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CONDITIONS ALONG THE PROPOSED ROUTE OF THE HUDSON BAY RAILWAY.

Quite recently, an expedition under Mr. J. R. Dickson, was sent out by the Dominion Government along the above referred to route. The central object of the party was to make a rapid reconaissance survey of the country adjacent to the proposed route of the Hudson Bay railway between The Pas and Split lake; the work of such a survey being in this case to locate, estimate, and map in the areas of commercially valuable timber that could be made use of in the work of constructing the railway. Any such timber within eight miles of the line was classed as available, and beyond this distance wherever waterways gave access. Timber under 8 inches in diameter at breast-height was considered not merchantable—as being too small for industrial use. All areas not timbered commercially—i.e., carrying only young growth of no marketable value—were passed over with a general description of the existing growth as to species, size, and quality. Areas of greater or less agricultural value were mapped in when possible and a study made of their local flora, natural products and probable cropping possibilities.

The surface of the country is undulating to nearly level, and almost monotonous in its sameness. However away from the railway line in places, as for instance round Wekusko lake, there are areas of rough rolling granite. Wherever exposed, the bed rock has been rounded, polished, worn down nearly to a general level by the tremendous and prolonged glacial corrosion of the Ice Age.

The divides between water courses are low and poorly defined, streams frequently starting from two sides of the same muskeg. The general exposure north of Moose lake is toward the northeast, but this slope is very slight. The absolute elevation of Moose lake divide, according to the railway engineers, is 836 feet, while Split lake, 200 miles to the northeast, is 496 feet above the sea. This gives a fall of only 20 inches per running mile, or a slope of .003 per cent. over that distance. Furthermore this fall is not uniform, almost exactly one-half occurs in the form of three rocky escarpments, each of which produces cataracts on rivers flowing into Hudson Bay.

The most important of these declivities crosses the Grass river some twenty miles above Paint lake, where Lynx and Sandy falls occur, each with a 43 foot drop or a total of 86 feet. The above facts clearly explain the presence of the vast muskegs and sluggish drainage which obtain in that country.

It is interesting to note that the fall from Split lake to Hudson bay is exactly twice the above—500 feet in 150 miles; a slope of .006 per cent over all, or 40 inches per running mile. The whole region is intersected by a net work of lakes and streams large and small, at least 10 per cent. of the gross surface of the country being water.

The bedrock for 100 miles northeast of The Pas is limestone—probably largely dolomite—and it frequently obtrudes through the muskegs or shallow soils which blanket it. These outcrops form low, narrow, flattened ridges, rising just above the general level of the muskeg, and nearly always running northeast and southwest.

The line of contact between this limestone area and the Laurentian granite (upon which it rests comfortably) runs northwest and southeast from a point ten miles east of Limestone bay on Lake Winnipeg across the southwest end of Hill lake on Minago river to Cameron falls on the Mitishto, thence passing in a westerly direction along the south shores of Reed, Wekusko and Cranberry lakes. Along this line, especially in the vicinity of Hill lake, there is a zone of deep clays of very promising agricultural value.

In the area of granite farther north, the whole future, so far as agriculture or forestry is concerned, depends upon the general depth of the boulder clay. From the mere fact that it is a drift deposit this depth constantly varies, but only a detailed soil survey of each township could show where and how much. There are large areas of almost pure rock outcrop and muskeg of little or no value even for timber production. But in general, over the great clay belt the soil, which is almost uniformly a very tenacious boulder clay (nearly free of boulders, however), averages between 4 and 12 feet in depth; quite deep enough therefore for cultivation.

It must be understood that no hard and fast boundary line can be laid down as showing the confines of the clay belt. The change is often so gradual, and so many as yet unknown factors enter—as for instance, soil, depth, and possibilities of drainage—that any estimate of the bounds, area and average arable content of this belt can, with our present very limited knowledge, be given only in general terms. I estimate the area of that portion included from north to south between Wintering and Cross lakes, and from east to west between Setting and Sipiwesk lakes at 2,000 square miles. An analysis of its soil types appears later in this report.

Judging by such necessarily superficial observations as the members of the party were able to make, the region we covered is not well supplied with economic minerals. Traces of copper were found at Wekusko lake, and samples of iron ore at Sipiwesk lake, and careful prospecting might perhaps disclose deposits of commercial value, but everywhere else so far as observed, the obtruding bedrock waas either pure granite or limestone. The latter, however, is mostly dolomite, the variety used as a flux in the reducing of iron ores, and future ore discoveries may give rise to such demand. This dolomite also will prove a valuable building stone for prairie towns, when made available by the Hudson Bay railway.

The deeper lakes all abound in whitefish of the finest size and quality. In Paint lake during the mayfly season (July up there) their dorsal fins could be seen cutting the water everywhere. Pickerel, and of course jackfish and suckers are likewise very abundant. We had no sturgeon net but saw quite a number jumping in Sipiwesk lake.

Altogether the fishing industry should be a decidedly profitable one after the railway goes through.

Much of that region is suited only and admirably to producing a permanent revenue from game and furs.

The beaver have been almost exterminated but mink, fisher, muskrat and other fur-bearers are still fairly numerous.

As to large game, moose and caribou are plentiful, but we saw no elk or bear. More stringent game laws will shortly be necessary with the opening of the country to white hunters.

Nearly all those northern lakes are thickly studded with beautiful islands—quite a similar Laurentian country to Muskoka but on a more extensive scale. Some future day these large island-studded lakes will become popular summer playgrounds for the people of the prairies, for the July and August weather is delightful. As yet of course they are almost inaccessible.

In the region we traversed, only five species of timber, namely: spruce, poplar, tamarack, birch and jackpine have any possible commercial value, and of these, speaking generally, only the spruce is large enough for sawmill purposes or railway tie material.

The poplar, birch and pine are invariably too short, spindly, limby and crooked for any use save fuel or pulpwood, and what mature tamarack there was is now standing dead from insect attack. We did not find over 200 green tamarack above 10 inches diameter all summer. This remnant is to the northeast end of Bear island in Sipiwesk lake Black spruce is easily the predominant species in all that region, except on very occasional well-drained tracts of spruce-flat type, (where it reaches 10 to 14 inches in diameter at breast height) it is a small spindly tree, only 4 to 8 inches diameter breast height at maturity, unless even for second class ties. This is the condition in which the jackpine also occurs.

The white spruce therefore is the only species large enough to furnish construction timber, sawlogs, or even railway ties, and the supply is very limited. In the first place this species occurs only on the best drained spots, such as river and lake margins or on the small islands, and in the second, the fires of the past 100 years have destroyed nearly all the old stand.

To sum up then, only a mere fraction of one per cent. of the area we surveyed, now carries merchantable timber—a fringe along the Lower Mitishto and Upper Minago rivers, and on a few of the islands nnd peninsulas in the larger lakes—as shown on the map. There is probably enough timber available to build the rough construction work of the Hudson Bay railway.

The following is a summary of the total timber found during the season exclusive of that on timber berths:—

System Totals.

System	Ties.	Lumber Ft. B.M.
1. Moose lake	54,500	180,000
2. Mitishto river	12,500	350,000
3. Grass river	173,050	4,065,000
4. Inter lakes	44,200	912,000
5. Nelson river	74,050	2,167,000
6. Minago river	3,000	1,750,000
Grand Total	361,000	9,424,000

If, from the above, the timber on Wekusko lake and lower reach of Grass river and on the Upper Nelson and Minago rivers is deducted as being commercially inaccessible to the railway, then the supply locally available for the building of this stretch of the road is reduced to approximately one-half the figures given above.

At 3,000 ties to the mile, the 235 miles between The Pas and the first crossing of the Nelson will call for some 700,000 ties, in addition to piling and construction timber, so that it is probable the above local supply will prove insufficient to meet all demands.

From the mere size of the country and the density of the oncoming second growth stands the possible supply of firewood is enormous. Because of its remoteness from settlement, however, it has no present commercial value.

Owing to the killing by bark beetles of practically all the larger tamarack (or possibly killed by larch sawfly previous to beetle attack, though we found no trace of the sawfly) there is almost no green pile timber of any value in the whole region. Hence unless by importation the only choice left is between dead tamarack and the largest of the close-grained black spruce. The latter would remain sound in soil contact for about ten or twelve years which would satisfactorily cover the first initial experimental stage in the operation of the new road.

Just at the present time, within the area we inspected, the timber is too young and small upon the whole to be cut at a profit even for pulpwood. But in the absence of fires for twenty years the now eighty-year-old stands of 4 to 8-inch timber can be profitably cut for this purpose, and it is probable that within the next quarter of a century part of the enormous energy now running free in the falls and rapids of the Nelson and Grass rivers will be harnessed to drive pulp and paper mills.

The age of the reproduction is in nearly every case a measure of the time which has elapsed since the last destructive fire occurred. As a general rule, to which, however, there are endless local exceptions and variations—the young growth is approximately either forty or eighty years of age; the former being now 1 to 4 inches in diameter, and the latter 4 to 8 inches, but none yet large enough for making railway ties. It will, however, soon be suitable for pulpwood.

Scattered trees from older stands occur in this second growth, but not in sufficient number to repay the cost of lumbering.

The rate of growth in the very dense stands that are usual in that latitude is decidedly slow except where the soil and drainage conditions happen to be just right. Black spruce on semi-muskeg, a site of average quality for that species, is only 4 to 5 inches in diameter breast height at one hundred years. White spruce is rather fastidious regarding moisture conditions and only appears on fairly well drained spots attaining there a size of 8 to 12 inches diameter within a century. Poplar in that time reaches 8 to 10 inches. As for jack pine occasional trees reach 12 to 16 inches, but only after long immunity from fires, and such trees are too limby for use. I saw no jackpine stand where the trees would average even 6 inches in diameter.

If the general drainage conditions could in some way be improved so as to partially replace the unprofitable black spruce with the white species, the wealth producing power of the region would be immeasurably greater.

Fire, insects and wind in the north country are all very destructive agents and all inter-related.

Bark beetles have not only destroyed practically all the large tamarack, but are everywhere actively at work to-day killing off the scattered patches of mature spruce which have escaped past fires.

The fire loss and danger is appalling. Within the past century two great general conflagrations, along with numerous intermediate fires, have reached every nook and corner of the vast region we traversed. Many instances were seen where the fierce conflagrations of some forty and eighty years ago had jumped lakes over a mile across. These great periodic fires accompany each cycle of very dry seasons—living in the deep moss during the winter and rushing hither and thither in summer.

Where the soil is thin, or as frequently seen, only a layer of more or less decayed moss on the bedrock, a fire is disastrous, the root zone being destroyed. And a fire up there is easily started for the whole lower half of each spruce or larch tree in the dense young stands which prevail, is a highly inflammable plume of dead twigs, moose moss, and lichens.

The bark beetles work in colonies, destroying the trees, and the moment they create an opening in the close-growing stand each following wind storm (and they are frequent) mows down its quota of trees. Finally a stroke of lightning sets fire to the whole tangled moss-covered mass of fallen and up-rooted debris, usually not only consuming it and much of the soil as well, but eating far and wide into the green timber. Then, reproduction being everywhere prolific, a dense young stand springs up on the ruins of the fire and nature's slow cycle of growth and decay begins all over again.

The climate and the soil conditions are the two basic factors which determine farming value. Where frequent or recent fires have not resulted in the formation of purely "temporary" or "fire types"—as e.g., young jackpine on heavy clay—a study of the existing flora answers many questions as to the climate and the soil.

Timber on Mitishto River.

On well-drained spots as far north as Split lake the flora is almost identical with that of similar sites in the Riding Mountains of Manitoba, proving that during the growing season these localities lie under one and the same isotherm, or nearly so. And yet the Riding Mountains are nearly four hundred miles southwest of Split lake.

Two other factors which help vegetation in this northern clay belt are the low absolute elevation—only 500 to 700 feet—and the large proportion of sunlight during the growing season, because of the long day. No doubt also the large proportion of the country covered by water has a tendency to prevent late spring and early fall frosts.

In the absence of weather records, it is impossible to say whether the summer of 1910 was an average season or not, but certainly it was favourable for farming operations. There were showers every week and the growth of the native vegetation was amazingly rapid. The total annual precipitation included 2 or 3 feet of snow would appear to be about the same as for western Ontario, to wit, 30 to 40 inches.

At Cross lake no damaging frosts occurred between June 8 and September 11, an interval of ninety-three days. But as a "sixty-day" oat or barley in Ontario will mature in that region in forty-five or fifty days—a general rule which applies as well to fruits, roots and vegetables—there would appear to be no difficulty from a climatic standpoint in growing all the hardier products of the temperate zone.

The size and quality of the wild fruits between Setting and Split lakes was first-class. During the last week of July we enjoyed ripe raspberries, gooseberries, black and red currants, blueberries, saskatoons and strawberries (late ones).

The first three mentioned were especially fine—the bushes loaded down with fruit as large and juicy as many tame varieties in Ontario. The average temperature of the growing season is about 60° Fahrenheit.

Certainly vegetables will grow to perfection anywhere between Cross lake and Nelson House. At the former we ate potatoes weighing a pound and a half each, dug on the last day of August, and when we left on September 10 the corn and tomatoes were still untouched by frost. I would respectfully point out the advisability of the Dominion government placing several small experiment stations at suitable points within the limits of this clay belt to make careful test of its seasonal variations and cropping possibilities. When the railway is completed such information will be of the utmost value to intending settlers.

As in all other northern districts one great drawback will be the insect pests. Mosquitos, "bulldogs," deerflies and gnats abound. It is doubtful, however, if they are as bad as in parts of New Ontario now being settled and farmed.

The winters are quite as enjoyable as in Manitoba—probably more so. Mr. Clifford, one of the railway location engineers, who has spent two years between The Pas and Split lake assured me that he liked the winter season there much better than the summer.

With regard to soil conditions, drainage is the great necessity everywhere. To render the soil fertile for cropping, the heavy stiff boulder clay must be opened up to the action of the air. Probably the use of a sub-soil plow might obviate the necessity for underdrainage over large areas. But however secured, aeration is necessary to change the present cold, dead, impervious soil to a warm, porous, friable one, full of bacterial life, available plant food, and resulting fertility.

The soil is exactly similar to that around Cochrane in New Ontario which yields such large returns under right treatment.

The manager of the Japan Rolling Stock Company (Mihon Sharyo Kaisha), has recently stated that a large amount of rolling stock will be required in Japan in the near future as a result of the extension of the government railways, and that it is estimated that by 1923 500 locomotives, 750 passenger coaches, and 9,300 freight cars will be placed on the government lines, necessitating an aggregate expenditure of about £2,500,000 to £3,000,000. In addition, considerable quantities of stock will be required for the lines built and will be constructed by private companies, of which 17 or 18 were organized last year.

A translation into English of the "Lectures on Biology," delivered by Dr. Curt Thesing in the Humboldt Academy and Urania in Berlin, has appeared in London. The point of the lecturer is that Darwinism or Lamarckianism or any other theory in itself is insufficient to cover our present knowledge. The writer is strong in his discussion of the transmission of acquired characteristics. The author gives a remarkable instance of the development of the spermatozoa of Rossia marcosia—a little cuttle fish—found in the Bay of Naples. Each spermatoblast regularly gave rise to four spermatozoa, which resembles the process among insects called polyembryony, by which a single egg will give rise to from four to a hundred or more individuals.

PROPOSED SPECIFICATIONS FOR STEEL WHEELS AND HEAT-TREATED CARBON STEEL AXLES.

At the fourteenth annual meeting of the American Society for Testing Materials, held at Atlantic City, N.J., June 27 to July 1, 1911 the Committee A-1 on Standard Specifications for Steel presented a report in which were recommended standard specifications for forged and rolled, forged, or rolled solid steel wheels for subway and elevated railway service and standard specifications for heat-treated carbon steel axles, shafts and similar parts. These recommendations were as follows:—

Proposed Standard Specifications for Forged and Rolled, Forged, or Rolled Solid Steel Wheels for Engine Truck, Tender and Passenger, Subway and Elevated Railway Service.

1. Steel for wheels shall be made by the open-hearth process.

2. The ingots from which the blanks are made must have sufficient discard to insure freedom from injurious pipe and segregation.

3. The steel for wheels shall conform to the following limits in chemical composition:—

Carbon	0.60 to 0.80 per cent.
Manganese	0.50 to 0.80 per cent.
Silicon	Not to exceed 0.35 per cent.
Phosphorus	Not to exceed 0.06 per cent.
Sulphur	Not to exceed 0.06 per cent.

4. Drillings from small test ingot cast with the heat shall be taken to determine whether the heat is within the limits of chemical composition specified in Paragraph 3. For check analysis the purchaser has the right to take drillings from any two points in the plate on radii at right angles to each other of any one wheel from each heat, but not at any point where the usefulness of the wheel will be impaired; drillings to be clean and free from scale, oil and dirt; and his check analysis may, at the option of the purchaser, be made from mixed drillings taken entirely through the plate at the two points.

5. When required, the purchaser or his representative is to be furnished an analysis of each heat from which rolled wheels are made, such analysis to cover elements specified in Paragraph 3.

6. All wheels must be free from injurious seams, cracks, laminations or other imperfections detrimental to strength or service.

7. Wheels shall be furnished rough bored and with hubs faced. They may be furnished with contours as rolled and without additional machine work, provided they conform to the dimensions specified within the following tolerances—

(a) Height of Flange.—The height of flange shall not vary more than 1/16 in. over nor more than 1/32 in. under that specified.

(b) Thickness of Flange.—The thickness of flange shall not vary more than 1/16 in. over or under that specified.

(c) Throat Radius.—The radius of the throat shall not vary more than 1/16 in. over or under that specified.

(d) Thickness of Rim.—The rim may vary in thickness, but the variation less than the specified thickness shall not exceed 3/16 in. The thickness of rim shall be measured at the center line of tread.

(e) Width of Rim.—The width of rim shall not vary more than 1/8 in. over or under that specified.

(f) Thickness of Plate.—The plate may vary in thickness, but the variation less than the specified thickness shall not exceed 1/32 in. for each 1/8 in. in the thickness of the plate.

(g) Limit Groove.—Where limit groove is called for, the location of the center of limit of wear groove shall not vary more than 1/16 in. from that specified and its distance from the inner edge of the rim at the thinnest point shall not be less than 11/16 in.

(h) Diameter of Bore.—The diameter of rough bore shall not be more than 1/16 in. greater nor more than 1/8 in. less than specified. When not specified the rough bore shall be 1/4 in. less in diameter than the finished bore, subject to the above limitations.

(i) Hub Diameter.—The hub diameter may vary, but the thickness of the wall of the finished bored hub shall not be less than 1 1/8 ins. at any point unless otherwise specified, and shall not vary more than 3/8 in. at any two points on the same wheel.

(j) Hub Length.—The length of hub shall not vary more than 1/8 in. over or under that specified.

(k) Depression and Projection of Hub.—For subway and elevated railway motor wheels the depression of hub from front face of rim shall not be less but may be 1/8 in. more than that specified. The projection of hub from back face of rim shall not be more than 1/32 in. over nor more than 1/16 in. under that specified.

(l) Black Spots in Hub.—Black spots in the rough bore shall not be longer than 2 ins. nor deeper than 1/8 in. Black spots longer than 2 ins. or deeper than 1/16 in. will not be permitted in rough bore within 2 ins. of either face.

(m) Eccentricity of Bore.—The eccentricity between the tread at its center line and the rough bore shall not exceed 1/16 in.

(n) Block Marks on Tread.—The maximum height of block marks must not be greater than 1/64 in.

(o) Rotundity.—All wheels shall be gauged with a ring gauge, and the opening between the ring gauge and tread at any one point shall not exceed 1/32 in.

(p) Plane.—Wheels shall be gauged with a ring gauge placed concentric with and perpendicular to the axis of the wheel. All points on the back of the rim equidistant from the center shall be within a variation of 1/16 in. from the plane of the gauge when so placed.

(q) Tape Sizes.—Wheels shall not vary more than five tapes under nor nine tapes over the size called for by the drawing.

(r) Mating.—All wheels shall be measured with a tape based on the standard M.C.B. tape, with tape divisions 1/8 in. apart. The tape numbers shall be stenciled in plain letters on each wheel. Wheels must be mated to tape sizes and shipped in pairs. A variation of one tape will be allowed in the same pair.

8. Wheels shall be stamped with the maker's brand and number in such a way that each wheel may be readily identified.

9. The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times while his contract is being executed. All reasonable facilities shall be afforded the inspector by the manufacturer to satisfy him that the wheels are being furnished in accordance with the contract. All tests and inspection shall be made at the place of manufacture prior to shipment and shall be so conducted as not unnecessarily to interfere with the operation of the mill.

Proposed Standard Specifications for Heat-Treated Carbon Steel Axles, Shafts and Similar Parts.

1. Steel under this specification shall be made by the open-hearth or other approved process.

2. A sufficient amount of discard must be made from each ingot to insure freedom from piping and undue segregation.

3. The steel shall conform to the following limits in chemical composition:—

Carbon	Not over 0.60 per cent.
Manganese	0.40 to 0.80 per cent.
Phosphorus	Not over 0.5 per cent.
Sulphur	Not over 0.5 per cent.

4. Drillings shall be taken from the crop end of one axle, shaft, or similar part from each melt represented, parallel to the axis on any radius one-half the distance from the center to circumference, to determine whether the chemical composition of the heat is within the limits specified in Paragraph 3.

In addition to the complete analysis, the purchaser has a right to call for a phosphorus determination, to be made from turnings from each tensile test specimen, and the phosphorus must show within the limits called for by Paragraph 3.

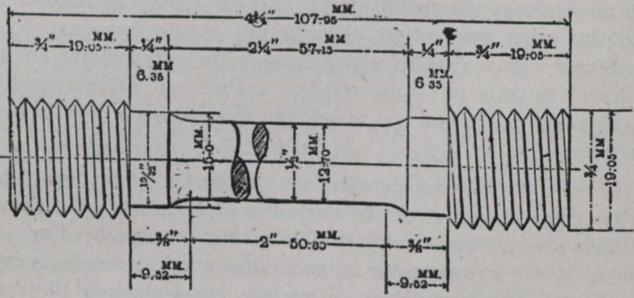

Fig. 1

5. The steel shall conform to the following minimum physical properties:—

Ultimate strength, lbs. per sq. in.	85,000
Elastic limit, lbs. per sq. in.	50,000
Elongation in 2 ins., per cent.	22
Reduction of area, per cent.	45

The elastic limit shall be determined by extensometer. Above 40,000 lbs. per sq. in., each increment of load shall not be more than 1,000 lbs. per sq. in.

6. The test specimen as shown by Fig. 1, 0.5-in. diameter and 2-in. gauge length, shall be used to determine the physical properties as specified in Paragraph 5. Tests specimens shall be taken from the crop end of one axle, shaft, or similar part, from each treating-plant heat; if more than one open-hearth heat is represented in a treating-plant heat, a test shall be taken from each open-hearth heat represented. A full-size prolongation shall be left on each axle, shaft, or similar part.

7. A cold bend test shall be made from the crop end of one axle, shaft, or similar part, from each treating-plant heat; if more than one open-hearth heat is represented in a treating-plant heat, a test shall be taken from each open-hearth heat represented. The test shall be made with 1/2-in. square specimen, not exceeding 6 ins. in length, around a flat mandrel with edges of 1/2-in. radius, and the specimen shall bend without fracture, 180 degrees around the said mandrel.

8. Specimens for tensile test and cold bend test shall be taken parallel to the axis of the axle or shaft and on any radius one-half the distance from the center to the circumference.

9. In case the physical results obtained from any lot of axles, shafts, or similar parts, do not conform to those called for by Paragraphs 5 and 7, the manufacturer shall have the privilege of retreating such parts, from which new tests shall be taken by the purchaser, and these shall govern the acceptance or rejection of the lot.

10. Each axle, shaft, or similar part shall be allowed to cool after forging, shall then be reheated to the proper temperature, quenched in some medium, allowed to cool, and then reheated to the proper temperature for annealing.

11. Warped axles or shafts or similar parts must be straightened hot; that is, at a temperature above 900 degrees F., and before offering the parts for test.

12. All axles, shafts, and similar parts shall be free from cracks, flaws, seams, or other injurious imperfections when finished. Those which show such defects while being finished by the purchaser will be rejected and returned to the manufacturer, who must pay return freight.

13. All axles, shafts, and similar parts must be rough-turned with an allowance of 1/8 in. on surface for finishing, except on collar, which is to be left rough forged. Turning must be done on 60-degree centers with clearance drilled at point.

14. The heat number shall be stamped on the rough forged collar. After rough turning, the manufacturer's name, heat number, individual axle or shaft number, and inspector's mark shall be stamped at place indicated by the purchaser, except at any point between the rough collars.

15. The inspector representing the purchaser shall have free entry, at all times while his contract is being executed, to all portions of the manufacturer's shop which concerns the manufacture of material ordered. All reasonable facilities shall be afforded to the inspector by the manufacturer to satisfy him that the axles, shafts, and similar parts are being furnished in accordance with the specifications. All tests and inspection shall be made at the place of manufacture prior to shipment and free of cost to the purchaser. The purchaser shall have the right to make tests to govern the acceptance or rejection in their own test-room, or elsewhere, as may be decided by the purchaser, such test, however, to be made at the expense of the purchaser and to be made prior to the shipment of the material. Unless otherwise arranged, any protest based on such tests must be made within six days, to be valid. Tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the mill.

THE HANDLING OF MEN.

The following, which is abstracted from a letter of G. O. Griffith, of Fort Flagler, to one of our contemporaries, is very much to the point:—

"In the management of men to get the best results the man in charge must have the respect of his men. To get their respect he must treat them as men who are in no way inferior to him except in the matter of work. There are many men who are working in a lower position than they really should be on account of some one higher up who does not appreciate their work and will not give them their just dues. Every chief should watch and study his men and when one shows that he is competent and deserving of advancement, the chief should give him what he deserves, and not show favoritism.

"Fair treatment will get better results than unjust treatment. Men dislike a person who is always 'cussing' and is 'grouchy' with them and they will not do as good work when he is away as they would if he were a man that was respected. Of course, there are some men who will not benefit by good treatment and with a man of that kind one has either to get rid of him or make him understand that he will have to do as he is required.

"Perhaps nothing will make a man slight his work more when he gets the chance than abusive language. And most men like to have their work praised occasionally."

CORRECTING BACK FIRING AND FUEL WASTE IN A LARGE PRODUCER GAS ENGINE PLANT.*

John G. Callan.

A short time ago the writer, with some associates, had occasion to test a large producer-gas engine plant in order to determine whether or not the plant met guarantees as to average and maximum output and fuel efficiency, and every effort was made to put the machinery in the best of condition and to obtain the best possible performance. It is not the purpose of this paper to report the entire test, which occupied the greater part of a month, but rather to point out some specific items wherein it was possible to improve performance, and to briefly analyze the more important of these. Since, in spite of best endeavors, it was not possible to bring the apparatus up to guarantee I omit any specific references by which the plant would be readily identified.

The installation consisted of single tandem double-acting producer-gas engines with 33 x 48-inch cylinders, driving three-phase 25-cycle alternators at 107 revolutions per minute. The alternators operated in parallel and delivered power to an industrial plant furnishing a substantially steady load, and to some other minor uses.

Gas was furnished by producers of a well-known type. From their individual wet scrubbers the gas passed through a common dry scrubber to a 30,000 cubic foot holder and thence to the distributing main leading to the engines. The fuel was lignite of about 7,600 B.t.u., containing about 34 per cent. moisture and 8 per cent. ash. The gas averaged about 105 B.t.u., high thermal value. In making our tests the mill load was adjusted to suit the engine output and there was always available as much load as the engines could carry.

The plant had been installed by the manufacturers and shortly after its installation the designer of the engines had spent a great deal of time in bringing it up to the best possible performance. Subsequent to this, the operating engineer of the station had continued running the plant along the lines which had been fixed upon by the designer and he obtained slightly better results from the engines, and also somewhat improved producer performance. The results were still very far from satisfactory, however.

We found that the engines had given much trouble with back-firing and some with premature ignition. The back-firing had been so serious that it had been deemed necessary to put throttles in the air lines and cut down the air supply to a point below that at which the rate of propagation of the flame in the mixture was a maximum. As is well known, this expedient, though wasteful of gas, is usually effective in stopping back-firing and it was so in this case.

We were told that the designer of the engines directed that they should be adjusted to give "round-top" diagrams and indicator diagrams which we took showed that these instructions had been observed. This shape of diagram is obtained by timing the ignition so that it is not early enough to bring about substantially complete combustion during the period of very slight motion near the dead center. The exact timing of ignition to give this or any other shape of diagram naturally depends on many factors, the principal ones being compression; composition and homogenity of mixture; shape of combustion space and location of spark plugs; temperature [?] and character of spark. The ignition points of the different engine cylinders in the plant under discussion differed somewhat and had been determined empirically as giving the desired diagram with the rich mixture deemed necessary to prevent back-firing.

This practice led, as late ignition is likely to do, to a magnification of the unavoidable differences between successive diagrams, so that a "card" consisting of twenty successive diagrams with one unchanged governor and mixture setting showed a very large range of contours. We were assured by the attendants, however, that if the mixture giving best maximum diagram were employed, the back-firing would recommence and in time become prohibitive. Tentative experiments seemed to confirm this and it therefore became necessary to determine the reason for this back-firing.

Back-firing is most likely to occur from ignition of the incoming combustible mixture at the inlet valve. In a double-acting engine it may also be caused by leakage of hot gases from the explosion in one end past the rings and into the other end where the suction stroke has just been completed. It may also occur from a lingering flame in an indicator fitting or from red-hot carbon or extremely hot metal parts so placed as to pocket gas between two heated surfaces.

If the back-firing is due to escape of flame past the piston rings it can occur in only one of the ends of a given cylinder on a four-stroke double-acting engine. For instance, if the cam setting is such that combustion is occurring in the crank end just as suction is finished in the corresponding head end, there may be preignition from this source in that head end but, since the cycle is never reversed, it can never occur in that crank end. Since one of the most obstinate cases of back-firing of which the writer had known was due to this cause the matter was carefully investigated. It was found that preignition occurred in the crank ends and head ends indiscriminately, so that blowing through the rings was certainly not the only source even if it was an occasional one.

The indicator fittings not already so made were changed to a type which closed off practically flush with the inner surface of the cylinder wall and it was at first thought that this effected an improvement, but back-firing developed again, proving that it was merely chance which caused its diminution when the new fittings were put on. This led to the inevitable conclusion that the trouble was ignition of the incoming gas either by the outgoing exhaust or by heated parts of the cylinder, or both.

The design of the engine differed from that of most American tandem double-acting gas engines in that the valves occupied a valve chamber connected by a relatively narrow neck with the main clearance of the cylinder. The exhaust valve was in the bottom and the inlet valve in the top of this chamber and they were separated from each other by a distance of only about ten inches.

The valve setting was such that the inlet opened before the exhaust closed. The amount of lap was different on different cylinders, due to slight wear of the cams and rollers, and it could be controlled to some extent by adjusting the amount of clearance between the valve rocker-arms and the stems, but with no normal adjustment which did not entail serious shock was there a complete closure of the exhaust port before the inlet valve opened. This suggested the idea that the slight back pressure presumably existing in the cylinders might force a little of the hot exhaust gas past the slightly opened inlet valve and ignite the mixture. This seemed highly improbable, however, on account of the cooling action upon the gases which would result from intimate contact with the water-cooled inlet-valve seat and the valve which had just risen from it.

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* Abstract of a paper presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

By diagrams and other means we endeavored to determine whether the back-firing took place at the end of the stroke or at some intermediate time and concluded that it was at the beginning, and for the time we fell back on the hypothesis that the heated valve chamber caused ignition of the combustible mixture during the early part of the inlet stroke.

Finally we took stop diagrams with a light spring, and full diagrams with the ordinary spring, but with the backlash in the indicator motion. These showed unforeseen conditions during exhaust and led to the true solution. It was found that the pressure in the cylinder immediately after the opening of the exhaust valve was above atmospheric, as might be expected, and that it remained there for a certain fraction of the exhaust stroke. For the remainder of the exhaust stroke, however, the proportion varying with load and cylinder from the last two-thirds to the last half of the exhaust stroke, there was a very slight vacuum in the cylinder instead of the positive back pressure which had been expected. This was found to be due to the wave set up in the long straight exhaust pipe by the first vigorous puff at release.

From this it immediately became clear that on the opening of the inlet valve explosive mixture began at once to enter the valve chamber, even though the piston had not yet finished its exhaust stroke, and that this inflow became more and more vigorous as the valve opened farther, the incoming mixture mingling with the outgoing exhaust gases and in part passing out with them through the exhaust port. The explanation of the back-firing was entirely rational. We did not have to assume that the exhaust gases were hot enough to pass through a slightly open, relatively cool port and still retain the temperature required to ignite explosive mixture, nor did we have to assume walls so hot that a rapidly whirling and eddying blast of incoming mixture impinging upon them was thereby ignited.

It was then assumed that a large number of incipient ignitions took place which did not propagate fast enough backward along the incoming gas stream to reach the mixing chamber and were blown out as the velocity of induction increased. Accepting this hypothesis and also recognizing the fact that a perfect mixture fires more easily and propagates flame faster than others, it was apparent why a rich slow-burning mixture prevented most of the trouble.

It was all along recognized that the use of an unduly rich mixture besides being wasteful was objectionable because it increased the luminosity of the flame and hence the radiation, besides coating the interior of the cylinder with a carbon deposit which tended to reduce the efficiency of the water jacket and to increase the skin temperature of the interior of the valve chamber.

While the matter was being analytically investigated a series of diagrams had been taken running with various mixtures and ignition settings and it had been decided that on account of the extremely heavy reciprocating parts the maximum stresses on the journals would not be greater with pointed than with round-top diagrams, since apparently the largest component in maximum journal pressure was that due to inertia rather than that due to the explosion. This last conclusion was borne out by the fact that the bearings ran much hotter on no load than on full load.

On account of the apprehensions of the station attendants these experimental settings were not at first maintained very long, but since they bore out the conclusions just mentioned, we finally changed the operation of all the engines as to both the mixture and the ignition settings. The mixture was adjusted for a slight excess of air over theoretical requirements and the ignition was timed materially earlier, producing a pointed rather than a round-top diagram and materially reducing the temperature of the gas at the moment of release when the explosive mixture mingled with it. After these changes were made the marked improvement in operation became so apparent as to convert even the more skeptical of the station men. Back-firing was not wholly eliminated, occurring occasionally in all cylinders and particularly in certain ones, despite the changes, but the improvement was distinctly greater than we had expected. The changes also enabled us to increase the engine output and to materially cut down the amount of gas used per kilowatt-hour. The reduction in fuel consumption was so marked that it was not merely observable by the methods of the test but was noticed by the producer men during a period when the engines were carrying considerably more load than was previously customary.

It was interesting to note that some analyses of the exhaust gas showed that if samples were taken as usual from a point a few feet below the top of the exhaust pipe, the analysis indicated a rather large excess of air in the mixture at a time when it was practically certain that such an excess did not exist. This might easily have misled previous observers and was, of course, due to the regurgitation of air into the exhaust pipe during the recession of the wave set up in the pipe by the "puff" occurring at release, as well as the loss of combustible mixture into the exhaust.

RAILWAY MILEAGE OF THE WORLD.

According to statistics in the Archiv fur Eisenbahniwesen, the railway mileage of the world in 1909 was 625,698 miles. This was divided as follows:—

	Miles.		Miles.
Europe	204,904	North America	277,014
Asia	61,800	South America	42,329
Africa	20,809	Australia	18,849
Total	625,698		

Of the total mileage 54 per cent. is in the Western hemisphere and 10,000 more in North America than in Europe and Asia together, although the latter geographical division has 1,280,000,000 inhabitants, against 115,000,000 in North America.

During the four years ending in 1909 the mileage added to the different continents has been the following:—

	Miles.		Miles.
Europe	12,359	South America	8,273
Asia	11,197	Australasia	1,306
Africa	4,518		
North America	25,057	Total	62,800

The world's total investment in 1909 amounted to about $51,000,000,000 which is about $33 per inhabitant.

TIMBER STATISTICS FROM QUEBEC.

The following comparative statement of timber, measured and culled to date, is furnished by the Supervisor of Cullers, office, Quebec, under date of July 5th:—

	1909 Cub. Ft.	1910 Cub. Ft.	1911 Cub. Ft.
Waney White Pine	583,000	236,240	440,720
White Pine	51,240	9,640	......
Red Pine	5,400	4,760	6,240
Oak	408,160	67,040	14,120
Elm	61,880	224,680	158,960
Birch and Maple	45,080	40,680	58,800
Ash	480	720	80

A STUDY OF THE VENTILATION OF SLEEPING CARS.*

By Thomas R. Crowder,† M.D.

For the purpose of securing a suitable exchange of air in railway cars many types of ventilators have been suggested and not a few have been given practical tests. About three years ago I was asked to report on the efficiency of one cf these. It became evident that it would be necessary to establish some basis of comparison, since it does not seem to have been estimated in exact figures to what degree natural ventilation of a railway car is effective. As the problem is of lasting importance and is likely to recur, it seemed advisable to make a fundamental study of the question and to place the results within reach of those who might have occasion to make use of them.

All air contains carbon dioxid as a normal constituent. The average amount in pure air is commonly stated to be 4 parts in 10,000.

The carbon dioxid in the expired breath averages more than 4 per cent. (400 in 10,000). The amount excreted hourly varies according to age, sex and the degree of bodily activity. In a mixed community of persons at rest it will average about 0.6 cu. ft. per person per hour.

If there were no ventilation whatever the air of an ordinary railway coach, containing 4,000 cu. ft. of space and occupied by 20 people, would have 34 parts of carbon dioxid per 10,000 of air at the end of one hour. This would continue to increase indefinitely in a direct ratio to the time, since carbon dioxid continues to be produced by the respiration of the occupants at a practically constant rate.

It is plainly impossible to measure directly the amount of air flowing into a car, since it enters at many points and at constantly changing velocities. But the amount of the interchange may be readily computed from the actual amount of carbon dioxid found from time to time by applying the figures given above to a simple mathematical procedure. Suppose a car contains 20 people and its atmosphere is found to have an average of 10 parts of carbon dioxid per 10,000. The incoming fresh air contains 4 parts, hence the respiratory contamination of the car air is represented by only 6 parts.

The 20 people produce 20 times 0.6 cu. ft., or 12 cu. ft. of carbon dioxid per hour. With what amount of air must the 12 cu. ft. be diluted so that the air will contain 6 parts of carbon dioxid in 10,000? The simple proportion, $6 : 10{,}000 :: 12 : x$ gives 20,000 as the answer (or 1,000 cu. ft. per hour for each person present.) The computation is better represented by the general formula:—

$$A = v\,p \div (x - N)$$

v = the CO_2 produced by one person (cu. ft. per hour),
p = the number of persons in the room,
x = the proportion of CO_2 in the air of the room,
N = the proportion of CO_2 in the outside air (0.0004)
A = the air-supply to the room (cu. ft. per hour).

TABLE I.—SUMMARY OF THE RESULTS OF NUMEROUS TESTS TO DETERMINE THE CONDITION OF THE AIR IN SLEEPING-CARS.

(Normal carbon-dioxid in air; 4 parts per 10,000.)

Cars with natural ventilation:	Ave. No. of people in car.	Carbon-dioxid per 10,000 parts of air Ave.	Min.	Max.	Necessary air to maintain ave. carb. diox. cu. ft. per hr.
1. Decks open; doors and windows closed	15	7.19	3.5	13.0	28,300
2. Ditto, but one or both doors open to vestibule	10	5.40	3.5	8.5	40,700
3. All decks, doors and windows closed	13	8.33	5.5	15.0	18,500
4. In lower berth (A)	16	8.32	5.0	18.0	1,389 per berth
5. In aisle opposite lower berth (B)	16	7.32	4.5	10.0	.....
6. In upper berth (C)	21	9.17	4.5	18.5	1,161 per berth
7. In aisle opposite upper berth (D) (4 to 7; windows and doors closed).	21	8.37	6.0	13.0	.....
Cars with Exhaust Ventilators:					
8. Decks open; doors and windows closed (day)	13	6.01	4.5	10.0	38,400
9. Ditto; for aisle only (night)	16	6.33	4.5	10.0	41,300
10. One or both doors open to vestibule	14	5.50	3.5	9.0	57,900
11. In lower berth (A)	16	6.96	4.5	13.5	2,027 per berth
12. In aisle opposite lower berth (B)	16	6.33	4.5	10.0	.....
13. In upper berth (C)	17	6.70	4.5	10.5	2,222 per berth
14. In aisle opposite upper berth (D) (11 to 14; windows and doors closed)	17	5.95	4.5	9.5	.....
Berth Tests.					per berth
15. Cars with natural vent; lower berth	..	8.45	...	....	1,354
16. Upper berth	..	8.85	...	....	1,237
17. Cars with exhaust vent; lower berth	..	6.51	...	....	2,391
18. Upper berth	..	6.70	...	....	2,222
19. Berth with one person	..	7.36	...	....	1,785
20. Berth with two persons	..	9.91	...	....	2,027

Note.—Observations (A) and (B) and observations (C) and (D) were made at the same level (lower and upper respectively) but on opposite sides of the berth curtains.

* Abstract of a paper presented at the annual meeting of the American Public Health Association in 1910. It is now issued by the author in pamphlet form, reprinted from the "Archives of Internal Medicine," January, 1911 (American Medical Association, Chicago).

† Superintendent of Sanitation, The Pullman Company, Chicago.

Some 15 or 20 years ago analyses of the air from passenger cars were made by Prof. Nickols, for the Board of Railroad Commissioners of Massachusetts. In 1894 a committee of the Master Car Builders' Association made a report on the subject of car ventilation, and with it submitted the results of several analyses of air from cars (see Table II.).

In 1904, Dudley* reported on analyses of the air of cars of the Pennsylvania Company, which were ventilated by the excellent system which he devised. He found from 10 to 18 parts of carbon dioxid per 10,000 in running cars, and 20 to 21 parts in cars standing still for 20 mins. The 52 people in the cars are assumed to have produced 0.72 cu. ft. of carbon dioxid each per hour; from which it is estimated 26,000 to 62,000 cu. ft. of air-supply per hour for the moving and 22,000 to 23,000 for the still cars.

The ventilation device upon which this report is based is designed to remove air by exhaustion from the upper portion of the car, and its operation is dependent on train motion.† Anemometer readings, have shown that each such exhaust ventilator will remove an average of about 15,000 cu. ft. of air per hour at a train speed of 40 m.p.h., and proportionately more or less for faster or slower speeds. While there is considerabe variation under apparently simiconditions, the outward flow is constant. One ventilator is placed over each alternate section of a sleeping-car, while two are applied to the smoking-room and one to the stateroom.

It is readily seen that a very large volume of air leaves the car through these openings; it must enter somewhere. The question was, does it enter at such places and take such courses as to cause a free dilution of the air at the breathing level in the occupied car? There seems no adequate answer to this question except by determining the carbon dioxid in such air, from which the amount of dilution may be computed as already indicated.

Nearly 3,000 carbon dioxid determinations were made for all purposes in connection with this work; about 2,000 of these were of the air from over 200 sleeping-cars. [Table I gives a summary of the author's tables of records of observations in sleeping cars; Table II. shows the comparison of observations made in various places, and includes the figures of the Master Car Builders' Association, mentioned above.—Ed.]

TABLE II.—COMPARATIVE RESULTS OF TESTS OF CARBON-DIOXID IN AIR.

Place	No. of observations	CO_2 per 10,000. Ave.	Max.	Min.	Equiv. hourly air supply per person. cu. ft.
Sleeping cars (body)	294	6.20	10.0	....	2,727
Sleeping cars (berths) ..	690	6.96	13.5	....	2,027
Day coaches (32 pass.) ..	43	9.38	21.0	....	1,100
Street cars	45	15.10	29.0	....	541
Elevated cars	17	13.90	26.5	....	674
Suburban coaches	47	14.30	38.0	....	583
Stores	23	8.80	10.0	....	1,250
Restaurants	51	16.10	26.0	....	496
Offices	26	13.91	19.0	....	670
Sleeping cars (12 pass.)	...	18.0	22.0	11.3	M.C.B.
Chair cars (17 pass.)	...	10.7	15.5	7.0	re-
Sub'n cars (½ full)	...	13.8	21.7	6.9	port

* "The Passenger Car Ventilation System of the Pennsylvania R. R.," C. B. Dudley.

† The Garland Ventilator; Eng. News, Dec. 23, 1909.

Before proceeding to an analysis of the findings it is necessary to know the amount of carbon dioxid in the air surrounding trains in order to have some basis for computing air-supplies to cars. The locomotive emits an enormous total volume of this gas, which, it is easily conceived, might play a considerable part in the amount of carbon dioxid found in the air of the cars. According to Leissner the air surrounding trains contains from 18 to 22.8 parts carbon dioxid per 10,000. My results are at variance with this; 46 determinations averaged 4.04; the highest was 10, the lowest 3.

Of course, the smoke and condensed steam do not diffuse as do the invisible gases; but with these is mixed a quantity of sulphur dioxid. My observation has been, in the examination of tunnel air, that where flue gases have contaminated the air, with 15 to 20 parts of carbon dioxid in 10,000, sulphur dioxid is readily detected. It occasionally happens that sufficient gas is carried into a train running in the open to render sulphur dioxid noticeable. It seems that my determinations of carbon dioxid in the surrounding trains have not dealt with the conditions that could bring this about. Consequently I concluded that this is a relative rarity, and that 4 in 10,000 is a proper average to deal with in considering the air outside of moving trains.

Adding to the open deck windows by opening one or both end doors to the vestibule (the outside vestibule doors remaining closed) would be expected to cause a greater air-supply. Such is the case, as shown by the records. [Table I.] Observations were made also where both doors and all the deck sash were closed. Whatever amount of the outside air enters the car under these conditions must find its way in through natural crevices and is driven in and out by the pressure of the wind and the suction effects produced by the motion of the train. As would be expected under these conditions, the average carbon dioxid is greater than in either of the preceding groups and the computed air-supply is smaller.

The air-supply to sleeping-cars, as computed from 555 carbon dioxid determinations, is (for all but that of the completely closed car depending upon natural ventilation) a large one relative to the number of passengers, and would not allow the average carbon dioxid to go above 10 in any but this one condition unless the cars were crowded beyond their natural capacity. Such overcrowding in sleeping-cars is prevented by the assignment of space and refusing further applicants when this is all taken. It very rarely happens that sleeping-cars carry more than 25 passengers.

It should be understood that all of the above observations apply to the main compartment of the standard sleeping car in motion; and in setting down the number of passengers only those persons were counted who were actually in this compartment, and who had been there for a period of at least ten minutes at the time the samples of air were being collected. The smoking-room, the drawing-room, and other small rooms constitute separate problems.

In order to test the consistency of the results obtained, and to find if the carbon dioxid actually does go up in proportion to the number of passengers, the 555 observations were divided into four groups, according to the number of passengers (Table III.). It is seen that it increases with the number of passengers:—

TABLE III.—RELATION OF AIR POLLUTION TO NUMBER OF PASSENGERS.

No. of Pass.	Carb. diox.; parts per 10,000 Cars with nat. vent.	Cars with exhaust vent.
Under 10	5.91	5.58
10 to 15	6.62	5.95
15 to 20	7.38	6.46
Over 20	8.85	7.24
Average	6.88	6.11

When taking samples of air from the berths it was the rule to take, as near simultaneously as possible, an average sample from the aisle for comparison. Samples from each place were generally repeated at 15-min. intervals, until 20 or more had been collected in the car. Two lower berths on each side of the car were generally selected, and one or two uppers when possible.

In order to gain some information concerning the conditions that would obtain if the closed berth had to lose its carbon dioxid by diffusion through the curtain, a series of experiments was conducted with the purpose of determining the rate of diffusion under similar conditions. The results show that the berth does not act as a closed compartment, but is essentially a part of the general space of the car body, and is subject to the effects of air-currents through and around the curtain very much as it would be were the curtain entirely absent.

Observations were made in crowded smoking-rooms of cars without ventilators. The occupants were from 4 to 7; the carbon dioxid from 10.5 to 20.5 per 10,000. The average carbon dioxid (14.88) with the average occupants (5.85) would be maintained by an air supply of 3,225 cu. ft. per hour for the room. Similar observations in smoking-rooms equipped with exhaust ventilators showed carbon dioxid from 7 to 16.5 per 10,000, with 4 to 8 occupants. The averages were 6.1 occupants and 11.41 carbon dioxid; the equivalent air-supply would be 4,940 cu. ft. No account is taken of the carbon dioxid produced by the burning of tobacco and matches.

About 200 samples of air from still cars have been analyzed. It is usual to find that the carbon dioxid rapidly increases when a train stops running. This increase reaches its maximum only after a considerable time, and the final height is variable, depending largely on the force of the outside wind. A strong wind will drive much air into the car, a light one proportionately less. Among these 200 observations the carbon dioxid passed 20 per 10,000 but twice (20.5 and 21.5), both in lower berths. It is usual to find the maximum around 15 in cars that are occupied at stations awaiting very late departures.

Sleeping-cars are snugly built; the crevices are small, but no crevice is too small to admit air, provided a little pressure is behind it. A row of windows covers each side of the car, another row of small ones extends along each side at the deck level, and each end has a door. There is a sum total of approximately 500 lin. ft. of crevices at their edges. If they average 1-50-in. in width and admit air at the rate of the train speed, the 40,000 cu. ft. would be more than accounted for. Some of these crevices are much larger than assumed, some are probably smaller. It is not unusual to find air entering certain areas of open windows at a rate equal to half the train speed, or even more. The crevices may act in the same way; the passage of air through such invisible openings is a much more important means of ventilation than might be thought. Pettenkofer showed that when all visible chinks were closed in a room the rate of ventilation was decreased only 28 per cent. as compared with the rate when the doors were closed in the ordinary way.

Samples of air were taken simultaneously from various locations in sleeping-cars with exhaust ventilators and the carbon dioxid determined, in an attempt to find where the contamination is greatest. So long as the samples are taken well within the body of the car they show nearly uniform results for different levels and different locations; hence the general mixing of the air must be good. The carbon dioxid, on the average, is a little less close to the floor than higher up. This is consistent with the upward trend of the flow to the ventilator exits. There is essentially no difference between the breathing zone and the bell-cord level. There is a slight difference between samples taken at the breathing level and near the ventilator exits, the latter being lower; but the difference is not so great as would be indicated by the difference in the dilution of the lower air and the amount leaving the car through these exits.

It has been attempted to determine the ventilation of sleeping-cars in terms of air-supply, using carbon dioxid as the only available basis of computation. In order to pass judgment on the findings recorded, it is necessary to know the hygienic significance of respiratory contamination of the atmosphere, and, if possible, to establish the cause of discomfort which may arise, supposedly as the result of an insufficient air-supply.

It has happened that a few of the cars considered in this work have been uncomfortable, have been called "close" or "stuffy." The temperature of these cars has invariably been high. There has sometimes been an unpleasant odor. This cannot be ventilated away so long as its source remains. A high temperature renders such odors more noticeable. The most marked offensiveness I have ever noticed was in a day coach where the air was of such a degree of chemical purity as to indicate ideal ventilation by any standard that has ever been proposed. The car was hot and had many filthy people in it. On the other hand, with perfect comfort has been sometimes associated the highest chemical impurity.

Even under the older applied principles of ventilation, the air-supply of sleeping-cars, as determined in this study, is ample under nearly all conditions. The average carbon dioxid in the air of running cars falls well within the limits of contamination, permitted by the earlier investigators, and it is relatively rare that the individual observations show more than 10 parts in 10,000. In the light of the newer conceptions, which have as yet been applied in practice only to a very limited extent, this air-supply is ample under all conditions observed. No danger to health is to be apprehended under the conditions ordinarily obtaining even in still cars. They are occupied only for short periods as a rule and are not uncomfortable if kept cool.

It would seem that the results obtained by the type of exhaust ventilator investigated in this study, which is now a part of the standard equipment of Pullman cars, are entirely adequate to meet the demands of hygiene, and that those difficulties and discomforts which do sometimes arise are due to other causes than lack of a sufficient amount of fresh air or to excessive vitiation. It is extremely unlikely that increasing the air-supply, which now amounts to from six to ten or more times the cubic content of the car each hour, and must maintain considerable motion of the atmosphere, would aid in any other way than by making overheating more difficult to bring about.

Overheating is the paramount evil. It is the thing to be chiefly guarded against in the attempt to maintain comfort and good hygiene. It is not feasible to cool the naturally overheated air in summer, or to dry it when excessively humid. Fan motors and open windows are the available means by which the difficulties arising in hot weather may be most readily overcome. Carry away the body heat as rapidly as possible by a strong current of air.

Though the avoidance of overheating in winter would seem to be an easy thing, its accurate control to meet the rapidly changing conditions under which cars may be operated is a matter of great difficulty. Experience has shown that it is necessary to have in sleeping cars at least twice as much radiating surface as is demanded in common practice for heating the same space in houses; this in order to warm the large volume of air received and discharged so that it will maintain comfort to inactive passengers. To decrease this surface would be to fail to maintain a sufficiently high temperature on occasion.

A system is needed capable of being quickly and effectively controlled to meet rapidly changing conditions. Such a system is now being experimented with in which there are multiple units of radiating surface, each with a separate control. The results so far indicate that from this a more uniformly comfortable condition can be maintained.

DESIGNING A CONCRETE CONSTRUCTION PLANT.

Sanford E. Thompson, consulting engineer, and an associate of Frederick W. Taylor in the application of scientific management to construction plants, says of the designing of a concrete plant:—

"On all work of such magnitude as to make the use of a concrete machinery mixing and handling plant expedient, it is of great importance in the matter of speed and economy to have the entire plant wall designed and planned out to the best advantage. And this design must of necessity vary according to the nature of the work; the way in which raw materials can be brought to the plant; the natural features of the ground where the plant is to be located; the cost of materials delivered on the job for constructing the plant; the time in which the work must be completed; the amount of money there is in the job; and any special conditions that may exist in connection with the work. Even where the general features of the plant are practically the same for two different jobs, the details are usually more or less at variance. Therefore, it means careful and thorough study and efficient planning to effectively meet the conditions, so as to prevent waste of money and to decrease cost.

"The design of the plant for handling the raw materials for concrete and for conveying the concrete to place usually has more to do with economy in mixing than the particular type of mixing machine. As there are plenty of good mixers, engines and other machinery on the market, the particular make used, is, in a measure, a matter of personal choice, or is determined by what can be economically had at any given location, either new or bought from some previous job.

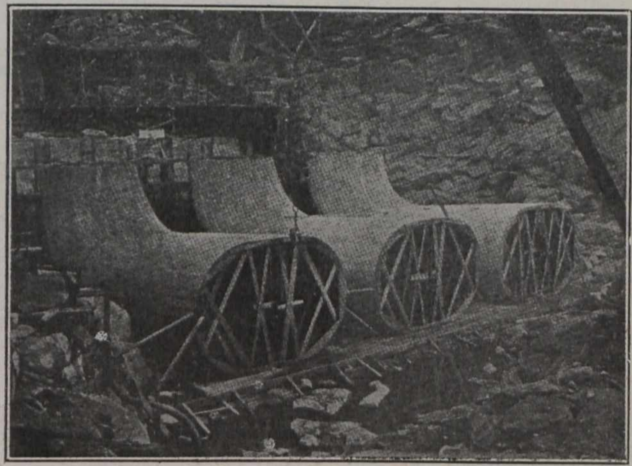
"The proposed plant should be drawn or sketched on paper, and the cost and expense of installation, as well as of operation, estimated as accurately as possible so as to determine whether the volume of concrete to be laid is sufficient to warrant the construction and operating expense. The authors have seen expensive machinery, which could be transported readily to another job, installed on a section of work where hand-mixing would have been actually more economical because of the small total volume of concrete and its distribution over a large area.

"Usually the important points to plan for are what shall be used for handling the machinery and the concrete; whether cableways; belt conveyors; elevators of various kinds; cars hauled by dinkies; by horses or by hand on level tracks; cars hauled by cable on inclines, or derricks; whether trestles shall be built and to what extent; whether the mixers can be so located that raw material can be dumped direct to bins from standard gage cars; whether the mixing plant shall be mounted complete on trucks or cars; or whether some special combination of a part or all these shall be used. The minimum amount of concrete that will make it advantageous to install a machinery mixing and handling plant is variable, depending on the nature of the work and local conditions to such an extent that it must be carefully figured out for each. On some jobs 500 cubic yards would be the minimum, while on others it might possibly be as high as 1,500."

CONCRETE IN A NEW HYDRO-ELECTRIC STATION.

One of the most recently completed hydro-electric power stations is that for supplying current to the Otis Company's Palmer Mills near Three Rivers, Mass. This development is located on the Chicopee River about 1,000 ft. below the mills, and Lockwood, Greene & Company, of Boston, were the consulting engineers. With the exception of a superstructure of brick, concrete was used throughout and it almost seems as if this was becoming standard practice.

The dam, which is of concrete masonry, stretches diagonally across the river and one end sets on a ledge on the north shore of the river, where the anchorage for the concrete is suitable, while at the other end is located the power house which is at right angles to the flow of the river.



Wherever practicable, the dam is ballasted with rubble and the face, crest and back have a uniform granolithic surface finish.

The wing walls, the abutments and the power house foundations and floors are also of concrete and of special interest in this connection are the forms used for the draft tubes.

These completed draft tubes are eliptical in shape with dimensions of 13 x 19, and the forms used were made up entirely of wood. The tubes are formed in the concrete foundations. They were designed to discharge the water from the wheels horizontally downstream and at a very low velocity. Under average conditions the discharge water emerges below the surface of the downstream storage pond at less than 2½ ft. per second.

THE NEW DRY DOCK FOR THE POLSON IRON WORKS.

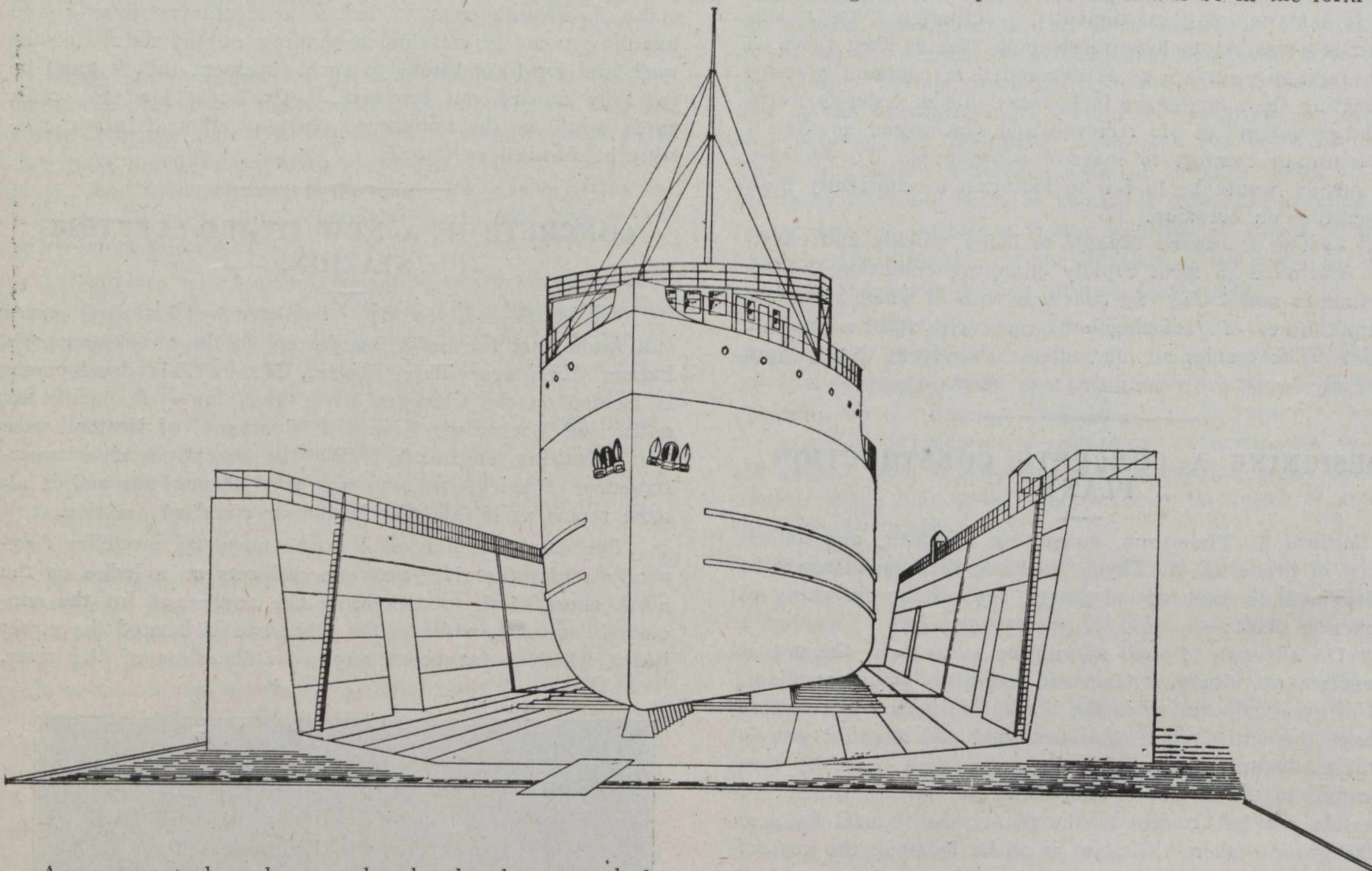
The directors and management of the Polson Iron Works, shipbuilders and engineers, have completed plans and specifications for a dry dock to be constructed at the foot of Frederick Street, to the west of their present plant.

The accompanying cut will clearly present the essential features. The construction is to be of steel plate.

The dock to be built at present will be in two sections 150 x 100 feet each, inside, and a total length of 165 feet inclusive of the outrigging.

A boiler shop, composed entirely of steel, excepting one wall which is to be of brick, will adjoin the dock. Its dimensions will be 300 x 120 feet. Two flange compartments will be erected, one 60 x 40 will find employment as a pump and compressor room, the other will measure 60 x 60, to be used as a flange fire shop, the construction being such that fumes, etc., will not reach the main boiler room. The roofing of the boiler shop will be fireproof asbestos.

The general shape of the dock will be in the form of a U, the design of the bulkheads and floodgates calling for entire freedom from leakage.



Arrangements have been made whereby these two docks may be merged in one, in this condition they will be able to accommodate a ship of 4,500 tons and 80 ft. beam. Allowance has been made for future additions in sections of this size.

The estimated cost of this dry dock is placed at $894,000 and it is expected that the Cabinet will shortly pass a bill authorizing a subsidy of 3 per cent. for 21 years.

A NEW FIELD GUN.

The Deport Field Gun was tried by the British Government last month at Shoeburyness and Salisbury Plain.

The weapon is of original design the leading feature being the "scissors" trail. When the gun is brought into action the two halves into which the trail is divided longitudinally are opened out at an angle of 60 deg., and their points are nailed to the ground by steel spikes. The effect of this arrangement is to allow of the gun being traversed, without moving the carriage, through a lateral angle of 56 deg., instead of about 5 deg. as with ordinary carriages. The gun has compound recoil gear, with an upper and a lower cradle. The top carriage, with the gun and upper cradle, recoils 3-ft. 6-in. on the lower cradle, and the gun itself recoils 1-ft. on the upper cradle. The elevation for angle of sight is given to the lower cradle, that for range to the upper cradle, and so to the gun. This arrangement provides for a recoil of 4-ft. 6-in. at low elevations, which is sufficient to keep the carriage steady, while at high elevations the recoil is principally on the upper cradle. This enables the gun to be fired at 45 deg. elevation without the breech striking the ground on recoil.

The breech action is the eccentric screw as in the French gun, with semi-automatic gear which opens the breech and ejects the cartridge during recoil. The breech is left open, and is closed by a spring as soon as the last round of fired ammunition is inserted. The gun is fully shielded and sighted with panorama sights. That tried by the government is a 14.3 pdr., weighing one ton in action, on 4-ft. 8-in. wheels, but a high-velocity 16-pdr. similar to the French service gun is also made on the same principle.

The trials were fully satisfactory, and the committee were impressed by the perfect steadiness of the carriage.

The Electric Construction Company, of Wolverhampton, England, has lately distributed information as to the use of electricity for driving heavy reversing mills, by means of the flywheel motor generator. This company has lately installed its power machines in the works of the English company of Alfred Hickman, Ltd., said to be among the largest in the world. The fly-wheel motor generator set consists of a motor, designed to develop 2,000 horsepower as a continuous working load, with two fly-wheels and two generators.

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CONTENTS OF THIS ISSUE.

THE GRAND TRUNK PACIFIC.

The predicted date of completion of the Grand Trunk Pacific Railway has been changed more than once. Mr. Charles M. Hays, the president of the road, recently spent six weeks inspecting the greater part of the system now under construction. After this visit, he stated the road will be completed from the Atlantic to the Pacific ocean in 1914—a forecast which has the benefit of twelve months' elasticity. From Winnipeg to Edmonton, ninety-five per cent. of the territory on both sides of the new transcontinental is good wheat-growing land. The remaining five per cent. is suitable for grazing purposes. But Edmonton is not the end of the fertile belt in Alberta. For 150 miles west of the provincial capital, there is more excellent land. This fact will in due time help Edmonton considerably. It must naturally become the distributing point for the Peace River region as well as for other large stretches of country, the settlement of which is but a matter of a few years.

Good progress has been made with the section of the road running through the clay belt of Northern Ontario. This is completed a considerable distance both east and west of Cochrane, a divisional point of the Grand Trunk Pacific and the present terminus of the Temiskaming Railway. On both sides of the line again, there is good farming land.

By the time the main line is finished to the port of Prince Rupert, in British Columbia, the company's branch from the port of Montreal to the main line will have been built and ready for traffic. Three charters have been granted by parliament for connecting Montreal with the main line.

The Grand Trunk Pacific will be able to give considerable assistance in the movement of the Western crop this year. The company has elevator facilities at Fort William. Last season they brought over their road 6,000,000 bushels of wheat to Lake Superior. During the coming crop movement, they anticipate carrying 12,000,000 bushels to the head of the lakes. A branch line will tap the coal deposits west of Edmonton, where the mines will be operated by at least three eastern companies. The distance from the coal mines to the main line is about fifty miles, and this track is practically completed.

The road will be practically level from ocean to ocean, the average gradient being four-tenths of one per cent. On completion, the company will take over the eastern section from the Dominion government and will operate it for the first seven years at cost, and after at a rental of 3 per cent. on the cost of construction. The completed Grand Trunk Pacific Railway will be made up as follows:—

Section.	Miles.
Moncton to Winnipeg (National Transcontinental, under construction)	1,805
Winnipeg to Edmonton (constructed)	793
Edmonton to Prince Rupert (part constructed)	962

The Canadian Northern Railway will probably have a completed transcontinental by the time the Grand Trunk Pacific is running trains from the Atlantic to its sister ocean. Canada will then have three coast-to-coast railway systems.

THE SPIRIT OF THE NORTH.

To attempt to add further to the details of the disaster that has recently swept the neighborhood of the Porcupine mining district would be useless. Not merely because of the vast amount of information that has already been scattered broadcast throughout the country —perhaps it would be nearer the truth to say throughout the continent—but because of another fact that stands out pre-eminently, overshadowing the blackness of the disaster.

Hardly have the daily papers begun to give authentic details of the fire as witnessed by those who passed through it, when the news arrives that the towns that have been razed to the ground are to be built again. Then follows news that not only are these centres to be built again, but also that operations are actually on foot to accomplish this end. Those that a few days before had faced agony unspeakable were already back on the spot of former activities, ready to take up the burden—more than ready, for they had already begun the task outlined.

Those who have never experienced the horror of a real bush fire, a fire that travels faster than a locomotive, can have little idea what this short intensity of disaster has been to the inhabitants of the fire-swept Porcupine. To those who live in the centres where fire-fighting is an organized science, the terror of the bush fire will never be known—and may it never be. To those of us who live in comparative safety from such disasters let this story of the North be an object lesson—not in mere words as to what should be done and what might have been done, as some pigmies would have one believe—but as an inspiration. Here we see the true spirit, showing out undaunted by momentary reverse, momentary because of the spirit which will let it be no more. To the survivors of the Porcupine fire let all praise be given for the manner in which they have taken reverse.

EDITORIAL NOTES.

The attendance at the Canadian National Exhibition is jumping at the rate of 100,000 a year. In 1909 it was 750,000; in 1910, despite the unfavorable weather, it was 837,000. This year only continued wet weather can keep it from reaching the million mark.

* * * *

There is great activity in railway construction throughout Central Alberta. The main lines of the Grand Trunk Pacific and Canadian Northern Railways are being pushed westward; the grading of the C.N.R. branch to Athabasca Landing is nearing completion; the C.N.R. Peace River branch has been commenced, and work is proceeding on the C.N.R. Strathcona-Camrose line. The Grand Trunk Pacific have established an excellent daily passenger service from Edmonton to Mirror on their Tofield branch. In the southern part of the district the Alberta Central and the C.N.R. Brazeau lines are progressing rapidly with construction towards the Brazeau coal fields.

Mr. J. D. McKay, St. John, N.B., has invented a coal economizer and smoke-raiser for locomotives and steamboats. This invention is of a very simple nature, and can be adapted to any locomotive or steamship funnel, and it is something that railway and steamship men have all been seeking in vain for years. The benefits that can be derived from it are numerous. An addition to the smokestack is arranged in such a way that it will drive the smoke straight up in the air, besides improving the draft. It will also do away with the blower now in use in all locomotives, and by the additional draft and by doing away with the blower it is estimated that a locomotive will save twenty to twenty-five tons of coal monthly. This will mean a big saving to railroads as well as steamers.

313 Main Street, W.
Hamilton, Ont., July 11, 1911.

Editor, The Canadian Engineer, Toronto:

Sir,—Enclosed please find a paper on "Chlorine Treatment of Drinking Water." This is submitted as an addition to present literature on this subject. Copies have been sent to two leading newspapers, with the comment "it is presented to the public on the basis, that the more that the people know about such important public questions, the more will they endorse efforts to put things right."

Yours truly,
J. M. Williams.

CHLORINE TREATMENT OF DRINKING WATER.

The Chlorine treatment for the purification of drinking water will necessarily require consideration from the two principal standpoints of physical and chemical condition after treatment. The first because this involves the potability, the appearance, the taste, and suitability to the common use. The second takes into account the constituents present or absent added or removed, and which improve or degrade the water.

To commence with, we will discuss the physical aspect or condition, and as the national importance of the experimental work being done by the Corporation of the City of Toronto, is well recognized, we may survey the subject direct from the case of the water supply of Toronto. In this case the water is being treated with Chlorine imparted to the water by the addition of Chlorinated Lime.

The physical condition of this water has one feature after the addition of the Chlorinated Lime which is a particularly serious one, that is that of a degraded taste, the other two conditions before mentioned that of color, and adaptability, are also to be taken into account. The color not being changed, relieves this item from account. The adaptability is open to serious consideration which will become more apparent when we discuss the second standpoint of chemical condition.

Referring to the taste of the water, it will be at once allowed that the taste of the water supplied to a community for its use, must be maintained as fine as is possible under nature's unalterable conditions, not nature's alterable conditions; these it is man's work to be ever dealing with.

The taste of the water treated with Chlorinated Lime, becomes a very important question when we find in the case under observation, that the taste has become pronounced and disagreeable, and because of this feature, a menace to the people whom it is provided for, because they will refrain from drinking it as freely as they ought.

We immediately ask what causes the taste and is it preventable, and find that the objectionable taste is caused by the presence of Chloride of Calcium and traces of Chloride of Magnesium, the first mentioned being mainly responsible for the taste, being present in the greater quantity. The Chloride of Calcium originates in the Chlorinated Lime; when this substance is put into water in small proportions, it soon resolves into stable salts, which is inevitable with all substances; they reach by the quickest process that condition where they can rest unchanged.

The taste referred to is characteristic of Calcium salts. That the assertion is correct that the taste of Toronto water is due to Calcium can be easily demonstrated.

The reason that the taste is so disagreeable is that the saliva of the human mouth is very active and quickly reacts with metallic or mineral matter; we taste because the saliva decomposes matter taken into the mouth and some substances in this reaction are precipitated on and slightly into the mucous membrane, and the taste remains for some time. This occurs with the Chloride of Calcium in the water we are discussing.

The next question is how necessary is it to have this Chloride of Calcium present? It is inevitable while using Chlorinated Lime, and we then must consider the use of other material as a source of Chlorine. It may at this point be discussed as to the merits of Chlorine as a purifier of potable water.

As a substance having the best adaptability for this purpose, Chlorine is used, it has three features which confirm it as such, cheapness and ease of obtaining, ease of use, and conformity to laws of hygiene. This last is the one feature which is open to discussion and question while Chlorinated Lime is used as the source of Chlorine, but Chlorine itself is not challenged, this remains the best substance to be used for the prime reason that in the reaction involved in its use, the resulting chemical salts which of course remain in the water are not detrimental to the human economy.

The principal salt resulting from the use of Chlorine in the purifying of potable water is Chloride of Ammonium, and this chemical is beneficial rather than otherwise.

The action of Chlorine in purifying water has been described as operating in several ways; the principal action is that of forming chlorides with such bases as it meets with in the water. If the water contained Lime as Carbonate, there would result Calcium Chloride; if the water was Magnesium there would be Magnesium Chloride, just because Chlorine has a very strong affinity for alkaline bases such as these.

In the present case the main factor in the water, and the one which is being destroyed by the use of Chlorine, is organic contamination with its consequent dangers, due to the generation of septic organisms.

We can arrive quickly at the point where we identify the action of the Chlorine in destroying this contaminating factor, and thereby purifying the water, when we take into account the group of elements which is principally involved in the constitution of such organisms as we are considering. This is the Ammonium group; the Nitrogen combinations with Hydrogen, in the diversified forms which occur, have the character that they find their ultimate form in the Ammonium group, they have this group in their constitution or in their break-up, or transformation, or reproduction, or dissolution, this group occurs.

The affinity of Chlorine for Ammonium and its stability when combined are well known and it is this affinity which is the element of activity which gives Chlorine its value as a purifier of water.

Organisms dangerous to the human constitution will have their constituent elements resolved by the presence of the Chlorine, its selective affinity for the Ammonium group will wrench, as it were, this group from their substance and this simple basic compound Chloride of Ammonium will be formed and the organisms are killed.

It will be here and at once asked, why does this Chlorine treatment appear to have from time to time fallen short of the strong claims for its efficiency, and culture tests showed the presence of dangerous bacteria after Chlorine treatment, it is not the fault of the Chlorine, it is the result of the use of Chlorinated Lime; there is formed very soon after it has been added to the water, as mentioned before, Chloride of Calcium, due to the presence of so much lime and the inevitable formation of basic and stable compounds, the Chlorine once united with the lime is not active in producing the break-up of organisms, and moreover the Calcium salt may even be utilized by some form of bacteria. This accounts for the supposed failure of Chlorine. It is here evident that we have got well into the second aspect of the question, the chemical standpoint, from which we must discuss it. We may omit the discussion of the hygienic aspect of having Chloride of Calcium in our drinking water, though it is objectionable for certain reasons.

We will go to the important question of how to administer Chlorine and avoid the difficulties inherent in Chlorinated Lime.

To do this we can use Chloride of Iron. This possesses the requisite qualities, as we will find when we analyse the character and action of this substance. We must here observe that the aim has been to use free Chlorine; this has been assumed to occur in the use of Chlorinated Lime, from an acceptance of the fact that it evolves Chlorine, and its reputation has been made because of that fact. True, and its efficiency as a deodorizer is just because of this fact, and also of the statement above, of the action of Chlorine on organisms in combating with the Ammonium group, and breaking up their constitution, and destroying them, we recognize the great value of Chlorinated lime to humanity, because of this, but we find another condition ensues when we put this substance into water, the Chlorine then asserts its affinity for Calcium and rapidly is combined and it is no longer nascent Chlorine, as it was when sprinkled in an infection area, developing free Chlorine ready to exert its beneficial influence.

Now we consider Chloride of Iron as a source of Chlorine for the reduction of organic contamination in water, we find that Chloride of Iron, when put into large quantities of water which are open to the air, is very unstable and the Iron takes up oxygen and becomes Oxychloride of Iron, and if organic matter is present, it is deposited along with the particles of insoluble Iron Salt, which becomes Oxide of Iron passing through the Oxychloride form, and becoming oxide, the Chlorine combining with any base present. In the case of potable water treated with this substance the organisms would be doubly acted on, they would be attacked by the Chlorine atom reaching for the Ammonium group, and the oxide of iron formed in the decomposition of the Chloride of Iron would act as a precipitant, and the organic matter including the debris of the organisms, would be carried down by the heavy oxide of iron.

We may well ask is this a new idea, and answer no, it is new in this, that when it was used, we were not familiar with bacterial infection, and the action was concluded to be a chemical precipitation of organic matter only, but it was recognized that the water was purified.

Its suitability to the present case can be freely considered, the qualities claimed for Chlorinated Lime are possessed to a sufficient degree in accessibility and cheapness, and when we come to its results on the basis of our knowledge of it, we may well assert that it will be found efficient in every way.

We eliminate the one pronounced disagreeable element of a bad taste in the water. We introduce an astringent compound which is immediately exerting its action on organic contamination. The astringent quality provides that albuminous and gelatinous bodies would be efficiently dealt with, apart from the destructive effect of Chlorine, but which of course is involved with this astringent effect, and the threefold action is exerted, chemical action, astringent action and precipitation action.

We are correct in the assertion that this substance, Chloride of Iron, will be the right material to use in the purification of drinking water.

We must furthermore conclude that sewage would be as satisfactorily purified by this chemical, the process followed through, gives the same conclusion, quantity only would be the factor.

COSTA RICA AND GUATEMALA SANDS.

Samples of Costa Rica and Guatemala sands were recently secured by a representative of the Aberthaw Construction Company, while on a visit to Central America.

These sands, which were obtained from such cities as Port Limon and San Jose, Costa Rica, and Puerto Barrios and Guatemala City, Guatemala, were tested by Mr. H. L. Sherman, of Boston. Their tensile strength with one part Portland cement and three parts sand by weight compared with that of one part Portland cement and three parts standard sand by weight under the same conditions of test showed that in general the Costa Rica sands were better than those of Guatemala, and also that the sands at present being used for local buildings were undoubtedly the best available. The results of these tests are presented in the following table:—

Costa Rica Sands.

Sample No. 1.—Average tensile strength pounds per sq. inch 1 part Portland cement, 3 parts sand.

	7 days		28 days	
	Costa Rica	Standard	Costa Rica	Standard
3,614	282	332	451	411
3,615	247	332	389	411
3,635	161	203	269	328
3,636	167	203	246	328
3,637	133	203	193	328

Guatemala Sands.

Sample No. 2.—Average tensile strength pounds per sq. inch 1 part Portland cement, 3 parts sand.

	7 days		28 days	
	Guatemala	Standard	Guatemala	Standard
3,634	96	250	169	340
3,649	132	270	146	404
3,650	82	270	137	404
3,651	168	270	208	404
3,652	229	270	308	404

BALLAST.*

George W. Vaughan,

Engineer Maintenance of Way, New York Central and Hudson River Railroad.

Ballast in that portion of the permanent way of a railway which forms the firm and dry foundation for the ties and rails, which they support. It is sometimes distinguished as sub-ballast, ballast proper, and top-ballast. Sub-ballast is that portion used as a foundation for the ballast proper, or as a mat between the ballast proper and sub-grade, made necessary on account of the poor material forming the sub-grade. Ballast proper, or under-ballast, is that which lies wholly below the ties and above the sub-ballast. Top-ballast is that which is filled in around from the bottom to the top of the ties.

Ballast is necessary for the following reasons:—

(a) To drain water from the ties.

(b) To provide a firm and even bearing for the ties and to distribute the pressure from the ties and to hold them in place.

(e) To prevent the growth of grass and weeds in the track.

(f) To allow surfacing and raising of track without disturbing the roadbed.

Ballast is a most important item and upon its quality depends the condition of the track, also the economy in maintenance and operation.

Ballast material should be carefully selected. A dusty ballast will cause greatly increased wear in the equipment and on roads with extensive passenger traffic an innumerable number of complaints from the traveling public, and it is as important to avoid dust and dirt by the use of clean ballast as it is to avoid smoke and dirt by the use of hard coal for fuel.

The best ballast is that which will best form a durable support to the ties, will not change its consistency when wet, will not disintegrate upon exposure to the elements, retain its solidity and position under the effects of traffic, gives good drainage, be free from dust and make an easy-riding track.

Broken stone and furnace slag drain readily, but burnt clay, sand, etc., will retain water more or less and will heave in frosty weather. With earth or mud ballast good drainage is absolutely essential to enable the track to be kept in safe and fairly good condition, as water-soaked earth becomes pasty and squashes up between the ties and over the right-of-way, and when in such condition it is impossible to tamp, so as to keep the track in surface.

A good depth of ballast will cheapen the maintenance by keeping the beds of the ties well drained, and it is not economy to economize too much on ballast.

The depth of ballast varies on different lines and according to the practice of different engineers. The following may be taken as ordinary limits:—

Sub-ballast	10 in.	to 18 in.
Lower-ballast	9 in.	to 18 in.
Upper-ballast	6 in.	to 8 in.
Totals	25 in.	to 44 in.

* Abstracted from Bulletin No. 136 American Railway Engineering Association.

The materials most generally used are Broken Stone, Furnace Slag, Gravel, Burnt Clay, Cinders and Earth.

Definitions.

Broken or Crushed Stone.—Stone broken by mechanical means into small fragments of specified size.

Gravel.—Small worn fragments of rock, coarser than sand, from natural deposits.

Sand.—Any hard granular rock material, finer than gravel or coarser than dust.

Cinders.—The ashes or residue from coal used in locomotives and other furnaces, including the sparks from the front end of locomotives.

Slag.—Waste product. A more or less vitrified form of furnace reduction of ore. This to include the granulated slag formed by dumping hot slag into water or any other product of a blast furnace, iron, copper or lead.

Burnt Clay.—Clay of gumbo, which has been treated with fire.

Mud Ballast.—Any natural material used as ballast, which, when well drained, will not churn under the ties.

Description.

Broken Stone.—This in general is considered the best material for ballast, as it meets the requirements; does not freeze nor heave in cold weather, and can be worked in wet and dry weather alike. Almost any hard building stone may be used, provided it breaks with an angular fracture and not into thin, flat pieces. Granite, trap, limestone and flint are mostly used.

Gravel.—This material is more used than any other and is a varying quality. It may be sandy, dusty or loamy, or else full of large stone, which, unless removed, will make an irregular and rough riding track. The best gravel should be clean and coarse, and as far as possible of uniform size and quality. It does not give as good drainage as stone, but a fairly coarse and clean gravel generally proves satisfactory, provided plenty of it is used.

Sand.—This, when clean, sharp and granulated, makes fairly good ballast under light traffic, but unless it is very coarse requires constant attention and renewal, involving a great deal of maintenance work, as it runs out from under the ties and is gradually weathered away by the action of the elements. Where gravel or sand ballast is full of dust it should be provided by a top dressing of coarse cinders or coarse stone screenings, so as to avoid dusty track.

Slag.—Furnace slag or cinder is commonly used on roads in the vicinity of blast furnaces and iron works. Coarse slag is about as durable as broken stone and in some ways almost as good, except that the ties decay more rapidly from dry rot than in stone ballast. At the present time slag from blast furnaces and iron works is being furnished in granulated shape. This is done by dumping the slag into water, the product of which, when taken out, is similar to and about the same quality as sand ballast. When first placed in the track it is very dusty, but the repeated rains relieve this condition. Its drainage qualities are much better than that furnished by sand ballast.

Burnt Clay.—This is being used in England and other foreign countries; has extended to this country and is being used extensively in the West. The most suitable is brick clay, or almost any clay that has not too much sand, gumbo, or clayey earth. Burnt clay is very light and is about equal to screened locomotive cinders.

Mud Ballast.—Dirt, earth and mud are used, the ballast being composed of natural soil along the road. This is the cheapest material to be used and generally the most troublesome to maintain. It is of a variable quality, from sandy to clayey. Unless very sandy, cakes in hot weather and when any work is done it becomes intolerably dusty. In the winter it heaves badly by frost and in rainy weather it washes out and in continued wet seasons, or in the spring, when the frost is coming out of the ground, it becomes so soft that it is almost impossible to keep track in safe condition, as the ties churn the saturated roadbed into mud. In other words, good mud ballast is a continuous performance, every day in the year, Sundays included.

SPECIFICATIONS.

Broken Stone.

Broken stone ballast shall be made from stone hard enough to prevent pulverizing under the treatment to which it is subjected, also durable and tough enough to resist the disintegrating action of the elements where it is used, or from other stone, acceptable to the Engineer.

When crushed it shall break into angular pieces and the maximum size shall not exceed pieces which will pass through a revolving screen having two (2) in. holes, and the minimum size shall lie on a revolving screen having three-quarter (¾) in. holes.

Stone shall be crushed in suitable crushers; be clean and free from all dust, rubbish, dirt and particles three-quarter (¾) in. in diameter and under. If crushed by hand, the stone should be broken in clean places especially selected for the purpose.

BALLAST.

Stone Screenings.

Stone screenings shall be made from the same quality of stone as stone ballast, as it is a by-product of the crusher. The maximum size shall not exceed pieces which will pass through a revolving screen having three-quarter (¾) in. holes and the minimum size shall lie on a revolving screen having one-quarter (¼) in. holes. The product shall be free from all dust, dirt, rubbish and particles that will pass through a one-quarter (¼) in. ring and under.

Cinders.

Cinder ballast shall be free from ashes, dirt and rubbish.

Slag.

Slag ballast shall be free from lime, dirt and rubbish, and the product from the mill, if not quenched in water, should be broken into pieces which will pass through a revolving screen having two (2) in. holes, and the minimum size shall lie on a revolving screen having three-quarter (¾) in. holes. If slag is quenched in water to form granulated slag, this product shall be free from dirt, lime and rubbish, or any material that will not pass through a two (2) in. ring.

Gravel.

The best should be clean and coarse, free from dirt, dust, marl lime, and stone that will disintegrate under the action of the elements, and should range in size from two (2) in. in diameter to coarse sand. Gravel should be screened or washed where prevention of dust is an object, but this need not be done when the traffic is such that it is not objectionable.

Sand.

Fine gravel or sand ballast should be free from dirt, rubbish, marl lime and pebbles that will disintegrate under the action of the elements, and should range in size from two (2) in. in diameter to fine sand, a portion of about 75 to 80 per cent. to 20 and 25 per cent. of coarser material.

Burnt Clay.

This ballast should be made of clay free from sand or silt. The clay should be burnt hard and thoroughly. The fuel used should be fresh and clean enough to burn with a clean fire. Ballast should be allowed to cool before loading.

Absorption of water should not exceed fifteen (15) per cent. by weight. Ballast must be free from all worthless material, dirt, dust and rubbish.

Earth or Mud Ballast.

Ballast should be taken from sub-soil and be of such material that when placed in the track water will drain off readily from the top.

Top Ballast.

This should consist of the same material as ballast proper, except when a dustless roadbed is required the upper two or three (2 or 3) in. should consist of two or three-quarter (2 or ¾) in. stone, slag, screened gravel, or cinders.

Sub-Ballast.

This should be sand, stone screenings, stone dust, granulated slag, or any material that will form a cushion and drain readily. Sub-ballast should be clean and free from dirt and rubbish.

RECOMMENDED PRACTICE.

Stone, Slag and Gravel.

Coarse stone, coarse slag or coarse gravel should be used, if obtainable, on all high speed and heavy freight tracks. When not obtainable, the best available material should be used, and if a dustless track is desired top dress with crushed stone, screenings, crushed slag, washed gravel or cinders.

Cinders, Stone Screenings and Sand.

The use of cinders, stone screenings and sand as ballast is recommended for the following situations on Main and Branch Lines with light traffic:—

On sidings and in yard tracks; as sub-ballast in wet springy places, in cuts, on fills, and through clay bottoms; as sub-ballast on new work where fills are settling and at places where track heaves from frost.

Burnt Clay.

The use of burnt clay as a ballast is recommended for the following situations:—

On Main and Branch Lines with medium traffic. On sidings as a top dressing to secure a dustless track.

Earth and Mud.

The use of earth or mud is recommended only when more suitable material is not obtainable. If used it should be rounded up in the center of the track, so that water will drain off readily.

Recommended Depth of Ballast.

Kind of Ballast.	Sub-Ballast.	Ballast-Proper.	Top-Ballast.
Crushed stone		12 in. to 18 in.	6 in. to 8 in.
Crushed stone screenings	10 in.	10 in. to 12 in.	6 in. to 8 in.
Crushed slag		12 in. to 18 in.	6 in. to 8 in.
Granulated slag	12 in.	10 in. to 12 in.	6 in. to 8 in.
Gravel	10 in.	12 in. to 18 in.	6 in. to 8 in.
Sand	12 in.	10 in. to 12 in.	6 in. to 8 in.
Cinders	12 in.	10 in. to 12 in.	6 in. to 8 in.
Burnt Clay		12 in. to 18 in.	6 in. to 8 in.
Earth or Mud			9 in. to 11 in.
Dust Guard: All kinds of ballast			2 in. to 3 in.

RECOMMENDATIONS AS TO THE USE OF OIL TO SECURE A DUSTLESS ROADBED.

Approximately 2,000 gallons of oil are required for each mile of single track and the first cost is about $80 per mile. Oil is usually applied in June and the one application is sufficient for the year, except where roadbed is disturbed, when a local application is necessary, which can be made with a sprinkling pot. The application of subsequent years is thinner and is sometimes postponed until dust develops, when the cost of applying, per mile of single track, where the company owns its own oil car, exclusive of the royalty, is approximately $38.

The oil is generally furnished by the Standard Oil Company for this purpose and appears to be unrefined, from which the more volatile parts have been removed.

The ballast on which oil is generally used is either cinder, a mixture of sand and gravel or sand. The oil has no appreciable effect on the effort to keep good line and surface, except where the ballast is largely sand. The oil makes the sand incohesive, causing the line and surface to deteriorate very rapidly. The oil helps to shed rainwater, but has no apparent effect on the durability of ballast, except as stated above, in regard to sand ballast. The oil penetrates usually about one (1) in. on cinder. On sand it appears to soak down indefinitely.

If clean washed gravel can be obtained or if gravel is only dusty a short time after being disturbed, the use of oil is not recommended, as even after the oil is applied, the high-speed trains raise a fine oily dust which is worse than the clean dust, so that if a dustless roadbed is required, the recommendations are the use of a top dressing of coarse stone screenings, crushed slag, burnt clay, screened or washed gravel or screened cinders.

RAILROAD AND COMPANY EARNINGS.

Railroad earnings for week ended July 7th:—

	1911.	1910.	Increase or decrease.
C. P. R.	$2,096,000	$2,022,000	+ $74,000
G. T. R.	943,095	879,36	+ 63,733
C. N. R.	346,550	294,800	+ 51,750
T. & N. O.	29,175	24,457	+ 4,718
Halifax Electric	5,696	4,882	+ 813

Land sales of the Canada Northwest Land Company for June were 2,809 acres less than a year ago. Following is a comparison for the month and for the year to date:—

	Acres.	For.
June, 1911	5,156.51	$ 80,884.12
June, 1910	7,965.66	104,357.52
Decrease	2,809.15	$ 23,473.40
Jan. 1 to June 30, 1911......	21,065.92	283,565.18
Jan. 1 to June 30, 1910	35,065.92	420,450.29
Decrease	14,126.90	$136,885.11

Shawinigan earnings continue to show big gains. For May the gross was $84,450, against $60,140 last year.

The Temiskaming statement shows a surplus as of July 1st of $309,951.73, made up as follows:—Cash on hand, $247,902.38; owing from smelters, $42,659; ore on hand, $35,944.85; accounts receivable and stock on hand, $25,119.86; unearned insurance, $3,138.05; total, $354,764.14, less accounts and taxes payable, $44,812.41; surplus, $309,951.73.

Toronto Street Railway gross earnings by months, with the gains to date, are:—

		Increase.
January	$362,380	$31,033
February	335,108	27,334
March	372,946	29,404
April	367,535	37,594
May	406,885	46,631
June	401,186	36,391
	$2,246,040	$208,387

The monthly earnings of the Montreal Street Railway are as follows:—

		Increase.
January	$363,147	$40,102
February	326,628	26,598
March	368,079	35,298
April	367,410	31,468
May	419,459	58,978
June	419,347	46,088

KINDS OF WOOD BEST ADAPTED FOR CROSS TIES.*

F. J. Angier.

The demand for cross ties is steadily increasing; the supply is as steadily decreasing. With the supply of the standard white oak tie nearly exhausted, the question is—where and from what kinds of wood is the ever increasing demand to be met? In 1900 first-class white oak ties were bought about 50 cents each; to-day they are costing about 80 cents.

The railways of the United States require annually upwards of one hundred million ties for renewals. In a statement made recently by F. W. Goltra, tie agent of the New York Central Lines, he showed that cross ties represent 8 per cent. of the cost of all material and supplies used by the New York Central Lines for maintenance, and that the increase in cost of ties in 11 years has been 53 per cent.

No doubt the time will come when there will be a satisfactory substitute for the wooden tie. It may be made of iron or steel, or of concrete, or of a combination of these; or, it may be possible to make it from corn-stalks, or of some substance which can be grown in a single season by the farmers of the country. No substitute now known can be called a complete success. The railways are still using the wooden tie, and doubtless will continue to do so for a number of years to come.

The inferior oaks, which a few years ago were hardly considered at all for cross ties, are now made as good, or better than the old standard white oaks, by giving them a preservative treatment. The first cost of the inferior oaks, plus the cost of treatment, is even less than the present cost of white oak. What is true of the inferior oaks, is also true to a greater or less extent of many other kinds of wood, among which might be named the beech, hickory, elm, maple, pine, fir, birch, hemlock and tamarack. Our knowledge of wood preservation has advanced far enough for us to say absolutely that these woods can be chemically treated and made to last many years beyond their natural life. We can now treat a tie so that it will resist decay for 10, 15, 20 or more years, but it is certainly unwise to spend one cent more than is absolutely necessary to preserve the wood from decay beyond its mechanical life. If a tie will be destroyed by rail and spike wear in 10 years, we surely must not use a preservative treatment to prolong its life for 15 years. If better mechanical appliances could be employed, such as screw spikes, and possibly larger tie plates, and if more care could be taken as to the drainage of roadbed, the proper selection of different kinds of wood for use under heavy and light traffic, the mechanical life could be materially increased, and the timber treating department could meet this by preserving the tie so it will resist decay for the increased period.

Up to a year ago all treated ties, with the single exception of oaks, were shipped out as soft woods and were used indiscriminately in the track. This meant that pine, cottonwood, poplar, soft maple, etc., were used with the harder woods. Beech, hard maple and hickory have greater spike-holding power than white oak and it seems nothing less than inexcusable ignorance to place ties made of such wood in side tracks, and to put the soft woods in main line. Through our endeavours of the past year or two we have learned of many of the characteristics and properties of the woods we purchase for cross ties, and under date of March 15, 1909, the general managers issued a circular classifying our ties as "hardwoods" or "softwoods." All ties shipped from the treating plants are now loaded in separate cars and billed out as "hardwoods" or "softwoods," and in addition every tie has stamped on the end a large letter "H" or "S," which is to designate "hardwood" or "softwood." With this arrangement there should be no excuse for mixing them in the track.

* Abstract of a paper read before the Burlington Association of Operating Officers.

You may be interested to know how our classification was made. For the past two or three years many thousands of ties, comprising about 25 kinds of wood, have been treated in the experimental laboratory at the Galesburg plant. The specific gravity and the density of the woods were determined, as well as other properties. In addition to our own experiments it was desired to get the opinion of our experienced men as to rail resisting and spike wearing properties of different kinds of wood, and the following letter was written to every division superintendent, road-master, and to many other officials on the Burlington, as well as to managers of timber treating plants on other roads:

"The attached list shows the principal kinds of wood used for ties on the Burlington system. There is quite a difference of opinion as to which will be classified as hardwoods and which softwoods. From a commercial point of view all broad leaf trees are considered hard woods, and all needle bearers are considered soft woods. This would throw out such woods as pine, cedar, fir, hemlock, tamarack, etc., in the soft woods, and the oaks, bush, hickory, ash, elm, maple, etc., in the hard woods. However, this classification does not answer our purpose. We wish to classify these woods as to their rail and spike wearing qualities. In other words we wish to know what kinds of ties you would order to put on a curve where you wish to have the greatest spike holding power, and the least cutting by the rail. The beech tie is probably just as good or better than a red oak tie for this purpose, and there are perhaps other woods such as hickory, and perhaps hard maple, which you could not hesitate to put on a curve. In order to get the opinion of as large a number as possible who have had years of experience along this line, you are requested to make a cross in one or the other of the last two columns on the attached sheet giving your ideas as to what you would call a hard wood tie and a soft wood tie."

Fifty-two replies were received. These were carefully tabulated with the results given herewith in Table 1:—

Table 1.—Classification of Ties.

Kind of Wood.	Percentage Received at Galesburg Tie Plant.	Summary of replies to circular letter. Classification.	Hard.	Soft	Don't Know
White Oak	.26	Hard	52	..	..
Red Oak	44.52	Hard	49	3	..
Pin Oak		Hard	51	1	..
Beech	6.65	Hard	41	8	3
Hickory	1.05	Hard	51	..	1
Ash	86	Hard	39	10	3
Hard Maple	3.48	Hard	47	3	2
Soft Maple		Soft	7	43	2
Slippery Elm	5.54	Soft	18	32	2
White Elm		Soft	18	32	2
Birch	.85	Soft	20	26	6
Chestnut	Not treated	Soft	18	32	2
Tamarack	.24	Soft	2	47	3
Hemlock	2.25	Soft	..	49	3
Tupelo Gum	19.49	Soft	2	42	8
Red Gum			6	38	8
Red Fir	Used only at Sheridan Plant	Soft	3	46	3
Loblolly Pine	8.54	Soft	1	48	3
Lodgepole Pine	Used only at Sheridan Plant	Soft	..	49	3
Sycamore	.16	Soft	4	44	4
Cedar	Not treated	Soft	..	..	..

This shows that the majority of our superintendents, roadmasters and others, classify the oaks, beech, hickory, ash and hard maple as hard woods, and the balance as soft woods. It has been argued that some of those to whom the circular letter was sent were not familiar enough with the different kinds of wood to make a classification along the lines suggested. This may be true, and some replied that they did not known about certain kinds of wood, and in all such cases the replies were either omitted entirely or placed in the column, "don't know." Many of the answers received were from men of long experience in railroading, and who have had practical experience in the use of timber and ought to be in a position to know. From a more theoretical point of view, Table 2 will show the spike holding power of different kinds of wood. Some of these tests were made at the University of Illinois, and others in our own laboratory at Aurora:—

Table 2.—Holding Power of Spikes.

Kind of Wood.	Maximum Resistance in Lbs. Pull		Resistance in per cent. of that of White Oak		Where Test Was Made
	Untr'td	Tr'td	Untr'td	Tr'td	
White Oak	7,870	....	100	...	Univ. of Illinois
Water Oak	....	6,780	...	86	" "
Black Oak	....	7,230	...	92	" "
Red Oak	6,460	7,730	82	98	" "
Burr Oak	....	9,210	...	117	" "
Ash	....	7,730	...	98	" "
Chestnut	5,190	5,200	66	66	" "
Elm	7,290	7,500	93	96	" "
Beech	8,180	8,900	104	113	" "
Poplar	4,920	5,670	62	72	" "
Loblolly Pine	3,630	4,210	46	55	" "
Sweet Gum	5,040	5,300	64	67	" "
Hemlock	5,633	4,200	72	53	Aurora Labor'try
Soft Maple	6,513	5,887	83	75	" "
Hard Maple	10,177	8,960	129	114	" "
Hickory	10,153	10,433	129	133	" "
Cypress	3,163	2,840	40	36	" "
Birch	6,337	5,907	80	75	" "
Cottonwood	2,810	2,743	36	35	" "
Nor'n Hard Maple	10,393	....	132	..	" "
White Cedar	1,467	....	19	..	" "

These tests, very largely, bear out our classification. Two exceptions, however, have been made by our purchasing department, viz.: elm and chestnut are classified as hard woods. The classification in use now is as follows:———

Hardwood Ties.

For use without treatment: White oak, burr oak, chestnut, locust, black walnut, mulberry, sassafras.

To be treated: Red oak, black oak, pin oak, water oak, turkey oak, Spanish oak, blackjack, beech, hickory, ash, elm, hard maple, cherry.

Soft Wood Ties.

For use without treatment: Cedar and cypress.

To be treated: Shortleaf pine, loblolly pine, bull pine, lodgepole pine, douglas fir, tamarack, hemlock, gum, tupelo birch, sycamore, soft maple, hackberry, butternut.

MONTREAL DOMINION EXPRESS BUILDING.

The new office building of the Dominion Express Company at the corner of St. James and St. Francois Xavier Streets, is well on its way toward completion. The stone work, of light colored granite, of the first and second storeys is now in place and most of the floors, all of concrete, have also been laid.

NOTES ON PILE DRIVING COSTS.*

Victor Windett.

A sand trench 4,017 ft. long and 10 ft. deep was sheeted with 2 x 10 in. x 14 ft. hemlock and yellow pine sheeting, to carry a steam shovel over the trench. Triple lap sheeting was made by nailing 1 x 6 in. x 12 ft. hemlock sides to give a 2 in. groove. The cost of making the sheeting ready for driving was 8.8 hours of labor at $2.63 per 1,000 ft. B.M. with labor at $0.31 per hour. The work was nailing on the side pieces, pointing the driving end, and cutting the hammer end to 8 in. in width to permit the use of a steel driving cap. The total labor cost, including the making of the sheeting in place, with labor at $0.30 per hour, was:—

	Per. M. ft. B.M.	Per lin. ft. of trench.	Per sq. ft. of penetration trench side of sheeting.
Hours of labor	21.9	1.4	0.12
Cost of labor	$6.56	$0.422	$0.035

A pile driver having two sets of leads complete was built for the work at a cost of about $600 for labor and material, excluding the double-drum hoisting engine. The leads and sheaves for the hammer line were fastened on the deck timbers so that when the width of the trench was reduced at a change in the size of the sewer, the leads were moved in towards the center line of the machine. This change took 1½ hours to make.

The sheet piling was pulled by a machine consisting merely of a platform to carry a hoisting engine and an A-frame carrying two sheaves. Over these sheaves two lines ran from the engine, on the free end of which was a few feet of ½-in. chain and a hook with which to pull the sheeting.

This machine would be manned by a pick-up crew of enginemen, firemen, and four laborers, who would pull, in 1½ hours to 2 hours' work, all of the sheeting corresponding to a day's progress of the work, which would be from 130 to 160 ft. The average rate of wages per hour was $0.30. The average of work was:—

	Per M. ft. B.M.	Per lin. ft. of trench.
Hours of labor	3.72	0.24
Cost of labor	$1.11	$0.07

One disadvantage of such sheeting was that the 1-in. side pieces had a short life, requiring renewing after about four times of use. The loss of the center pieces from hard driving and even though used nine times was very little. The pulling chain was rather severe upon the sheeting, as it was liable to cut into the wood. At the close of the work the sides were stripped off and half of the 2 x 10-in. pieces were sawed up for catch-basin bottom, which otherwise would have required the purchase of new lumber. The total waste of sheeting was about one-fourth and the remainder was shipped to another job.

Hand driven sheeting of 2-ins. x 10-12 ft. long is best driven in sand by a combination of hand mauling and the use of the water jet. Employing labor at $0.314 per man per hour, the expense of this work for 1,102 ft. of trench was:—

* Abstracted from a paper presented before the Western Society of Engineers.

	Per M. ft. B.M.	Per lin. ft. of trench.	Per sq. ft. penetration.
Hours of labor	11.9	0.973	0.042
Cost of labor	$3.70	$0.305	$0.013

Foundation Pile Driving.—This statement is the record of a large piece of work carried on by the contractor with great vigor. At times as many as 9 pile drivers were at work simultaneously.

TABLE I.—FOUNDATION PILES. CHICAGO DROP FORGE & FDY. COMPANY. NASH DOWDLE COMPANY., CONTRACTOR.

	Hours.	Cost.	Cost per lin. ft.	Material
Erection and dismantling driver	386.5	$160.53	$0.088	
Unloading and sawing piles in two	39	15.96	0.016	
Driving piles	236	99.32	0.011	96 piles.
Sawing pile tops to grade	53	19.88	0.054	20 ft. long
Total	714.5	$295.69	$0.169	Crew 10 men
Freight, supplies and piles, cost		279.02	0.152	
Total cost		$574.71	$0.321	

Soil, hard clay; hammer used, 3,000-lb. drop hammer.

In foundation pile driving, where piles are driven in clusters, the general level of the ground will be higher after driving than it was before. This swell of rise of the level will cause an extra amount of excavation for the placing of the footing concrete around the pile tops.

Careful levels were taken over an area in which 1,570 piles were driven 2½ ft. centers. The piles were 35 ft. long, having 12-in. tops and 7-in. points. The swell of the ground amounted to 1.5 ft. in height, or 8.3 cu. ft. net measurement of the earth per pile, or 0.28 cu. ft. of pile penetration. Inasmuch as the volume of the piles below the original surface averaged 14.1 cu. ft., the consolidation of the earth amounted to 5.8 cu. ft. per pile. The soil consisted for about 10 ft. of a mixture of loose sand, gravel, and clay. Below this was a moderately soft blue clay.

At the job for the hammer shop, a drop hammer, weighing 3,000 lbs. was used. In fact, the same driver and crew foreman did the work as the drop-hammer driving, for which costs are given in Table II. But the soil was clay, whereas the first 10 to 12 ft. was sand, in the other case mentioned in Table II.

From points of view of speed, economy, and excellence of driving, the comparison between drop and steam hammers is strongly in favor of steam hammers.

In addition, a proportional share of local general office and yard expense and the general office expense, should be added.

In sawing off pile-butts two saw filers kept the saws sharp for the gang of sawyers. A pair of sawyers would cut 40 to 60 mixed wood piles per day at a cost per pile of $0.10 to $0.12.

Other men were employed in making runways and unloading piles from cars which were delivered at the edge of the work—a team and 2 men hauling piles to the more inaccessible drivers.

TABLE II.—FOUNDATION PILES; GREAT LAKES DREDGE & DOCK COMPANY, CONTRACTOR.

	No. 1 Vulcan Steam Hammer	3,000-lb. Drop Hammer
Total number of piles	10,417	519
Total length of piles	373,715 feet	17,855 feet
Total length of pile penetration	358,090 feet	16,817 feet
Average length per pile	36.0 feet	34.4 feet
Average length of piles undriven	1.5 feet	2.0 feet
Average day's work for one driver	277 days	30 days
Average piles driven per day	37.7 piles	17.3 piles
Average piles driven per day	1,349.2 lin. ft.	595.2 lin. ft.
Average piles penetration per day	1,296.2 lin. ft.	560.6 lin. ft.
Crew per driver	10 men	9 men
Auxiliary men per driver per day	8 men	6 men
Total crew per driver per day	18 men	15 men
Crew time 8 hr. day	2,770 days	270 days
Auxiliary time 8 hr. day	1,364 days	180 days
Total time 8 hr. day	4,786 days	450 days
Daily pay roll crew	$34.00	$30.60
Auxiliaries	19.75	15.25
Total	53.75	45.85

Unit Cost.	Lin. ft. of pile	Lin. ft. penetration	Lin. ft. of pile	Lin. ft. penetration
Labor	$0.04	$0.042	$0.007	$0.082
Saving pile butts	0.003	0.003	0.003	0.003
Total labor	0.043	0.045	0.08	0.085
Supplies and repairs, est.	0.01	0.01	0.015	0.015
Piles	0.125	0.125	0.12	0.12
Total "field expense"	$0.178	$0.180	$0.295	$0.220

The ordinary pile driver crew was composed of men as follows:—

Foreman, $0.58¾ per hour	$ 4.80
1 engine runner, $0.55 per hour	4.40
1 fireman, $0.37½ per hour	3.00
1 winchman, $0.45 per hour	3.60
1 leadsman, $0.45 per hour	3.60
3 groundmen or deckhands, $0.40 per hour	9.60
1 coal passer, $0.25 per hour	2.00
1 pile hooker and trimmer, $0.37½ per hour	3.00
Total labor of crew	$34.00
Auxiliaries, 6 men	15.00
Proportion of pumping station labor, supplying water for jetting	2.00
Field superintendence	2.75
Total labor	$53.75

Marine Pile Driving.—The marine pile driving, as given in Table III was all within a protected harbor shielded from the heavy waves of the open lake, so but little time was lost by rough seas. In the delivering of piles from cars to scows, a large part of the labor was done by steam devices, but it is considered as being equal to the expense of six men all of the time the marine driving was going on. The soil was sandy for a few feet and below that it consisted of a moderately soft clay. The piles stood out of the water on an average of 12 ft. per pile, undriven. A tug was occupied about one-third of a day per driver in towing out and back to the yard. A drop hammer of 3,500 lbs. weight was generally used, being attached continuously to the hoisting rope. Each driver had two scows for piles, one on the work and one at the yard being loaded with piles.

TABLE III.—MARINE PILE DRIVING BY GREAT LAKES DREDGE & DOCK COMPANY.

Number of piles driven	9,896
Length of piles driven	326,295 lin. ft.
Length of pile penetration	207,816 lin. ft.
Average of piles	33 lin. ft.
Average of piles driven	21 lin. ft.
Total days' work and driver	137
Piles per day work and driver	72.2
Piles per day work and driver	2,380 lin. ft.
Penetration per day work and driver	1,516 lin. ft.
Crew of driver	10 men
Auxiliaries driver	6 men
Total men per driver	16 men
Total crew time	1,370 days
Total auxiliaries time	822 days
Total	2,192 days
Pay roll per day:	
Tug service	$15.00
Crew	34.00
Auxiliaries	19.75
Total	$68.75

Costs	Lin. ft. of piling.	Lin. ft. of penetration.
Labor	$0.029	$0.0453
Supplies and repairs	*0.015	*0.0235
Piles	*0.125	*0.1962
Total "field" expense	$0.169	$0.265

* Estimate.

Foundation Pits.—Triple lap sheeting was driven for three foundation pits. The upper 15 ft. of ground is sand, below which is a soft clay. Through the sand, driving was assisted by using a water jet. The expense of this work is given in Table IV.

TABLE IV.—FOUNDATION SHEET PILE DRIVING.

Piling driven, pieces	405
Piling driven, lin. ft.	9,291
Piling driven, ft. B.M.	83,622
Moving out and off job, 5 days	$227.50
Driving, 19 days	679.00
Total, 24 days	$906.50

Unit Cost of Labor—
$ 2.24 per pile.
0.098 per lin. ft.
10.84 per M. ft. B.M.

Two No. 1 Vulcan steam hammer drivers were used. Hence the item of moving on and off the work was somewhat high. The average rate of pay per man per 8-hour day was $3.50; including men nailing the sheeting planks together, the average size of crew per machine was from ten to twelve men. Including supplies and repairs, the expense per machine per day was approximately $50.00, whereas the labor as above given amounted to $37.77 per day.

At the same place 717 pieces of 9-in. by 12 in. 28 ft. triple-lap sheeting were driven. This formed a subaqueous front of a concrete-topped wharf. Table No. V. gives the cost of this work.

TABLE V.—WHARF SHEET PILING.—TIME OCCUPIED IN THE WORK, 29½ DAYS.

Piling driven—
405 pieces.
14,340 ft. driven in ground.
180,784 ft. B.M. of lumber

Towing, ⅓ of cost of 30 days at $10	$ 300.00
Making sheeting, 75 days at $3	225.00
Driving, 285 days at $3.50	997.50
Pulling, 10 days at $3.50	35.00
Total, 370 days	$1,557.50
Labor cost per piece	2.17
Labor cost per lin. ft. driven	0.109
Labor cost per 1,000 ft. B.M.	8.62

TREE CUTTING UP-TO-DATE.

For some time it has been known that a wire drawn tight and heated by an electric current red hot would cut its way through a thick tree. Mr. Hugo Gautke, a German inventor, has improved this process by causing the wire to become incandescent simply by friction in working its way through a tree. A steel wire one twenty-fifth of an inch in diameter is used, and it is said that this can be made to traverse a tree twenty inches in diameter in six minutes. The wire is worked to and fro rapidly by an electric motor and becomes so hot by friction that it burns its way quickly through the trunk. The wire will cut through the tree without the use of wedges to keep the cut open, and the cut may be made several feet up the tree, on the ground level, or even below the ground.

THE INFLUENCE OF UNDERDRAINAGE ON SPRING FLOODS.*

Professor W. H. Day.

During recent years my attention has been drawn to the opinion held by some that underdrainage increases floods. After much thought and some investigation, I have come to hold the opposite view.

In the first place, facts, so far as I have been able to observe and otherwise learn, show that underdrainage lessens the amount of water at times of freshet. Let me illustrate: On a certain farm of which I could give the lot, concession and township, there was a swamp of 15 acres, the water from which flowed along a lane ditch, a part of the fall being quite rapid. The swamp was all cleared at one time, but the upper 5 acres had been allowed to grow up into a slash. The remaining 10 acres was cropped, but with indifferent results, as it was too wet, a few open ditches and water furrows providing the only drainage. Every spring freshet brought down large volumes of water, the evidence of which might be seen in the washing of the banks and the cutting of the rock in the rapid portion of the ditch, and also in the large deposits of mud lower down where the grade was not so steep. Some years ago the 10 acres was tile drained, and personally observing the ditch from time to time since then, I have wondered at the comparative freedom from washing, cutting and sediment. The 5 acres was afterwards cleared and tiled and the erosion and deposit of sediment still further reduced. Only a week or so ago the owner corroborated my own observations and stated very emphatically that in his case tile drainage, and that alone, had decreased the floods.

There is the fact, as revealed by observation and testimony, in one case at least. Let us examine whether it is what should be expected as a result of underdrainage. Speaking for Ontario generally, there is more precipitation in June, July and August than in any other months, as may be learned from the records kept at the observatory in Toronto, nevertheless the ground is drier in August and early September than at any other time. In late September, October and November, however, the ground becomes wetter and wetter, not because of increasing rainfall, for it is really less then than in the summer, but because evaporation is less, and any rain that does fall remains to moisten the ground instead of being returned to the air in vapor. The soil, however, is porous like a sponge, and in its dry state it is capable of absorbing a great deal of water before becoming really wet, and before any is lost either by run off or drainage. Often the rainfall for November is very large, for instance, in 1908, at Guelph, it was 5.07 ins. for one month, and in 1909, 6.41 ins., which is more than for April and May combined, except once in the 23 years' record at the college, yet the November rains do not cause floods, nor even the phenomenal rain of November, 1909. Why? Because the soil is far from saturation, and consequently is able to absorb most of the rain that comes. Moreover, the November rains are usually of the moderate, steady nature, giving plenty of time for absorption of the water by the soil. By the middle of December when in most parts of Ontario it is permanently frozen up for the winter, the ground is usually pretty thoroughly saturated, and from the highlands considerable drainage, either natural or artificial, has occurred, with the result that much undrained, low land, such as slashes, swamps and marshes, is under water. On December 4, 1909, I attempted to cross a swamp that I had crossed a month before without difficulty, but found the water so deep that I could not have done so had it not been frozen over. Practically all the undrained, slashes, swamps and marshes have their soil saturated, indeed, covered with water, by the middle of December, and in that condition they remain until spring, when in March or April the snow melts and several inches of water all over the country is liberated within a few days, sometimes, indeed, within a few hours. The soil on the upland being still frozen, or practically saturated with water, if the frost is out, the melted snow, unable to find entrance to the soil, takes the steepest slope for the low land, the slashes, swamps and marshes, where it finds a soil long since saturated and covered with water. These reservoirs, already nearly full, soon overflow and a flood results. These are conditions familiar to all who have given any thought or observation to the subject. What should we find if the slashes, swamps and marshes were tile drained? During the latter part of December last the drains in the one-time swamp previously mentioned were pouring a nice stream of water down the lane ditch, as they do every winter, and when the spring time comes around that 15 acres is thoroughly drained. Therefore when the snow-water from the high land reaches the swamp (?) instead of finding a saturated soil covered with water, it finds a soil comparatively dry and capable of absorbing great quantities of water. When this absorption has taken place, and when the soil has become covered with water to the same depth as it used to be during the winter before the drains were put in, there is not nearly so much surplus left to cause floods as if the snow-water had found the swamp already nearly full as it used to. Consequently, underdrainage should be expected to lessen floods, not increase them. That experience bears out the logic is strong evidence of its correctness.

To be sure, the drains begin working in the spring as soon as the water has saturated the soil, but underdrainage is slow compared with run-off, and the amount of water the drains deliver in a given time is small compared with the overflow that must occur in the same time if the water running into the swamps found them already full almost to overflowing.

* Abstract of report to Minister of Agriculture.

THE WORLD'S LARGEST CRANE.

According to Consul J. N. McCunn, of Glasgow, there has been erected at Govan, on the River Clyde, for the Fairfield shipyards, the largest crane in existence. The official trials of this mammoth appliance have been satisfactory and it stands in bold relief on the River Clyde, where a number of the most powerful cranes in the world had previously been erected.

The jibhead of the crane is of the hammer-head type, built on the cantilever principle, and stands 160 feet above high-water level, or to rail level 169 feet. The jib, with a total length of 270 feet, extends 169½ feet outward from the center and can be utilized within every point of a circle 336 feet in diameter. The motors for operating the gear vary from 60 to 90 horsepower, and are situated in the machinery house at the rear end of the crane, the test load of which is 250 tons.

The crane, on slow gear, can elevate 200 tons extended 75 feet along the jib, and on quick gear it can manipulate a load of 100 tons at 133 feet. The maximum load of 200 tons can be lifted from 30 feet below wharf level to 140 feet above, a total of 170 feet. The three controlling brakes are worked by magnetic, mechanical and hydraulic action. The stability of the structure of the crane depends on four huge steel cylinders, one under each corner of the tower. These great tubes, 15 feet in diameter at their base, are filled with concrete and sunk 74 feet below ground.

THE TRAINING OF ENGINEERS.

A number of interesting papers were recently read at a Convention on Education and Training of Engineers, held by The Institution of Civil Engineers. The following is abstracted from a few of the addresses given and presents sufficiently well the ideas of the speakers.

Discussing the requirements of practical training in works with the necessary complement of scientific study, Mr. W. H. Allen, M.Inst., C.E., pointed out the following:—

One is often asked, in the case of a student determining to go both to college and to works, which he should enter first. My views on this point are that a schoolboy coming direct to the works do not succeed so well or stand the same chance as the one who has been to college first. The latter has been better broken in, as it were. He has been formed in character by association with others of the same age in like pursuits, has learnt the value of time, and to recognize the serious side of life, and those qualities which tend to manliness, and has also received training in mental development. Much economy in time is also effected by preserving the continuity of study. I should therefore say that the man who sets himself the task of obtaining his degree before entering the works stands a much better chance of securing a higher and more responsible position in life than the one who is trained in the reverse order. The former not only takes a greater and more complete interest in the works and workshop life, but makes the most of his time, and grasps ideas and their principles much more readily than the man who comes to the works with merely a public-school training.

Another question frequently asked is, "How much study should a pupil undertake during the period of his practical training?" In my opinion, if a young man conscientiously does his duty from 6 o'clock in the morning until 6 in the evening, he will find that as much as his health can stand, without burdening it by further serious study at night. At the same time, unless some attention is paid to the work which has been done at college, this part of his studies is apt to lose its freshness and interest for him, his attention being concentrated purely on his daily task to the exclusion of everything else. My custom has been not to make this a compulsory part of the training, but to give lectures weekly explanatory of the actual work being carried on in the shops, thus greatly increasing interest in and adding to the knowledge of the work being done.

It must be remembered that the workshop to-day, involving as it does so many different classes of measurement, the use of instruments, and more elaborate styles of drawing—all necessitating a much higher educational standard throughout the works—requires a man of more thoughtful age and education to enter fully into his workshop apprenticeship than was formerly the case. A college training, moreover, must inculcate that habit of accuracy of thought which cannot be obtained in any other way.

As regards the requirements of workshop training, there seems little doubt that a period of 3 years—the actual time depending on the previous education of the subject—comprising a year in the drawing office, should be spent in the works in a not too specialized manner, that is to say, it should cover work in some or all of the branches of mechanical and electrical practice, which may be found in some of our better establishments. So long as this part of an engineer's training has to be carried out under commercial conditions, so long will it be more or less dependent on the state of trade and other local conditions. This is not altogether a disadvantage, for the alternating periods of exceptional activity in trade, and the reverse, will carry their own important lessons to the observant student.

It will always be difficult, if not impossible, to lay down a plan either for scientific study or works' apprenticeship which will suit all, and each individual case will require consideration on its merits; at any rate, whatever plan is arrived at will have to be very elastic as regards the arrangement of details. I think we are inclined at present to attach rather too much importance to the direct value of scientific study as being the means of providing the student with certain mental tools for use in after life, and too little to the indirect side to which I have already referred, i.e, the development of the mental faculties generally, and the cultivation of a true scientific insight.

Without a systematic training, sole reliance must be placed either on continued experiment or on a highly developed instinct of discernment, in order to diagnose what must then be invariably regarded as phenomena.

Mr. William Barton Worthington, M.Inst., C.E., brought out in his paper on "Practical Training in Workshops or on Works Construction with Special Reference to Training in the Engineer's Office" a point that so many lose sight of namely, the fact that much training in certain branches does not make one a true Engineer. In brief, he says:—

"Mr. Ellington—dealing with the mechanical branch of the profession—in his Presidential address to the Institution of Mechanical Engineers, illustrated most excellently the need for the combination of the works training with office training in the education of the engineer. He says:—

"The great difficulty is to distinguish between a mechanical engineer and a good artizan on the one hand and the commercial man on the other. A very large number of men are employed in various capacities as managers, draughtsmen, engineers-in-charge, foremen and others who really have no ground for being considered mechanical engineers, but who in considerable numbers seek admission into out Institution."

During his term of office training whether he be there as a pupil or as an assistant under agreement to serve for a term of years, the man who is to become a civil engineer should have the opportunity of becoming familiar with as great a variety of work as possible. He must gain experience in draughtsmanship and design, specifying, costs and estimating.

On the other hand, the mere fact of being a member of the staff in an engineer's office will not train a man to be an engineer. He must, while in the office, see and deal with as many aspects and varieties of the work as possible, and he must above all have his training in or upon works, otherwise he may become a draughtsman, surveyor, clerk or commercial man, but will not become a civil engineer; just as, on the other hand, he may spend his time of training on or in works, and may become a skilled mechanic or a resourceful contractor, but without varied office experience he will not become a civil engineer."

In a paper on "Workshop Training as a Preliminary to other Training and Engineering," J. A. Brodie, M.Inst., C.E., says:—

"Probably all experienced engineers are to-day agreed that a period of practical training both in shops or works and drawing-office is of undoubted advantage to the engineer, much increasing the value of his services as an assistant, and adding to the weight of his advice and opinion at a later stage in his career. Important points for consideration are: (1) The class of workshop he should enter; (2) the class of work most likely to be helpful in his future career; and (3) the length of time which can be given to works and drawing-office training.

As the result of experience I am firmly convinced that the best type of workshop is one in which the materials used and the classes of work done should be as varied as possible.

If repair and maintenance work is done so much the better.

It will generally be found that in a comparatively small works the youth's ability will be more fully utilized, the necessity for quickness and accuracy more quickly brought home to him, and he will also have the advantage of being more directly under the eye of the master.

As against this view, it is often considered that training with a well-known firm more than counterbalances the advantages obtainable in a small general workshop, and it must be admitted that training in a great works, especially if followed by a pupilage or subsequent experience in one of the best offices, is still looked upon as a good introduction to the profession, particularly for those desirous of taking up work of a public character.

For the youth who does not propose to remain in the workshop it is not, I think, so necessary that he should learn to equal the workman in his knowledge and ability to execute any one class of work as that he should acquire an intelligent knowledge of the processes and methods of treatment of the various metals and other engineering materials.

Perhaps of greater importance than anything else is the ability to form a correct opinion of the capability of the men in a workshop, a knowledge of their methods of thought and work, a study of the systems adopted to get work pushed through to completion, and generally such knowledge as will enable him to handle men advantageously when occasion requires."

SOME EXTRACTS FROM THE REPORT ON THE EPIDEMIC OF TYPHOID FEVER IN THE CITY OF OTTAWA, ONT., 1911.

The City of Ottawa, Ont., the seat of the Federal Government, was visited in the opening months of the present year with an epidemic of typhoid fever, which for devastation and destruction of human life has probably never been equalled in the history of Canada.

The immediate cause of the epidemic was the pollution of the drinking water supply from infectious matter, chiefly sewage, which was carried into the intake from the south shore of the river. Ottawa's water supply is equipped with an emergency valve, which was opened quite frequently. It was through this, and very probably through the joints of the intake, that the water was inoculated.

The Ottawa River at many points above the city receive sthe raw sewage from many smaller municipalities.

The object of the report and investigation was to determine the cause of the outbreak.

An epidemiologic study of several cases was made.

A sanitary survey of the premises where cases had been reported.

A sanitary survey of the north shore of the river.

A sanitary survey of the south shore of the river.

A study of the city's milk supply.

An enquiry into the sewerage system.

An enquiry into the waterworks system.

An examination of the plumbing in some of the infected houses.

A study of meteorological and other climatic conditions.

The cases by the month, as reported, might be arranged as:—

December 1910	10
January 1911	382
February 1911	454
March 1911	65
Total	911

After the investigation had commenced work it was brought to the attention of the commissioners that certain unsanitary conditions existed in respect to the disposal of typhoid excreta in some of the homes, which was regarded as a menace to public health.

In every instance the diagnosis as made by the attending physician was accepted.

The inspection of the premises of the individual milk vendors showed that the precautions taken to immune milk from contamination were somewhat open to criticism. In one case a dark underground, badly lighted, unventilated cellar, without either a wooden or a concrete floor, with an open drain was used for dairy purposes.

The normal water supply as derived from the river cannot be regarded as the immediate cause of the outbreak.

The City of Hull, P.Q., receives its water supply from the river at a point 3,000 ft. distant from the Ottawa intake. The City of Hull was practically free from typhoid fever while the epidemic was severe in Ottawa.

The unsanitary conditions which effected the water from which Ottawa was being supplied previous to the outbreak were:—

(1) The unusually low water in the river.

(2) The low temperature which allowed the water to freeze to the bottom, in many cases thereby blocking some of the channels.

(3) The occurrence of typhoid fever in some municipalities above the city in the autumn preceding the outbreak.

The opening of the emergency valve at Pier No. 1.

The pollution of the old aqueduct by sewage.

The possibility of contamination while the water was in passage through the intake pipe.

The neglect to carry out a suggestion to apply hypochlorite treatment.

The cause of the continuance of the epidemic was, in the main, due to a continued contaminated water supply.

After steps had been taken to apply the hypochlorite treatment, which was in full effect by the latter portion of February 1911, there was a marked decrease in the number of cases.

No doubt many secondary causes were operative after the epidemic had made a foothold on the community, such as personal contact, the washing of uncooked food stuffs, and household utensils in the infected water, also the defective plumbing and general unsanitary conditions which existed in many premises.

PROPORTIONS OF CONCRETE MATERIALS.

Engineers frequently have occasion, in ordering material for concrete, to estimate the quantities of various materials needed. The following table is sufficiently accurate for all ordinary purposes and gives the amount of the various materials needed per yard of concrete:—

Mixture	Cement Barrels.	Sand (Cu. Yds.)	Stone (Cu. Yds.)
1-2-3	1.83	0.51	0.77
1-2-4	1.57	0.44	0.88
1-2½-5	1.29	0.45	0.91
1-3-5	1.22	0.51	0.86
1-3-6	1.10	0.46	0.93

QUEBEC ASBESTOS FIELD.

Some new developments in the Quebec asbestos fields are recorded in the latest report of the Geological Survey branch. New concentrating mills have been completed and put into operation at the Bell, the Jacobs, and the Black Lake Consolidated Mines. The maximum capacity of these mills is from 800 tons to 1,000 tons of rock per day. The B. and A. Asbestos Company at Robertson, and the Berlin Asbestos Company near Leeds station, have built 4 cyclone mills which are also in operation on their respective properties; while the Belmina Consolidated Company, having acquired the property formerly owned by the Asbestos Mining and Manufacturing Company at Chrysotile, has re-equipped the mill and mine, and has renewed operations in both.

Asbestos at Numerous Points.

The Thetford Asbestos syndicate of Montreal has recently done some substantial development on lot 24, range A, Coleraine. A pit 60 feet by 50 feet has been carried to a depth of 45 feet. As far as could be judged from the walls, the rock carries a workable quantity of asbestos, an appreciable portion of which is crude. There is a boss of granite near the pit, and exposures in the vicinity show asbestos at numerous points, over an area of some 10 or 12 acres.

The present equipment consists of a cable derrick, a hoist, one steam drill, two pumps, and a 65 horse-power boiler; but an adequate mining and hoisting equipment is expected soon to be installed, and a concentrating mill built. The right-of-way has been obtained for a tram-line to connect the property with the Quebec Central Railway, less than 2 miles distant.

In Commercial Quantities.

The property is situated near the eastern side, and in the northern part of the serpentine area, which contains the principal mines of Black Lake. Asbestos is reported to have been discovered in commercial quantities on lots 2, 3, and 4, range B, Coleraine. There was no opportunity found during the season to verify the report.

One of the most important developments for the asbestos industry, however, is the establishment by the Asbestos Manufacturing Company of large works at Lachine, Quebec. This plant—the only one of the kind in Canada—is designed to manufacture all classes of asbestos goods. When completed the factory will have a capacity to consume about 1,000 tons of asbestos fibre per month. The plant was built by and is being operated under the management of Mr. G. R. Smith, long the manager of the Bell Asbestos mine. A more complete description of the plant and process will be given in a later report.

In the district examined this season few occurrences of asbestos have been found. On lot 22, range VI, Melbourne, about 100 feet south of the Melbourne slate quarry, a small pit was sunk some 35 years ago in the dump, of which there is a small amount of fairly good milling rock. The surrounding rock is drift covered, and the pit or shaft is partially filled with debris. It is locally reported that a small shipment of crude asbestos was made from these workings by the operators of the Melbourne slate quarry about 1876, and which was probably the first asbestos shipped from Canada.

Near Key pond some prospecting and development was done by Mr. R. H. Fletcher of Sherbrooke, and others, during the past season, but no very definite results were obtained.

Prospected Twenty Years Ago.

The principal development of the district has been made by Mr. John McCaw on lot 26, range IX, Brompton township, near Brompton lake. On this property, which was somewhat extensively prospected some twenty years ago, work was resumed in the spring of 1910. Asbestos is exposed in pits that have been opened in different parts of the property, over a distance of half a mile. In general, it may be said that the contents of the wider veins are usually hard and brittle, but that the smaller veins contain a quality of fibre that may be used. More complete development of the property probably awaits better facilities for transportation. A little slip fibre has been obtained in the first range of Stukely, south of Long pond. Except in the localities mentioned the rock of this district usually contains too much pyroxene to yield an asbestos-bearing serpentine.

FOREST PRODUCTS OF CANADA.

Value of Wood Pulp Exported—Dutiable Imports from Great Britain Increased—Forest Area of the Dominion.

The most definite and complete statistics in relation to forest products are those in regard to import and export furnished by the trade returns. These show that in 1868 the total unmanufactured wood products exported were valued at $18,742,625, while in 1908 they reached the sum of $44,170,470. Manufactured wood products in 1908 amounted to $4,997,795, making a total for 1908 of $49,168,265, says Mr. A. H. D. Ross, M.A., M.F., of the Faculty of Forestry, University of Toronto, in a comprehensive report recently issued.

Of the unmanufactured wood products $12,956,521 went to other parts of the British Empire, including $11,843,094 to Great Britain; $27,470,574 went to the United States; $401,280 went to the Continent of Europe; $2,968,246 to South America and the West Indian Islands; $112,415 to Mexico, and $163,500 to China and Japan. The United States is a customer for over 60 per cent. and Great Britain for over 25 per cent. The square timber trade declined from 651,736 tons valued at $4,188,862 in 1868, to 59,833 tons valued at $1,520,005 in 1908. The average price per cubic foot increased from 16 cents to 63 cents. Timber was prepared in this way for shipping to Great Britain and the chief advantages were the removal of sapwood and the greater convenience over round logs in lading vessels. It is a decided advantage to have this wasteful method replaced by the shipping of deals to the British market.

In 1890 the value of the pulpwood exported was $80,005. Much the greater proportion in each year has gone to the United States, and since 1903 the whole export has been to that country. In 1904 the export to the United States was 479,238 cords valued at $1,788,049, and in 1908, 901,861 cords valued at $4,655,371. From these figures it will be seen that in five years the quantity of pulpwood exported from Canada to the United States has almost doubled, and that its value has increased 160 per cent. The increase per cord was from $3.73 to $5.16. The last report, that of 1907, in regard to consumption of pulpwood in the United States shows a total of 3,661,176 cords, of which the Canadian product formed about one-fourth.

Value of Wood Pulp Exported.

The value of wood pulp exported in 1890 was $168,180, and in 1908 $4,037,852; the value of the export to the United States being $3,545,530, and to Great Britain $485,199. The quantity of mechanically ground pulp exported was 4,027,939 cwt., and of chemically prepared pulp 783,224 cwt.

The total export of wood products would be about three billion feet, board measure.

Notwithstanding the fact that Canada exports forest products largely, there is a considerable import, mainly from the United States. The total value of the imports increased from $2,412,572 in 1874 to $12,032,595 in 1908. For the ten years, 1897 to 1906 inclusive, the total imports amounted to $59,934,770, $57,520,731 coming from the United States, $919,398 from Great Britain, and the remaining $1,494,541 from other countries. For this period 94 per cent. of imports were from the United States, two per cent. from Great Britain, and four per cent. from other countries.

In recent years the western prairie provinces have imported considerable quantities of lumber and other construction material from some of the western states, particularly Minnesota. In 1905 the import of pine from Minnesota and Wisconsin was 125,000,000 feet, board measure, but this fell in 1907 to 62,642,941 feet. In the older provinces there is a considerable import of hardwoods, such as oak, ash, walnut, hickory, cherry, etc., which is largely due to the denudation of the hardwood districts in south-western Ontario and elsewhere. The import of oak for 1908 was 54,542,685 feet board measure, but this was exceeded by pitch pine (under which are included several species of pine from the southern states) with an import of 68,946,389 feet, board measure. The import includes also such manufactured articles as furniture, veneers, hubs, spokes, staves, dressed lumber, ties, lath, shingles, etc.

Dutiable Imports From Great Britain Increased.

Between 1874 and 1906 dutiable imports from Great Britain increased from $30,450 to $106,563, whilst free imports varied greatly. From the United States dutiable imports have increased from $911,211 in 1874 to $2,310,836, whilst free imports have risen from $1,398,870 in 1874 to $5,939,059 in 1906. For the ten years, 1897 to 1906, inclusive, the total imports amounted to $59,934,770, $57,520,731 coming from the United States, $919,398 from Great Britain, and the remaining $1,494,541 from other countries. Thus it appears that in recent years about 94 per cent. of imports are from the United States, 2 per cent. from Great Britain, and 4 per cent. from other countries.

The sources of information in regard to forest products available annually are the reports of the cut on Crown lands obtained through the returns furnished to the Dominion and Provincial Governments, but these are incomplete in the respect that they give little or no information of the cut on lands which are held privately, and which furnish a considerable proportion of the total product. The product of the year 1907, as shown by such returns, was in the neighborhood of three and one-half billions of feet, board measure. The pine of the eastern states, including white and red pine, still leads in the production with probably one-third of the total, spruce taking second place with about one-fifth. Other species are not so distinguished in the returns that the quantities can be determined. The hardwood production, as far as the returns show, was less than 2,000,000 feet, board measure.

It is only at the decennial census that information is obtained in regard to the whole forest product, including that from private lands. The census of 1901 showed a product valued at $51,000,000, and including a total of about nine billion feet, board measure. With the rapid development of the lumber and pulp industries, and the increasing interest in the whole question of the timber supply of Canada, it is desirable that information of a reliable nature in regard to the forest product should be available from year to year. The necessity for such information was recognized some time ago in the United States, and the Forest Service and the Census Bureau have, with the co-operation of the lumber associations and manufacturers, carried out a scheme for gathering annually the statistics of forest production, which is now so fully elaborated as to give reliable results. The report for 1907 shows a cut in the United States of 40,256,154,000 feet, board measure, of lumber, 3,663,602,000 of lath, 11,824,475,000 shingles.

Forest Area of Canada.

The information available in regard to the forest area of Canada is of the most general nature, and the various estimates which have been made are uncertain. Actual knowledge is confined to restricted areas and general conclusions are based on deductions therefrom, on judgments from climatic, geologic and other conditions, or on measurements made upon the map. In regard to the timber granted under timber license, and that included in forest reserves, there is fairly definite information, but in regard to the general forest areas knowledge is confined to the routes of travel followed by and reported on by the members of the staff of the Geological Survey. No attempt, except the survey undertaken by the province of Ontario in 1900, has been made either by the Dominion or Provincial Governments to have any systematic examination or estimate of the greater forest areas. In the interests of accurate knowledge of one of the greatest of Canada's natural resources, it is desirable that in all the provinces, and in Dominion territory, a forest survey should be undertaken and systematically carried out throughout the whole forested area.

In the census of 1891 the forest area of Canada was estimated at 799,000,000 acres. More recent estimates reduce the area to between 500,000,000 and 600,000,000 acres, but this will include areas of timber which are not at present merchantable, and for land covered with merchantable timber presently available estimates have been made as low as 200,000,000 acres, and even 100,000,000 acres. These are estimates based from deductions from a general knowledge of conditions or of special areas, and none of them are entitled to great reliability. The stand of timber is even less known, but between five and six hundred billion feet of timber suitable for sawing would be a conservative estimate. In addition there are large areas suitable for pulpwood. The whole forest area of Canada has suffered so severely from fire that the average stand must be computed at a low figure. The area included in forest reserves and parks in the Dominion is 128,060,800 acres, and the area held under timber license or lease is 75,800,000 acres, but these areas overlap to a considerable extent.

District Under Dominion Administration.

The district under Dominion administration includes the provinces of Manitoba, Saskatchewan and Alberta, and in the province of British Columbia a belt of forty miles in width along the main line of the Canadian Pacific Railway and a tract of three million acres at the headwaters of the Peace River. It also includes all the districts outside of provincial jurisdiction. The area under license and permit is 9,422 square miles, or 6,030,080 acres. The area included in forest parks and forest reserves is 16,296 square miles or 10,429,440 acres.

The lumber cut in 1907 was 141,050,292 feet, board measure of lumber, 14,273,300 lath and 60,000 shingles. The cut in the railway belt in British Columbia was 42,000,000 feet, board measure, and the remainder, consisting mainly of spruce, but including also jack pine, tamarack and fir, was cut in the prairie provinces. The official returns do not differentiate the species. No general survey of the timber districts has been made, but special surveys have been made of some of the forest reserves. The forest area has been computed at ninety-six million acres, and the stand of timber at one hundred and ninety-two billion feet, board measure.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

14104—June 15—Directing C.N.R. to repair diamond and crossing at Tache Ave., St. Boniface, Man., within 30 days, also that ambulance and street cars have right-of-way over switching movements, under penalty of $10.00 for each default.

14105—June 15—Dismissing complaint of MacPherson Fruit Co., of Winnipeg, Man., re alleged overcharge by Dominion Express Co., on shipment of strawberries from Burlington, Ont., to Winnipeg and Brandon, Manitoba.

14106—June 14—Rescinding Order 13119, of February 24th, 1911, re C.N.R. spur on blocks 17, 18, 61, 62, 63, 64, from Russell St., to Fifth Street, between Vanhorne and College Avenues, Brandon, Man.

14107—June 14—Directing Brandon, Sask., & H. H. Ry. (G.N.R.), to construct transfer track to connect with C.N.R. and C.P.R. Application, city of Brandon, Manitoba.

14108—June 26—Approving by-law of Quebec Railway, Light, Heat & Power Co., authorizing C. E. A. Carr, G. M. or J. A. Everell, Supt., to prepare and issue tariffs of tolls.

14109—June 27—Directing C.N.R. to fence its right-of-way and erect farm gates on its Calgary-Vegreville Branch upon which rails have been laid, before August 1st, 1911, under penalty of $100 per day. Complaint, United Farmers, of Alberta.

14110—June 28—Authorizing Quebec Railway, Light and Power Co. to construct its railway across Cote de Courville Road, in village of Montmorency, Province of Quebec.

14111—June 28—Approving location and plans for passenger station and restaurant at Cobourg, Ontario.

14112—June 28—Approving Vancouver, Fraser Valley & Southern Railway Co.'s Tariff (Std. Freight), C.R.C., No. 1.

14113—June 29—Directing that B.C. Electric Co., Ltd., be made party to application re protection by C.P.R. of street crossings in city of Vancouver, B.C.

14114—June 22—Directing C.P.R. to furnish certain information to Vancouver Board of Trade within thirty days from date, in connection with segregating annual return.

14115—June—General Order re Boiler Inspection, Testing, etc. Order being printed, not yet issued, will send soon as printed.

14116—June 30—Authorizing C.P.R. to cross five streets in town of Perth, Ontario.

14117—June 29—Authorizing G.T.P. Branch Lines Co. to cross with its Regina-boundary branch highway in municipality of Enniskillen, Sask.

14118—June 15—Authorizing G.T.P. Branch Lines Co. to open for carriage of freight traffic its Melville-Regina Branch from Melville to Balcarres, Saskatchewan.

14119—June 30—Authorizing G.T.P. to erect station at Pacific Junction Block 25, S.D. of Parish Lots 32-34, St. Charles, Man.

14120—June 30—Authorizing G.T.P. Branch Lines Co. to erect 14 stations.

14121—June 30—Authorizing G.T.P. Branch Lines Co. to divert road on its Prince Albert Branch, in Province of Saskatchewan.

14122—June 28—14123—June 30—Authorizing G.T.P. Railway Co. to cross and divert 12 highways in Province of Alberta, and divert one highway in Province of Manitoba.

14124—June 29—Authorizing G.T.P. Branch Lines Co. to construct bridge over Elbow River, at mileage 200.7.

14125—June 29—Approving location of G.T.P. Branch Lines Co. Regina-Moose Jaw Branch from east line of Sec. 25, Twp. 17, R. 24, to west line of Sec. 3, Twp. 17, R. 26, west 2nd Meridian, mileage 23.32 to 40.01, Sask.

14126—June 30—14127—June 28—Authorizing G.T.P. Branch Lines Co. to cross with its Moose Jaw Northwest Branch 23 highways in Saskatchewan, and cross and divert 4 highways in same province.

14128—June 29—Authorizing G.T.R. to cross with four additional tracks, McKinstry, Dickson, Hillyard, Niagara & Wentworth Streets, Hamilton, Ontario.

14129—June 29—Authorizing G.T.R. to construct spur into premises of Dominion Sewer Pipe Co., Ltd., at Waterdown Station, Ont.

14130—June 29—Authorizing G.T.R. to use and operate bridges 155, 157, 158, and 159, Eastern Division, and bridge at mileage 289.83.

14131—June 28—Directing C.N.R. within 30 days from date of Order under penalty of $25 per day to do certain cleaning of ditches and yard at Emo, Ontario.

14132—June 29—14133—June 30—14134—June 29—Authorizing C.N.R. Alberta Railway to construct its St. Albert Westerly Line across nine highways in Province of Alberta.

14135—June 29—Authorizing C.N.O.R. to cross four highways in Twp. of Montagu, County of Lanark, Ontario.

14136—June 29—Authorizing C.N.O.R. to cross public road in Twp. of Nepean and Gloucester, County of Carleton, Ontario.

14137—June 29—Authorizing C.N.O.R. and approving revised location at Otter Creek, near Lombardy, Ont., in Lots 1 and 2, Con. 1, Twp. of Bastard, and Lots 26 and 27, Con. 1, Twp. of South Elmsley, County of Leeds, mileage 50, from Ottawa.

14138-39—June 28—Authorizing C.N.O.R. to cross public road in Township of Camden, County of Addington, Ontario.

14140—June 29—Approving C.N.O.R. revised location of line and station grounds in city of Belleville.

14141—June 29—Authorizing C.N.R. to cross with its Crooked Lake Branch, 6 highways in Saskatchewan.

14142—June 28—Extending until October 31st, 1911, time for installation of interlocker by C.N.O.R. at Cobourg, Ontario, (G.T.R.).

14143—June 30—Authorizing C.P.R. to construct road diversion in Twp. of Manvers, Ont.

14144—June 29—Authorizing C.P.R. and approving detail plans of new station at Lacombe, Alta.

14145—Authorizing C.P.R. to construct an additional track across road allowance between Secs. 29 and 30, in Twp. 9, R. 22, west of the 4th Meridian.

14146—June 29—Authorizing C.P.R. to construct two wye tracks across Government Road at Yahk Station, B.C.

14147-48—June 29—Authorizing C.P.R. to reconstruct bridge 37.3 on its Mountain Subdivision, and to construct bridge over Kaministiquia River at Fort William, Ontario.

14149—June 28—14150—June 29—Authorizing Algoma Eastern Railway Co. to cross under tracks of Aerial Tramway at mileage 24.25, and to cross highway at Lot 3, Con. 3, Twp. of Drury, mileage 28.45.

14151—June 28—Approving location of Algoma Eastern Railway Co. from mileage 21 to mileage 46.75.

14152—June 29—Approving detail plan of proposed G.N.R. station at Otter, B.C.

14153—June 29—Authorizing Dominion Atlantic Railway to reconstruct bridge over Moose River, in County of Digby, N.S.

14154—June 29—Authorizing Province of B.C. to construct suitable level crossing on Lot 265, Group 1, Similkameen Division of Yale District, B.C.

14155—June 29—Directing C.P.R. to construct highway crossing over its railway in village of Barons, Alberta.

14156—June 28—Authorizing city of Toronto to reconstruct bridge over C.P.R. at Weston Road.

14157—June 28—Authorizing Quebec Railway, Light & Power Co. to open for carriage of traffic east bound track from its junction with main line near Beauport Station to a point at Montmorency Falls, a distance of 3.4 miles.

14158—June 29—Authorizing Quebec Railway, Light & Power Co. to construct one double-track span over culvert at Beauport, P.Q.

14159—June 15—Directing C.N.R. to raise its track on River Ave., Main St., and Belle Ave., in city of Winnipeg, by Sept., 1912; 20 per cent, Railway Grade Crossing Fund, 30 per cent. of remainder by C.N.R., 30 per cent. by city of Winnipeg, 30 per cent. city of St. Boniface, 10 per cent. by Winnipeg Street Railway Co.

14160—June 28—Authorizing C.N.R. to construct bridge over Napanee River, at village of Yarker, mileage 153.44 from Toronto.

14161-62—June 30—Authorizing C.N.R. to construct across highways on its Vegreville-Calgary Branch, Alberta.

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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—
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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
Arcola, Sask., schoolhouse	Aug. 1.	July 20.	92
Brandon, Man., pumping machinery	Aug. 7.	July 20.	64
Dresden, Ont., waterworks	July 26.	July 13.	68
Kirkfield, Man., sewer and waterworks	July 31.	July 20.	92
Orillia, Ont., transmission line	July 27.	July 20.	64
Ottawa, Ont., Hudson Bay Railway	Aug. 1.	June 8.	64
Ottawa, Ont., harbor works, Courtney Bay	Aug. 10.	June 22.	68
Ottawa, Ont., stations	Aug. 3.	July 13.	68
Ottawa, Ont., breakwater, Brooklyn, N.S.	July 26.	July 13.	62
Ottawa, Ont., post office, Kingston	July 31.	July 13.	62
Ottawa, Ont., freight sheds, Halifax	Aug. 1.	July 20.	64
Ottawa, Ont., pier and sheds	July 31.	July 20.	68
Ottawa, Ont., public building, Humboldt, Sask.	July 31.	July 20.	91
Ottawa, Ont., lockgates and valve gates	Aug. 4.	July 20.	91
Ottawa, Ont., wireless telegraph station, Tobermory, Ont.	July 29.	July 20.	91
Ottawa, Ont., asphalt pavements	Aug. 1.	July 20.	91
Ottawa, Ont., public building, Tilbury, Ont.	Aug. 8.	July 20.	91
Penticton, B.C., generators	Aug. 10.	July 6.	68
Regina, Sask., sidewalk	July 28.	July 13.	68
Regina, Sask., pavement	July 28.	July 13.	68
Regina, Sask., building for Leader Publishing Co.	July 26.	July 13.	54
Regina, Sask., drain	Aug. 1.	July 20.	92
St. Catharines, Ont., hall and gymnasium	July 31.	July 20.	91
Tavistock, Ont., pumping equipment	July 20.	July 6.	72
Toronto, Ont., bridge work	July 31.	July 13.	66
Toronto, Ont., macadam roadway	July 29.	July 20.	68
Toronto, Ont., main drainage	Aug. 4.	July 20.	68
Toronto, Ont., arch bridge	July 31.	July 20.	68
Westmount, Que., fire station	July 27.	July 13.	68
Victoria, B.C., work on Parliament buildings	Aug. 15.	July 13.	54

TENDERS.

Guelph, Ont.—Tenders will be received until August 5th, 1911, for the construction of a reinforced concrete arch bridge and viaduct over the C.P.R. and the River Speed, Guelph. L. Malcolm, Acting City Engineer, Guelph. (Adv. in the Can. Eng.)

London, Ont.—Tenders will be received until August 12th, 1911, for about 3,300 feet of 18-inch and 1,600 feet of 12-inch cast-iron pipe, with a number of valves and specials. H. J. Glaubitz, General Superintendent, Waterworks and Electrical Depts., London, Ont. (Adv. in the Can. Eng.)

Ottawa, Ont.—Tenders will be received until August 8th, 1911, for the erection of a public building at Dundas, Ont. Plans, specification and form of contract can be seen and forms of tender obtained on application at the office of Mr. Thos. A. Hastings, Clerk of Works, Postal Station F., Yonge St., Toronto; at the Post Office, Dundas, Ont.; and at the office of R. C. Desrochers, Secretary, Dept. of Public Works, Ottawa.

Ottawa, Ont.—The time for receiving tenders for pier and sheds has been further extended from Monday, July 31st, 1911, to Thursday, August 10th, 1911. L. K. Jones, Dept. of Railways and Canals, Ottawa, Ont. (Adv. in the Can. Eng.)

Ottawa, Ont.—Tenders will be received until August 8th, 1911, for the construction of steel highway bridge, with concrete floor, at Chapeau, Pontiac County, Que. Plans, specification and form of contract can be seen and forms of tender obtained at the offices of J. G. Sing, Esq., Dist. Engineer, Toronto, Ont.; J. L. Michaud, Esq., Dist. Engineer, Merchants Bank Bldg., Montreal, Que.; on application to the Postmaster at Pembroke, Ont., and at the office of R. C. Desrochers, Secretary, Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until August 7th, 1911, for the erection of a frame schoolhouse on the Reserve of the Chippewas of the Thames. Plans and specifications may be seen at the office of Mr. S. Sutherland, Indian Agent, Delaware, and at the post-offices at London and Strathroy. J. D. McLean, Assistant Deputy and Secretary, Dept. of Indian Affairs, Ottawa.

Ridgeway, Ont.—Tenders will be received until August 2nd, 1911, for the construction of approximately 2,700 feet of concrete drain or sewer in the township of Bertie, along "Erie Road," as shown on plan 27 and 33, and thence to Lake Erie. Engineers' plans and specifications re same can be seen at the office of M. S. Pound, Clerk of Bertie, Ridgeway, Ont.

Toronto, Ont.—Tenders will be received by the Board of Control until August 1st, 1911, for the construction of asphalt pavements, bitulithic and concrete pavements, grading, concrete curbs and concrete walks. Specifications may be seen and forms of tender obtained at the office of the City Engineer, Toronto. G. R. Geary, Mayor, Chairman, Board of Control, City Hall, Toronto.

Toronto, Ont.—Tenders will be received until July 31st, 1911, for the various trades required in the erection of a rectory for St. Anne's Church, on Dufferin Street, Toronto. Gordon & Helliwell, Architects, Confederation Life Bldg.

Toronto, Ont.—Tenders will be received until August 8th, 1911, for the construction and supply of twenty-inch special castings and twelve-inch and twenty-inch valves for the Waterworks Department. Plans and specifications may be seen and forms of tender obtained from the Waterworks Department at the office of the City Engineer, Toronto. G. R. Geary, Mayor, Chairman, Board of Control, City Hall, Toronto. (Adv. in the Can. Eng.)

Toronto, Ont.—Tenders will be received until August 22nd, 1911, for the stone and brick work, fireproofing, steel work, roofing and carpenter work, for the new government house in Chorley Park, Rosedale, Toronto. Plans and specifications may be seen at the offices of H. F. McNaughten, Secretary, Public Works Department.

Toronto, Ont.—Tenders will be received until August 4th, 1911, for the various trades required in the erection of a building on Gerrard Street, near Yonge Street, for the W.C.T.U. Burke, Horwood & White, 28 Toronto, St.

Welland, Ont.—Tenders will be received until July 29th, 1911, for the construction of a warehouse on the government wharf. Plans and specifications to be seen at the Town Engineer's Office. George R. Boyd, Clerk, Welland.

Dauphin, Man.—Tenders will be received until July 29th, 1911, for the erection and completion of a solid brick and stone hotel building in Dauphin, Man. Plans, etc., and all information can be obtained at the office of the architect, J. H. Bossons, Dauphin, Man.

Winnipeg, Man.—Tenders will be called for shortly for the erection of a large hotel at Edmonton.

Winnipeg, Man.—Tenders will be received until August 2nd, 1911, for the construction of a station at Souris. Plans, specifications and forms of proposals can be seen at the offices of the Superintendent at Brandon and Souris, and the Division Engineer at Winnipeg. Frank Lee, Division Engineer, C.P.R., Winnipeg.

Virden, Man.—Tenders will be received until August 18th, 1911, for the installation of a steam heating plant in the Virden Municipal Hall. Plans of building may be seen and other particulars obtained at the office of J. F. C. Menlove, Town Clerk, Virden.

Saskatoon, Sask.—Tenders will be received until August 5th, 1911, for the erection and completion of a brick school building. Plans and specifications and blank tender forms may be seen at the Waldon Heating Co.'s office, 92 Princess Street, Winnipeg, and at the office of W. W. Lachance, Architect, Saskatoon, Sask.

Moose Jaw, Sask.—Tenders will be received until August 14th, 1911, for the laying of approximately 16,885 lineal feet of sewer and water extensions, as well as for the supply of all cast-iron and vitrified tile pipe and specials, etc. J. M. Wilson, City Engineer. W. F. Heal, City Clerk, Moose Jaw, Sask. (Adv. in the Can. Eng.)

Wilkie, Sask.—Tenders will be received until August 21st, 1911, for the supply and delivery of electrical machinery: One 100 I.h.p. international combination engine, pumping machinery, one pneumatic storage tank, cast-iron water pipe, etc., and the erection of power-house and construction of reservoir. McArthur & Murphy, Engineers, Bottomly Block, Saskatoon, Sask. T. A. Dinsley, Secretary-Treasurer, Wilkie, Sask. (Adv. in the Can. Eng.)

Gleichen, Alta.—Tenders will be received until August 11th, 1911, for waterworks supplies. W. J. Burr, Secretary-Treasurer, Gleichen, Alta. (Adv. in the Can. Eng.)

Victoria, B.C.—Tenders are invited by the Department of Public Works for the erection of a schoolhouse at Long Lake, Kamloops District, to be received on or before noon, August 4th, 1911. Tenders are also being asked for the erection of a large one-room frame schoolhouse at Columbia Gardens, Ymir district, these tenders to be received not later than July 31st.

Victoria, B.C.—Tenders will be received until August 10th, 1911, for the erection and completion of a large one-room frame schoolhouse at Denman Island in the Comox Electoral District. Plans, specifications, contract and forms of tender may be seen at the offices of the government agent, Cumberland, B.C.; George Dalziel, Esq., Secretary of the School Board, Denman Island, and at the office of J. E. Griffith, Public Works Engineer, Dept. of Public Works, Victoria.

CONTRACTS AWARDED.

Halifax, N.S.—A dispatch from Sydney states it is reported there that Swan & Hunter have been awarded the contract for the construction of the Canadian navy, and that a shipbuilding plant is to be located at Halifax.

Fredericton, N.B.—The Building Committee have entered into a contract with Mr. Moses Mitchell, of this city, to undertake under the supervision of Architect J. deLancey Robinson, of New York, several general parts of the restoration work on the Cathedral building. The total cost for restoration will be about $75,000.

Sault Ste. Marie, Ont.—The contract for the last link of Algoma Central Railway has been let to Mr. J. D. McArthur, of Winnipeg. The contract includes grading and ballasting of 104 miles, and involves an expenditure of $3,000,000.

Welland, Ont.—Contracts for the erection of four additional buildings to the plant of the Page-Hersey tube works, have been let to David Dick & Sons. The total cost of these buildings will be about $40,000. They will consist of pumphouse, pattern shop, storehouse building and butt weld mill.

Ottawa, Ont.—Improving lower entrance to Lock No. 24, Rapide Plat Canal.—Contractors: Messrs. Roger Miller & Sons, Ingersoll and Toronto, Ont.

Ottawa, Ont.—Extension to the North Mooring Pier at Upper Entrance of the Sault Ste. Marie Canal.—Contractor: Mr. J. F. Boyd, Sault Ste. Marie, Ont.

Ottawa, Ont.—Protection work at head of the Soulanges Canal.—Contractors: Messrs. Haney, Quinlan & Robertson, Montreal, Que.

Toronto, Ont.—The agreement between the Board of Control and Messrs. Roger Miller & Sons, in connection with the new intake pipe, has not been definitely concluded.

Toronto, Ont.—Messrs. Wells & Gray, Ltd., Confederation Life Bldg., Toronto, have received the contract for the construction of a subway at Jane St., West Toronto, for the C.P.R., also the contract for the construction of a large reinforced concrete factory for the Ford Motor Company, at Walkerville, Ont.

Toronto, Ont.—The Board of Control have awarded Messrs. Roger, Miller and Company the contract for the second intake pipe at a cost of $259,900. The only other tender considered by the Board was that of Messrs. Cummings and Robertson, who offered to do the work for $225,000, this amount to include their proposed twenty per cent. commission. The general opinion of the controllers was that it was a question of time more than cost. Roger, Miller and Company promised to do the work in one year's time.

Niagara Falls, Ont.—Messrs. Murray & Spencer, of this city, have the contract for erecting the Oshawa sedimentation tanks and screening chamber.

Regina, Sask.—The City Commissioners have awarded the Parsons Construction Company the contract for the work on the Broad Street Subway, the entire cost being $120,000.

Fort William, Ont.—The contract for the erection of a new Y.M.C.A. building has been awarded to Mr. H. H. Braden, at a cost of $76,702.

Fort William, Ont.—The Elliott Construction Company, of Winnipeg, have received the contract for the reinforced concrete warehouse to be erected for the International Harvester Co.

Calgary, Alta.—The contract for the excavation for the new $1,000,000 Canadian Pacific hotel, west of the station at Ninth avenue and First street west, has been awarded the Ross Cartage Company, a local concern. Work will be commenced immediately. The contract includes the excavation for the west wing of the station.

Edmonton, Alta.—The Dominion Bridge Co. have secured the contract for the construction of a steel bridge over the Saskatchewan River at Edmonton. Price $58,300 for steel delivered.

Victoria, B.C.—The contract for the erection of the new suspension bridge at Churn Creek in the Lillooet district, has been awarded to Messrs. C. Gardiner, Johnson & Co., of Vancouver. The contract for the erection of the lock-up and government offices at Hope has been placed with Donald J. Macrae, a local contractor.

Victoria, B.C.—A contract has been let to the Canadian Wire Goods Manufacturing Company, Hamilton, Ont., for the installation of an automatically released steel front system of opening cell doors, to be operated from a central point in the jail. The automatic release fronts are to be installed in all the jails in the province.

Prince Rupert, B.C.—Work has begun on a new $20,000 vaudeville theatre, which is being built by the Westholm Lumber Company.

Merritt, B.C.—The contract for the Merritt general hospital has been awarded to Fowler & Lawson, of Merritt, for the sum of $19,247. That contract includes heating and plumbing installation. Work is to be started at once, and the hospital is to be ready for occupancy by the first day of January, 1912.

Vancouver, B.C.—The floating drydock to be installed here by the Canadian Government for British warships of the Pacific fleet, is now under construction at the great shipping yards of Swan, Hunter & Wigham Richardson, Newcastle-on-Tyne, to whom the contract for their construction has been awarded. The other order for the Dominion drydock to be for Montreal Harbor, has been secured by Messrs. Vickers' Son & Maxim of Barrow.

Vancouver, B.C.—The contract for the erection of the new school, at an estimate of $47,220, has been awarded to Messrs. Smith Brothers, of North Vancouver.