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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Heavy Steel Highway Bridging at the Front

Four General Types Used by the British Army in France for Spans Greater Than 30 Ft.—Inglis, 60-Ft., 85-Ft. and Hopkins Types—Loads, Foundations, Details of Design and Novel Methods of Launching

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IN the following brief record of the methods and types of spans used for highway bridges by the British Army during the recent great war, no attempt is made either to discuss standard-gauge railway spans or to take up in detail the very first bridges erected after an advance—namely, the infantry barrel-pier footbridges and the pontoon bridges used by the first-line transport.

The subject to be discussed may be called "Heavy Highway Bridging" for loads starting with the standard three-ton-capacity lorry and reaching their limit in the modern tank. The loads and methods are those of the British "G.H.Q. Heavy Bridging School," which, during the course of the war, in the winter months only, gave a series of courses of from two to three weeks' duration, to officers and others of the Royal Engineers and colonial engineering units who had already received all the usual technical training in light bridging and who had also received a fair share of "battle training."

The bridging school, under Lt.-Col. Robinson, with its supply base at Havre, was organized on the assumption that the Germans would fight a strong rearguard action from the Ypres-Amiens line clear back to the Rhine, destroying all bridges and communications on the way. Records and plans were obtained and kept of all bridges constructed before the war in Belgium and North-east France, and enough material was stocked at Havre to replace the bridges most essential for the re-establishment of communications. Actually, the destructiveness of the Germans ceased near Mons and the destroyed gap was only about 60 miles in width.

Loads

Following is the classification of bridges by loads from the AA class, which carried tanks, to the H class, which carried infantry in single file:—

Class AA—Crowded 30-ton tanks.
" A—17-ton axle loads at 15-ft. centres, or whippet tanks.
" B—Caterpillars at 11 tons.
" C—Foden 5-ton-capacity steam lorries.
" D—3-ton lorries, 60-pdr. guns.

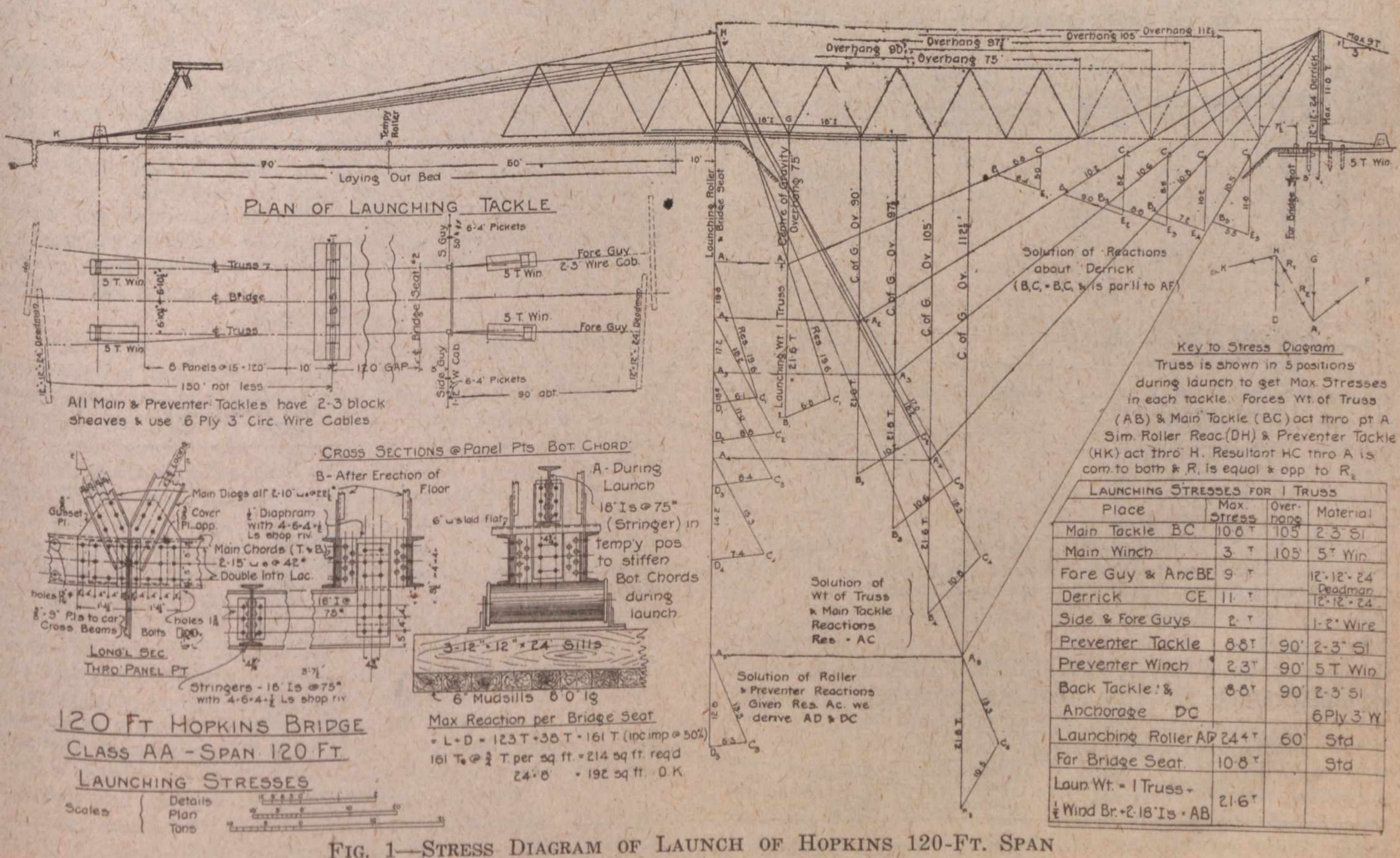


FIG. 1—STRESS DIAGRAM OF LAUNCH OF HOPKINS 120-FT. SPAN

Class E—Field guns (3-in. and 4.5-in. howitzers), and all horse-drawn vehicles.
" F—Infantry in file, pack mules.
" G—Cavalry, dismounted, single file.
" H—Single file infantry.

[NOTE.—Ordinary pontoons were of Class E only. All guns would go on Class B, except a 6-in. British long (naval). The Inglis bridge was rarely used for over a Class C. load.]

Tanks, of course, were in a class by themselves, but a "heavy" bridge was usually of at least B class and thus could carry all other highway traffic loads such as steam rollers and dismantled heavy howitzers, the tractors of which imposed an axle load up to about 13 tons.

The tank was regarded as having its load of 30 tons distributed over a length of 4 ft. and its "sponsons" for its 6-pounders, or machine guns, projected to a total width of 12 ft. 9 ins., which was much in excess of the standard clearance width of 11 ft. 6 ins. It was, therefore, frequently necessary for a tank to draw in its sponsons in order to cross a bridge, and so be delayed for several hours. The standard height clearance was 12 ft. 6 ins., which was close enough to compel passengers to descend from the second story of the London busses so often seen at the front.

Foundations

All spans were of steel, with close fitting bolt connections. These bolts were 1¼ ins. or 1⁵⁄₁₆-in. diameter of shaft, with a threaded end of 1⅛ ins. or 1³⁄₁₆ ins. respectively, which both ensured tightness and also minimized danger of stripping bolt threads.

The foundations normally were simply timber mudsills and one to three 12 by 12-in. timber bridge seats for abutments on dry firm soil. For piers it was often necessary to construct pile trestles. The loading on mudsills was kept down to about ¾ ton per sq. ft., and care was taken to keep the toe of the mudsill at crest within a 1 to 1 slope to water level.

The bridge rollers on the larger spans were about 3 by 4 ft. on their base, giving a good bearing area on bridge seats, and the latter were figured as beams with trusses causing two downward concentrated loads, and mudsills causing a distributed upward reaction. Each 12 by 12-in. bridge seat was continuous under both trusses in order to avoid unequal settlement.

In certain cases such as when a canal with a tow path was being bridged, cribs were built of steel cubes, with 4-ft. face, of light angles. These cribs were not allowed to exceed 12 ft. in height and could not be used to advantage in midstream.

Piling was often done with man or horse power lifting a 1,500-lb. monkey on the formula:—

Bearing strength of pile = $[(\text{Fall of M, in ft.})^{1/3} \times (\text{Wt. of M, in cwt.}) \times \frac{1}{2}] \div [1 + (\text{set of last blow, in ins.})]$

It was found that working outwards from the shore was very slow, and it was often possible to use the bridging pontoons as rafts and to drive from them. For a pile-bent trestle it was then possible to construct the whole bridge of pontoons and to drive a bent between each pair of close-lashed pontoons.

Four Types of Bridges

Four general types of bridges were used for spans of over 30 ft. (Below this size merely enough rolled steel

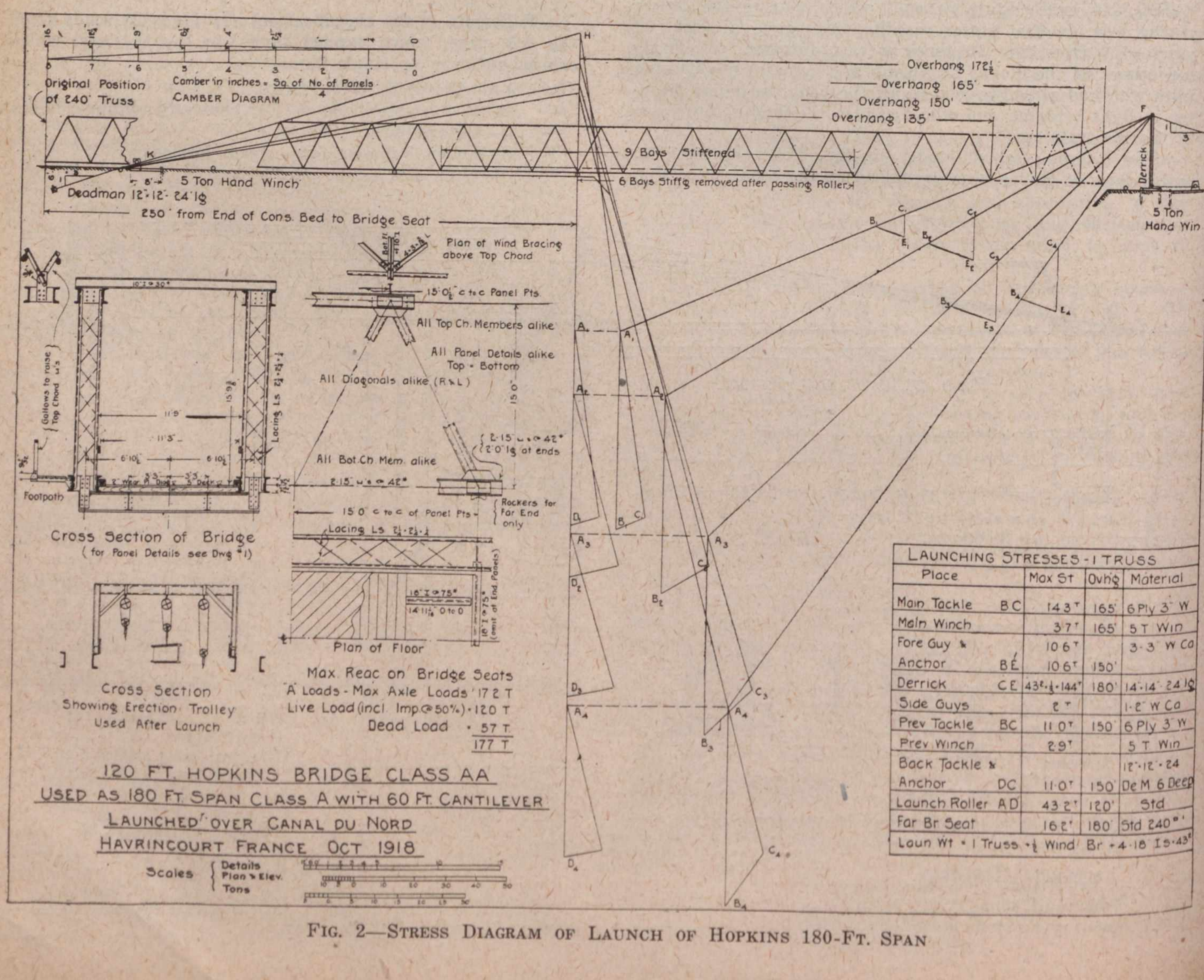


FIG. 2—STRESS DIAGRAM OF LAUNCH OF HOPKINS 180-FT. SPAN

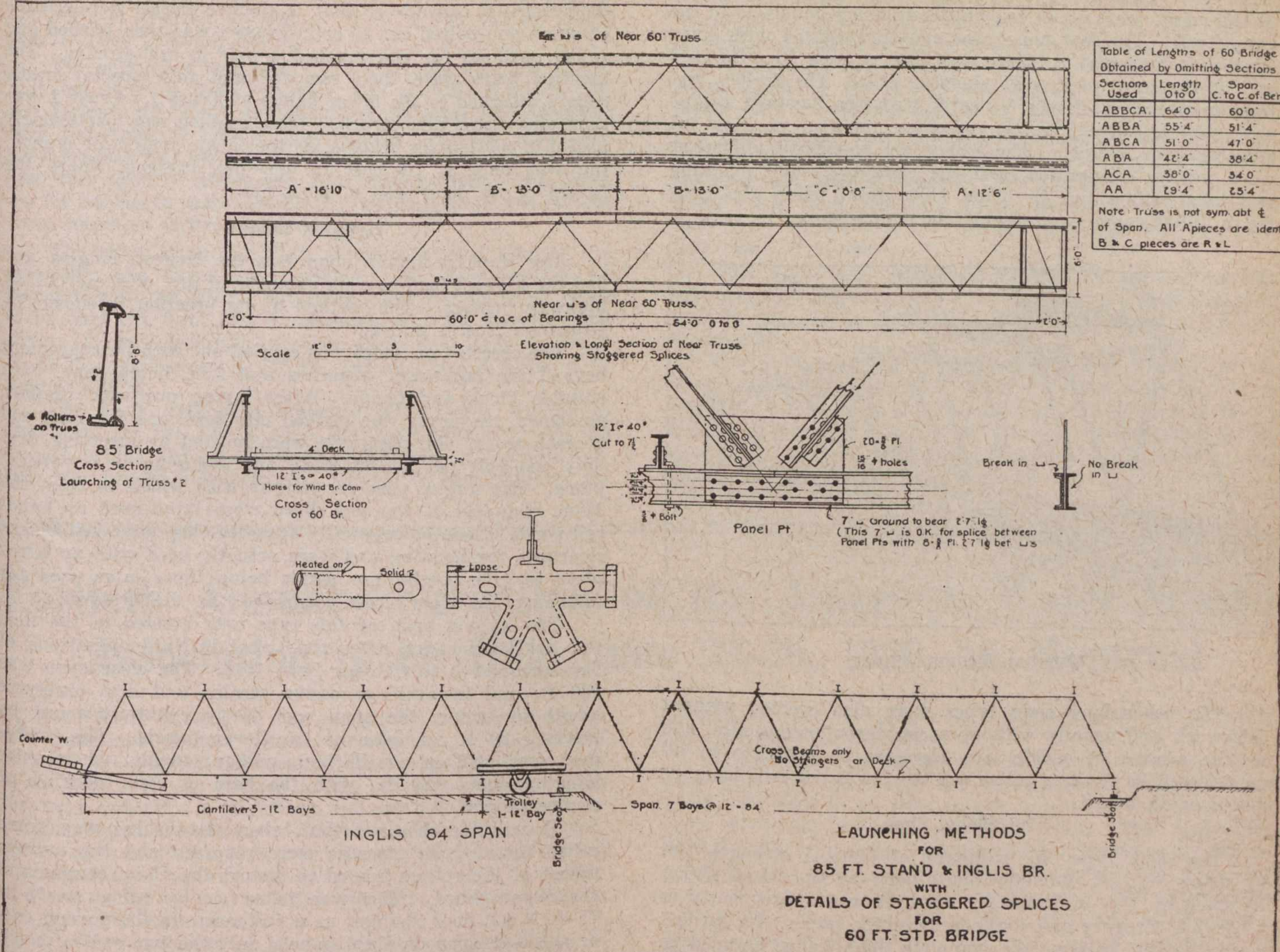


FIG. 3—ERECTION AND LAUNCHING DETAILS OF 60-FT., 85-FT. AND INGLIS BRIDGES

joists—or R.S.J.'s were used to make up the necessary span and strength.) Of these four general types, two—the Hopkins and Inglis—are through bridges, and the other two are known as the 60-ft. and 85-ft. spans. The two latter were half deck if used in one position, or deck type if inverted. All these bridges could be varied in length, below the maximum for which they were designed, simply by omitting sections. No field riveting was done, close fitting 1¼-in. diameter black bolts being normally used, and large pins in the Inglis.

Inglis Bridge

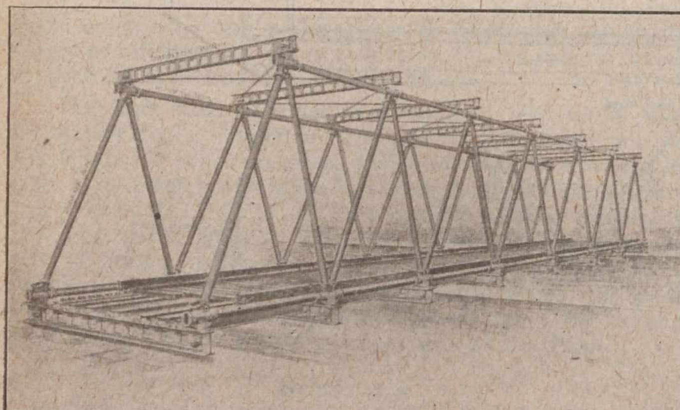
The Inglis was originally designed with a triangular cross-section and only a single top chord, but that proved inefficient, and the later Inglis type was rectangular in cross-section. In the Inglis bridge (See Drawing No. 3), the cross-beams, both ledgers and transoms, were R.S.J. sections, with four sockets in the vertical plane at each of their ends. These sockets were pierced by heavy cross pins. The members of the trusses were heavy steel 5-in. pipes, with solid projecting ends pierced by cross holes. These truss members were slipped into the sockets on the transoms and ledgers, and the cross pins inserted. The holes, however, were slotted, so there was way to take up, and a screw sleeve on the bars was turned to prevent movement.

The Inglis bridge was designed in identical 12-ft. panels and made a series of equilateral triangles of the Warren type. Its great advantages were (1) speed of its erection, and (2) portability. It was often used for a week or two until a heavier bridge was erected alongside, when it was dismantled and shipped by lorry further forward.

The well-known picture, "Canadians Bridging Canal du Nord, Arras-Cambrai Road, September 28th, 1918," shows an Inglis bridge in use on the centre line of the highway. Later, two Hopkins bridges were erected on a diversion site close alongside. This Inglis bridge was good only for a Class C load of 8 tons per axle at a span of 120 ft., but it was good for a Class A load of 17 tons per axle at 72 ft. The span was about 108 ft., but the original civilian girder bridge had been dropped bodily into the shallow water directly beneath, and on the visible few inches of its top chord, a crib had been erected to support the Inglis bridge, and therefore, with a maximum span of, say, 60 ft., it could have been used for any British gun, but not for tanks.

The history of its erection is briefly this: The canal was crossed at 5 a.m., September 27th, on a dry portion about three miles south of the highway. The attacking Canadians then passed north and consolidated on the far side at approximately 8 a.m. Barrel-pier and pontoon bridges were rapidly thrown over, and by noon our field artillery were fully two miles in advance of the canal. The erection of the Inglis was commenced about noon. In addition to its true nine spans, this length required a counterweight of six more spans, in addition to a "trolley" span (in the centre) which acted as a carriage for the progression of the whole in launching. The 16 spans were not completed until dark, and as it was unwise to use lights owing to hostile aircraft, the launching was postponed until dawn. The bridge was in commission about 11 a.m., September 28th, and was used for several weeks.

The method of launching the Inglis was slightly different from that of launching the other types. All spans over 30 ft. were built on shore and launched without falsework in the river, but this type had a two-wheeled trolley, secured by jacks, just back of its rear "bridge seat." Back of this again were about two-thirds as many panels as in the span itself. The last panel was counterweighted with some of the decking and a small live load of men, the forward end of the bridge being in skeleton only. The trolley was then manhandled slowly forward, with the forward bridge seat slightly raised, and on reaching its final position the structure was lowered. The trolley and counterweight spans were rapidly dismantled, and the stringers, solid planking and hand-railing put in place. The total labor allowance for a 120-ft. span was about 2,000 man-hours.



TYPICAL INGLIS BRIDGE

The other long span types were also erected without falsework and usually without a counterbalancing arm, and as the system of tackle was identical in principle in all spans over 30 ft. to a maximum of 180 ft., it will later be discussed in detail.

The 60-Ft. Span

The 60-ft. type was originally of Class A strength, but by using $1\frac{5}{16}$-in. diameter black bolts at the panel points in place of $1\frac{3}{16}$-in. diameter bolts, it was subsequently in Class AA category and could carry single tanks. Its girders were Warren trusses, the complete span being shipped in five pieces per truss—namely, 2A, 2B and 1C (see Drawing No. 3), all joints being staggered, only a single 7-in. channel and 8 by ⅝-in. plate being needed at each splice. Each main member was composed of two 8-in. channels.

By the omission at will of any of the B or C pieces, the overall length of 64 ft. could be reduced to 55 ft. 4 ins., 51 ft. 0 ins., 42 ft. 4 ins., 38 ft. 0 ins. or 29 ft. 4 ins. as required.

The cross-beams, consisting of 12-in. I's at 40 lbs., were spaced in pairs between (but close to) the panel points, and had their depth at ends reduced to 7½ ins. to avoid fouling diagonals. They were bolted by their angles through the vertical centre line of trusses, and wind-bracing flats were bolted to their lower flanges. Five of them extended far enough beyond trusses to allow lateral vertical braces against upsetting of trusses.

The 4-in. decking was laid longitudinally and flared out for 4 ft. at 30 degs. at end of trusses, in the usual way, to join a graded earth roadway.

The 85-Ft. Span

The 85-ft. standard span was of similar type, but had a total depth of 8 ft. 6 ins. The main chords were of two 5 by 4 by ¾-in. angles, stiffened with a vertical web plate. This type was often used near Etaples in crossing the tidal river. Two spans were usually sufficient. Two bridges were used for highway traffic, but a third one was erected for the eventual use of the narrow gauge (60-cm. or 24-in. gauge), upon which the B.E.F. would have had to rely had they lost St. Pol in the great "Battle of France," which started March 21st, 1918. Actually, rails were not laid nor the approaches graded.

The chords of this type had greater lateral stiffness than those of the 60-ft. type, and it was quite common to launch them singly in cantilever; that is, the two trusses were erected on shore and bolted end to end. Truss 1 was then pushed and rolled until its far end reached a pier in mid-stream. The erection bolts were then removed and four special cradle rollers attached to the lower flange of Truss 1. Truss 2 was then slid along this "track." This method was particularly useful in multi-span bridges, as the tackle system of launching was only at its best in one-span bridges, where the height of its mast was of most use.

Hopkins Bridge

The Hopkins 120-ft. span was the largest, longest and had the highest load-bearing capacity of any of these G.H.Q. highway bridges. The method of its erection is shown by Drawings Nos. 1 and 2.

The erection on shore was carried out with no equipment beyond the necessary wrenches and 2-in. hemp rope, with suitable block and tackle. After laying out with camber, as shown, the party was divided into four, one for each end of each truss. All diagonals were hoisted by inserting first only one bolt per gusset plate and swinging in a vertical plane. The angles used as gallows with which to hoist the 15-in. channels of the top chord were later used as hand-rail posts. Used as originally designed, they gave insufficient clearance for hoisting and were actually used with an extra plate to give height, the plates being those later used for fastening the floor cross-beams to the diaphragms.

The largest span of this type ever erected in the field was at Havrincourt, after the Canal-du-Nord operations of September 27th to October 10th, 1918. The clear span was 180 ft. and to avoid excessive strains and also excessive length of tackle, the span was partly counterbalanced by erecting 60 ft. of false or cantilever panels. The bridge then was still in equilibrium, without tackle, when over-hanging about 120 ft., with the help of some decking as counterweight.

It will be observed that when the bridge was being rolled forward all stresses were reversed and the upward thrust of the rollers tended to distort the 15-in. channels of the lower chord. This was taken up by using an 18-in. 75-lb. R.S.J. floor stringer as a stiffener. In the normal case of a 120-ft. span on eight panels, only the two centre panels were thus stiffened, but in this extreme (Havrincourt) case, panels 4 to 12 were all stiffened, and the beams removed after crossing the roller to avoid overloading of the over-hang.

Bridges of this type were launched in skeleton. The trusses were complete, and also the wind-bracing in the upper horizontal plane, but in place of the floor cross-beams and stringers, we had only a few pieces of decking wedged in place, with the diagonal tension taken up by means of wire ropes and turn-buckles. In the Havrincourt bridge, tarpaulins were slung below the flooring gang to save men and tools.

The bridge was launched from and supported by special rollers with a diameter of 12 ins. and a length of about 3 ft. 6 ins., as the two 15-in. channels of the lower chord were separated, and double latticed internally with 2½ by 2 by ¼-in. angles. Later a rocker was bolted under one end.

A footpath about 3 ft. wide was built on the outside of each truss, the angle-irons of its floor being spaced at 3 ft. centres, and only each alternate floor angle had an upright angle as support for the 1¼-in. diameter gas-pipe hand-rail. (See Drawing No. 2.)

A railing was also fastened inside of trusses (to guide road traffic) at an elevation of about 3 ft. The 5-in. decking was laid crosswise on the lower flange of 15-in. channels, and on two 18-in. 75-lb. I-beams spaced 6 ft. 6 ins. apart. These R.S.J.'s were set with tops of stringers about 2 ins. above tops of cross-beams, thus allowing small beveled plates to be riveted on the uncut lower flanges of the stringers and simplifying erection.

The floor was erected by means of a light steel trolley which ran on upper flanges of inner 15-in. channels. To facilitate erection the stringers were made only 14 ft. $11\frac{1}{16}$ ins. out to out on a panel length of 15 ft., and two ¼-in. fillers were later inserted. The cross-beams at side were supported by both a long and a shorter plate, putting four of six bolts in bearing on web of 18-in. I and two in single shear. (See Drawing No. 1.)

The only other long span types of bridge were the 120-ft. Hopkins with an 18-ft. roadway, and a 75-ft. Hopkins. In the former, all chord and diagonal material was identical with the standard 120-ft. type, but the overhead horizontal wind-bracing was revised to suit, and two long plates at each end were used to fasten the 3-ft. cross girders. The 18-in. I's for stringers were practically unchanged in design but were increased to five in number.

The other type, the 75-ft. Hopkins, at the time of the armistice had never been erected. Its floor was to be identical with the 120-ft., but its top and bottom chords were to be only two 9-in. 19½-lb. channels, and its diagonals the same. It was designed to carry Class AA loads or tanks at 75 ft., single tanks at 105 ft., and all Class A loads of 17 tons at 120 ft.

The 60-ft. type was launched with tackle similar to that used for the 120-ft. type, but there was only one set to each bridge instead of one to each truss. The single derrick was braced sideways and allowed to lean slightly towards the bridge. Care had to be taken in every case when launching to adjust all tackle correctly, as it was only by fastening the tackle to the bottom of the forward end and the top of the rear end that the rotating couple of the downward thrust of the bridge and the upward thrust of the roller were counterbalanced by an equal and opposite couple.

The normal time for launching alone was about 40 minutes, and the labor cost of the entire erection of a 120-ft. Hopkins was 4,000 man-hours. On military work time is of more value than men, but about 200 men were the most that could be employed, so about three days was the minimum time of erection.

The Inglis was sometimes erected in one day on the true site, the Hopkins near it in a week on a diversion site, and the permanent civilian bridge a year or more later on the true site.

The military bridging practically ceased with the armistice. In both France and Belgium there were so many workless mechanics and laborers that the civilian authorities were encouraged to do as much as possible, and in the ensuing six months a great many of the permanent railway and highway bridges were replaced.

Fortieth Annual Convention of the American Water Works Association to be Held June 21-26, 1920, in Montreal

At a recent meeting of the convention committee of the American Water Works Association, it was decided that the dates of the next annual convention should be June 21-26, 1920. It was decided at the last convention to hold the next assembly in Montreal, but the dates were left to the convention committee. The dates selected by this committee have to be confirmed by the executive committee of the association, but this no doubt will be largely a matter of form, as the convention committee is a sub-committee of the executive committee.

The five members of the convention committee met in Montreal last week and made final arrangements with the manager of the Windsor Hotel. Windsor Hall, adjoining the hotel, will be used for the exhibition. Access to Windsor Hall can be obtained from the hotel or directly from the street. Delegates entering Windsor Hall from the hotel will pass the rooms used as convention offices, and in order to reach the room where the papers will be read, the delegates will have to go through the exhibition hall. The convention hall will not immediately adjoin the exhibition hall, so the reading of papers will not be interfered with by the noise incidental to the exhibition.

The members of the convention committee declared that they were delighted with the arrangements that had been made, and that at no time in the history of the association have facilities been so absolutely ideal. The committee expect a big attendance of water works superintendents, contractors, consulting engineers and manufacturers from all parts of the United States and Canada. The conventions are attended every year by nearly a thousand members and guests, and it is thought that next year's convention at Montreal may prove to be a record-breaker, as a number of very interesting trips are being planned for the entertainment side of the program, and special effort will be made to have interesting papers, including a number of papers on Canadian work.

The convention committee have appointed a local committee on arrangements, consisting of a number of Montreal and Toronto members of the association, with H. G. Hunter, of Montreal, as chairman.

Association of C. B. & C. I.'s Proposed Constitution

As a result of several months' thought and study, and after a large number of conferences with many members of the association from coast to coast, J. P. Anglin, president of the Association of Canadian Building and Construction Industries, has perfected a draft of proposed constitution and by-laws for the association. Last December the national council appointed Mr. Anglin as a committee of one to carry out this work. The constitution as prepared by Mr. Anglin has been submitted to the various members of the council, and while it has not yet been officially adopted, as no letter ballot has been sent out, a great many of the members of the council have expressed their approval, and it is thought that the constitution will be adopted with few, if any changes.

The constitution as prepared by Mr. Anglin consists of sixteen articles, covering respectively name, purpose, membership, annual fees, meetings, government and election, officers, duties of officers, executive committee, committees, order of business, expulsion and discipline, audit, seal, arbitration, and amendments.

The objects of the association are stated to be: (a) To promote better relations between the members on the one hand; and owners, architects and engineers on the other; (b) To establish and maintain standard methods of practice between members within the industry; (c) To acquire, preserve and disseminate valuable information concerning the industry; (d) To extend construction and improve conditions in the combined industry; (e) To co-ordinate the units of the industry in its producing, manufacturing, distribution, professional and constructive activities, thereby increasing its efficiency and extending its usefulness, to the end that the industry shall be established.

The membership is divided, as planned at the conference in Ottawa last November, into three sections: (a) General contractors and contracting engineers; (b) trade and sub-contractors; and (c) supply firms, manufacturers and producers of building materials and plant. Each section may be further sub-divided.

Two classes of membership are provided for: Direct, or individual membership; and indirect, or collective membership. The latter comprises the membership of existing local builders' associations, contractors' sections of local boards of trade, etc. Such bodies are to pay an annual per capita fee of $5, minimum payment from any association to be $50. These bodies to be allowed one representative at each annual or special convention of the association for each $50 paid in fees.

The dues for individuals are to be $50 per annum for firms doing less than $500,000 business annually, with additional tax of $50 per annum for each additional $500,000 of annual business. The fiscal year commences October 1st, 1919, and all fees for the current year are to be considered as having been due upon that date. Members can resign at any time if their current dues have been paid.

The affairs of the association are to be managed by a national council, consisting of 45 members to be elected at the next convention of the association, which is to be held at Chateau Laurier, Ottawa, January 27th to 30th, 1920. Fifteen of these (according to the highest votes obtained) are to serve for a term of 3 years, 15 for 2 years, and 15 for 1 year, and thereafter 15 will be elected annually to serve a term of 3 years.

For the purpose of ensuring an equitable representation in the council, 5 councillors are to be elected from each of 9 electoral districts. These districts are as follows: District No. 1 (headquarters district)—Province of Ontario outside of District No. 2; District No. 2—City of Toronto and adjoining territory within a radius of 25 miles; District No. 3—Province of Quebec outside of District No. 4; District No. 4—Montreal and adjoining territory with a radius of 25 miles; District No. 5—Maritime Provinces; District No. 6—Manitoba; District No. 7—Saskatchewan; District No. 8—Alberta; and District No. 9—British Columbia.

In additional to the 45 members mentioned above, the chairman and secretary of each of the three main sections of the association are to be members of the national council. The president, two vice-presidents, honorary secretary and honorary treasurer are to be elected by the national council from among their number. There is to be an executive committee consisting of the officers of the association and the chairman of each of the three main sections. The national council is to direct the affairs of the association between annual conventions and the executive committee is to direct the affairs between the meetings of the national council.

RECENT PUBLICATIONS

A Public Building Group Plan for St. Louis.—Issued by the City Plan Commission, St. Louis, Mo.; 16 pages and cover, 8 by 11 ins.; illustrated.

Platinum Situation in Canada.—By J. J. O'Neil. Published by the Geological Survey, Ottawa; 15 pages, index, folded map and cover; 6½ by 9¾ ins.

Silurian Geology and Faunas of Ontario Peninsula and Manitoulin and Adjacent Islands.—By M. Y. Williams. Published as Memo 111 of the Geological Survey, Ottawa; 188 pages, index, folded map and cover; 6½ by 9¾ ins.; illustrated.

Cole Pitometer System.—Reprint of paper read at the last annual convention of the American Water Works Association by Geo. C. Andrews, water commissioner of Buffalo, N.Y., on "Reduction of Water Consumption by Means of Pitometer Survey and House Inspection."

The Zone Plan.—Cloth bound book, 82 pages and cover, 6¾ by 10¼ ins.; published by City Plan Commission of St. Louis, Mo.; contains a number of illustrations and numerous folded maps printed in several colors. Harland Bartholomew is engineer of the commission.

Fair Average Prices in Cost of Reproduction and the Trend of Prices After the War.—By Morris Knowles, consulting engineer, Pittsburgh, Pa., and Windsor, Ont. Reprint of paper prepared for the New Jersey Utilities Association; 15 pages and cover; 6 by 9 ins.; illustrated.

Summary Report, 1918, Part D.—Issued by the Geological Survey, Ottawa; 15 pages, index and cover; 6½ by 9¾ ins.; includes reports by E. L. Bruce, F. J. Alcock and W. A. Johnston on various districts in Manitoba, including report of the superficial deposits and soils of the Winnipegosis area.

Summary Report, 1918, Part E.—Issued by the Geological Survey, Ottawa,; 32 pages, index and cover; 6½ by 9¾ ins. This booklet contains reports by E. R. Faribault and A. O. Hayes on investigations in Nova Scotia and New Brunswick, and report by A. Anrep on peat investigations in New Brunswick.

Summary Report, 1918, Part C.—Issued by the Geological Survey, Ottawa; 48 pages, index and cover; 6½ by 9¾ ins. Contains reports by F. H. McLearn, J. A. Allan, B. Rose, D. R. Dowling and J. Stansfield, on geology of various districts in Alberta, gasoline and natural gas in Alberta, and surface deposits of southern Saskatchewan.

Load Concentrations on Steel Floor Joists of Wood Floor Highway Bridges.—By T. R. Agg, highway engineer, and C. S. Nichols, assistant director, of the Engineering Experiment Station of Iowa State College of Agriculture and Mechanic Arts; issued as Bulletin 53 of the Good Roads Section of the Station; 32 pages and cover, 5¾ by 8½ ins.; illustrated.

Road Material Surveys in the City and District of Montreal, Que.—By Henri Gauthier. Published as Memo 114 of the Geological Survey, Ottawa; 47 pages, index, folded map and cover, 6½ by 9¾ ins. The booklet includes discussion of the conditions affecting road construction, the geology of the district, road materials (bed rock, field stone, sand and gravel) results of laboratory tests, list of and data concerning deposits of bed rock and field stone. It is illustrated by a few views of local quarries.

The next convention of the International Association of Fire Engineers, which is to be in Toronto, will probably be held in June, 1920. It will be the first time in 25 years that this association has held its annual convention in Canada.

A series of lectures on municipal government will be given this winter at McGill University. These will deal with various phases of the subject, including municipal government in Canada, Europe and the United States. The lecturers are Senator L. O. David, Dr. H. L. Brittain, Thomas Adams, C. R. Woodruff, Dr. J. A. Hutchinson, Frederick Wright, Oscar Moran, K.C., C. J. Yorath, C.E., Thos. Bradshaw, W. D. Lighthall, K.C., and Howard S. Ross, K.C.

G. A. Crain, of Ottawa, honorary treasurer of the Association of Canadian Building and Construction Industries, has issued his report covering (1) the Ottawa conference, November 26th to 28th, 1918, and (2) the period from December 1st, 1918, to September 30th, 1919. During the first period there was collected $1,060.34, and the expenditures amounted to $1,012.83. During the second period the receipts were $3,038.71 and the expenditures $2,777.03. The principal items of expenditure during the second period were the salary and expenses of the former paid secretary, A. S. Clarson, of Montreal, while the expenditures during the first period were entirely in connection with the general conference at Ottawa.

MOUNTAIN HIGHWAYS AT HAMILTON, ONT.

Report Submitted by Noulan Cauchon, of Ottawa, Plans Access to Stadium and Park Development with Ruling Grade of Three Per Cent.

AT the request of the city council of Hamilton, Ont., Noulan Cauchon, of Ottawa, consulting engineer and town planner, has presented a report outlining the development of the "Mountain Top" and planning highway approaches. Mr. Cauchon's report is accompanied by a plan showing a 3% grade to the proposed stadium and park development on the heights overlooking Hamilton. Following are excerpts from Mr. Cauchon's report:—

The Mountain Park of Hamilton is a rare natural health resource of exhaustless value to its citizens. It is the city's great playground—its training camp of potential energy and efficiency. Town planners and sociologists, all those concerned in the welfare of the public, no longer look upon parks as mainly ornamental features to a city, but as being of essential economic necessity in fostering and sustaining the development of human energy and efficiency in the rising generations, who are the citizens and workers of to-morrow. The mountain face park stretches for five miles along a populous area, but is separated from it in large measure by a railway barrier which denies to much of this population the free enjoyment, the recuperation and enhancement that is within its gift, and theirs by right.

Lack of easy access for attaining its benefits, lack of ease in surmounting, its almost impassability to normal traffic seeking its summit, have deprived this marvellous asset from benefiting the dwellers at its base and from fostering the expansion of life upon the very attractive and desirable tableland stretching back from its summit.

Railway Tracks Retard Development

The obstacle retarding development has been primarily the railway trackage upon and along a considerable stretch at the base of the mountain, with level crossings at rare and distant intervals—instance the distance of two miles from Wentworth to Kenilworth Ave., with only one, a level, intermediate crossing over the multiple tracks of the Toronto, Hamilton & Buffalo Railway at Ottawa St., and at that within half a mile of one end of this stretch, and on the Grand Trunk Railway Co.'s mountain line, only a level crossing about opposite the previously mentioned one, and one other, also level, approaching "incline." This abnormal state of affairs, further, has prevented the adequate development of roads for access and for overcoming with reasonable grade the declivities within the physical limitations of the site, the legal road allowances, moreover, having been largely projected straight up the hill at impossible angles.

New Road System

A system of roads has been devised and their grades determined to facilitate the transmission of city traffic to and from the mountain top. Moreover, this road system will enable access for the enjoyment and for the further development of the park, as such, and of its amenities. An easy and ruling uniform grade of 3% has been obtained not only throughout the main arteries, but also realized throughout the minor tributaries, this notwithstanding the necessity of adjusting numerous road junctions within the limits of this grade, and of finding fortunate turning points throughout free from the large areas of steep side hill. The subsequent work of building these roads will in general not entail any abnormal cut and fill beyond the usual well-balanced cross-section. There will be some heavy cutting at the approach to the summit, where routes have been concentrated from the various tributaries into one main deep portal through the brow of the mountain in the hospital grounds.

Recommends Immediate Trail Construction

I strongly recommend, as a means of enabling the public immediately to realize their heritage in the park, that a selection from the grades forthwith be opened progressively as narrow footpaths to begin with, thus giving prompt access for inspection and use by the citizens, that they may see and understand the problem and its solution; also that they may begin to enjoy the wide vision of city and hills and valley and lake, and determine to their satisfaction the needed progression in widening the trails into arterial highways.

Attention is drawn to the manner of road junction that eliminates or reduces to a minimum what are known as "collision points," and also to the advantages derived from making turning points level, so compensating for curvature and diminishing resistance to pull; in other words, increasing the tractive capacity and the loads which may be hauled up these hills with any given power.

The Railway Tracks

The elimination of the railway trackage within and along the base of the Mountain Park is now under consideration by the Dominion Railway Board. For the purposes of this highway report these tracks are taken as they stand and under or over crossings of the railway suggested, as seem necessary under the circumstances and merits of the case, to maintain a ruling grade of 3%.

Justification for Ruling Grade

The adoption of this 3% ruling grade claims justification by factors of height, distance, haulage, capacity, climatic effect on surface, and the exigencies of pavement, of ideal residential area development, of attainment of park facilities—in sum, justification on the broad and comprehensive principle of civic enhancement and amenity.

Grade Separation

Of the two grade separation schemes heretofore considered by the city in relation to James St., I hold the alternative one of track depression as therein submitted to be the lesser evil of the two, in the city's interest, but even at that not depressed enough.

Under the modern dispensation of motor transport, a city should claim the right to protection of its factor of haulage efficiency, the ruling grade of its arterial highways, as determined within and without. In grade separation schemes through cities, the principle of respecting the ruling grade of the arterial highways and main streets should prevail on its merits of paramount public importance. To date, the tendency has been unquestionably to allow railways their ruling grade, adjusting that of the community as of minor importance, usually at 5%. Where economically possible, both ruling grades should be attained; otherwise the disabilities, like the whole costs, be distributed proportionately on their merits.

Further, whilst the grade of a street at a given point may be altered without lessening its ruling grade of the whole artery, yet it may cause locally serious disfigurement, depreciation of property values and of amenity.

In a comprehensive scheme of grade separation throughout Hamilton as may be submitted by the railways in balance against their removal, as is now sought by the city, there should be no question of kinking or humping a number of the principal streets of the city.

Advocates Removal of Tracks

This dissertation on comparative evils in no way alters my firm conviction that the proper and most advantageous solution for the city is to labor and negotiate towards their removal, saving such spur connection as may be necessary for maintenance of existing industrial service.

Grade separation, at its best, will eliminate but life danger, one only of the many afflictions that evolve from the strenuous activities of railways in the wrong place—injuriously affecting general well-being.

Poor's Manual will give you detail as to the worthy stature enjoyed, as a private corporation, by the Toronto, Hamilton and Buffalo Railway, and, let me add, through able, courteous and effective management—yet the city of Hamilton embodies an aggregate corporate entity of about a hundred millions of dollars, representing public interest and as of paramount importance, where a benefit or an injury to a part is a benefit or an injury to the whole.

The 3% Highway Grade

The city is well within right and fairness in claiming reservation for itself of a 3% grade as against the 1% prevailing on the railway. The 3% grade adopted for this sytem of roads was arrived at by first determining the objective points and their relative elevations. This means by finding a central common controlling point of highest city elevation and joining it in the most direct and continuous manner with the lowest central controlling common point of mountain tableland elevation.

Climatic Conditions

The climatic conditions of generally mild winters, little snow, occasional rain and intermittent freezing result in frequent periods of glare ice on the mountain grades.

I have observed the general difficulty, often impossibility, and the ever-constant danger of negotiating the existing mountain grades—even motor chains unable to grip—and there is a chapter of fatal accidents to their discredit.

Surface Paving

Steep grades as now existing preclude satisfactory paving and efficiency in maintenance. Observation of traffic on John St. in the vicinity of the Arkledun turn, in bad or frosty weather is convincing proof of the futility of smooth permanent pavement on such heavy grades.

Observation of the lack of pavement under similar conditions, say, the Jolley Cut, shows that rain and drainage scour the unprotected surface and materially heighten its resistance to traffic.

Three per cent. grades would allow of permanent pavement to the minimum of inconvenience and danger and maintenance, to the maximum of comfort, safety and tractive efficiency.

Importance of Motor Traffic

The advent of mechanical transport has brought the problem of highway haulage under the same principles for economy and efficiency as heretofore prevailed for railways and upon which railway grade reductions are figured and justified.

The "Good Roads" efficiency for mechanical transport is the beginning of what might be termed the democratization of transportation—independence for the individual.

Whoever owns a boat may place it upon water with the freedom of the seas, and compete in the markets of the world. Whosoever owns a motor truck may, in the near future, place it upon a national highway and compete freely for the traffic of the country. This already obtains between Toronto and Hamilton as the index of coming expansion, and is welcome warning to the community that it carefully nurse the efficiency of its public highways.

There are said to be 5,000 locomotives in Canada, also 250,000 automobiles (including motor trucks). If the number of locomotives be multiplied by 300, it would represent 1,500,000 h.p. hauling all the passenger trains and freight of Canada. If the autos and motor trucks be averaged at 20 h.p., it would represent 5,000,000 h.p. on our highways.

Trailers in the Future

Now, whilst this illustration is given with the candid admission that auto power to date is largely light traffic, yet it points to the growing power on our highways and to the future doubling, trebling, quadrupling, within measurable grasp, of motor traction and the economic advantage of its use with trailers.

Whilst disclaiming any inherent virtue in any particular grade, except in its relation to the economics of any particular case, on its merits, the fact stands out that the future of highway transportation enjoins upon cities the responsibility of determining at least the best ruling grades that its circumstances afford, and justifies communities in claiming that such be absolutely respected in any intersection with any railway or other transportation device.

Reverting to Hamilton: A good five-ton motor truck will barely haul itself and load up the "Jolley Cut." The same motor truck would haul itself and load and three trailers up the proposed mountain grades, in all 15 to 20 tons, according to surface conditions.

If the building up of the Mountain Top as a suburb be considered, this means cutting to a third, or better, the cost of delivering up there all bulk materials, brick, sand, lumber, coal, etc. This means cheaper "housing" and keeping down the capitalization of the "home."

These 3% grades also mean that degree of efficiency in the radiation of Hamilton's highways to all the country between it and Lake Erie; increasing the quantity and lessening the cost of produce receivable, lessening the cost of long haulage and expediting the city's industrial production.

Town Planning and Arterial Highways

The synthesis of organic town planning is, first, solution of the railway problem; secondly, determine arterial highways; thirdly, zoning, that planning may be to purpose.

Regarding the great provincial arterial highways and their subsidiary collection and distribution of the traffic they carry, it may be well to note that the motor world is coming to accept the 5-ton truck as the standard haulage unit.

This truck can be unwisely overloaded to 7 tons; it can be made advantageously to haul 4 trailers on level roads, an aggregation of 25 tons. Individual or special trucks or trailers will be loaded with boilers, machinery, and other items exceeding 10 tons.

It is manifest that a city cannot rovide all its pavements for the indiscriminate admission of such loads, and must determine certain routes throughout its mesh of streets for heavy haulage with special foundation and maintenance for same, or risk having all its pavements in a generally crushed and disintegrated state.

Anticipating such routing (a further argument for zoning), I have endeavored to provide a level road across the base of the park, south of the present Toronto, Hamilton & Buffalo trackage, as a collecting channel for the main north and south heavy arteries, which are about half a mile apart—Kenilworth, Ottawa, Gage, Sherman, Sanford, Wentworth, Victoria, Wellington, and the principal streets between this latter to and including James, in the present report. These arteries will no doubt in time come to be dedicated for heavy traffic bearing and be provided with deep concrete bases.

May Expropriate Railway's Land

A peculiar situation arises in connection with the mountain base road referred to, being that not only would an extension of Kinnear Yards, as previously attempted, prevent the carrying out of this provision, but that the further use of the adjacent property by the Toronto, Hamilton & Buffalo Railway Co., and now owned by them, would also prevent proper access to the whole Mountain Road system for nearly a mile and a half between Ottawa and Sanford Aves.

It may be that this land outside of the right-of-way which may be taken by franchise is still but railway real estate, and, failing its having been authorized by the Dominion Railway Board as "extra land," can be taken by the city under the ordinary provisions of Municipal Act for highway and for park purposes. In any case, the matter should be submitted to the Dominion Board for discussion and authorization of the road system as road diversions, and for protection of necessary supporting physical conditions for accomplishing same.

Park Development

The topography of the Mountain Park is such that its natural treatment will be one of terraces. The road system proposed for economic purposes so happens to be admirably adapted to further this particular style, for which the park contains many magnificent opportunities.

The street railway tracks on the two main grades from James and from Kenilworth Streets should, where within the park, be at the curbs, in order that passengers may enter and leave anywhere without slowing or interrupting the passing motor traffic.

PRESSURES IN PENSTOCKS CAUSED BY THE GRADUAL CLOSING OF TURBINE GATES*

By R. D. Johnson
Consulting Engineer, New York City; Formerly Chief Engineer, Ontario Power Co., Niagara Falls, Ont.

MR. GIBSON'S remarkable paper deserves the closest attention on the part of all who are interested in the water-hammer problem.

He remarks that the theory has not been experimentally confirmed, but it is so obviously complete and correct as scarcely to need such confirmation to establish strong faith in its accuracy.

The writer has been especially interested in a completely correct treatment of this subject, in order to be able to fix the limits of K within which his pressure-time curve, previously presented to the American Society of Civil Engineers, is sufficiently accurate for practical purposes.

It is found, fortunately, that this smooth curve†, $\log. x = n \log. [T/(T-t)]$, is applicable with much precision to such a wide range of conditions as to justify its use for practically all the water-hammer problems arising in connection with the design and operation, under ordinary heads, of water turbines, when properly regulated.

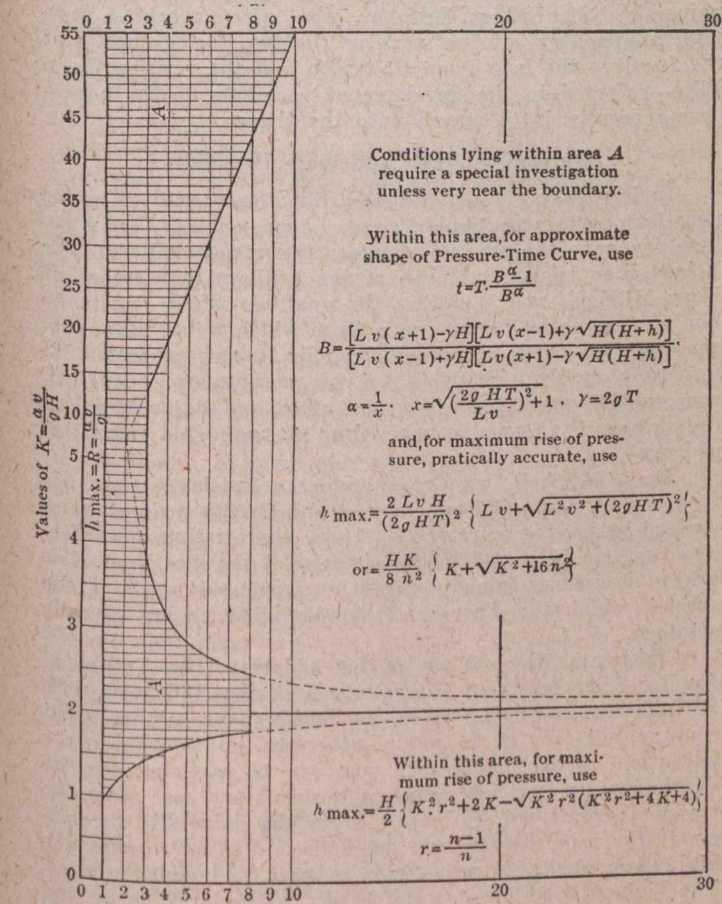


FIG. 12—CHART OF LIMITATIONS FOR WATER-HAMMER PROBLEMS

By differentiating Mr. Gibson's equations, it is possible to express rigidly correct values of the tangents to the true pressure-time curve at (a), the beginning of gate closure (b), the end of the first interval, and (c), the beginning of the second interval.

Using Mr. Gibson's nomenclature, with omission of subscripts, that is, putting $R_0 = R$, and $S_{T1} = S$, and $H_0 = H$, these tangents may be expressed as follows:—

$$\tan. (a) = 2RH/(R+2H)T$$

$$\tan. (b) = [R^2(T-T_1)/HT^2]\{(S+2R+2H) \div [S(S+4R+4H)]^{1/2} - 1\}$$

$$\tan. (c) = [R^2(T-T_1)/HT^2]\{[S(Z+1)+2R+2H] \div [S(S+4R+4H)]^{1/2} - (Z+1)\}$$

where $Z = 4H^2T/R(R+2H)(T-T_1)$.

It is clear that the effects of vibration in the water column, due to elasticity, tend to disappear when the conditions are such that tan. (b) and tan. (c) approach equality; also, if the change in the rate of pressure rise at the beginning of the second interval, due to the effect of the returning wave, is less than the rate at which the pressure begins to rise

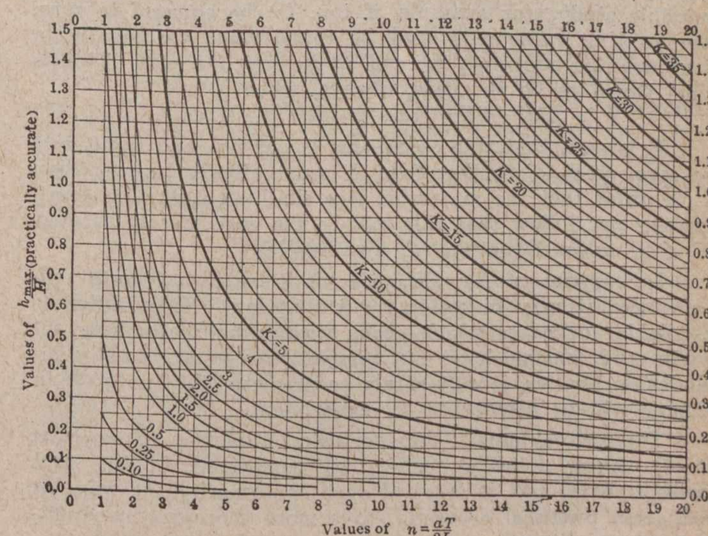


FIG. 13—WATER-HAMMER CHART FOR UNIFORM GATE CLOSING

when the gate starts to move, it is evident that the conditions are such that the effect of elasticity is rapidly dying out, and that it should be scarcely appreciable during the remainder of the closing period.

If, then, tan. (b) — tan. (c) < tan. (a), the writer's Equation (7), above referred to, or the maximum value of h, given by the so-called Alliévi formula, may be used with much precision.

This may be shown to be the case when.

$$K > 2/[(3r^2+1)^{1/2} - 1] \quad \ldots\ldots (1)$$

where r is the ratio $(T-T_1)/T$; and $K = R/H$.

Equation (1) marks the lower limit for values of K, below which it is not safe to use Equation (7). To find the upper limit of safety, for values of K, it is noted that, as H decreases, the pressure-time diagram passes through a transition stage where an ogee form of curve most closely approaches to a straight line, and, that thereafter, as H continues to decrease, Equation (7) begins to produce a curve sharply upturning and curving one way, for the most part, as its extremity reaches toward infinity, thus leading to serious errors in its results.

By trial, assisted by arithmetic integration, it has been noted that, for large values of n, the head may be reduced to about one-half the value which produces the approximate straight-line diagram.

To find this point we may equate the value of $h_{max.}$ in the so-called Alliévi formula to the value of the pressure rise found at the end of a straight-line pressure-time diagram, enclosing the same impulse area, and solve for the value of H.

In this way it is found that

$$K = 3n \quad \ldots\ldots (2)$$

(where n is the closing time expressed in intervals), and Equation (7) may be used so long as

$$K \leqq 6n^2/(n+1) \quad \ldots\ldots (3)$$

which, for large values of n, is nearly twice as great as the value given by Equation (2), but which becomes equal to 3, as it necessarily must, when n becomes unity.

*Discussion (presented to the American Society of Civil Engineers) of Norman R. Gibson's paper (see September 4th and 11th issues of *The Canadian Engineer*).

†The derivation of this curve, Equation (7), is given in Transactions, Am. Soc. C.E., Vol. LXXIX, p. 280.

Equation (3) marks the upper limit for values of K, above which it is not safe to use Equation (7). Therefore, the smooth logarithmic curve given by Equation (7) may be applied only when K lies between the values given in Equations (1) and (3), and preferably, also, when n is not less than three intervals.

Fig. 12 shows that Equation (7) covers a very wide range of conditions, and, furthermore, in the design of a water-turbine installation, the values of V and n should, when possible, be adjusted so that Equation (7) will be correctly applicable; and particular attention should be given to the limitations set forth in Equations (1) and (3), in order that the speed of the water unit may be regulated most effectively.

The expressions for the tangents (a), (b) and (c), are rigidly accurate, and form a substantial basis for further possible study; for example, if tan. (c) be equated to zero, the limiting value of n may be found when the maximum pressure-rise occurs at the end of the first interval. This is thus found to be the case, always, when

$$n > (4K^2+8K)/(12-K^2-K^3) \quad \ldots\ldots\ldots\ldots\ldots (4)$$

It is seen that this expression is positive and finite only so long as $K < 2$; therefore, K must always be less than 2, in order that the maximum rise shall occur at this point. It does not follow that this will be the case merely because $K < 2$, unless Equation (4) also applies.

In support of Mr. Gibson's work by experimental observation, it may be pointed out that much information is available for cases which occur within the limits here set forth, and, inasmuch as his complete work incidentally includes such cases, it may safely be predicted that no error in theory will be discovered by experiment.

The writer, himself, has confirmed Equation (7) a great many times, under a variety of conditions, in the past twenty years, and, because of such confirmation, he was not led, from practical necessity, to a more thorough investigation of the theory.

In conclusion, the writer wishes to urge those interested to a further study of the limits here graphically presented, with the idea either of confirming or improving them, because it is not profitable to resort to the very tedious processes incident to the methods presented by Mr. Gibson, except when a comparatively simple formula is inapplicable. The chart, Fig. 12, indicates that this is very rarely the case, and practically never need be, with proper care in the design and operation of any water system.

It is interesting to note that Mr. Gibson's methods may be used to work out a system of perfectly general cases, thus enlarging, indefinitely, the scope of such diagrams as he has presented, which are based, merely, on a specially selected set of data.

This is made possible by simply substituting in his scale of ordinates, values of the ratio ($h_{max.}$) $\div$ H in place of ($h_{max.}$), and substituting for the values of H, written on the curves, the values of K.

This trifling change, it will readily be seen, will make such diagrams applicable to an infinite variety of special cases.

In this manner, the chart, Fig. 13, has been roughly prepared, and, for the range of values covered, it is not necessary to resort to formulas.

All combinations of a, V and H which produce a constant value of K must invariably result in a definite single value of the ratio ($h_{max.}$) $\div$ H for each selected value of n. Therefore, in fact, each point of the chart covers, theoretically, an infinite variety of conditions.

In the use of the chart or simple formulas to replace the accurate but tedious methods, it should be borne in mind that it is not ordinarily practically necessary that the agreement should be perfect, because, as Mr. Gibson has shown, the shape of the curve is so sensitive to the vagaries of the gate motion, in closing, as to make it almost out of the question to reproduce, experimentally, any definitely selected shape of curve; so that, after all, the element of judgment must enter as usual.

The effects of velocity-head and friction-head have been neglected in the preparation of Figs. 12 and 13. These factors are nearly always of minor importance, as affecting the rise of pressure, but, nevertheless, they may be taken into account by means of arithmetic integration in special cases where great accuracy is thought to be warranted. These effects, at any rate, cannot be included in a usable formula, covering the whole range of the charts.

DEAN MITCHELL INSTALLED AT TORONTO

Discusses Trend of Scientific Education and Indicates Probable Broadening of the Curriculum—Greater Attention to be Paid to Certain Civil Engineering Subjects

DECLARING that the aim of university education to-day should be to produce broadly educated, cultured gentlemen and good citizens, even before the production of trained technologists, Brig.-Gen. C. H. Mitchell, C.B., C.M.G., D.S.O., delivered an interesting address on Wednesday of last week, at Convocation Hall, Toronto, at his installation as dean of the Faculty of Applied Science and Engineering of the University of Toronto.

The new dean was introduced by the president of the university, Sir Robert Falconer, who, after speaking with high appreciation of the work of the two former heads of the faculty—the late Dean Galbraith and the retiring Dean Ellis—referred to the development necessary if the engineering faculty is to march with the times.

University Must Anticipate Demands

In introducing Dean Mitchell, Sir Robert said: "On the new dean rests a particularly heavy responsibility, and I believe we have the man to shoulder the responsibility." Sir Robert then spoke at length of the brilliant war record of Dean Mitchell, and said that the qualities which had made him so successful in war, were those which would make him successful as dean. In conclusion, Sir Robert expressed his gratitude to Dean Mitchell for his acceptance of the responsibilities attaching to his new office, and, as president of the university, formally asked him to make his inaugural address.

Dean Mitchell, who rose amidst enthusiastic applause from the students and members of the faculty present, commenced by paying a warm tribute of appreciation and affection to Dean Ellis and to the memory of the late Dean Galbraith, to whose splendid work he attributed much of the success which the Faculty of Applied Science has already attained.

Taking as the subject of his address, "The Future of Applied Science," Dean Mitchell declared that this rests with all who are concerned with the development of this great country, not only in the actual processes, but equally in the education of the young men who are to participate in its development. It is not sufficient to "wait and see" what the trend of events will be, but it is for the university to anticipate the requirements and demands and to have ready the highly educated and trained men to meet the country's needs. The highest function of a university, he declared, is to lead the country in thought and action.

Influence of the War

Turning to the influence that the war has had upon the lives and ideals of men who have served in it, the speaker referred to the important part that engineering science played in the war, recalling the words of Lloyd George early in the struggle, that it was an engineer's war. Dean Mitchell, in proof of this, reviewed some of the contributions of science to the success of the struggle, referring to the elaborate developments in trench warfare, in artillery, in the air and under the sea.

"There is a new world ahead in applied science," he declared, and pointed out that Canada has realized the greatness of her resources during the war, and her ability to apply them to her own life and the life of the Empire. The speaker saw ahead a great resumption of manufacturing and industrial activity in the country and a great need for the services of many applied scientists and engineers.

Discussing the educational requirements to meet this demand, Dean Mitchell saw a greater need for training in the industrial group of electrical, mechanical, chemical and metallurgical engineering work. An interesting fact is observable in the present year at the university, where one-quarter of the new students in the engineering faculty are in chemical engineering.

Dean Mitchell then discussed the tendency of scientific education to become too specialized, though this had not been the case so much in Canada. He declared that the first principle in applied science education is undoubtedly that a sound general education should be obtained as a foundation.

"Thirdly,—Educated Technologists"

"Considering the entire education of the young engineer," he continued, "there seems only one conclusion as to the necessity of to-day in this young country at its critical stages of development. For nowadays we require not only technologists in the form of applied scientists or engineers, but we want men who are more than that—we require to produce men who by their college education will be: First, broadly educated, cultured gentlemen; second, good citizens of Canada and leaders of influence within the community in which they may be placed; and after this, third, thoroughly educated technologists in whatever branch of applied science they may chance to enter."

How to obtain these results next occupied the attention of the speaker, and he referred to the returned soldiers present among the students, who would look to have the great principles of science that played so important a part in the war, applied in an even greater measure to the problems of peace. The curriculum under which the students studied would need radical changes designed primarily to broaden the present educational outlook of the "science" student.

Greater Attention to These Subjects

Referring to the actual engineering teaching itself, the speaker showed how greater attention will have to be paid to such subjects as municipal and sanitary engineering, transportation and highway engineering, irrigation engineering, aerodynamics, shipbuilding, architecture and town-planning.

In order that the science student may go out into the world a practical man in touch with the full life of industry, Dean Mitchell thought that such questions as the philosophy of values and costs, the psychology of labor and industrial problems, should be taken up during his training. If the engineer and the applied scientist are to take their places in the community, they must be trained to appraise correctly what men consider worth while, he declared. Dean Mitchell concluded by impressing upon his audience the fact that character and personal qualities rank above mere technical knowledge.

"A hardening solution for concrete floors that prevents dusting is made from sulphate of alumina and acidulated water. To 10 gals. of cold water (as soft as possible) add slowly 1 fluid ounce of commercial concentrated sulphuric acid. Heat the liquid to boiling point and stir in gradually 25 lbs. of commercial sulphate of alumina. When this solution has been effected let it cool and settle for several hours. Strain through muslin. The concrete surface to be treated must first be swept and thoroughly washed. After drying, the hardener is put on, preferably with a broom. Four applications are recommended; three consist of varying dilutions of the hardener with water, while the fourth is the hardener used 100% straight. These first three solutions are respectively: (1) 30 hardener to 70 water, (2) 50-50, and (3) 70 hardener to 30 water. Allow an interval of twenty-four hours between successive applications. The above quantity suffices for the complete treatment of an area of from 50 sq. yds. to 100 sq. yds., depending upon the porosity of the surface treated."—From the Municipal Engineering and Sanitary Record, England.

THE PROSPECTS OF RAILROAD ELECTRIFICATION

By F. H. Shepard

Director of Heavy Traction, Westinghouse Electric & Manufacturing Co.

World-wide shortage of coal during the great war has emphasized more clearly than ever the necesssity of fuel economy in industry, while the present shortage of labor and the certainty of its continuing scarcity throughout the reconstruction period, forms another most serious problem. But fortunately we have at our disposal a means that will greatly assist in alleviating both of these conditions, namely—electrification.

The use of electricity in industry saves both fuel and labor. This fact is recognized throughout the world to-day, and in order to secure these advantages, practically all of the nations are now considering plans for the electric generation of power. In England, Belgium and France, among others, these plans are being prepared by official commissions, so a tremendous activity in electrical power development may be expected with the stabilization following the advent of peace. In all cases, the ideal in view is a broad one: To use electricity for all possible power purposes, including railroad operation.

Advantages of Electrification

The operation of the railroads will naturally form an important part of any program of general electrification, for in almost every country the railroads form one of the largest users of fuel and labor. Nor are the advantages obtained from railroad electrification limited solely to economy in fuel consumption and the more effective use of labor. Among others, the following may be mentioned:—

1.—Greater speed of movement for the heavier trains, due to the fact that electric locomotives can be made much more powerful than the largest steam locomotives.

2.—Greater nicety of control.

3.—Increased traffic capacity of existing tracks, terminals, grades, tunnels and other points of traffic restriction. When electricity is used, heavier trains can be operated at higher speeds and less time is consumed at terminals and in yards.

4.—Operation where the use of steam is impossible or objectionable, as in long tunnels.

5.—Independence of weather conditions, since the electric locomotive is not affected by cold weather.

6.—More reliable operation, as proved by the statistics of all existing electrifications.

7.—More effective use of all rolling stock, due to more expeditious movement of traffic.

Those are some of the advantages that are now being obtained by the mere substitution of the electric locomotive for the steam locomotive, but they by no means tell the whole story.

Unlimited Inherent Possibilities

Consider electric illumination. When first introduced, the electric lamp supplanted a gas or an oil light because of certain advantages it possessed, and at first it occurred to no one that it would ever do much more. But within 30 years the electric lamp has revolutionized illumination and has given us our light-flooded factories, with their greatly increased production and safety, and our "Great White Ways" also.

The industrial electric motor is another case in point. At first it merely took the place of a steam engine in the factory. To-day, practically every machine has its own motor of specially selected characteristics, and feats of production are now possible that were undreamed of a generation ago.

A further example is the growth of our great city and interurban electric transportation service of to-day due to the substitution of the electric motor for the horse on street cars.

In other words, an electrical method will in the beginning take the place of an older practice because of some economic superiority. Then its almost unlimited inherent possibilities are developed, and in time results are accomplished that would be impossible at any cost with the older methods.

There is good reason to expect that the electric operation of the railroads is capable of a similar development and will in time revolutionize our present transportation methods and provide us with services we know little or nothing about to-day.

Conditions in United States

Since the United States has an abundance of coal, railroad electrification there has been determined solely by local conditions. Passenger terminal problems caused the electrification of the New York Central at New York and of the Pennsylvania at New York and Philadelphia. The limitations of the steam locomotive determined the electrification of the Baltimore Tunnel on the Baltimore & Ohio, the Cascade Tunnel on the Great Northern, the St. Clair Tunnel on the Grand Trunk, the Hoosac Tunnel on the Boston & Maine, and the Detroit River Tunnel on the Michigan Central. Examples of electrified railroads with freight as well as passenger service are the Norfolk & Western; the Chicago, Milwaukee & St. Paul; and the New York, New Haven & Hartford.

While the other electrifications are successful and interesting, the last three are more properly representative of general railroad electrification. The Norfolk & Western is an example of electrification under the heaviest conditions of freight traffic on a mountain grade. The Chicago, Milwaukee & St. Paul has in operation the longest continuous mileage in the world, and when completed will cross five mountain ranges. The New York, New Haven & Hartford has a very large movement of both freight and passenger traffic.

All three installations are successful and profitable and, when financial conditions are stabilized and the American railroad question settled, it is expected that all three will extend their electrified service.

In addition, there are sections of railroads, in various parts of this continent, where the present congestion of traffic or the availability of water-power warrants the early adoption of electric power. Under normal conditions of finance, as no engineering problems now remain to be solved, these possibilities alone promise extensive activity in the electrification of railroads for many years to come.

Conditions Abroad

Differing from North America, European and South American countries, with the exception of England alone, lack an adequate supply of fuel, but many of them, including Norway, Sweden, Switzerland, Italy, Spain and Brazil, have large amounts of water-power, while France has a moderate amount. These resources, combined with the high cost of fuel, make extensive railroad electrification in these countries inevitable sooner or later.

The neutral countries will probably be the first to undertake this work, Switzerland having a well-established program covering a term of years, while both Norway and Sweden are giving active consideration to definite projects.

In England, a considerable amount of electrification is in contemplation along with the general plan for the electrification of industry.

A French commission composed of government and railroad engineers have already visited the United States in order to familiarize themselves thoroughly with American practice.

The Italian government will continue their definite program as soon as financial conditions permit.

An official Belgian commission is already planning to rehabilitate with electric power at least a portion of the railroads destroyed by the Germans.

In Spain, Brazil and South Africa, railroad electrification is under active consideration.

It is evident, therefore, that the next decade will see a large amount of railroad electrification in almost every quarter of the world.

The next (second) general conference of the Association of Canadian Building and Construction Industries will be held in Ottawa beginning January 20th, 1920. The association will also hold a convention next month in Winnipeg.

RULES FOR DRAFTING PRACTICE

Cover Concisely Dimensions of Drawings, Allowable Scales, Character of Lettering and Many Other Points

SOME ten years ago H. N. Savage, then with the United States Reclamation Service, and now hydraulic engineer for the city of San Diego, Calif., drew up the following rules regarding drafting practice. They have been in use ever since on his projects, with excellent satisfaction, says Engineering News-Record, of New York:—

Drawings should conform to the following sizes, several sheets being used if necessary, supplemented with an index sheet:—

Out to out.	Inside border.
8 x 11 ins.	7 x 10 ins.
11 x 16 ins.	10 x 15 ins.
16 x 22 ins.	14½ x 20½ ins.
22 x 32 ins.	20½ x 30½ ins.
32 x 44 ins.	30½ x 42½ ins.

Drawings of 10-in. vertical dimension, inside border, may be made any length necessary over 15 ft.

Trimming lines for drawings should be drawn on each tracing and the tracing cut ¼ in. outside these lines. Paper drawings should be cut to the same dimensions as tracings.

Tops of drawings should orient with north cardinal point.

Maximum dimension of drawings should be horizontal.

Do not abbreviate any words on drawings.

Sufficient legends should be used to identify all parts of a drawing.

Drawings must be independently checked with a degree of accuracy commensurate with the importance of the work involved.

The initials of the persons who draw, trace and check a drawing should be shown in the lower left-hand corner thereof. Those of the checker should be affixed by him in writing; the others should be printed.

The names of the supervising and project engineer or engineer in charge should appear on all drawings, but may be printed on drawings not requiring approval. Drawings of projected work and drawings involving policy, after being signed by the project engineer or engineer in charge, and before construction is begun, must be submitted to the supervising engineer, and if they are approved separate prints will be furnished to the project or feature office. Approved tracings will usually be retained in the files in the supervising engineer's office.

The subject of the drawing should form the major feature of the title, as, "Lower Yellowstone Dam." Such words as "map," "plat," "sketch," "location," "proposed," etc., should not be used in titles.

Drawings accompanying correspondence should be stamped on the margin "Transmitted to ....with letter dated ....19..," or, "Received from.................with letter dated ....19..," appropriate name and date being written in ink.

Paper drawings and prints should be folded right side out to letter size, title on top.

Only a minimum amount of work should be done on pencil drawings which are to be traced. Whenever practicable, preliminary penciling should be done directly on the tracing cloth.

Every tracing, in advance of its making, should receive an appropriate title and project number. Project and supervising engineers' file numbers should be placed on the margin in the lower right-hand corner.

Lettering on drawings should be placed to be read from the lower right-hand corner of the drawing. Plain single-stroke letters should be used except on drawings requiring distinctions between different kinds of names. Liberal and uniform spacing should be provided between words. Inclined Gothic lettering should be used on structural and mechanical drawings; capitals for special emphasis and in titles; lower case for general description and notes. Lettering on drawings 11 x 16 ins. or over should be of sufficient size to be legible when the drawings are reduced to one-half the original dimensions.

Contract drawings, except profiles, for photolithographic reproductions should be prepared for a reduction to about two-thirds the original dimensions, and to come down to a vertical dimension of 10 ins. between the border lines. Profiles should be prepared for reduction to one-half the original dimensions, with a vertical dimension of 10 ins. between the border lines. Where possible, two lines should be placed on a sheet. The horizontal scale of profiles should be made as small as practicable. Lettering on contract drawings intended for photolithographic reproduction should be in pencil, the final lettering being left to be put on in the director's office with standard type.

Drawings of land should show legal subdivisions or other co-ordinate lines referred to some fixed point, as section or quarter-section corners.

True north, also magnetic north if known, should be indicated on each drawing of land unless section lines are shown.

Vertical sections and elevations taken across a stream or canal should be shown looking downstream. Vertical sections and elevations taken along a stream or canal should, wherever practicable, show stream flowing from left to right. Stationing of profiles should, wherever practicable, increase from left to right of the drawing.

The direction of streams and of canals through structures should be shown by arrows.

Contours should be in 1, 2, 5, 10, 20 or 100-ft. intervals. Contours and figures showing their elevations should be in burnt sienna. Distinguishing contours should be of deeper color.

Graphic scales should be shown on each drawing. Following are approved scales:—

For maps and allied drawings, 10, 20, 40, 100, 200, 400, 500, 1,000 and 2,000 ft. and ½, 1, 2, 5 miles, and even multiples of 2 and 5, to an inch.

For engineering structures, ⅛, ¼, ½, 1, 3 and 6 ins. per foot, and 10, 20 and 40 ft. to an inch.

For mechanical and architectural drawings, 1/16, 1/18, ¼, ½ and full size.

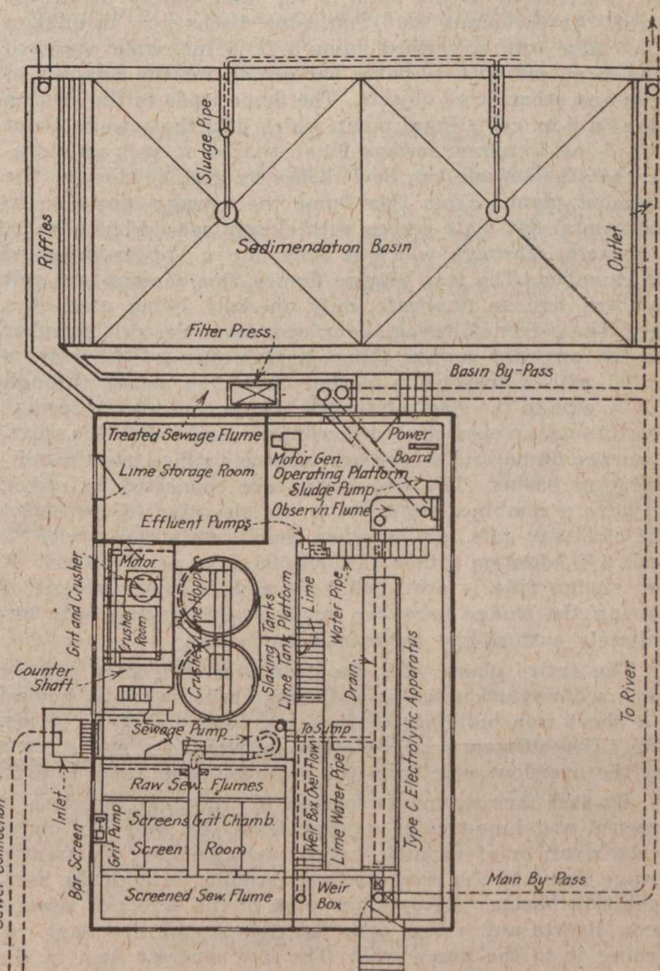
Following is a partial list of Canadian patents recently obtained through the agency of Ridout & Maybee, Toronto: Henry P. Fletcher, means for the conversion of water pastes into oil pastes by chemical and mechanical action; Jabez Muskett, hose couplings and hose attaching devices; Diaphone Signal Co., Ltd., metal bending and forming machine; Nile Testrup, methods of conducting high temperature reactions; E. O. Williams, slipways for the construction of reinforced concrete ships, barges and other floating structures.

The Portland (Oregon) Telegram announces the opposition of engineers of Multnomah County to the appointment of an eastern bridge engineer to design and construct several bridges in the city of Portland. The estimated cost of the bridge program is between $2,500,000 and $5,000,000. A number of Portland engineers appeared before the Board of County Commissioners and registered a protest against the plan to engage a Kansas City bridge firm to carry out the work. As a result of the protest, the Board of Commissioners asked the engineering societies of Portland to recommend an Oregon engineer who in their estimation is competent to undertake the entire program.

Two 25,000 k.w. steam-driven turbine units, which, when installed, will complete the largest steam-driven electrical installation in the Far East, are now being erected at Osaka, Japan, for the Osaka Electric Light Co. Located in an extensive industrial district, this company furnishes light and power to street railways, steel works, ship builders, copper refining plants, paper mills, electro-chemical installations and other industries. In 1908, the Osaka Co. installed three steam turbine units of 3,000 k.w. each. In 1910, two more units of like capacity were added, and in 1911 two, 5,000 k.w. units. The 25,000 k.w. units now being installed will bring the capacity of the plant up to 100,000 h.p.

OPERATING RESULTS OF "DIRECT OXIDATION" EXPERIMENTAL SEWAGE TREATMENT PLANT AT EASTON, PA.

IN November, 1917, the city of Easton, Pa., granted permission to C. P. Landreth, of Philadelphia, patentee of the "direct oxidation process" of sewage treatment, to construct an experimental plant for treatment of the city sewage. The plant was to have a nominal capacity of 1,000,000 gals. per day, and was to be installed without obligation on the part of the city. The plant was placed in operation shortly after May 1st, 1918. Tests of the experimental plant were conducted in December, 1918, by engineers of the State Department of Public Health, an 8-hour test run being made on December 4th, followed by a 24-hour test, starting at 8 a.m., December 6th. The results of these tests are given in a report by C. A. Emerson, Jr., chief of the Engineering Division of the Department. The matter following is an excerpt from this report:—



PLAN OF EXPERIMENTAL PLANT AT EASTON

The area tributary to the plant is divided into two distinct districts. The first is sewered on the separate system, contributing sanitary sewage only, while the second district contains combined sewers, contributing both storm water and sanitary sewage. A survey of the district indicated 585 properties connected to the sewer system as follows: 511 dwellings, 37 combined stores and dwellings, 10 stores, 2 office buildings, 3 hotels, 3 schools, 1 laboratory, 7 churches, 1 armory, 8 garages and 2 breweries. The order of the Federal Government closing breweries became effective four days previous to starting the test of the plant, hence the volume of manufacturing waste discharged from these breweries was much reduced.

The sewage received at the experimental plant appears to be a fresh, domestic municipal sewage of ordinary concentration and composition, and passes through a centrifugal pump before treatment.

The rainfall during the last part of November and the few days of December preceding the test was negligible.

The time of passage of sewage from the most distant house in the district to the sewage treatment plant is comparatively short, and probably does not exceed 1¼ hours. The low quantity of total solids, suspended solids and oxygen consumed indicate a relatively dilute sewage; the presence in appreciable quantity of nitrates and nitrites and the ratio between the organic nitrogen and the free ammonia contents show that the sewage is quite fresh as treated at the plant. The process of treatment at the plant consists of (1) coarse bar screens; (2) flat plate fine screens, ¼-in. circular openings; (3) grit chamber; (4) chemical treatment—3,720 lbs. lime per 1,000,000 gals.; (5) electrolysis; and (6) settlement.

Description of Plant

Sewage is diverted from 3 ft. by 4 ft. 6 ins. egg-shaped combined sewer through a 12-in. pipe, a concrete dam having been constructed in the main sewer immediately below the lateral. At the plant the 12-in. pipe discharges through a 10-in. valve into a covered flume 3 ft. 6 ins. wide equipped at its inlet end with a coarse bar screen for the removal of sticks and other large objects. The flume leads to the suction well of a 6-in. centrifugal pump which lifts the sewage about 14 ft. 6 ins. to a raw sewage flume, placed at such an elevation that the sewage can flow thence by gravity through the treatment plant. From this flume the sewage flows on to a horizontal flat plate screen with closely spaced holes ¼ in. in diameter, through which it falls into a hopper-bottomed grit chamber. The raw sewage flumes, fine screens and grit chambers are in duplicate, only one-half being used at a time. The screened sewage overflows from the grit chamber into the screened sewage flume, passes over a 3-ft. weir, is treated with a suspension of lime, and then passes through a 12-in. pipe to the electrolytic cell. From the cell the sewage flows through an open observation flume connected to the treated sewage flume, and thence over concrete riffles into the sedimentation basins. The two basins are connected in series, and have a combined capacity, to the elevation of the outlet weir of 88,740 gals., giving when clean a detention period of about 2⅛ hours on a flow of 1,000,000 gals. per 24 hours. A 4-in. sludge pipe is provided from each basin to permit of drawing the sludge onto two small sludge drying beds immediately east of the sedimentation basins.

The entire plant, with the exception of treated sewage flume, sedimentation basins and sludge beds, is neatly housed in a sheet iron building; 48 ft. 3 ins. long and 35 ft. 6 ins. wide. The difference in elevation between the fine screens and the overflow weir from the sedimentation basin is 5 ft.

By-pass arrangements permit of running screened or screened and lime-treated sewage from the weir box direct to the river, or of running treated sewage from the treated sewage flume to the river without passing through the sedimentation basins. An overflow pipe in the screened sewage flume diverts any excess over the capacity of the plant, returning it to the pump well. The low concrete dam in the main sewer permits the latter to take the entire flow when the pump is not operated or excess flow in time of storm.

Electrolytic Apparatus

The electrolytic apparatus is enclosed in a horizontal wooden tank, 27 ft. 3 ins. long, 3 ft. wide and 2 ft. 9 ins. high (outside dimensions), reinforced with steel plates and mounted on supports 18 ins. high. The 2-in. wrought iron vent pipes are carried up from the top of the tank for the removal of any excess gaseous products of electrolysis. A series of blow-out valves are provided along the bottom of the tank.

This tank contains 22 banks of plates, arranged in two layers of 11 banks each. Each bank of electrodes consists of 48 rectangular steel plates 16 ins. long, 10 ins. high and 3/16 in. thick, placed parallel to the sides of the tank, and spaced ⅜ in. apart. The plates are so connected that alternate plates have the same polarity, giving 24 pairs of plates connected in multiple in bank, the 22 banks being connected in series. Spaces between the banks and the sides of the tank are closed, compelling the sewage to flow through the ⅜-in. spaces between the plates. In each space between the plates two straight paddles of Bakelite are revolved, being attached to shafts passing through holes punched in the plates to receive them. The paddles are driven at a speed of 20 revolutions per minute by a 3-h.p. motor, the power being transmitted to the paddle shafts through suitable reduction gearing. The total number of paddles in this plant is 2,068.

At the normal rating of the plant, i.e., 1,000,000 gals. daily, the time of passage through the electrolytic cell is approximately 70 seconds, of which 17.4 seconds represent the time of contact with the electrodes, the remainder of the time being occupied in passing through dead space between successive electrodes. During contact the sewage travels in streams ⅜ in. thick for a distance of 14 ft. 8 ins. at a theoretical velocity of 0.84 ft. per second.

Lime Apparatus

Provision is made for using either lump or hydrated lime. When the former is used the lumps are broken by hand on a 3-in. grid placed over a crusher, which discharges into an elevator boot. When hydrated lime is used a spout delivers it directly into the elevator boot. The elevator discharges into an overhead hopper from which it is fed dry by adjustable feeding devices to the solution tanks.

The solution tanks are two in number, each 7 ft. in diameter and 3 ft. deep, each with an independent feeding device and agitator. Only one tank is used at a time.

The feeding device consists of a trough with a double worm feed actuated by a ratchet and pawls, which in turn are driven by a reciprocating link attached to an eccentric. The rate of feeding lime to the solution tank may be adjusted within certain limits by changing the throw of the eccentric and by varying the number of teeth engaged on the ratchet by changing the position of the pawl arm.

Either city water or plant effluent can be used in the solution tanks; when the effluent is used it is pumped by a motor-driven 1-in. centrifugal pump. In either case, the water enters the tank tangentially near the bottom to help the agitation and the lime suspension or milk of lime is drawn from the top of the tank. Agitation is by means of a two-bladed 10-in. fan placed at the bottom of the tank and operated at 900 r.p.m. by the 1-h.p. motor, which also drives the feeding device. The circulation is downward at the centre and upward at the sides.

Suitable piping delivers the lime suspension into either the spillway of the weir or the observation flume as desired.

Electric Motors

The following is the list of electric motors installed:—

For initial pumpage of raw sewage	1—7½ h.p. motor.
For lime treatment—	
Lime crusher	1—5 h.p. motor.
Effluent pumps	2—1 h.p. motor.
Feeding and agitation	2—1 h.p. motor.
For electrolytic cell—	
Paddles	1—3 h.p. motor.
Electrolysis	1—5 k.w. motor generator set.
For handling grit and sludge—	
Grit pump	1—2 h.p. motor.
Sludge pump	1—1 h.p. motor.

Of the four 1-h.p. motors listed under lime treatment only two would be in service at a time.

Description of the Process

The process is essentially one of fine screening, followed by lime precipitation, agitation, electrolysis and sedimentation.

The screening through ¼-in circular openings removes from the crude sewage solid particles of larger size than these openings.

The addition of the lime is claimed by the owner of the electrolytic process to be essential to that phase of the treatment of the sewage, but it should be borne in mind that chemical precipitation of sewage is one of the oldest processes known to the art and produces a very considerable removal of suspended solids.

The electrolytic action liberates nascent oxygen and hydrogen by the passage of the electric current through sewage rendered alkaline by the addition of lime. The agitation, in addition to its well-known effect in inducing precipitation, brings the sewage into intimate contact with the products of electrolysis. Chemical reaction is thereby stimulated while the gases are still in the nascent state and before they have an opportunity to escape. The paddles undoubtedly serve also to mechanically clear the plates and prevent polarization.

Positive Alkalinity

In normal operation the lime suspension is added to the sewage immediately before entering the electrolytic cell in order to insure positive alkalinity, a condition considered necessary for electrolysis without attack of the electrodes. There is a gradual deposit of calcium carbonate on the plates, which it is claimed can be remedied by temporarily shifting the point of applicaton of the lime to the outlet flume leading from the electrolytic cell. The sewage under such conditions is said to rapidly remove the coating from the plates, permitting normal operation to be resumed in 15 or 20 minutes. A heavy deposit on the plates is indicated by a marked increase in the power required to drive the paddles. No considerable increase was noted during the period of the test.

Some polarization of the plates occurs from time to time, but this is overcome by a reversal of the polarity, which quickly decreases the necessary voltage and increases the current.

For satisfactory operation it is said that the cell effluent should contain not less than 30 parts per million of excess alkalinity. During the period of the test this content was always exceeded.

As the sewage reaches the observation flume after passage through the electrolytic cell it contains the lime and the suspended solids. The subsequent sedimentation is to permit the deposition of these materials so as to clarify the effluent and separate the sludge for treatment.

Condition of Test

The plant had been closed since about October 15th, and intermittent operation was again resumed on December 2nd, only two days prior to starting the 8-hour test.

During the test the plant was operated by the company in order that there might be no division of authority and to controvert possible criticism regarding inefficient operation. The department's representatives observed the operation of the plant, made tests on power consumption, quantity of lime used, flow of sewage, and took samples of the sewage, etc.

Prior to undertaking the test all by-pass connections were closed and sealed, electric meters and water meters were read, and various measurements were made of the dimensions of the units.

During the 8-hour test electric and weir readings were taken at intervals of 15 minutes and at intervals of 30 minutes during the 24-hour test. Samples of the sewage, proportional to the flow, were collected every 30 minutes during the 8-hour test and every hour during the 24-hour test. These were mixed to form composites for chemical analysis for each test run. Settleability and alkalinity samples were collected every four hours, and putrescibility, dissolved oxygen and bacteriological samples were collected every 8 hours. Lime samples were collected at irregular intervals, averaging probably two hours, and thoroughly mixed, forming a single sample for analysis.

The Standard Methods of Analysis of the American Public Health Association were followed at the laboratory.

The flow of sewage was determined by weir readings taken every 30 minutes during the tests and varied from a minimum of 309,000 gals., which occurred at 2.30 a.m., to a maximum of 816,000 gals., which occurred at 11.30 a.m. The average flow during the 24-hour test was at the rate of 460,000 gals. per day, or slightly less than one-half the rated capacity of the plant.

During the 8-hour test the polarity of the electrolytic cell was changed at 3.23 p.m. in order to decrease the effects of polarization. Immediately after such change the voltage was found to be 40 and the amperage 55. During the 24-hour test a similar change was made on several occasions, but the exact hours were not noted.

At 4.20 on December 6th a portable voltmeter was applied to the various electrodes to determine whether the total voltage at that time was evenly distributed throughout the electrolytic cell. The results at the outlet end were as follows:—

Upper bank..	2.8	2.7	2.85	2.7	2.75	2.9	2.95	2.9	3.1	3.0	3.75
Lower bank..	3.0	2.7	2.55	2.65	3.0	2.9	2.8	2.75	3.4	2.8	3.45

Immediately after the completion of the test the switchboard ammeter was compared with a portable millivoltmeter with external shunt. The two were found to agree within 2 or 3 per cent.

Summary of Results of Tests

The following is a summary of the results of the tests:—

Power Consumption.	8-hr. test.	24-hr. test.
Lights and electric heaters..	11 k.w. hrs.	47 k.w. hrs.
Pump motor	30 k.w. hrs.	90 k.w. hrs.
All other power	50 k.w. hrs.	130 k.w. hrs.
Total	91 k.w. hrs.	267 k.w. hrs.
Total water consumption*..	66 cu. ft.	166 cu. ft.
Quantity of lime..........	....	1,712 lbs.
CaO content	....	61.52%
Average voltage for electrolysis	56.3	57.5
Average current for electrolysis, amperes	37.8	33.8
Average wattage for electrolysis	2,125	1,944
Average wattage for paddles	1,388	1,355
Sewage flow in gals. per 24 hrs.	482,700	460,000
Average sewage flow in gals. per hour	20,110	19,190
Electrolytic hydrogen liberated in grams per hour..	31.04	27.82
Electrolytic oxygen liberated in grams per hour......	247.73	222.03
Ratio of electrolytic hydrogen to sewage by weight....	0.4 p.p.m.	0.4 p.p.m.
Ratio of electrolytic oxygen to sewage by weight...	3.2 p.p.m.	3.0 p.p.m.

Bacteriological Results

Figures represent Bacteria per C.C.

8-Hour Test.

	Time	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
Total bacteria.	2.30 p.m.	800,000	200,000	38,000	2,000
B. Coli	2.30 p.m.	36,000	24,000	0	0

24-Hour Test.

	Time	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
December 6th—					
Total bacteria.	8.00 a.m.	920,000	680,000	24,000	65
B. Coli	8.00 a.m.	100,000	120,000	0	0
Total bacteria.	4.00 p.m.	240,000	216,000	2,500	1,500
B. Coli	4.00 p.m.	12,000	50,000	0	0
Total bacteria.	12 midnight	48,000	16,000	190,000	18,000
B. Coli	12 midnight	15,000	18,000	0	0
December 7th—					
Total bacteria.	8.00 a.m.	1,200,000	1,800,000	24,000	30,000
B. Coli	8.00 a.m.	45,000	30,000	0	0

*Includes toilet, lavatory and the stuffing boxes of the centrifugal pump.

Physical and Chemical Results

8-Hour Test.

	Time	Screened Sewage	Basin Effluent
Total alkalinity	12.15 p.m.	106	193
Total alkalinity	4.00 p.m.	103	326

24-Hour Test.

	Time	Screened Sewage	Basin Effluent
December 6th—			
Total alkalinity	8.00 a.m.	98	380
Total alkalinity	12.00 m.	89	276
Total alkalinity	4.00 p.m.	88	252
Total alkalinity	8.00 p.m.	98	282
December 7th—			
Total alkalinity	12.00 midnight	85	288
Total alkalinity	4.00 a.m.	86	341

Screenings Removed—(24-Hr. Test)

Bar screen	117 lbs.
Plate screen	379 lbs.

Results Expressed in Parts per Million—(24-Hr. Test)

	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
Total solids	217	248	608	640
Volatile solids	114	140	196	94
Fixed solids	103	108	412	546
Suspended solids	74	69	215	26
Nitrogen as—				
Organic	34.5	34.2	21.5	21.6
Free ammonia	11.3	11.5	9.2	9.3
Nitrites	0.045	0.05	0.06	0.06
Nitrates	0.46	0.45	0.93	0.90
Oxygen consumed	53	52	44	44

Raw sewage samples were collected from the discharge pipe of the pump after sewage had passed the bar screen. Screened sewage samples were collected after the sewage had passed the bar screen, the pump, the plate screen and the grit chamber. The samples of the cell effluent were taken from the observation flume. This sewage had passed the bar screen, the pump, the plate screen, the grit chamber and the electrolytic cell, and had also received the lime treatment.

Dissolved Oxygen

	Time	Temperature Degrees C.	Content P.P.M.	Saturation Pct.
Cell influent	10 a.m.	12.0	3.7	34
Cell effluent	10 a.m.	11.0	5.2	47
Cell influent	6 p.m.	12.0	6.8	63
Cell effluent	6 p.m.	11.0	7.0	63
Cell influent	2 a.m.	12.5	6.7	62
Cell effluent	2 a.m.	12.5	8.3	77

Putrescibility

Using Methylene Blue at 20 Degrees C.

8-Hour Test.

	Raw Sewage Days	Screened Sewage Days	Cell Effluent Days	Basin Effluent Days
1.45 p.m.	1	1½	4½	9½

24-Hour Test.

	Raw Sewage Days	Screened Sewage Days	Cell Effluent Days	Basin Effluent Days
December 6th—				
9.00 a.m.	1	1	14	14
3.00 p.m.	1½	1½	14	12
11.00 p.m.	1½	1½	14	14
December 7th—				
7.00 a.m.	1½	1½	14	14

Putrescibility of Sludge from Resettling Basins

	100% sludge	75% sludge, 25% river water	50% sludge, 50% river water	25% sludge, 75% river water	100% river water
Standard quantity methylene blue solution	3 hrs.	3 hrs.	3 hrs.	3 hrs.	14 days
Three times standard quantity methylene blue solution	3 days	14 days	1 day	3 days	14 days

In the above table the entries signify the period during which the samples retained a blue color excepting in cases where the entry reads 14 days, which signifies that the color was still present when the samples were thrown away at the end of the 14-day period.

It was feared the bleaching properties of the lime would have a marked effect on the methylene blue solution added to samples of sludge mixed with varying proportions of the river water. Accordingly, the standard quantity of methylene blue solution was added to one set of samples and three times this standard quantity to the check set, including the control samples. It will be noted that the samples of 100% river water were stable for two weeks in both cases, but in the other samples, containing varying proportions of sludge and river water, the lime apparently had a perceptible effect upon the methylene blue. The samples containing the greater proportion of methylene blue retained the color for longer periods, although the period of retention of color was not proportional to the percentage of river water, tending to throw some doubt upon the accuracy of this determination.

The appearance of the raw sewage was typical of fresh dilute sanitary sewage from an American municipality except at times when brewery wastes are present.

The effluent from the electrolytic cell had a brownish cast, contained a flocculent precipitate, and evidenced tendency to form a floating froth in the observation flume and inlet end of the settling basin. The flocculent precipitate settled rapidly, leaving a clear, greenish-tinged supernatent liquid, excepting when large volumes of brewery wastes were passing through the plant, when the effluent from the basin was clear amber color and contained some suspended matter.

There was no opportunity during the test to determine the feasibility of drying sludge from the settling basin upon the sand beds.

At the end of the 24-hour test the cover on the effluent end of the electrolytic cell was removed and the electrolyte drawn down a short distance below the top of the plates. After removal of the coating these plates, as far as could be seen, were bright and in good condition. The coating, which was removed easily by rubbing with the fingers, was found on analysis to contain 1.73% of iron.

There was no evidence during the test that under operating conditions there is a rapid deterioration of the plates to form a chemical coagulant, which was purposely intended in the early processes for the electric treatment of sewage.

Life of Electrolytic Cell

The company states that the cell under test at Easton had not received any repairs during the summer, and, in fact, the cell cover had not been removed prior to the conclusion of the 24-hour test when it was opened at request of the department representatives in order to observe the condition of the plates.

Records of electric current consumed during the past summer (May to October, inclusive) were obtained from the monthly statements of the local electric company. It was found that the current consumed by the pump would have been sufficient for approximately 18 days' continuous operation and current recorded by the meter supplying circuits for the lime-feeding and mixing devices, the solution pump, electrolytic cell and revolving paddles would have been sufficient for approximately 16 days' continuous operation. These periods are obtained by using the current consumption during the 24-hour test as a basis. The higher figure for the pump is probably due to the fact that the flow of sewage was greater on some days than during the 24-hour test, while the current required for the lime-feed and the cell did not vary uniformly with the flow of sewage.

The company states that the cell remained filled with sewage during periods when it was not operated.

Freedom from Nuisance

During the department's test the entire apparatus was free from objectionable odors. Inquiry was made at houses in the vicinity and it was found that the residents quite generally had no cause for complaint.

There is little reason to anticipate nuisance conditions from the screens, cell or settling basins when handling fresh sewage for there would normally be dissolved oxygen present throughout the process. Freedom from nuisance, however, cannot be predicted with any degree of certainty in a large municipal plant which must necessarily contain sludge beds or sludge presses for dewatering the sludge. In fact, it is altogether probable that disposal of the sludge would at times be attended by offensive odors.

Difficult to Predict Costs

It is difficult to predict, with a satisfactory degree of accuracy, the cost of operating a large unit by comparison with data collected through operation of a single small unit. However, in the absence of complete information reliance must be placed upon such data as are available and reasonable factors applied to meet expected conditions in the larger plant. The following figures regarding cost of operating the plant at Easton are therefore given as a rough indication of what might be expected, but apply more particularly to a plant of a similar size operating under the same conditions—namely, pumping of sewage and the addition of lime at a rate stated by the owner of the patent as being greatly in excess of that necessary to secure satisfactory results:—

Cost of Operation

Without Pumpage—	
Hydrated lime, 1,712 lbs. at $6.75 per ton	$ 5.78
Water for mixing lime, 20 cu. ft. at $0.003 per cu. ft.	.06
Electric power, 130.6 k.w.h. at $0.0226	2.95
Electric lights, 6¼ k.w.h. at $0.0805	.50
Heating	1.25
Labor and superintendence	15.00
Electrode renewals, company's estimate	1.00
Maintenance and repair	1.50
Total	$28.04
Add for Pumpage—	
Electric power, 88.3 k.w.h. at $0.0226	2.00
Water, 120 cu. ft. at $0.003 per cu. ft.	.36
Total	$30.40
Equivalent cost per 1,000,000 gals.	66.00

These figures are on the basis of pumping and treating 460,600 gals. excluding allowance for interest and sinking fund charges and cost of sludge pumping, treatment and disposal. The costs of hydrated lime, water and electric current are those which the department understands obtain at Easton. The figure for labor and superintendence is based upon employment of a superintendent at $1,650 a year who should be able to make necessary bacteriological and chemical tests and who is familiar with the theory of operation of the

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GOVERNMENT CONTROL OF G.T.R.

The Grand Trunk Railway System of Canada, with all its lines in and out of the Dominion, including the Grand Trunk Pacific, is to pass into the possession and control of the Dominion Government. The bargain has been made with the government by Sir Alfred Smithers, representing the stockholders of the Grand Trunk. It will have to be ratified by Parliament and by the stockholders of the Grand Trunk.

The stock of the company is to be acquired by the government. The payment will not be in cash, but by an exchange of securities. The holders of the preferred and common stock will transfer their shares to the government, and will receive in exchange therefor shares which will have no voting power, but will earn four per cent. guaranteed by the government. As the preferred and common shares of the company are now considerably below par, their value is to be determined by a board of arbitration and the agreement provides for the appointment of such a board.

The debentures will be assumed by the government. They amount to £31,926,125. The guaranteed stock, amounting to £12,500,000, will be treated as debenture stock, and the payment of the 4 per cent. dividend will be guaranteed by the government.

The holders of debentures and guaranteed stock are to surrender all voting powers.

The other stock of the company falls into four classes, namely, first preference, second preference, third preference and common; the total par value of these four stocks is £37,073,492.

As soon as the bargain has been ratified, the road will be turned over to a committee of management. Two members of the committee will be named by the government and two by the company, and the four will select a fifth member. This committee will operate the road during the arbitration, and will operate it in close connection with the Canadian National Railway System. After the arbitration has been completed and the stock has been transferred to the government, the committee of management will be discharged and the Grand Trunk lines will become a part of the Canadian National Railway System.

In estimating the value of the stock the arbitrators are to refer to the fixed charges and other liabilities of the Grand Trunk and will take into consideration all the liabilities of the Grand Trunk on account of the Grand Trunk Pacific.

Hon. Arthur Meighen, Minister of the Interior, has introduced into Parliament a resolution ratifying the agreement with the G.T.R. It will be debated at length during the present session.

PROPOSED SCHEDULE OF CIVIC SALARIES AT BALTIMORE

The Baltimore chapter of the American Association of Engineers presented to the Board of Estimates of the city of Baltimore, under date of September 27th, a report of the compensation committee of that chapter on salaries of engineer employees of the city, with the request that the board analyze the situation and take such action as seems advisable.

The schedule recommended covers more than 60 grades of engineer employees of the city. It recommends an increase for the chief engineer of at least $2,500 to bring his salary up to a minimum of $10,000 per annum, with a maximum of $15,000. Some of the other recommendations are tabulated below:—

Present Title	Present Annual Salary	Annual Salary Recommended by Committee, Minimum	Maximum
Highways Engineer, Water Engineer, Harbor Engineer, Chief Engineer Paving Commission and Inspector of Buildings	$4,000	$5,000	$7,500
Division Engineer of Sewers	3,300	3,600	5,000
Principal Assistant Engineer Water Department	3,000	3,600	5,000
Mechanical Engineer Water Department	2,700	3,600	5,000
Assistant Engineer Water Department	2,200	2,700	3,300
Assistant Engineer of Bridges and Improvements Highway Dept.	2,000	2,700	3,300
Designing Engineer Water Department	1,800	2,700	3,300
Assistant Engineer, Grade AA, Water Department	.....	2,400	3,000
Office Engineer Paving Commission	2,000	2,400	3,000
Field Engineer Highways Department	1,500	2,400	3,000
Draftsmen all Departments	1,500 max.	1,500	2,100
Instrumentmen all Departments	1,200	1,500	2,100
Rodmen all Departments	1,020	1,200	1,500
Tracers all Departments	840 max.	1,080	1,200
Chainmen all Departments	900 max.	1,080	1,200

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PRINCIPAL CONTENTS

ASSOCIATION OF C. B. & C. I. CONSTITUTION

THERE should be no delay in adopting the constitution that has been drawn up for the Association of Canadian Building and Construction Industries by its president, J. P. Anglin, of Montreal. The association has been badly handicapped in its work this year by the lack of such an instrument. Both Mr. Clarson, the former general secretary, and Mr. Reilly, the present acting general secretary, have been placed in the undesirable position of "passing the hat" instead of being able to solicit membership upon a clean-cut basis in a definite organization.

The Association of Canadian Building and Construction Industries began well at the splendid general conference held last November in Ottawa, but since then it has been largely a mythical and shadowy form, lacking definiteness and concrete shape. The constitution which Mr. Anglin proposes, if formally adopted by the members of the national council, to whom the delegates of the last convention gave the right to prepare and adopt such a constitution, the whole status of the association will be materially and beneficially changed.

By the adoption of this constitution, the association will become a living entity. There will be a definite *modus operandi* and fees will be collected upon a business-like basis. The relations of the association to local bodies will be clearly defined, and through the large representation of local bodies in the membership of both the association at large and of the national council, the various builders' exchanges through the country will, to a large extent, govern the affairs of the national association. In fact, with the strengthening and growth of the local associations that will result from the cooperation of the national association, the representation of local associations will so grow that the national association will largely become a national parliament of representatives of local associations.

These representatives, who will in the main be representatives of a large number of comparatively small firms throughout the country, will be aided in their deliberations, and their actions will be given additional weight and prestige, by the presence in these national parliaments of the direct members, who will in the main be representatives of the big business interests of the country.

ARBITRATION vs. INVESTIGATION

AN interesting article in the constitution that is being considered by the national council of the Association of Canadian Building and Construction Industries, but one which is not likely to prove of very tangible benefit to members of the association, is the article providing that the executive committee be empowered to appoint arbitrators to hear and decide controversies, disputes or misunderstandings relating to any commercial matters or practice as between members of the association, which may be voluntarily submitted by the parties in dispute.

We venture to predict that the executive committee will not be worked overtime with the appointment of such boards of arbitration. A board appointed in such a manner would be a tribunal or investigating committee, but not a board of arbitration. The members who make use of this clause will be practically referring their disputes to the executive committee, or at least, practically speaking, to a sub-committee whom the executive committee may appoint to examine into and settle the dispute.

There is only one way in which a real board of arbitration can be formed, and that is the generally recognized method of having one party to the dispute appoint one member and the other party to the dispute appoint the second member, and then to have those two members select a third.

It is possible, however, that the arbitrations which the framers of this constitution had in mind, were not so much industrial or financial disputes as trade customs or practices. Just how far the executive committee or national council of the association should go, either directly or through appointed committees, in legislating trade practices, is a debatable point and one which will no doubt be the subject of much discussion in years to come.

There is no question but that the association could be of material benefit to the building and construction industry as a whole by enforcing certain desirable customs and by eliminating a number of undesirable practices; however, activities along these lines are very likely to be challenged by individual members, and might be misunderstood by the public as savoring too much of a "gentlemen's agreement" or "contracting ring." The arbitration article in the association's constitution will prove to be either a dead letter or else somewhat of a "joker," pregnant with possibilities.

C. M. I. COMMENT ON CLASSIFICATION

"COMMENT on the new Civil Service classification and schedule of compensation has already appeared in several recent issues of the 'Bulletin,'" says the October issue of the "Canadian Mining Institute's Bulletin." "The proposals embody the recommendations made to the government by Arthur Young & Co., of Chicago, Toronto and New York, and they have called forth serious objections from many of the engineers in the civil service.

"The classification proposed is so unscientific and cumbrous that it is an almost impossible task to make a comparative analysis of the salary schedule as it applies to technical men in the different government departments. So far as is possible, however, such an analysis has now been made by Arthur S. Tuttle, chairman of the U.S. Engineering Council's committee on classification and compensation of engineers.

"Since this committee has made a special study of the subject, Mr. Tuttle's report carries weight. It raises many of the same criticisms which have already been voiced by individual engineers."

OPERATING RESULTS OF "DIRECT OXIDATION"

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process and upon employment of an operator on each 8-hour shift at a salary of $1,200 a year.

If we assume that the plant could be operated continuously at a normal rating (1,000,000 gals. a day) the unit costs would be materially reduced and would probably be approximately as follows:—

Without Pumpage—	
Hydrated lime, 3,720 lbs. at $6.75 a ton	$12.56
Water, 20 cu. ft. at $0.003 per cu. ft.	.06
Electric power, 185.5 k.w.h. at $0.0226	4.19
Electric lights, 6¼ k.w.h. at $0.0805	.50
Heating	1.25
Labor and superintendence	15.00
Electrode renewals	1.00
Maintenance and repairs	1.50
	$36.06
Add for Pumpage—	
Electric power, 117.7 k.w.h. at $0.0226	$ 2.66
Water, 120 cu. ft. at $0.003	.36
Total	$39.08

These figures are exclusive of allowance for interest and sinking fund charges and cost of sludge disposal. It will be noted that the lime has been increased proportionately to the flow as this quantity was added during the test. Should it later appear that the quantity of lime can be reduced without deterioration of the effluent there would be a corresponding reduction in cost of treatment. It is probable that the cost of sludge, pumping, treatment and disposal will be in the neighborhood of $7.50 per 1,000,000 gals.

Conclusions of Engineering Division

Consideration of the performance of the plant as operated by the owners and as observed by the members of the Engineering Division of the department on December 4 and 6, 1918, lead to the following conclusions:—

1. The combined action upon the sewage of the fine screen, lime treatment and the electrolytic cell render the sewage in such a condition that after sedimentation in properly designed tanks, the effluent can be discharged into a stream, affording a reasonable dilution of relatively clean water, without danger of creating a nuisance. It is, of course, assumed that the effluent will be discharged through properly designed outlet so as to cause dispersion in the stream.

2. The fine screen, lime treatment and electrolytic cell have a destructive action on bacteria of the colon group. If, however, the use of the receiving body of water demands a high degree of bacterial removal in sewage effluents discharged therein, it would be on the side of safety to provide for disinfection of the cell effluent.

3. Assuming fresh domestic sewage, proper design, operation and maintenance of the various devices, the treatment of sewage by the above described processes should be free from objectionable odors, with the possible exception of the removal and disposal of the screenings and the sludge from the final settling basins.

4. Similar screenings are being successfully disposed of elsewhere by incineration or burial and the sludge from the final settling basins should be susceptible of dewatering by presses such as are used in sewage treatment works, including the lime precipitation method.

5. The process should be extended by installation of some adequate method for treatment of sludge removed from the settling basins as discharge of this sludge with the cell effluent is not permissible.

6. The cost of installation of a sewage treatment works, including the above processes should not be excessive, but the cost of operation would appear to be higher than for other methods of sewage treatment in general use to produce an equal quantity of effluent.

Each proposed installation should be examined by com-

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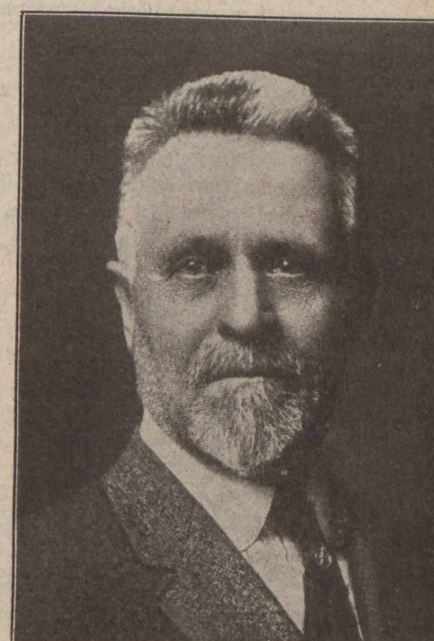
PERSONALS

J. M. Diven, secretary of the American Water Works Association, who is planning the details of the next annual convention, which will be held in Montreal, Que., has resigned as superintendent of the bureau of water of Troy, N.Y., and will devote his entire time hereafter to the affairs of the association. Mr. Diven's headquarters will be in New York City, the association having secured rooms at 153 West 71st St. Mr. Diven's connection with the water works industry has been of long standing. In November, 1873, he was appointed as an assistant in the office of the Elmira Water Works Co., in Elmira, N.Y., and two years later became secretary-treasurer of the company. At first he was in charge of the office, but later he gradually assumed the outside work, and in 1886 he was appointed superintendent of the company. In January, 1905, Mr. Diven resigned at Elmira in order to go to Charleston, S.C., as superintendent of the Charleston Light & Water Co., which position he relinquished in 1912, when he was appointed superintendent at Troy. Mr. Diven was first appointed secretary of the American Water Works Association in 1889, and he served in that capacity until 1891, when he was elected president. The following year he became secretary-treasurer, but later those two offices were separated and since 1902 he has been secretary of the association.



D. W. Munn, of Montreal, has been appointed professor of civil engineering at the Royal Military College, Kingston, Ont.

Leonard Dunaway, who has been in the British navy for the past four years, has been appointed superintendent of the Vermilion, Alta., power plant.

M. J. Butler, managing director of Armstrong & Whitworth of Canada, Ltd., of Montreal, has resigned and is now living in Oakville, Ont. Mr. Butler was deputy minister and chief engineer of the Department of Railways and Canals from 1905 to 1910, when he resigned to become second vice-president and general manager of the Dominion Iron & Steel Co. and the Dominion Coal Co. He left the Dominion companies in 1912 in order to organize a Canadian branch for the well-known English firm, Sir W. G. Armstrong, Whitworth & Co., Ltd. Mr. Butler is a Companion of the Order of St. Michael and St. George, and is also a doctor of laws. He was called to the Illinois bar in 1897, nineteen years after he commenced practice as an engineer and Dominion Land Surveyor.

OBITUARY

Frank J. Lyman, managing director of the Lyman Tube & Supply Co., Ltd., Montreal, died suddenly two weeks ago at the age of 42. He was the founder of the business, which was the successor to the railway department of John Millen & Son, Ltd., Montreal, which department he managed for 10 years prior to the establishment of the Lyman Tube & Supply Co., Ltd.

OPERATING RESULTS OF "DIRECT OXIDATION"

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parison with other methods of sewage treatment to determine if savings in installation cost would be sufficient to counterbalance the increased maintenance and operation charges.

If it should be determined that the proportion of lime could be materially reduced without deterioration in the quality of effluent there would be a proportionate reduction in operating costs.

7. To permit continuous operation of a works including these processes, electrolytic cells and other equipment must be in duplicate. It is undoubtedly necessary to replace plates in the electrolytic cell from time to time and accordingly a type of cell should be adopted which admits of such renewals in place and at a minimum cost for labor.

8. The short observations of the combination of fine screening, lime treatment, electrolytic cells and final settlement appear to justify an extended test by this department should the opportunity be offered. Such tests should include study of results secured with lime additions reduced to the proportion the owner of the patent claims as the actual needs of the process and should also include study of various methods of treatment and disposal of the sludge from the resettling basins.

CONSTRUCTION NEWS SECTION

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

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

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

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Belleville, Ont., excavation and building foundation walls	Oct. 17.	Oct. 9.	48
Hartney, Man., wooden pile bridge	Oct. 17.	Sept. 25.	45
Port Maitland, Ont., reconstruction of pier	Oct. 20.	Oct. 9.	54
Rimouski, Que., monument	Oct. 30.	Sept. 25.	52
Shellmouth, Man., bridge floor	Oct. 21.	Oct. 9.	45
Toronto, Ont., annual supplies	Oct. 28.	Oct. 9.	46

BRIDGES, ROADS AND STREETS

Barrie, Ont.—Sidewalks may be constructed on Victoria St., between Sanford and Innisfil Streets, on the south side of Sophia St., on the west side of Bayfield St., and on the north side of Ross St., from Small St. to Kidd's Creek.

Barrie, Ont.—The town council instructed K. S. Macdonell, town engineer, to secure estimates on a pavement for Dunlop and Elizabeth Streets.

Batiscan, Que.—The provincial government has decided to erect a steel bridge over the Batiscan river.

Bedford Tp., Que.—The township council decided to carry out a programme of road improvement. Application will be made to the Provincial Road Department for $20,000 under the Good Roads Act, and the roads will be built as early as possible next year.

Calgary, Alta.—City council decided to have Tenth Ave., from Eighth St. W. to Fourteenth St. W., graded, at a cost of $2,366. City clerk, J. M. Miller.

Chatham, Ont.—Tenders will be received by W. M. Abraham, R.R. No. 1, Chatham, Ont., up till noon on Saturday, October 18, for the construction of about 18,000 square feet of sidewalk on Grand Ave. and Taylor Ave., near Chatham. Plans and specifications may be seen at the office of W. G. McGeorge, C.E., Chatham.

Dundas, Ont.—Ratepayers will vote on a by-law to provide $3,500 for rebuilding Head St. bridge. Engineer, J. W. Tyrrell, Hamilton.

Hamilton, Ont.—The city council intends to construct a pipe sewer on Bay St., from Macaulay St. to Burlington St. S. H. Kent, city clerk.

L'Assomption, Que.—Tenders will be received up to 10 o'clock a.m. of October 20th, 1919, by Jos. E. Duhamel, secretary-treasurer, L'Assomption, Que., for the erection of a bridge. One price must be for the superstructure in steel and another price for all the other work in constructing the bridge. For all further particulars, address the secretary-treasurer.

Lindsay, Ont.—Town council instructed the board of works to construct several granolithic walks. Clerk, Duncan Ray.

London, Ont.—A by-law will be submitted to the ratepayers in January, authorizing an expenditure of $50,000 for a new bridge on Ridout St.

London, Ont.—Tenders, addressed to the "Chairman and Members, No. 2 Committee," will be received at the office of the city clerk up to 3 p.m. on Monday, October 27th, 1919, for the supply of one 1,200 U.S. gallon capacity motor-driven street flusher, complete. Specifications, etc., may be obtained at the office of H. A. Brazier, city engineer.

London, Ont.—The construction of a new pavement on King St., between Wellington and Richmond Sts., is to be commenced at once. City clerk, S. Baker.

New Westminster, B.C.—The provincial department of railways has decided to construct a footbridge sidewalk as an addition to the railway bridge which spans the Fraser river here. Estimated cost about $13,000 or $14,000.

Norwood, Ont.—It is reported that the Provincial Highways Department, in order to test the qualities of the rock from the Belmont township quarries for road-building, will construct a piece of road between Havelock and Trent River, a distance of about four miles.