PAGES

MISSING

Volume 21. Toronto, August 17, 1911 Contents of this issue on page 195

The Canadian Engineer

An Engineering Weekly.

BIGHORN COAL BASIN.*

G. S. Malloch

The Bighorn coal basin, situated in western Alberta, is named from the Bighorn range, an outlier of the Rocky mountains, nine miles east of the first range, and extending from the North Saskatchewan to the Brazeau river. The first discovery of coal in the basin between this range and the mountains was made by Mr. D. B. Dowling, in 1906. Analyses of his samples proved that the coal was well adapted for use in locomotives, and inasmuch as at that time, no occurrence of a satisfactory fuel was known nearer to the routes of the Grand Trunk Pacific, and Canadian Northern railways, the discovery attracted much attention when made public soon after Mr. Dowling's return. Two companies purchased large holdings in the basin, shortly afterwards, and its importance as a coal field was fully proved in 1907, when Mr. Dowling discovered that the coal-bearing formation contained at least nine workable seams, with an aggregate thickness of 66 feet. The next summer the German Development Company sent Mr. James McEvoy to make a thorough examination of their properties. During the same season the writer, in accordance with the instructions of the Director of the Geological Survey, made a photo-topographic survey of the basin and a study of its geological structure. Mr. McEvoy, who was a member of the Geological Survey for a number of years, has furnished sections of the Coal Measures, at two widely separated points, with thicknesses of the various seams, and analyses of carefully averaged samples from the more important ones.

The area mapped is bounded on the north-east and south-west respectively by the Bighorn range, and the first range proper of the Rocky mountains. These ranges form the geological as well as the topographic boundaries of the basin; and though the coal-bearing strata extend beyond the Saskatchewan and Brazeau rivers, the term basin is no longer applicable there, owing to the dying down of the Bighorn range, which does not form a well marked topographic feature except between these rivers. On the south, the valley of the Saskatchewan is mapped, and the slopes of the first range and the foothills east of it. To the north of the basin, the valley of the Brazeau is very broad owing to the confluence of three large tributaries, but because of lack of sufficient time it was found impossible to survey more than a portion of it.

The length of the area mapped south-east to north-west is about 36 miles, and its average width about 9 miles. The area is, therefore, about 320 square miles. The basin is situated, roughly, 85 miles north-west of Banff, 140 miles west-south-west of Edmonton, and 70 miles south of the surveyed routes of the Grand Trunk Pacific and Canadian Northern railways.

At present the basin can be reached by means of pack trails only. The shortest of these leaves the main line of the Canadian Pacific railway at Laggan, ascends the Pipestone to the high pass of that name, descends the Siffleur to the Saskatchewan, and follows it for about 18 miles to the basin. This trail cannot be used in the winter, spring, or early summer, owing to the depth of snow which accumulates in the pass. Another trail leaves Banff and follows the Cascade trough, crossing Panther creek, Red Deer, and Clearwater rivers, and descends to the Saskatchewan by Rabbit creek, which enters it about 2 miles below the mouth of the Siffleur. The four summits on this trail are from 1,000 to 2,000 feet lower than the Pipestone pass, so that it can be used much earlier in the summer. Another trail, much used by the Stoney Indians, leaves their reserve at Morley, and traverses the foothills to the Red Deer river, by which it enters the mountains.

The basin may be reached from Morley or Innisfail without entering the mountains, but several bad muskegs must be encountered. In character the topography of the basin is intermediate between that of the eastern ranges of the Rockies and the foothills east of them. For the greater portion of the space between the International Boundary to the Athabaska river there is a sharp line of division between the two types. To the east the foothills from a succession of long ridges with even crest lines, and without noticeable differences in elevation, while to the west, the mountains are much higher and exhibit serrate crest lines and great irregularity in height. Seen from Calgary, situated 50 miles east of them, the mountains extend in a long line of peaks and appear to rise as abruptly from the foothills region as from a plain.

At certain intervals, however, outlying ranges occur in front of the general line of the mountains, and at various distances from it. In height, these outliers are not greatly inferior to the mountain ranges; but, unlike them, they extend for short distances only, and near their extremities they are so reduced in height that they pass almost imperceptibly into ridges of no greater elevation than the other foothills.

Both the mountains and the foothills are crossed by the deep transverse valleys of the rivers draining the region. Some of the rivers, like the Bow, follow longitudinal valleys for some distance, but the majority break almost directly across the ranges, and receive only small tributaries from the longitudinal valleys. The general direction of the ranges of the mountains and ridges of the foothills is south-east and north-west.

Local.—The distance between the Bighorn and first range—about 9 miles—is much greater than is usual between the ranges of the mountains, and the intervening basin bears a strong resemblance to the foothill country. It is traversed by three fairly well defined ridges running parallel with the bordering ranges. These ridges differ from foothills only in their slightly greater height and more irregular outlines. The transverse valleys of the Saskatchewan and Brazeau are broad and deep, and their tributaries, with three other streams which break through the Bighorn range, so dissect the area that its basin-like form only becomes apparent when a mountain is climbed, and its general elevation can be compared with that of the bordering ranges. The general elevation of the basin is between 2,200 and 3,000 feet below the ranges, and about 2,000 feet above the deep valley of the Saskatchewan.

The valleys of the Saskatchewan and Brazeau run across the ends of the basin. They are broad and deep, and like the other transverse valleys in the mountains and foothills are U-shaped. The Bighorn range reaches an elevation of

* From Dominion Government Report.

4,700 feet (approximately) above the Saskatchewan valley. This height and its length of over 30 miles make it the most important of the outliers which have been described along the edge of the Canadian Rockies. Near the Saskatchewan and Brazeau the height of the Bighorn range decreases rapidly, and beyond them it is represented by ridges no higher than the rest of the foothills.

In its general form the range differs little from the eastern ranges of the mountains. Like them it presents a precipitous face to the north-east, but to the south-west the slope is usually at an angle between 20 and 40 degrees. The crest line is serrate throughout, and cirques have been developed on both sides, cutting the slopes into spurs and re entrants. The cirques developed on the north-east face are usually deeper, and three of them extend entirely through the range, and are continued as semi-circular depressions behind it.

As has been stated, the basin is traversed by three longitudinal ridges approximately parallel to the bordering ranges. The first of these is only a short distance behind the Bighorn range, but is separated from it by a depression which is never less than 200 feet deep. This ridge bounds the depressions inside the Bighorn range, and, in some cases, it reaches an elevation of 7,500 feet. The outline of the ridge is very irregular, however, and the strata composing it have been much dissected by cirques and stream gullies. Wapiabi, Blackstone, and Chungo creeks divide into numerous tributaries inside the Bighorn range, and then cut through the ridge, often obliquely to its general direction. As a general rule, the ridge reaches its greatest elevation on its western side, but the spurs of the ridge often rise to subordinate summits, and many hills are wholly detached from other portions of the ridge by the valleys of the streams crossing it diagonally. Immediately north of the Saskatchewan, the ridge is cut almost in half by the valley of Bighorn river, and its total width is much increased owing to an irregularity of the geological structure in this locality.

The second longitudinal ridge is much more regular than the first, and except for the gaps of the larger streams, and a few notch-like depressions cut by smaller ones, it is continuous from the Brazeau valley to that of the Bighorn. The general trend of this ridge is not quite parallel to the Bighorn range, from which it gradually recedes towards the south-west. However, it is never far from the centre of the basin.

The climate of the basin does not differ much from that of Morley and Banff, on the main line of the Canadian Pacific railway. The rainfall varies somewhat from year to year, but is always sufficient for the growth of grass wherever openings occur in the woods. Summer frosts are frequent, except at the low level of the Saskatchewan valley, where turnips have been grown successfully. Here the growth of grasses and pea vines reaches the knee, and is so thick that tracks of horses made fully a month before could be followed. The frequency with which this valley is visited by Chinook winds prevents the accumulation of snow in winter, and it has long been a favorite spot with the Indians for wintering their horses.

Only seven varieties of trees were seen in the basin—spruce and Banksian pine being much the commonest. The pine flourish where the soil is sandy and the drainage good, while spruce requires more moisture. One grove of spruce, probably 10 to 12 inches in diameter and 75 feet high, was seen near the mouth of Bighorn river, but the greater part of the Saskatchewan valley and the surrounding hills has been burnt over at a comparatively recent date. There has been much less fire farther north, and the valley of the Brazeau has escaped altogether. Balsam usually grows with the spruce, while aspen poplar and cottonwood are found at lower levels, especially in old brules. A few Douglas fir occur on the gravel banks which line the Saskatchewan.

Lithological Characters.—The Bighorn formation consists of siliceous and shaly sandstones, black and brown shales, and several bands of conglomerate, which, like the rest of the formation, bears a strong resemblance to corresponding strata occurring in the Kootanie formation.

Age and Thickness.—The only well preserved fossils found in this formation were specimens of Inoceramus umbonatus, but a few ribbed shells, probably cardia, were also seen. The horizon is Colorado; the thickness is 390 feet. The Bighorn and the first range of the Rocky mountains are huge fault blocks, tilted and thrust to the north-east until Devonian strata at their base have overridden Jurassic and Cretaceous. Along the south-western side of the basin all the formations between the Upper Banff shales and the Brazeau formation come into direct contact with the Intermediate beds at the base of the first range. The throw of the fault east of the Bighorn range is sufficient to bring Intermediate beds into contact with Wapiabi shales near the middle of the range, but the amount of the throw decreases rapidly near its ends. This decrease is much more rapid at the southern end of the range, where it is accompanied by a sudden change in the direction of the dip of the beds. To within 5 miles of the end of the range the dip shows but little deviation from the south-west direction which is general throughout the rest of the range, but at the end it has swung round to nearly directly south. This sudden change has probably induced some of the minor structural irregularities which will be described later.

The angle of dip of the strata in the Bighorn range varies between 35 and 60 degrees, and, as a general rule, the angle of dip of the younger strata in the basin west of it decreases gradually until the axis of the deep syncline traversing the basin is reached. Just west of the axis the change in dip is abrupt, and the strata of the western limb are generally nearly vertical, or have been overturned so as to dip to the south-west like those of the eastern limb, though usually at much higher angles. In extreme cases their southwesterly dip may be as low as 60 degrees. The sharpness of the fold has resulted in the thinning out of the softer shale formations, and a great deal of crumpling among the harder beds.

The economic importance of the Bighorn basin arises solely from the coal seams occurring in the Kootanie formation. As has been stated, the strata of this formation vary along the strike, and owing to this variation it is practically impossible to correlate seams in different parts of the basin. General experience in other fields, where seams belonging to the Kootanie formation have been worked, has shown that the coal seams are more regular than the intervening strata. In one case noted by Mr. McEvoy the total thickness of three seams showed a diminution of from 52 to 46 feet in a distance of 7 miles, while the thickness of the intervening strata diminished from 337 to 102 feet.

Kootanie coals are now being worked at Fernie, Coleman, Blairmore, Hillcrest, Canmore, and Bankhead; and except in rare instances the seams have been found continuous, unless cut off by crumples or faulting.

Our knowledge of the number and thickness of the coal seams occurring in the basin is not as complete as might be desired, but, from the list which will be given, at least an approximate estimate of the coal content can be made. It may first be pointed out, however, that in this area it is rather the exception than the rule to find coal seams exposed naturally on the surface, and that, unless the strata have been carefully prospected, the failure to see a seam is no evidence that one is not buried beneath the surface debris which has accumulated in the outcrops of all the softer beds. A case particularly in point is the detailed section of the Kootanie formation given above. Since this section was measured in less than two days, no attempt was made to find all the buried seams, or even to strip for measurement all those whose presence beneath was revealed by pieces of float coal at the surface. In some cases the debris included large blocks of sandstone, which had slid down over the seams. The summarized statement of the seams seen in this section, with each thickness and that of the intervening rock, is as follows:—

The glacial and river drift have been grouped together, since at present it is impossible to separate them over large portions of the basin. They form thick sheets in the Saskatchewan and Brazeau valleys, and also in the third longitudinal depression, where they are trenched by streams to a depth of over 100 feet without bed-rock being exposed. A large part of the Bighorn valley is buried under drift, as is also the transverse valley extending to the Wapiabi Creek gap through the Bighorn range. The boundaries of the drift are only approximate, and rock exposures may occur at a number of points which escaped notice.

Section on Chungo Creek.

Rock	131.
Coal	2.4
Rock	2.9
Coal	4.7
Rock	161.
Coal	3.9
Rock	2.5
Coal	2.4
Rock	127.
Coal	4.5
Rock	353.
Coal	6.6
Rock	288.
Coal	.2
Rock	2,567.
Total	3,658.9
Total Coal	26.5

The section on George Creek extends down from the first seam, which outcrops a short distance below the base of the Dakota formation. It is as follows, the important seams being numbered:—

	Feet.
Coal	0.5
Rock	70.
Coal	0.3
Rock	1.5
Coal	1.
Rock	40.
Coal and Shale	5.
Rock	60.
Coal with three bands shale	3.
Rock	0.5
Coal	4.
Rock	110.
Coal	0.8
Rock	240.
Coal with three bands of shale 1 inch each	10.6
Rock	110.
Coal, dirty at outcrop	3.
Shale and coal	0.3
Coal, 1 band shale 3 inches	4.3
Rock	80.
Dirty coal	1.7
Coal	1.5
Shale	0.5
Coal, with band shale 2 inches	6.7
Rock	30.
Coal	1.
Rock	40.

Three natural exposures of coal were found on Wapiabi creek. The lowest of the three is situated just below the junction of the two main branches, and the others about a quarter of a mile above, on the northern branch. These were measured, with the following results, beginning with the highest:—

Seam No. 1.—Coal 9.3 feet, shale 1 foot, coal 2.2 feet.
Seam No. 2.—Coal 5.2 feet.
Seam No. 3.—Coal 5.4 feet.

Coal was also seen at several points on the hills north of the Saskatchewan valley, including the most westerly hill, where the strata form part of the westerly limb of the syncline and are nearly vertical. On the southern side of Opabin creek more coal was seen. Here the Kootanie also forms part of the western limb of the syncline, and the beds are overturned, and the seams so badly crushed that they did not permit of measurement.

The following are analyses which have been made of samples and specimens of coal from the basin. The only sampling was done by Mr. McEvoy, who had tunnels driven far enough into the various seams to secure as near as possible samples free from the effects of surface weathering. His analyses represent coal taken across the several seams in equal amount for their full width. Mr. McEvoy made coke from different seams, taking care to use coal fairly representative of the whole width of the seam. The numbered and lettered seams from which Mr. McEvoy's samples were taken correspond with those so designated in his sections given above. Those lettered are from Bighorn river, those numbered from George creek:—

COAL ANALYSES.

(Samples.)

No.	Thickness.	Moisture.	Vol. Comb. matter.	Fixed Carb.	Ash.	Calor. Value. B.T.U.	Sulphur.
A....	5 feet	0.38	22.62	68.85	8.15	......	....
B....	4.5 "	0.20	22.95	69.78	7.07	......	....
C....	7 "	0.32	19.51	71.17	8.70	14,011	0.98
3....	6.7 "	0.28	29.04	64.52	6.16	......	0.68
4....	10.2 "	0.90	27.60	60.08	11.42	......	0.46
5....	4 "	0.34	25.28	68.13	6.25	......	....
8....	4.7 "	0.36	26.72	62.35	10.57	......	1.21
11...	9.5 "	0.20	24.13	69.34	6.33	14,483	....
12...	12 "	0.56	22.82	70.30	6.32	......	0.69
14...	3.2 "	1.46	24.04	67.93	6.57	......	0.70
6....	6.5 "	0.50	20.10	49.62	29.78	......	0.56
9....	8 "	0.30	24.58	62.95	12.17	......	....

With one or two exceptions coal from these seams cokes, and in most cases its quality is excellent. The following are analyses:—

ANALYSES OF COKES.

No.	Thickness.	Moisture.	Fixed Carbon.	Ash.
A......	5 feet	0.06	92.49	7.45
C......	7 "	0.06	91.77	8.17
D......	13 "	0.03	90.77	9.20
F......	7 "	0.03	91.09	8.88
5......	4 "	0.04	94.63	5.33

8	4.7 "	0.06	88.71	11.23
9	8 "	0.04	92.23	7.73
11	9.5 "	0.05	93.35	6.60
12	12 "	0.03	90.38	9.69

As has been stated, the German Development Company has purchased two concessions: one on Bighorn river, and the other extending across George and Blackstone creeks, a short distance within the Bighorn range. Other holdings have been secured on Wapiabi, Smith, and Chungo creeks. The Bighorn property, situated above the falls, could be reached by a railway skirting the hills north of the river from the end of the Bighorn range. A little cutting near the head of the canon is probably all that would be neces- of coal which it will be possible to mine from above the entry, for, not only is the valley of the river situated near the axis of the shallow synclinial wave traversing the measures in this locality, but the hills on each side of it have not been dissected into narrow ridges by erosion, as is the case farther north.

This is due to the presence here of a thick bed of sandstone and conglomerate near the top of the Kootanie, which has protected the seams under it.

The gaps through the Bighorn range which gives access to the other properties are narrow, and some rocky spurs would probably have to be tunnelled before railways could be built to them. The grades would be high just outside the gaps, but beyond, the valleys appear to broaden out and probably present no engineering difficulties.

Estimate of the Amount of Workable Coal in Bighorn Basin.

In making the following estimate of the amount of workable coal in the Bighorn basin a number of factors were considered. The most important of these were, of course, the aggregate thickness of the workable seams in the section, the area underlaid by the portion of the measures containing these seams, the increase in the amount of coal underlying the area owing to the dip of the strata, and the reduction of the amount of coal which it will probably be profitable to work owing to crumples and faults of the strata.

The only approximately complete sections of the measures are those measured by Mr. Dowling on a tributary of Blackstone creek, and that by Mr. McEvoy on George creek. Mr. Dowling classes as workable nine seams, with a total thickness of 64 feet 4 inches, and Mr. McEvoy eight seams, with a total thickness of 60 feet. Mr. Dowling's section was not complete, however, and several of the seams in Mr. McEvoy's were locally reduced in thickness by crumples, so that the aggregate thickness workable is probably above the figures quoted. Mr. McEvoy's section on Bighorn river is incomplete, less than 1,300 feet of strata having been examined. Seven workable seams were measured, which gave a workable thickness of 46 feet 2 inches.

In the north-west corner of the basin, the Brazeau formation—uppermost in the section—underlies an extensive area, and, after allowing for the portion along the edge which could be reached from shafts less than 6,000 feet in depth, and levels 2 miles long, an area of 17 square miles remains, which must be subtracted from the area of 190 square miles obtained above. This reduction leaves the area at 173 square miles, but the dip of the strata increases the area of the underlying seams by about 8 per cent., so that the figure used in the calculation amounted to 187 square miles.

Great difficulty was also experienced in deciding the amount of coal which it will probably not be profitable to mine owing to the crumples and faults which traverse the strata. A list of the localities, where crumples were observed on the surface, has already been given, and it is extremely improbable that the deeply buried strata will be free of them—though probably they will be less numerous, for the beds are flatter, and the irregularities observed in the overlying strata are largely of the nature of gentle flexures rather than sharp folds. The writer finally reached the conclusion that in the estimate resulting from the above data as to area and thickness of the coal seams a reduction of 40 per cent. should be made, in order to allow fully for the detrimental effects which these faults and crumples will have on the profitable extraction of the coal. The final data for the estimated area, therefore, is 60 per cent. of the coal in an area of 187 square miles, having a thickness of 60 feet. The estimate is accordingly 6,600,000,000 long tons.

SERIES OPERATIONS OF ARC AND INCANDESCENT LAMPS.*

C. M. Wills, E.E.

The Direct Current Series Arc Circuit has been used for distributing light in cities and towns for many years. In later years the very wide adoption of alternating current by central stations in all parts of the world has been responsible for the development of the constant current arc transformer and for the A. C. series arc lamp system. For certain classes of service the series arc system cannot be excelled, but in residential and suburban districts, parks and boulevards where the foliage of the trees interferes with the distribution of the light, the arc lamp becomes less efficient. For the same amount of energy expended, a much better distribution of light may be had by the adoption of the Mazda Incandescent Lamp.

Among the systems which already have installed the A. C. series arc circuit, there may be those who would be interested in knowing that the Mazda Incandescent Lamps may be connected by the series arc circuit. Both the series arc and the incandescent lamps burn very satisfactorily together, with the only condition that the incandescent lamps have the same current rating as that of the arc lamps.

The following is the experience that The Nevada-California Power Company has had with the street lighting system in Goldfield, Nevada:

In 1909 the Power Company secured a contract for lighting the streets of Goldfield for a period of two years. The series arc circuit was the plan adopted, and a G. E. constant current arc transformer of 25 lamp capacity was ordered. The current rating was to be 6.6 amperes. Before this contract had expired, the city had asked for 25 lamps, which was the full capacity of the transformer.

At the beginning of the current year, the city renewed the contract and asked for an addition of one more arc lamp and nine 60 watt incandescent lamps, with the privilege of adding more lamps as occasion demanded. The incandescent lamps were to be installed in the alleys in the main business section of the town. This wiring was arranged in a loop which can be short-circuited in case of a disastrous fire in the business section, thereby allowing the lights of the remainder of the city to burn undisturbed.

The capacity of the constant current transformer was increased by the use of an ordinary 6,600 to 440 volt transformer. The primary of this transformer was connected in parallel with the primary of the constant current transformer, and controlled by the same oil switch. The secondary was connected in series with the arc circuit so that it would act as a booster and would add its 440 volts to the capacity of the arc circuit. This plan is now working in a very satisfactory manner.

* From the Iowa Engineer

THE CONSTRUCTION AND MAINTENANCE OF EARTH ROADS IN THE SOUTH.*

W. S. Keller.

It matters not how active we are in our efforts to encourage the construction of macadam, gravel, and other hard surface roads, there will of necessity, for years to come, be a greater percentage of earth roads in every southern state.

The reasons for this are apparent to anyone familiar with conditions from a financial and population standpoint, to say nothing of the lack of road building material that exists in a large number of counties.

We are informed by the United States Office of Public Roads, that the ten southern states; namely, Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Texas, had, in 1904, 472,589 miles of unimproved roads. Assuming that since then the mileage of improved roads has doubled, we will have left 458,381 miles. If these figures are approximately correct, should not the question of the proper construction and maintenance of these roads receive our most careful and thoughtful attention?

Wonderful improvements have been made in earth roads where common sense men have used common sense methods of construction and maintenance, but so long as we are content to place this important work in the hands of incompetent or grafting politicians, as is so often the case, we cannot expect anything but the worst. I would not for a moment say that all failures in this work are due to graft, for I am convinced that a large majority of road commissioners and overseers are honest men, but as a rule they are elected to office not because of their fitness for the work, but because of their personal popularity. These evils coupled with the statute labor system, have fostered upon the south the very worst earth roads in the nation.

The first and most important thing to do is to change our laws, abolishing the statute labor system and substituting therefor the cash tax system. If this can be done and the work of improving and maintaining our roads be placed in the hands of men who are engaged in no other occupation and are required to give their full time and attention to the work, there is no question but that the greatest good will result.

Very few earth roads have, in the true sense, been constructed. The average road is opened without regard to grades or proper location and simply because it is desirable to have it pass the house of A, B and C. The opening consists of cutting down any trees or bushes that cannot be avoided by crooks and bends, leaving the stumps just high enough to allow a wagon to pass over and requiring expert driving to miss. The highway is then ready for traffic. Unfortunately houses have been built and other improvements made near and abutting on these old roads to such an extent that it is detrimental to such property to make any great change in location, or to rectify bad alignment and grades. Of course, beneficial changes that will be an advantage not alone to the road but also to the abutting property, can be made in many places.

As to the proper reconstruction of an old public earth highway: The road should be gone over carefully by the proper official and such changes of a proper nature as can be made, should be noted, taking into consideration initial cost, cost of maintenance, alignment and grade. The center line and grade of the road should be established by an engineer, if it is possible to secure one. If an engineer cannot be secured, the ordinary method of lining a fence, that is, by means of sight poles, can be used. After the center line has been established and the width of roadbed agreed upon, you are ready for construction work. The proper and efficient grading force for this work should consist of a foreman, eight or ten good two-horse teams with drivers, one wheel and one drag scraper for each team and one extra wheeler and drag for emergencies, one good railroad grading plow, one grading machine, one road drag, one dump man and one loader, with five or six extra men for grubbing and other work. The foreman should be an experienced grading man who understands handling earth and knows when it is proper to use drag scrapers, wheel scrapers or wagons. The road should be so graded that the ditches or gutters are parallel with the centre line of the road and at uniform distances from it. When completed the road should be uniform in width and the surface should be smooth and even, free from holes and high places, with a uniform crown having a fall of one inch to one foot from center to gutters. On grades this ratio of fall should exceed that of the grade to such an extent that water will readily flow to ditches instead of down the road. Drain pipe should be freely used and no water should be allowed to flow over the road if it can be avoided. In some cases it is not practicable to build the road above high water. In such cases, danger signs should be posted, showing at what stage the water becomes too high to ford the stream.

We have, in the south, nearly every kind of soil, from sticky gumbo on the one hand to coarse sand on the other. The methods used for the improvement of roads through a section of one will not do altogether for the other. The worst roads, by far, that we have in the south, are in our rich and fertile prairie lands, where, unfortunately, there is very little road building material to be found. This soil readily absorbs water and becomes very sticky after rains. It expands freely, and dries rapidly when the sun shines, and becomes very hard under the tamping effect of teams and vehicles. From observation and experience I have learned that these roads more than most others, require a very high crown and that the driving surface should be only wide enough to allow two vehicles to pass. If a prairie road is narrow, with a fall of not less than 1½ inches to one foot, water will shed rapidly to the ditches and the entire surface will dry out quickly. A road of this kind can be constructed quickly and at little expense, except where grades are to be reduced or bottoms filled, with a grading machine, or even with a road drag. The latter method will require more time, but in the end will be found to be very satisfactory. No earth road can be maintained in good condition unless it be so constructed as to drain well, and unless it be kept free from ruts and holes.

The best method of maintaining an earth road, especially a prairie road, is by the systematic use of the road drag. A sand road is never good under any circumstances, but certainly is not improved by crowning. A sand road is at its best when moist, so it should be left flat. No one wants a sand road, so, if possible, clay should be added to, and mixed with the sand, making what is known as a sand clay road; the construction of which cannot be discussed in this paper.

The old way, and it is used to-day by many, of filling a mud hole with brush with a little earth on top, cannot be too strongly condemned, and is only permissible in cases of emergency, when it is impossible to drain the hole or to get sand or stone to fill it. The overseer or foreman should in dry weather, center his work on such places until the road is raised to a sufficient height to drain well. I have seen overseers have brush hauled two miles to fill a mud hole when sand was within shovelling distance of it.

---

* Paper presented at Good Roads Congress, Birmingham, Ala.

As it seems to be impossible to abolish statute labor, the question that confronts us now is, what is the best system, coupled with this labor, to use in the maintenance of our roads? Splendid results have been accomplished by Montgomery and Dallas counties in Alabama, by putting all road work in the hands of a few regularly employed foremen who give all of their time and attention to the work, instead of leaving it to many beat overseers who work when it suits their convenience, or do not work at all when that suits them, as it usually does. These foremen are furnished with two or three teams with regular drivers, wagons, scrapers and grading machine, road drag and necessary small tools, and as many beats or districts assigned to each as he can work. A census is taken in each foreman's territory, at the first of the year, of all men subject to road duty, and he is furnished with a list of the names and is required to work every man who has not paid the required amount of cash into the county treasury in lieu thereof. No foreman is allowed, under penalty of dismissal, to receive cash from work hands, but such hands as desire to pay, must make their payments to the proper county official at the court house. This method has proven good for several reasons:

First, and most important, this foreman, unlike the average overseer, knows what he is trying to do and does it.

Second, not being a resident of the community in which work is to be done, he plays no favorites among the hands and all have to work alike or show their receipts for money paid.

Third, he works his force the full number of hours required by law.

Fourth, the requisite amount of road tools and machinery for one foreman is much less than that required for many overseers, and such tools and machinery are taken care of and not loaned to other persons as is the case when in the hands of the average overseer.

Fifth, he makes weekly reports to some county official, who has the roads in his charge, and the work accomplished is tabulated and a comparison made with that of other foremen.

In conclusion let me say, that if our farmers do not take a community interest in the improvement of the roads and put their shoulders to the wheel, we will surely remain "stuck in the mud."

SOME COMPARATIVE CORROSION TESTS OF STEELS AND IRONS.

The subject of corrosion of steel received very interested consideration at the recent meeting of the American Society of Testing Materials. Three papers describing comparative corrosion tests gave figures which bring out important characteristics of corrosion tests, and we therefore reproduce the substance of these papers herewith. The most prominent characteristic is the great variability of results under seemingly identical conditions (as in the figures given by Mr. A. W. Carpenter), and the influence of very small variations in test method or composition of metal (tests of Mr. C. M. Chapman and Prof. W. H. Walker).

The unavoidable factors of variation in metals and corrosion as well as in tests of corrosion resistance are so great that it is doubtful whether greater clearness of knowledge will be attained within measurable time. Yet the extreme importance of the subject justifies strong effort to reach better knowledge. The development of uniform, reproducible test methods having positive and invariable relation to what might be called "commercial rusting" is the first essential; the papers given below are directly concerned with this problem.

THE MARKED INFLUENCE OF COPPER IN IRON AND STEEL ON THE ACID CORROSION TEST.

By William H. Walker.

In investigating samples of iron and steel which had withstood corrosion for years and which notwithstanding dissolved in acid very readily, together with samples which withstood solution in acid in a remarkable manner and yet were rusting at the ordinary rate, it was found that the acid-resistant specimens contained in every case a substantial amount of copper; that is, the presence of copper seemed to be the controlling factor in the resistance to solution in acid.

Upon examining the literature of the subject, sufficient data to justify this conclusion were found. A number of investigators have studied the matter, and the results of all are fairly well presented in the Carnegie Research Report of Pierre Breuil on Copper Steels, in the Journal of the Iron and Steel Institute of Great Britain for 1907. It is here found that small amounts of copper in iron or steel reduce enormously the tendency to pass into solution in acid.

In order to determine whether there is any foundation for the alleged fact so widely disseminated, that a highly acid-resisting iron or steel is also therefore a very pure product, the writer succeeded in having made a number of heats in a basic open-hearth steel furnace, under ordinary conditions, and using ordinary materials, into which metallic copper was added a little before or during tapping. The treatment of the product in the bar and sheet mills, and the annealing operation, were in every case as nearly identical as could be maintained. Although, as the work developed, many heats were made, the results were so uniform that but few will be here presented.

Composition and Acid-Loss of Open Hearth Steels Containing Copper.

	A.	A2.	B.	C.
Carbon, per cent.	.08	.08	.10	.09
Manganese, per cent.	.50	.50	.41	.31
Sulphur, per cent.	.018	.018	.027	.031
Phosphorus, per cent.	.017	.017	.026	.063
Copper, per cent.	....	.21	.19	.19
Loss in weight in 20 per cent. sulphuric acid in 3 hours, grams...	.2235	.0075	.0082	.0095

The influence of small amounts of copper in these heats is truly remarkable and shows conclusively that this wonderfully slight tendency to dissolve in acid is not indicative of great purity.

Inasmuch as the presence of metallic copper in contact with iron increases enormously the rapidity with which such iron will dissolve in acid, it at first seems surprising that in this case copper should retard this action. But we have a direct analogy in the case of zinc and copper. Zinc free from iron dissolves in acid very slowly; mix with it some metallic copper, however, and solution is greatly accelerated. But make an alloy of the two, namely brass, and the solvent action of the acid is negligible. So long as copper is not added to iron or steel in excess of the amount which can remain homogeneously alloyed therewith, the writer can see no reason why there may not be an advantage in its use. But such advantage cannot be ascribed to purity, but rather to what we may call a ferro-brass of small copper content. Reasoning from analogy with zinc, pure iron should dissolve in acid very slowly; but the converse is here shown not to be true, namely, that a slow-dissolving iron or steel is on this account to be considered an exceptionally pure product.

RECENT DEVELOPMENTS IN BRIDGE CONSTRUCTION.*

Frank P. McKibben.

Never before in the history of bridge engineering has the influence of public opinion been so noticeable as at the present time, and the interest shown by the public in this important branch of construction is very gratifying, especially to those engineers who have labored unceasingly to have bridges regarded from the artistic as well as from the utilitarian standpoint.

Public opinion is now demanding not only that bridges shall be made better but that they shall be more suited to and expressive of their purposes and environments. Although great advances have been made in the status of bridge engineering there is still room for improvement, for it is often impossible to make communities realize that a bridge is something more than merely a means of crossing an opening. They are not willing to make the additional appropriations necessary to secure artistic bridges, even though the structures may occupy such conspicuous positions as to require more impressive and finer treatment than some public buildings upon which vast sums of money are expended to secure pleasing architectural effect.

How common it is to see post office buildings, for example, beautifully designed and well constructed but placed in such surroundings as to lose the intended effect, while nearby may be a bridge in a location of magnificent possibilities but upon which no attempt has been made to display grace or beauty. Let the public fully realize that when a bridge is built without making it architecturally beautiful a splendid opportunity for civic improvement is lost. In the past the one great difficulty in securing pleasing structures has been that appropriations for bridges have generally been so small as to exclude all but the more utilitarian requirements, but, fortunately, more recent awakenings of civic pride are resulting in great improvements.

A beautiful arch bridge is a wonderful structure. There is something inspiring about it. And engineers must do all in their power to have the public realize this and to appreciate the beauties that can be created by proper and simple combinations of common materials of construction. Symmetry, grace, simplicity and truthfulness are essential elements in a bridge possessing architectural merit. Truth is a basic element, and when one material is disguised to represent another, or when a part is made to appear as if performing a certain function when in reality it is performing quite a different one, the result is a dismal failure.

The most remarkable development in bridge construction during the past quarter of a century has been the progress made in the use of concrete, either alone or reinforced with steel. When it is considered that only twenty-two years ago the first reinforced concrete arch bridge was built in Golden Gate Park at San Francisco, and that from this small span of only thirty-five feet to the recently constructed arch span of three hundred and twenty-five feet in New Zealand is a tremendous step, it is evident that progress has been truly wonderful. Concrete, like stone, is best suited to resist compressive stresses, and it can be readily molded into any desired form or size. It is, therefore, not surprising that when concrete came into use as a bridge material it should have been used in the arch form. It was a comparatively easy change from the stone arch that had been the standard arch form for many centuries to the concrete monolithic or voussoir arch of similar outline. But it was soon realized that concrete in combination with steel has a distinct individuality of its own, and hence important changes were made in the form of construction, resulting in the use of lighter structures of more pleasing design and appearance. The constant tendency has been towards the elimination of redundant material. The use of arch ribs, with the variation in size and shape thereof to conform to different classes of loads, or the use of solid arch rings upon which rest columns or cross walls to support the roadway above, approaches the design so commonly adopted for arches with steel ribs, and, in this respect, represents a decided departure from, and improvement upon, the solid arch ring with its superimposed earth fill, which was until recently the standard form of masonry arch construction.

The most recent type in reinforced concrete highway bridge construction consists of a flat deck on which the roadway is placed, the deck in turn being supported by columns or cross walls resting on a solid arch ring or upon ribs. These ribs are usually rectangular in cross section, although those of circular form would give a more pleasing appearance but would be more costly and more difficult to build. Unless the ribs are very wide they should be braced to prevent lateral displacement under stress. Much can be said in favor of this open spandrel construction except for very short spans or for spans of small rise, where the old method of placing the roadway on earth filling retained between longitudinal side walls is better. In the absence of such limitations, however, the open spandrel construction results in a great saving of weight of superstructure, with consequent diminution in size of foundations, and often also in a more pleasing design. For railroad bridges the column and rib type has not been adopted, but open spandrels with cross walls of solid arch rings are of frequent occurrence.

Arch analysis, that is, the determination of forces and stresses acting upon and within the arch is an interesting and beautiful application of mathematics and mechanics, and it is doubtful if in the whole category of engineering design a more enticing field for study can be found. The insertion of three hinges in the arch makes the solution more nearly determinate, and in case of slight settlement of foundations the stresses within the arch ring remain unchanged. In addition to this advantage, hinges relieve the ring from temperature stresses, since as the temperature of the arch changes the crown rises or falls with almost perfect freedom. For arches of small rise the advantages of hinges are so notable that their use will undoubttdly become more common, especially if some form be devised which can be economically constructed. For analysis of hingeless arches the elastic form theory should be employed because of temperature stresses which are usually large and which can be computed only by this method.

Little progress can be reported in short span steel bridges; in fact, concrete beams or arches are so admirably adapted to shorten span construction that steel hardly holds its own in this field. But for long spans, steel easily leads. Great progress is now being made in the manufacture of alloy steels and the time is not far distant when record breaking spans of steel will be built.

As a result of the increased strength of nickel steel, the new Municipal bridge spanning the Mississippi river at St. Louis has a span of six hundred and sixty-eight feet, which far surpasses any single truss length previously attempted. The manufacture of vanadium steel, nickel steel and other alloy steels for structural purposes is only in its infancy and seems to be a most promising field of investigation and progress for the immediate future.

No notable advances have been made recently in the type employed for long steel spans but many wonderful structures similar to those tried and not found wanting are

* Paper presented before the Congress of Technology.

now being erected. The cantilever and the suspension forms are the two kinds commonly used, although there is also an increasing tendency to employ steel arches of considerable length. The Quebec bridge failure has had the effect of temporarily throwing the cantilever type of truss into some disrepute, but engineers must not let the pendulum swing too far because the cantilever has certain well defined advantages which should not be completely ignored simply on account of one failure of its truss members. Lamentable as was this failure, it has been the cause of inaugurating a searching investigation into methods of design that are founded upon empirical knowledge and much good is being derived therefrom. Resulting from the influence which the Quebec bridge failure had upon the engineering world there is a tremendous desire on the part of experimenters to discover new laws underlying the action of structural materials and to verify experimental methods of design which until recently were accepted as being sufficient for all cases that might arise in practice.

One hesitates to predict what developments science may bring forth in bridge engineering but it is probable that for the next decade progress will be made along three lines, the perfection and increased use of alloy steels, the production of structural shapes which are free from objectionable details of fabrication, and finally, the combination of steel and concrete into a composite structure in which the steel will afford great strength and the concrete will be a protection against corrosion and other destructive elemens.

ELECTROLYSIS TROUBLES FROM STRAY CURRENTS AND THE REMEDY.*

Dr. L. A. Herdt, in the course of a valuable paper on Railway troubles due to Electrolysis, observes that experience has demonstrated that the proper method of preventing electrolysis is to reduce stray currents to a minimum, and that the remedial scheme advocated by some to bond the tracks with the water and gas pipes, although it may afford local protection, increases the amount of stray current, and must not be encouraged. The cure for the electrolysis trouble should come from the electrical railway companies, as the owners of pipes, cables, etc., can do little, if anything, to protect their system from stray currents. The remedial means are simple enough if properly and intelligently applied.

1st. High conductance return circuit provided by good bonding of the rails and additional feeders.

2nd. Proper bonding and cross bonding work at all track intersections.

3rd. Sub-stations at different points of the railway system to limit the amount of current through the rails.

4th. Systematic inspection of track returns.

Of all the appliances used in electric traction the rail bond has been one which has given possibly the most trouble and to which little or no attention has been paid. Bonds are still in use composed of pieces of iron or copper wire crudely rivetted to the rails, making little or no electical contact and are worse than useless.

A good bond should show a conductivity that will add to the resistance of the section of the rails an amount of more than 3 to 4 ft. of rail. All bonds whose resistance is greater than that of 4 ft. should be replaced or improved. Track intersections should receive careful attention. Heavy bonding and cross bonding should be used so that little or no potential difference exists from one side of a crossing to the other.

*Read before the American Institute of Electrical Engineers.

A sub-station system of power distribution does away once and for all with electrolysis troubles. In large electric railway systems the current fed out by the stations reaches into ten thousands of amperes. In such cases it is practically impossible to provide a return circuit of sufficiently low resistance if such currents have to be returned to one station only, otherwise potential differences between pipes and rails will be set up, giving rise to stray current and electrolysis corrosion.

In a large number of cases the electrolysis trouble is due to a concentration of current in the track near the station. The current density in the track must be kept low, if electrolysis trouble is to be avoided. Sub-stations equipped to feed from 2,000 to 3,000 kw. and placed at different points of the system will subdivide the current required for the operation of the cars. It will also improve the problem of distribution, giving better voltage and better service and will, as stated before, do away once and for all time with electrolytic troubles.

In making an electrolysis survey of a piping system, potential differences between pipes, rails, telephones, cables, etc., should first be taken in order to locate the areas in which the stray currents flow between pipes and rails and between pipes and pipes. These readings are easily obtained by using a high resistance centre zero reading portable voltmeter. These readings should be marked upon a map showing the general lay-out of the gas and water mains, and telephone cables. The lay-out of the tracks, showing size of rails, type of bonds and all negative copper supplementary to the rails should also be marked. The areas in which pipes assume positive potentials to the rails can be tinted red.

An examination of the general condition of the track returns, return feeders, location of stations, demand of electric current, condition of the soil, run of the underground piping system and cables, will usually give very good indications as to the places where electrolytic corrosion due to stray currents is likely to exist. The track returns should be under test in order to remedy at once any faulty bonds as they appear, and accurate records of the potential difference of the track to ground at different points of the system should be kept at hand.

WATERPROOFING BLUE PRINTS.

Waterproofing blue prints to be carried into wet mines or tunnels, is accomplished by the following process, according to the "Mining and Scientific Press." Immerse in melted paraffine until saturated a number of pieces of an absorbent cloth one foot or more square. When withdrawn and cooled they are ready for use at any time. To apply to a blue print, spread one of the saturated cloths on a smooth surface, place the dry print on it with a second waxed cloth on top, and iron with a moderately hot flatiron. The paper immediately absorbs paraffine until saturated, and becomes translucent and completely waterproof.

RAILROAD EARNINGS.

Railroad earnings for week ended July 31st:—

	1911.	1910.	Increase.
C. P. R.	$2,905,000	$2,752,000	+ $153,000
C. N. R.	427,700	360,600	+ 67,100
T. & N. O.	48,893	30,378	+ 18,515
Halifax Electric ..	7,591	7,172	+ 419

The returns of the Guelph Junction Railway Company for the quarter ending June 3rd last show the earnings of the road for the city for the three months to be $8,897.37, as against $8,066.09 for the same period of 1910.

SOME TESTS OF THE RATE OF CORROSION OF METALS EXPOSED IN A GASEOUS ATMOSPHERE.

A. W. Carpenter.

The problem of finding a suitable metal for structural purposes, not prohibitive in cost, which will resist corrosion when exposed to locomotive gases, is important to railroads. In order to get first-hand information, the N.Y.C. & H.R.R. R. Co.'s Engineering Department (Mr. Geo. W. Kittredge, Chief Engineer) has made some tests, which, while perhaps crude and limited, still are thought to give some valuable information both on the rate of corrosion of the metals tested and on the comparative rate of corrosion of iron and steel.

Pieces of the metals to be tested, generally in the form of thin sheets, were exposed in two places, one in a tunnel where the atmosphere is very highly charged with locomotive gases and steam, the other the interior of a smoke-jack in an engine-house. In the tunnel exposure the specimens were attached to a wooden frame fastened to one side of the tunnel, in which location they received no blast action from locomotives and it was thought that all would be exposed to equal conditions. In the smoke-jack the plates were hung inside the jack so that the conditions would probably be equal for all plates.

In the first test-series, only few results were obtained. A plate of special iron exposed in the smoke-jack for 189 days corroded at the rate of about 1/32-in. per annum for each surface, or 1/16-in. per annum for a plate with both sides exposed.

In the second series of tests the tunnel test showed resistances to corrosion in the following order, beginning with the most resistant, and with a loss after 289 days total exposure as given:

Second Series, Tunnel Test.

	Loss, grams per sq. in. surface.
Special-coated metal	0.51
Soft steel, uncoated	0.55
Special galvanized iron	0.67
Special iron, uncoated	1.72

The excessive corrosion of the special uncoated iron over that of the others will be noted. The amount of this corrosion, compared with that of the similar material in the smoke-jack tests, shows the tunnel conditions to be very much less severe than those of the smoke-jack.

In the smoke-jack one of the special-coated plates, one special iron galvanized plate and one special iron plain plate were exposed. At the first examination, after 65 days' exposure, the special-coated metal showed very much less corrosion than the special iron plates, but this plate was lost before the second examination took place, leaving only the special iron plates, one plain and one galvanized, in this test. The galvanizing was pretty well removed during the first period of exposure (65 days) and thereafter did not assist much (although it did a little). The last examination, after a total exposure of 193 days, showed a loss about the same as that in the first series (189 days' total exposure).

A third and more extensive series of tests has been inaugurated this year and one examination of one exposure (in tunnel, 58 days) has been made. This series includes special irons, ordinary wrought-iron, various steels, and some special non-ferric metal. Some of the irons and steels have galvanized coatings and some have lead coatings over the galvanizing.

Some of the results of the one examination so far recorded for this series were unexpected. The galvanized plates show the greatest loss of the ferric metals. The loss of one lead-coated plate was some 75 per cent. greater than that of the other, which might be accounted for by the difference in thickness of the respective lead coatings as indicated by the chemical analyses of the two plates, but as one of these analyses was made upon sheared samples and the other upon drillings the writer does not wish to put too much weight upon this point. The average loss of the two lead-coated plates was greater than that of one of the special plain irons and the open-hearth steel angles. The special "A" iron was accepted as the same material as the special iron of previous tests; in this examination it reversed its previous record, being the most resistant, for the short period exposed.

The relative order of resistance of the specimens for the 58 days' exposure was as follows, beginning with the most resistant:

		Average loss, grams per sq. ft.
1.	Special "A" iron sheets, plain	.047
2.	Open-hearth steel angles, plain	.060
3.	Lead-coated, galvanized steel sheets	.067
4.	Special "B" iron sheets, plain	.077
5.	Open-hearth steel bars, plain	.082
6.	Wrought-iron sheets, plain	.090
7.	Open-hearth soft steel plates, plain	.095
8.	Bessemer steel angles, plain	.098
9.	Special "A" iron sheets, galvanized	.121
10.	Special "B" iron sheets, galvanized	.137
11.	Bessemer steel bars, plain	.147
12.	Special non-ferric metal sheet, plain	.226

The calculated rate per annum from the above, assuming a uniform rate of corrosion, would be 0.002-in. to 0.011-in. per sq. in. of each surface.

It should be borne in mind that the time of exposure for this series was too short to lead to proper conclusions from the results. The specimens in the smoke-jack exposure will be removed and examined after having remained about the same number of days as those which were in the tunnel, and both sets will be returned to their respective exposures and the tests continued, it being the intention to make examinations after successive exposures of about 60 days.

A METAL THAT ACTS LIKE FLINT.

Arthur D. Little, Inc., of Boston, in the annual report as official chemists to the American Brass Founders' Association, describes a recent interesting commercial application of cerium alloys:

These alloys possess the property of emitting sparks when struck, and this property has been made use of in the shape of a match box. The alloy used is of cerium and iron and the spark is produced by a rubbing contact with a steel file wheel, the spark igniting a wick saturated with gasoline which is contained in the interior of the case. The application is unique as it employs a metal which heretofore has had no commercial use. The same idea has also been used in a device for lighting gas, consisting of a holder with a cerium iron alloy which rubs on a steel file and emits a sufficient spark to ignite gas.

A TREATISE ON RETAINING WALL DESIGN.

Specially Contributed For Student Readers.

By J. H. EVEREST, C.E.

Engineering Considerations.

I am of the opinion that many engineers believe that retaining walls and their design come under the category of simple structures, thereby forming a conclusion that the theory regarding their design and stability may not be seriously considered or assiduously adhered to. Evidently it must be admitted that either ignorance or shall we say idleness is responsible for such drastic conclusions, for it is a well-known fact that a retaining wall is one of the most difficult structures an engineer could possibly design. This is the reason why it is with a certain amount of reluctance one decides to mention much about this important subject, for there can be little doubt that we have not yet entirely solved the question of the stability of retaining walls; and the matter is an important one. True, the existing theoretical conclusions which are so often adopted in practice are reliable, but on the other hand they are not economical, which from an engineering point of view is of the utmost importance. This I will endeavor to demonstrate later.

An Engineer Defined.

An engineer is sometimes erroneously quoted to be a man who designs, constructs, and supervises means by which the resources of nature are harnessed and equipped

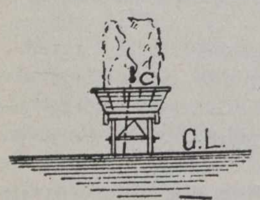


Fig. 1a.

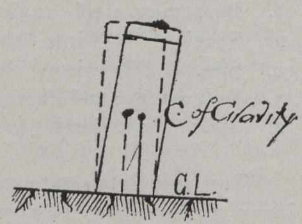


Fig. 2b.

and the obstacles overcome and subjugated. This is a very poor description and is liable to convey a wrong impression of what an engineer's duties really are. It sounds too poetical, seems medieval in the modern light, and lacks the effect of a sound businesslike interpretation. A more modern definition of an engineer is: A man who can do for $5, what any silly fool can do for $10. It will need little reflection to convince the student how strikingly appropriate is this description, for certainly any fool could design a retaining wall and guarantee its stability, simply by taking the thickness at the base say 10 ft., when perhaps the true economical thickness should be only 5 ft. But if the alleged "fool" was informed that 5 ft. was just sufficient, no more no less, could he prove unquestionably that this theory was wrong and he was right? Being inexperienced of course he could not, and this is just where the especial duties of an engineer are demonstrated, that is to design economically and ensure the stability of structures for the benefit of the community, and thus save an otherwise useless expenditure of money. It will therefore be seen how important it is for the young engineer to understand thoroughly both the practical and theoretical sides of his profession. Again taking the case of a retaining wall, there is a rule which states: make the thickness at the base of the wall one quarter the vertical height. It seems incredible that men worthy of the name engineer should adopt such a rule as this without taking the trouble to further investigate the stresses, yet in many instances I have known this to occur. When one considers the great importance the stress diagram or stress calculations has upon the stability and especially the economic design of many structures, incompetency in this respect seems all the more remarkable. It seems inconceivable that any engineer would resort to such antiquated rule of thumb methods as the above, and we therefore come to the only sane and inevitable conclusion that it is an engineer's duty to the community to practise economy compatible with stability. Unless an engineer thoroughly understands the technical part of his profession it is difficult to see how this is going to be accomplished, and further when one reviews the enormous amount of technical matter that an engineer has to master in order to economically design, and ensure the stability of structures, it behoves intending students to commence when young. In this way confidence and determination will result as a natural course of events, ultimately ensuring the success of the aspirant.

A True Engineering Structure.

The designing of a true engineering structure is very rarely accomplished, but nevertheless the fact remains that it is practically possible,. In designing any structure, be it small or large, the true engineering instinct is shown when the engineer can truthfully demonstrate the existence of two imperative axioms: (1) When economy is practised compatible with local conditions, expenses are necessarily cut down to the lowest possible margin. (2) When economy has been studied in conjunction with the stability of the structure, the maximum profit of an engineer's experience has been reached. The promiscuous blending of these two important considerations will then form what may be called a true engineering structure. The above remarks may be considered to deviate somewhat from the prefatory, but sufficient importance is attached to them to warrant their inclusion in this article.

Rankine's Theory and Earth Pressure.

From a strictly practical point of view the theory of earth pressure and friction at back of wall is still in a very confused and empirical state, and the existing theories which are so often adopted in practice are founded upon this conclusion, viz., that friction is neglected at back of wall. Again latterly an attempt will be made to show that in Rankine's theory for instance, the horizontal pressure at back of wall is just double what it would be if friction were taken account of, thus proving the contention that Rankine's theory has never been known to fail is well founded. Recent research however proves that notwithstanding the difficulties engendered by former theoretical conclusions, retaining walls may be designed whereby the practical problems receive a fair share of consideration in design. It is proposed to adopt Rankine's theory of earth pressure and show by recent experiments the effect of neglecting friction at back of wall.

Definition of Retaining Wall.

It seems to be a general misconception that any wall which supports a bank of earth, is a retaining wall. Strictly speaking, however, the name retaining wall should be confined to walls which support an artificial bank of earth, all other walls being called breast walls.

Stability of Bodies.

Suppose Fig. 1a represents a load of hay being drawn across hilly ground, and C the centre of gravity of the whole mass. Then if a perpendicular drawn from C can be found to fall within the space allotted by the two wheels, the load will remain stable. If not, and is found to fall outside, it will fall over.

Again Fig. 1b represents a leaning tower or wall. If a perpendicular can be drawn from the centre of gravity to a point within the base, it can be considered safe. If not, it will fail by falling over. The more erect the wall, the further will the perpendicular from the centre of gravity fall within the base, as shown in Fig. 1b. Considering the wall to be a solid mass capable of overturning, the foregoing investigations will help the student to realize why the resultant thrust of a retaining wall should be confined to the base. However, resistance to overturning is not so important as the tendency of the courses if laid horizontally, to slide upon each other, in which case the resistance would depend upon the adhesion of the mortar. It is readily seen that in practice this would necessitate waiting for the wall to finally settle, thereby resulting in a great loss of time and inconvenience. To avoid this the wall should be constructed with a battered face, with the courses of brickwork inclined to the horizontal. By this means a greater resistance will be offered to the thrust of the bank, thus rendering the adhesion of the mortar a secondary consideration and merely an additional security. It will need little reflection to convince the student of the desirability of effectually draining the back of a retaining wall so that the wall may be relieved of supporting the additional thrust of surplus water. The lack of the necessary draining facilities is a constant source of failure in retaining walls, and its importance cannot be too highly impressed.

Surcharged Wall

A wall is said to be surcharged when it supports a sloping bank of earth.

Natural Slope

Is the slope which a bank of earth assumes when exposed to the weather and has no artificial support, this depends upon the composition of the earth.

Angle of Repose

Is the angle which the natural slope makes with the horizontal plane or ground line.

Line of Rupture

Is the line about which the wedged portion of the material would break away.

The student may find the following tables useful for reference to angles of slope, and weights of material:

Weights of Material.

Earth	125 lbs. cub. ft.
Brickwork	112 lbs. cub. ft.
Masonry	168 lbs. cub. ft.
C. Concrete	135 lbs. cub. ft.
Clay	120 lbs. cub. ft.

Natural Slopes.

Gravel	40	degrees
Vegetable earth	30	"
Wet clay	16	"
Moderately dry clay	45	"
Sand	38	"

Failure of Retaining Walls.

A retaining wall may fail in a variety of ways:—

(1) By overturning.
(2) By crushing at toe nearest resultant.
(3) By increased tension on inner toe.
(4) By sliding of courses upon one another.
(5) By sliding upon foundation.

Failure by Overturning.

The method which may be adopted to prevent retaining walls failing in this manner, has already been shown, viz., to confine the resultant pressure within the base of the wall. If the resultant assumes a position outside the base it will fail by falling over.

Failure by Increased Compression on Outer Toe.

The safe crushing strength of the material of which the wall is composed must first be determined. To ensure safety from crushing the safe crushing value should never be exceeded.

Failure by Increased Tension on Inner Toe.

This is avoided by ensuring that the resultant thrust shall everywhere be confined to the middle third of the base. The middle of the half section or the "middle half" as it is called, is sometimes resorted to, the middle third theory, however, is the safest and will be adopted.

Failure by Sliding of Courses One Upon Another.

To avoid failure in this manner, the angle of friction of the material should never be exceeded.

Failure by Sliding Upon Foundation.

If there be any liability of the earth at back of wall becoming waterlogged, precautions should be taken to secure adequate drainage. To resist sliding the wall should either be inclined or a piling system adopted at the toe of the wall. This will ensure greater stability and resistance to the thrust.

Calculation of Maximum Stress.

The pressure on the base of a retaining wall increases and decreases according to the eccentricity of the resultant with respect to the centre of gravity. By this is meant that directly the resultant leaves the centre of gravity, the pressure at once becomes uneven, that is the edge nearest resultant proportionately suffers an increase in pressure, and the edge farthest away similarly encounters a decrease in pressure. Only when the resultant coincides with the centre of gravity of form is uniform pressure maintained. It will now be understood that it is of some importance to know exactly the amount of compression or tension that exists due to the eccentricity of the resultant. This may be done by the aid of the following formulae:—

$$\frac{W}{A} \pm \frac{M}{Z}$$

In this formula:—

W = Total load or perpendicular component of resultant.

A = Area of surface upon which intensity of stress is to be calculated.

M = Bending moment = W multiplied by distance from centre of gravity of section.

Z = Section modulus.

+ Compression.

— Tension.

The application of this formula in practice will be simple until the value of Z is to be determined. The student may then find a difficulty which it is proposed to endeavor to overcome.

(To be continued.)

LOW PRESSURE TURBINES.

Turbine engines have been so much exploited of recent years, most conspicuously in relation to steamships of high speed, that the value of the low pressure turbine in saving power that commonly goes to waste as exhaust steam has had less recognition than it deserves. The case for the low pressure turbine as the user of otherwise "waste" power, is well put in a paper by J. G. Callan, of Arthur D. Little, Inc., Chemists and Engineers, of Boston.

The time-honored machine for developing power from steam, says Mr. Callan, is the reciprocating engine; it has carried the power load of the world all but unaided until the last decade, and the vast numerical majority of power-using enterprises still depend upon it. Engines do very well indeed in getting power out of high pressure steam, but they can do so little with the by-product,—the low pressure steam,—that it is often thrown away to save trouble, and it has apparently been taken for granted that it was of small value compared with the same amount of steam from boiler down to atmosphere. Now we find that theory shows we ought to get as much power out of the low-pressure ranges as out of the high,—that throwing away steam at atmospheric pressure is equivalent to throwing away ore tailings which still contain half the gold—that even the engine that uses the low pressure ranges as well as it can, gets at best rarely more than a third of the values out of these tailings—and most important of all, we shall see that there is a simple way of working them as efficiently as the engine works the steam of higher concentration.

Of late years marked changes have occurred in the practice of power development, and a study of the new incentives and new machines will advance us in our subject.

Water power and Gas Engines are used as prime movers solely to economize fuel—Turbines for this and because their small size and high speed rotary motion gives them great inherent advantages for driving electric generators and for some few other things. The coming of the turbine has been one of the most striking and impressive engineering conquests of the last quarter century, and it will repay a correspondingly careful analysis.

Turbines are not less reliable than engines, price is generally competitive or better, and for generator drive their inherent characteristics are very favorable, hence if steam economy is as good as that of engines we need not wonder at the revolution they have wrought. Examining the steam economy of the best turbines and of the best engines we find in general that the turbines somewhat more than hold their own when both exhaust into vacuum—somewhat less when both exhaust to the atmosphere. This at once suggests the obvious explanation that while good steam engines get slightly more power than do turbines out of the steam above atmospheric pressure, turbines do so much better with it from atmosphere down to vacuum as to compensate for this and leave a margin in their favor. If this explanation is the true one—and we may save time by saying that it is—we have here our machine for working the tailings—for efficiently utilizing our by-products—for turning into money an asset heretofore unavoidably thrown away.

And here we have the beginnings of the low-pressure turbine.

The low-pressure turbine is simply a steam turbine of any of the several successful systems, which is built to take exhaust steam after an engine is through with it and has discharged it at or near atmospheric pressure,—and to realize from that steam all the power possible during its further expansion and pressure-drop down to vacuum.

Now the value of this proposition rests upon the fundamental assumption that such a turbine can get a great deal more out of such steam than an added cylinder can. It is necessary that this should be certainly established, since the low pressure cylinder of a triple expansion engine works over just about the same pressure range, and it is well proven that it rarely pays in land practice to add such a cylinder.

In addition we must be very sure that unreckoned disadvantages will not offset the promised benefits, that complexity and cost shall be moderate, and the requisite operating conditions readily achieved and maintained, and finally that the savings shall be great enough to show attractive return on investment after reckoning an amortization or depreciation which is usually abnormally high, on account of the fact that the life of the whole plant is determined in most cases by the remaining years of usefulness of the old engine that the new turbine supplements.

In order that we may estimate how large a credit footing the low pressure turbine gives us to charge off against, it may be said roughly that if a good simple engine running non-condensing delivers its exhaust to a low pressure turbine, the turbine can ordinarily expand this exhaust steam on down to good vacuum and thereby generate and deliver at least as much power as the engine,—thus doubling the yield of power per pound of steam or per ton of coal if no exceptionally unfavorable conditions intervene. If the engine had been running condensing before, it must be changed to run non-condensing in order to give exhaust steam which a low pressure turbine can use. In this case the engine relinquishes the use of the low pressure ranges to the turbine which is able to make more efficient use of them. The net gain in a fairly favorable case may then be taken as 50 per cent. Where the engine was originally very economical the possible gain is less, the case correspondingly unfavorable to the turbine and the gain in coal or steam economy will probably not exceed 25 per cent.

CARE WITH ELECTRIC LIGHTS.

A wiring expert of the Ottawa municipal electrical department has given a timely warning to householders in connection with the tendency to meddle with lights and fuses. A large number of fires put down to defective wiring, he says, are simply due to the insertion, by the residents of houses themselves, of any metallic substance such as a piece of copper wire or even a hairpin, so as to prevent the fuse from blowing out. People who have had their fuse blow out and cut off their lights one or two times, do this to avoid a further inconvenience. They court danger and death. A fuse is inserted in every house's lighting system, so as to give entry to enough electricity to supply all the lights in that house and not enough to fuse the wires inside and start a fire. If lightning strikes the wires outside the house or if something goes wrong with a transformer the fuse simply blows out and thus protects the house wires.

Some people do not seem to think anything under about 400 volts is dangerous whereas in reality if one were standing on damp ground or otherwise non-insulated, less than 200 volts might readily result in death. The great thing is to have one's wiring done by a competent person and then not to meddle with it.

In about 90 per cent. of the cases where persons are shocked, their lives might be saved if artificial respiration as in drowning were started immediately after the accident occurs. The shock stops the heart and the thing to do is to get it started again by forcing the air into the lungs.

The Canadian Engineer

ESTABLISHED 1893.

Issued Weekly in the Interests of the

CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Managing Director.—James J. Salmond.
Managing Editor.—T. H. Hogg, B.A.Sc.
Advertising Manager.—A. E. Jennings.

Present Terms of Subscription, payable in advance:

Canada and Great Britain:		United States and other Countries:	
One Year	$3.00	One Year	$3.50
Three Months	1.00	Six Months	2.00
Six Months	1.75	Three Months	1.25

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone, Main 7404 and 7405, branch exchange connecting all departments.
Montreal Office: B33, Board of Trade Building. T. C. Allum, Editorial Representative, Phone M. 1001.
Winnipeg Office: Room 404, Builders' Exchange Building. Phone M. 7550. G. W. Goodall, Business and Editorial Representative.
London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.
Germany and Austria Hungary: Friedrich Lehfeldt, 2 Lindenstrassa, Berlin. S.W., 68. Telephone IV., 3198; Telegrams, Advertise, Berlin.
Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor.
The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 21. TORONTO, CANADA, Aug. 17, 1911. No. 7.

CONTENTS OF THIS ISSUE.

THREE AND A HALF YEARS WITH A TECHNICAL JOURNAL.

With this issue the position of managing editor of The Canadian Engineer has been assumed by Mr. T. H. Hogg, B.A.Sc., and I feel certain that the co-operation and the assistance which I have received from the contractors and the engineers of Canada during the three and a half years that I have been connected with this journal will be extended to Mr. Hogg in even a greater degree. His experience as an engineer will make it possible for him to prepare a journal that will meet the requirements in Canada, and that will be of great assistance to the individual practitioner and to the profession generally.

In January, 1908, The Canadian Engineer was a monthly publication of some eighty-four pages; since then it has developed into a weekly of ninety-two pages, and with the increase in the paper there has been a marked increase in the character and scope of the article presented.

The growth of the paper is an indication of the growth of the profession in Canada and of the development in this country generally.

Engineering is not a close corporation, nor is it a secret society, and the standing of the profession in Canada will be largely judged by the character of the periodicals, which represent in a large degree the profession.

In the past The Canadian Engineer has not been the organ of any society or organization, but has steadily aimed to improve where improvements were possible the condition of the society in which engineers were interested, as well as the spreading of news and knowledge amongst the profession.

We wish to personally thank our readers for the kindness shown to, and the interest taken in, the writer personally during his connection with the technical press, and, whether his absence from that field will be long or short, the acquaintance made and friendships formed and the experience gained during those three and a half years will always be considered by him as one of the most pleasant periods.

Mr. Hogg brings to the new position knowledge, experience and enthusiasm, and we bespeak for him a kind reception.

Yours, etc.,

E. A. James.

HIGHWAY ENGINEERING.

It is safe to say that highway engineering on this continent was practically at a standstill five years ago; even at the present day very little progress has been made. A beginning seems to have been made, however, and prospects for the future seem to be promising. All over the United States the movement for better roadways has been gaining momentum, and in Canada the problem has also been attacked, although necessarily on a smaller scale, but nevertheless with a great deal of vigor.

Looking into the history of the development of any engineering branch, one feature is outstanding, namely, that, as the educational tendencies grew in any particular line, so did that department grow in strength. It is noticeable in this respect that highway engineering as a specialization in educational centres has been practically neglected up to the present, so that one can hardly wonder at the present state of affairs.

It is worthy of note that American universities are beginning to take this subject up. Quite recently certain announcements were made relative to the establishment of a graduate course in highway engineering at Columbia University. That the future will reveal the great worth of this step needs no comment.

In view of the present tendency toward roadway development in Canada it behoves Canadian universities to look into this important question with a view toward giving more chance for specialization on this line. That this specilization need be of a post-graduate nature is questionable. The necessity for it being so in the States arises from the difficulty of men getting appointments during the summer vacation that would be of value. It would seem, however, that this objection would hardly hold in Canada, as the vacations are longer and begin at a time when engineering work commences. Be this as it may, the present call is for some move toward a more active study of this important and undoubtedly growing branch of engineering. The time is now, if ever.

CIVIC INSPECTION.

The recent disaster at Buffalo, in which the roof of the new pumping station fell, killing several of the workmen employed and causing great monetary damage and delay to the city, invites comment at this time. The impression to be gained from a digest of the evidence of the witnesses seems to indicate that there was on this work a lack of proper inspection, and that there was no definite responsible head. The condition of affairs which led to this accident is similar to some extent to that existing in many of our towns and municipalities.

It is a usual thing in these places to appoint men as inspectors who are absolutely incompetent, and useless as such. Political, and many other, reasons interfere to cause the appointment of undesirable men. If the work is to be done well, and if the municipality is to obtain value for its money, then the appointing of inspectors, with adequate recompense, should be in the hands of the engineer.

No large private corporation, or even small, will allow money to be spent on constructiton without rigid inspection through all the different stages of the work. Yet towns will allow work to be done for them in a slipshod manner when, by allowing the appointment of capable inspectors, the work would be well done.

It is usually true that adequate inspection and placing of responsibility is provided on all work done by the larger cities. But even there constant care must be exercised in order that there may be no misunderstanding as to individual responsibility for the work.

Many of the municipalities are beginning to recognize this, and are placing more and more of the work under the direct charge of the engineer, leaving him free to make his own appointments.

EDITORIAL COMMENT.

The Electric Commission, composed of Messrs. Beaudry-Leman, R. S. Kelsch and L. A. Herdt, recently appointed by the city of Montreal to deal with the problem of putting the overhead wires underground, will begin work soon. They have addressed a communication to the Board of Control for funds to open an office and engage a competent staff. The staff will be made up of an engineer, who will devote his whole time to the work of obtaining and grouping the necessary data for the preparation of plans; also a secretary-treasurer to look after correspondence, disbursements, the preparation of the minutes, etc.; and they will require two draughtsmen, a stenographer and general office man.

GENERAL NOTES.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for July, 1911:—

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	2.10	—9.50
Edmonton, Alta.	0.80	—2.95
Swift Current, Sask.	2.60	+0.11
Winnipeg, Man.	3.00	—0.33
Port Stanley, Ont.	4.00	+0.64
Toronto, Ont.	2.53	—0.41
Parry Sound, Ont.	2.26	—0.93
Ottawa, Ont.	3.10	—1.00
Kingston, Ont.	2.00	—0.86
Montreal, Que.	2.20	—1.76
Quebec, Que.	3.80	—0.63
Chatham, N.B.	5.30	+1.58
Halifax, N.S.	2.50	—1.06
Victoria, B.C.	0.10	—0.25
Kamloops, B.C.	0.80	—0.46

THE HAUSERLAKE HYDRO-ELECTRIC DEVELOPMENT.

The new hydro-electric development of the United Missouri River Power Co., located on the Missouri River about 18 miles below Helena, Montana, consists of a large concrete dam 670 feet long and a power house equipped with five 2,800 kw. units, capable of producing 16,000 h.p. under an effective head of 66 feet.

This new concrete dam replaces the large structural steel dam of triangular section which was completed in February, 1907, and failed within a year after going into service. It was designed by Chas. T. Main, of Boston.

The new dam is located in the same place as the former steel one, and is of the ogee type. The spillway is 491 feet in length. There have been 88,000 yards of concrete placed in the dam and at maximum capacity stores 91,800 acre feet of water. From foundations to spillway crest it is 110 feet with a thickness at the base of 86 feet tapering to 67.5 at the ogee section. At the height of 19 feet over the dam extends a bridge supported by 24 piers each 2 feet thick and a [illegible] 8¼ feet in the clear.

The construction of this new dam was started in 1908, but proceeded slowly as the cofferdams and temporary structures were washed out. In March, 1910, work was held up for several months by the main cofferdam being carried away. In building that portion of the dam below low water the Foundation Co. employed their pneumatic caisson method and work was commenced in August, 1910. A number of wooden caissons were sunk to the bed rock filled with concrete, the spaces between them being sealed with the same material. The cofferdam thus constructed proved efficient, the concrete being then laid on bed rock.

PROGRAMME 1911.

Thirteenth Annual Meeting,

ONTARIO MUNICIPAL ASSOCIATION,

City Hall, Toronto,

Thursday, Aug. 31, and Friday, September 1, 1911.

The Ontario Municipal As ociation are holding their Annual Meeting in Toronto, on Aug. 31, and Sept. 1.

An abbreviated programme of the meeting follows:—

Wednesday, the 30th of August—

8.00 p.m. Meeting of the Executive at the Queen's Hotel, Toronto.

Thursday, the 31st of August—

9.00 a.m. Registration of Delegates.

10 00 a.m. Convention opens.

Address of Welcome—
His Worship, Mayor Geary, Toronto.

Presidential Address—
Pres. Hopewell, Mayor of Ottawa.

Address by W. A. Clark,
Chairman Rural Section.

Report of Executive.

Financial Report.

Appointment of Committee on Resolutions.

Communications.

Questions and Suggestions.

Resolutions.

Tax Reform—
Address by A. B. Farmer, Secretary.
Tax Reform League.

1.00 p.m. Luncheon to Delegates by City of Toronto.

1.30 p.m. Meeting of Committee on Resolutions.

2.00 p.m. The Highway Improvement Situation in Ontario—
Address by W. A. McLean, C.E., Provincial Engineer of Highways.
Discussion, Recommedations and Resolutions.

3.00 p.m. The Local Improvements Act—
Address by W. B. Wilkinson,
Law Clerk, Legislative Assembly.
Discussion and Resolutions.

4.00 p.m. County Associations—
Address by W. C. Caughell,
Secretary, Elgin Association.

4.30 p.m. Town Planning Suggestions for Canadian Municipalities—
Illustrated address by J. P. Hynes,
of the Toronto Civic Guild.

7.00 p.m. Meeting of Executive and Committee on Resolutiors, Queen's Hotel.

Friday, the 1st of September—

9-30 a.m Municipal Auditing—
Address by J. W. Sharpe,
Provincial Municipal Auditor.
Discussion and Resolutions.
Hydro-Electric Power and its Development—Address by representative of Provincial Power Commission.

10-30 a.m. Discussion on relations between Boards of Light and Water Commissioners and Municipal Councils as to charges for water and light for municipal purposes—
Opening address by Geo. Geddes,
Water Commissioner,
St. Thomas, Ont.

11.30 a.m. Report of Committee on Resolutions.

12.30 Election of Officers.

CANADIAN BUILDING STATISTICS.

A gain of thirty per cent. over the same period of 1910 is shown by the statistics of building operations in twenty-six Canadian cities and towns for the first six months of the year:—

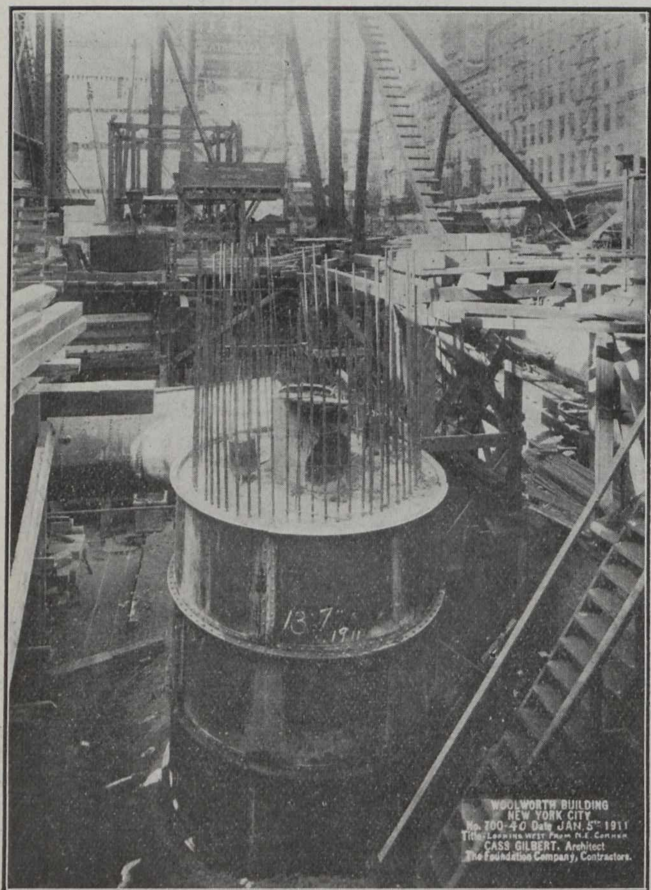
Town or city.	1st 6 mos. 1910.	1st 6 mos. 1911.	Approx. Inc. % 6 mos.
Toronto	$9,820,648	$11,939,953	22
Vancouver	6,885,880	9,188,406	33
Winnipeg,	9,906,100	8,581,550	13
Calgary	2,394,942	8,212,248	242
Montreal	7,126,880	7,305,816	2
Regina	1,342,003	2,936,930	111
Saskatoon	1,657,131	2,575,441	55
Hamilton	1,232,725	2,246,657	82
Edmonton	1,054,476	1,620,431	54
Victoria	1,202,835	1,432,585	19
Ottawa	1,690,025	1,393,370	12*
Moose Jaw	513,210	1,295,575	154
Brandon	401,700	803,574	101
Sherbrooke	300,000	675,000	125
Fort William	939,280	750,075	20*
Lethbridge	659,570	485,625	26*
London	452,466	458,423	1
Windsor	109,480	395,495	261
Port Arthur	310,465	315,660	2
Sydney, N.S.	204,652	382,052	87
Halifax	175,450	211,150	20
Strathcona	234,500	214,183	9*
St. John, N.B.	222,000	211,700	5*
St. Thomas	112,850	136,150	21
Kingston	100,143	136,462	36
Stratford	190,000	62,500	67*
	$49,240,411	$64,068,029	30

*Decrease.

MORE THAN A MILE OF CONCRETE FLOOR.

The recently completed Armour-Swift-Burlington Bridge crossing the Missouri River at Kansas City, is 5,998 feet long and the entire floor is of concrete mixed in a single mixer which was located on the shore directly under the bridge, the material being hoisted in a tower. This is probably the longest concrete floor in the world.

THE FOUNDATION OF A 55-STOREY BUILDING.

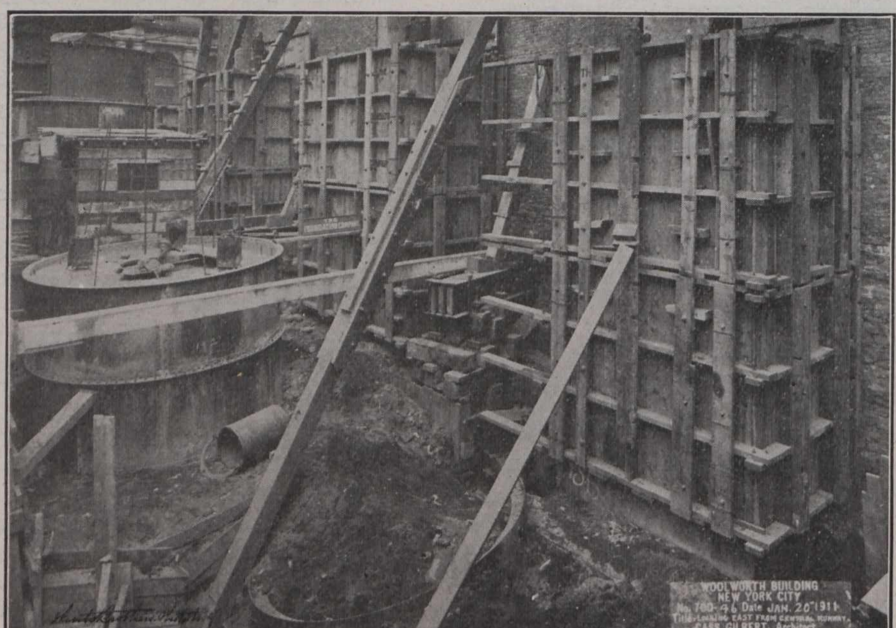


The four cuts are reproductions from photographs recently received of the site of the new Woolworth building, New York City. Mention has been made from time to time in these columns regarding this structure, but these cuts of the foundations and the caissons used in their construction will not be out of place.

The building will, in its rough features, resemble its neighbor the Singer building, rising above that structure however by some thirteen storeys.

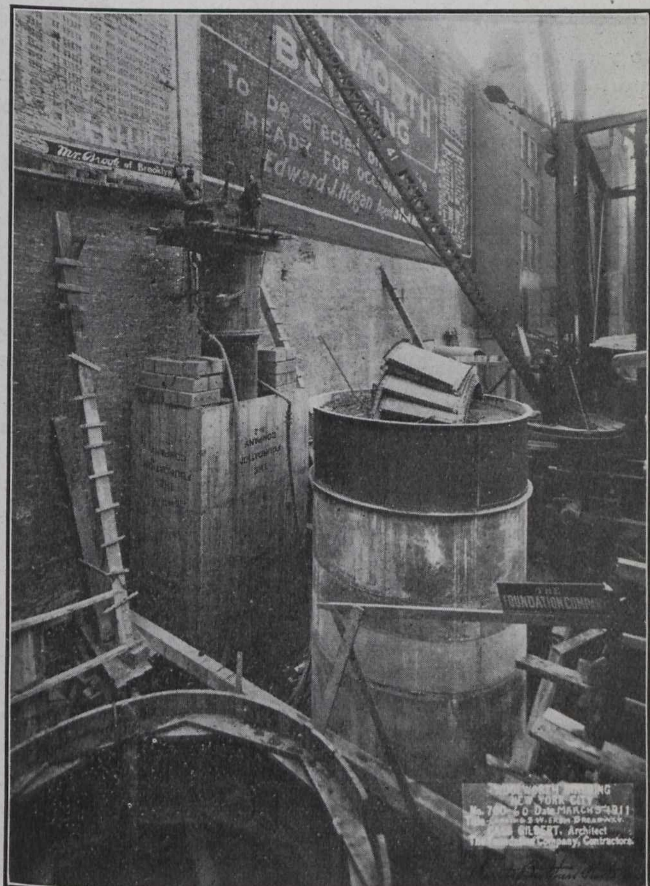
The site chosen for the building is unfortunately of a quicksand nature, and for this reason the foundation caissons have been taken down 110 feet. This distance, with the height above the sidewalk gives the building a total elevation of 885 ft.

The foundation plans, as well as those of the building, comply with the laws of the building code of New York City. This law allows 150 lbs. pressure per square foot on basement and first floor, and 75 pounds per square foot on each of the other floors.



The steel framework, supported by the foundations, will reach an aggregate weight of 20,000 tons.

The exterior covering of the fifth floor will be granite, and above that terra cotta will be employed.



The doors, sashes, etc., will be pressed steel, no wood or other inflammable material entering into the construction of this building.

RAILWAY TESTS OF AIR BRAKES: 1878 TO 1909.*

The air-brake was the invention of an American, and its success was early demonstrated at home, but the first important brake tests on scientific lines were made in England. These tests originated with a suggestion made by Mr. George Westinghouse before the Institute of Mechanical Engineers, London, 1878. He called attention to wide variations in shoe friction observed at different speeds, emphasized the importance of ascertaining the facts, and volunteered to design the recording apparatus necessary. The Institute assigned Captain Douglas Galton, assisted by Mr. Horace Darwin, to the personal direction of these tests, which were made on the London, Brighton and South Coast Railway and the North-Eastern Railway in 1878-9.

It may be said that the art of braking rests upon the facts and laws evolved from the Westinghouse-Galton tests. These trials established the following new principles: (1) permissible brakeshoe friction is limited by the adhesion between rail and wheel; (2) train retardation as measured by the coefficient of friction at the brakeshoe is subject to fixed laws directly affected and controlled by three factors: time, pressure and speed.

In 1886, the Master Car Builders' Association committee on Freight Train Brakes (Mr. Godfrey W. Rhodes, Chairman) arranged for a seriees of brake tests at Burlington, Iowa, on the C., B. & Q. R. R. These trials originated on account of the gradual increase in length of freight trains, the growing importance of interchange facilities, and the very evident necessity for the establishment of some standards in railway brake requirements.

At that time, trains of 50 cars represented maximum operating conditions and this length of train was therefore specified as the basis of comparison. Two types and five different makes of apparatus were entered, including the Westinghouse plain automatic brake. The schedule of tests specified service and emergency stops from various speeds on level track and grades with different combinations of loaded and empty cars in the train, however, due to excessive train slack, amounting to 6½ ins. per car, and slow serial action of the brakes in trains 1,900 ft. long, very heavy shocks, destructnve both to cars and lading, resulted during stops. The results of this series of tests were disappointing and unsatisfactory in the extreme, but exceedingly instructive. Recognizing the absolute necessity of developing a brake system providing practically simultaneous action throughout a 50-car train, or eliminating the slack between cars, or both, the committee postponed further tests until the following year.

Following these tests, brake manufacturers bent their energies chiefly towards improving quick serial brake action. In the Burlington tests of 1887 five different brake equipments (four compressed air and one vacuum) were again represented. All, with one exception, were operated either electrically or used electric auxiliary attachments for insuring simultaneous brake application throughout the train. The Westinghouse apparatus also included at this time a quick-action feature which was an attempt to accomplish quick serial action pneumatically. The results obtained, so far as pneumatic operation was concerned, however, practically duplicated those of the year before, showing pneumatic operation as then designed to be impracticable for 50-car trains by reason of shocks occasioned, but that an extraordinary improvement resulted in this particular when electric operation was employed.

Naturally the committee was favorably inclined toward electric operation and in recording conclusions stated: (1) the best type of brakes for long freight trains is one operated by air but actuaed electrically; (2) this type of brake possesses four distinct advantages, (a) shortest stop distances, (b) elimination of shocks, (c) instantaneous release, (d) perfect graduation. Nevertheless the committee withheld any definite recommendations as to the type of brake that might be adopted generally and continued the subject for further investigation.

Following the Burlington tests of 1887 and during the autumn of the same year Mr. Westinghouse produced his quick-action automatic brake by means of which the time of brake application through a 50-car train was reduced to three seconds. The Westinghouse train used in the Burlington trials was therefore equipped with the improved apparatus and sent on a tour of the country, runs being made at various railway centers. These private tests were remarkably successful, demonstrating the practical possibilities of all-pneumatic operation, thereby eliminating any necessity for electric operation with attendant complication, maintainenance, etc.

So completely was the problem solved that the Master Car Builders' committee on Freight Train Brakes reported to the Association at Alexandria Bay, N.Y., in 1888, that "there is now a brake (non-electric) on the market which can be relied on as efficient in any condition of freight service." The principles of pneumatic brake operation thus evolved for freight service became at once generally ac-

* Condensed from information published by the Westinghouse Air Brake Company, Pittsburg, Pa.

cepted standards and so continued until within the last few years, when the quick-service uniform-recharge uniform-release freight brake was developed to meet modern conditions created in the operation of trains of over 50 cars.

In 1902, the value of the high-speed brake as compared with standard quick-action automatic brakes for passenger service was demonstrated in trials conducted at Absecon, N.J., under the supervision of the Pennsylvania R. R. A locomotive and seven cars (as well as shorter train combinations) were used and the conclusions derived were of an unusual importance, showing over 20 per cent. shorter stops in favor of the high-speed brake at all speeds from 45 to 80 m. p. h. The need for the engine truck brake was also brought out by break-away tests, showing the normal stopping power of engine and tender brakes to be materially less than the train brakes.

In 1903, high speed brake tests to determine maximum brake efficiency with available apparatus were made under the direction of the Central R. R. of New Jersey, at Atsion, N.Y. In general the conditions and results were similar to those obtained in the Absecon tests, the demonstrated loss in brakeshoe frictional efficiency with higher speeds emphasizing the vital necessity of compensating therefor through improved brake equipment.

In 1908, the Southern Pacific Ry. undertook the most complete series of brake tests since the Burlington trials of 1886-7. Perhaps the most important demonstration of this series was the possible increase in train tonnage on grades due to improved brake control. It was ascertained that the volume of traffic at certain points was limited not by the tonnage that could be hauled up the hill with powerful locomotives, but by the tonnage per brake that could be safely controlled down the grade. The use of Westinghouse quick-service uniform-release uniform-recharge freight brakes raised the normal tonnage rating for the Siskiyou to Ashland grade from 80,000 lbs. to 145,000 lbs. per operative brake; for the Siskiyou to Hornbrook grade from 80,000 lbs. to 132,000 lbs. per operative brake; and on Beaumont Hill from 110,000 to as high as 182,000 lbs. per operative brake, trains being controlled well within safe limits in every case.

These results were possible on account of quick serial service operation and the ability to keep the brake system charged to practically full pressure at all times. Few performances in freight brake history have been more spectacular than the increased tonnage rating possibilities demonstrated for heavy traffic work on long grades.

In 1909, at the instance of the Master Car Builders' committee on Air Brakes and Train Signals, the most important and complete passenger train control tests ever made were carried out on the line of the Lake Shore & Michigan Southern Ry., some distance east of Toledo, Ohio. The purpose of these tests was to determine the possibilities in stopping modern high-speed passenger trains. The results of these tests were exceedingly instructive, bringing out clearly large losses in breaking efficiency during stops from high speeds with trains of very heavy cars weighing 125,000 lbs. and upwards which exceed the capacity of a single brake cylinder. The practical effect of these trials was to indicate the necessity for a two-cylinder brake equipment in order to divide the work of braking since a new brake of this type was required in order to stop these very heavy trains from a speed of 60 m. p. h. within 1,200 ft., the distance fixed upon by the M. C. B committee.

In general, perhaps the most far reaching result of these trials was a realization on the part of the air-brake manufacturers and the railways of the vital bearing which present day conditions as to car weights, train lengths, train speeds, and train frequencies have upon the large problem of adequate braking.

ARMOUR FOR SHIPS (1860 TO 1910).*

Charles E. Ellis.

The period under review practically coincides with the history of the use of armour, and its manufacture for ships of war, from its inception to the present time. As will be seen, there has been an unbroken struggle for ascendency between the weapon of attack and the material produced to resist it, the advantage now lying with one side and now with the other, th most gratifying feature being that it is a story of continuous development on both sides, modifications and improvements in ordinance necessitating and suggesting modifications and improvements in armour, and vice versa. My object is merely to set out, historically, the principal features of the various types of armour, during the period in question, from which the modern plate has been evolved.

In the year 1860 there was under construction in France and England the first two armoured sea-going battleships, the Gloire, building at Toulon, and the Warrior, at Blackwall, the former having broadside protection of 5 in., the latter similar protection of 4½-in. iron plates. Of the two vessels, the Gloire was commenced in March 1858, the Blackwall ship being ordered in June, 1859. Th use of armour in the two navies, for all important vessels, was subsequently uninterrupted, and in this country armour was gradually increased in thickness until it culmilnlated in the maximum of 24 in. of armour fitted on the sides of the Inflexible (1881).

Prior to 1860, a large number of experiments connected with the manufacture of armour iron plates had been made, the thickness varying from ½ in. to 4 in., and plates of this material, of varying dimensions, had been fitted to floating batteries in many countries of the world. It is somewhat difficult to state positively the names of the firms who were most successful at this period of the history of armour. I am inclined, from the materials at my disposal, to give the honour in France to the St. Chamond Company, and in England to the firm of Beale and Company, of the Parkgate Iron Works, near Rotherham. The former company held practically the monopoly of armour manufacture in France for a considerable period—1855 to 1870—and I am informed that their success was mainly attributable to the pure quality of their iron, and to the fact that, contrary to the general opinion, their plates were much improved by water treatment. In England the competition was much more severe, various makers competed against one another, both with rolled and hammered plates, with varying success, and in a paper written by Captain Inglis in 1862, giving a full account of various trials, the following are some of the practical conclusions which he laid down as the result of his investigations:—

1. Good, tough wrought iron of high elasticity, but not necessarily of the highest ultimate tensile strength, is the best material for use in iron defence.

2. Rolled iron, though not perhaps equal in resistance to the best hammered iron, has such great advantage as to cost, if used in simple forms, as to justify its use when lightness is not of extreme importance.

* Paper read at the Jubilee Meeting of the Institution of Naval Architects.

† It was subsequently proved at Shoeburyness, conclusively, in 1877, that a solid plate of 17 in. to 17.5 in. was the equivalent, so far as resistance was concerned, to three plates 6.5 in. each.

3. In plates of ordinary dimensions, the resistance to cannon shot varies in proportion (approximately) to the square of the thickness of the plate.

4. Rigid backing is immensely superior to elastic backing, so far as the endurance of the front face is concerned.

5. The larger the massees,† and the fewer the joints, the stronger the structure, so long as the limits of uniform and perfect manufacture are obtained.

It is curious to note, in passing, how many of the conclusions of this eminent officer have been found to be applicable to nearly all the subsequent kinds of armour fitted for the protection of war vessels. I should like to quote here the opinion of another distinguished authority, Captain Dyer, on the results of the same experiments, about the same period.

1. Plates of hard crystalline structure are inferior to those of a soft fibrous nature.

2. The great weakness in forged plates is unsoundness in welding.

3. The quality necessary for an armour-plate is ductility. The purer and better the iron is, the more this quality is perceptible; any impurity or alloy hardens the metal and produces brittleness.

Rolled armour, was in the end, adopted for use in all the ironclad vessels for the British Navy, including the Warrior. The following description of the method of manufacture, given at this period, is of interest:—"Several bars of iron were rolled 12 in. broad by 1 in. thick, and were cut 30 in. long. Five of these bars were piled and rolled down to another slab, and these two slabs were welded and rolled down to a plate, inch thick, which was sheared to 4 ft. square. Four of such plates were then piled and rolled down to one plate, measuring 8 ft. by 4 ft. 2 in. thick. Lastly, four of these were piled and rolled to form the final and entire plate. There were thus welded together sixteen thicknesses of plate, each of which was originally 1½ in. thick, to form one plate 4½ in. thick. In this operation from 3,500 to 4,000 square feet of surface had to be perfectly welded by the process of rolling.

The increase in the calibre of guns, and to some extent the use of steel shot, soon brought about an increase in the thickness of wrouught iron armour. Thus we find experiments against 5½ in., 6½ in. and 7½ in. iron plates in March. 1863, with guns of varying diameter of bore up to 10 in., while the side armour of the Bellerophon (1866) was increased to 5½ in. in thickness. Another important factor in this connection was the introduction of Palliser's ogive hardened chilled iron shot, which was first tried at Shoeburyness in November, 1863, and afterwards, with slight modification in form, generally adopted for use in armour trials. Against these improvements in attack, the iron manufacturer could, at the time, only reply by increasing the thickness of his armour. This is exemplified by the following table, showing the maximum thickness of armour in later ships down to the period of the construction of the Inflexible:—

		Thickness of Side Armour. Inches
1868	Agincourt	5½
1870	Repulse	6
1872	Swiftsure	8
1874	Rupert	11
1877	Thunderer	12
1878	Belleisle	12
1881	Inflexible	24 (in two thicknesses of 12 in.)

In each case I have given the date of the completion of the vessel. In the meantime, however, important experiments were being carried on in connection with the use of steel for armour plates. The Spezzia trials of 1876 proved that the resisting power of steel was far greater than that of iron, although the plate itself was broken up in the act of repelling the attack, which was in this trial, unduly severe. The manufacture of steel in large masses was, however, in its infancy; the metal was wanting in toughness, and could not stand up to the racking effect of heavy projectiles.

Other interesting proposals were made and adopted at this period in connection with the use of steel. A notable case is that of the Polyphemus, in which compound steel plates, in two layers, were fitted by Sir Joseph Whitworth, & Company, in the year 1879 to 1881, the inner layer being composed of steel plates of considerable area, with a tensile strength of 45 tons per square inch, the outer layer being formed of small steel plates about 10 in. square, having a tensile strength of 60 tons per square inch, all the plates being oil-hardened.

The introduction of compound armour about the same period, however, effected a revolution in ship protection. In the Inflexible the highest point, so far as iron protection was concerned, had been reached, and to meet the increasing power of the attack it had been found expedient to increase the thickness of side protection as above stated to 24 in., with the result that only the vital parts of the vessel were protected at all. The design was much discussed at the time in papers read before the Institution, and, curiously enough, it was during its construction that the new type of armour came to the front, and its quality was sufficiently proved to justify its adoption in the turrets of the same ship. The two Sheffield firms, Brown and Cammell, working on independent lines, conceived the idea of a steel face, welded to an iron back, the object being to break up the point of the shell by means of a hard steel face, and to hold the plate together by the tough iron back. The modes of manufacture were different in detail, the Wilson plate being made by casting a steel face on the top of a rolled iron back; while Mr. J. D. Ellis made a comparatively thin rolled steel plate for the front of the target, and cast steel between it and the iron back. In each case the plate was subjected to heavy rolling after the casting was completed. Various proportions of steel and iron were tried, and in the result a proportion of about one to two was found to give the best results. The increase in resistance afforded by this type of armour was soon recognized in Great Britain, and its partial adoption for the turret protection of the Inflexible effected a saving of 600 tons in weight.

Speaking generally, the superiority of compound armour over iron was computed to be in the proportion of three to two, and it was generally adopted in the British Navy for a long period. Orders were given for all the armour for the celebrated Admiral class to be of the compound quality, together with a number of armoured cruisers, which were completed about the same time—1882 to 1889. On the Continent, the superiority of the compound plate was not so universally acknowledged, and in France the battleships building during this period werer protected by steel and combined armour in about equal proportions.

Considerable improvements had been made by M. Schneider in the manufacture of solid-steel plates, and for a long period of years this eminent firm competed, with varying success, with the compound armour makers. Numerous International trials were held, of which the following were the most important:—(a) Spezzia, 1882; (b) Ochta, 1882; (c) Copenhagen, 1884; (d) Spezzia, 1884; (e) Pola, 1885; (f) Annapolis, 1890; (g) Ochta, 1890. It is not within the scope of this paper to give the result of these trials, but from an examination of the various reports it would appear that in b, c, e the superiority lay with the compound armour, and in a, d, f, g with the all-steel plate. In the case of the Annapolis trial, the superiority lay with a plate containing a considerable portion of nickel. The Ochta trial of 1890 introduced another firm as manufacturers of steel plates. Messrs. Vickers had produced an excellent solid-steel armour plate in the year 1888, which was tested on the Nettle, and this class of armour was adopted for use, to some extent, at a later date by the British Adimiralty.

M. Barba, the chief engineer of the Creosot Works, in a paper read before this Institution in March, 1891, strenuously argued in favour of the all-steel plate, but in the discussion that followed the preference generally appeared to be given to the compound plate. In the First Lord's Memorandum of the same year, explanatory of the Navy Estimates, it was expressly stated that for the main defence of first class battleships compound armour was to be preferred, but that steel armour had been adopted for the secondary defence of battleships, for the protection of auxiliary armaments, and for the protection of machinery in vessels of the cruiser classes. In accordance with this decision, the main defence of the Royal Sovereign class and other vessels built at this period, consisted of compound armour, whilst the secondary armament of these ships was protected by 4 in. of steel. The greatest thickness of compound armour fitted to British ships was 20 in. tapering to 16 in. I refer to the Nile and Trafalgar, two powerful vessels carrying four 67-ton breech-loading guns.

Numerous experiments were, however, being made by all armour manufacturers, both with compound, steel, and nickel-steel plates, in order to improve their quality. Various processes of hardening were tried—air, steam, water, lead, and oil, all with more or less encouraging results. The earliest case I find of water-hardening on one side only of the plate appears in the records of the eminent firm of Fried. Krupp, in 1885, in connection with a compound experimental plate (one-third crucible steel and two-thirds mild Siemens-Martin steel). This was followed by other plates, treated in the same way, the water impinging on the face by the force of gravity only; but, as the firm were not makers of armour for ship protection at the time, the idea was not carried out beyond the experimental stage.

In England, the attention of Captain Tressider was drawn to the importance of making the face of the plate so hard as to break up the point of the projectile before it had time to effect any serious penetration. The particular process he adopted was the application of a cold douche of water, under sufficient pressure, and of sufficient volume, to prevent any envelope of steam forming on the face of the plate, and thus insuring a rapid face chilling of consequent hardness. Various compound plates were tested, treated in this manner, and the object was attained. The best forged steel armour-piercing projectiles were broken up by the hardened face, and a considerable increase of resisting power was obtained.

In Octobr, 1891, however, a plate was being tested in America which was the precursor of a complete change in armour manufacture. Mr. Harvey had obtained considerable success in applying water-hardening to cemented steel, in the construction of small articles, and conceived the idea of the manufacture of armour-plates in the same conditions. The process was, shortly, as follows:—solid-steel armour-plate was pressed and rolled, and highly cemented on the face; it was then subjected to a severe water-hardening process, somewhat similar, in the later plates, to that above referred to. The resultant was a glass-hard face, with a mild steel back, and subsequent trials in various parts of the world secured its nearly universal adoption. The resisting power of armour was raised by 50 per cent. Sir William White, in a speech made at the meeting of this Institution in 1894, put the superiority even higher, referring to experiments which showed that, so far as rsistance was concerned, 6in. of Harveyed steel was equal to 10 in. of compound armour. This being so, naturally we find in the battleships of this period a corresponding diminution in thickness of the plates utilized for ship protection; thus in the well-known Majestic class (1895-1897) the thickness of side armour was reduced to 9 in., advantage being taken of the saving in weight effected by the new armour for a given resistance by fitting two tiers of the thickness above mentioned on the belt of the vessel, and greatly increasing the length so protected.

The best American results had been obtained with Harveyed nickel-steel, but the value of the nickel alloy was not sufficiently proved by later experiments as to make its adoption universal. The Harvey plate, however, with all its merits, had one defect; the back was not sufficiently tough to withstand the racking effect of steel projectiles. It is due to the genius of the experts of the firm of Fried. Krupp that a most valuable improvement was effected in this connection. After various experiments with different alloys of mild steel, chrome steel, and nickel-chrome steel, the first properly so-called Krupp plate was made in the year 1894, and on trial gave excellent results. In this plate, which was in nickel-chrome alloy, for the first time the principle of differential treatment in the final processes of hardening was adopted. A special heating-furnace was built, and the temperature of the face of the plate was raised to a certain depth, sufficiently to allow of the highest degree of hardness being obtained. The remainder of the plate was only heated sufficiently to ensure toughness and a fibrous structure when hardened by water. The hardening was then effected by spraying under pressure the front and back of the plate simultaneously until completely cooled.

In the following year the results obtained by this mode of treatment were repeatedly confirmed, and the invention became a practical success. The crystalline structure of the back of the Harvey plate was replaced by a tough fibrous quality, which prevented cracking, and, by spreading the resistance to the impact of the projectile over a wider area, assisted materially in reduction of penetration. Trials of similar plates made by British makers followed, with similar results, and this class of armour was soon afterwards universally adopted in the Service.

In the year 1894 it was my privilege to be allowed to give to the Institution the result of trials of Harveyed armour, and it will be of interest to give a few instances of trials of the more modern type, without going into detail, but giving particulars sufficient to show the advance that had been obtained in ship protection. In 1899 a trial of a Krupp plate 5.9 in. thickness took place. Six shots (Wheeler-Stirling armour-piercing projectiles) were fired at striking velocities ranging from 1,928 to 2,211 foot-seconds. In each case the projectile was completely broken up, the greatest penetration did not exceed 5 in., and the plate was practically free from cracks, a slight opening only being observable in the bulge at the back in the case of one of the shots. The behaviour of a plate 8 ft. square by 8.3 in. in thickness was practically similar when attached by an 8-in. armour-piercing projectile with velocities of 1,854. 1,964, and 2,039 foot-seconds respectively. I give a further instance of a plate 12 in. thick tested in 1897. The plate, which measured 10 ft. by 7 ft., was attacked by three armour-piercing projectiles of high quality, weighing 720 lb. each, at velocities of 1,860, 1,861 and 1,868 foot-seconds. In each case the projectile was completely broken up, no cracks appeared in the plate, and the greatest penetration was computed to be 2.75 in.

The instances above given are put forward as being fairly representative, and not selected as showing the highest point of efficiency this type of armour has reached. They are, however, sufficient to show the great characteristics of the Krupp plate; resistance to perforation, and practical freedom from cracking. In each case the plate could have stood considerably more punishment. Summing up the results, it would appar that the relative thickness of wrought iron to give equal rsistance to the attack would be, according to the recognized formula, from 230 to 280 per cent. of the thickness of the plate tried, and it must be remembered that in no case was the plate tested to the point of complete perforation.

The superiority of the Krupp type of armour has been long acknowledged. It must not, however, be assumed that finality has been reached. It may well be that, particularly in connection with capped projectiles of large diameters, as compared with the thickness of armour, attacked, improvements will be made, and this Institution may rest assured that armour-plate manufacturers are very desirous of taking advantage of any invention of prctical utility which may be brought to their notice, or which may be discovered in their own research laboratories. Consideration of these matters may, however, be left to the future.

I feel, in conclusion, that I have only touched on the fringe of this great question. Had it been possible, I should have liked to refer in detail to the excellent work which has been done by the various firms individually in connection with the manufacture of armour, and to have noted the great success which the newest of the armour-making countries, Japan, has achieved in supplies to war vessels, both battleships and cruisers. I should have liked, also to have referred to the important question of power of production in the various armour-making countries of the world. These are facts, however, well known to many of the foreign guests of the Institution. It is sufficient to say that the world supply appears more than equal to the world demand, and, speaking in the name of armour makers generally, I am confident that any increased requirements will be readily met, whether in quantity or quality. At any rate, no effort has been, or will be, spared to give to the navies of the world the best protection that can be devised. Many papers have been read at this meeting illustrating the great advance which has been made during the past fifty years in various branches of naval architecture and marine engineering. I trust that the remarks I have had the honor to make may be sufficient to show that, in the manufacture of armour for ships during the same period, satisfactory progress has been achieved, commensurate with the great importance of the subject.

MONTREAL'S WATER SUPPLY.

Some slight apprehension, it is claimed, is felt in insurance circles concerning the fire insurance position in the vicinity of Montreal just now. The drouth has been long and severe, thus leaving everything inflammable in the most favorable condition to carry fire. For instance, the grass in the vicinity of the city is exceedingly dry and several fires caused by children playing with matches, it is thought, called for the attention of the fire brigade. Because of the water shortage these grass fires in the north part of the city had to be fought with sand and earth and by a chemical engine. Although in no case was any property in danger from these fires, the incidents were not reassuring, when all the circumstances are taken into consideration. The aldermen in the different outlying wards of Montreal are complaining that they are not getting proper fire protection from the city. This protection was promised them when these outlying wards were taken into the city, and although the installation of a fire-fighting apparatus was to be made immediately, no action has yet been taken in the matter.

The controllers in reply state that it is impossible for the city to lay water systems in several wards in a year's time even if it had the money, which it has not. They will install the water mains as quickly as possible. In the city of Montreal itself there is some shortage of water so that in case of fire the protection is not so good as would otherwise be the case. The lower level reservoir is being repaired and the water is down to a depth of 17 feet, which is 6 feet under normal, while the contents are at present but 20,000,000 gallons or about 45 per cent. of what it should contain. There is not much danger from any of these sources at the present time, it is thought.

The contract has been given for the new 12-inch pump at the water works, which will have a daily capacity of 12,000,000 gallons. This will increase the city's total pumping capacity to 55,000,000 gallons a day.

The average daily consumption of water during the present year has been 42,000,000 gallons a day; but the hot spell caused these figures to mount. On August 6th there were 47,000,000 gallons used; on August 5th, a total of 48,000,000 gallons flowed through the city taps, and the day previous, August 4th, saw a consumption of 46,500,000 gallons.

CHLORINE TREATMENT OF DRINKING WATER.

J. Race, F.I.C.

In your issue of July 27th, 1911, there appeared an article on this subject which, if allowed to pass unchallenged, might create an erroneous impression as to the method by which the bacterial count of a water is reduced by treatment with Chlorine in the form of bleaching powder.

It is now generally accepted that the germicidal action of bleach is not due to the chlorine "per se", as would be understood from this article, but to the nascent oxygen liberated during its reaction with water. This action may be represented thus:

$$Cl_2 + H_2O = 2HCl + O$$

The hydrochloric acid liberated reacts with the carbonates present with the production of chlorides and free carbonic acid gas. The chlorides usually produced are those of calcium and magnesium. These salts, when present in large quantities (100 grains per gallon) may impart an appreciable saline taste to the water but the quantity usually present in a chlorinated water is much too small to exert any effect on the palate flavor. It is well known, in the brewing industry, that chlorides of calcium and magnesium (20-40 grains per gallon) increase the "fullness" of the palate flavor of a beer (by extraction of the albuminoids) but do not produce an astringent effect.

Laboratory experiments have demonstrated that it is impossible to detect chlorine in water, when present in quantities less than 1 part per million (0.07 grain per gallon) either by the odor or taste. The odor and palate flavor of chlorine cannot easily be distinguished from those which are natural to raw lake water. This water often possesses an odor which might be described as fishy and is probably derived from the Diatomacae and Schizophycae invariably present. Certain forms of these, such as the Uroglena Americana, are known to transmit a fishy odor to water by rupture of the oil sacs which they contain.

It is possible that chlorine, when present in large quantities, may impart an odor to the water by acting on the Albuminoids present with the evolution of chloramine, NH_2Cl. This substance has been shown by Rideal (Jour, Royal Sanitary Institute XXXI. No. 2) to possess even stronger germicidal properties than chlorine. Thus the addition of an equivalent of ammonia to chlorine solutions increased the Walker-Rideal carbolic acid figure from 216 units to 636 units. Chloramine has a pungent, objectionable odor. The addition of another equivalent of ammonia resulted in the production of hydrazine chloride (odorless) which has a Walker-Rideal figure of only 24 units.

$$NH_2Cl + NH_3 = N_2H_4HCl.$$

Addition of more ammonia would probably result in the formation of ammonium chloride (NH_4Cl) which is odorless and without germicidal properties.

The article above referred to also suggests the use of perchloride of iron for the treatment of water on the grounds that the chlorine resulting from its decomposition would act as a germicide and the ferric hydroxide as a coagulant. The writer experimented with this method with Lake Ontario water with the following results:

Media. Nutrient Gelatine 1.0% acid.

Incubation. 3 days at 20-22 degrees Centigrade.
The water before treatment showed 164 colonies per c.ccm.
Period of Contact Ferric chloride in grains per gallon:

	0.5	1.5	4.0	10.0
45 minutes	172	162	125	24
2 hours	179	98	111	7
6 hours	188	140	88	0

From these figures it will be seen that evidence of definite germicidal action was only obtained in one case, viz: with the use of 10 grains per gallon. With this amount precipitation did not commence until 12 hours after the addition of the ferric chloride and was not complete in 72 hours. During this period the liquid showed a deep orange color that alone would be sufficient to condemn the process. Ferric chloride, when added in an amount equivalent to the bicarbonates present, precipitates fairly rapidly and produces a clear liquid, but the whole of the ferric hydroxide formed does not settle to the bottom. A portion of it is carried to the surface by the gas liberated and would be a distinctly objectionable feature to the process when carried out on the large scale. The action of ferric chloride on Lake Ontario water is probably represented by the following equation:

$$Fe_2Cl_6 + 3Ca\ (HCO_3)_2 = 3CaCl_2 \quad Fe_2(OH)_6 + 6CO_2$$

If calcium chloride is an objectionable feature of the bleaching powder treatment the same remark must also apply to this method but this has been shown above to be a misstatement of the facts. The treatment of the water supply of the city of Toronto with 10 grains of ferric chloride per gallon would require 6 to 8 tons of this substance per day and would obviously be very costly.

To summarize:—

(1) The germicidal action of chlorine is due to the nascent oxygen liberated.

(2) Chlorine, in quantities up to one part per million, does not impart odor or taste to water.

(3) Lake Ontario water often possesses a distinct odor and taste not unlike those of chlorine.

(4) Ferric chloride, in quantities less than 10 grains per gallon, has no germicidal action.

(5) That the quantity of ferric chloride necessary to exert a germicidal action, imparts an objectionable color.

THE ROAD BOARD OF GREAT BRITAIN.

General Directions and Specifications Relating to the Tar Treatment of Roads.

ROAD BOARD SPECIFICATION NO. 1.

General Directions For Surface Tarring.

1. Surface tarring may be advantageously applied either to an old road surface in good condition or to a new surface after it has been consolidated and dried, but the tarring should never be carried out unless the road is thoroughly dry.

If there are any depressions, pot-holes, waves, grooves, or other irregularities, these should as far as practicable be made good before tarring is commenced, so as to provide an even surface.

2. Painting and spraying machines get through the work of tarring more rapidly than application by hand, and consequently are to be recommended, but hand work gives satisfactory results, and the selection of the method to be employed must be largely determined by the available supply of efficient labor.

3. If it is intended to tar an old surface it is advisable to take advantage of the early months of the year to scrape or brush the road during wet weather as a preparation for subsequent tarring, and especially to keep the road free from caked mud.

4. If the crust of a road is thin at the sides, but adequate in the centre, the sides should be strengthened and consolidated before application of tar to the surface.

5. In resurfacing any road the surface of which is afterwards to be tarred, stone chippings, and not fine material, should be used for binding.

6. The road while being tarred should be closed to traffic over half its width, or, where practicable, over its whole width.

7. The road should be thoroughly brushed and cleaned before application of the tar. Wet brushing should be used some time previous to dry brushing, if there is any caked mud. Any method of brushing may be used which will scour and clean the road thoroughly, the best being horse brushing, followed by hand brushing.

8. Tar should be used for surface tarring, which complies with either Road Board Specification for Tar No. 1 or Road Board Specification for Tar No. 2, but if the heavier grade of the tar is used, care should be taken to apply it only when the road is dry and well warmed by the sun's rays, otherwise it will not flow freely.

9. The tar should be heated to its boiling point at convenient positions on the works, and should be applied as hot as possible, so that it may flow freely. The desired temperature will be generally found in practice to lie between 220 deg. and 240 deg. Fahr. for Tar No. 1 and between 260 deg. and 280 deg. Fahr. for Tar No. 2.

10. In order that the tar should be applied to the road as hot as possible, it is advisable, if the method of application is by hand, to use flexible pipes to convey the tar from the boiler to the point of application. If these are not available, it will be found convenient in case of hand pouring to use 3-gallon cans specially constructed for the purpose, fitted with spouts leading direct from the bottom of the cans, and being not less than 1½ in. in diameter at the orifice.

11. Immediately on application the liquid tar should be brushed so far as necessary to ensure regularity in thickness of the coating.

12. The quantity of tar required will vary according to the physical conditions of the road, but generally, in the case of a road to be treated with tar for the first time, the quantity should be one gallon to coat from 5 to 7 super. yds.

13. If the road must be opened for traffic before the tar has set hard, grit should be spread on the surface to prevent the tar from adhering to the wheels of vehicles, but gritting should be delayed as long as possible, and the quantity of gritting material to be spread should be no more than sufficient to prevent the tar from adhering to wheels. Stone chippings, crushed gravel, coarse sand or other approved material (free from dust) not larger than will pass through a ¼-in. square mesh should be used for gritting, in quantity not exceeding 1 ton for 300 to 350 super. yds. if grit is used, and 1 ton for 200 to 250 super. yds. if coarse sand is used.

14. Precautions should be taken to prevent liquid tar passing directly through drainage gratings or outlets.

15. For the safety of the public precautions should be taken by lighting, watching and warning.

Notice boards should be placed in suitable positions bearing in large letters printed in conspicuous colours the following words:—

CAUTION.

Tarring in Progress.

Cyclists Advised to Walk.

It is specially desirable to place warning notices at points in the neighborhood of the work where other roads join or cross the road being tarred, to enable motorists and cyclists to avoid the obstructed road by taking any available alternative route.

16. On heavily trafficked roads it is advisable to apply a second coat to either the whole width or from 9 to 12 ft. of the centre of the road in quantity of one gallon to coat from 8 to 10 yds. super. about two to three months after the first application.

17. Surface tarring should be renewed annually on all important roads, and as required on roads with light-traffic. On such recoatings the quantity of tar to be applied will vary with the extent to which the previous coating of tar has been removed by weather or by traffic.

18. Two or more samples of the tar used should in all cases be kept in quart tin cans, and be carefully labelled, including particulars fixing the locality or length of the road on which the tar was used. The Road Board will arrange with the National Physical Laboratory to submit a selection of these samples to a series of chemical and physical tests with a view to the results being recorded for future reference, and surveyors will from time to time be invited to send samples for the purpose.

19. In all cases careful record should be kept of the condition of the road surfaces in winter and summer, both before and after tarring, the quantity and quality of tar used, the superficial area covered, the state of the weather when the work is being done, the time occupied in actual work, and in waiting while work is stopped owing to wet weather, the number of men employed, and full details of the cost of labor and material.

20. Surveyors are invited to send records to the Road Board to be classified and published for general information. Forms for these records will be supplied by the Board.

21. Surveyors are recommended to have samples of the tar supplied to them under contracts properly tested by a qualified analytical chemist for—

(1) Specific gravity,
(2) Freedom from water,
(3) Fractionation,
(4) Free carbon.

Note.—These general directions are not intended to displace or to discourage the use of proprietary articles, of which there are several of proved value.

ROAD BOARD SPECIFICATION, No. 2.

General Directions for Surfacing With Tar-Macadam.

1. Any road which is to be surfaced with tar-macadam should have a proper foundation or sub-crust of adequate thickness to bear the traffic likely to use it.

2. Before laying a new surface of tar-macadam the thickness of the old crust, including foundation, should be ascertained by opening trial trenches at intervals averaging about 150 yds., extending from the haunch of the road to the centre, such trenches to be made alternately on opposite sides of the road.

3. The thickness of the surface coating of tar-macadam when consolidated by rolling should be from 2 in. to 3 in., according to traffic requirements. For a greater thickness than 3 in. the material should be applied in two coats.

4. In the case of naturally hard subsoils, not materially softened by infiltration of surface water, the total thickness of the road crust, including foundation, if any, after consolidation of the new surface of tar-macadam by rolling, should not under ordinary circumstances be less than 6 in. unless the subsoil is so hard as in itself to act as a good foundation, in which case the thickness of the road crust may be reduced to 4 in. In the case of clay or other yielding subsoils, the total thickness should not be less than 11 in.

5. The finished surface should have a cross-fall of about 1 in 32.

If the crust is not sufficiently thick at the crown to enable this cross-fall to be obtained with a new coating of the thickness above mentioned, then the old surface should be left intact and unscarified, and the thickness of the new coat of tar-macadam increased as far as may be necessary.

If the crust is of sufficient thickness for the purpose, the regulation of the cross-fall should be carried out by scarifying the surface and removing material from the crown to the sides previous to the application of the new coating. The material loosened by scarifying should be screened and all finer material than ½ in. should be thrown aside.

6. The aggregate of the new surface of tar-macadam should be composed of broken stone of approved quality, or selected slag of approved quality, and should contain at least 60 per cent., broken to the size of 2½ in., not more than 30 per cent. of from 2½ in. to 1¼ in., and 10 per cent. of ¾ in. to ½ in. for closing. The last-mentioned size should be kept separate and used as top dressing during rolling operations.

7. The stone used must be thoroughly dried before being coated with tar.

8. For making tar-macadam, tar should be used which complies with Road Board Specification Tar No. 1, or Road Board Specification No. 2, the choice being determined by the circumstances of each case.

If tar No. 1 has been used for tarring the stone, care should be taken, especially in hot weather, that the tarred material has been allowed to stand for a sufficient length of time to allow the tarred surface of the stones to become partially hardened and in a tacky condition.

If tar No. 2 has been used for tarring the stone, the macadam should be laid soon after being tarred, and if the tar be of the heavier grade of this quality, the stone coated with such tar should only be laid when the road is quite dry and in warm, sunny weather.

(To be continued)

AN EXAMPLE OF FIGURING THE HORSE-POWER FOR MANILA ROPE.

The following figures recommended by the Plymouth Cordage Co. for determining the power which can be transmitted by a given size of rope are interesting. It is stated that the power transmitted is directly dependent upon the three following things:

(1) The resistance to slipping in the grooves.

(2) The speed of the rope.

(3) The maximum tension to which it is advisable to subject the rope.

Referring to the first factor, it may be said that the resistance to slipping depends upon the coefficient of friction of the rope on iron, angle of groove used, the arc of contact of the rope on the sheave and the size of the sheave, all taken in connection with the stiffness of the rope. To be brief, this matter may be stated in a general way by saying that the ratio of the tensions between the slack and driving size of rope is commonly taken as 1:2, i.e., when the rope is well lubricated, and the arc of contact at least 165 deg. In other words, 1 lb. tension on the slack side will support 2 lbs. on the driving side.

The second factor, speed, adds to the carrying power of the rope directly in proportion to its increase, while the centrifugal force adds tension as the square of the speed. Therefore, it follows that after a certain speed is reached, if this speed is exceeded more tension will be added from centrifugal force than can be gained in carrying power. The tension from centrifugal force is equal to the diameter of the rope squared in inches times the weight of the rope all divided by 32.

A common rule arrived at by careful comparison of different economical and satisfactory rope drives, is that the maximum tension which should be put on the rope, may be taken as 200 times the diameter of the rope in inches squared. While there are instances in which this rule is exceeded without apparent harm it is a reliable foundation to start figuring rope drives from, and should be exceeded only after very careful consideration.

To make the above clear, the following specific example should be studied:

Example.—Assuming that the angle of grooves is 45°, and that the least arc of contact is 165°, find the horse power which can be transmitted safely by a 2-in. manila rope running at 4,200 ft. per minute.

Let T = Maximum tension advisable to use,
t = Tension from centrifugal force,
v = Velocity of rope in feet per second,
d = Diameter of rope in inches
w — Weight of 1 ft. of the rope.

Then from what has been said we have

$$T = d^2 \times 200 \qquad t = \frac{v^2 \times w}{32}$$

As 1 ft. of the rope weighs 1.34 lbs., substituting the proper values we have

$T = 4 \times 200 = 800$ lbs. the maximum allowable tension.

$t = \frac{70^2 \times 1.34}{32} = 205$ lbs. tension from centrifugal force.

Then 800 minus 205 equals 595 lbs. A part of this is balanced by the initial tension necessary to stop rope from slipping in groove, which we have decided to be in the ratio of 1 : 2. Therefore, we have

$\frac{595 \times 2}{3} = 396$ lbs. to be utilized in work.

$\therefore \frac{396 \times 4200}{33{,}000} = 50$ h.p. Ans.

MONTREAL ASSESSORS MAKE REPORT.

The Canadian Pacific Railway is making arrangements to shorten its line from Montreal to Quebec. The line at present passes northwestward, from the city of Montreal across the island and over the Ottawa River until it reaches St. Martin's Junction, or Quebec Junction, a distance of about twelve miles from Montreal, when it turns in the direction of the city of Quebec. This makes a considerable detour which it is desirable to avoid. In addition to the extra mileage, as compared with a more direct route, the section of line traversed to the Junction is much travelled. It is used by all the trains going up into the Laurentian Mountains, besides which it is a portion of the Canadian Pacific Railway north shore line to Ottawa, so that the traffic is very heavy and the large number of trains which have to be handled necessitate frequent delays in the interests of safety.

The Canadian Northern line now starts from Montreal in a direct line for the city of Quebec. Thus it crosses the Ottawa at the eastern extremity of the island of Montreal. This is the territory through which it is expected the Canadian Pacific Railway will build its shortened line. It is claimed that the engineers are now taking soundings for a new bridge, which will be built near the present Canadian Northern bridge. It is expected that connection will be made with the present line near L'Epiphanie, about thirty-five miles from Montreal. The company has already made application to the Railway Commissioners for permission to build a line on the island in the direction indicated, and it is said that new shops will be erected along the route, and that a portion of the material being consumed in the different shops of the Canadian Pacific Railway will here be produced. The company will not confirm the report of this intention to build the short line, but allows that it intends building an industrial line from the city towards the eastern extremity of the island.

LUMBER USED BY AGRICULTURAL IMPLEMENT AND VEHICLE MANUFACTURERS IN CANADA DURING 1910.

Statistics of the lumber used have been received from 162 companies, consisting of the agricultural implement and vehicle manufacturers of Canada in six provinces, by the Forrestry Branch of the Department of the Interior. 76,474,000 feet of lumber were used, worth $2,513,265, or an average cost of $32.86 per thousand. Ontario used nearly 90 per cent. of the total for the Dominion; Quebec purchased 6 per cent.; Manitoba 4 per cent. and Nova Scotia, New Brunswick and Prince Edward Island used very small amounts. Woods used in these industries require strength and durability which is shown by the large amount of Maple, Ooak, Ash, Birch and Hickory that were used. Of the native woods, cherry was the most expensive at $104.00 per thousand, and Ironwood the cheapest at $15.00 per thousand. Mahogany at $120.00 per thousand, was the most expensive of impored woods.

The species of woods having the technical qualities required by these industries at present grow only in small quantities in the agricultural and farming districts of Canada. The supply is rapidly becoming diminished so that unless steps are taken to reforest or conserve the production, we must depend for our supply on the United States. The fact that the woods necessary for the proper building of agricultural implements cannot be secured in any quantity tends to increase the cost of manufacturing in Canada.

CANADA'S PROGRESS TOLD IN STATISTICS

	1871	1881	1891	1901	1905	1910
	$	$	$	$	$	$
Chartered Banks Capital Paid up	36,415,210	59,384,987	60,742,366	67,095,718	82,199,900	98,728,342
" " Deposits	57,787,922	83,666,189	142,633,216	315,775,426	468,571,648	797,849,593
Post Office Savings Banks Deposits	2,497,260	6,208,227	21,738,648	39,950,810	45,368,321	42,848,026
Government Savings Banks Deposits	2,072,037	9,628,445	17,661,378	16,098,146	16,649,136	14,563,225
Special Savings Banks Deposits	4,798,644	7,685,888	10,982,232	19,125,100	25,050,965	32,156,708
Total Deposits	67,155,863	107,188,749	193,015,474	390,949,482	555,640,070	886,417,552
Chartered Banks—Loans to the Public	86,121,888	134,113,252	202,692,481	318,240,549	480,906,634	717,773,400
" " Assets	121,014,395	198,967,278	269,491,153	528,304,110	757,988,531	1,230,825,305
" " Liabilities	77,486,706	125,063,546	188,337,504	417,320,761	609,989,375	1,040,324,464
Total Bank Clearings	....	....	....	1,871,061,725	3,334,614,000	6,054,298,453
Dominion's Total Revenue	19,335,561	29,635,298	38,579,311	52,514,701	71,182,773	101,503,711
" Total Expenditure	17,589,469	25,502,554	36,343,568	46,866,368	63,319,683	79,411,747
" Total Debt	115,492,683	199,861,537	289,899,230	354,732,433	377,678,580	470,663,046
" Net Debt	77,706,518	155,395,780	237,809,031	268,480,004	266,224,167	336,268,546
Fire Insurance—Amount in Force:						
Canadian Companies	68,465,914	153,436,408	177,785,359	221,756,637	328,340,100	502,014,834
British Companies	132,731,241	277,721,299	497,550,395	694,491,228	785,219,445	1,146,496,335
American Companies	27,256,629	31,053,261	84,266,437	122,439,754	204,586,950	387,003,859
Total Fire Insurance	228,453,784	462,210,968	759,602,191	1,038,687,619	1,318,146,495	2,035,515,028
Premiums Received:						
Canadian Companies	707,418	1,206,470	1,278,736	1,727,410	3,013,714	4,316,163
British Companies	1,299,840	2,353,258	4,189,171	6,595,447	8,582,925	10,243,235
American Companies	314,452	267,388	700,809	1,327,491	2,689,032	4,148,489
Totals	2,321,716	3,827,116	6,168,716	9,650,348	14,285,671	18,707,887
Life Insurance—Amount in Force:						
Canadian Companies	8,711,111	46,041,591	143,368,817	284,684,621	397,946,902	565,669,110
British Companies	18,405,425	20,983,092	32,407,937	40,216,186	43,809,211	47,801,798
American Companies	18,709,499	36,266,249	85,698,475	138,868,227	188,578,127	242,629,174
Total Life Insurance	45,826,035	103,290,932	261,475,229	463,769,034	630,334,240	856,100,082
Premiums Received:						
Canadian Companies	291,897	1,291,026	4,258,926	9,133,890	13,947,827	19,971,666
British Companies	570,449	613,595	1,030,479	1,346,666	1,500,232	1,580,555
American Companies	990,628	1,190,068	3,128,297	4,709,298	6,632,658	8,239,486
Totals	1,852,974	3,094,689	8,417,702	15,189,854	22,080,717	29,791,707
Loan Companies—Total Loans	....	64,498,542	110,082,219	125,887,911	160,370,957	*207,468,197
" " Total Assets	8,392,464	73,906,688	125,041,146	158,523,307	208,081,227	*300,494,306
" " Total Liabilities	8,392,958	71,965,017	123,915,704	158,523,307	208,081,227	*300,299,219
Total Mineral Production	....	....	18,976,616	65,804,611	69,078,999	105,040,958
Gold	....	....	930,614	24,128,503	14,159,195	10,224,910
Silver	....	....	409,549	3,265,354	3,614,883	17,106,604
Asbestos	....	....	999,878	1,259,759	1,503,259	2,573,603
Cement	....	....	108,561	660,030	1,924,014	6,414,315
Value of Money Orders issued in Canada	4,546,434	7,725,212	12,478,178	17,956,258	32,349,476	60,967,162
Total Gross Earnings	14,485,648	27,987,509	48,192,099	72,898,749	106,467,199	173,956,217
Total Imports	96,092,971	105,330,840	119,967,638	190,415,525	266,834,417	391,852,692
Total Exports	74,173,618	98,290,823	98,417,296	196,487,632	203,316,872	301,358,529
Total Imports and Exports	170,266,589	203,621,663	218,384,934	386,903,157	470,151,289	693,211,221
Exports—Canadian Minerals	2,841,124	2,767,829	5,784,143	40,367,683	31,932,329	40,087,017
" Canadian Fisheries Produce	3,994,275	6,867,715	9,715,401	10,720,352	11,114,318	15,663,162
" Canadian Forest Produce	23,063,223	24,960,012	24,282,015	30,009,857	33,235,683	47,517,033
" Canadian Animal Products	12,608,506	21,360,219	25,967,741	55,495,311	63,337,458	53,926,515
" Canadian Agricultural Produce	9,853,924	21,268,327	13,666,858	24,781,486	29,994,150	90,433,747
" Canadian Manufacturing Products	2,432,750	3,075,095	6,296,249	16,012,208	21,191,333	31,494,916
" Canadian Miscellaneous Produce	387,554	622,182	45,337	44,489	49,675	125,161
Total Exports—Canadian Produce	55,181,356	80,921,379	85,757,744	177,431,386	190,854,946	279,247,551
Total Exports—Foreign Produce	9,853,244	13,375,117	8,798,631	17,077,757	10,617,115	19,516,442
Area (Sq. miles)	3,729,665	3,729,665	3,729,665	3,729,665	3,729,665	3,729,665
Population	3,518,411	4,336,504	4,844,366	5,413,670	6,086,530	7,489,781
No. of Post Offices	3,943	5,935	8,061	9,834	10,879	12,887
Letters sent	27,050,000	48,170,000	97,975,000	191,650,000	285,541,000	456,085,000
Railway miles in operation	2,695	7,331	13,838	18,140	20,487	24,731
Passengers Carried	....	6,943,671	13,222,568	18,385,722	25,288,723	35,894,575
Freight Carried (Tons)	....	12,065,323	21,753,021	36,999,371	50,893,957	74,482,866
Vessels Arrived and Departed—Number	61,637	127,290	194,893	208,738	220,703	247,378
" " Tonnage	13,126,028	28,919,198	43,788,778	60,474,604	76,655,081	101,318,919

* 1909

The lesson of the European circuit aeroplane race is the necessity of developing a better motor. The delays to the airmen from accident were comparatively rare, but motor trouble was a frequent complaint.

The power in the motor is believed to have been excessive. In this respect the experts agree with the general contention of Wilbur Wright, who recently pleaded for a halt in the struggle to attain great speed. What Wright wishes is that the rules of speed races should be changed so as to limit the size of the motors, eighty miles an hour, in his eyes, being a good average. French experts want manufacturers to strive for the same regularity of motor in an aeroplane that now exists in an automobile; in other words, give up the struggle for speed and concentrate on regularity and safety.

MUNICIPAL FIRE INSURANCE

In Relation to Fire Underwriters' Profits — Some Figures of Interest.

An article designed to make it appear that fire insurance is a money-making business finds place in the August issue of The Canadian Municipal Journal. After a rose-colored statement of English insurance companies' profits and the wonders of profits achieved by a single Canadian company quite lately, a paragraph of the article concludes: "Municipal Insurance has paid in England—why should it not pay here?"

One cogent reason why any sort of fire underwriting enterprise which may pay in England does not pay here is the marked difference in conditions in the two countries. In Great Britain, solid stone and brick construction, conservative building laws, municipal regulations and careful habits of the populace with respect to combustible substances, keep the annual fire loss down to something like 40 cents per annum per head of the population. The average percentage in Germany, France, Denmark and Italy is only 33 cents. In Canada, lax building laws, houses built largely of wood, forest fires, a variable climate, and careless habits with respect to fire, have caused the fire loss of Canada to mount to $2.70 per head in 1909, and to $3.14 per head in 1910. Here is one answer to the editor's "Why?"

While it is quite true that British fire underwriting companies of the first class make good profits, they do not make them out of Canadian risks, but out of the enormous business they do in other parts of the world. The result of five years' fire underwriting in Canada in 1868 to 1874 by all companies was a loss of 1.23 per cent. instead of a profit. Taking the years 1875 to 1908, inclusive, the Dominion Insurance Report shows that the Canadian, British and American companies doing business in Canada took $251,260,021 in premiums. They paid for losses in those 33 years $163,242,836; for expenses $78,391,456; and they carried a liability for reserve on unexpired premiums of $9,453,479. Adding these items together we have $251,087,171 showing a profit of only $172,850, equal to a mere fraction of one per cent., all told, on the Canadian business.

In some of these years the companies showed a good profit the favorable margin being, for example, in 1874, 1880, 1889, 1896, 1902 and 1906, nine, seventeen, thirteen, six, twenty-five, and twenty per cent., respectively. But the conflagration of 1877 in St. John swept away millions; for ten years, between 1891 and 1901, the outgo was always over 100 per cent. of the income; big fires in Quebec, Hull and Ottawa in 1901 and a bigger one in Toronto in 1904 carried the expenditure in the one case to $105 and in the other to 142 per cent. of the premiums. As we have already stated forty years' underwriting in Canada was a loss. Thus, unfailingly, does the Fire Fiend at longer or shorter intervals pull to pieces the reserves which insurance companies laboriously accumulate in favorable years. If a company here and there manages by selection of risks and by great economy to make good profits for five or even ten years and build up good reserve, this cannot efface the facts of past experience, nor can it remove the conflagration hazard.

It might be well for The Canadian Municipal Journal, which has built up an alluring fabric of possible money-making out of the success of one Canadian company and the large dividends of a dozen or two prominent British and American to look further into the record of fire underwriting in Canada. It will find the list of unsuccessful companies a long one. In the thirty-six years, ended with 1906, twenty-seven United States companies either went out of business or retired from Canada, the best-remembered being the New England, of Hartford, the Andes, of Cincinnati, and the Agricultural, Watertown. In the same period eighteen British companies gave up the struggle, notable among them being the State, the Monarch, the Albion and the United. The Canadian companies which were removed from the list numbered twenty-two, making a total of 67 of all nationalities. A list of some of these Canadian organizations may be of service to the readers of The Canadian Municipal Journal, and an enlightenment, at least, to its editor.

Provincial, Toronto.	Prince Edward Co., Picton.
Isolated Risk, Toronto.	Canada Farmers, Toronto.
Ottawa Agricultural. Ottawa	Canada Fire & Marine do.
Canada Agricultural, do	Dominion Grange, Hamilton
Stadacona, Quebec.	Citizens, Montreal.
Beaver, Toronto.	St. Lawrence do.
Toronto, do.	Victoria-Montreal do.
National do.	Eastern Townships Mutual Stanstead, Que.
Phoenix Mutual, do.	Eastern, Halifax.

This is a convincing list.

MONTREAL HARBOR REPORT.

Large Floating Dock to be One of the Latest Acquisitions—Policy of Development.

An extensive report of the Harbor Commissioners of Montreal has been published for the year 1910. The development of Montreal's harbor, which was planned and devised by their chief engineer, Mr. F. W. Cowie, was accepted and approved of by Parliament, and work on the same was commenced during the year under review. This scheme has its objective in a twelve years' continuous policy of development, but while the report naturally deals almost solely with the work accomplished during 1910, it also outlines in some measure the lines upon which this progress is to be continued in the future.

Floating Dry Dock.

Referring to the floating dry dock, which Messrs. Vickers, Sons & Maxim are building and will operate, the commissioners state that the dredging of the site at Molson's Creek has been carried on continuously, and it is expected that the dock will be installed and ready for work in the spring of next year. The plans, which have been approved for this work, call for the reclamation of some 30 acres of land, which will be sufficient to provide sites for all the workshops and other buildings that may be found necessary.

Reverting to the shipping itself, the commissioners draw attention to the fact that during the past year two new lines of vessels have been operating in the port. The chief of these is, of course, the Royal line, owned and operated by the Canadian Northern, and plying between Bristol and Montreal. The second new enterprise in this direction which saw its birth in 1910 was the service between this port and Australia, which was undertaken by the vessels of the New Zealand Shipping Company's fleet, under the direction and management of the Canadian Pacific Railway. Mention is also made of the enterprise shown by the Donaldson line in building and putting on the St. Lawrence route a new steamer in the Saturnia, which has helped in no slight degree to increase the trade between this port and Glasgow.

As regards the grain business in 1910 the commissioners find that their elevator No. 1 handled over fourteen million bushels of grain of all kinds, but some disappointment is expressed at the comparative failure of the floating elevators which the commissioners purchased at considerable cost from the Montreal Grain Elevating Company. This failure is expected to be amply redeemed during the present season. The demand for more shed space became so imperative that it was decided that the two new steel and concrete sheds should be built on the Tarte pier, and work on these has already been commenced.

Want Better Insurance Rates.

The matter of insurance rates is touched upon in a general way, and the commissioners state that they are endeavoring to get a betterment in the rates quoted by Lloyds for the St. Lawrence route, and would seem to have every hope of success.

The revenue of the port for 1910 exceeded that of 1909 by no less than $107,055. The disbursements charged to capital account for the year were $812,669, of which sum $435,812 was for interest charges, and the loans on capital account amounted to $1,300,000.

Number and Tonnage of Vessels.

Dealing with the number and tonnage of all vessels arriving in the port for the year, the commissioners furnish some interesting tables. It would seem that while the number of ships entering the port was 39 in excess of that recorded for 1909, the tonnage of ships had increased over the previous year to no less an extent than 220,000 tons, thus showing that the work that has been done and the money that has been spent in the improvement of the ship channel is commencing to bear fruit. The revenue accruing from the vessels showed an increase of more than $100,000 over the figures for 1909.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain; Secretary, A. C. D. Blanchard,, City Hall, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary, E. Brydone Jack. Meets first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 40-41 Flack Block, Vancouver. Meets in Engineering Department, University

OTTAWA BRANCH—
Chairman, A. A. Dion, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Mr. George Geddes, Mayor, St. Thomas, Ont.; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Mayor Reilly, Moncton; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King s Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Hopkins, Saskatoon; Secretary, Mr. J. Kelso Hunter, City Clerk, Regina, Sask.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons. Regina; Secretary-Treasurer, M. B. Weeks, Regina

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Charles Kelly, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, 11 Queen's Park, Toronto.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN GAS EXHIBITORS' ASSOCIATION.—Secretary-Treasurer, A. W. Smith, 52 Adelaide Street East, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H. Mortimer-Lamb, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., Castle Building, Ottawa, Ont.

CANADIAN RAILWAY CLUB.—President, H. H. Vaughan; Secretary, James Powell, P.O. Box 7. St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer. A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEER'S CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W H. Trewartha-James and J. B. Tyrrell.

MANITOBA LAND SURVEYORS.—President, George McPhillips, Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, S. Fenn; Secretary, J. Lorne Allan, 15 Victoria Road, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby,

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, H. P. Ray; Secretary, J. P. McRae.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

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

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Battleford, Sask., town hall	Aug. 14.	Aug. 3.	68
Moose Jaw, Sask., sewer and water extensions	Aug. 14.	July 27.	68
North Toronto, Ont., main sewerage	Aug. 14.	Aug. 3.	70
Ottawa, Ont., harbor works, Courtney Bay	Aug. 10.	June 22.	68
Ottawa, Ont., pier and sheds	Aug. 10.	July 27.	72
Ottawa, Ont., tunnel bay dock, Brockville	Aug. 21.	Aug. 3.	151
Ottawa, Ont., post-office building, St. Lambert, P.Q.	Aug. 15.	Aug. 3.	151
Ottawa, Ont., public building, Uxbridge, Ont.	Aug. 21.	Aug. 3.	151
Ottawa, Ont., wharf, Papineauville, Que.	Aug. 23.	Aug. 3.	151
Penticton, B.C., generators	Aug. 10.	July 6.	68
Reil, Man., bituminous pavement	Aug. 14.	Aug. 3.	68
Reil, Man., roadway	Aug. 14.	Aug. 3.	68
Toronto, Ont., government house	Aug. 22.	July 27.	121
Victoria, B.C., work on Parliament buildings	Aug. 15.	July 13.	54
Victoria, B.C., bridge work	Aug. 31.	Aug. 3.	152
Victoria, B.C., construction of bridge	Aug. 31.	Aug. 3.	152
Virden, Man., steam heating plant	Aug. 18.	July 27.	122
Wilkie, Sask., electrical machinery, etc.	Aug. 21.	July 27.	64
Windsor, Ont., concrete outlet	Aug. 22.	Aug. 3.	68
Whitehead, Man., bridge and abutments	Aug. 25.	Aug. 3.	68

TENDERS.

Montreal, P.Q.—Sealed tenders, addressed to the Board of Commissioners, City Hall, will be received until 12 o'clock noon, on Thursday, the 31st day of August, 1911, for the supply and delivery of the following apparatus, viz.:—(a) One automobile truck to haul aerial ladder truck. (b) One automobile truck to haul 1,200 gallon steam fire engine. (c) One automobile hose wagon, to carry 2,000 feet of 2½-inch, cotton, rubber-lined hose, etc. (d) One combination automobile engine of a capacity of 1,000 Imperial gallons, to carry also 1,000 feet of 2½-inch cotton, rubber-lined hose. (e) One 1,000 U.S. gallon steam fire engine. (f) One 800 U.S. gallon steam fire engine. Specifications, etc., may be obtained at the office of the Chief of the Fire Department, corner of Craig West and Chenneville Streets.

Montreal, P.Q.—Sealed tenders, addressed to the Board of Commissioners, will be received until 12 o'clock noon, on Friday, the 18th day of August, 1911, for the construction of a cement sidewalk, in Notre Dame Street, Longue Pointe Ward. Blank forms of tender, etc., may be obtained at the City Surveyor's Office, City Hall.

St. Jerome, P.Q.—Tenders will be received until noon, August 28th, 1911, for a complete Hydro-Electric power and distributing system. Total estimate, $60,000. For specifications apply: de Gaspé Beaubien, consulting engineer, 112 St. James, Montreal.

Espanola, Ont.—Tenders will be received by the Superior Construction Company for sub-contracts on the Algoma Central and Hudson Bay Railway.

Ottawa, Ont.—Sealed tenders addressed to Mr. Louis Lavoie, Purchasing Agent, Department of Railways and Canals, Ottawa, Ont., will be received up to Thursday, August 31st, 1911, for the supply of ties and switch ties for the Intercolonial Railway. Specifications and forms of tender may be obtained at stations after August 9th, 1911.

Ottawa, Ont.—Sealed tenders will be received at the office of the Commissioners of the Transcontinental Railway, until 12 o'clock noon, of the 21st day of August, 1911, for the erection of trainmen's houses required on the lines of the Transcontinental Railway.

Ottawa, Ont.—Sealed tenders will be received until 12 o'clock noon, on Friday, the 25th August, 1911, for the construction of a stone passenger station at Truro, Nova Scotia. Plans, specifications, etc., may be seen at the office of the Chief Engineer, of the Department of Railways and Canals, Ottawa, and at the office of the Chief Engineer of the Intercolonial Railway at Moncton, N.B., or at the office of the Board of Trade, Halifax.

York County, Ont.—The Highway Commissioners for York County have decided to advertise again for tenders, and to include in the specifications improvements on the Lake Shore, Malton, and a number of other roads near Toronto, aggregating 23 miles in all.

Toronto, Ont.—Tenders will be received until noon, August 23rd, for laying a 6-foot steel conduit from a connection with the present intake southerly into Lake Ontario, a distance of 500 feet, including all connections. (Advertisement in this issue).

Hamilton, Ont.—Tenders will be received up to noon Saturday, August 19, 1911, by Jas. L. Taylor, Chairman Road and Bridge Committee, Court House, for the erection of a concrete bridge.

Edmonds, B.C.—Messrs. Cleveland and Cameron, the municipal engineers for carrying out of the water scheme, have been instructed to call for tenders as soon as possible for digging the trenches for the water mains.

CONTRACTS AWARDED.

River St. Francis, Que.—Dredging. Contractors, Trefflé Bastien, Jas. Laurin, W. C. Leitch, of Montreal.

St. Pierre les Becquets, Que. — Dredging. Contractors, The W. J. Poupore Company, Ltd., of Montreal, P.Q.

Berthierville, Que.—Dredging. Contractors, The W. J. Poupore Company, Ltd., of Montreal, P.Q.

Batiscan River, Que.—Dredging. Contractors, The W. J. Poupore Company, Ltd., of Montreal, P.Q.

St. Maurice River, Que.—Dredging. Contractors, The W. J. Poupore Company, Ltd., of Montreal, P.Q.

Nicolet River, Que.—Dredging. Contractors, L. Cohen, & Son, of Montreal.

Kingston, Ont.—Post office addition and alterations. Contractors, McKelvey & Birch, of Kingston, Ont., $49,100.

Toronto, Ont.—The Robb Engineering Co., Amherst, Nova Scotia, and South Framingham, Mass., have recently received an order from the Sturgeon Lake Development Co. of Toronto, for two Rob-Mumford boilers 54 in. by 18 ft. and one stack 48 in. diameter and 80 ft. high, with smoke connection.

Toronto, Ont.—The Bishop Construction Co., Ltd., have been awarded contracts for the plant for the Swift

Canadian Co., at Toronto Junction and the new reinforced concrete building for the Union Stock Yards Co., Ltd., also at Toronto Junction.

Toronto, Ont.—Contracts were awarded this week for valves to the Canadian Fairbanks Co., Ltd., at following prices:—

20 in. valves	$102.61 each
20 in. check valves	137.81 each
12 in. check valves	45.24 each

Toronto, Ont.—Contracts for cast iron pipe were awarded this week to the National Iron Works as follows:—

36 in. C.I. Pipe, 1¼ in. metal, each 12 ft. length, $97.25
36 in. C.I. Pipe, 1⅛ in. metal, each 12 ft. length, $88.91
24 in. C. I. Pipe, 1⅛ in. metal, each 12 ft. length 58.35

Galt, Ont.—The contract for the building of the bridge across the Canada Woolen Mills race has been let to Mr. Fraser, of New Hamburg. The contract price of the superstructure is $605.

Midland, Ont.—Dredging. Contractors, Canadian Dredging Company, Ltd., of Midland, Ont.

Port Arthur, Ont.—Contracts have been let to Warren Bitulithic Paving Company for 9,000 square yards paving on parts of Arthur, Algoma, Waverly and St. Paul Street, 5-inch concrete base.

Port Arthur, Ont.—Tenders will be called for a reinforced bridge over Current River on Block Bay Road. Bridge will be 26 ft. wide 212 ft. long over all and 35 ft. high. Main span will be a 2 rib arch 130 ft. long and 20 ft. rise.

Humboldt, Sask. — Public building. Contractors, The Brown Construction Company, Ltd., of Winnipeg, $37,673.

Moose Jaw, Sask.—The Canadian Westinghouse Company and Messrs. Dawson & Company, Limited, of Winnipeg, have secured the tender of supplying the posts, lamps, etc., for street lighting.

Regina, Sask.—The Bitulithic & Construction Company, and the National Paving Company, have secured the paving contract, the former securing 52,042 square yards at $3, and the latter 52,872 square yards at $2.90. The quantity of the work has been increased since asking for tenders.

Regina, Sask.—The Parsons Construction Company, Regina, have secured the construction work on 175,000 square feet of concrete sidewalk at 16¾c. per square foot.

Victoria, B.C.—The construction work of the first large portion of the proposed sewer improvement and extension work for this city will be carried out by the City Engineer, using day labor. The work consists of the construction of approximately 9,000 feet of egg-shaped brick or concrete sewer, and approximately 12,500 feet of cement or vitrified circular sewer pipe ranging from fourteen to twenty-four inches in diameter with the necessary man-holes, lamp-holes, outfalls, chamber and pumping station, including approximately 22,500 cubic yards of excavation.

Victoria, B.C.—The contract for the construction of the Ross Bay sea wall has been awarded to Thomas Stedham, who put in the lowest bid. Mr. Stedham, who was formerly a member of the Pacific Coast Construction Company, which is at present building the Dallas Road sea wall, figured on the contract at the exceedingly low figure of $69,301. The condition attaching to the ratification of the contract is that Stedham puts up $20,000 bonds within five days, in default of which the contract will go to the next lowest bidder, J. Haggerty & Company. The report of the committee showed the various bidders in the following form: Angus Smith, city engineer, $85,840; C. Hoard, Pemberton Building, $87,-845; Messrs. Chase & Board, Seattle, $83,620; Pacific Coast Construction Company, city, $107,500; Thomas Stedham, city, $69,301; N. D. Chetham, Vancouver, $127,724; Zindorf & Elliott, Seattle, $86,906; C. F. Graff, Seattle, $89,996; John Haggarty & Company, city, $73,963; Jeffer & Bufton, Portland, $105,820; Westholme Lumber Company, Ltd., city, $75,147; Moore & Pethick, city, $103,600. In addition alternative bids permitted upon plans supplied by the bidders were received from the following: Westholme Lumber Company, Ltd., city, $110,260; Westholme Lumber Company, Ltd., city, $54,094; Moore & Pethick, $111,000; Moore & Pethick, $148,000.

Contract has been awarded for the construction of the Algoma Central & Hudson Bay Railway from Hobon, on the Canadian Pacific Railway to a point on the National Transcontinental Railway, a distance of approximately 101 miles, to Superior Construction Company, Limited, of Espanola, Ontario.

RAILWAYS—STEAM AND ELECTRIC.

Fredericton, P.E.I.—The new station to be erected for the Intercolonial Railway will be on practically the same site as the present building. Several petitions had gone forward to Ottawa asking that a new site be selected. The present station and the changes which are to be made along with the building of the new station will cost $30,000.

Halifax, N.S.—The receipts for the Halifax Electric Tramway Company for week ending August 7, 1911, show an increase of $570.11, as follows:—

1910.	1911.	Increase.
$5,071	$5,641.11	$570.11

Kingston, Ont.—At the annual meeting of shareholders of the Kingston & Pembroke Railway Company, held recently, it was reported that the past year was the best in the company's history. Extensive improvements were made to the line during the past twelve months, and further work is to be done this year.

Winnipeg, Man.—President C. M. Hays of the Grand Trunk Pacific has opened negotiations with the Dominion Government in regard to the taking over by the G.T.P. of the completed section of the National Transcontinental Railway from Superior Junction to Winnipeg.

LIGHT, HEAT AND POWER.

Province of Quebec. — The provincial government has adopted a new policy as to water powers belonging to the crown. In future no such water power shall be definitely sold. Twenty years ago these water powers were allotted for nothing. Ten years ago such water powers like Shawinigan and Grand Mere Falls were sold for $50,000. Now they shall not be sold at all but rented on long leases of 99 years. The minister of crown lands, Hon. Mr. Allard, has just decided to offer at auction in September next ten water powers situated in different portions of the province.

SEWAGE AND WATER.

Kingston, Ont.—The municipal authorities are considering the installation of a filtration plant to secure a good supply of drinking water. The medical health officer, Dr. A. B. Williamson, states that the water of the harbor is contaminated from the sewage poured into it. The waterworks intake pipe is tight, but on some days the water shows the presence of colon bacilli.

Calgary, Alta.—The municipality are considering the installation of a septic tank system for the disposal of sewage. It has been estimated that the cost of installing the disposal works will be about $150,000. The city engineer will work on the plans for the tanks. It is not necessary to undertake the work of the construction immediately, as it will take some time to have the sewer outlet put in.

Edmonton, Alta.—A twenty-inch main burst in the pumping station and flooded out the six million gallon pump. The pump is placed in a pit forty feet deep and the water flooded that twenty-five feet before it was shut off. Employees at the Misericordia hospital did not know that the water was turned off and the fires were kept going under the boilers with the result that they exploded. Several hundred dollars worth of damage was done.

Victoria, B.C.—Since the beginning of the year a total of nine and one-quarter miles of sewer and surface drain work has been completed by the city engineer. In all some 33,125 feet of sewer have been laid, about six and one-quarter miles, while lateral work necessitated by the new paving programme called for 15,216 feet of construction work and 468 feet of surface drains also laid.