12,786.18 feet, or a little more than 2.42 miles. The tunnel proper consists of two parallel tubes laid on girders in a trench dredged across the bottom of the river, the trench afterwards being filled in with concrete. The depth of the tubes will be 65 feet below the water level, and the under-water portion, 875 yards long. These tubes, which have an internal diameter of 20 feet, are being constructed of three eight-inch plates, stiffened on the outside by webs 12 feet apart. The laying is done in sections of 263 feet long, which are afterwards rivetted together under water. The tubes which are each 23 feet 4 inches outside diameter, have a concrete lining 20 inches thick, which gives a clear diameter of 20 feet. Each tube contains one track and the roof of the tunnel is 18 feet above the rails. Running along the sides of the tunnel are concrete platforms 5 feet 3 inches above the rails, and 3 feet 10⅜-inches wide at the top. These concrete platforms contain conduits for signal lighting and electric power cables, telephone and telegraph. The platforms also provide a walk for passengers in case of necessity and room for the workmen.

The method used in laying these sections of tunnel consists in placing sections of tube in the dredge channel, connecting them together when in place, and then filling in with concrete. The pumping out of the water in each of the continuous tubes follows. The trench is 48 feet wide at the bottom and about 32 feet deep, with a slope of ½ to 1, so that the trench is between 50 and 60 feet wide at the top. The dredging is performed by dredges equipped with powerful clam-shell buckets, while following the dredges are the pile-drivers. The tubes are located on temporary piles which are driven into the trench. Piles are driven on either side of the trench in two rows, reaching to the surface of the water, and guide the tubes as they settle into position. These piles are afterwards removed. In the operation of floating a section of the tunnel containing two tubes and 23 diaphragms is blocked up at each of the twin tubes with bulkheads of wood, and made ready to float on the river. This method makes the tubes air tight. Four temporary floating cylinders, each of about 10 feet in diameter and 60 feet long, are chained on the top of the tubes. These cylinders are filled with compressed air, so that with the enclosed air in the main tubes, and the outside planking the whole structure is made buoyant. An accompanying illustration shows the lowering of one of these sections between the guide piles and the river. While the air is allowed to escape from the tubes, final adjustments are made by the compressed air cylinders. The tubes shoulder in rubber gaskets at the joints, in each side of which are partially cylindrical chambers.



The First Section for Detroit River Tunnel Ready to be Submerged.

The joints are finally locked with heavy pins, entering into corresponding sockets in the adjoining sections and securely bolted. A sleeve 17 inches in length, situated at the forward end of each of the tubes, fits over the end of the section already sunk. The work of filling in the concrete then follows. A great deal of the work is done at the surface, greatly lessening the dangers connected with the undertaking.

ARTS AND MANUFACTURE CLASSES IN MONTREAL.

The secretary of the Council of Arts and Manufactures has issued the report of the attendance in the various classes for October in Montreal, which shows an increase over the previous year. There are 1,213 pupils following the instruction given by competent teachers. Mechanical drawing is taught to 637 pupils in Montreal; plumbing to 117; modelling, 30; free hand drawing, 154; carpentry and stair building, 70; architectural drawing, 102. A lack of room is one of the drawbacks found in Montreal, where the classes are conducted in the Monument National on St. Lawrence Street.

DESIGN AND SPECIFICATION OF A CONCRETE BRIDGE ABUTMENT.*

By T. M. FYSHE (S. Can. Soc. C.E.)

The past few years have seen a tremendous growth in the use of concrete, plain and reinforced. One has only to look at the remarkable growth of the Portland cement industry, both in the United States and Canada, to realize this fact. Cements have, of course, been known for a very long time, but within the past twenty-five years the cost of the manufacture of Portland cement has, through a great deal of scientific study, been very much reduced, and the same time the quality and uniformity of the cement have been greatly improved. These facts in a large degree account for the great increase in its consumption.

With the increase in the use of Portland cement concrete, the study of its qualities has gone hand in hand. The use of steel to overcome the inability of concrete to resist tensile stresses was a remarkable discovery. This combination of concrete and steel is made possible by the fortunate coincidence of their coefficients of expansion and contraction. It virtually gave the world a new material, steel concrete, the possibilities of which, with further study and knowledge, will certainly be very great.

In the use of every new material mistakes are bound to occur, sometimes through lack of knowledge, sometimes through carelessness or through attempts at the impossible. These failures should not discourage the use of reinforced concrete when carefully and conservatively applied by one who has sufficient knowledge of its possibilities.

One of the greatest fields for the use of reinforced concrete has, so far, been its application to railway structures, such as retaining walls, culverts, abutments, bridges, buildings, etc. It is peculiarly adapted to these purposes for the following reasons:—

1st. It is more economical than solid masonry or concrete.

2nd. It is more durable; for concrete, properly reinforced, can stand all stresses, including temperature and shrinkage stresses, without cracking; and steel, protected by concrete, is rustproof.

3rd. It is fireproof.

4th. There is practically no maintenance cost, since the concrete improves rather than deteriorates with age.

5th. It is a material in which the stresses can be accurately determined, and is in consequence of greater reliability than masonry.

6th. Its erection requires very little, if any, skilled labor, and any form of construction can be employed without shopwork, the only materials necessary being timber for forms, materials for concrete, and steel bars.

The introduction of any new material, of course, depends upon its initial cost; the more economical it is, the more general its use will become. For this reason reinforced concrete has already been used extensively by railroads in the United States, principally in the West. A knowledge of its properties is, of course, necessary, the lack of which, and a natural conservatism, makes some engineers reluctant to give it their unqualified recommendation. With the great increase in its use and the greater knowledge thus being gathered every day, it will not take very long before reinforced concrete will be everywhere recognized as a standard form of construction.

The abutment herein described was designed by the writer in order to compare it with a standard abutment of plain concrete made by the National Transcontinental Commission. The end in view was to show the greater economy of material effected by the use of concrete reinforced.

Before proceeding with the design, it will be necessary to devote a few words to the formulae employed and the assumptions made. The whole design really resolves itself into the solution of beams and cantilevers, thus making necessary the use of some theory of flexure for reinforced concrete beams. There are a great many of these theories differing from one another in several respects. The majority of these theories are what may be termed straight line formulae; for they assume a constant modulus of elasticity for concrete in compression, whereas this modulus is a variable decreasing with increasing stress. In the formulae employed in this discussion a parabola is assumed as the compression curve of concrete. There are two main groups of formulae: those attempting to represent the condition of the beam under working conditions and working stresses, and from these assumptions arriving at the safe load that any beam can carry; and those representing the beam at its ultimate carrying capacity and hence at ultimate stresses, and from these assumptions arriving at the load which will cause any beam to fail, and then by the application of a safety factor to this load, determining the safe load to which the beam may be subjected. When straight line formulae are used, that is, when it is assumed that the ratio of strain or deformation of any fibre is directly proportional to its distance from the neutral axis, and that concrete in compression has therefore a constant modulus of elasticity, the area of compression may be represented as a triangle.

Providing the assumptions were correct, it would follow then that the condition of a beam under working conditions would be represented by substituting in a formula working stresses based on the ultimate stresses allowable in the material used. In other words, the compression area at any working stress would be in the same proportion to the compression area at ultimate stress as the assumed working stress to the ultimate stress.

It has, however, been now established without doubt that the assumption of a uniform modulus of elasticity for concrete in compression is incorrect. The stress-strain curve cannot correctly be represented by a straight line. Some other curve must be assumed, and a parabola has been generally chosen as the closest approximation. It cannot be denied that with the use of straight line or empirical formulae, safe designs may be made, but it must appeal to every engineer that a formula representing conditions as clearly as possible is much more desirable. When such a formula is derived, based on the assumption of a variable modulus of elasticity, the use of working stresses in connection with it must be condemned, principally, because at present there are in existence very few data on the condition of beams under ordinary working conditions. Nearly all the stresses up to date have been to destruction, and from these the ultimate strength of beams is fairly well-known. Secondly, assuming a parabola or any other curve excepting a straight line as the cross-strain curve of concrete, the ratio of the area of the ultimate compression curve to the area of the compression curve for any working fibre stress cannot be the same as the ratio of ultimate stress. These ratios must vary as some function of the second or third power according to the equation of the curve assumed. The assumption of working stresses in a case like this will therefore naturally not give the required factor of safety, and in some cases not even be a possible condition; that is, the assumed stresses in the steel and concrete may never occur together. From the above it would seem to be far more consistent and conservative, until further knowledge on the subject has been gained, to base formulae on the ultimate strength of the concrete and the elastic limit of the steel, applying the factor of safety to the loads.

Formulae can further be divided into two groups, those basing the ultimate strength of a beam on the ultimate strength of the steel, and those basing the ultimate strength on the elastic limit of the steel. When calculations for the strength of beams were first made, it was naturally assumed that the working stress allowable in the steel was some factor of its ultimate strength. Closer inspection and study of tests made this very doubtful. It is readily seen that, when steel is strained beyond the elastic limit, the bond between concrete and steel is destroyed, due to the reduction of the cross-section of the steel. If the bond is one of adhesion

* Extract from paper read before the Canadian Society of Civil Engineers at Montreal, October 17th, 1907.

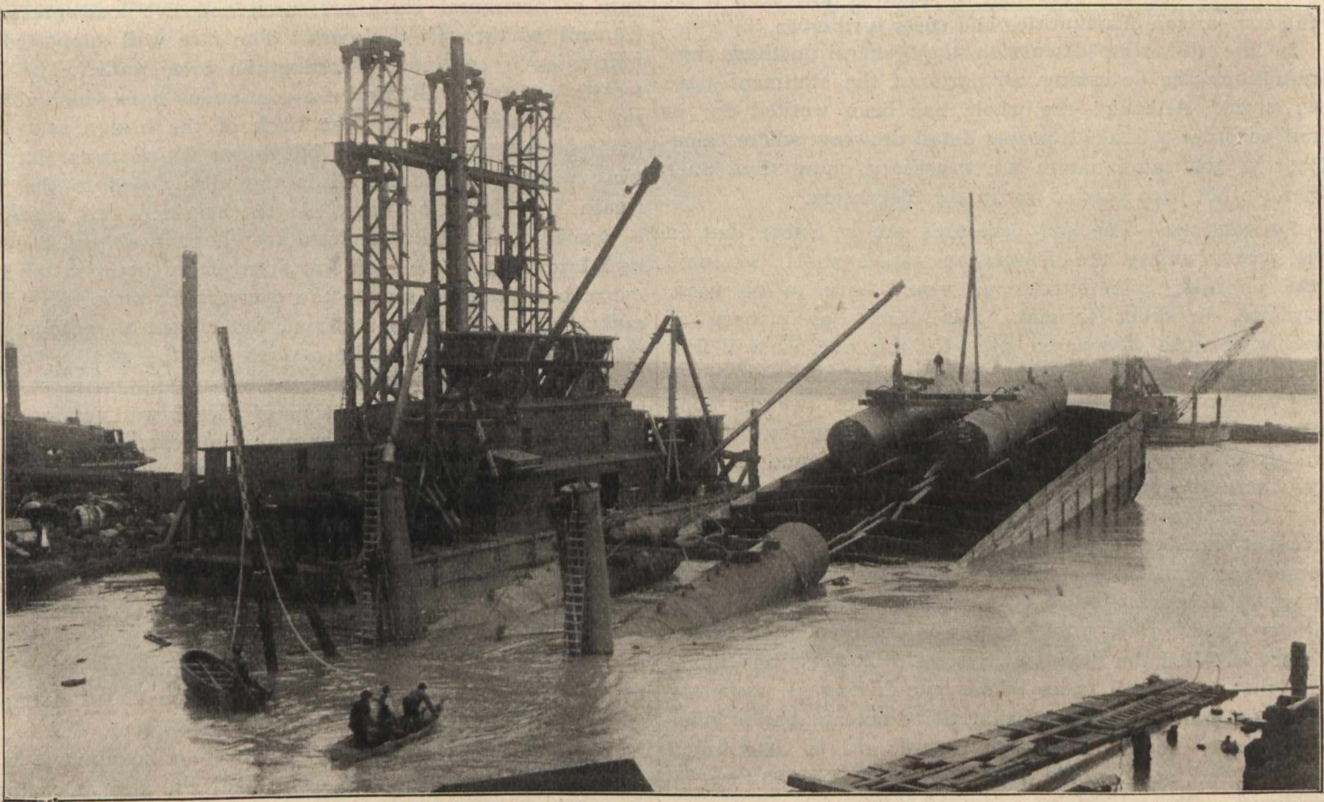
only, it is unquestionably destroyed; if the bond is a mechanical one, there remains, of course, much resistance, to slipping, but the beam is seriously weakened. The best description of the condition of a test beam at this point has been given by Professor A. H. Talbot, of the University of Illinois, in his bulletin of September, 1904, discussing results of tests carried on under his supervision at the engineering station of the University. Professor Talbot says in discussing beams reinforced with sufficient steel to take all tensile stresses: "The maximum load averaged about 6 per cent. more than the load at the yield point of the metal. It would seem then that for beams not having an excess of metal, the maximum load is nearly reached when the steel is stressed up to its yield point, and that the load at the yield point of the metal may be properly taken as the ultimate strength of the beam. It seems also true that the load which will stress the steel to its elastic limit, may be calculated by using the elastic limit of the naked steel for the tensile stress in the beam, and neglecting tension in the concrete."

What probably does occur in a beam when the elastic limit of the steel is reached is that, owing to the rapid extension of the steel, the neutral axis rises and the beam fails by compression of the extreme fibres of the concrete. For the above reasons, a formula in this discussion has been adopted which represents the ultimate strength of a beam at the point where the steel reaches its elastic limit.

A great deal of work has been designed, using steel which has an ultimate strength of say 64,000 lbs. per square inch, and using a working stress of 16,000 lbs., the designer thinking he has a factor of safety of 4. The real factor of safety accepting the foregoing conclusions is only 2, as the elastic limit of the above steel would average 32,000 lbs. That these conclusions are correct, is pretty well conceded by all authorities in the United States at present, yet a great deal of work, designed as above stated, is still being done. This, of course, can only be to the detriment of reinforced concrete, and be the cause of unnecessary failures. It stands to reason that as the ultimate strength of the beam depends on the elastic limit of the steel, the higher this elastic limit is, the more economical it will be. To the use of high carbon or high elastic limit steel the objections may be made that it is not reliable, and that its full value may not be developed owing to insufficient adhesion. Several years ago it was thought that economy could be effected by employing high carbon steel for bridge work. It was found, however, that owing to punching and the irregular stresses produced in plates and structural shapes, high carbon steel was unreliable. For this reason some engineers condemn its use for reinforced concrete. It should be remembered, though, that in this class of work there is no punching of the steel necessary. The stresses in the steel are nearly all tensile, and the ability of the steel to safely withstand them has been proven many times over. Shearing stresses need never be considered either, as they are always far within the shearing strength of the steel.

The objection that adhesion may not be sufficient to develop the full strength necessary of high elastic limit steel, is easily overcome by furnishing a suitable mechanical bond. An intimate union or bond between concrete and steel is of first importance, especially as failure of bond or lack of it may often have disastrous effects. Plain round or square bars depend on adhesion for the union of steel and concrete. This adhesion is partly due to friction, but chiefly to a mechanical bond, formed by the grout of the concrete entering into the irregularities on the surface of the bar. There are three influences affecting the adhesion and making a mechanical bond advisable: first, water percolating through the concrete (no concrete is perfectly watertight) has been proven to reduce the bond between ½ and ⅔; second, reinforcing bars when stressed, even within their elastic limit, must have their cross-section slightly reduced, and any shrinkage of the cross-section of the metal, however slight, is sufficient to materially affect the adhesion, inasmuch as the adhesion consists principally in the entering of the cement particles into the pores on the surface of the metal. If the metal has a working stress of 15,000 lbs. per square inch, then the proportionate elongation is .0005 per unit of length, with a decrease in diameter of practically one-half or .00025, by no means a negligible quantity.

Finally vibrations and shocks have also been proven to affect the adhesion. The last would alone warrant the adoption of mechanical bond reinforcement for railroad structures. To the above reasons may be added the many chances of bars being disturbed in partially set concrete during construction. From the foregoing it would seem wise to adopt a style of reinforcement with a suitable mechanical bond.



Lowering the First Section for the Detroit River Tunnel.

General Dimensions.—The general dimensions for the described design were taken from the set of Standard Abutments of the National Transcontinental Railway Commission, which were very kindly furnished the writer by Mr. H. D. Lumsden, chief engineer.

A rather high abutment was chosen as the economy of reinforced-concrete construction increases with the height of the structure. The distance from ground level to sub-grade was taken at 50 feet 1 inch, the span allowed for is a 100-foot deck plate girder with the girders 9 feet 0 inch centre to centre, and the same width and depth of bridge seat was allowed as that shown on the standards referred to. The distance from the ground line to the bottom of the foundations was assumed as 5 feet, as shown on the standard plan, but this distance is, of course, an assumption. It depends entirely on local conditions, and would vary accordingly. The wing walls of the abutment slope at an angle of 60 deg. to the track. These walls are stopped at a height from which a 1½ to 1 slope will fall inside the line tangent to the face wall of the abutment at the ground line. This is the only point of difference from the standard plan. In it the wing walls are run out to a height of 4 feet above the ground line. This seems hardly necessary, as by the former method a clearance equal to that between the two face walls is maintained, which in most cases will be all that is necessary. An allowance for this reduction in quantity has been made in the comparison of quantities and costs further on.

In the following discussion the general methods and assumptions for designing all parts of the abutment have been given. Although the whole has been worked out in detail, in order to make a proper detail drawing, where calculations of the same nature are necessary, more than once they have not been carried out in the discussion.

Foundations.—The soil pressures are so great that in most cases, unless the foundation consisted of cemented gravel or rock, pile foundations would have to be used. Therefore, in order to make this design as modern as possible, the use of concrete piles for this purpose will first be considered. The use of concrete piles may not in all cases be economical, especially in localities where good timber piles are available and not too expensive. In a majority of cases, however, their use will be found satisfactory where the following conditions obtain: where timber piles are scarce and consequently expensive, where the distance between low water line and ground level at face of abutment is considerable, and when a concrete pile is used that gives a bearing capacity much larger than that of an ordinary wooden pile. Such a pile is obtained when driven by what is called the Raymond System. It must be remembered that nearly all cases where pile-driving is necessary differ from one another, and that the exact number of piles used for any foundation is, of course, always determined on the ground, so that only a general discussion can here be introduced. Raymond piles are of the following sizes:—

20	feet long,	20	inches diameter	at top,	6	inches at the point.			
25	"	"	20	"	"	"	8	"	"	"
30	"	"	20	"	"	"	8	"	"	"
35	"	"	18	"	"	"	8	"	"	"
40	"	"	18	"	"	"	8	"	"	"

The method of driving and making these piles is briefly as follows: A collapsible steel core of a conical shape corresponding to the above dimensions is encased with a thin, tight-fitting sheet iron shell, generally No. 20 gauge. This core and its casing are driven to the required depth by an ordinary pile-driver. The core is so constructed that when the driving is completed, it is collapsed by a system of wedge surfaces, and is easily withdrawn from its casing, leaving it in the ground as a form for the concrete, and preventing the earth from closing up the hole made. The casing is then filled up with Portland cement concrete.

The advantages of this system of piling are: 1. The use of a shell or form for each pile. 2. The tapering shape of the pile. 3. The ease of reinforcement. 4. The fact that the concrete is not subject to blows and shocks from driving.

The shell protects the green concrete against quicksand and mud, etc., and makes it possible to ascertain that every hole, and therefore every pile is perfect. The tapering shape effects an economy in the number of feet of piling necessary, producing a greater bearing capacity. As it is driven into the ground, it drives harder with each blow since it has to increase the size of the hole for the entire distance of its penetration into the ground. It thus takes advantage of the full bearing power of the soil. The absence of driving on the concrete is also to be commended as, when driven, concrete piles cannot stand a hard blow of the hammer without fracture. It is very difficult to say exactly what load these piles will safely carry, all the tests made, however, would indicate that they will bear from two to three times as much as an ordinary wooden pile. The economy in the use of these piles lies in the fact that less lineal feet of piling are used, and there is a great saving generally, in excavation and masonry, as the tops of these piles do not have to be placed below water line.

Design.—In general the abutment has been designed as follows: The base is about half the height. This dimension is greater than 4/10 usually allowed for solid masonry abutments, and therefore makes the structure much more stable. This extension of base is also very easily obtained without much extra cost. Two main buttresses support the bridge seat and are placed directly underneath the centres of bearing of the girders. A face wall connects these buttresses to take care of horizontal earth pressures and live load pressures transmitted through the earth. The face wall supported by buttresses is continued, forming the wing walls. The buttresses and face wall rest on a continuous base which resists the earth pressures. At the back of the bridge seat is a parapet wall supported by buttresses which runs into the wing walls. The face wall is thoroughly tied to the buttresses by reinforcing bars. As the height of this abutment is considerable and the resultant horizontal thrust would therefore be large, a shelf has been placed between the four entire buttresses to reduce the overturning moment. This makes somewhat more material, but effects an economy by reducing the extreme soil-pressures and the steel necessary in the buttresses to withstand the overturning moment.

Parapet Wall.—This consists of 16-inch wall supported by the continuations of two of the main buttresses. This wall is designed as a horizontal beam supported by the buttresses, which are 9 feet centre to centre. In nearly all reinforced concrete structures beams act as continuous ones, due to the method of construction. It is, however, difficult to say exactly how much this continuity can be relied upon. Some designers neglect it altogether and figure the beam as one simply supported.

Face Wall.—The face wall is designed by the same method as the parapet wall. It was considered better to make this wall somewhat stronger than figured, due to the fact that besides being subjected to cross bending, it is in compression due to its own dead load, and also in compression due to its T beam action in conjunction with the buttress. For this reason a batter of 1 in 24 was put on the face. Horizontal bars are hooked over the bars in the face wall and run back into the buttress. These were figured stong enough to take the horizontal reaction of the wall between buttresses, without depending on the tensile strength of the concrete. Impact loads were not considered below the parapet wall, as at that depth they will be pretty well dissipated in the embankment. The greatest stress in the face wall in the centre of the abutment will be found according to the assumption made just above the relieving shelf. When figured as already shown, the amount of metal necessary per square foot was 0.43 square inches. Three-quarter-inch bars 12 inches on centres are used in face and parapet walls to take care of cross-bending. This is somewhat more than actually figured; but as the increase of metal increases the cost only slightly, it is generally better to incur a small increase in cost and be on the safe side. To tie the face wall together vertical ⅝-inch bars 2 inches on centres are used, and to take care of the reverse moment over the supports, ¾-inch bars 12 inches O.C. 5 feet long are used.

Bridge Seat.—The main buttresses are large enough, and are designed to carry the bridge loads directly to the base, so the bridge seat has no direct load to carry. In this case it was made 2 inches thick. It should be strong enough to tie the structure together thoroughly, and for that reason it is well to reinforce it so, that if the necessity arises, it will be capable of developing its full strength.

Buttresses.—The main buttresses should in all cases be placed directly under the bed plates of the girders; they are widened out at the bottom to distribute their load on the base, and are reinforced by bars placed in the rear, anchored in the base, to take care of the overturning moment. In case of through spans, it will be found necessary to place an additional buttress between the two main ones. The wing walls are similarly treated, buttresses being placed 9 to 10 feet on centres sufficiently reinforced, to resist the overturning moment due to horizontal earth pressures. The buttresses were figured as cantilevers fixed at the base. In reality they will most likely act in conjunction with the face as T-beams, the face wall taking the compression. It will be safer, however, to figure the buttress as a simple beam. The factor of safety in figuring the ultimate moment has been reduced to three in this case, as this moment is greatly in excess of the moment of stability of the abutment, as a whole, and, therefore, it is not advisable to design any member to resist a very much greater overturning.

Comparison of Standard Plain Concrete Abutment and Reinforcing Concrete Abutment.—Initial cost is generally the principal and most important point of comparison, and in this respect the reinforced concrete abutment makes a very creditable showing. The contents of the standard abutment from the standard plan is 1,786 cubic yards. Making an allowance of 142 cubic yards for the shortening of the wing walls, the basis of comparison would be 1,644 cubic yards. A rough estimate of the design places the quantities at 1,060 cubic yards of concrete, and 101,200 pounds of steel.

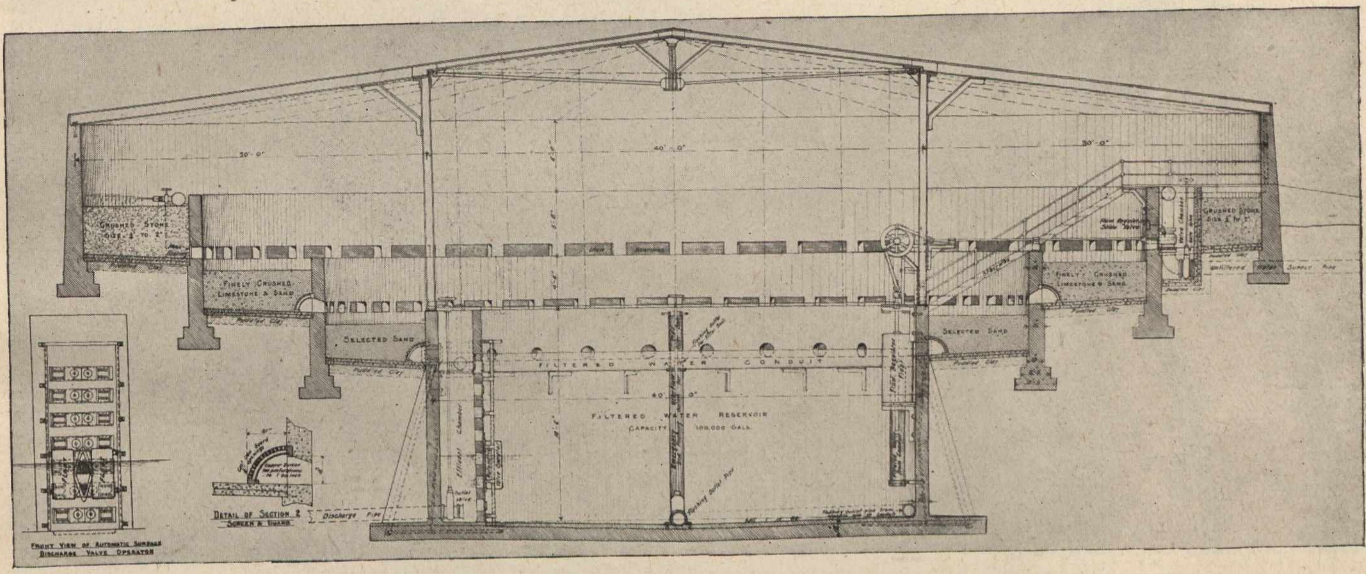
The contract prices per yard of concrete on the National Transcontinental Railway are $10 on the eastern section, and $12 on the western section. These figures are used. An allowance of 50 cents per yard has been made for the increased cost in placing concrete reinforced. The cost of steel, including placing, has been figured at 4 cents per pound. On the basis of $10 a yard, the standard abutment will then cost $16,440, and the reinforced concrete abutment $14,657, effecting a saving of $1,783. On the basis of $12 per yard these figures are $19,728 and $16,687 respectively, and the difference in cost is $3,041. In the first case the standard abutment is 17 per cent., and in the second 18 per cent. more expensive.

Another advantage of this abutment is its greater stability. To this may be added the saving that would be effected if pile foundations were necessary. The standard abutment having a great dead load and a much greater extreme soil pressure.

These points of advantage, together with those mentioned in the beginning of the paper on the advantages of using reinforced concrete for railway structures, should be sufficient to convince any railway engineer of the great advantages of reinforced concrete construction, and of the great possibilities of this material.

GRAVITY FILTRATION PLANT.

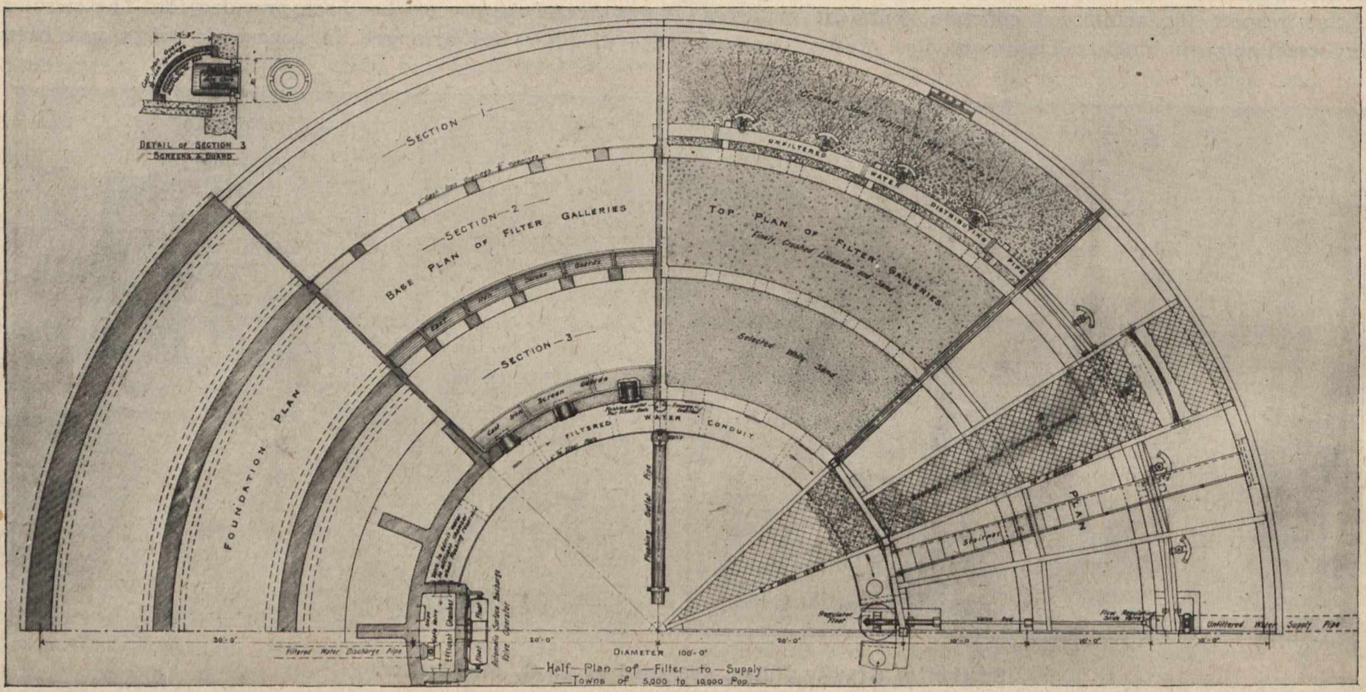
The accompanying views are from the plans of the "Alpine Gravity Filtration Plant," of which Mr. J. Grant MacGregor, C.E., of Goderich, Ont., is designer and patentee. This form of filtration plant is designed in the interests of corporations, promoters of public works, and the public generally, and is the result of several years of careful study along the line of economical filter plants which can be made adaptable to large or small water supplies. The filter beds are so arranged as to permit of a slow lateral flow through the filtering material. It is claimed that this is a marked advantage over a system permitting only of the water passing vertically through the filter beds, as in the case of the former, a greater area is traversed, and the natural courses of water in subterannean passages, invariably the source of the clearest spring water, is in a measure imitated. As regards the requirements from a slow process, it is so designed as to be economical in construction, while a larger surface of filter material in the earlier stages of the process has been provided for. The circular form of filter bed arranged in concentric rings has been introduced for this purpose, the outer or larger one of the series acting as a coagulating chamber, where the size and nature of the material employed is such as will be most effective in arresting suspended matter susceptible of being treated in this manner. In considering the question of economy in proportioning the walls to resist earth and hydraulic pressure as well as in dispensing with an elaborate pipe system, the circular form has been found to be superior to a polygonal or rectangular form. The filter galleries are arranged at superimposed elevations to permit of water passing from the base of a higher to the surface of a lower one of the series, the process being induced by an inclination of the floor of each section, and concentrating the flow to the points of discharge of the lowest section where the clear water is finally intercepted by a circular steel conduit and discharged into a central storage reservoir.



Section of Gravity Filter, designed by J. G. MacGregor.

Three classes of material have been employed for the filtration, each class being kept separate by partition walls, and in this manner is capable of being washed and treated without its being removed from the filter, provision being made for flushing or cleaning both filter beds and central reservoir without interruption to the flow of clear water. In the process of filtration the passage of suspended matter from one filter bed to another is prevented by screens of varying degrees of fineness which are protected from the weight of the material in contact by cast iron quadrantal gratings having a groove on the inside in which the metallic perforated screens slide. The filtration process is completed by the final passage of the water to the reservoir through a duplex wire cloth strainer, the inner cylinder being of exceedingly fine mesh; the cylinders being detachable and removable for cleansing purposes.

The distribution of the unfiltered water over the surface of the uppermost filter bed is effected by means of a wrought iron pipe laid in a circular path at or near the surface. The points of distribution being fixed at determined distances apart, and consisting of arc formed spray nozzle attachments capable of distributing the water uniformly over the entire area of the filter beds. The flow of unfiltered water from the main supply pipe is controlled automatically during fluctuations of the discharge from the reservoir by means of a float operating a slide gate valve with connecting rod and crank wheel attachments. A constant flow from the surface of the water in the reservoir is maintained at any elevation by means of an automatic valve operator consisting of a double float connected rigidly at its upper and lower extremities, leaving enough space between the floats to permit of a free passage of the water to the valves, the floats moving vertically in channel-shaped guides by the aid of friction pulleys. The valves are opened by means of a cam frame engaging the friction pulleys of the valves, and are closed in the same manner by the aid of spring coils. An emergency overflow is provided on the flushing output pipe, which is also connected with the circular conduit for flushing filter beds. The filter beds are divided radially in compartments each one acting independently of the other, permitting of a continuous supply of clear water being maintained during flushing operations.



Half-Plan of Gravity Filter, designed by J. G. MacGregor.

The side walls and bottoms of filter beds and central reservoir are designed to be constructed of reinforced concrete. Where it may be necessary to construct a plant of this kind on a large scale the reinforced concrete roof may be sloped inwards towards the edge of central reservoir, the roof of the central reservoir being sloped outwards to connect with that of the filter beds, and the drainage disposed of through the emergency overflow.

The designer has obtained exclusive right to this construction in order that he may be able to bring to a successful issue, and place in a practical form what he considers will eventually become a great public benefit. The arrangement has been planned with a view to reducing the work of operation and cost of maintenance to a minimum, as experience has shown that many valuable filtration systems have been condemned by the owners on account of lack of care in their maintenance. This feature has been carefully considered, and may have had the effect of adding slightly to the cost of construction, but undoubtedly cheaper and more satisfactory when in operation. The designer is prepared to demonstrate its efficiency to any corporation about to adopt this plant, by constructing a section in timber at a small cost so that the principle of its operation can be made clear.

A SPLENDID EXAMPLE OF REINFORCED CONCRETE CONSTRUCTION.

The warehouse for Andrew Darling Company, now nearing completion, at the corner of Spadina and Adelaide Streets, Toronto, is an excellent example of the use of reinforced concrete construction, and is the largest concrete building now on British soil. The building is about 100 x 112 feet, and nine storeys high. The building throughout is of monolithic reinforced concrete, designed with concrete slabs and intermediate concrete beams. It is designed to carry a live load of 125 lbs. per square foot on the typical floors, and 150 lbs. live load per square foot on the first floor. The typical floor slabs are 5 inches thick and are reinforced with ½ x 1½-inch bars spaced 11 inches on centres, continuity in the slabs is provided for by inverting ½ x 1½-inch bars over the beams 45 inches on centres. At right angles to the bars and on top thereof ½-inch diameter round rods are laid 3 feet on centres to provide for shrinkage and temperature stresses. The intermediate beams are 14 x 30 inches, and are reinforced with two 1¼ x 3¾ ins. and one 1 x 3-inch bars. The intermediate beams are spaced 9 feet 6 inches on centres, the columns being 19 feet centre to centre in this direction and 22 feet in the other direction. The girders supporting the intermediate beams are 16 x 36 inches and are reinforced with three 2 x 3½-inch bars. The intermediate beams and girders are figured as simple beams, but 1 x 3-inch bars are inverted over the supports to provide for reverse moments.

Actual concreting was begun the last week of June, and the roof of the building was completed November 8th, this year. It is understood that companies with whom the insurance will be placed have made a rate of approximately 5½ cents per $100, an exceedingly low rate for this section of the city, and for a structure of this size. The contractors were the Provincial Construction Company of Toronto, and the engineers the Trussed Concrete Steel Company of Canada.

ENGINEERING NEWS FROM GREAT BRITAIN.

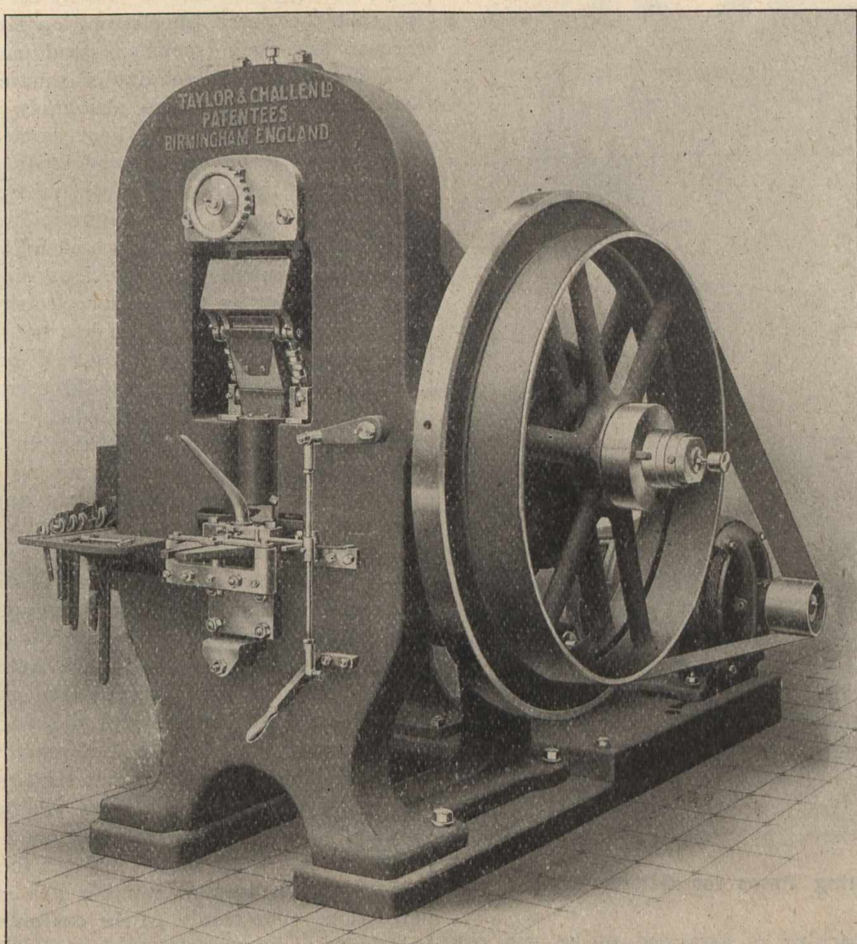
(From Our Special Correspondent.)

Smoke Nuisance Prosecution in London.

The smoke problem in large cities is one which the authorities have to face in all industrial quarters of the world, and it is a matter of supreme interest to engineers in charge of machinery who are called upon to consume in their furnaces practically all the smoke they evolve. The most diversified laws exist in Great Britain on this subject, practically a different rule existing for every town. A special Act of Parliament was passed relating to London, but this, true to the traditions of Acts of Parliament, leaves a very wide construction to be placed upon its wording, which it has been the constant aim of the Coal Smoke Abatement Society to have altered in such a manner as to make it more stringent for factory owners generally. So far, their efforts have been fruitless, but certain borough councils have been by no means loth to take out summonses under the Act. Fortunately, it is open for any magistrate to take a common-sense view of the whole situation, and to have regard, in giving a decision, to the functions of the particular chimney complained of. The case which has led up to this homily involved the electrical generating station of the Underground Electric Railways Company of London, which was erected several years ago, when the late Mr. Yerkes came over to England and secured control of the underground railways in the metropolis. The Westminster Borough Council summoned the company for allowing the emission of black smoke, but the evidence produced by the company to the contrary was so overwhelmingly strong that the magistrate, after a visit to the works, came to the conclusion that the arrangements were as perfect as science could make them, and that the summonses ought never to have been taken out. He gave a verdict against the council, with $1,500 costs, and strongly commented upon the unscientific nature of their evidence.

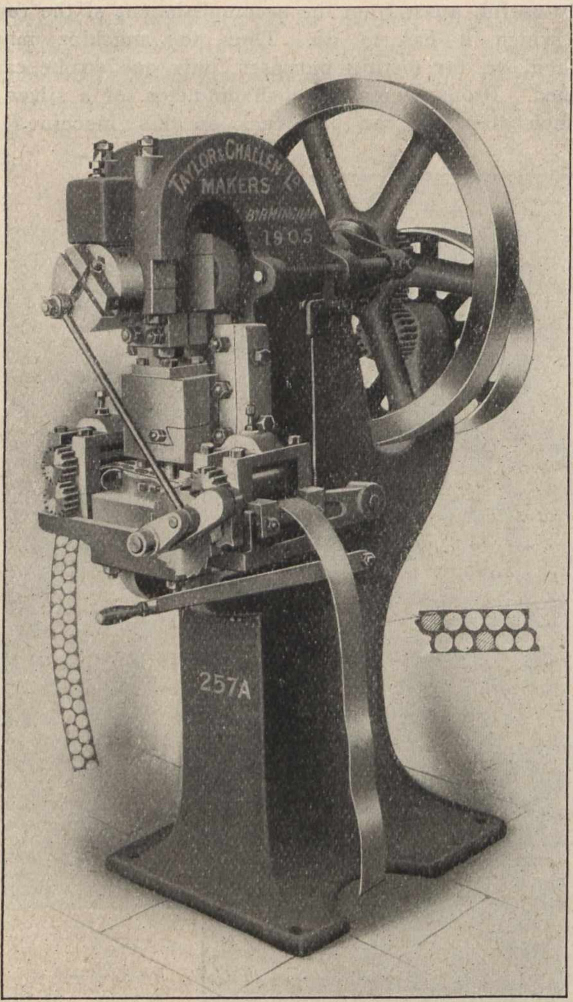
British Machinery for Ottawa Mint.

By the courtesy of Messrs. Taylor & Challen, of Birmingham, illustrations of some special minting machinery which they have supplied to the Royal Mint at Ottawa are shown. The belt-driven coining press, which is driven by an 8-horse-power motor, has a toggle lever operated by a forge steel crank shaft at the back, the latter also carrying the flywheel. All danger of the dies clashing and damaging the surfaces is prevented by an automatic clutch, which stops the machine when the hopper is empty. A number of movements are fitted to the machine, which are distinctly useful, apart from the accomplishment of the regular work which it has to do. Thus, the machine may be hand-fed, or, for testing purposes, only one stroke can be obtained. Bronze coins 1⅛ inch diameter, or a silver coin 1¼ inch diameter, can be struck on this machine. The motor-driven rolling mill, the rolls of which are 14 inches diameter and 16 inches long, has, for its function, the rolling down of the precious metals from the bar. The motive power in this case is a 30 horse-power motor, the method of the transmission of the power being clearly seen in the illustration. An adjustment of the roll to .0005 inch is claimed as possible by means of the hand-wheels seen at the head of the machine. The surface speed of the rolls is, when running at a speed of 40½ revolutions per minute, 148 feet per minute. The fillets produced on this machine are finished in a similar piece of apparatus, which has an accuracy of .0002 inch, measured on a circular scale. All these machines have a common bedplate, on which the rolls, motor and gearing are all mounted. It is from these fillets that the blanks are cut. The rotary motion of the horizontal flywheel and of the screw in the belt-driven screw-press is obtained through the medium of friction discs. The pressure on a handle brings one of the discs into action, the



Motor-Driven Rolling Mill for Ottawa Mint.

result being a downward motion of the screw. The release of the handle brings the other disc into action, which turns the flywheel and the screw in the opposite direction. At the required height the friction discs are moved clear of the flywheel and automatically brought to rest. The screw has a diameter of 6 inches and a pitch of 5 inches. The object of this machine is to "hub" the dies which are used in the coining press already mentioned. Another illustration shows a self-feeding cutting press which will cut three 1⅛ inch blanks at one stroke, and the total capacity is 450 per minute. The strip shown is 3½ inches wide and 1-16 inch thick. There are two sets of rolls working simultaneously, these being connected by a shaft and mitre gearing. This method has the advantage that the full length of strip can be converted into blanks. Electric driving will also be adopted in the case of this machine



Self-feeding Cutting Press for Ottawa Mint.

through belts. The machine is arranged to be run continuously if desired, or it can be stopped at each turn by means of a special clutch. In connection with this plant it is interesting to note that the London Gazette recently contained a proclamation by His Majesty, establishing a branch of the Royal Mint at Ottawa, at which gold coins of the same denomination, designs, weights and fineness as are coined at the Mint in England may be coined.

Rail Corrugation.

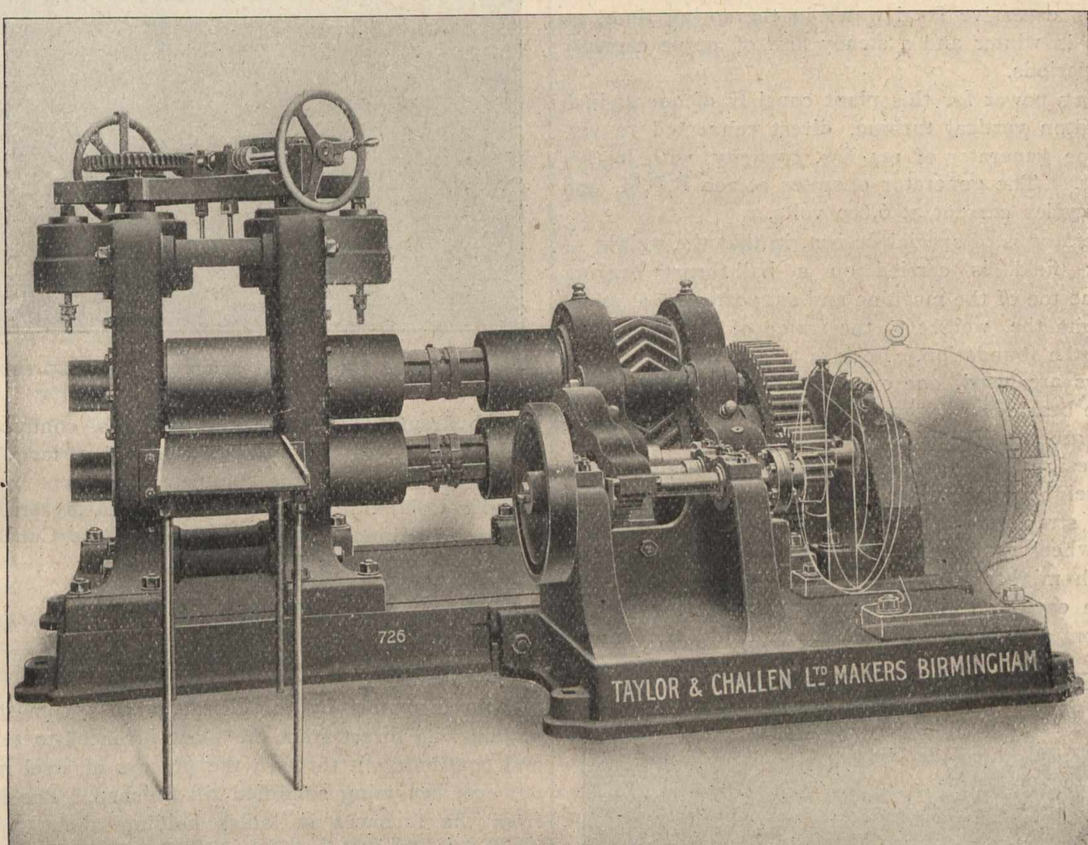
The corrugation of tramway rails—and also those upon railways—continues to give cause for serious consideration. This form of wear is specially virulent upon the tramways of the United Kingdom, and many are the theories put forward for its existence, and equally numerous are the remedies propounded. These corrugations are one of those mysterious happenings which vary with different localities, although it cannot be said that local conditions seriously enter into the question. The general symptoms are the same throughout the country, but the great divergence of opinion respecting the causes and probable remedies keeps the interest at top pitch. An excellent paper dealing with the question was read recently before the annual convention of the Municipal Tramways Association by Mr. A. L. C. Fell, the chief officer of the London County Council. Mr. Fell does not pin himself down to any specific cause, but inclines to the belief that rail corrugations are possible as the result of many things, either singly or in combination, and that, similarly, many things are possible for their eradication. The paper in question specifies no less than thirteen possible causes of rail corrugation, and in order to avoid them, as far as may be, the following suggestions are given as tending towards this end. The rails should be anchored down at intervals of not less than 7 ft. 6 ins. A hardwood packing block, ¾ ins. thick, should be placed between the anchor and the rail flange. All joints should be close-butted and carefully filed. Possibly it would be an additional safeguard if the rail joints were welded. A water-car, fitted with carborundum grinding blocks, should be run over the line to remove all irregularities before the cars commence running. This will be found a simple, quick, and inexpensive process if carried out immediately after the track is constructed, and the development of corrugations will be deferred for a considerable time. Immediately the slightest sign of corrugations appear, grind the rails as suggested above. Partly fill up groove of outer rail, so that the outer wheels run on flanges at sharp curves. Secure first-class trucks of good mechanical design, which will not buckle or get out of square at very sharp curves. See that the trucks are absolutely square. The diameter of the wheels should be kept as nearly as possible equal. Separately drive each wheel or introduce differential gearing, as in the case of the motor car. Use continuous-flow sand-boxes. Use magnetic track brakes as service brakes. In the discussion which followed the reading of this paper, and in all other previous discussion upon this subject, the point as to whether electric traction has anything to do with the phenomenon has not been cleared up. Such corrugations have been observed on the Indian railways, which are steam, which would seem to point to the suggestion that electric traction does not enter into it; yet, on the other hand, it is stated that in a certain British town, when the tramways were steam no corrugations were encountered, yet they immediately appeared when the conversion to electric traction took place.

British Standard Screw Threads.

In October a conference was convened by the Engineering Standards Committee upon Screw Threads, to which were invited representatives from the Royal Automobile Club, the Institution of Automobile Engineers, the Commercial Motor Users' Association, the Agricultural Engineers' Association, and the Society of Motor Traders and Manufacturers. The conference was held with the view of ascertaining to what extent the series of fine threads laid down by the committee were adapted to the special conditions of design existing in motor car construction. It transpired that for most purposes the existing standard fine threads were deemed suitable for employment in car construction. The results of the conference may be summarized as thus: 1. An expression of approval on behalf of the automobile industry of the work already carried out by the Engineering Standards Committee, and the suitability of the British standard fine threads for employment in car construction. 2. The advantage of lightening the existing Whitworth nuts by reducing their width across the flats when employed in motor car construction. 2. The desirability of adding certain special standard threads to those already standardized by the committee. During the discussion attention was called to the necessity of standardizing the thread commonly used on sparking plugs, which has a 1.5 mm. pitch, since several firms were manufacturing a thread which, though closely resembling this, did not interchange with it.

Railway Accidents and Railway Design.

Three important and fatal railway accidents, which have taken place within a comparatively short time of each other, once more raise the query as to whether the advance in the design of high-speed locomotives in Great Britain is not outrunning equivalent improvements in track construction. Since my last notes a terrible accident upon the London and North-Western Railway at Shrewsbury has occurred, and to all appearances it has been due to too high speeds when running round a curve on a downward slope. The efficiency of the brake power also comes into the question; in fact, the jury added a rider to their verdict to the effect that the evidence went to show that the brake power was insufficient. However this may be, the fact remains that much of the existing permanent way was constructed for speeds considerably lower than those now prevalent upon many main lines, and the flattening out of severe curves on important portions of our railway system is becoming imperative. I believe, indeed, that some of our railway companies have directors with sufficient boldness to tackle it in spite of the costly nature of the process. Although speed limits are frequently placed at the approach to sharp curves, these are bound to be ignored sooner or later, and the easiest way to avoid such catastrophies is, as an Indian railway engineer has put it, to do away with the cause rather than provide rules for evading it. Apropos of this may be mentioned several attempts to provide a signalling apparatus which shall provide an absolute indication to the driver of the position of his signal. Experiments are now being carried out upon the Liverpool Overhead Railway and the South-Eastern and Chatham Railway, in which there is, upon the driver's cabin, an exact reproduction in miniature of the home and distant signal. These miniature arms are moved up or down, electrically, according to the state of the road, when shoes under the engine make contact with a short length of live rail placed a certain distance away from the signal post. Whilst the train is upon this third rail also, telephonic communication with the signalman in his box is possible, so that when the signal is against the train proceeding the driver can ascertain if everything is in order. A terrible accident upon the Metropolitan Electric Railway a few days ago indicated the need for such an apparatus.



Motor-driven Rolling Mill for Ottawa Mint.

RAILWAY EXTENSIONS.

The Canadian Northern Railway has applied to Parliament for an Act authorizing the construction of the following lines: Humboldt, Saskatchewan, south-westerly to Calgary; Brandon—Regina line near west boundary of Manitoba westerly to Lethbridge; North Battleford—Northwesterly to Athabaska Landing, with a branch to Green Lake; Strathcona-Alberta—Southerly to Calgary, with a branch to connect with authorized line from Regina to Red Deer River; Regina—South-westerly to international boundary; Edmonton—To head waters of MacLeod and Brazeau River; Russell, Manitoba—Via Yorkton to authorized line near Goose Lake, Saskatchewan; south of Neepawa, Manitoba—To main line crossing of South Saskatchewan River; and extending the time for commencement and completing of the following lines: From south of the line between Winnipeg and Ste. Anne to international boundary; between Port Arthur and Fort Frances to Quebec, with branches to Port Arthur, Ottawa, and Montreal; Battleford, westerly to the Brazeau River; Regina to Humboldt and via Carrol River to Pas Mission, and between Humboldt and South Saskatchewan River to crossing of same river south of Prince Albert; also authorizing the increase of the capital stock of the company by $19,250,000.

The following companies have also made application to Parliament for authority to make extensions to their lines: The Alberta North-Western Railway—For a line from a point on the Calgary and Edmonton Railway between Olds and Red Deer northwesterly to Rocky Mountain House, on the North Saskatchewan River, and thence westerly to Kootenay Plains, in the Rocky Mountains; also for a line from Bighorn, on the North Saskatchewan, northwesterly to connect with the G.T.P.; Edmonton, Yukon and Pacific Railway Company—For power to construct branch lines to Vancouver and to the head water of MacLeod and Brazeau Rivers; Dominion Atlantic Railway Company—For a line from Kentville to Middleton, N.S.; Canadian Northern Ontario Railway Company—For a line from Udney to Orillia; and the Canadian Northern Quebec Railway Company—For a line from St. Jerome to St. Eustache, and from Ottawa via Hawkesbury to Montreal, traversing Montreal Island, to enter Montreal from the north-east and south-west.

Two years ago the City of London Corporation abandoned electric street lighting and reverted to incandescent gas lighting. The Corporation are not quite contented with the present system, and will probably adopt electric arc lamps again in the near future, it is said.

SAUBLE FALLS LIGHT AND POWER COMPANY AT WIARTON, ONT.

Sauble Falls is situated about one and a half miles from the mouth of Sauble River on the Lake Huron side of the Bruce peninsula, about twelve miles above the town of Southampton. A transmission line runs from the falls to Wiarton on the Georgian Bay side about eight and a half miles across the narrowest part of the peninsula. There is a splendid reservoir capacity situated behind the power in the two lakes, Boat lake and Sky lake, which are drained by the Rankin River, which flows into the Sauble about a mile above the falls.

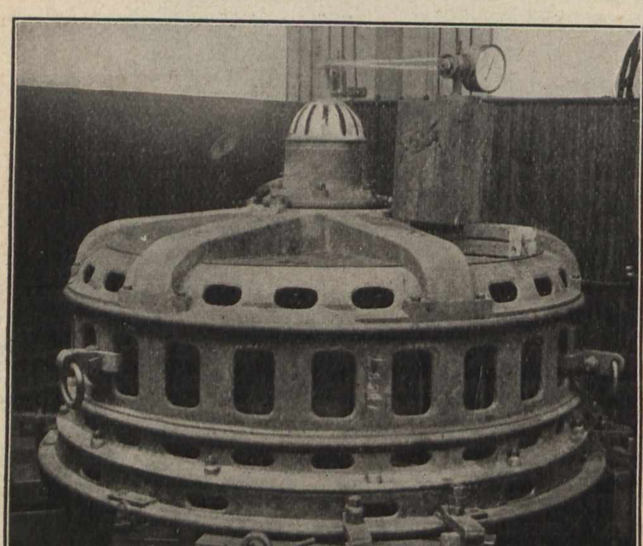
There is a natural head of about 15 feet supplemented by a concrete dam of about four feet elevation. The head race extends about 200 feet down from the dam to the foot of falls and is constructed of concrete reinforced with steel rods. Water is taken from the head race by means of a cement tube entering a timber built head in which the turbine is placed.

The power house is 14 x 20 feet and is constructed of concrete, on top of which is erected a cable tower. This water-power is singularly free from the usual disturbances, there being no excessive flood water in the spring time, no ice difficulties in winter and a steady flow of ample capacity at low water periods.

The driving power for this plant consists of one 42-inch William Hamilton vertical turbine, direct connected to vertical turbo type generator of 145 Kw. capacity with leather strap coupling. The generator operates at 200 R.P.M. and generates 60 cycles current at 6,600 volts.

This generator is of special design, in that the weight of the revolving field is carried on a ball-thrust bearing mounted on the top of the machine and supported by a spider which transmits the weight to the frame of the generator, and thence to the foundation. Besides this ball-bearing, two guide bearings are used, one on each side of the revolving field, all these bearings are provided with bolts for centreing the field, and are supplied with oil by gravity system.

In this design the generator is all self-contained and imposes no weight on the water wheel. A flexible coupling of the leather strap type is used to eliminate the possibility of the water-wheel runner imposing its weight on the ball-bearing, which might be caused through wear in the step-bearing. The exciter, which is also of the vertical type, is belt-driven from a pulley on the generator shaft, the pulleys

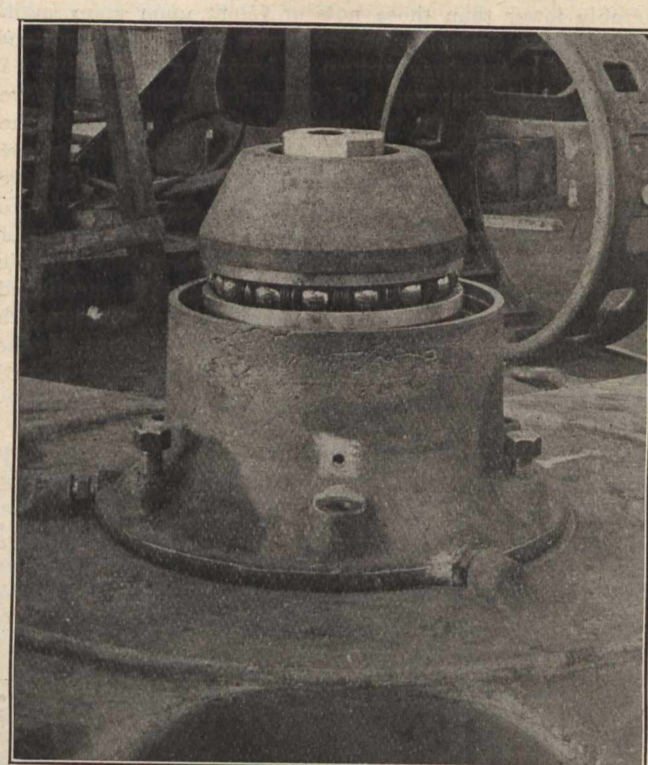


View showing generator in position.

on both machines being below the floor line. The armature on this machine is also supported on ball-bearings.

The switchboard consists of 3 A.C. ammeters, and 1 A.C. voltmeter, as well as fixed rheostats, exciter switch, and automatic oil switch. The series and potential transformers and all high tension apparatus are mounted behind the panel and separated from it. The sub-station at Wiarton contains 3-50 K.W. (6,600, 2,200, 1,100) volt oil cooled transformers of the core type, lightning arresters, etc.

This type of equipment promises to be a solution of the low head problem, in doing away with the use of the old style gear and pinion, and belt-driven generator, and although it is slightly more expensive in first cost, it will show an annual saving in power through its higher efficiency, the belt and gear losses which amount to a considerable percentage of the total power, being eliminated.



View showing ball-thrust bearing carrying revolving field.

The hydraulic development work was conducted by Mr. John Thede, of Port Elgin, who is a large shareholder in the company, and the complete equipment by the General Electric Company, of Sweden, of which Messrs. Kilmer and Pullen, McKinnon Building, Toronto, are Canadian agents.

STEEL RAILS.*

By Franklin E. Abbott.

Making steel by the direct process consists in taking molten iron direct from the blast furnaces to the steel plant and continuing it through the process of steel making without ever becoming solidified till finished. The iron is taken from the furnaces in ladles holding about 20 tons, from which it is poured into a large mixer holding about 200 tons. The object of the mixer is to make a better average composition of iron, and hence a more uniform grade of steel. From this large vessel, or mixer, the iron is drawn into a ladle holding about 10 tons, and from this charged into the converter, when the process of steel making begins.

The blowing of the iron in the converters sets up reactions which result in decarbonization, and also burns out silicon and manganese, but sulphur and phosphorus originally in the iron will remain after the blowing, and in slightly increased percentage, owing to reduction of the original volume by oxidation. The blowing takes from 10 to 20 minutes, depending on the quality of iron, and a skilful operator can tell when the metal has been sufficiently burned out by the colour and dropping of the flame, when the vessel is immediately returned to a horizontal position. The contents of the vessel at this stage are nearly pure iron.

When the molten iron is still in the vessel, a quantity of other molten metal called splegeleisen, containing a known quantity of iron, carbon, managanese and silicon, is poured into the vessel and is immediately diffused through the whole mass; thus iron is changed into what is known as Bessemer

* Extracts from a paper presented at a meeting of the Central Railway Club, Buffalo, N.Y., November 8, 1907.

steel. The steel is then poured from the vessel into a ladle, and from that tapped out into ingot moulds in which it is left to solidify.

The ingot moulds are cast iron boxes, open at both ends, averaging about eighteen inches square, but tapering outwardly toward the base. The ingots are cast with these moulds standing upright on heavy cast-iron table cars, the car tops serving as bottoms to the moulds. They are then moved forward on these cars from the steel plant to the stripper. The stripper consists of a powerful horizontal electrical crane, equipped with a combination of lifters and plunger. The ingot moulds are grappled by enormous links automatically hooked into ears or lugs at the end of the moulds, made for that purpose, and as the ingot mould is raised the plunger comes down, forcing the ingot from the mould through the open bottom, leaving it standing upright on its own base on the car. With the ingot thus cast and the mould stripped from it, the process of steel making is completed.

The red-hot ingots are then forwarded, still standing on the same iron cars, to the rail mill where they are deposited in reheating furnaces called "soaking pits" and left there till brought to proper temperature for rolling. The placing of ingots in the soaking pits is substantially the beginning of the rail making. But before passing to that step in the description it will be of interest to understand as well as possible the behaviour of the steel and what takes place when it passes from a liquid to a solid state.

When the liquid or molten metal comes in contact with the cold iron of the mould, it immediately freezes at the sides and base and gradually toward the centre. The interior is the last to cool, and the part of that last to cool will be at the top. The wide contraction that the metal undergoes in passing from molten to a solid state makes a very considerable reduction or shrinkage in its volume. As the top of the ingot is the last to solidify, the drawing in of the mass will concentrate at that place, and there is formed a cavity or honeycombed part, extending a few inches down. This opening or unsoundness at the top of the ingot is known as piping.

Another peculiarity that develops when steel passes from liquid to solid is segregation of some of its constituent elements, especially carbon, sulphur and phosphorus. The term segregation when used in connection with the metallurgical characteristics of molten steel must be understood as the drawing away from one part of the mass to another of such elements as will separate before the steel freezes or becomes solid.

Segregation apparently proceeds in the same way that the steel solidifies. It works from the outer parts toward the centre, and there will be the greatest concentration of the segregated elements at the top of the ingot where the metal is last to cool. There is found in this part not only the piping and spongy mass, but the part of the steel made inferior by an overload of carbon and probably manganese and also excessive sulphur and phosphorus. This inferior steel is discarded as will be seen further along.

Keeping in mind, then, the shape and condition of the steel in the ingot, we will take up the second step, that of making ingots into rails. As already noted, the ingots are placed in the soaking pits, always in a vertical position, where they remain from 90 to 150 minutes, in order to be brought to proper temperature for rolling.

This heat treatment in the soaking pits results in lowering the temperature at the centre of the ingots, which may at time of charging be nearly fluid, and raising the temperature of the outer part, which at the same time may be solid and reduced to cherry red. The whole mass is thus brought close to a uniform and approximately plastic condition, which makes it fit for the rolling process.

The reheated ingot is then taken from the pit, placed on an electric conveyer and rushed forward to the mill, where it is turned down on its side preparatory to entering the rolls. This is the first and only time an ingot lies in a horizontal position during the whole process of making and reheating the steel. It may be well to note here the great advantage gained by both makers and users of steel rails in this modern practice of always keeping ingots in a vertical position, from the time they are cast till the metal has been brought to proper consistency for rolling.

In nearly all specifications for steel rails there is a short clause which reads about as follows: "No bled ingots shall be used." This restriction, so much needed in old methods, is of little or no account at the present time.

The longer time given under the present practice for the metal to solidify in the moulds, and always keeping the ingots in a vertical position in the reheating furnaces, practically eliminates all possibilities of any bleeding, and in a corresponding degree makes a protection against getting piped rails in the product.

When the ingot is turned down on its sides for the first time, it enters the blooming rolls. The first two passes are through two separate sets of rolls of large diameter, operated by powerful engines. The motion is slow, and the reduction heavy. It then moves forward to the next set of rolls, where four passes are made and a bloom about eight inches by eight inches, 20 to 22 feet long is completed.

In these shapes, the size of the bar is reduced sufficiently so that the ends can be sheared off. Enough metal is cut from the end coming from the top of the ingot to remove all traces of piping or spongy steel, and also removes the part containing greatest amount of segregation. From the other end, coming from the bottom of the ingot, enough is cut off to make the end face square and solid. After the shearing, the bloom is conveyed to the roughing rolls where in four passes a rough form of the rail section is worked out. From there the bar goes to the finishing rolls, making four more passes, thence moved sidewise across the mill floor to the last finishing pass, where the rail section is finally completed to the minute refinement of its detailed dimensions.

The block of steel which started at the other end of the mill about 18 inches square and 50 inches long, has now become a rail with a sectional area six or seven square inches and 175 feet in length. All this change has been made in an interval of eight to nine minutes.

In a two-high mill the ingot is continued throughout the entire rolling process in one piece, and finally a single length is furnished equal to four or five 33-feet rails. The long rail is carried from the last finishing pass to the hot saw, where it is cut into standard lengths, according to order, cutting one rail at a time, thence through the cambering rolls to the cooling beds, where the rails are left till brought to the temperature of the atmosphere, or about 70 degrees.

In passing through the cambering rolls the rails are forced into a curvature with the head arching upwardly. That is to say, if the rail, immediately after coming out of these rolls, were made to rest on its base, or in the trackman's parlance, "work ways," the ends would be low. From this shape it warps first to the opposite curvature, bringing the ends high, then back toward the first shape and finally drawing back again in the final cooling, leaving the rail, when resting freely, on its base with a back sweep or the ends up.

The effort on part of the mill superintendent is to regulate the cambering so that the rails will cool as nearly straight as practicable, but as absolute straightness is almost impossible to attain, they are preferably brought, when cold, to a slight back sweep as already described.

There are two reasons for having rails at their normally cold temperature with back sweep rather than head sweep, if they do not come out perfectly straight: First, the cold straightening work will be done mainly on the base, thereby escaping the danger of indentations from gaggling iron on the running surface of the head. Second, the internal stresses left in the rail when it becomes cold, tending to draw the ends upward, even after it is cold straightened, will help to hold the joints up and maintain better track surface when the rails are put into use.

The rails pass from the cooling beds over live rolls, by which they are distributed to the presses where they are straightened, drilled, finished and inspected, thence they are carried down through the mill to the loading sheds and finally loaded on cars. This completes a general outline description as to how rails are made.

MODERN ENGLISH AND FRENCH WATER PURIFIERS.

A French purifier of a capacity of 4,000 cubic meters per day is shown in Fig. 1 as installed at the station of the North-Eastern Railway at Hessel, near Hull. This automatic purifier was installed by the Societe Anonyme l'Epuration des Eaux, of Paris, and a similar outfit of 3,000 cubic meters of pure water per day is in operation at the Valenciennes station of the Cie. des Chemins de Fer du Nord. These automatic filters were designed by H. Desrumaux, and when applied to feed-water purification for locomotives they prevent mud and incrustations or deposits

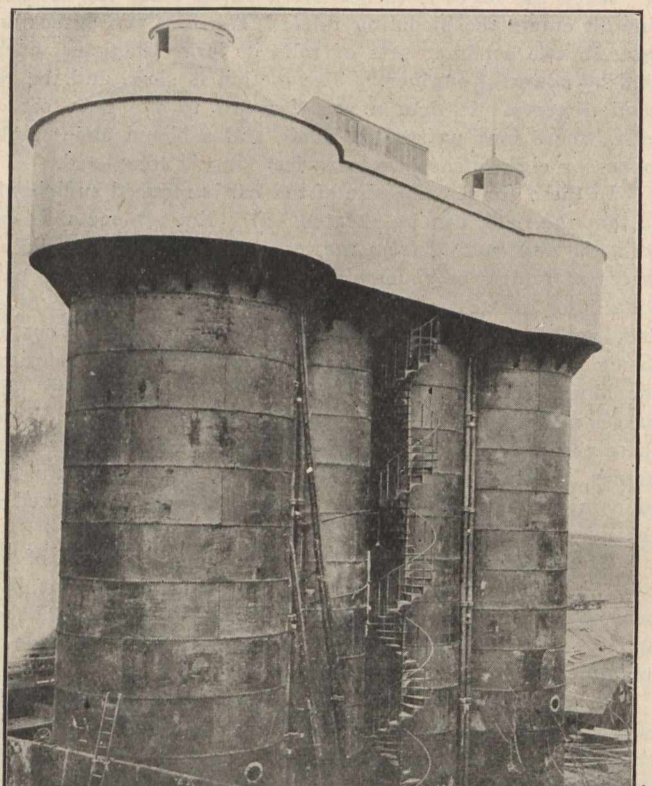


Fig. 1. Water Purifier of 4,000 Cubic Metres Capacity per day at North-Eastern Railway Station, Hessel, England.

on the steam boilers. They also do away with cleaning, and so locomotives need not remain idle, while there is an economy of combustion, 10 per cent. of the sediment being avoided. The life of boiler tubes is prolonged, and there is security against accidents due to damage of tubes and walls because of the mud or crust deposits.

The use of pure water is not only necessary for locomotives, but also for steamships and electric power stations. The accompanying illustration, Fig. 2, shows method of operation of an English condensation water purifier and grease eliminator installed at the Gibraltar dockyard by the Paterson Engineering Co., Limited, of London.

Most engineers are well aware of the difficulty of the absolute removal of oil from greasy condensation water, and it is becoming generally recognized that no form of simple mechanical filtration is adequate for the purpose. The greasy condensation water from the modern high-speed type of engine generally contains a large proportion of the oil in the form of an emulsion, which gives it its characteristic milky appearance. The futility of any system of mechanical filtration can be readily shown by passing such water through the very finest filter paper, when it will appear after the process directly as it did before.

In the Paterson purifier the oil is mechanically suspended, and emulsified forms are removed by a system of coagulation and filtration. Referring to the sectional elevation of the purifier, the greasy condensation water enters by the inlet pipe, and, after passing through a perforated baffle-plate to free it from undue agitation, it enters into the measuring chamber, in the side of which there is a narrow, vertical discharge-slit, or tumbling-bay, through which the condensation water discharges into the mixing trough below. It is obvious that the level of the water in this measuring chamber bears a definite relation to the amount of condensation water passing through; indeed, a tumbling-bay constructed as in these purifiers is a most accurate method of measuring the flow of any liquid: the weight, being long and narrow, gives a larger range of motion to the float, which rides on the surface of the water.

The float is counterpoised by a balance weight, to which it is connected by a flexible metallic core, passing around and fixed to the motion pulley, keyed to the cross-spindle, from which the needle valves controlling the discharge of the coagulent are hung. These needle valves are from four to six inches long, carefully calibrated so as to give an annular discharge orifice, which permits the escape of an amount of coagulent bearing a direct proportion to the greasy condensation water. They have a ground seat formed on the top, so that when the supply of greasy condensation water is cut off and the measuring float sinks to the bottom of the measuring chamber these ground seatings prevent any escape of reagent. On the arrival of the condensation water the float rises in the measuring tank to the level corresponding to the amount of greasy condensation water passing, and remains stationary so long as the load is constant, the needle valves, of course, rising with the float and giving their proportionate discharge. The level of reagent in these valve tanks is maintained constant by a ball-cock connected to the storage tank alongside.

The greasy condensation water with its coagulent is thoroughly mixed in the mixing trough before passing into the reaction and precipitating chamber, where the bulk of the free oil separates out in the form of a thick sludge, the heavy impurities falling to the bottom. After passing upwards through a strainer of a wood wool fibre, the water overflows into the quartz sand filter-bed, where the final

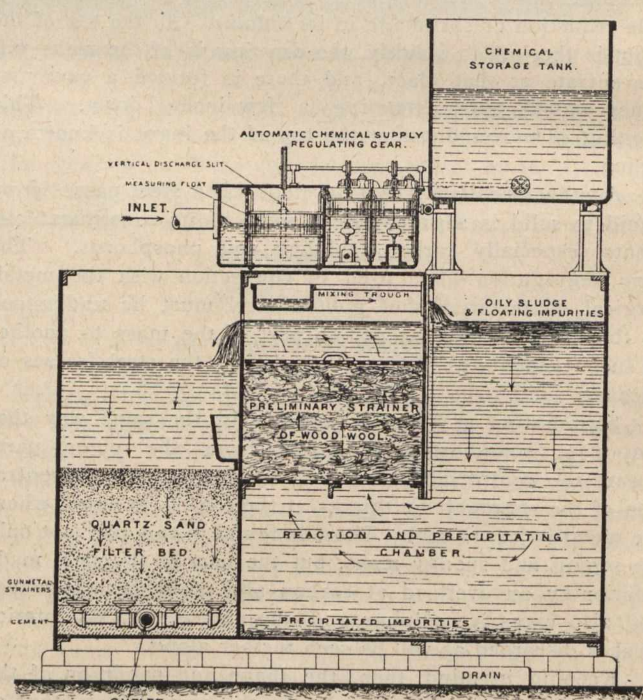


Fig 2. Method of Operation of an English Condensation Water Purifier.

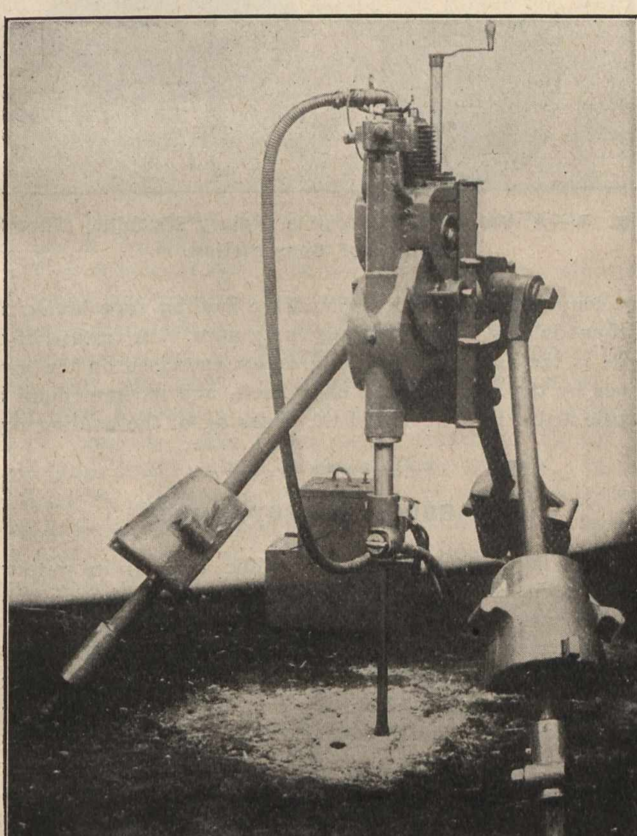
purification takes place, from whence the water is discharged, absolutely free from any trace of oil.

The makers claim for their apparatus as an advantage over any other system its extreme simplicity, low cost of treatment and maintenance. They guarantee the absolute removal of the last trace of oil at a cost not exceeding ¼d. per thousand gallons, with a maximum drop in temperature between the inlet and outlet of not more than 10 degs. F. The quartz and filtering medium is said to be practically indestructible. It is thoroughly cleansed in place by reversing the current of water through the bed, which is thoroughly agitated and sterilized by the injection of compressed air through a steam jet compressor, provided with and fixed on the apparatus. The waste water overflows into the waste gutter, shown on the sectional elevation, and passes thence to the drain.

MISCELLANEOUS MACHINERY EXHIBITS.

The following article describes a number of miscellaneous exhibits at the recent engineering and machinery exhibition held at London. These are products which have not been on the market any particular length of time and which possess features of novelty which render their application in Canada within the range of practicability.

A distinct novelty is the Warsop petrol rock drill, which, as will be seen from the illustration, is a very self-contained affair, being fitted with a small petrol motor. The small hand case shown in the illustration encloses a tank holding about one gallon of petrol, which is sufficient to drive the drill for about eight hours. The ignition battery is also enclosed in this case, and the necessary wires from the battery pass inside the metallic hose, which also conveys the explosive mixture to the drill. For ordinary quarry drilling in the open, the drill is mounted on an adjustable tripod stand as shown. For sinking a shaft, the drill is mounted on a stretcher or cross bar extending across the shaft. The rotation of the jumper when drilling is effected automatically by a simple arrangement in the head of the drill. The pumpers can be changed by giving one turn to the fixing nut, and the drill may be tilted sufficiently on one side so as to allow long jumpers to be inserted and afterwards tilted back again exactly into their original position. For drilling plug and feather holes, the drill is mounted on a special quarry bar adjustable so that holes may be drilled at any



Warsop Petrol Rock Drill Fitted With Petrol Motor.

angle. The machine illustrated has a 2½-inch cylinder engine.

The show of woodworking machinery by Messrs. Kirchner & Co., was one of the most extensive in the exhibition. The most noticeable point about the Ideal band-sawing machine is that both ends of both top and bottom saw pulley spindles are supported by bearings instead of, as in all other types of such machines, having only the bearing at one end and the saw pulley overhanging. The bearings are of phosphor bronze, and the machine is made in all sizes with wheels 24, 28, 32, 36, 42, and 48-inch diameter. A combined hand and power feed planing thicknessing and moulding machine has its stop tables adjustable upon inclined planes by hand-wheel to regulate the strength of cut to be taken off, whilst in addition, in order to allow of sharpening or changing the knives, the tables have a second horizontal adjustment and can be drawn out to leave a gap over the clutter block of seven inches. The clutterblock is four slotted, so that mould cutters can be fixed on the two opposite faces not carrying the planing knives and without removing the latter. A recent notable improvement in this firm's hand-feed planing, jointing and moulding machine is that the ends over the clutterblock are now fitted with steel lips tapered

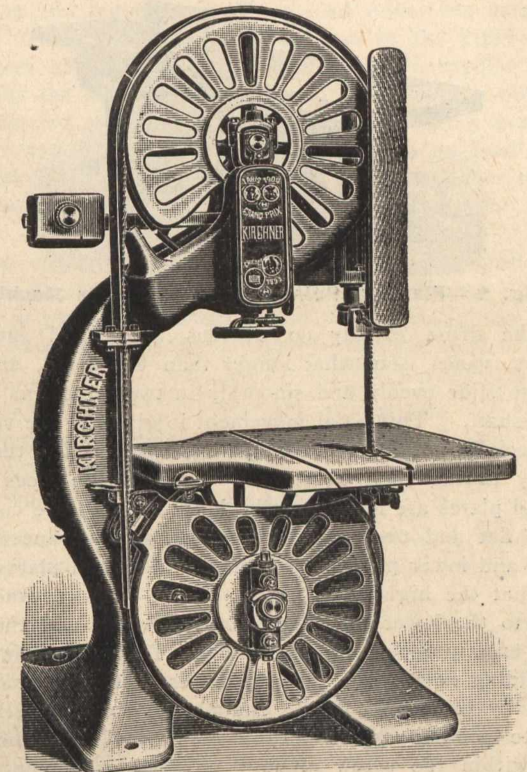


Fig. 1.—Patent Band-sawing Machine.

to a feather edge, thus adding to safety working. Another machine is a heavy horizontal slot-boring and mortising machine specially suitable for heavy fencing and wheelwright work. The firm displayed a number of other machines, and have prepared four sets of catalogues relating to machinery for all classes of wood-work.

Two systems of our gas were shown, one by the National Air Gas Company and the other by the Non Explosive Gas Company. The former is composed of air, impregnated with 1.48, or less than one and a half per cent. of hydrocarbon vapour. The apparatus for making this gas, which is really obtained from commercial petrol, is very compact and is said to require no skilled labour. The owners of the patents for the second system, which in principle is much the same, state that the quantity of hydro carbon vapour is 1.4 per cent. The apparatus employed consists of a water jacketed tank from which the petrol flows through a cock and regulating valve to the carburetter cylinder where, by means of a rotating arrangement of wire gauze or plates, and without the application of heat, the liquid petrol, being exposed in very small quantities over an extensive moving surface is vapourised and mixed with the requisite quantity of air. There is a small gas holder.

The Britannia Foundry Company showed the only moulding machine in the exhibition, which has some special features, and is illustrated. It is practically a power machine without power, i.e., it has a patent mechanical gear in the head which enables a man, without undue exertion to ram any mould as hard as it is required, and so does away with the enormous expense of hydraulic or pneumatic power. The patent power ram and lift, the makers ask, should not be confounded with the numerous lever and toggle joint hand machines. The ram works with a squeezing motion, and the operator can easily gauge the amount of pressure. The lift not only lifts the mould off the pattern but moulding box off the table pins. This firm also showed a large number of enamelling stoves, core ovens, etc., and samples of iron and steel treated by new anti-rust process.

A valveless reversible rotary machine is claimed for the Pittler universal rotary machine, Fig. 4. This apparatus, the invention of W von Pittler, of universal lathe fame, consists of five parts: (1) the outer casing; (2) drum with driving shaft; (3 and 4) two end plates forming the bearings; (5) the vanes. The outer casing has two ports, an inlet and an outlet, which are used alternately for the purpose of reversing the direction of motion. Four grooves are milled

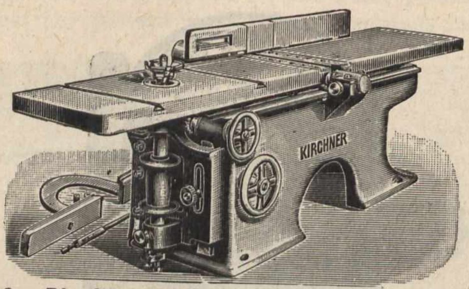


Fig. 2.—Planing, Pointing and Moulding Machine.

into the drum exactly 90 degrees apart, and into these grooves, vanes, somewhat longer than the drum, are fitted so as to slide evenly and smoothly in two directions parallel to the shaft. This axial movement is given to the vanes bv the specially constructed end plates, upon which they bear slightly during their revolution. The inside faces of the two end plates are made exactly duplicate, and are composed of two flat and two curved or screw planes connecting the higher and lower placed flat planes. The end plates are so fixed that the higher flat planes of the one are exactly opposite to the lower flat planes of the other, and the screw planes exactly opposite to each other. The vanes being made to a sliding fit between the end plates, it follows that being guided by the planes of the end plates, they will slide into opposite positions each portion of a revolution the vanes come within the screw planes; no sliding moment of the vanes takes place during the portion of the revolution that they are within the flat planes or otherwise during the time that pressure is upon them. The vanes being set at 90 degrees and pressure being on two opposite ones at the same time, prevents any dead point, and provides a constant turning moment in either direction. In securing this immobility of the vanes during the time that work is upon them Pittler

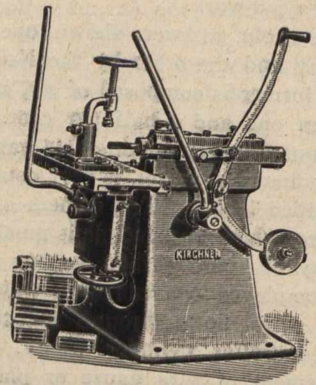


Fig. 3.—Horizontal Slot Boring and Mortising Machine.

claims to have succeeded where all previous inventors have failed.

A new departure in metal slotting was shown by the Smith Slotting Machine Company, this machine doing away with all chipping, filing and broaching. The fundamental idea of this machine is to apply the principle of the form milling cutter to internal work. This has always appeared impossible on account of the arbor preventing any ordinary milling cutter from penetrating to a depth sufficient to enable it to reproduce its own cross section. This difficulty has been surmounted by eliminating the arbor and substituting an oscillating motion for the usual rotary ore. The special form of cutter adopted consists of a circular body of the required cross section having a shank which fits the dovetail shaped recess in front of the head. The shank is of such a length that the centre of the cutter exactly coincides with the axis of the machine spindle. When the spindle and head therefore are made to oscillate rapidly by means of the adjustable crank and connecting rod provided for the purpose, the cutter also vibrates freely about its axis as though it were on an arbor. There being no arbor actually present to form an obstruction sinking cuts of very considerable depth can be taken.

The Lamp Pump Syndicate showed a water lift and force pump driven by a paraffin stove; there being only two working parts. The superheating coil of the boiler is placed away from, and not in contact with, the flame.

A patent safety cage was shown by the Pit Cage Syndicate, Limited, which can be adapted equally well to steel, wood, rope, or any form of guides that may be in use. The cage is fitted with sliding bars, each bar having a gripping screw with a weight or spring attached, by which the bars

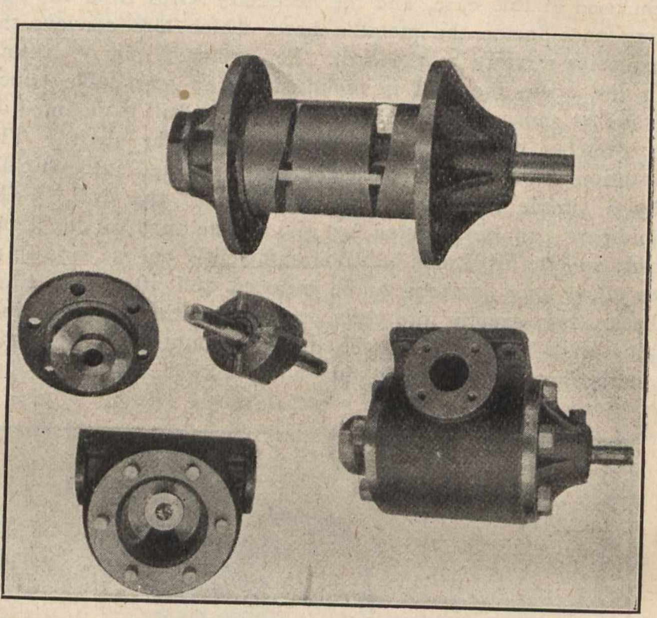


Fig. 4.—A Valveless Reversible Rotary Machine, Showing Details of Construction.

are coupled to the guides should the hauling rope break, and without in any way damaging the guides. A feature of the cage is the automatic gripping action exercised on the guide ropes by the weight of the cage itself, and its immediate but gentle arrest in the event of the breaking of the hauling rope.

HARBOUR IMPROVEMENTS.

The later years revival of public interest in waterway development comes as a natural effect of the perfection of the railway systems of our continent, and incidental to the waterway movement comes also a renewed interest in the improvement of harbours. Before any harbour plans are considered, however, it should seem pertinent to have the advanced systems as developed in Europe investigated. The main characteristics of these are a concentration of shipping business on limited lengths of wharf, allowing a paying installation and operation of hoisting machinery and railway tracks in adequate yard lay-outs. When this is done it will often be found that the space available in harbour plants, inadequate under the present obsolete system with the excessive dock-lengths, will prove satisfactory, modified for the modern methods, for the object or aim of this is to enable the wharf to do continuous business and to save time, money and work, both for the harbour and the ships.. The consequence of the development of these methods is that our system of slips and piers are as obsolete as are the canalized streets of the Dutch cities. Though that rational, truly commercial shipping system by no means is so very new, it has evidently, in its 40 years of existence, never been studied by our harbour engineers, and we frequently see very large sums of money invested in facilities, which we, for the good of the country may wish to see condemned or abandoned as useless before they are finished.

THE INDICATED POWER AND MECHANICAL EFFICIENCY OF THE GAS ENGINE.*

By Professor Bertram Hopkinson.

In the report of the Committee of the Institution of Civil Engineers on the "Efficiency of Internal-combustion Engines,"† the following remark occurs:—

"It would be desirable but for one circumstance to calculate the relative efficiency only from the indicator horse-power. But it appears that in the case of gas engines, and especially gas engines governed by hit-or-miss governors, the indicator diagrams do not give as accurate results as is generally supposed. The diagrams vary much more than those of a steam engine with a steady load, and the mean indicator horse-power, from the diagrams taken in a trial, may, it appears, differ a good deal from the real mean power."

This statement is fully borne out by the tests of the committee, which show that the mechanical efficiency taken as the ratio of brake to indicated power varied from 80 per cent. to 94 per cent. in the three engines tested. These engines were of similar type, but of different sizes, and whereas the smallest of 5 horse-power showed a mechanical efficiency of 90 per cent., the intermediate engine of 20 horse-power showed a lower efficiency of 80 per cent. The committee remarked that these values were obviously incorrect, and the values adopted by them for the mechanical efficiency were obtained by running the engine light and making an estimate of the indicated horse-power under these conditions. Assuming that the mechanical loss is constant at all loads, the indicated power at full load can be determined by adding the power absorbed at no load to the brake power. The mechanical efficiencies of the three engines found in this way were respectively:—

Engine	L	R	X
Mechanical efficiency	0.86	0.866	0.888

These results are just what would be expected, the mechanical efficiency showing a slight improvement with the size of the engine.

The opinion of the committee quoted above is obviously important, and may be expected to have a widespread effect in gas-engine testing. It throws doubt upon many of the efficiency tests on gas engines which have hitherto been made and published. Moreover, the method which the committee themselves adopted for getting the indicated power from the brake power seems to require further investigation before it can be accepted as accurate. It may no doubt be assumed on the evidence of steam-engine tests that under given conditions of lubrication the friction is practically independent of the pressure in the engine. But whereas in the steam engine the whole of the mechanical losses are to be ascribed to friction, that is not the case in the gas-engine, in which a considerable amount of power is wasted in pumping, and is usually included in the mechanical losses. Moreover, with a given supply of oil, lubrication conditions in the steam engine are practically constant, but in the gas engine that is by no means the case. Great changes can take place in the temperatures of the cylinder walls in a comparatively short time, and this will affect the viscosity of the oil, and, therefore, the work spent in friction. The author, therefore, determined to undertake an investigation with the object of finding whether the indicator power of the gas engine does, in fact, vary so much and is so difficult of determination as the report of the committee referred to suggests. If it were found that the indicated power could be accurately determined directly, it was further desired to test, by direct comparison of brake and indicated power, the validity of the committee's method of getting the mechanical efficiency. Briefly, the conclusions reached are:—

(1) If precautions are taken to keep the pressure of the gas supply constant, the diagrams given by the engine are remarkably regular, and whether the engine be missing ignitions or not, it is possible, by the use of a sufficiently accurate indicator, to obtain the indicated power from diagrams within 1 or 2 per cent. It seems probable that the difficulty experienced by the committee was due either to the essential defects, for this purpose, of the ordinary form of indicator, or to casual variations in the gas supply per suction, due, perhaps, to variation in the gas pressure at the engine.

(2) The difference between I.H.P. and B.H.P. is rather less than the horse-power at no load under the same conditions of lubrication, mainly because of the difference in the power absorbed in pumping. In the particular engine tested by the author the error from this cause in obtaining the indicated power would amount to about 5 per cent. The friction is substantially constant from no load to full load, provided that the temperature of the cylinder walls is kept the same, but the influence of temperature is very great.

The engine used in the tests was kindly placed at the author's disposal by Messrs. Crossley Brothers. It is intended to give a maximum output of 40 horse-power on the brake, and the following are the particulars of it:—

Cylinder	11½ in. diam. by 21 in. stroke.
Speed	180 revs. per minute.
Compression space..	407 cub. in.
Compression ratio...	6.37.
Compression pressure	175 lbs. per sq. inch absolute.

When exploding every time the indicated horse-power at 180 revolutions per minute is 0.495 times the mean effective pressure.

The engine works the ordinary "Otto" cycle, governed by hit-and-miss. The ignition is by magneto. The engine was loaded by belting it to a dynamo (lent by Messrs. Mather & Platt), which also served to motor it round when required. The fuel used was Cambridge coal gas. When an accurate measurement of brake power was desired, all-round rope brakes were used, one on each flywheel, and, as the measurements were such that the brake tests only lasted a few minutes, it was not necessary to use any water cooling. The engine was fitted with an exhaust gas calorimeter of the spray type.

For measuring the gas supply a standard holder by Messrs. Parkinson & Cowan, having a capacity of 10 cubic feet, was placed between the main gas supply and the engine, and as close as possible to the latter. In the ordinary running of the engine the holder stood at a constant level, the flow of gas into it just balancing the flow out, and under these conditions it served as a gas-bag, coming down by about one-tenth of a cubic foot at each suction of the engine. In a measurement of gas consumption the supply to the holder was cut off, so that the engine took gas only from the holder, and the quantity taken in a definite number of suctions (usually about 50) was noted. The indicator diagrams were photographed at the same time as this measurement was made. After the completion of the measurement the inlet pipe to the holder was opened and the counterweights adjusted, so that the holder slowly rose to nearly its highest position, when the measurement could, if necessary, be repeated. It was possible in this way to read off the gas consumption correct to one part in 500, and, allowing for possible inaccuracies in the gas-holder divisions, small changes in temperature and pressure, etc., it may be taken as certain that the gas consumption given is within ⅕ per cent. of the truth. This method of gas measurement is, of course, especially adapted for cases like the present, in which the actual gas used in a particular cycle or series of cycles is desired, but it may be noted that it is almost equally suitable for the measurement of gas consumption for a long period. It was found that it made no perceptible difference to the power given by the engine whether the inlet pipe to the holder was open or closed, and it may be assumed, therefore, that the gas consumption remains the same under these two conditions. The rate of consumption determined by the holder may, therefore, be

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* Paper read before the Institution of Mechanical Engineers on October 18th.

†Proceedings, the Institution of Civil Engineers (1905-06), Vol. LXIII.

assumed to hold during the intervals when the boiler is filling or is standing at a constant level. This method of measurement, which is much superior in accuracy to any meter, and is very convenient, might easily be applied to much larger engines, since all that is required is a holder of capacity sufficient to run the engine for about one minute.

The first requirement for the investigation proposed was an accurate indicator. In order to get at all satisfactory results, it was necessary to construct an instrument which could be relied upon absolutely to give the indicated power within 2 per cent. Further, it was necessary that the instrument should be capable of working for long periods without breaking down, so that large numbers of diagrams could be taken under given conditions. The author's experience of indicating gas engines has convinced him that it is quite impossible to fulfil the first of these conditions, to say nothing of the second, with any form of pencil indicator. It is unnecessary to discuss here the various sources of error in the pencil indicator, but it may be noted that two of them, namely, the inertia of the piston and looseness in the joints, are of especial importance in the gas engine. In the engine on which the experiments here described were made the pressure rises on explosion from 170 to 500 or 600 lbs. per square inch in less than 1-100th of a second. Now, the natural period of oscillation of a Richards' indicator of the kind made by Casartelli, of Manchester, for gas-engine work, when working with a three-hundred spring, is of the same order—that is, about 1-100th of a second. In consequence of this, as is well known, violent oscillations may be set up by the explosion and continue along the expansion line of the indicator. The magnitude of these oscillations depends upon the relation between the time taken by the pressure to rise to its full value and the period of oscillation of the indicator. Thus with certain gas charges there may be practically no oscillation, while with a slightly different mixture the oscillations may become so great as to make accurate measurements of the diagram impossible. The effect of indicator inertia on gas-engine diagrams is well known, but the other defect referred to, namely, back lash in the mechanism, has not, I think, been fully appreciated, though it is fairly obvious. The maximum pressure in a gas engine in which the compression ratio is 6 in 500 to 600 lbs. per square inch, and it is necessary, therefore, to use a very stiff spring. Stiffness is also required to reduce the natural period of the instrument, and so to bring within reasonable limits the oscillations due to inertia. In practice the author has found that in the Crosby indicator a spring giving a deflection of 1 in., with a pressure of 300 lbs. per square inch, is barely stiff enough. Now, the mean pressure is about 100 lbs. per square inch, giving a mean height with this spring of 0.3 in.; slackness in the joints amounting to a total movement of the pencil of 1-100th of an inch will, therefore, cause an error in the diagram area of 3 per cent.

The author has examined a considerable number of pencil indicators for back lash, and has not yet succeeded in finding one, even when perfectly new, in which it amounts to less than 115-100 inch, and in very few is it less than 2-100 inch, giving an error of 6 per cent. in the diagram area. It is by no means surprising that this should be so when one considers that in the Crosby indicator motion there are four pin joints between the piston and the pencil, and that the motion is magnified six-fold. Thus, a movement of 1-100 inch at the pencil corresponds to only 1-2400 inch at each joint. Another error of the same kind is that due to the deformation of the lever carrying the pencil set up by friction of the pencil on the paper. The combined effect of this and of back lash is to increase the mean height of the diagram by an amount which, from the nature of the case, is quite uncertain, but which may easily reach 1-30 inch, even with a new indicator in perfect adjustment. This error is in most instruments counterbalanced to some extent, and in many overbalanced, by that due to motion of the pencil at right angles to the piston bore.

The pencil motion should, of course, be accurately parallel to the piston motion, but in all indicators looseness in the joints prevents this motion from being perfectly definite. The pencil can move anywhere between two parallel lines, and the friction between pencil and drum is quite sufficient to make it take either of these. In the diagram the expansion line and compression line are both shifted inwards and the area and mean pressure reduced. This defect is sometimes rather serious in the Crosby indicator, which in other respects is as good as a pencil indicator can be for gas-engine testing. The author has never found it amount to less than 2-100 inch, and the mean pressure taken with this instrument is, in consequence, often too small. Using a three-hundred spring, the mean pressure taken from a diagram 2½ in. long from a gas engine compressing to 170 lbs. per square inch absolute will be 3½ per cent. too small if the horizontal back lash amounts to 2-100 in. Stretching of the cord caused by drum friction of the kind discussed by Professor Asborne Reynolds acts in the same way. It would appear that on account of these disturbances, in themselves so minute, gas-engine diagrams taken with a pencil indicator cannot be relied upon as accurate to within 5 per cent., and the error must often be more like 10 per cent When the indicator is subjected for any considerable time to the wear and tear involved in recording the explosions of a gas engine with high compression and using heavy charges, its joints rapidly become so slack as to destroy its value for any but the roughest measurements. Indeed, it may almost be said that the life of a pencil indicator (as an instrument of precision) when used on such a gas engine is limited to a few hundred explosions.

To overcome both these defects of inertia and back lash it is necessary to reduce very much the motion of the moving parts of the indicator and to use optical means for magnifying that motion. The diaphragm manograph first proposed by Perry, and now in use to some extent as a commercial instrument in the form of the Hospitallier-Carpentier manograph is unsuited for accurate quantitative work for a number of reasons, the chief of which are that the displacement is not proportional to the pressure, so that the diagrams cannot be integrated by a planimeter, and that it is inconvenient to calibrate. The author, therefore, determined to get a new design of indicator of the piston and spring type with optical magnifying mechanism. In the form finally adopted, after a considerable amount of experimenting, the spring consists of a straight piece of steel strip held as an encastred beam in a steel frame. A piston slides in a bore communicating with the engine, the axis of this bore being at right angles to the spring and passing through its centre. The pressure on the piston deflects the spring, and so tilts a small mirror about an axis at right angles to the bore, the pivots of this mirror being carried on a steel frame. To give the other motion to the mirror the whole apparatus (straight spring and mirror with its pivots) is positively connected to an eccentric on the crank axle, by which it is rocked about the axis of the bore, thus giving the piston motion of the diagram without the possibility of any lost motion. This instrument is practically indestructible, and it has been left open to the engine for considerable periods without giving it any attention. The vertical deflection is accurately proportional to the pressure, so that the diagrams can be integrated with a planimeter. Finally, the period of oscillation is only about 1-700 of a second with such strengths of spring as were used in the mechanical efficiency tests. The indicator is very easily calibrated with dead weights. The diagrams used in these measurements were photographed, but for many purposes it has been found sufficient to observe them direct by means of a telescopic arrangement by which they are projected as a bright line of light on to a transparent screen with vertical and horizontal scales It is easy to plot the diagram on to a piece of squared paper, and its area can thus be obtained within 5 per cent. without the trouble of photography.

It is certain that in a continuous series of, say, 100 explosions, the diagram area does not vary more than 1 per cent. on either side of the mean value. When the governor cuts out charges of gas, however, a slight enlargement of the diagram is sometimes perceptible in the cycle following a miss. Occasionally this enlargement amounts to as much as 4 per cent., while at other times it disappears completely.

(To be continued.)

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.

MUNICIPAL.

Ontario.

HAMILTON.—The plan adopted by the City Council for the municipal light and power plant provides for a system of four, eight, twelve and sixteen ducts—four for the outlying portions, increasing to eight, twelve and sixteen ducts as it gets into the central district. The cost is estimated at $225,000.

PORT ARTHUR.—The City Council has authorized the purchase of a 250 horse-power motor generator, at a cost of $8,000, for additional street railway power.

WELLAND.—The ratepayers will vote at the January elections to issue $13,000 5 per cent. 30-year debentures to pay the city's share of a trunk sewer from Lincoln Street to the Welland River. Henry W. Boyd, Clerk.

WINGHAM.—A new issue of $1,800 debentures has been approved of by the Ontario Railway and Municipal Board, in order that certain waterworks extensions may be made. J. B. Ferguson, clerk.

WOODSTOCK.—The County Council of Oxford have secured the official sanction of the Ontario Government to the by-law which will be put through the council this month to issue $350,000 from time to time, to defray the cost of building country roads, one--third of the cost to be refunded to the county by the Government. F. J. Ure, county engineer.

Quebec.

MONTREAL.—The Road Committee has asked for the sum of $3,000,000 in order to adminster the road department next year. It is proposed that over a million of this amount shall be spent in putting new macadam on a large number of streets, and a large portion is to be spent in putting down new and larger sewers in various streets.

Manitoba.

WINNIPEG.—The freight rates question has been referred to a committee of the council, which will go into it thoroughly and report as to the stand which should be taken by the Board of Trade as a whole.

Saskatchewan.

MAPLE CREEK.—This town is installing a gravity waterworks system.

Alberta.

LETHBRIDGE.—A by-law has been passed providing for $30,000 for gas boring. G. W. Robinson, secretary-treasurer.

British Columbia.

VANCOUVER.—This city will make the following improvements during the coming year: Concrete sidewalks, $100,000; pavements, $400,000; sewers, $300,000.

VANCOUVER.—A by-law for $1,000,000 will be submitted in January next. This sum is for the construction of bridges over False Creek. W. H. Clement, city engineer.

INDUSTRIAL.

Ontario.

BARRIE.—The Fleming Aerial Ladder Company has submitted a proposition to this town, for the erection of a plant to cost $26,000.

FORT WILLIAM.—The Fort William Car Company, which has a capital of $3,000,000, will begin with an output of twenty-five freight cars per day, and passenger cars will also be constructed after the first year's operations.

OTTAWA.—The Ottawa Corporation has placed an order with Messrs. Glenfield and Kennedy, Kilmarnock, Scot., for two sets of Duplex Pumps, each 19¼-in. diameter by 26-in. stroke. Each pump will deliver 4,000,000 gallons in 24 hours against 125 pounds per square inch when running at 26 r.p.m.

Quebec.

BROUGHTON.—Two new asbestos mills are being constructed here.

Nova Scotia.

GLACE BAY.—The Dominion Coal Company's Hub (No. 7) Colliery has been put in thorough repair. New machinery has been installed, and everything is in first-class condition for the commencement of mining operations in a few weeks.

RAILWAYS—STEAM AND ELECTRIC.

Ontario.

KEMPTVILLE.—This municipality is considering the advisability of applying for a charter to construct a railway from Kemptville Junction or Mountain across the country to the Grand Trunk line at or near South Indian.

OTTAWA.—The Canadian Northern Ontario Railway Co. is seeking for power to build from its main line between Rathbunar Udney to the Georgian Bay; the Owen Sound and Meaford Railway is asking for a time extension; the Grand Trunk Pacific Branch Lines Co. wants an extension of time; and the Edmonton, Yukon and Pacific Railway is seeking for legislation to extend the limit of its bond issue to $25,000 per mile for that portion of the line east of the foothills and to $35,000 per mile for other portions.

OTTAWA.—The Railway Commission has passed an order for the building of a bridge over the C.P.R. in Winnipeg to be used as a public highway, connecting Brown and Brant Streets. The commission has decided that it should be paid for by the city. In the meantime an engineer will report, making reasonable provision for a spur line for Gaar Scott & Company.

Quebec.

MONTREAL.—The double-tracking between Montreal and Vaudreuil has been completed, and considerable work has been going on between the latter station and Smith's Falls during the past season. It is expected that the road bed will be ready for rails in the near future, and that the work will be pushed forward between Smith's Falls and Toronto next year.

MONTREAL.—The president of the Montreal Street Railway Company stated in his annual report that the company had secured the right-of-way from the present terminus of the Back River route to a point outside the village of St. Vincent de Paul, a 50-year franchise has been secured for an extension through Notre Dame de Grace, and additional right-of-way has been purchased on the Cartierville line.

MONTREAL.—It is announced that the new transcontinental system has been permanently located through Yellow Head Pass and the Rockies.

MONTREAL.—Orders were given this week by the Grand Trunk Railway for one hundred locomotives at a cost of about $1,500,000. The locomotives are of all kinds, but chiefly heavy freight engines. The orders have been distributed amongst various Canadian and American firms, and call for delivery within the first nine months of the next year.

WESTMOUNT.—The new Canadian Pacific station at the corner of Victoria Avenue and St. Catherine Street is ready for use. It is much larger than the old building, and is a combination brick and cement structure.

Manitoba.

OAKLAND.—The C.N.R. are laying the steel on the Oakland extension. About fifteen miles have been laid this fall.

PORTAGE LA PRAIRIE.—The C.P.R. is very much opposed to the by-law to close Pacific Avenue and certain streets for the entrance of the Grand Trunk Pacific, as they claim it will mean the loss of millions to them. The Government has promised to consider the matter.

Saskatchewan.

INDIAN HEAD.—The Board of Trade has been considering the question of getting railway connection with the C.N.R., which is now some fifteen miles from here. It is probable that some definite action will be taken at an early date to get a branch run in from that road.

REGINA.—The City Council have passed a resolution condemning the new C.P.R. tariff, and have appointed a committee to act in conjunction with the Board of Trade for the purpose of further urging upon the Board of Railway Commissioners the necessity of taking instant steps to amend the tariff.

British Columbia.

VICTORIA.—Application will be made to the Legislative Assembly for an Act to incorporate a company to build a line of railway from Port Simpson to a point on the north Skeena passage. The railway will be of standard or narrow gauge, to be operated by steam or electricity, from a point at or near Port Simpson; thence following the Work Canal; thence to the Skeena River to a point on the north Skeena passage.

LIGHT, HEAT, AND POWER.

Ontario.

OTTAWA.—The Metropolitan Electrical Company of Ottawa has offered to sell their power plant at Britannia for $200,000. The company also offers to put up a guarantee of $100,000 that from its completed plant power can be delivered at the Ottawa sub-station at less than $10 per horse-power.

INGERSOLL.—Public Utilities Committee of this town have been instructed to secure the services of an electrical engineer to value the plant of the Ingersoll Electric Power & Light Company. The committee have arranged with the firm of Ross & Holgate, electrical engineers, Montreal, to furnish a valuation. Some months ago when the question of municipal ownership was before the council $5,000 was the price asked by the company for their plant.

PARRY SOUND.—A deputation from this town have asked Hon. Frank Cochrane to send an engineer to see if the water supply here could not be improved, as the lack of water is interfering with the operation of the power plant. The Railway Board has been asked for permission to issue debentures for $20,000 to be spent on the power plant. E. E. Armstrong, clerk

TENDERS.

Ontario.

OTTAWA.—Tenders will be received until February 1st, 1908, for the works connected with the construction of Section No. 2, Ontario-Rice Lake Division of the Trent Canal. L. K. Jones, Secretary Department of Public Works. (Advertised in Canadian Engineer.)

WALKERTON.—Bids are asked until December 11th by P. A. Malcomson, clerk of the County of Bruce, for $20,000, 5 per cent., 20-year installment debentures for bridge purposes.

Quebec.

MONTREAL.—Tenders will be received until December 23rd for the construction of the Grand Trunk Pacific Railway, 120 miles west from Edmonton.

Manitoba.

WINNIPEG.—Tenders will be received until January 15th by the Board of Control, for furnishing fifteen miles of assorted water-pipe. M. Peterson is secretary. H. N. Ruttan is city engineer.

WINNIPEG.—Tenders will be received until January 2nd, by the Board of Control, for supply and installation of pumping and air compressing machinery for Well No. 7. M. Peterson, Secretary.

British Columbia.

REVELSTOKE.—Tenders will be received after November 28th by the Municipal Council, for constructing a sewage system for this city. H. Floyd, city clerk; H. A. Brown, mayor.

MISCELLANEOUS.

Ontario.

CHESLEY.—This town is agitating for a new post office.

GUELPH.—The Government are considering a plan for the extension of the Winter Fair buildings here.

Nova Scotia.

HALIFAX.—It is understood that the Department of Public Works, Ottawa, has in view the building of a large pier on the Cunard property for ocean-going steamers. The pier will accommodate 100 cars.

SYDNEY MINES.—An automatic telephone system for public service has been opened here. The system is of the Western Electric Company. It does away entirely with the offices of the central operator.

Manitoba.

BRANDON.—A reinforced concrete bridge of three 90-foot spans and two 60-foot spans, with a 24-foot clear roadway, and provision for street car traffic, may be built here.

Saskatchewan.

REGINA.—The Provincial Government has decided to operate the coal mine in Eagle Lake district for the benefit of the settlers in the district. The point where the supposed mine is to be located is some forty or fifty miles from the nearest surveyed line of the railway.

British Columbia.

COQUITLAM.—The British Columbia Government intends erecting a provincial asylum here to cost about $200,000. Hon. F. J. Fulton is Provincial Secretary.

NELSON.—The Granby mines and smelter have re-open-re-opened this week with a staff of 1,200 men.

LATE NEWS NOTES.

(Unclassified.)

KINCARDINE.—Wm. Nicholson, of Wingham, has been awarded the contract for the new post office here. The building will cost about $17,000.

ST. THOMAS.—The City Council have decided to submit a by-law to raise $42,000 for a Niagara power distribution plant to the people. J. A. Ball, city engineer.

BRANTFORD.—Engineer Richards, of the Hydro-Electric Commission, has handed in an estimate to the City Council of $67,011 for the cost of this city's Niagara power distribution plant.

NEW WESTMINSTER.—The British Columbia Electric Railway has completed arrangements for extensive additions to the company's car shops in this city, and work will be commenced immediately.

VICTORIA.—Tenders will be received until December 31st by the Chief Commissioner of Lands and Works, Victoria, for furnishing and delivering fir and cedar piles, at the bridge site on the North Arm of the Fraser River. F. C. Gamble, public works engineer.

VICTORIA.—Tenders will be received until December 31st, by the Chief Commissioner of Lands and Works, Victoria, for manufacturing and delivering f.o.b. scow at Vancouver or New Westminster, all the metal work required for the superstructure of a steel swing span. F. C. Gamble, public works engineer.

MONTREAL.—An official of the Canadian Pacific Railway states that the question of whether the C.P.R. will complete its double-track the entire distance between Montreal and Toronto or whether it will build another line through a portion of the territory, will come up for decision when the appropriations for the various divisions of the system are considered in January.

MONTREAL.—It is stated that a strong agitation exists at the present time in the United States in favor of the removal of duty on pulp-wood. The supply of pulp-wood in the United States is yearly becoming less and prices are increasing so that manufacturers are beginning to look to Canada as a field for future operations. This removal of the duty ought to be of considerable assistance to Canada.

REGINA.—A Department of Telephones has been created, and is to be presided over by the Commissioner of Railways for Saskatchewan. It is expected that the actual construction work will commence in the spring, should the Legislature approve of the Government scheme. The Government's intention is to build a system of trunk lines through all the more settled portions of the province. S. P. Porter is Deputy Commissioner of Railways.

MONTREAL.—The report of the Montreal Steel Works for the three months, September, October, November, shows an increase of 40 per cent. in excess of any three months in the history of the concern. Owing to the certain continuation of railroad building for many years to come, it is thought that the output of the company will be maintained notwithstanding possible industrial depression. Both the preferred and common stock of the Steel Company now pays a dividend of 7 per cent., and it is claimed that the year ending the last of this month will show earnings of double the amount paid to shareholders.

PERSONAL.

HON. DR. REAUME, Minister of Public Works, Toronto, was able to assume duty this week for the first time since his illness of two weeks ago.

MR. A. H. SISSON, at present general manager of the St. Louis Car Works, will have charge of the Fort William Car Company, Fort William, and with him will be associated R. W. Morrison, also of the St. Louis company, who will be head of the sales department at Fort William.

MR. J. B. CHALLIES, hydraulic engineer of the Department of the Interior, Ottawa, has been in Winnipeg this week. He is preparing a report on the trouble between the City of Winnipeg and the Street Railway in connection with the development work at Pinnawa Channel.

MR. D. H. SIMPSON, of the firm of Midgley & Simpson, Leeds, England, manufacturers of the Pelapone Oil Engine, has recently returned to the Old Country after a business visit here lasting about five weeks. During his stay he made arrangements with Mr. Geo. P. Wallington, 32 Church Street, Toronto, whereby that gentleman will act as Canadian agent for the firm. Mr. Wallington's acquaintance among engineers and others who are likely to be in the market for machinery of all kinds, together with the organization he has at his command will no doubt enable him to dispose of quite a number of the Pelapone Oil Engines, which in point of first cost and maintenance, are very economical.

ENGINEERING SOCIETIES.

CANADIAN RAILWAY CLUB.—President, W. D. Robb, G.T.R.; secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, E. A. Evans, Quebec; secretary, Acton Burrows, 33 Melinda Street, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, J. F. Demers, M.D., Levis, Que.; secretary, F. Page Wilson, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. McLea Walbank; secretary, Prof. C. H. McLeod. Meetings will be held at Society Rooms each Thursday until May 1st, 1908. A meeting of the General Section was held on Thursday, the 5th inst., and a discussion took place on the paper by Mr. T. M. Fyshe, C. Can. Soc. C.E., entitled, "Discussion, Designs, and Specifications for a Reinforced Concrete Bridge Abutment," which was read at the meeting of October 17th last. A paper by Mr. J. S. Armstrong, M. Can. Soc. C.E., entitled "Schemes Showing the Possibilities of St. John, N.B., as a Great Port, and How the Interior of New Brunswick Can be Opened Up to Ocean Traffic," was read by the author.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, C. B. Smith; secretary, C. M. Caniff, 100 King Street West. Meetings held every Thursday during fall and winter months.

CANADIAN ELECTRICAL ASSOCIATION.—President, R. S. Kelsch, Montreal; secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN MINING INSTITUTE.—413 Dorchester Street West, Montreal. President, Frederick Keffer, Greenwood, B.C.; secretary, H. Mortimer-Lamb.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, R. McColl.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, TORONTO BRANCH:—Louis W. Pratt, Secretary, 123 Bay Street, Toronto

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—29 West 39th Street, New York. President, Frederick R. Hutton; secretary, Calvin W. Rice. The 28th annual meeting is being held in New York this week.

TRADE INQUIRIES.

From the Department of Trade and Commerce, Ottawa:—

Machine Tools.—Inquiries are invited by a Durham firm from engineering and other firms in Canada interested in high-speed machine tools, especially lathes and drilling machines. No agents required.

Machinery.—An English firm, making all kinds of machinery used in all branches of the leather trades, specially inquires for manufacturers in Canada likely to be interested in the purchase of these goods.

Ropes and Cordage.—A Durham firm are buyers of sisal ropes and all kinds of small cordage, and asks for prices and particulars from manufacturers in Canada.

Boiler Disincrustant.—A Yorkshire firm, specializing in the manufacture of a well-known vegetable boiler disincrustant and anti-corrosive compound for boilers of every description, desires to introduce it to the notice of inquirers (engineers), manufacturers, and all users of steam boilers in Canada, and invites inquiries.

Sawing Machine.—North of England firm makes inquiry for engineers and other firms in Canada likely to be interested in the purchase of a band sawing machine for cutting cold iron or steel. No agents required.

Motor Oil.—The manufacturers of a registered motor oil for motor lubrication which was recently introduced and has met with a popular demand on the British market, seek to do business with Canadian houses handling this line of goods.

The following have been received at the office of the High Commissioner for Canada, 17, Victoria Street, London, S.W., England:

Copy Drawing Machine.—The manufacturer of an electric machine for copying drawings of constructional works, etc., desires to bring the same under the notice of interested parties in Canada.

Machinery, Steel, Etc.—Inquiry is received from a firm of machinery dealers at Winnipeg for the names of British manufacturers of machinery, steel and steel products desiring representation in Western Canada.

From the City Trade Branch, 73, Basinghall Street, London, E.C.:

Foundry Goods.—A Midlands Company, manufacturing brass foundry goods, also plumbers' supplies, sanitary goods, etc., seeks suitable Canadian resident agents.

Pig Iron, Etc.—A firm in Toronto would be pleased to represent United Kingdom manufacturers of pig iron; also merchant iron and steel, and similar goods.

MARKET CONDITIONS.

Montreal, December 5th, 1907.

The situation in the market for pig iron in the United States shows very little change. Production is now at a very low ebb as compared with some months since when all the blast furnaces were in operation. The blowing-out of the furnaces has been fairly general of late and is naturally exerting a strengthening influence on prices, which influence is, however, off-set by the decreased demand. Had it not been for the decision to curtail production, unquestionably prices would have been much lower than they are at present. The feeling throughout business circles has shown a considerable improvement during the week. This has been reflected in many ways, more particularly in the stock markets, and the influence is also felt in the iron and steel trade. There are also reports from various sections of the United States, showing that large numbers of employees, who were discharged some time since, are being re-engaged. This naturally gives a brighter color to the outlook, even though it should happen that an equal number of employees in the smaller industries are being discharged. There is little, if any, actual improvement in business, and there probably will be none until after the turn of the year. Whether an improvement will then take place or not is a point which is in dispute.

In Great Britain the situation remains the same as a week ago. Generally speaking, there is an improvement and firmer prices are being demanded all along the line. This applies particularly to No. 1 metal of which there is no more than sufficient to supply the demand. Warrant stock continues to show an enormous decrease, as compared with a year ago, and this naturally exerts a strengthening influence throughout the market. Good orders are expected to arrive from the continent before much longer, and meantime producers do not exhibit any undue anxiety to force sales.

So far as the local market is concerned, there is practically nothing new to be said. The last iron to arrive by water has now been received and from this out orders will have to be filled from stock or from iron received by rail. Consequently the market here continues firm. Holders show considerable confidence in the situation and are not expressing any anxiety as to the disposal of the iron they have on hand.

Antimony.—There has been no change in this market during the past week. The tone is firm and prices continue at 13½c. to 14c. per lb.

Bar Iron and Steel.—The market is dull and weak. Quotations are: Bar iron, $2.15 per 100 lbs.; best refined horseshoe iron, $2.55, and forged iron, $2.40; mild steel, $2.20 per 100 lbs.; sleigh shoe steel, $2.20 for 1 x ⅜-base; tire steel, $2.30 for 1 x ⅜-base; toe calk steel, $2.95; machine steel, iron finish, $2.30.

Boiler Tubes.—Demand is on the light side, but prices still hold firm. Quotations are: 2-in., 8 to 8½c.; 2½-in., 10¼ to 10¾c.; 3-in., 12c.; 3½-in., 15 to 15¼c.; 4-in., 19¼ to 19½c.

Cement—Canadian and American.—Canadian cement is quoted at $2 to $2.10 per barrel, in cotton bags, and $2.30 to $2.40 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 is steady at $1.10 per 350 pounds, basis Lehigh mills, conditions being the same as in the case of Canadian mills, save that when the cotton bags are returned in good condition, only 7½ cents is allowed for them.

Cement—English and European.—English cement is unchanged at $1.80 to $1.90 per barrel in jute sacks of 82½ pounds each (including price of sacks), and $2.10 to $2.20 in wood, per 350 pounds, gross. Belgian cement is quoted at $1.75 to $1.90 per barrel, in wood. German is $2.52 to $2.55 per barrel of 400 pounds for Dyckerhoff.

Copper.—There is little or no change in the markets for copper. Demand has been very fair, but the situation continues undecided, and, in the meantime, prices are quoted unchanged, at 16 to 16½c. per pound.

Iron.—Londonderry is only offering for future shipments, and is quoted at $24 f.o.b. Montreal for No. 1. Toronto prices are about $1.25 more. Summerlee iron is arriving, and is quoted at $24 f.o.b. on cars, Montreal, for No. 2 selected, and $25 for No. 1. No. 1 Cleveland is unobtainable at the present time, and Clarence at $20 to $21.50. Carron special, $24; soft, $23.75, to arrive.

Lead.—There has been no change in the market for lead during the past week. Demand is not very active, but prices hold steady, at $4.90 to $5 per 100 pounds.

Nails.—No change has taken place in the market during the past week, save that demand continues to fall off, owing to the gradual suspension of building operations, now that the winter has arrived. Cut nails are quoted at $2.50 and wire at $2.55, base prices.

Pipe—Cast Iron.—As is usual at this time of year, demand has fallen off to next to nothing. Lower prices would not induce purchases as business is over for the season, consequently, although quotations in the United States are lower, those here are steady. Prices are firm at $36 for 8-inch pipe and larger; $37 for 6-in. pipe, $38 for 5-in., and $39 for 4-in., at the foundry. Gas pipe is quoted at about $1 more than the above.

Pipe, Wrought.—Demand continues active and dealers claim they are only about able to keep up with it. The tone is steady and firm. Quotations and discounts for small lots, screwed and coupled, are as follows: ¼-inch to ⅜-inch, $5.50, with 53 per cent. off for black and 38 per cent. off for galvanized. The discount on the following is 66 per cent. off for black and 56 per cent. off for galvanized: ½-inch, $8.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36; and 3-inch, $75.50.

Steel Shafting.—Demand is now very quiet and there would be every reason to anticipate a decline in prices were it not for the indications of an understanding among producers with respect to output and prices. Under the circumstances it is expected that the market will advance before much longer. At the present time prices are steady at the list, less 25 per cent.

Steel Plates.—The tone of this market is firm and demand is fair. Dealers do not talk as though they expected a decline in the immediate future. Prices are steady at $2.75 for 3-16 and ⅜, and $2.50 for ¼ and thicker, in small lots.

Spikes.—Railway spikes are not in very good demand, and prices have declined to $2.60 per 100 pounds, base of 5½ x 9-16. Ship spikes are steady at $3.15 per 100 pounds, base of ⅝ x 10 inch and ⅝ x 12 inch.

Tin.—The tone is firmer and consumption is apparently fairly large. Quotations still are 36 to 36½c. per lb.

Tool Steel.—The situation is fairly active and firm Base prices are as follows: Jessop's best unannealed, 14½c. per pound, annealed being 15½c.; second grade, 8½c., and high-speed, "Ark," 60c., and "Novo," 65c.; "Conquerer," 55 to 60c.; Sanderson Bros. and Newbould's "Saben," high-speed, 60c.; extra cast tool steel, 14c., and "Colorado" cast tool steel, 8c., base prices. Sanderson's "Rex A" is quoted at 75c. and upward; Self Hardening, 45c.; Extra, 15c.; Superior, 12c.; and Crucible, 8c.; "Edgar Allan's Air-Hardening," 55 to 65c. per pound.

Zinc.—The market for zinc is weak, demand being on the dull side. Prices are, however, steady, at 6 to 6¼c. per pound.

* * * *

Toronto, December 5th, 1907.

Building operations show some falling off in city and country, as was to be expected from the season of the year and the advent this week of cold weather. The building permits for Toronto last month were less in value than in the previous November, though for the whole eleven months of 1907 there is an increase of a million over 1906.

There is a slowing-down in business generally over the province, in warehouse as well as in factory. Jobbers and manufacturers are about to take stock, and as a consequence are not giving orders. With the exception of Christmas assorting orders, in what may be called fancy hardware, the orders to metal merchants from country districts are small. Brick and cement prices keep up, though some small dealers were offering common brick a week ago at cut prices because hard up, and so do those of lumber, and there is still much movement. This is especially so in Toronto. Remittances are moderately good, complaint being still made of a lack of ready cash.

British advices say that finished iron and steel are lower. What was said last week as to metal markets will still apply, with the single exception of lead, which is ¼c. lower at $4.75. Advices from the States indicate a weaker feeling in prices. which results doubtless from the awkward situation of many manufacturing and other houses by reason of the prolonged scarcity of currency. British advices show fairly steady quotations.

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

American Bessemer Sheet Steel.—14-gauge, $2.70; 17, 18, and 20-gauge, $2.80; 22 and 24-gauge, $2.90; 26-gauge, $3; 28-gauge, $3.25.

Antimony.—Active but easier at 11½ to 13c.

Bar Iron.—$2.30, base, from stock to the wholesale dealer. A moderate supply on hand.

Boiler Heads.—25c. per 100 pounds advance on boiler plate.

Boiler Plates.—¼-inch and heavier, $2.50. Supply probably adequate and quotations still firm.

Boiler Tubes.—Lap-welded steel, 1¼-in., 10c.; 1½-in., 9c. per foot; 2-in., $9.10; 2¼-in., $10.85; 2½-in., $12; 3-in., $13.50; 3½-in., $16.75; 4-in., $21 per 100 ft. Stock is moderate, lowest in small sizes.

Bricks.—Common structural $10 per thousand, as before, and the demand very brisk. Same may be said of red and buff pressed, which are worth $18 at Don Valley Works.

Cement.—Star brand, $1.95 per barrel, f.o.b., Kingston, National, $1.95 per barrel, Toronto, in car lots; retail price, $2.15; English, Anchor, $3 per barrel in wood. Demand moderate.

Fire Bricks.—In steady request; English, $32 to $35; Scotch, $30 to $35; American, $25 to $40 per 1,000.

Ingot Copper.—Markets are puzzling abroad, but firming up again. Locally, things are quiet. Repeat quotations at 15c.

Lead.—Demand less strong; goods scarce for immediate delivery; a fair business is doing in small lots here. Toronto wholesale price is $4.75, which is a decline of ¼c. on the week.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3.15. Supply moderate.

Pig Iron.—Summerlee No. 1, to arrive, steadily in demand but hard to obtain, still quotes, nominally, $27; Glengarnock, $26.50; No. 2, $26; Cleveland, No. 1, $23.50, $24; Clarence, No. 3, procurable in Montreal, price here $23 to $24.

Steel Rails.—80-lb., $35 to $38 per ton.

Sheet Steel.—Firm, 10 gauge, $2.70; 12 gauge, $2.80; in moderate supply.

Tank Plate.—3-16-in., $2.65; Tees, $2.90 to $3 per 100 pounds; angles, 1¼ by 3-16 and larger, $2.75 to $3. Extras for smaller sizes.

Tin.—Foreign markets erratic. Matters quiet here with price 34c. to 35c.

Tool Steel.—Jowitt's special pink label, 10½c. per pound; Capital, 12c.; Conqueror, highspeed, 70c. base.

Wrought Steam and Water Pipe.—Trade prices per 100 feet are: Black, ¼ and ⅜-in., $2.59; ½-in., $2.89; ¾-in., $3.90; 1-in., $5.60; 1¼-in., $7.65; 1½-in., $9.18; 2-in., $12.24; 2½-in., $22.15; 3-in., $30.00. Galvanized, ¼ and ⅜-in., $3.41; ½-in., $3.74; ¾-in., $5.06; 1-in., $7.26; 1¼-in., $9.90; 1½-in., $11.88; 2-in., $15.84; 3½-in., black, $39.00; 4-in., $42.85. Prices firm but unchanged, stock light.

Zinc.—Sheet zinc rather active but weakening in primary markets. Toronto, slab, $6.25; sheet, $8.

CATALOGUES AND CIRCULARS.

Miscellaneous Machinery.—The Parker Hoist and Machine Company, Chicago, have issued a catalogue descriptive of cranes, helve hammers, hoisting engines, derricks, steam hoists, tracks, gasoline engines, etc.

Electrical Supplies.—The Canadian Westinghouse Company, Hamilton, Ont., send us circulars No. 1096, 1130, and 1146, respectively, descriptive of oil switches and circuit-breakers, electrostatic voltmeters, and lightning arresters. Size, 7 x 10, pp. 23.

Presses.—The Canadian Boomer and Boschert Press Company, Montreal, have issued a neatly arranged catalogue giving a general idea of the styles of presses manufactured by them, as well as several illustrations, and accompanying data as to size of presses, costs, etc. Size, 9 x 6.

Storage Batteries.—The Westinghouse Machine Company, of Pittsburg, Pa., sends us an illustrated catalogue dealing with portable batteries. A number of different types of batteries are illustrated with additional data as to size of plates, dimensions, etc., given for each particular type. Size, 6¼ x 9¼, pp. 31.

Mechanical Draft.—Sheldons, Limited, Galt, Ont., in their catalogue No. 22 point out some of the advantages of mechanical draft when applied to power plants. It contains considerable information of interest to those connected with the manufacturing and power generating industries of this country. Size, 7½ by 6, pp. 40.

Electric Lamps.—The Engineering Department of the National Electric Lamp Association, of Cleveland, Ohio, send us bulletins Nos. 5 A, 6 A, and 7, descriptive of electric lamps, data on illumination compiled especially for use of electrical and illuminating engineers architects, builders, etc., besides several cuts of lamps in use, and considerable data of general interest to engineers. Size 6 x 8.

Concentrating Tables.—The Traylor Engineering Company, of New York, have issued an attractive catalogue describing concentrating tables. It contains several illustrations and points out clearly the advantages which are claimed for their special make of table. Extreme simplicity, and maximum durability are two of the features claimed for their product. Size, 10 x 7, pp. 22.

Gas Engines.—The Lazier Gas Engine Company, of Buffalo, N.Y., have issued a catalogue descriptive of their gas engines of the multiple cylinder type for general power and lighting service, designed to operate on illuminating gas, natural gas, and producer gas, with accompanying data for each source of power as to operative costs, etc. Several illustrations are shown of sections and parts of these.

Contractors' Supplies.—Mussens Limited, Montreal, Que. Catalogue No. 15 of this company is a very excellent one, and every contractor should find it a valuable asset; particularly if he is in the market for supplies of any kind. In its 640 pages this catalogue shows almost everything that the railway, mining and municipal contractor requires. Some idea of the extent of the contents may be gathered from the index, which occupies nine pages. Size 5 x 7¾

It is intended that wireless telegraph stations, established by the Dominion Government on the Pacific coast shall go into operation on December 15th, when marine casualties and other marine reports will be forwarded from these stations direct to Captain C. Gardiner Johnson, Lloyd's agent for British Columbia, with headquarters in Vancouver. This arrangement has been made by the Deputy Minister of Marine and Fisheries with Lloyd's agent, and will be a convenience of great benefit to the shipping interests of this coast and elsewhere. The Government stations are now being erected at Point Grey, Victoria, Cape Lazo, Pachena Point and Estevan Point. It is not unlikely that a wireless station will be put up at Vancouver as well.

THE SHEFFIELD-CANADIAN ENGINEERING CO.

Mr. Wm. Brawley has just reached Toronto from London, England. Mr. Brawley comes as the representative of the Sheffield-Canadian Engineering Company, a British firm of engineering specialists, who will act as representatives in Canada of some of the greatest and most widely known British engineering firms. Mr. T. W. Sheffield, A.M. Inst. I.E., A.M.I. Mech. Engineers, the organizer of the company, has had considerable experience in such work and the company we hope will have entire success.

SWITCHING LOCOMOTIVE.

The accompanying illustration shows a view of a 25-ton switching locomotive, built by the Jeffrey Manufacturing Company, Columbus, Ohio, for use in handling freight cars for the Cerveceria Cuauhtenoc Brewery, of Monterey, Meico. This style locomotive takes the same electrical equipment as the mine type, the only changes being in the side and end frames, and the addition of a platform and suitable cab to accommodate the conditions incident to surface work. The motors are of the waterproof steel frame type having drum-wound armatures, laminated pole pieces, oil lubrication with auxiliary grease boxes and liberal wearing surfaces.

NOTES FROM MONTREAL.

A by-law authorizing the Montreal Street Railway to carry freight over its line has been adopted. The company, which has signified its willingness to accept the conditions, will be allowed to carry freight at all times save between five and seven o'clock in the evenings and six and eight o'clock in the mornings; freight is never to be carried to the detriment of the passenger traffic. The company is to pay a percentage to the city on the gross earning received on freight cars entering or leaving the city as follows:—Four per cent. on earnings up to $200,000, 6 per cent. on earnings between $200,000 and $500,000, 8 per cent. between $500,000 and $800,000, 10 per cent. between $800,000 and $1,000,000, 12 per cent. between $1,000,000 and $1,500,000, and 15 per cent. thereafter. The franchise shall be for fifteen years, so as to terminate concurrently with the company's present franchise.

There was quite a scramble recently among car building companies in Canada and the United States for an order which might be given out by the Grand Trunk. The company, to comply with the wishes of the railway commission, contemplated the purchase of 1,000 steel cars. This order involved an expenditure of millions of dollars, and there is but one company in Canada equipped to fill it. Owing to the financial situation, orders of this nature are rare in the United States at the present time, and, as a result, the companies on the south of the border were extremely anxious to obtain the Grand Trunk work. On account of the financial situation the company has decided not to give the order yet. As to ordinary box cars for Canadian railways, the feeling that these should be manufactured in Canada has given rise to representations to the Minister of Finance favouring an increased duty, in order to exclude the produce of the American establishments. The Grand Trunk lines are partly in Canada and partly in American territory, and, owing to its American mileage, the company has been able to introduce American cars, free of taxation, into the system, while other systems in Canada have had to pay duty. The matter of imposing duty will consequently require some adjustment.

With respect to the question of supplying gas and electricity for the City of Montreal, the claim is made in some quarters that the Montreal Light, Heat & Power Company is in possession of a perpetual charter, although this charter is not exclusive, and the company does not theoretically hold a monopoly. The corporation has an arrangement with the city, terminating three years hence, whereby it has an exclusive franchise to supply gas and public lighting at the rate of $1.20 per 1,000 feet for lighting gas, and $1 for cooking gas. The contract for the electric lighting expires in three years also, but the city has not the right to grant an exclusive franchise in this matter. The company's two existing plants at Chambly and Lachine are capable of producing respectively 25,000 and 12,000 horse-power, and another water power at Soulanges, with a capacity of 12,000 horse-power is now being developed.

The mining industry in Hastings County, Ontario, has now a fair prospect of obtaining cheap power owing to the practical extinction of the timber about the head waters of the Moira River and some of the tributaries of the Trent. The lumber operators are offering to sell their dams and other improvements at a reasonable figure. A local committee has the matter in hand.

BOOK REVIEWS.

Land Treatment of Sewage.—By Herbert T. Scoble; publishers, St. Bride's Press, 24 Bride Lane, Fleet Street, London, E.C., Eng. Size, 9 x 11, pp. 76. Price, 5/- net.

This work includes articles which appeared recently in the columns of the Surveyor and Municipal County Engineer, and are issued in book form on account of their permanent value as a work of reference. The articles are based largely upon the reports to the Royal Commission on sewage disposal of 1898, made by the officers specially appointed. The author has presented the whole question cf land treatment of sewage in a convenient form, and has arranged a largely detailed subject in a pleasing and easily accessible manner.

The Practical Engineer.—Publishers, the Technical Publishing Company, Manchester, Eng. Size, 5½ x 3½, pp. 648. Price: Cloth, 25c., leather, 40c.

This is a very up-to-date and carefully arranged reference pocket book, containing information on ball and roller bearings, boilers for steam motor vehicles, cranes, reinforced concrete, superheated steam, tests of steam turbines, tractive resistence on roads, strength of rings, concrete piles, a table of piston constants, cooling towers, and a great many other useful notes. This little book should be found exceedingly useful, since much unimportant matter has been eliminated, and only the newer features that would interest the engineer are taken up in detail. The book should be a valuable work of reference to any engineer.

The Practical Engineer (Electrical).—Publishers, The Technical Publishing Company, Manchester, Eng. Size, 5½ x 3½, pp. 496. Price: cloth, 25c., leather, 40c.

This book is arranged as a convenient pocket edition. It contains a great many new features, including cost of overhead cables for transmitting power, some further notes on aluminium conductors, cable section constants for various systems of supply, magnetic clutches, some figures concerning efficiency of generation and depreciation of plant and machinery, electrical winding systems for mines, the Osram lamp, and Thermit welding. The book will be found of practical value, both in the office and elsewhere, for those who are engaged in the various departments of designing and equiping electrical machinery. The size and concise arrangement of this book should appeal to all electrical engineers who wish a handy reference.

Plane Surveying.—By John Clayton Tracy, C.E., Assistant Professor of Structural Engineering Sheffield Scientific School, Yale University; publishers, John Wiley & Sons, New York. Pp. 792. Price, $3 net.

This is a text-book and pocket manual combined, carefully arranged for ready reference. It is divided into three parts:—360 pages devoted to field work, 176 pages to office work, 82 pages to care and adjustment of instruments, 124 pages of tables and a complete index, all combined in pocket-book size. This work is specially designed for beginners, as well as being valuable to chainmen, rodmen, and others who desire to study the subject with little or no help from a teacher. Besides a detailed study of instruments and their adjustment along with many practical suggestions, the whole subject is treated in a very systematic way, embodying the fundamental principles and methods. Valuable suggestions are given as to note-keeping for field notes, office work, finishing maps, lettering, etc. The book is especially designed for work outside of college, such as summer courses where much of the instruction formerly given in the class-room has been translated to the field. It does not cover the whole field of surveying, but gives a thorough treatment of all the fundamental principles connected therewith. Great care has been taken to make the book convenient for ready reference, enabling the student to turn quickly to any part of the subject Each branch in the field work is treated under three general heads: first, the use of the instrument; second, the general method of procedure; and third, the practical details of field work. Field work and office work are treated in separate parts of the book, but the important relations between the two are emphasized throughout.

A great deal of practical information is given without obscuring general methods, while special effort has been made to give a systematic, practical discussion of the whole subject, so far as the fundamental principles and methods are dealt with. Such a text book, so conveniently arranged, should prove a valuable aid to all engineers interested in the subject of plane surveying.

TESTS ON CONCRETE RESERVOIR.

A series of tests were recently made in England on a covered ferro-concrete reservoir. This reservoir is one of two million gallons capacity, and was built for the Gosport Waterworks Company on the Mouchel-Hennebique system. The reservoir comprises vertical walls 6 in. thick at the bottom and 4 in. thick at the top, a continuous floor-slab 7 in. thick distributing the load over the ground, which is about two tons per square foot. The walls are stiffened by counterforts at frequent intervals on the exterior, and the reservoir is divided by an interior partition wall. The roof is supported by the outer and partition walls and by columns 10 in. square, built up from the floor-slab and spaced apart 16 ft. 8 in. longitudinally and 16 ft. transversely. These columns support 8 in. by 16 in. main beams, and 7 in. by 12 in. secondary beams, each bay being subdivided into three panels by two additional secondary beams. The thickness of the roof slabs is 4 in. throughout. One complete bay between four columns and one main beam were selected for the tests. The normal superload of 2.75 cwt. per square foot was left on during one whole night, and after an equal time had been allowed for recovery the instruments beneath the roof bay showed the permanent deflection of 0.024 in. In the test one instrument showed a maximum deflection of 0.160 in. and the other of 0.168 in. at maximum load, and in the case of the beam tests with a weight on the beam in tons of 36.66 the deflection rose to a maximum of 0.108 in. The tests may be accepted as indicating a high degree of elasticity for the construction.

CEMENT TRADE OF UNITED STATES.

The consumption of foreign cement in the United States shows a marked increase this year, as noted by the imports below for the nine months ending with September; the figures represent short tons of 2,000 pounds.

	1906	1907	Changes.
Belgium	69,436	95,879	I. 26,443
France	4,259	5,293	I. 1,034
Gemany	92,351	120,315	I. 27,964
Great Britain	62,637	72,671	I. 10,034
Other Europe	149	465	I. 316
Total Europe	228,832	294,623	I. 65,791
Canada	1,327	157	D. 1,170
Other countries	29,850	2,816	D. 27,034
Total	260,009	297,596	I. 37,587
Re-exports	2,315	2,804	I. 489
Net imports	257,694	294,792	I. 37,098

The total value of the net imports this year was $1,902,-825, as against $1,764,959 in 1906; an increase of $137,866. There is an import duty of 8 cents per 100 lbs. on Roman, Portland and hydraulic cement in barrels and sacks and 7 cents per 100 lbs. in bulk.

Exports of domestic cement for the nine months were 676,792 barrels, valued at $1,110,077, which compares with 448,340 barrels, $714,187, in 1906; an increase of 228,452 barrels, or $395,890.

LIFE OF INCANDESCENT LAMPS.

The useful life of frosted incandescent lamps is only a little more than half that of the corresponding plain bulb lamp. One explanation of this, which is given in the current number of a trade journal, is that the temperature of the frosted lamp is higher, due to the increased absorption by the bulb. Mr. Edward P. Hyde, of the Bureau of Standards, Washington, D.C., claims, however, that this explanation is not correct, but that the decreased efficiency of the frosted lamp depends upon the fact that, although the filament in the frosted bulb emits the same total flux of light as that emitted by the filament in the plain bulb, the light is reflected through the glass of the frosted lamp several times, and the absorption of light by the carbon filament itself becomes so great in that case that the apparent intensity of the frosted lamp at any time during its life is less than that of the plain lamp, and the difference in intensity increases with the length of time a frosted lamp is used.

IRON ORE INDUSTRY.

The official returns give the supplies of iron ore available in Great Britain for the last two years as follows in long tons:—

	1905.	1906.	Changes.
Mined in Great Britain	14,590,703	15,500,406	I. 909,703
Imported	7,344,786	7,823,084	I. 478,298
Pyrites residue	524,059	569,493	I. 45,434
Total	22,459,548	23,892,983	I. 1,433,435
Exports	26,179	18,712	D. 7,467
App. consump'n	22,433,369	23,874,271	I. 1,440902

There was an increase in ore mined in all British districts. The large part of the imports were from Spain, which furnished 5,949,131 tons. Other considerable exports were 391,615 tons from Greece; 363,739 from Norway; 351,736 from Algeria; 222,499 from Sweden; 220,919 from France; 161,953 from Russia.

Assuming that there was no material change in stocks, which is probable, the consumption of iron ore per ton made was 2.34 tons in 1905, and 2.37 tons in 1906. The proportion of domestic ore used, which was 65.1 per cent. of the total in 1905, fell very slightly, to 64.9 per cent. last year.

The demand for all kinds of mathematical instruments all over Canada is an evidence that many important engineering works are projected. We are informed that in connection with this development there has arisen a very gratifying call for Cooke instruments. One of the reasons why this demand is so announced, is that T. Cooke & Sons, the manufacturers of York, and London recognized the necessity for adapting their instruments to this market. This adaptability, coupled with fine workmanship, for which this concern is so well-known, makes the combination a hard one to beat.

Stinson-Reeb Builders' Supply Company, Limited, who have for some time been handling the products of the Imperial Plaster Company of Toronto, has found the demand so heavy that they have just completed the erection of a thoroughly equipped plaster mill. It is conveniently located between the Canal Bank and St. Ambroise Street, with both Grand Trunk and Canadian Pacific Railway shipping facilities. By this arrangement the raw materials can be brought in by both rail and water and shipments of goods made without delay. Imperial plaster, as manufactured under Patent Rights of the Imperial Plaster Company of Toronto will be the product. Besides the above, it is the intention of this firm to manufacture a special finish to be used in connection with their plasters.

The Canada Chemical Manufacturing Company have again built a new addition to their Toronto warehouse, so that they now have a frontage of 200 feet on Mill Street, and the buildings run back to the C.P.R. tracks. The two sidings provide ample facilities for unloading tank cars and other carloads. This is the third addition which has been built to the warehouse since the company has located its distributing warehouse in Toronto, but the rapid growth of the sales for acids and chemicals in the district has necessitated this constant enlargement of storage space. For the last couple of years the Toronto sales office, with Mr. Nieghorn in charge, has been located in the McKinnon Building; but Mr. Nieghorn and his staff are now moving out to the new Mill Street warehouse, where the sales office for Toronto district will be located for the future. The company report that sales of their acids and chemicals so far this year are considerably greater than for any previous year, and that the chemical works at London, as well as their other manufacturing works, are being operated to full capacity in an effort to keep up with the large demand for these products.

BOOK REVIEWS.

The Blacksmith's Guide.—By J. F. Sallows; publishers, the Technical Press, Brattleboro, Vt. Size, 4½ x 7, pp. 160. Price, $1.50.

This book is written for blacksmiths, machinists, and toolmakers, and contains valuable instructions on forging, welding, hardening, and tempering, treatment of high-speed steel and annealing, case-hardening, coloring, brazing, and general blacksmithing. The methods described in its pages have been derived from the practical experience of the author during many years on the forge, and deserve the consideration of all firms doing machine work, and all mechanics who wish to become skilled and independent workers. Information that is no real help to the mechanic has been omitted in this work. The book is strictly practical, since the author's experience has been very wide, having had to do with nearly all kinds of shops, including horse-shoeing, marine, railroad, printing press, sawmill machinery, and automobile shops. The methods described show how to become a rapid and independent workman. The book contains 165 illustrations, three of which are in colors, and one folding plate. This little book should be a valuable aid to any mechanic, and especially to those engaged in this particular work.

Practical Design of Irrigation Works.—By W. G. Bligh, M. Inst. C.E.; publishers, Archibald Constable & Company, Leicester Square, London, W.C., Eng. Size, 7 x 9, pp. 390. Price, $5 net.

This work sets forth the principles governing the design of irrigation works in a detailed as well as a general aspect, and the information is arranged and described in such a way that any engineer, even if not specially conversant with this branch of engineering science, may by attention to the principles on which good design must be grounded, evolve suitable plans of irrigation works. The method adopted in this book consists mainly in the pro-in what to accept and follow, and what to reject. The first four chapters deal with the sections of various parts of irrigation structures. The groundwork of the subject is given considerable attention in view of the fact that errors in many designs occur, even in the more alimentary parts of the subject. A chapter descriptive of weirs is the only phase of the work described from that of dams. A chapter dealing with hydraulic formulae and tables and their practical application, includes several based on a new and original theory. These will be found of great help in facilitating the calculations of numerous problems and examples subsequently introduced. The work as a whole is dealt with in the remaining chapters, and consists of the practical application of the results arrived at in the previous five chapters. A practical application is made of the new theory and the so termed "frictional stability" of a sand substrata. Throughout the whole work graphical solutions have been adopted entirely with the one exception of high dams. An idea of the size of this work may be obtained from the following chapter heads: Retaining walls; Dams (section); Weirs (section); Piers, Arches, Abutments and Floors; Hydraulic Formulae; Canal Headworks (three chapters devoted to this work); Canal Falls; Canal Regulation Bridges, and Escape Heads; Canal Cross-drainage Works; Design of Channels; Reservoirs and Tanks. The concluding chapter deals with screw gear for tank sluices and roller gates. This work contains a great many illustrations, which in most cases are sections of work, each placing before the engineer the practical side. A short appendix deals with a repetition of hydraulic gradient, etc., in sand foundation. The whole work is very carefully gotten up, and should be of great assistance and a valuable work of reference for the engineer.

Concrete Factories.—By Robert W. Leslie, Assoc. Am. Soc. C.E.; publishers, Bruce & Banning, New York. Size 7 x 10, pp. 152.

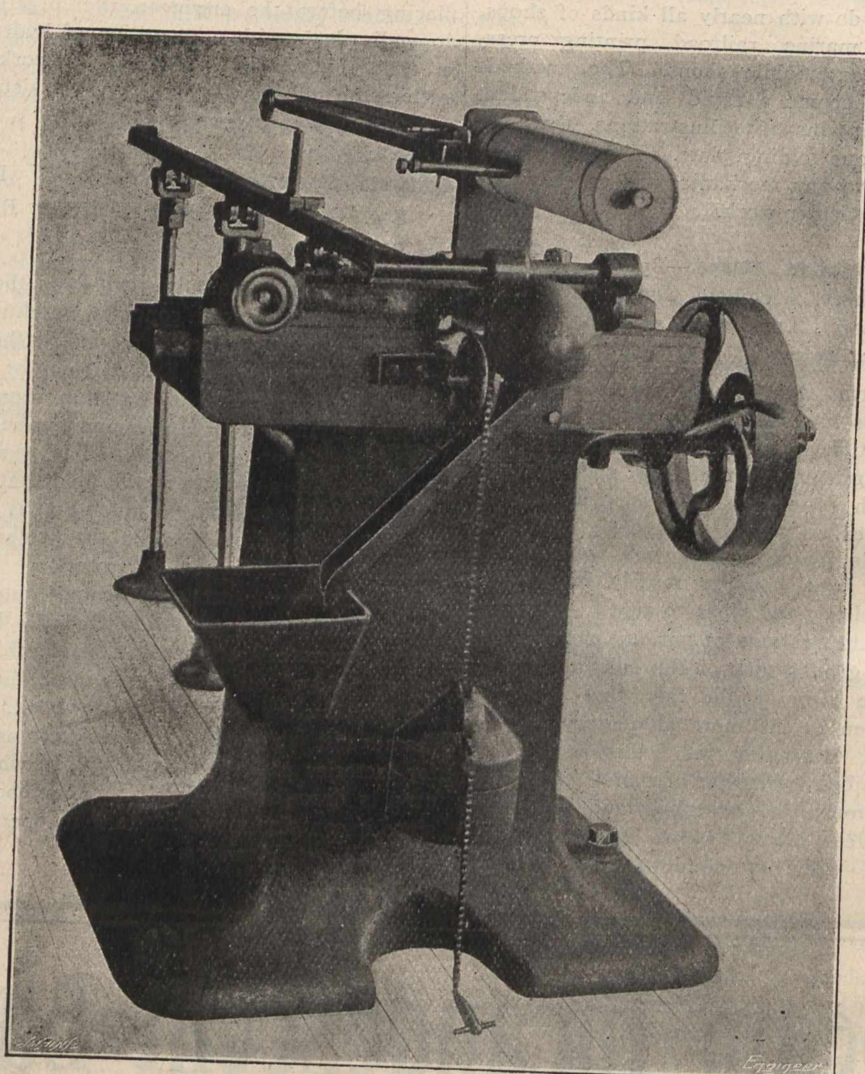
This book contains a review of the principles of construction of reinforced concrete building, including reports of the sub-committee tests, reports of the United States Geological Survey and the French rules of reinforced concrete, while in conclusion a symposium represents the views of leading engineers, architects and experts in the field of concrete and reinforced concrete. The work is not intended to be used as an authority in the field that it sets out to cover, but is intended to impress much that is of interest and value in the way of information on the present state of the art of concrete and reinforced construction. The reports of the sub-committee on tests, the United States Revisory Board on fuel and structural materials, and the French rules on reinforced concrete, are given in considerable detail, covering the newest field of this branch of engineering. These constitute the introductory chapters of the book, and are followed by the advantages of reinforced concrete as a structural material for factories and other buildings, in which the reinforcement used is described in detail. This book is well illustrated, since it contains views of work in operation at different sections all over America.

AUTOMATIC FILE TESTING AND INDICATING MACHINE.

The file to be tested is held between two headstocks on a reciprocating table. The headstock is provided with a nut and a hollow squared screw for holding the tang of the file and exerting end pressure; a slide and a hand wheel is provided the headstock whereby the file may be adjusted with its working face parallel to its direction of motion.

The reciprocating motion of the table is obtained from the pulley and main shaft through a pair of bevel wheels, driving a T slotted crank disc. A crank pin whose position in the T slot can be varied according to the stroke required, carries a slide block of rectangular form, which slides between two vertical bearing surfaces in an extension of the table, and serves to drive the latter to and fro. The driving mechanism is inside the box frame of the machine and entirely protected from the filings. The machine is started and stopped by a clutch operated by a handle.

The test bar is supported in a horizontal position on grooved rollers and is pressed against the file by a weight, and a chain passing over a pulley and under the bar, to the far end of which is attached by a hook. The support rollers are grooved to accommodate the chain. The bar is drawn out of contact with the file during the back stroke of the latter, by means of a clutch lever having two hardened jaws embracing the test bar. At the commencement of the back stroke, motion is communicated from a cam on the crank shaft to the outward end of the clutch lever, causing it to tilt and grip the test bar after the manner of a spanner. A slight continuation of the same motion causes it to draw back the test bar, which is again released at the commencement of the forward or cutting stroke. A spherical weight with a screwed stem, is supported by the headstock and of course reciprocates with the file. The end of the stem rests against the back of the file and the inertia of the weight prevents the chattering and jarring of the file which would otherwise take place. The drum round which is wrapped the diagram sheet of squared paper, is driven from a cam on the crank shaft through a pawl and ratchet wheel and a train of reducing gears, so as to make one revolution to 120,000 strokes of the file. A pencil is pressed against the paper by a light spring and is carried on a bar capable of sliding longitudinally in a fixed bearing. A block is attached to the test bar, and a fusee chain is attached to this block, and passing over a pulley on the pencil bar, is held by a fixed terminal. It is evident that as the test bar is filed away it is moved forward by the weight, and a given movement of the test bar causes the pencil to move forward by half that amount. The diagram sheet is graduated in half inches, each of which represents one inch filed off the test bar. The circumference of the drum is 12 inches, and as it revolves under the pencil each inch represents 10,000 strokes of the file. At the commencement of a test the pencil is set to zero, and as the drum revolves and the test bar is filed away, a curve is drawn by the compound motion of the drum and pencil. This curve is a complete picture of the life of the file from the commencement of the test until the file is worn out and ceases to cut, the slope of the curve indicating the sharpness or rate of cutting, while the vertical and horizontal ordinates give respectively the total amount of work done by the file and the number of strokes required to do this work and to wear the file out. The file testing and indicating machine was invented in England in 1905. Sample files were procured from the principal English and American makers, and tests were made which revealed extraordinary differences of quality, some files being worn out after filing away less than 1 cubic inch of iron, and cutting at the rate of 1 cubic inch per 10,000 strokes, while the best file removed 12½ cubic inches of metal and cut at the rate of 5 cubic inches per 10,000 strokes.



The Testing and Indicating Machine.