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CONSULTING ENGINEERS

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Construction of the Woodville Avenue Sewer, Toronto

Circular Sewer, 8 Feet in Diameter, Which Presented Many Difficulties Owing to Nature of the Ground—Method of Testing Employed to Ascertain the Line of Sewer—Needle-Beam Method of Supporting Timber Used Throughout the Job

By W. G. CAMERON, B.Sc.
District Engineer, Sewer Section, Department of Works, Toronto

WOODVILLE AVENUE sewer was designed to serve the easterly section of the West Toronto sewer system. The boundaries of the district served are difficult to describe clearly, because of the fact that Dundas Street describes nearly a quarter circle in this section. In its southern part, the district is bounded on the south by Conduit Street, on the west by Keele Street and on the east by Dundas Street. As stated above, Dundas Street sweeps around to the west and cuts across the course of the sewer so that, north of Dundas Street, the boundaries are: On the east, Symington Avenue; on the west; Clendenan Avenue; on the north, the city limit. To make its location more clear, we shall trace its course from the stand-by tanks in the corner of High Park at Bloor Street and Keele Street. From the tanks, a 9-ft. sewer leads north along Keele Street, 1,400 ft. south on Conduit Street and thence east one block to Woodville Avenue. It is at this point that the work under description begins.

Woodville Avenue Sewer Complete and 3-foot Concrete Pipe

The sewer proceeds north along Woodville Avenue to Annette Street, where the direction of Woodville Avenue changes to about north-northeast. The sewer continues along Woodville Avenue, crosses under Dundas Street and the C.P.R. tracks and reaches Junction Road, where it turns west to Mulock Avenue. It follows this street north to St. Clair Avenue.

The total length of the sewer is 5,780 ft. It is circular and all one size, 8 ft. in diameter. The grade changes to accommodate the laterals as they are picked up, becoming greater as the outlet is approached. The first 240 ft. north from Conduit Street was built on bents across a shallow ravine. Then 1,650 ft. were built in open cut and the last 3,890 ft. in tunnel. Each of these three divisions is described in turn.

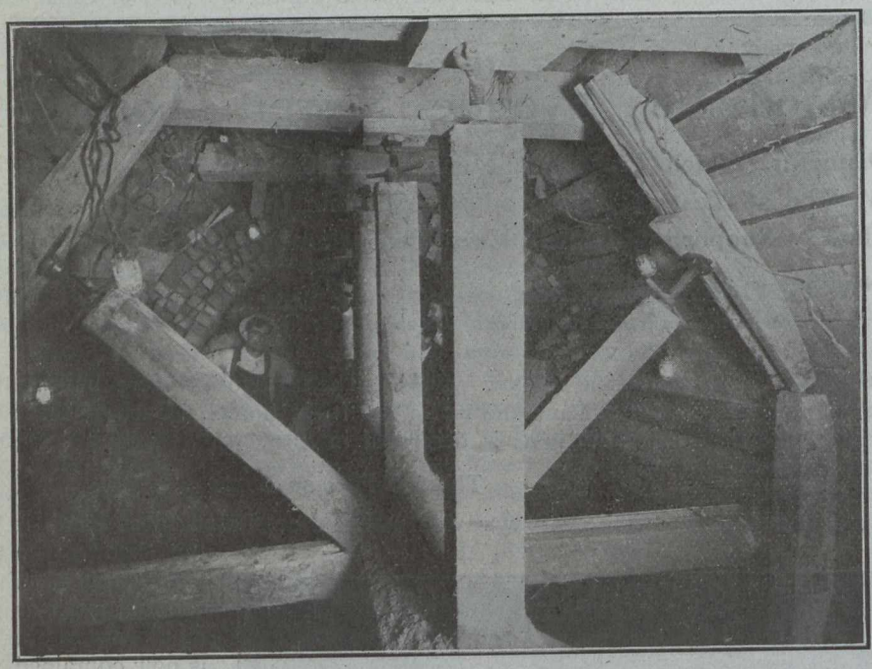
The 240 Feet on Bents

The shallow ravine which necessitated these bents is the bed of a creek which in former times was much larger but is now contained in a 3-ft. concrete pipe which terminated at Conduit Street at the time when the construction of the Woodville Avenue sewer was begun. At that time, the pipe was extended and the ravine was afterwards filled in where Woodville Avenue crosses it, with surplus material taken from the sewer excavation. This filling provided both the roadway and a future foundation for the sewer when the bents will have decayed. As in the case of Clendenan Avenue, pipes were left through the bottom of the sewer through which sand was later run to fill the space left by shrinkage.

An excavation 3 ft. deep was made across this ravine to obtain a solid foundation for the timber bents. In the centre and low part of the ravine, the ground for 30 ft. was rather soft and on this account a 3-in. plank decking, placed lengthwise of the sewer with broken butt joints, was provided for the sills to rest upon. Throughout the remainder of this excavation the sills rested on the ground. The bents were 5 ft. apart between centres. The sills are 10-in. x 12-in., five vertical 10-in. x 10-in. posts, 2-ft. 6-in. centres rest on each of these sills and are let into them 1 inch, and are held apart by light 2-in. x 8-in. straps. There is an 8-in. x 6-in. runner placed lengthwise with the sewer at the top of each row of posts and let into the

sides of the posts 3 inches. A 3-in. decking is then placed overall, leaving the tops of the posts exposed.

The sewer in this section is culvert-shaped outside with a semi-circular top, while the inside is circular. The crown and invert of the sewer are built of reinforced concrete with a half ring of paving brick in the invert for a wearing surface. The concrete in the bottom is 1 : 2 : 4 mix and is provided with a layer of .3 square inches per square foot mesh 2 inches from the bottom. At the springing line of the arch the concrete is 18 ins. thick and gradually reduces to 12 ins. thick in the crown. Two layers of mesh of the same weight as used in the invert are used in the crown, one near the outside and the other near the inside. The outside layer extends around the top and down the side walls to the flow line, while the inner layer extends only to the springing line of the arch.



Needle Beam Method of Supporting Sheeting—Taken from Heading

The 1,650 Feet in Open Cut

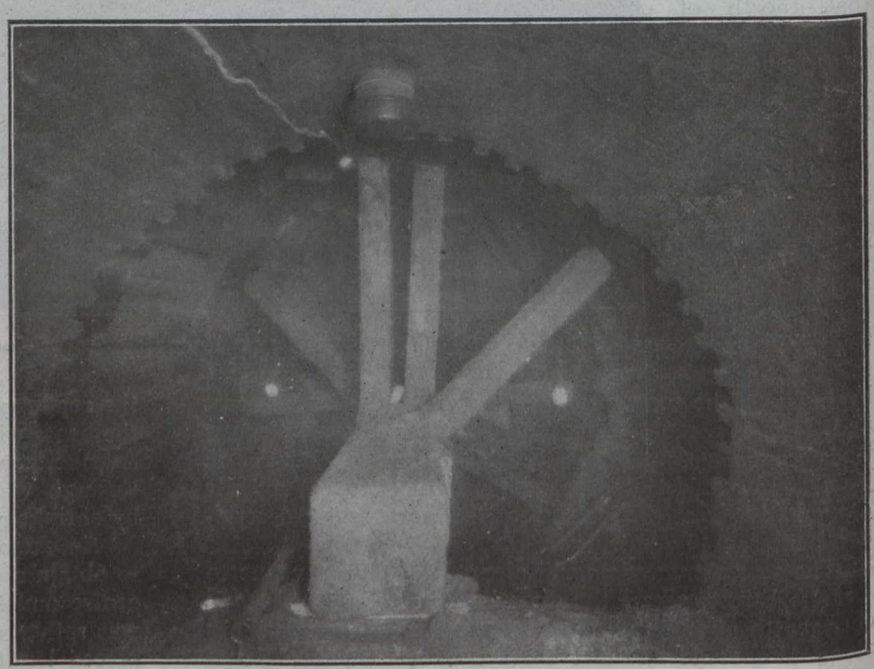
The part of this section as far as Humberside Avenue was at an average depth of 22 ft. and was built of three rings of brick. At this point, a 4-ft. ramp was provided, but in spite of this, the average depth from Humberside Avenue to Annette Street was 29 ft. and this part was built of four rings of brick. At Annette Street, another 4-ft. ramp was provided. From Conduit Street to Humberside Avenue the grade is 1 ft. in 185 ft. Two lateral sewers, a 12-in. and a 15-in., are picked up. From Humberside Avenue to Annette Street the grade is 1 ft. in 195 ft. At Annette Street a chamber was designed to pick up five laterals, a 12-in. and a 24-in. pipe, a 2-ft. x 3-ft. and a 2-ft. 8-in. x 4-ft. (all brick).

As an aid to handling the material from this excavation a cableway 250-ft. in length was provided. The excavated material was raised from the bottom of the trench in one-half cubic yard buckets by the cableway and carried to the rear, part to be used as back-fill over the completed sewer, and the rest to be hauled in wagons to the nearby ravine. At first, the bottom of the excavated trench was dry and the work proceeded rapidly, but as the trench was continued northerly and became deeper, the bottom became soft and wet. It was necessary then to square the bottom and use decking. This extra labor of course delayed the work, but it was, nevertheless, well managed and quickly accomplished. The bricks were hauled to the job in wagons and piled along the trench, whence they were lowered as required in iron baskets, each holding about twenty bricks.

North of Humberside Avenue, the contractor intended to construct the sewer in tunnel, but the ground was found to be too wet for tunnelling without the aid of compressed air. It was found, after investigation, that this could not be economically used for two reasons. One was the presence of a badly cracked old storm sewer about five feet above the crown, and the other was the fact that about ten feet or twelve feet of the ground on the surface was filled, and therefore of a loose nature. The open cut was accordingly continued to Annette Street.

Tunnel Portion

We have already stated that 3,890 ft. of this sewer were planned to be built in tunnel. It was now certain that the ground would be very wet. This had been suspected from borings taken, but it was thought that these might indicate merely a local condition. Accordingly, it was decided that compressed air would be necessary to drive out the water and a pair of compressed air pumps of 1,000 cubic feet capacity were provided and a plant erected. It was later found that these two pumps did not supply sufficient pressure and a third and later a fourth were added to the plant. South



Heading a 6-inch Iron Pipe Used in Testing Line of Sewer

of the C.P.R. tracks, an open cut 70 ft. long was made for locks and shaft. When the locks were built, a hollow wedge of timbers was forced over them into the solid earth at each end of the open cut. This wedge was filled with concrete and served to seal up the broken strata at and over the ends of the lot, and so help to prevent the escape of air. A shaft was timbered up midway between the two lots, and the remainder of the open cut back-filled. A head-frame was then built over the top of the shaft and a rough skip, with guides on two sides, was used for raising and lowering surplus and building material. The proximity of a C.P.R. siding was a convenience in handling material. Bricks, cement, timber, etc., were unloaded into the sheds there and carried to the shaft in small cars as required. Tunnelling was proceeded with in both directions simultaneously, but work had to be suspended in the north tunnel because it was found that all the air available at the time was needed in the south tunnel.

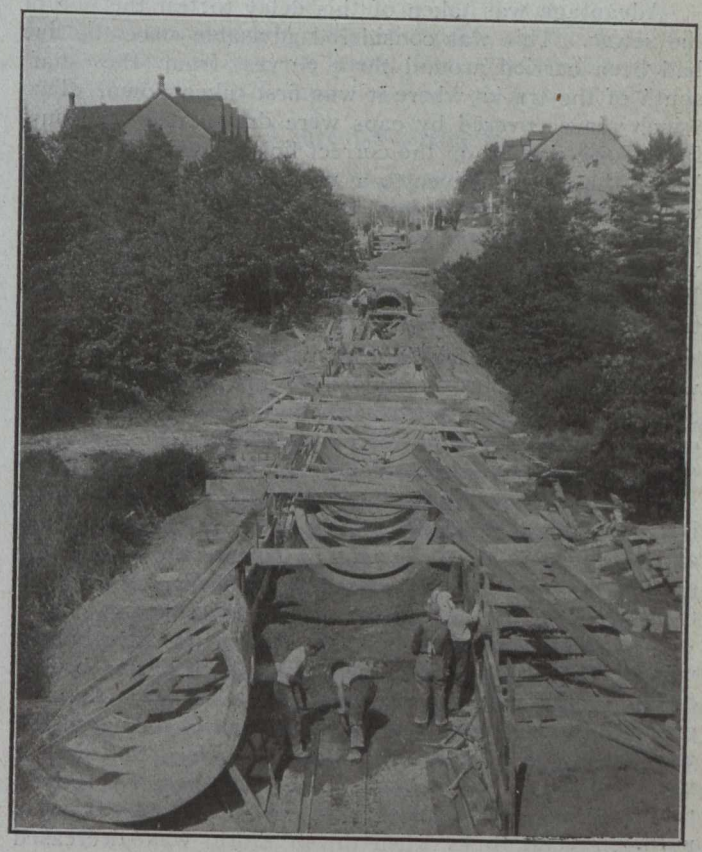
South Tunnel

Work in this direction went well for a time but was delayed on several occasions by the escape of the air into an old local sewer overhead. The joints in this sewer were very imperfectly made and in a number of cases the pipes were cracked. The escaping air carried the supporting earth into the old sewer in such quantities that it collapsed and had to be rebuilt before work could be carried on underneath. At Dundas Street the worst of these breaks occurred under the street railway tracks and for a few days the street cars had to turn back at this point instead of at Keele Street. Repairs were made by open cutting and supporting the tracks with heavy timbers. When this point was successfully passed, the work went smoothly for a time. However, the overhead cover of earth was now becoming less and it was increasingly difficult to contain enough pressure in the tunnel. When, added to this, defects in another old overhead sewer were encountered, tunnelling had to be abandoned and the old sewer had to be moved to one side and rebuilt. A test hole was made to prove the exact location of the end of the tunnel. The cableway was again set up and an open cut 360 ft. long was proceeded with. Here it was necessary to use heavier timber than was used in the other open cut since the sewer made a slight bend at this point, which brought it close to the houses on the street. Since the bottom of the trench here was very wet and the ground running sand, besides putting heavier timber in the work the contractors cut holes in the brick work foundations of the buildings and inserted under them heavy timbers which were held in place with jacks. Every day levels were taken and if the timbers showed any sign of settlement, the jacks were tightened. This work was given such good and close attention that when the open cut was complete and the back-fill made the buildings showed not the least sign of settlement. The holes were then filled up and everything left as formerly. The sewer was now complete as far north as the shaft at the tracks.

North Tunnel

When work was resumed on north tunnel all the air from the two pumps was turned into it. But very soon this was found to be insufficient, and it was at this point that the third and then the fourth pumps were added to the plant. The addition of a fifth was considered, but it was decided that the four pumps were supplying as great a pressure as the ground conditions would permit. Progress was very slow, averaging only two or three feet per day.

The worst difficulties were encountered under the C.P.R. tracks, where the natural strata of the earth had been broken up by the constant pounding and vibration caused by the heavy engines and trains. Work had to be suspended and the air turned off, sometimes every other day, to allow the ground to settle and consolidate. Every scheme that could be thought of was used to assist in this consolidation. The surface was soaked constantly with water, sand was brought and washed into the ground, sand bags were heaped up between the tracks to hold the ground down when the pressure was on in the tunnel, and grout was pumped into the earth from the surface and through the brick work of the sewer. At this time blow-holes could be seen all over the surface of the



Illustrating Open Cut and Method of Construction

ground above the tunnel. These were sometimes so large that the end of a pick handle could be shoved into them and the sand blown therefrom would rise six or seven inches from the mouth of the hole. At some distances from the centre line of the tunnel the surface of the ground looked as though it was covered with small ant-hills and the sand was constantly in motion. The greatest pressure that could be used was twenty-six pounds, which was often barely sufficient to dry the ground. The bottom foot or two of the excavation was frequently wet and sometimes took as long to prepare and remove as the ten or eleven feet above.

When the heading got so far away from the shaft that it was no longer economical to use man power on the construction cars, mules were introduced to do this work. Two cars were hitched together and one mule would draw them. The mules, however, did not like the compressed air any too well and when first introduced to it raised considerable objection.

After the Canadian Pacific Railway tracks were passed the work continued fairly regularly until Mulock Avenue was reached, where an old local sewer again gave trouble.

This was a tile-pipe sewer with joints so imperfectly made that the air escaped into it in ever-increasing quantity until it was found impossible to contain enough pressure to hold back the water. It was then decided that the old sewer would have to be plugged and a new local was built along each boulevard. Every effort had been made to avoid doing this; the contractors even hauled earth from the south side of the tracks (about one-quarter mile) and deposited it on the street to a depth of two or three feet, also a new lock was built near the heading which would reduce the volume of air and, therefore, the area for possible escape. The compressors were also moved up and pipes driven from the surface through which the air was pumped into the tunnel. But all these efforts proved of no avail, and the new locals had to be built.

Advantage was taken of this delay to test the line of the sewer. This was considered advisable since the line had been carried around three curves from the shaft south of the tracks where it was first taken down. Two 6-inch pipes covered by caps were driven from the surface of the ground on the correct line ahead of the work. When these were driven to a sufficient depth plumb lines were dropped to the bottom, the top ends of which were placed exactly on the correct line of the sewer. Afterwards, when the tunnel reached these points, Mr. R. C. B. Tempest, the resident engineer, found to his satisfaction that his line was almost exactly true.

While the new locals were being built, a new shaft was sunk at a point on Mulock Avenue, north of Hirons Street. Another lock was also built and in this case a concrete collar was provided to prevent the air from escaping back over the lock and into the shaft. The shorter haul more than compensated for the cost of sinking the shaft. Work from here went on rather quickly and without any more accidents. Toward the end of this section the greatest progress was reached, from twelve to fifteen feet of sewer being completed each day.

The needle-beam method of supporting the timbers was used throughout. Several of these beams broke, owing to the various accidents which lessened the air pressure in the tunnel and thus necessarily increased the weight on the beams. After each accident the size of the needle-beam was increased until a 16-inch by 16-inch timber, reinforced on each side with steel plates, was used. Several times when the pressure was decreased the timbers in the crown of the tunnel settled so much that there was room only for one or two rings of brick. These places were built in temporarily, but when the rest of the sewer was complete they were opened up again, the timber raised and the brick work replaced correctly.

This large trunk sewer supplied a great need in the part of West Toronto which it served; besides providing a direct outlet for all the sanitary sewage and storm water of this the business and most thickly populated section, it also provided a direct and adequate outlet for all the sewage and waste water from the abattoirs. This had formerly all been carried in greatly over-charged tile pipe sewers winding through the principal streets and discharging into a 24-inch tile pipe outlet.

Considering the whole work, with the many difficulties overcome, the contractors, Messrs. Donnelly & Graham, deserve very great credit for their spirit and perseverance.

On the canals between London and Liverpool there are nearly 200 locks. On the waterway between Berlin and Hamburg there are only three locks. This is an extreme contrast, but taking the canals of England and Wales altogether, there are 2,377 locks for 3,800 miles of waterways.

LECTURES IN HIGHWAY ENGINEERING AT ONTARIO AGRICULTURAL COLLEGE

Arrangements have been made whereby during the fall term of the Ontario Agricultural College at Guelph, a course of ten lectures on highway economics, construction and maintenance will be included in the regular curriculum. The lectures will be given by the engineers of the staff of the Ontario Department of Highways, each dealing with the branches of the work of the department with which he is connected.

The following syllabus indicates the extent of the course which will be of value and of interest to those attending:—

1. History of Road Development, Growth of Traffic and Economic Value of Roads.—This lecture to briefly consider the origin of roads under Rome, and in ancient times, and to trace their early development in France and Great Britain, leading up to modern methods and to modern traffic and traffic requirements; economic value to develop from early military uses to present-day value of roads in general scheme of transportation.

2. Outline of Road Construction.—This lecture to discuss types of roads, suitability to traffic, steps in construction and the essential features of a good road. From this lecture, the remainder of the lectures should develop the details.

3. Road Drainage and Grading.—This lecture to deal with earth work, objects to be attained in grading, methods of handling earth, finished camber of the road, side ditches, under-drains, drain outlets, drainage laws, treatment of roadside.

4. Road Foundations and Subordinate Structures.—This lecture to include bridges, culverts, guard-rails, protective devices at railway crossings, etc. The depth of road crust would be fully discussed in relation to traffic and sub-soil.

5. Road Surfaces and Materials.—This lecture to discuss earth roads, broken stone roads, bituminous surfaces, concrete roads, the materials available for road surfaces, their qualities, tests and methods of treatment.

6. Road Maintenance and Dust Prevention.—This lecture to discuss effects of traffic, methods of road protection, methods of making small repairs, general methods of maintenance for each class of road.

7. Road Machinery and Its Operation.—This lecture to describe road graders, rock crushers, road rollers, implements for screening and handling stone and gravel road scrapers, the log drag, etc.

8. Road Laws and Organization.—This lecture to describe road laws in Ontario, their development, the responsibility of municipal authorities, compare Ontario laws with those of other countries, and lead to proper methods of road management under councils and road superintendents.

9. Financial Aspects.—This lecture to cover cost of roads, methods of finance, debenture issues and cost data in detail.

10. General Summary.—This lecture to review the entire course and more definitely co-ordinate the various parts of the subject.

The construction of merchant ships of a uniform type, of about 8,000 tons, has been commenced in the Italian shipyards.

The Society for Electrical Development, New York City, has issued a booklet giving a list of more than 3,000 applications of electricity, and it has been sent free to its members.

Consulting Engineers Disagree Re Montreal Aqueduct

Messrs. St. Laurent and Vautelet Say that the City Should Proceed with Scheme and Build Power House Foundations Now at Cost of $400,000—J. B. McRae Advocates Purchase of Power

THE city of Montreal should cancel its contract with the Cook Construction Company and should refuse to allow the company to continue the aqueduct work at cost plus fifteen per cent., according to the advice given in a supplementary report by Messrs. Vautelet, St. Laurent and McRae, presented last week to Montreal's Board of Control. Regarding further development of the scheme, the board of engineers failed to agree.

Messrs. Vautelet and St. Laurent recommended that the city go ahead with the hydraulic development plan, and that the foundations of the aqueduct power house be built at once. Mr. McRae did not agree to this.

Following is the letter of transmissal of their supplementary report, written August 18th, by the three consulting engineers, and addressed to the mayor, board of control and city council:—

"According to instructions from the Board of Commissioners, our Board met in consultation with Mr. Herdt to consider the tender of the Civic Investment and Industrial Company for the supply of electric power to the city, and our Board also considered the offer of the Cook Construction Company either to do any work connected with the aqueduct project at cost plus 15 per cent., or to abandon their contract, waiving their right to anticipated profits.

Should Cancel Cook Contract

"Our Board is unanimous in recommending that the contract with the Cook Construction Company be cancelled as per the terms of their letter of July 17th, 1917, and that their offer to do the work at cost plus 15 per cent. be rejected.

"Our Board, in consultation with Mr. Herdt, calculated that, according to the new specifications and tender of the Civic Investment Company, the cost of purchased power for pumping an average of 100 M.I.G. per day would be $235,585 per year.

"From a letter of A. B. Cook, dated July 17th, 1917, it was ascertained that the said Cook Company were willing to waive their rights to anticipated profits. The cost of work to be done if hydraulic development be abandoned was, therefore, diminished by $279,575. On the other hand, since December 31st, 1916, work has been done and undertaken for an amount of $185,225. The total cost of buying current was, therefore, diminished by $94,350, and the interest thereon by $4,718. The total cost per year for the operation of the pump house at Atwater Avenue, and of the filtration plant for an average consumption of 100 M.I.G. was, therefore, reduced from $656,000 to $606,991 and the cost on H.P. basis from $62.47 to $57.81.

"We would call your attention to the letter of the Civic Investment and Industrial Company, accompanying their tender, and more especially to clauses 'd' and 'g.'

"Clause 'd' might be interpreted as meaning that a minimum of 8,000 H.P. must be used at Atwater Avenue and the wording of the beginning of the clause re minimum payment is not clear.

"Clause 'g' may be interpreted as meaning that to the prices mentioned in the tender must be added the taxes, municipal, provincial and federal, other than existing municipal taxes. This should be made clear and the proportion of said taxes, if any, chargeable to the city should be determined in advance.

"It remained for the Board to decide whether it would recommend to the city to accept the tender of the Civic Investment Company, or to go ahead with the hydraulic development as per Scheme No. II.

"After discussion it was found impossible for the members of the Board to agree and it was, therefore, resolved to make two different reports on the final recommendations to be made in addition to the recommendations and findings of the report of April 30th, 1917."

St. Laurent-Vautelet Report

Paul E. Mercier, city engineer of Montreal, forwarded to *The Canadian Engineer* a copy of the majority report, signed by H. E. Vautelet and A. St. Laurent, as follows:—

"Messrs. St. Laurent and Vautelet beg to report as follows on the final recommendations to be made:—

"Remarks on the tender of the Civic Investment and Industrial Company:—

"The calculations of the cost have been made on existing data for the monthly peak load for periods of 2½ and 3 hours. As the specifications call for payment on maximum monthly peak load for a period of 20 minutes, the sum to be paid may be larger than calculated.

"The indefinite amount of taxes to be paid in addition to the contract prices may also make an appreciable difference.

"We are also of opinion that the provision made for heating the filtration plant is inadequate and will further increase the cost of buying electric current.

"As the average monthly peak load calculated is 1.16 of the average consumption, it follows that the minimum price paid by the city for power actually used will be 1.16 x 26.50 = $30.74 per e.h.p., and the total cost per h.p. will be $57.81.

"It must be remarked, however, that the annual amount of $235,585 will have to be paid only when the water consumption of the city reaches 100 M.I.G. per day, and that until that time the power bills will be smaller, but after that time will gradually increase with the increased consumption of water.

Abandonment Means $1,500,000 Expenditure

"The abandonment of the hydraulic development will necessitate a capital expenditure of $1,500,000, the greater part of which need not be immediately made.

"It will also necessitate the immediate capital expenditure of $373,000 for the construction of the electric pump house.

"Remarks on Scheme No. II.:—

"If it is decided to go on with the hydraulic development as per Scheme No. II., it will not be necessary to prosecute the work immediately and it will be better to wait until the cost of labor and material has become normal again.

"In the meantime, the city can continue to pump the water by steam.

"It is, however, necessary to insure the supply of water in case of an accident to the conduit. This has been provided for to a certain extent by the emergency supply from the Lachine Canal, but that supply can only be resorted to for a short period.

"To insure it more completely, it will be necessary to be able to draw the water from the aqueduct canal and, therefore, to build a dam at the site of the old power house, so that the canal may be filled up in case of need.

"We think the best way to do this, would be to put in the foundations of the power house at a cost of $400,000 and to proceed with the rest of the work as circumstances will allow.

"The cost on h.p. basis as mentioned in our previous report will be $56.90 when the average consumption of water is 100 M.I.G. per day, but until such time it will not be necessary to have all the works completed and the annual expenditure will be less.

"It must be remarked, however, that when that average consumption becomes larger than 100 M.I.G. per day, the cost on h.p. basis will diminish to $50.35 as mentioned in our previous report, and that the city will have an additional power of 11,500 h.p. at a cost of $5.06 per h.p., or $6.74 per e.h.p. during seven summer months.

"From the previous remarks we conclude:—

"1st.—The cost on h.p. basis for the buying of current ($57.81) is larger than in the case of Scheme II. ($56.90).

"2nd.—When the consumption of the water by the city is larger than 100 M.I.G. per day (probably in 10 years), the cost on h.p. basis for buying current will remain the same ($57.81), whereas in the case of Scheme No. II. it will diminish ($50.35).

"3rd.—During seven months of summer, Scheme No. II. will give the city 11,500 additional h.p. at a cost per e.h.p. of $6.74 per annum, whereas it would have to pay $15.46 for that same power to the contractor.

"4th.—In the case of purchased power, the boulevard scheme as proposed has to be abandoned. Though we cannot attach a tangible value to the boulevards, they certainly will be a benefit to the city.

"5th.—The immediate capital expenditure necessary in both cases will be about the same.

"We, therefore, recommend:—

"That the city proceed with the hydraulic development of the aqueduct as per Scheme No. II.;

"That the foundation of the power house be built as early as possible to insure the water supply of the city;

"That the balance of the work be proceeded with as circumstances will allow."

J. B. McRae's Report

J. B. McRae, of Ottawa, dissented from the views of Messrs. St. Laurent and Vautelet, and presented a minority report, copy of which has been secured by *The Canadian Engineer*, and which is as follows:—

"As stated in our Board's letter to you of the 18th inst., we have not been able to agree on a recommendation regarding the aqueduct schemes.

"The estimates show that the cost of operation is in favor of buying power, under the terms of the tender, made by the Civic Investment and Industrial Company. The figures for pumping at a rate of 100,000,000 Imperial gallons per day being:—

"Cost of operation—Scheme II.	$740,000
"Cost of buying power	606,991
"Difference in favor of buying power..	$133,009

"This saving is per annum, and assuming present conditions of operation. Modern machinery and proper operation will reduce the cost of power considerably. Your attention is also drawn to the fact that it will be some years before the city requires the 100,000,000 Imperial gallons per day. In the meantime you pay for the power used to meet your requirements, which is much less proportionately for bought power than any of the power development schemes.

"I am informed that certain improvements are to be made at the reservoir and in the piping system. These improvements are for the purpose of cutting down the quantity of water pumped and reducing the friction head, against which the pumps are working. These improvements will favorably affect all the schemes, but it should be particularly noted that the reduction in cost of operation is greater in the case of bought power than in any of the other schemes.

Cost Per H.P. Not True Comparison

"The figures for the cost of operation have been used here for comparison and not the cost per horse-power. The horse-power basis should not be used, as it does not give a true comparison when comparing bought power with the other schemes.

"I would recommend that you enter into a contract with Civic Investment and Industrial Company for a quantity of power to meet your present requirements. The aqueduct should be put in such shape as will safely bring a supply of water, for domestic and fire purposes, to the pump house. Provision should also be made for the future development of such hydraulic power as may be developed economically. Such power, in combination with that purchased, will make the most economic power supply now possible, and should be sufficient for the city's requirements for, at least, the time of the power contract."

ST. AUGUSTINE-QUEBEC ROAD

Much of the preliminary and foundation work of the St. Augustine-Quebec road has been done and the contractor has just completed the erection of his asphalt mixing plant. The top surface will be asphaltic concrete of the "Improved Topeka" type. Work to date has been done under the direction of W. Gauvreau, C.E., formerly chief engineer of the Quebec Road Commission, and, since the turning over of the Quebec road to the province, engineer in charge for the Provincial Road Department. The chief engineer of the Provincial Road Department is Gabriel Henry.

Milton Hersey Company, Limited, of Montreal, have been retained by Messrs. Henry and Gauvreau as consulting, testing and inspecting engineers. The road is being constructed with Imperial asphalt. It is ten miles long, and is being built on an old macadam base.

The Corporation of Leicester, England, has prepared a town-planning scheme to be put into operation after the war.

The National Assembly of Panama has approved a contract made for the construction of a railway on the Atlantic Coast of Panama, starting from the mouth of the River Chagres and running south-west for at least 50 kiloms. to the city of Almirante. The concession is for seventy-five years, but the Government reserves the right to purchase the road after thirty years. The line has to be completed within five years.

Letters to the Editor

Glare from Concrete Sidewalks

Sir,—We note the inquiry of Mr. A. Crumpton in your issue of August 16th, as to the removal of the glare from concrete sidewalks. It may interest you to know that there is an ordinance in the city of Los Angeles, as also San Diego, to incorporate a color to remove this glare. A black has been used, as the greens, even though a chrome green is used, are not permanent, while a proper black is unaffected by the sun's rays. It is likewise common practice in New York to produce a bluestone effect by the addition of a carbon black (carbon black is produced from the combustion of natural gas).

A. E. HORN,
Sales Manager, A. C. Horn Co.
New York City, August 24th, 1917.

"Outline the Terms of Arbitration"

Sir,—In your editorial of August 23rd, entitled "Outline the Terms of Arbitration," in connection with the taking over of the C.N.R. by the Dominion government, you express the opinion that if the physical value of the road is to be considered in the transaction, it should be determined upon the basis of the cost of reproduction less depreciation, and not upon the basis of the cost of reproduction alone.

That the depreciation of the road must be deducted from the reproduction cost in order to arrive at the physical value of the existing property as it is at present, can hardly be disputed. Cost of reproduction is usually understood to mean something like this:—

If, on the identical spot where the present road is located, we were to build under present conditions and market prices, a new road with new bridges, new rails and ties, and new equipment and rolling stock, what would be the cost of the road?

It is evident, therefore, that the cost of reproduction does not represent the value of the existing property which includes many old, worn-out rails, partially decayed ties and bridges that may have reached the limit of their services and would have to be renewed soon. All such physical items in the existing road can only give service for a certain number of years, after which they must be completely renewed.

If, therefore, a portion of their probable life is already gone, a like portion must be deducted from their value new, in order to arrive at their present value. This depreciation of the various items which is due to age, wear and tear, and other destructive agencies, is usually determined either by the use of mortality tables which are based on an assumed length of life for each item, or by personal inspection in the field and an examination of the actual condition of these items.

But, while it is realized that depreciation should be taken into account in determining the value of the road, it seems fair that appreciation of such items as have a tendency to improve in value as time goes on, should also be considered. There are several such items in a railroad, but the condition of the roadbed serves as a good example. Railroad engineers are quite familiar with the fact that the roadbed of a newly built railroad frequently keeps on settling for a time and requires occasional filling until it finally solidifies. Thus the existing roadbed would represent a greater value than the cost of reproducing the new roadbed which would, strictly speaking, be a non-finished product.

Frequently reproduction cost based solely on present-day condition does not represent a fair valuation. Certain conditions may have existed prior to the building of the road which may have considerably affected the cost of the original construction, but which may not be evident to-day, such as unusually deep cuts or the building of trestles for filling. Such costs should surely receive certain considerations. It is, therefore, desirable to investigate records as far as possible, and consider original conditions as well as present-day conditions.

In the case of some railroad valuations in the United States, with which the writer was connected, a complete study of the history of the road had first been made. All records that were available were examined and all information that could be procured was noted. A complete survey and inspection of the road was then made, and upon the combined information from all these sources was then based the physical valuation.

H. A. GOLDMAN, C.E.,
Assistant Designing Engineer,
Toronto Harbor Commission.
Toronto, Ont., August 27th, 1917.

The Railway Problem

Sir,—On both sides of the House of Commons, the discussion of the railway problem seems to have drifted further and further from the real issue, the economic one, the consideration of the capital and the operating burden which Canada may be saddle-galled with.

The question as to what may or may not be paid for the Canadian Northern Railway stock is one of equity to be determined, comparatively small.

The big issue is what does the *sole* acquisition of the Canadian Northern Railway, *exclusive* of the other two (G.T.R. and G.T.Pac.) mean?

All the authorities who have dealt with the question, the Drayton-Acworth report, W. F. Tye's paper, also Sir Thos. Tait's contribution, have assumed without hesitation that *consolidation* was fundamentally indispensable to any scheme of redemption or of recuperation from the unfortunate financial muddle these railways now find themselves in. The following quotation from W. F. Tye's paper illustrates the principle very clearly:—

"1. The National Transcontinental, the Grand Trunk Pacific and the Canadian Northern Railways are unable to earn their operating expenses and their fixed charges. Canada has built, and is operating, the first of these roads, and Canada and the various provinces have guaranteed the principal and interest of most of the bonds of the other two. As the roads are unable to earn their fixed charges they must, of necessity, be paid by the country.

"2. The failure of these roads is due to the duplication of lines by all the railways, encouraged and bonused by the government; to the excessive cost of the Grand Trunk Pacific and National Transcontinental Railways; to the failure of the Grand Trunk Pacific to provide itself with an adequate system of feeders in the West; and to the construction, by the Canadian Northern, of the long and unproductive stretches of road across British Columbia and Northern Ontario, without feeders, terminals, etc.

"3. If the Canadian Northern, the Grand Trunk Pacific and National Transcontinental be maintained in two separate systems, it will cost at least $400,000,000 to build the necessary branch line feeders and terminals, to provide them with adequate rolling stock, and put them in proper physical condition to compete with the Canadian Pacific.

"4. It will be necessary that the Grand Trunk Pacific build five to six thousand miles of feeders in the West.

"5. It will be necessary that the Canadian Northern build two to three thousand miles of feeders in the east, and terminals costing many millions in Montreal, Toronto, Ottawa, Quebec and Vancouver.

"6. Canada has already sufficient railway mileage for years to come. The additional mileage necessary for these roads could only be had by duplicating existing lines. Such duplication of lines would only add to the burden to be borne by Canada in the way of subsidies, guarantees, etc., without doing the country any good.

"7. Canada has sufficient railway mileage and traffic for two good transcontinental systems, the Canadian Pacific and another—but has not enough for three.

"8. A consolidation of the Grand Trunk, the Grand Trunk Pacific, Transcontinental and Canadian Northern Railways would give a well-balanced system. The Grand Trunk has an excellent system in the east, with terminals in all large and important centres. The Canadian Northern has not. The Canadian Northern has a good system of feeders in the West. The Grand Trunk has not. Each is strong where the other is weak. Combining them must, of necessity, be the most economical and efficient way of handling the situation.

"9. Such a combination would not require more than $100,000,000 to provide it with sufficient rolling stock and to put it in proper physical condition to compete with the Canadian Pacific.

"10. The saving in capital cost would be at least $300,000,000 and, at present rates of interest, the saving in fixed charges at least $15,000,000 per annum."

Thus the *exclusive* taking over of the Canadian Northern Railway means that it must be provided with branches in the east. The construction of these feeders in the east must necessarily duplicate, parallel, the Grand Trunk's Ontario and Quebec lines—the inadequate earnings of which, to support them and the Grand Trunk Pacific, the government is also called upon to supplement to the extent of their deficiency.

The argument, moreover, applies inversely to the Grand Trunk Pacific in the West, if it be left isolated and necessarily to be supplied there with the indispensable feeders.

If we have to pay the deficiencies of the Canadian Northern Railway and also of the Grand Trunk Pacific as well why, from an economic point of view, burden the one and the other with the extra capitalization of from fifty to one hundred millions of dollars in each case for branch feeders, etc? The interest on this illogical proceeding would also have to be paid by the Dominion.

People are seemingly losing sight of the fact that it is this very wasteful and unnecessary duplication of lines which has landed the railways and the country where we are.

It seems strange that the recognized authorities who have given this matter careful and expert study should not be heard before a committee of the House; that the members may have the opportunity to satisfy themselves with economic views on the question, before committing the country to the "last straw that breaks the camel's back."

NOULAN CAUCHON,
Consulting Engineer.

Ottawa, Ont., August 25th, 1917.

POWER FIGHT IN THE SENATE

The Railway Committee of the Senate is hearing arguments by representatives of the Ontario municipalities and of private electric companies in regard to the government's bill to amend and consolidate the railway act. The section in dispute is that which takes away from power companies their right to distribute electricity in any municipality in Canada without first obtaining the municipality's consent.

The Privy Council's decision of 1912 in the injunction suit brought by the Toronto-Niagara Power Co. against the town of North Toronto, virtually declared that the power company has the right to enter the streets of any municipality and to erect and maintain poles and wires for the distribution of electricity for all purposes.

When the bill to amend and consolidate the railway act was before the House of Commons this session, a clause was inserted which takes away this right. As the bill passed the House, a power company may build its transmission lines through any municipality upon terms to be fixed by the railway board, but may not distribute electricity to consumers in any municipality without obtaining the consent of the municipality.

The particular case which led to the insertion of that clause was the situation in Toronto. The franchise of the Toronto Electric Light Co. expires in 1919, and the company has been ordered to remove its poles and wires from the streets. The Toronto-Niagara Power Co., as the assignee of the Toronto Electric Light Co., claims perpetual right to maintain its poles and wires in Toronto, and to distribute power without the city's permission.

MAY USE CONCRETE PIPE

Consulting Engineer Jas. H. Fuertes and Chief Engineer W. G. Chace, of the Greater Winnipeg Water District, have presented a report to the commissioners recommending reinforced concrete pipe for the portion of the Shoal Lake Aqueduct from the westerly shaft of the Red River tunnel to the MacPhillips Street reservoir. It was originally intended to build this section with cast-iron pipe, but on account of the increase in cost of cast iron, the engineers now recommend a 48-inch reinforced concrete pipe.

Mayor Davidson, of Winnipeg, was not satisfied with the reason for the change, stating that price is not the ultimate consideration, and after some discussion, decision in regard to the matter was held over until another meeting of the Board. The report of the engineers, which was presented to the commissioners last week, is as follows:—

"The lowest tender received on April 16th for cast-iron pipe for this line was $321,015. The market price of cast-iron pipe at New York on that date was $50.50 per ton. The market price on July 31st, 1917, was $65.50 per ton, which would correspond to an increase in cost of the cast-iron pipe for this line, considering the Cana-

dian customs duty, of $74,000 if the cast-iron pipe be purchased immediately.

"Our estimate on the cost of laying cast-iron pipe in the trench is approximately $180,000, making the total cost of the pipe laid, at to-day's price, $575,000.

"If the recommendation above set out for the adoption of reinforced concrete for this pipe be approved, we believe that the entire line can be built for about $400,000, or at a saving of $175,000."

SECRETARY KEITH'S WESTERN TRIP

(Special Correspondence)

Edmonton, Alta., August 23rd.—Fraser S. Keith, secretary of the Canadian Society of Civil Engineers, spent Wednesday, July 22nd, with the Edmonton Branch of the Society. Mr. Keith met the executive informally and discussed a number of matters of interest to the Society and especially to the western membership. Mr. Keith gave an interesting talk on the proposed new by-laws of the Society and mentioned especially the following proposed changes:—

The name of the Society.

The voting for members of council, each district to elect its representatives instead of the whole membership electing them.

The broadened objects of the Society, which has in view the establishing of closer relations with the manufacturing and business world outside of the Society, to which the engineer's work in this day and age is so closely allied.

The secretary feels, as does the branch executive, that engineers as a class, to get more general recognition, should become better known outside the profession, and should take the more active part in public affairs for which their training and experience qualifies them.

Mr. Keith's visit indicates that the society recognizes the importance of the branches to its welfare, and to its future usefulness to the engineer and to the public at large.

He left on Wednesday night for Vancouver and Victoria, via Calgary, stopping for a day at Banff, en route.

Calgary, Alta., August 21st.—Mr. Keith was the guest of the Calgary members of the Society at a luncheon at the board of trade rooms yesterday. Mr. Keith gave an inspiring address after the luncheon, on the enlarged scope of the work of the engineering society. One example of the assistance which the society has been rendering the government is the work of the Honorary Advisory Council of Scientific and Industrial Research. The appointment of the advisory council which is now permanently established, was the outgrowth of a report to the government by members of the society, and it was stated that 95 per cent. of the work of distributing the questionnaires issued by the advisory council is being done by the voluntary efforts of members of the society.

The part which members are taking in active service for their country is indicated by the extensive roll of honor which is now being prepared in the Montreal office of the society, and which will contain more than 800 names. Many of them have received decorations and 47 have made the supreme sacrifice.

W. A. Duff, chairman of the Manitoba branch of the society, was another guest at the luncheon yesterday and made a brief speech.

Local members of the society entertained Mr. Keith and Mr. Duff at the Calgary Auto Club last night.

DESIGN AND CONSTRUCTIONAL FEATURES OF TURBINE PUMPS

By A. E. L. Chorlton

(Continued from last week's issue.)

All the earlier turbine-pumps employed some form of thrust bearing, either of the collar or the ball type, to keep the impellers in correct alignment with the guide passages, and it was not until much trouble had been experienced with these that hydraulic control was ultimately adopted. Experience showed that much higher end pressures were set up than were ever anticipated, but for a period mechanical devices were persisted in, improvements being made attempting to withstand the excessive loads, and scant notice, it would appear, being taken of water-turbine practice where for many years it had been the custom to relieve axial thrust hydraulically. Fig. 19 illustrates an hydraulic balancing device in use on Francis turbines, and which, if properly proportioned, is automatic, and thus embodies all the essential points of many present turbine-pump balancers. One should bear in mind that the relation between the calculable axial thrust and the thrust realized in a water-turbine is much closer than in a centrifugal pump of the multi-stage type, the reason of this being that the disturbing factor in a high-lift pump is the leakage from stage to stage.

The well-known application of turbine-pumps to high lifts by Messrs. Sulzer at Horcajo Mines in 1898, was carried out with back-to-back impellers, and a ball thrust-bearing was provided to take the end-thrust (in one direction only), which is inseparable from this arrangement of impellers. In 1901, Professor Rateau was manufacturing pumps with end-thrust approximately eliminated hydraulically by his well-known method of shroud reduction, and provided with a balancing piston, Fig. 20. This method was not automatic, and the pressure on the piston could only be adjusted by means of a hand-operated throttle-valve. However, this was the first step, and the automatic control of the necessary pressure on the balancing

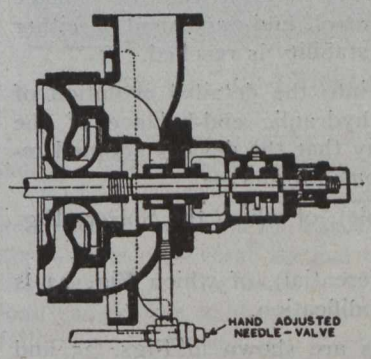


Fig. 21.—Hand Adjusted Balancer

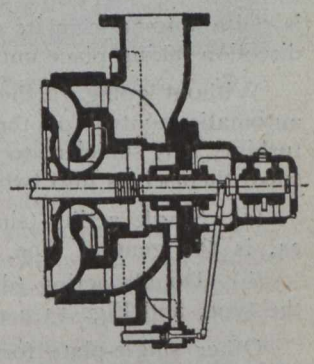


Fig. 22.—Mechanically Adjusted Balancer

device and determined by the end movement of the spindle followed as a matter of course. The development of the differential type of balancer carried out under the author's direction in 1913, extended over several years, progressing step by step from a hand-adjusted needle-valve, Fig. 21, regulated to produce the required balancing pressure, to a mechanically-operated needle-valve, Fig. 22, actuated by the axial movement of the spindle, and then through several forms of rotating throttle-valve disposed on the spindle itself and actuated by the same means. Further

reference to the final balancing appliance (diagrammatically shown in Fig. 23) will be made shortly.

In 1906, Messrs. Sulzer brought out their device for relieving thrust shown in Fig. 24, and the principle used has been followed by many other makers and introduced

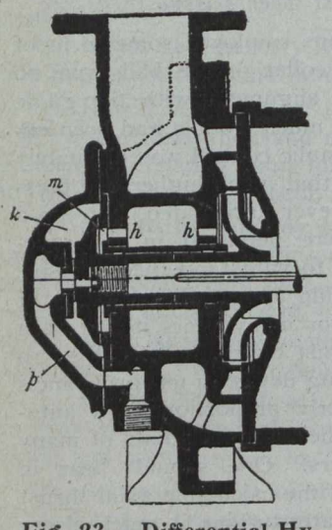


Fig. 23.—Differential Hydraulic Balancer

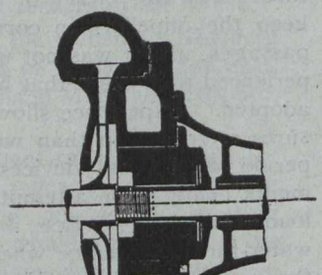


Fig. 24.—Single Plate Balancer (Sulzer)

with many variations. The action of the Sulzer device is simple; it comprises a single plate with a throttling device, through which the pressure water has access to the plate. The area of the plate is sufficient when acted on by a somewhat throttled delivery-pressure to overcome the tendency of the rotor to travel in the opposite direction. As the pressure gradually rises before the plate, its increased power carries the rotor to the right until further motion is arrested by the escape of the increased pressure through a widening annular space between the plate and its facing seat. An ultimate running position is reached when the leakage through the clearance between valve and seat is sufficient to maintain a pressure at the back of the plate, equal to the set of the rotor in the opposite direction. It will be seen that the balance is quite automatic in its control, end-movement in either direction taking place until stability is reached.

Without going further into the detailed evolution of automatic control of the hydraulic end-balance of the turbine, it is sufficient to say that the devices adopted resolve themselves into two basic forms:—

(a) Single acting (simple), of which the Sulzer, Fig. 24, is the general type.

(b) Double acting (differential), of which Fig. 23 is the type, and Fig. 13 a modification.

Other single-plate forms are shown in Figs. 25 and 26. In the first of these the throttling agent, a small nipple, is removed to the discharge side of the plate, thus giving, in a measure, a double action to the plate; the quick action and limited travel due to the second face of the differential type is not obtained, however, and there is a possible disadvantage in the small aperture when dealing with impure water. The second example combines some of the points of both forms of balancer, but as the pressure in the spent-water chamber is always augmented by high-pressure leakage into the low-pressure side of the plate, the device is, obviously, relatively extravagant in leakage water, and must therefore be considered inefficient.

The general effect of wear on single-plate balancers is increased leakage, the outcome of which is further end-movement in one direction until finally the impeller discharges do not match their guide-vane entrances, but become off-set. This tendency in hydraulic balancers led the author to devise form "b," or the double-action control with which such difficulties are overcome.

Fig. 23 (also in Fig. 12), finally shows the present standard double-plate or compound differential balance arrangement. The balance-piston and regulating valve are combined, and form a balance-disk with two active throttling surfaces floating between two fixed seatings with a minimum clearance. All the working faces are arranged vertically so as to be independent of possible vibrations of the rotary system. The pressure-water, escaping from the rim of the last impeller, passes through the holes h, into the pressure chamber m, from which it escapes along the throttling surface of the balance-valve into the regulating pressure-chamber k, and from there, past the small throttling surface into the escape-pipe p,

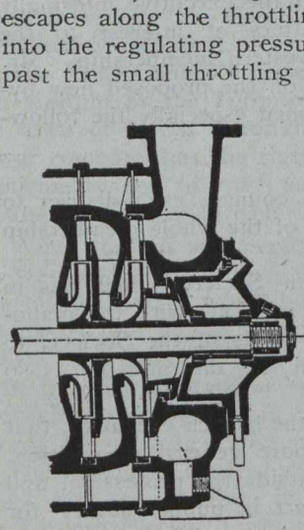


Fig 25.—(Millington)

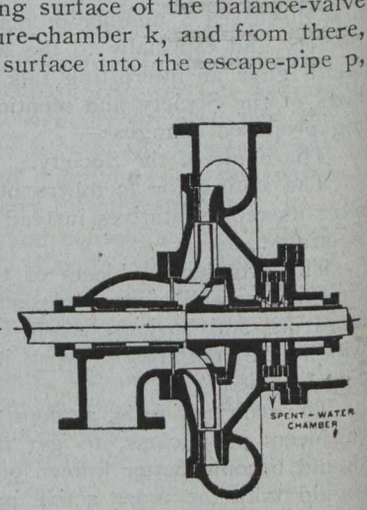


Fig. 26.—(Scheurmann)

Single Plate Balancers

leading preferably to an open drain, or, back into the suction-chamber of the pump. The double-plate balance appears to be the most sensitive automatic balancing device in practical use, for by it, closing up of the plate on the large throttling face causes an opening out on the small one, thus multiplying the balancing effect; a movement of a thousandth part, or so, of an inch being all that is required to counterbalance the most extreme and sudden changes of the hydraulic equilibrium of the pump. The other and most important feature of this auto-plate balance is that it always maintains the central position of the impellers, even if the throttling surfaces become worn, as is invariably the case when pumps are working on gritty water.

A continental form arising out of this type is shown in Fig. 27, and it is obvious that the same remarks concerning extravagance in leakage water apply to this example as to Fig. 26. The arrangement of the balancer at the end of the spindle outside the external bearings is not a good one, for the reason that a high-pressure gland at the delivery end of the pump is still required, and an additional gland also for the balancer-housing. A single-plate balance made by the same firm as the above is shown in Fig. 28, and this, too, is open to the same objection as regards disposition on the spindle.

It is usual to make hydraulic balancers with renewable faces at the points of close-running, so that the appliance can be readily repaired after wear has taken place. As regards the best material to be used for the renewable

part, some considerable experience is needed before a decision can be made. Gun-metal was probably the first material to be used, but cast-iron, cast-steel, and hard bronze have all been tried, the present practice usually being to fit hard bronze. The ideal material is one which is hard and "short," and has a very low coefficient of friction when working in water; a material which "drags" is quite unsuitable, and apparently an incorrodible iron, one containing a high percentage of silicon or a nickel steel, seems to best fit the requirements. Non-metallic substances, such as red-fibre, woodite or dexine, have been considered, but any material which becomes slightly absorbent after long immersion is useless.

Sometimes difficulty is experienced in starting up large turbine pumps on account of the large diameter balance-rings being held together in metallic contact instead of being apart in their usual running position; the result is an abnormally high starting torque for the motor and probable damage to the faces of the balancing device. When a turbine-pump with differential balancer is "stopped," the rotor will always take up a position with the balancing faces apart if the waste-water outlet (Fig. 29), is taken to an open drain; however, if the spent water is led back to the suction pipe of the pump and a foot-valve is

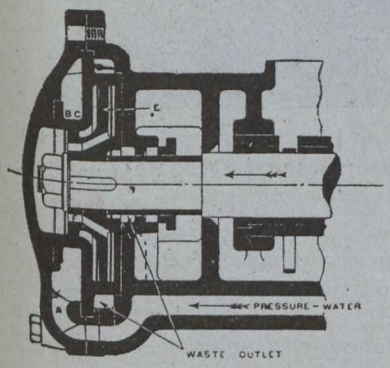


Fig. 27.—Differential Continental Hydraulic Balancers

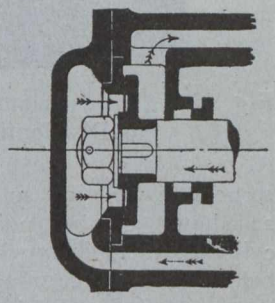


Fig. 28.—Single Plate Balancers

provided at the end of the suction-pipe, the whole rotor is forced towards the suction-end of the pump as soon as the foot-valve closes and the head pressure comes on. The reason for this is that the area of the balances on the outlet side is greater than on the inlet side by an amount equal to the diameter of the spindle. For this reason, the waste water from a balancer should not be connected to the suction-pipe of a pump, or means should be taken in the pump to equalize the areas subject to the static hydraulic pressure (Fig. 12).

(Continued in the next issue.)

Steel and wooden vessels to the value of $27,000,000 are at present under construction, or contracted for, on the Pacific Coast.

The Judicial Committee of the Privy Council will probably hear argument by counsel for the Electrical Development Company, regarding permission to proceed against the government of Ontario without a fiat from the provincial attorney-general, at its November session.

Contract for the first ships of the new emergency fleet being built by the United States Shipping Board, under the supervision of Major-General Goethals, were awarded to the Los Angeles Shipbuilding and Dry Dock Company, Los Angeles, Cal. This contract calls for eight steel vessels of 8,800 tons deadweight capacity, 426 ft. long and 54-ft. beam. Each of these vessels will be equipped with four marine oil-fired boilers built for 200 lbs. working pressure, each boiler containing 2,900 square feet of heating surface.

SANDS AND CONSISTENCY OF CONCRETE

By L. N. Edwards,
Supervising Engineer of Bridges, Toronto

(Continued from last week's issue.)

Failure of Cylinders.—In the tests of cylinders three forms of failure were observed, as follows:—

1. Double cone, resulting from a thorough, uniform distribution of materials;

2. Diagonal shearing, resulting from the distribution of stone in a manner producing cleavage planes. Occasionally a wedge-shaped stone may be so placed as to cause a double-wedge-like fracture; and

3. A general "mushing down" or disintegration of the entire structure at its mid-length. This form of failure invariably indicates a failure of the mortar content of the concrete.

Although the three forms of failure were more or less common to all tests for grading of sands, it was found that the third was more generally characteristic of low-strength concretes. In these cases few of the stones were broken.

In the tests for consistency of mix, the first and second were the forms of failure for the first and second consistencies, while the third was the general form of failure for the fourth and fifth consistencies.

Fig. No. 19.—Broken Test Cylinders

Fig. 19 shows a collection of broken cylinders indicating different forms of failure.

Failure of Beams.—Critical failure of beams of first and second consistencies was usually accompanied by the appearance of several vertical cracks, within the middle-third length of the beam. A further application of the load caused one of these cracks to develop, and ultimate failure was produced by the breaking of the two outer (bent) bars of the reinforcement and the slipping of the middle bar. Compression in the concrete caused little or no failure of same by crushing.

Critical failure of beams of the third consistency was similar to those of the first and second consistencies, except that crushing of concrete adjacent to the point of application of the load was more common.

Critical failure of beams of the fourth and fifth consistencies was accompanied by the appearance of a less number of vertical cracks. Usually two of these cracks developed simultaneously for a time, producing a wedge-like block in the centre of the beam. Ultimate failure of beams of the fourth consistency was commonly produced

by the breaking and slipping of the reinforcement on one side of the wedge, but in some cases was the same as described below for beams of the fifth consistency. Ultimate failure of these latter beams was produced by a spalling off of the concrete below the reinforcement at the centre of the beam. In beams of both these consistencies, compressive stresses produced a distinct crushing of concrete adjacent to the point of application of the load.

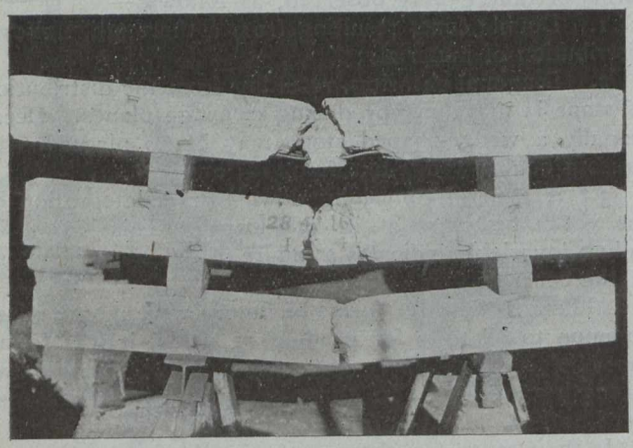


Fig. No. 20.—Typical Forms of Failure of Reinforced-Concrete Beams

Fig. 20 shows typical forms of failure for the beams.

Relation of Weight of Test Cylinders to Strength.—In the tests for gradings of sands, all cylinders for 90-day tests were weighed before testing. This weight varied from 31 lbs. 2 ozs., minimum, to 32 lbs. 3 ozs., maximum, the average weight being about 31 lbs. 7 ozs. A critical examination of results shows no conclusive evidence that high strength and high weight are co-

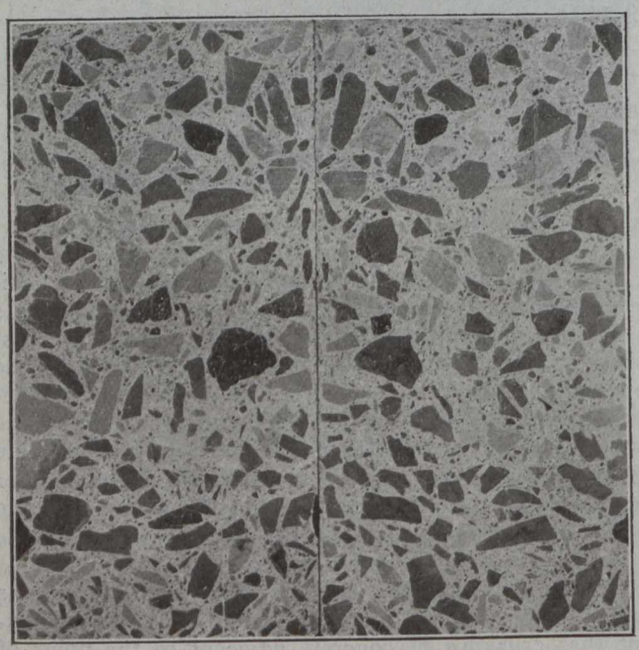


Fig. No. 21.—Distribution of Aggregate in Concrete, 1:2:4 Mix

incident. However, it is reasonable to assume that this should be the case.

Texture of Concretes used for Testing Gradings of Sands.—The consistency of the mix used, together with the special care exercised in the mixing and placing of the concrete, insured a uniform distribution of the stone aggregate. Fig. 21 shows a cylinder selected at random sawed through the centre. In addition to the distribution of the

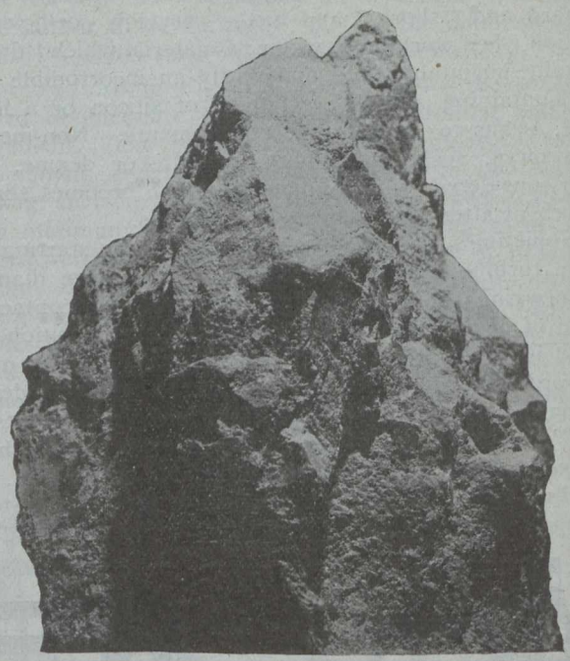


Fig. No. 22.—Specimen of Low-Strength Cylinder; due to Distribution of Stone Aggregate

stone, the wedging action of the stones is shown. Fig. 22 shows a rather unique combination of stones in a cylinder cone. This cylinder broke under a load 37,072 lbs. below the average of the other four cylinders composing the set of five. Single stones and combinations of stones tending to produce cleavage planes are unavoidable.

The texture of the mortar content for a given mix varies very considerably with the grading of the sand. Fig. 23 shows the texture of the mortar in 1:2:4 concretes of Sands Nos. 2 and 12. The granular appearance

(*a*) Sand No. 2. (*b*) Sand No. 12.

Fig. No. 23.—Texture of Mortars in Concrete, 1:2:4 Mix (× 2½)

of the latter is largely due to the inadequacy of the fine material of the sand to bolster-up the cement by the formation of a sandy paste.

Irregularity in the strength of individual cylinders at the age of 30 days or over indicates to some extent the unreliability of the sand for use in a concrete intended to resist impact. This condition is not evident from a study of average strengths.

The characteristic failure for high-strength concretes, age 30 to 90 days, was a sudden break usually accompanied by a loud report. For low and for irregular-strength concretes, the methods of failure varied from a sudden break to a "mush down."

Toughness and durability were roughly tested under the impact of hammer blows. Friability and shortness so observed were not confined to low-strength concretes. However, this condition was common to all sands producing concretes of low strengths and to all consistencies of mix below the second.

Air and Water Voids and Cavities.—In the following discussion the author uses the word "void" to indicate a spherical shaped opening within the body of the mortar content of the concrete. The word "cavity" is used to indicate an opening, usually irregular in shape, located adjacent to the surface of a particle of the sand or the stone aggregate.

The semi-plastic mix described under "mixing" is well adapted to the removal of occluded air, when a reasonable amount of work is done in connection with the compacting of the concrete during placing. The consistency of the mix is such that excess water is not available for the production of myriads of water voids and cavities. However, it is not possible to produce an absolutely voidless concrete.

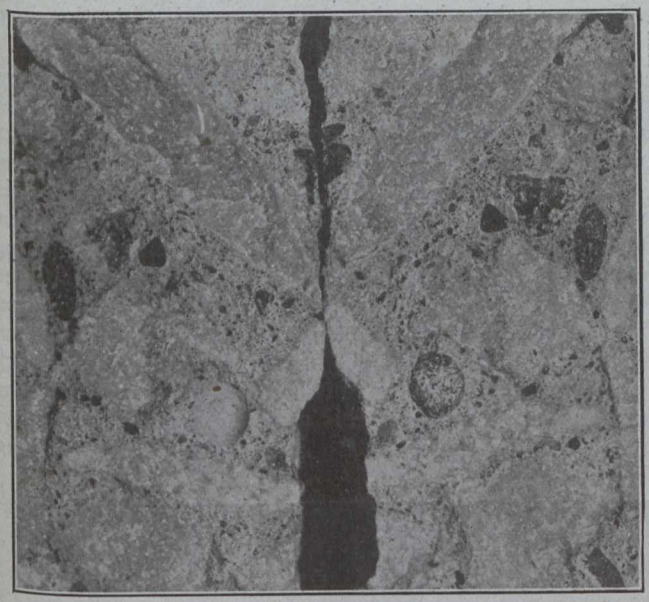
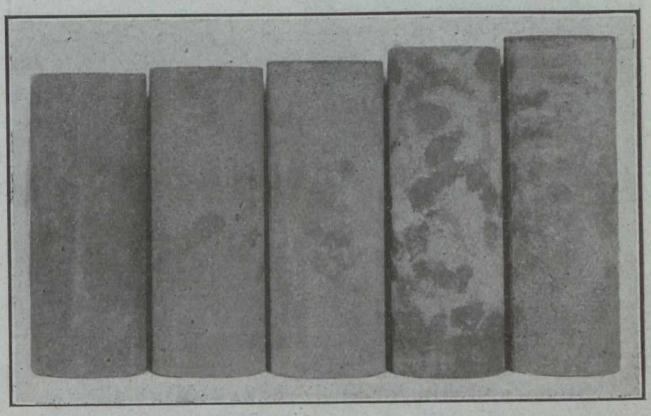


Fig. No. 24.—Field Produced Concrete of Limestone Aggregates; 1:2:4 Mix (× 1½)

Fig. 24 shows the character of concrete produced as above described. This photograph, taken in connection with field construction work, shows a very small number of voids in the mortar content and the absence of cavities adjacent to the stone particles. There are also fractured sand grains and stone particles, indicating beyond question that the mortar content of this concrete is equally as strong as the stone aggregate.

Present-day methods of preparing, transporting, and placing concrete are especially favorable to the occlusion of air in the concrete produced. This air becomes entrapped in the concrete mass forming voids and cavities. In a well-prepared and properly placed concrete the actual volume of the voids and cavities produced by occluded air is relatively small, as compared with that produced by the water content of the mix. In a concrete of sloppy consistency, the voids and cavities produced by air are, no doubt, of less volume than in a saturated semi-plastic mix, since the less resistance of the former permits air to more readily escape.

Unlike air, the inclusion of water as a constituent material of concrete is absolutely necessary. Its proper function is (1) to combine with the cement in producing the pasty cementing material necessary for the union of the aggregates into a thoroughly united, uniformly strong, conglomerate mass, and (2) to render this mass, in its transitory state, capable of being formed with a



(*a*) (*b*) (*c*) (*d*) (*e*)
(*a*) Original. (*b*) 10 per cent. (*c*) 20 per cent. (*d*) 35 per cent. (*e*) 50 per cent.

Fig. No. 25.—Mortar Cylinders in Which the Water Content Was Increased by 10, 20, 35, and 50 Per Cent.

Fig. No. 26.—Fractured Concrete; 1:2:4 Mix; First Consistency (× 1½)

reasonable amount of work into the various shapes required in its adaptation to the construction of bridges, buildings, roadways, and various other practical uses.

The addition of a small quantity of water to a saturated, semi-plastic concrete mix, will change its consistency to that of a readily flowing mixture. The inclusion of a greater quantity of water than is required for the development of its natural functions, is decidedly detrimental to the strength and reliability of the final concrete.

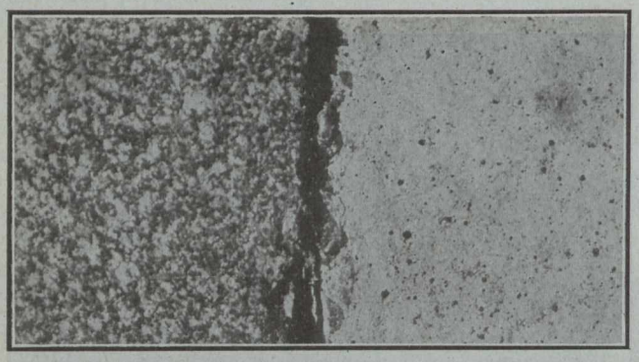


Fig. No. 27.—Surface Contact Between Under Side of Stone and Mortar Bed; 1:2:4 Mix; First Consistency (× 5½)

Fig. 25 shows a series of mortar cylinders in which the quantity of cement and sand is constant. The water content was successively increased by 10, 20, 35 and 50 per cent. over that required to produce normal consistency. The bulking-up effect of the water is apparent.

The effect of increasing the water content from the quantity used in concrete of the so-called standard or first consistency, to that of concrete of the- fifth consistency, is clearly shown in Figs. 26 to 31, inclusive, for cylinders, and in Figs. 32 to 35 for reinforced-concrete beams.

Fig. 26 shows a 1:2:4 concrete of first consistency produced from sand No. 2. Voids are minimum. The cylinder from which the specimen was taken was tested at an age of 308 days. Its compressive strength was 168,970 lbs. (5,735 lbs. per sq. in.).

Fig. No. 28.—Surface Contact Between Under Side of Stone and Mortar Bed; 1:2:4 Mix; Fifth Consistency (× 5½). Note Voids and Cavities Due to Excess Water.

Fig. 27 shows a 1:2:4 concrete of first consistency. The under surface of the stone was in close contact with its mortar bed, and is slightly coated with a gray film of cementing material. The mortar bed is grayish in color, showing few voids and no cavities.

In the test cylinders of concretes of second consistency, three conditions were noticeable, namely, (1) an increase in the number of voids in the mortar bedding of the stones; (2) a tendency of the concrete toward friability and shortness; and (3) a general tendency of the concrete to become white in color, as compared with the gray color of concrete of the first consistency.

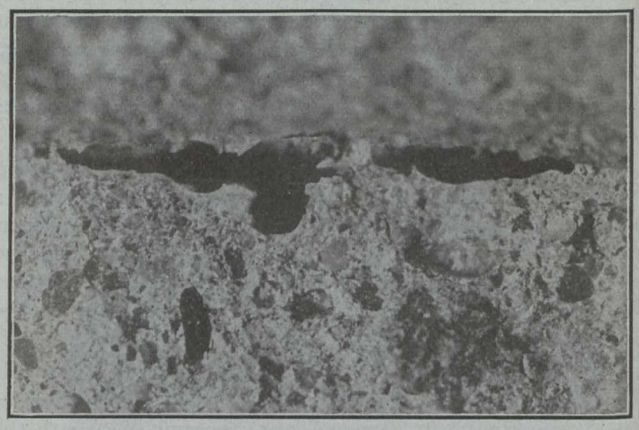


Fig. No. 29.—Water Cavities Underlying Stone Aggregate (× 8)

Fig. 28 shows a 1:2:4 concrete of fifth consistency. As compared with concrete of first consistency, Figs. 26 and 27, which contain a comparatively small volume of voids in the mortar and no cavities adjacent to the stones, it is evident that the voids have not only increased in number and size, but that the excess water, in the physical and chemical operations incident to the mixing, placing and hardening of the mass, has accumulated in flattened globules adjacent to the stones, and by its final evaporation, has left comparatively large cavities which are separated by ridges of a soft, chalk-like substance upon which the superimposed stones must take their bearing. The under surface of the stone is also covered with this material—"laitance"—giving to it a pitted, crater-covered appearance, not unlike that of the surface of the moon when seen through a good field glass. A similar appearance is occasionally found upon the surface of water-cooled furnace slag.

Fig. No. 30.—Surface Contact Between Under Side of Stone and Mortar Bed; 1:2½:5 Mix; First Consistency (× 5)

The accumulation of water cavities adjacent to the stone aggregate, together with the formation of the dividing walls or ridges composed mainly of lime which separate them, probably constitutes the most important reason why concrete of the fifth consistency attains a strength of

approximately 55 per cent. of that attained by concrete of first consistency. The increased volume of voids is also an important factor to the same end.

Fig. No. 31.—Surface Contact Between Under Side of Stone and Mortar Bed; 1:2½:5 Mix; Fifth Consistency (× 5). Note Voids and Cavities, also "Valleys" in "Laitance" on Surface of Stone

In this connection, the water cavity shown in Fig. 29 is of special interest.

Figs. 30 and 31 show for 1:2½:5 concretes of the first and fifth consistencies, respectively, the condition of

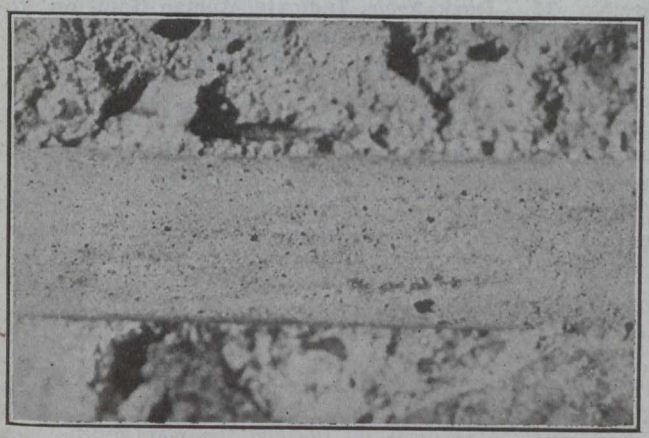


Fig. No. 32.—Texture of Mortar Forming Bond on Upper Side of Reinforcing Steel, Bar Removed; 1:2:4 Mix; First Consistency (× 4)

the under surfaces of stones and of the mortar beds under same. The remarks made above relative to 1:2:4 concretes of first and fifth consistencies (Figs. 27 and 28)

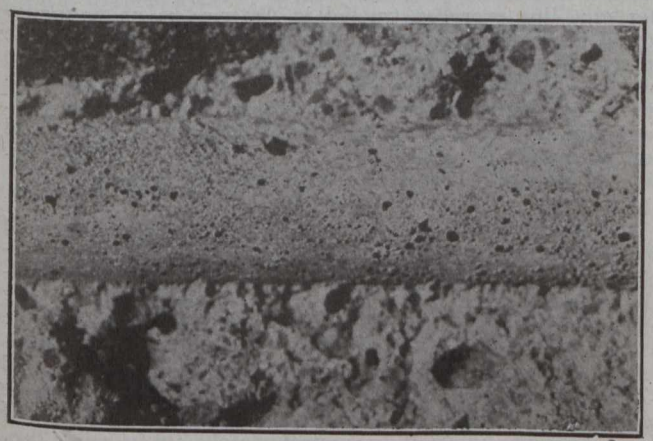
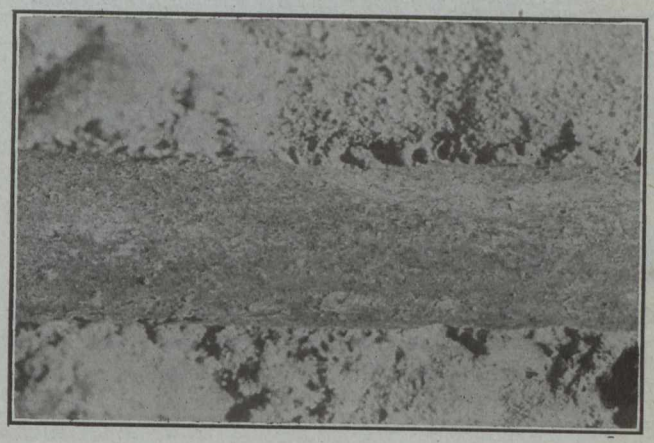


Fig. No. 33.—Texture of Mortar Forming Bond on Under Side of Reinforcing Steel, Bar Removed; 1:2:4 Mix; First Consistency (× 4)

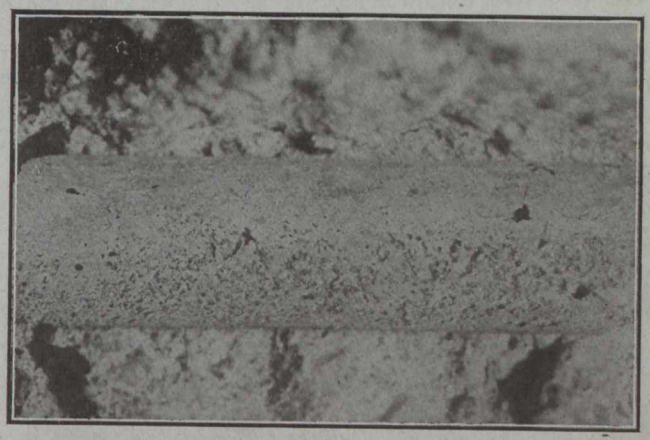
apply here, with the exception that in the case of Fig. 31 the irregular lines upon the mortar bed were apparently produced by currents of water, which washed away a portion of the accumulated laitance, leaving miniature valleys.

In reinforced-concrete construction, practically the same conditions exist as are above described for plain concrete, in so far as consistency of mix is concerned. Figs. 32 to 36, inclusive, illustrate these conditions.

In connection with Figs. 32 to 36, inclusive, it must be borne in mind that the consistencies used for the test beams, contained a somewhat greater quantity of water than did those chosen for plain-concrete test cylinders. All concrete used in beam tests was 1:2:4 mix.



(*a*) Upper side.



(*b*) Under side.

Fig. No. 34.—Texture of Mortar Forming Bond on Upper and Under Sides of Reinforcing Steel, Bar Removed; 1:2:4 Mix; Fifth Consistency (× 4)

Fig 32 shows the texture of the mortar forming the bond upon the top or upper side of the reinforcing steel in concrete of first consistency. The voids, although existing by hundreds, are mere pin-holes. The mortar is gray in color.

Fig. 33 shows for concrete of first consistency, the mortar bedding forming the bond on the under side of the reinforcing steel; although it contains hundreds of minute voids it is nevertheless in close contact with the metal. No cavities are visible.

Fig. 34 shows for concrete of fifth consistency, the appearance of the bedding and the character of the bond attained on the upper and lower sides of the reinforcing steel. Fig. 35 shows to better advantage the condition on the under side of the metal. The water cavities with

the barriers of laitance occupy a considerable percentage of the total bonding area.

Fig. 36 shows the results attained in actual practice. The concrete in the portion of the bridge abutment from which this photograph was taken was known to have been of a sloppy consistency when placed.

Fig. 37 is interesting in that it shows the results of failure by the slipping of the reinforcing steel. The dark areas were produced by a breaking down of the laitance

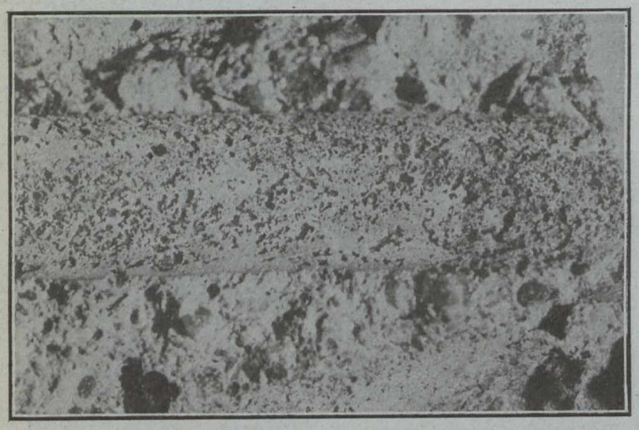


Fig. No. 35.—Texture of Mortar Forming Bond on Under Side of Reinforcing Steel, Bar Removed; 1:2:4 Mix; Fifth Consistency (× 4)

walls or ridges, these surfaces taking a polish as if a lubricant had been applied to them. It is of interest to further note that these polished areas exist only along the sides of the under bedding area, and that along the centre of the bed the water cavities remain undisturbed, indicating that through the hardening of the concrete the centre of the bed may have shrunk from contact with the steel.

Fig. No. 36.—Field-Produced Concrete. Texture of Mortar Forming Bond on Under Side of Reinforcing Steel; 1:2:4 Mix; "Sloppy" Consistency

In the tests for the strengths of reinforced-concrete beams (see Fig. 15), it was found that those of the fourth and fifth consistencies decreased very materially with the increase of age. It appears reasonable to assume that this decrease is produced by changes in the bonding material, whether by changes in shape or by changes tending to decrease its resistance to crushing is not clear.

In connection with the above, it is interesting to note that one of the earliest American investigators in the field

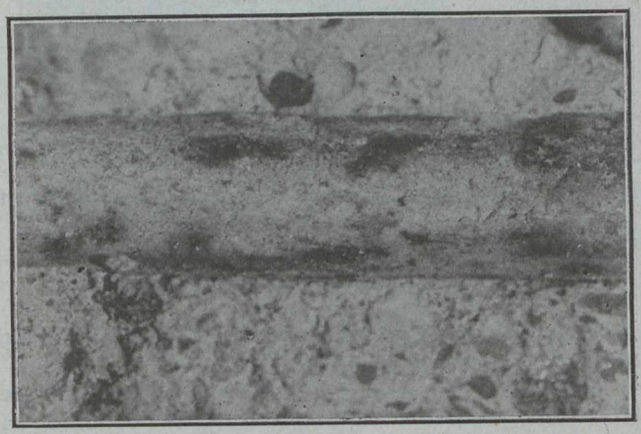


Fig. No. 37.—Dark Areas Indicate Mortar Bond on Reinforcing Steel at Slip. Note Portions of "Laitance" Undisturbed by Slip (× 4)

of concrete construction, Brevet Maj. Genl. Q. A. Gillmore, held the opinion concerning Portland cement that "its most prominent and valuable properties are displayed" when mixing with a quantity of water "capable of producing a semi-fluid or creamy consistency."

(Concluded in the next issue.)

A parallel road system providing two continuous highway routes between New York City and Buffalo, N.Y., passing through the centres of population, is the plan of the New York State Highway Commission, according to a report.

It is reported that a rich Molybdenite mine has been discovered in Nova Scotia. As this metal has increased greatly in value since the war the property has attracted considerable attention in interested circles, several people from the United States having inspected the property to which they were conducted by C. L. Normandin, of Halifax, who is in charge of its affairs.

What is believed to be the largest diameter wooden stave water pipe line ever constructed in America is being manufactured at Seattle for a Pittsburg, Pa., steel company. The pipe will be over two miles in length and twelve feet inside diameter. It will take 100 railroad cars to transport these Douglas fir stave pipes from Puget Sound to Pittsburg, and, in addition, will require 50 cars to haul the steel bands and other equipment necessary for the erection of the pipe line. This will amount to over five train loads of material in the contract.

Twenty-two miles of wood-stave pipe will be a feature of the new water supply for the American town of Everett, Washington. The works, now under construction, consist essentially of a low rock and timber crib diversion dam on the river, approximately 20 miles of 28-in. continuous wood-stave pipe, 5 miles of 28-in. by ¼-in. riveted steel pipe, and 2 miles of 22-in. continuous wood-stave pipe. Wood pipe will be used for heads up to 350 ft., and steel and cast iron pipes are to be used above that head to a maximum of 450 ft. The rate of fall in the pipe line will be approximately 1.5-ft. per 1,000. Wherever possible the wood pipe will be built on cradles above the ground and will be given a protective coating of water-gas tar, followed by a coat of coal-gas tar on those portions of the line where the head is less than the saturation head.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.

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BOOK REVIEWS

Railroad Construction. By Walter Loring Webb, Major, Engineer Officers' Reserve Corps, U.S.A. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. 846 pages, 4¼ x 6¾ ins., 218 figures and 10 plates, flexible binding. Price, $4 net.

[NOTE.—This is not the formal review of Prof. Webb's book, but is a letter from a well-known railroad engineer, who does not desire his name to be quoted. We had sent Mr. Webb's book to him for review. He refused to review it, but wrote the following letter, which contains so many good points that we feel it should be published, even though the writer insists that his name be not mentioned. Prof. Webb's book is now being reviewed by another engineer, who, we regret to say, was unable to have his review completed in time for this issue, but has promised it for our issue of September 27th.—EDITOR.]

"Your letter of August 1st regarding review of Prof. Webb's 'Railroad Construction.' I have read the book, and feel like Mr. Jiggs, of the cartoons, when he bought Dinty Moore's books. I am fully aware that 'tearing down' is easier than 'building up'; therefore, the work of the critic who does nothing but find fault is not a very hard job.

"Personally, I do not believe that one hundredth part of the ground that is covered in this book should be attempted in any book. If I were buying this book I would pay more for it if the material from page 1 to page 610 had been eliminated. You can gather from this that if I should attempt to write a book I would preface it with the remark, 'This book is not intended for use in schools and colleges, nor for the use of axemen who hope to become engineers.'

"The only value that I can see in a work of this kind would be as an index of engineering subjects, and if an engineer wished to get any information on these different subjects he would have to go to up-to-date special works; and, to be serious, the only problems that I really think would be necessary in an engineering field book would be ones that we find in very few books. For instance, one showing how to lay out a wye when the main track is on a curve. Another, how to calculate how much to throw off from a curve to make resultant tangent strike tangent to an adjacent curve. This is a problem that comes up in everyday practice on location, or more particularly when revising line, when a more careful chainage has been made. It is very often found that tangents from adjacent curves do not coincide, although they are parallel to each other. This is the result of poor chaining on rough ground during original location. Another problem would be to put in a cross-over when both main lines are on curve. These are simply a few problems I have worked out in my experience that I did not find in the field books at hand.

"Section 56, Par. (b), Page 64. This is the proper way of keeping notes. The author should have stated that when these notes are calculated and put in a field book they are always available, no matter what position on the curve the transit is located, while in the case under Par. (a) the notes recorded are only good for the position of the transit in that particular case. The author should also have stated, however, that care must be exercised where compound curves or spirals are used, as this method is only true for a simple curve. I have known a case where a graduate engineer thought it was true for a compound curve. You can guess the result.

"Another rather bad feature about this book is the fact that it is entirely out of date. The author evidently brought a few paragraphs up to date, but he left others in exceedingly bad shape. As an instance of this, on page 83 he states: 'Another (and better) rule is to elevate for the speed of the fastest trains.'

"This is not the general practice on the best roads. Most all of our best roads have long ago realized that we were elevating our tracks altogether too high, with the result that we were having altogether too many derailments by slow trains running over the outside rail of a curve. If the track is well constructed, the only possible danger of a wreck from lack of elevation is that the train will tip over, as a train in Canada actually did some years ago, when a freight engineer brought an excursion train over a 11° 30' curve at a speed estimated at between 60 and 65 miles an hour.

"Another glaring example is Sec. 398, page 429. There are very few of us old enough to remember the type of engine herein described as being up-to-date.

"Such statements appearing in a book revised to November, 1916, and published in 1917, would not lend confidence to the student who might have to use such a book. You will note further that when data is given, it is back in the 80's or 90's with a very few exceptions.

"On any subject where there is a difference of opinion between engineers you will note that the author carefully avoids taking any side. To my mind, a teacher, to be convincing, should have ideas of his own and back them up with his arguments.

"If I were buying books for a son who might be studying railway engineering, I would rather that he would take the manual of the American Railway Engineering Association than to have in his library all the books I have ever seen on the subject written by any

single individual, for the reason there is no man living who could have first-hand knowledge of all the subjects that are attempted to be covered in this book. The work in the manual of the American Railway Engineering Association, while some stuff gets through that is not first-class, is the result of experts in their various lines and is up-to-date."

Steam Turbines. By James Ambrose Moyer, S.B., A.M. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. Third edition, 1917. 468 pages, 225 figures, 6 x 9 ins., cloth. Price, $4 net. (Reviewed by R. N. Austin, Turbine Equipment Co., Limited, Toronto.)

Most engineers and students interested in steam turbines have in their possession the first and second editions of Moyer's "Steam Turbines" and those who have not already done so should obtain the third edition of this author's work, as such unprecedented progress has been made in this branch of engineering development that several chapters in the previous edition (1914) do not adequately represent modern practice, and the author has found it necessary to completely re-write several of them. He has also revised and extended most of the others.

These remarks apply in particular to chapter IX. on Low Pressure Turbines, which is now very complete. Also those relating to Extractor and Mixed Pressure Machines. Chapter VII. relating to Commercial Makes has also been re-written, and embodies improvements which have been made during the last few days by all the leading makers.

The chapter on Reaction Turbines deals very thoroughly with the combined impulse and reaction type, which is now being built in America and Europe with very successful results.

Nozzle and blade design, mechanical losses, governing, Marine Turbines and testing are fully covered, and there are also interesting chapters on Steam Turbine economies, Gas Turbines, and Electric Generators for Turbines.

A very useful Entropy-Heat Chart is contained in a folder in the cover of the book.

Engineering for Masonry Dams. By William Pitcher Creager. C.E., M.Am.Soc.C.E. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 250 pages, illustrated, 6 x 9 ins., cloth. Price, $2.50 net. (Reviewed by George R. Heckle, M.Can.Soc.C.E., general manager, Ambursen Hydraulic Construction Co., Montreal.)

This excellent book on the design of masonry dams starts on a chapter on "Investigations for Surveys," dealing with the choice of location and investigation of the foundation conditions, and in eleven succeeding chapters the author covers very completely the various methods and assumptions usually employed in conservative practice in the design of various types of masonry dams.

The largest part of the book is devoted to the design of solid concrete dams of the gravity type on a rock foundation, including both bulkhead and spillway sections. Matters of ice pressure, expansion joints and static wave action are all dealt with.

The design of hollow dams of the "Ambursen" type is particularly well covered in one chapter, and there is also a chapter on the design of masonry arch dams.

It is possibly to be regretted that under the broad title of "Engineering for Masonry Dams" the author has not devoted more space to the subject of cost, and especially economy in choice of type of dam for a given location. From a standpoint of design the book is a distinct addition to present literature on the subject.

Handbook of Clearing and Grubbing Methods and Cost. By H. P. Gillette, M.Am.Soc.C.E. Pubilshed by the Clark Book Co., Inc., New York, 1917. 232 pages, 67 illustrations, 5 x 7¼ ins., leatherette. Price, $2.50 net. (Reviewed by H. M. Anderson, McAuslan & Anderson, Engineers and Surveyors, North Bay.)

The author, in the above book, has contributed to the engineering fraternity a very concise and readable reference of tried methods, which deal with a class of work which is one of the most important parts of the contracting field as pertaining to works carried forward in bush or semi-bush country.

The work of land-clearing is well-nigh a transcontinental problem to Canada. Whether from the standpoint of farming, road, railroad or hydraulic construction, the removal of trees and stumps, save in a portion of our south middle-west, forms a very formidable and costly part of all constructive work.

One would, therefore, quite naturally expect that there would at least be plenty, if not an abundance, of booked information on so important a subject. Such is, however, not the case; and, by careful compilation of numerous departmental issued bulletins, and from observations carried out under his own supervision, Mr. Gillette has produced a very valuable reference pertaining to this subject.

Some of the methods detailed are, in many cases, new to the eastern section of Canada, and in one or two cases are novel, I believe, to the large fir forests of British Columbia. The work should fill a long-felt want along the lines it references, and should find a place in the libraries of those engineers who have occasion to carry forward works which include land preparation.

Mechanical Equipment of Buildings. Volume II. By L. A. Harding, B.S.M.E., and A. C. Willard, S.B. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 766 pages, illustrated, 7 x 9¼ ins., flexible binding. Price, $5 net. (Reviewed by H. H. Angus, B.A.Sc., Toronto.)

This is the second of a series of three volumes by the above writers. All three volumes deal with the mechanical equipment of buildings, and, as pointed out in the review of Volume I., the work is by far the most complete so far undertaken along this line. The first volume dealt with heating and ventilation of buildings; the second deals with power plants and refrigeration, while the third volume will deal with elevators, lighting sysetms, sprinklers and plumbing. The work forms a reference book for engineers, and all available sources of information relating to this field of engineering have been drawn upon, so that the work is on a comprehensive scale.

The present volume is devoted to power plants and refrigeration, but some of the matter published in the first volume has been included in this book also in order to make the work complete in itself. The book is well supplied with illustrations, and the use of the various

formulas used is explained by concrete examples. There are also numerous tables useful in this kind of work.

After going into the properties of water, steam and air, the construction and setting of boilers is discussed. The new rules of the A.S.M.E. regarding boiler construction and installation are included, and the smokeless setting of boilers and stoker installations are gone into thoroughly. One chapter is devoted to superheaters and economizers and another to chimneys.

Following this comes a discussion of the various types of steam engines, turbines and condensers, giving sizes, types and efficiencies of the various kinds. In close relation to this are the chapters devoted to arrangement and piping in power plants; also a chapter devoted to coal and ash-handling machinery, which gives some valuable reference information. Data on the cost of operation of different plants concludes the section of the book devoted to power plants.

The remaining part of the book is devoted to refrigeration. This part of the book is not so complete as the power plant section, but contains data on heat transmission through walls, methods of refrigeration, brine circulation systems and ice manufacturing plants.

It is safe to say that the present volume comes up to the same high standard which the authors set in the first volume.

American Hydro-Electric Practice. By Capt. William T. Taylor and Daniel H. Braymer, A.B., E.E. Published by McGraw-Hill Book Co., Inc., New York. First edition, 1917. 439 pages, 79 tables, 257 figures, cloth. Price, $5 net. (Reviewed by T. H. Hogg, Hydro-Electric Power Commission of Ontario, Toronto.)

This volume is a compilation of data and information on the design, construction and operation of hydro-electric systems.

Chapter I. General Survey of Water-power Engineering, thirty-six pages in length, covering the hydraulics of hydro-electric design, gives in a most cursory manner certain methods used in determining the safe capacity to install at any site, proper line design, characteristics of water-wheels and their selection, and speed variations of water-wheels, with a few words on steam load characteristics.

Chapter II. Low, Medium and High-head Developments, gives very complete descriptions of thirty-nine modern plants of different characteristics. This chapter covers about twenty-five per cent. of the volume.

Chapter III. Layout and Selection of Plant Equipment covers in a concise manner station design from the electrical standpoint entirely, including the low and high-tension switching, and also outdoor equipment.

Chapter IV. Transmission Line Construction and Operation. The title of this chapter is self-explanatory. The costs of different types of construction are discussed, and the design of the lines, with numerous curves for the determination of conductor sag and stresses, are given.

Chapter V. is a chapter on costs, in which the economics of plant, line and substation are discussed. Considerable space is given to the economics of small outdoor substations.

Chapter VI. deals with system operation and economics, mainly from the standpoint of transmission line effects on the station.

Chapter VII. Special Plant and Line Problems. In this chapter are grouped discussions of bus structures, outdoor substation design, high-tension fuse and switch operation, transmission line conductors, insulator selection and testing, telephone troubles and special protection schemes.

Chapter VIII. is a compilation of data, reference tables and system diagrams, together with a bibliography of construction and operation of transmission systems.

The fact that only thirty-six pages of the book are devoted to the purely hydraulic end of hydro-electric design indicates that this is a volume for the electrical engineer rather than the hydraulic engineer. This impression is borne out by a careful reading of the volume. The hydraulic information included is very indefinite in its application, and will probably do more harm than the service it renders. It would have been better to have left out the first chapter entirely and devoted the treatise entirely to the electrical side of the problem, since this side is very well treated in the available space.

Probably the most valuable part of the volume is the second chapter, with its descriptions of recent installations, compiled from recent publications.

This book should be of service to the student or practising engineer who desires to study or keep in touch with recent practice as shown by modern installations.

The Engineers' Manual. By Ralph G. Hudson, S.B., assisted by Joseph Lipka, Ph.D., Howard B. Luther, S.B., and Dean Peabody. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 310 pages, 5 x 7¾ ins., 227 figures, flexible leather cover. Price, $2 net. (Reviewed by T. H. Hogg, Hydro-Electric Power Commission of Ontario, Toronto.)

This manual comprises a consolidation of the formulas and constants of mathematics, mechanics, hydraulics, heat and electricity. The application of each formula is given in the form of a concise statement accompanying the formula, but without the process of its derivation. The author states that the aim throughout has been to enable the user of the volume to obtain results quickly and accurately, even in a branch of engineering to which he can give little attention.

This little volume should prove invaluable to the practising engineer as a time-saver and as an aid to the memory.

Hudson's "Manual of Mathematics," the text of which, as a whole, is taken from the Mathematical Section of "The Engineers' Manual," in which are consolidated the pricipal furmulas and tables of Mathematics, Mechanics, Hydraulics, Heat and Electricity, is published separately, the price being $1.

PUBLICATIONS RECEIVED.

City of North Vancouver, B.C.—Annual report for the year 1916.

The Toronto Hydro-Electric System.—Sixth annual report, 1916.

Winnipeg, Man.—Annual report for 1916 of the Public Works Department.

Topographical Surveys Branch, Department of the Interior, Ottawa. Annual report, 1915-16.

Canadian Society of Civil Engineers.—Transactions of the Society from October to December, 1916.

Quebec Public Utilities Commission.—Seventh annual report for the year ending June 30th, 1916.

City of Halifax, N.S.—Report of the city engineer for the civic years, 1913-14, 1914-15 and 1915-16.

Report on the Main Drainage and Sewage Disposal. of the area tributary to Jamaica Bay, city of New York.

City of Worcester, Mass.—Annual report of the Street Commissioner for the year ending November 30th, 1916.

Specifications for Bituminous Materials.—Publication No. 24. Issued by the Ontario Department of Pubilc Highways.

University of Pennsylvania Engineering Alumni Society.—By-laws, annual report and list of members, April, 1917.

The Value of Peat Fuel for the Generation of Steam.—By John Blizard, B.Sc. Bulletin No. 17, Department of Mines, Canada.

Sun Oils.—Volume VII. Marine number. Illustrated booklet. Issued by the Sun Co., 1428 South Penn Square, Philadelphia.

The Drainage of Irrigated Farms.—By R. A. Hart, senior drainage engineer. Bulletin No. 805, Department of Agriculture, Washington, D.C.

Mining Operations for Gold, Coal, etc., in the Province of British Columbia.—Annual report of the Minister of Mines for the year ending December 31st, 1916.

American Wood-Preservers' Association.—Report of proceedings of the thirteenth annual meeting, held in New York City, January 23rd, 24th and 25th, 1917.

Geology of a Portion of the Flathead Coal Area of British Columbia.—By J. D. MacKenzie. Memoir 87, Geological Series No. 73, Department of Mines, Ottawa.

Permissible Explosives, Tested Prior to January 1st, 1917.—By Spencer P. Howell. Technical Paper 169. Issued by the Bureau of Mines, Department of the Interior, Washington, D.C.

Occurrence and Mitigation of Injurious Dusts in Steel Works.—By J. A. Watkins. Technical Paper 153. Issued by the Bureau of Mines, Department of the Interior, Washington, D.C.

Recent Construction Work.—A 16-page booklet, 6 x 9 ins. Issued by Ford, Bacon & Davis, consulting engineers, New York, descriptive of double-deck wharf house bulit at Galveston, Texas.

Properties of the Calcium Silicates and Calcium Aluminate Occurring in Normal Portland Cement.—By P H. Bates and A. A. Klein. Technologic Paper No. 78 of the Bureau of Standards, Washington, D.C.

Strength and Other Properties of Concretes as Affected by Materials and Methods of Preparation.—By R. J. Wig, G. M. Williams and E. R. Gates. Technologic Paper No. 58 of the Bureau of Standards, Washington, D.C.

The Mining Industry in the Territory of Alaska during the Calendar Year, 1915.—By Sumner S. Smith, United States mine inspector for Alaska. Bulletin No. 142, Bureau of Mines, Department of the Interior, Washington, D.C.

Photomicrographic Apparatus.—Twenty-three-page booklet. Issued by Sauveur & Boylston, metallurgical engineers, Cambridge, Mass., giving descriptions, illustrations and prices of their different types of photomicrographic apparatus.

Elevator Map of Manitoba, Saskatchewan and Alberta. Shows location and capacity of elevators throughout the three Prairie Provinces. 1917 edition. Issued by the Natural Resources Intelligence Branch, Department of the Interior, Canada.

Limits of Complete Inflammability of Mixtures of Mine Gases and of Industrial Gases with Air.—By George A. Burrell and Alfred W. Gauger. Technical Paper 150. Issued by the Bureau of Mines, Department of the Interior, Washington, D.C.

Street Railway Negative Return System for the Mitigation of Electrolysis.—By L. A. Herdt, M.Can. Soc.C.E., and E. G. Burr, A.M.Can.Soc.C.E. Paper read before a sectional meeting of the Canadian Society of Civil Engineers, April 19th, 1917.

Boiler-House Elevators.—A well-illustrated 30-page booklet, size, 7 x 9½ ins., distributed by Ed. Bennis & Co., Limited, 28 Victoria Street, Westminster, London, S.W. 1, England, illustrating and describing a number of Bennis labor-saving devices for boiler-houses.

The Mining Industry in that Part of Northern Ontario Served by the Temiskaming and Northern Ontario Railway.—By Arthur A. Cole, mining engineer. Appendix to the annual report of the Temiskaming and Northern Ontario Railway Commission for the calendar year, 1916.

Vulcan.—No. 1, Vol. I., of a new house organ. Published by the Vulcan Steel Products Co., of New York. Devoted to steel export trade. Printed in three colors, 9 x 12 ins., 16 pages. This issue contains an article on the history of steel-making and an article on trade with Brazil.

Problems of St. Louis.—A description, from the city planning standpoint, of past and present tendencies of growth, with general suggestions for impending issues and necessary future improvements. By Harland Bartholomew, engineer. Issued by the City Plan Commission, St. Louis, Mo.

Specifications for Bituminous Materials.—An eight-page pamphlet, 6 x 9 ins. Published by the Department of Public Highways, Parliament Buildings, Toronto, and containing specifications for light, medium and heavy asphaltic road oils, asphalt binders, refined coal tar binders, and refined coal tars, cold and hot application.

Concrete Ships.—Thirty-six-page booklet, 6 x 9 ins., distributed free by the Portland Cement Association, 111 West Washington Street, Chicago. Contains photographs and drawings of various types of concrete ships in successful use, including the barge "Pioneer," used in the Welland Canal. Reviews the history of concrete shipbuilding, costs, merits, etc. Brief bibliography on the subject.

Concrete Roads.—Thirty-page report, 5½ x 8½ ins. Published by St. Bride's Press, Limited, London, England. Price, 6d. By H. Percy Boulnois, formerly city engineer of Liverpool, and past-president of the Institute of Municipal and County Engineers. Report reviews the present position and future of concrete roads in England. Was prepared under the direction of the Road Improvement Association. It also reviews United States and Canadian methods of concrete road-building.

Bituminous Surfaces for Macadam Roads.—Twenty-two-page and cover booklet, 6 x 9 ins. Issued by the Department of Public Highways, Parliament Buildings, Toronto, reviewing the selection of bituminous materials and the methods of testing. The author is G. Cameron Parker, M.A.Sc., assistant engineer of the department. Fourteen of the most prominent tests for determining quality of bitumious materials are described in detail, and the necessary apparatus for the tests is illustrated.

Editorials

THE DOMINION RAILWAY SYSTEM

During debate on the Canadian Northern legislation, Sir Thomas White announced last week in the House of Commons that the issue, in his opinion, is public ownership. According to the report published in the Toronto Mail and Empire, he said that the government "in the very near future, would take over the Grand Trunk Pacific and probably the old Grand Trunk as well."

This announcement, if the report is correct, is of the greatest importance. When the C.N.R. bill was first introduced, speeches on the government side clearly indicated a fixed decision never to take over the old G.T.R. system, but to relieve that system of the G.T.P. at a later date. But the idea of taking over the G.T.R. is apparently gaining ground with the government.

Were Sir Thomas White to go just one step further, and announce a definite decision to introduce future legislation looking toward the acquisition of the G.T.R., the country would be reassured that the purchase of the C.N.R. would then have a chance to become a profitable venture, even though as much as par were to be paid for the capital stock. Merged with the Grand Trunk, the C.N.R. would be a splendid railway system, capable of giving the C.P.R. competition of a sort which that well-managed road has never yet experienced, and capable of serving the public of Canada as they have never yet been served.

Without the benefit of the G.T.R. facilities, the C.N.R. is a "lame duck." It straddles the country from the Atlantic to the Pacific, but it has one "game leg." It needs the G.T.R. feeders in the east in order to stand firmly upon both feet.

The Dominion Railway system outlined and recommended in the Drayton-Acworth report may yet come to pass. It will be remembered that the merger of the C.N.R. and the G.T.R. systems has also been strongly recommended by W. F. Tye and other railway experts.

THE PLEDGEES OF THE STOCK

Much of the criticism of the C.N.R. bill, by the opposition in parliament, has been levelled at the "unknown pledgees." There has been insistent demand for the names of the pledgees and detailed information regarding their interest in the bill. Sir Thomas White last week stated that $51,000,000 of the $60,000,000 capital stock owned by Mackenzie & Mann and their associates, is now pledged to the Canadian Bank of Commerce, along with other securities, as collateral for advances.

This announcement lets light into many corners that have been dark until now. It is an announcement which should have been made by the government at the time the legislation was introduced. The government has apparently been unduly cautious in regard to the information given out concerning the C.N.R. bill. It assured the members of parliament, from the time the bill was first introduced, that the owners or pledgees of 51 per cent. of the capital stock had offered to turn their stock over to the government, but it refused to tell who were these owners or pledgees. As a result, most people thought that Mackenzie & Mann and their direct associates had voluntarily offered to sell out to the government, and the natural inference was that Mackenzie & Mann must have felt assured of the result of the arbitration.

The fact which now comes out, that the Canadian Bank of Commerce, as pledgees of 51 per cent. of the stock, is the instrument through which the government is to secure control of that amount of stock, places a different aspect upon the financial end of the situation. Mackenzie & Mann have unofficially protested right along that they do not want the road taken over by the government, and now one can believe that their protest is sincere. It appears, upon the surface at least, as if the Canadian Bank of Commerce had decided to make the best bargain they can in regard to the sale of the stock, probably having failed to collect their loans to the C.N.R. or Mackenzie & Mann.

If this be true, the public will accept the situation with much greater equanimity, as the Canadian Bank of Commerce would probably secure, in whole or in part, the repayment of its advances from the award of the arbitrators, while possibly little or nothing might be left for Mackenzie & Mann. No one desires to see the Canadian Bank of Commerce sustain any loss as a result of its support of the C.N.R. venture. If parliament is disposed to show any consideration toward Mackenzie & Mann, even more consideration should be shown to the bank that has been financing them. It is undoubtedly to the interest of the country that the Canadian Bank of Commerce advances be repaid in full, and there is possibly no better way of doing this than by arbitration of the value of the stock which the bank holds as collateral.

At the same time, neither Mackenzie & Mann nor the Canadian Bank of Commerce should expect to cut a melon. We would again urge that some definite limit be placed by parliament as the maximum possible award by the arbitrators without further ratification by parliament.

A TECHNICAL DISABILITY

George Stephenson, after the ordeal of his appearance before a Parliamentary Committee in the early days of railways, felt himself beaten and stalled by the very clever individuals who cross-examined. They smashed to atoms the life experience of this great pioneer of steam, and pulverized his testimony, proving indeed that the facts within his knowledge were absurd; making it plain that these facts did not exist, and that a railroad was totally different from anything that Stephenson knew.

For ever afterwards Stephenson was convinced that the greatest power on earth was not steam, but "hot air." Most technicians in similar case feel the same; their executive powers very rarely aid them in the presentation of facts within their knowledge when before laymen. Expert training in engineering matters does not avail very much; the very commonest terms in daily use, universally understood in the profession, simply mystify a normal

committee or tribunal. The engineer is reduced to impotence even when the facts are in his favor, by the need for clothing his thoughts in a garb that will be recognized by the uninitiated.

It is difficult to bridge the gulf which separates the mysteries of craftsmanship and the simple commonsense of an outsider willing to be enlightened. The wish to understand and the desire to impart knowledge does not serve to give comprehension.

For reasons of this kind editors of daily newspapers do not send experts to elicit information and write up technical matters. If the specifically trained man be selected, it is most probable that his account will be unintelligible to the average reader. No matter how he tries to simplify his material, the expert cannot divest himself,—save in very exceptional cases,—of his technical language.

Until, therefore, the engineer can divest himself of technicality upon occasion, or until the general public become more scientifically minded, there is little real hope of genuine understanding between them.

Some of the greatest scientists have had the happy faculty of making abstruse theory clear to the average man. Sir Robert Ball is an instance in point. Kelvin stated that he never believed in the most promising theory until he had made a model to illustrate it in the simplest manner. He even went so far as to state that unless a model could be constructed, he was inclined to the belief that the theory was untenable.

The first step toward the engineer taking his proper place in public affairs is that the general populace should have some real understanding of his work. If the engineer is ever to become a focal point for popular vision, he must cultivate popular comprehension; he needs to adjust his view-point from the particular to the general.

For many reasons it is desirable that the engineer should bulk more largely in public affairs. One reason why he does not is outlined above; it is undue insistence upon exact technicality.

Try to explain to a child of seven,—and permit cross-examination,—some engineering device or abstruse theory. Try to reduce to the child's comprehension some natural law underlying practice. It will reveal how far one has travelled in a technical sense. The attempt is worth making and the result will prove the hopelessness of mere technical explanation.

PERSONALS

Hon. Robert Rogers, Minister of Public Works, Dominion Government, has resigned.

L. A. Pardo, Chatham, has been appointed superintendent of good roads for Kent County.

B. W. Knowles has succeeded W. Sampson as superintendent of the Nickel Plate mine, Hedley, B.C.

Howard G. Kelley, M.Can.Soc.C.E., has been appointed president of the Grand Trunk Railway, vice E. J. Chamberlin, resigned.

Colonel William F. Morse, consulting sanitary engineer of New York City, recently visited Toronto and inspected the Don incinerator.

George Scott has been appointed superintendent of the Moncton Tramways, Electricity and Gas Company, succeeding A. B. Coryell, who has resigned.

R. L. Davis, Buffalo, general superintendent for the Southern Ontario Gas Company, was in London recently to discuss the natural gas situation with the utilities commission.

W. E. Segsworth, mining engineer, Toronto, has been appointed by S. A. Armstrong, director of the military hospitals commission, as his assistant in the vocational training department.

R. B. Bennetts, of Tacoma, has been appointed consulting engineer for the Ladysmith Smelting Corporation. He will supervise the installation of a copper converter plant at Ladysmith, B.C.

J. D. Murray, superintendent of the Alberta and Great Western Railway, is confined to the General Hospital, Edmonton, as the result of a motor accident. His condition is considered serious.

W. G. Ross, chairman of Montreal Harbor Commission, has been presented with a special decoration by the Navy League in recognition of valuable services on behalf of the naval service and Navy League.

Prof. John C. McLennan, University of Toronto, chairman of the Industrial Research Commission, has been honored by His Majesty by being appointed an officer of the newly founded Order of the British Empire.

R. M. Halfpenny, superintendent, and W. Jackson, assistant, chief engineer, of the Edmonton, Dunvegan and B.C. Railway, have retired, and were tendered a banquet by forty members of the staff at the Phœnix Cafe, Edmonton.

A. T. Perrin, assistant chief draughtsman of the Dominion Bridge Co., of Lachine, P.Q., has resigned his position to become manager of the Iberville, P.Q., plant of the Rapid Tool & Machine Co., the head offices of which are located at Lachine, P.Q.

Alfred E. Forstall, consulting gas engineer of New York, has been appointed by P. A. Macdonald, public utilities commissioner of Winnipeg, to investigate the conditions that prevail in the gas industry in Winnipeg with a view of fixing a standard rate for gas.

Arthur J. Farnsworth has been engaged by the Taylor Engineering Company, Vancouver, to conduct a research department in connection with the works of that firm. Mr. Farnsworth has occupied several posts at industrial power plants in Eastern Canada, and was for a time on the staff of the New York firm of engineers, Stone and Webster.

W. F. Tye and N. Cauchon, the consulting engineers who reported to Hamilton on railway entrances, addressed a representative gathering of citizens at a luncheon held last week in Hamilton. By means of lantern slides, the engineers explained the scheme which they recommend, and it was endorsed by those present, including members of the City Council, the Board of Trade, Rotary Club, Manufacturers' Association and other organizations.

Lieut. Frank Steers, son of Mr. C. J. Steers of the Department of the Interior, Ottawa, has been wounded in the recent fighting. He was educated at Toronto University, but before being graduated left for the Canadian Northwest to do surveying for the Dominion government. He latterly was in the employ of the Department of the Interior in Ottawa. He was given a commission in the Canadian Engineers Training Depot at St. Johns, P.Q., and went overseas last fall.