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Old Series, No. 137. New Series, No. 55. | TORONTO, CANADA, SEPTEMBER, 1902. | 10c. A Copy $1 A Year.

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TORONTO, CANADA, SEPTEMBER, 1902.

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The Midland Railway Bridge Over the Shubenacadie River, N.S.

By G. E. Thomas, M.W.S.E.

In this paper it is intended to point out some of the difficulties encountered and overcome in locating and sinking the caissons. This river may be called an arm of the Bay of Fundy, the tide coming in through Minas basin and up through Cobequid bay, rushes through the narrow passage with a velocity of 10 ft. per second on the neap-tide to 15 ft. per second on the spring-tide. There are two tides in 24 hours, and the peculiarity at this point being, that we have all the flow in 2 hours and 30 minutes, it taking 9 hours and 20 minutes to run out; also, that on the incoming spring-tides we had a rise of 17 ft. of water in 20 minutes.

This is known as the Bay of Fundy bore. I have heard it said of its coming on a level plane of 8 ft. I never saw it over 2 ft., and I think the mistake is made by the undulation caused by the tide striking the sand bars and making quite a wave, but I do not underrate the power of the tide in the Bay of Fundy.

The substructural work on this bridge consisted of 2 abutments, 4 pedestals and 6 river piers, and are located as follows: Starting from the west side of the river with a concrete abutment, 30 ft. from the center of this was one pair of concrete pedestals; the next pair was placed at an equal distance from those; then pier 1 was located just 30 ft. east of those. Pier 2, or the draw pier, was located 42 ft. from center of pier 1, and the other piers were 219.50 ft. from center to center, and the east abutment was the same distance from pier 6.

We started work on the west abutment and found a soft shale rock cropping out; we excavated through this about 12 ft. to a hard rock bottom; on this was placed the concrete, bringing this up to surface of ground, and then placing the mould and building up the work to the proper elevation. The same course was followed with the pedestals.

Pier 1 begins at low water and was built up in the open. We had considerable difficulty in preparing the rock under this pier, as it was very uneven, and we had only one and a half hours in which to work on each tide. We succeeded in making a true and practically level bottom on the hard rock, into which we drilled and put in a number of anchor rods, to which was fastened the first course of crib timbers to the rock, consisting of 12 x 12 in. white hemlock timber. It was slow work, as it had to be very carefully done in order to secure success. After this course was securely fastened, it was much less difficult to care for the courses above, each being drift-bolted to the one below. Hemlock timber was used only up to ordinary low water, and above this point we used what is known in that country as bay shore spruce.

When this crib was built up 3 ft. and calked, we put in the first 2 ft. of concrete. The reason for starting so early on this filling was that we could not put in on the low tide more than this quantity. The time was so short during low water, before there was a return of a very rapid tide water, bringing with it a heavy body of sand and mud, and before this came we had to protect the new made concrete by very carefully covering it with canvas, placing on this large stones and filling in between those with small ones to break the force of the incoming water. We learned several lessons before completing our work. This pier 1 was formed differently from the others, it being rectangular. The purpose of this was to enable a protection to be built against it to keep off the ice, etc., during the winter. This crib was not completed last season, winter coming on before it could be done.

THOMAS McHATTIE,
Master Mechanic, Eastern Division, G.T.R.

The first pneumatic pier to be put in was no. 6, and was the one on the Colchester county or east side; the plans of piers and the profile showing the bed rock, etc., were furnished by the M.R. Co.'s engineer. This profile proved faulty, as the rock did not materialize at the points indicated. Low water was shown at a given elevation, and immediately under the bottom of pier 6 the rock was shown to be too close to enable us to put on a timber roof and have this submerged, as we required at least 6 ft. for a working chamber in a pneumatic caisson.

With the consent of the Chief Engineer I decided to build up the walls of the caisson 10 ft. high, putting on a roof of two courses of 12 x 12-in. timber, lined with 3-in. spruce plank, and calking the seams, fitting up air and supply shafts, and building up a temporary crib around the sides and ends, and loading this with rock to overcome the uplift of the tide. After reaching the bed rock we removed this temporary roofing, etc., and carried up the concrete continuous to the bridge seat. This involved a large amount of extra work, but we did not consider it safe to put in a timber roof that would be exposed to the climatic changes and subject to rapid decay. However, I found upon reaching the point indicated as rock on the profile, that we had still nearly 3 ft. deeper to excavate in order to reach bed rock. This greater depth, if known in advance, would have enabled me to put in a permanent roof on which we would have built up the permanent concrete, thus not only saving labor, but very valuable time. Immediately overlaying the bed rock under this pier we found a hard conglomerate, embedded in which were large boulders, making it a hard material to excavate.

Our next pier was no. 5. This was located 219.50 ft. from the centre of no. 6, and about 500 ft. from shore. The caisson for this pier was built to pass through the class of material indicated on the profile, that is a soft material permitting rapid sinking; but in this we were disappointed, as from start to finish we encountered an entirely different formation to that represented. Not only was the material which we passed through different to that represented, but we had to go about 14 ft. further to find bed rock. This, of course meant a great expenditure of time and money, especially in such a river as the Shubenacadie.

We met with a strange accident in the early stage of sinking this caisson. The tide was due in half an hour and the men were getting ready to come out, as I never allowed them inside the caisson when the tide struck the

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The Midland Railway Bridge Over the Shubenacadie River, N.S.

(*Continued from page 293.*)

site. This caisson was out on a sand-bar, and the tide was so low there was absolutely no current at this point at the time; and as there was only 4 ft. of water in the working chamber, there was a very light air pressure. Due, I think, to some carelessness, the two doors of the air lock were allowed to be opened at the same time, and in this way there was a rush of water into the body of the caisson which so frightened some of the men, they made a stampede for the shaft, each trying to get there first. I was informed by some of the older pressure-men, who were not frightened and stood their ground, coming out after all the trouble was over, that if the men had kept cool all would have been well. However, we are not all built on the same lines, and we would all be better men were our first thoughts equal to our second. We lost four men, who were taken out dead. In three minutes from the time the air was lost from the chamber everything was again in working order and the water was out of the working chamber. In fact, it was not realized that four men were injured until they were found in the bottom of the caisson chamber. The accident was thoroughly investigated by the coroner, a competent jury and the friends of the deceased, and all exonerated the contractors. I would say there was not any change made in any of the machinery or appliances after the accident, the men showing implicit confidence in the system by returning to work as soon as the bodies had been shipped to New York, except one who was buried in a little churchyard near the bridge site, and who, I was informed, had been a soldier in Her Majesty's service at Halifax. His fellow-workmen erected a very handsome stone over his grave giving an account of the accident.

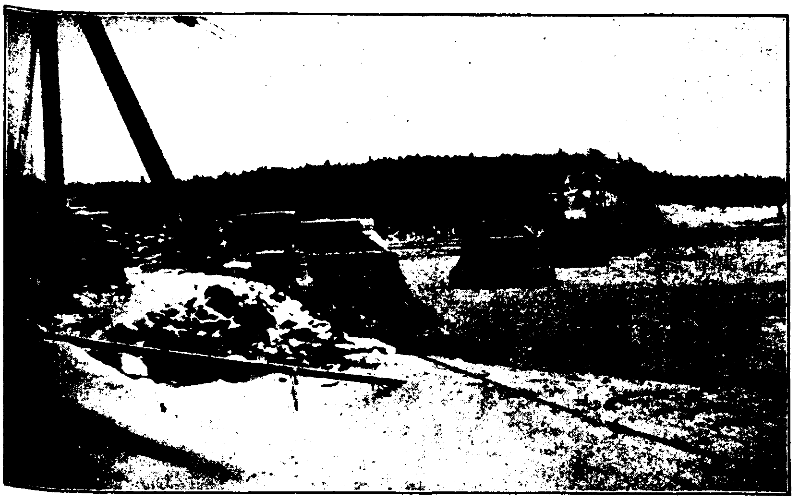


FIGURE 1.—SHUBENACADIE RIVER BRIDGE.

We experienced much difficulty in getting this caisson to the bed rock, having to take it about 14 ft. deeper than indicated, through a very hard tenacious material, which necessitated the use of a large quantity of dynamite. We could not make much impression on it with ordinary picks, and had to resort to drills, steel bars and explosives. However, we finally reached bed rock, and made a first-class concrete pier.

We next went over to pier 2, which is the draw pier and is located about 42 ft. from the centre of pier 1. It will readily be seen that the opening for vessels to pass is small. On pier 2 rests the small jack-knife draw. We experienced great difficulty in getting the rock under this pier level enough to receive our caisson, as at low water there was only 2½ft. of water at one end and nearly 12½ ft. at the other. This necessitated doing some under-water drilling and blasting before bringing the caisson down. The point of location of this pier was the most difficult to do this work in, as it had to be done at extreme low water, and the lower the water the greater was the concentration of the tide. The incoming tide, in time and force, depended somewhat on the direction and force of the wind in the lower bay that would cause it to vary as much as thirty minutes between some tides. One day it came up so much before it was expected, it washed away our steam drills and tools, swamping the heavy working float that was held by heavy steel wire cables. This float came up after the tide slacked up, but the tools were never seen afterwards. There is no use trying to handle these tides during the strong run. After a hard fight and persistent effort we finally got this rock so levelled up by the use of stone and clay thrown in on the slack tide from our cable bucket, that it was possible to put this caisson in position and get enough weight on top to hold it down. This enabled us to get inside of it and level the rock, taking the caisson down through the temporary filling and making a first-class job. We filled the working chamber and completed this pier up to the coping, none of which was set, however, until the concrete was well settled.

The next pier was no. 3, and with this one we had the least trouble. This is not saying it was easy work, but we had been well drilled into the work with the others by this time, that this one seemed comparatively easy. After the experience I had with the material and location of bed rock in no. 5, I concluded I would alter the form of the cutting edge and strengthen the caissons for piers 3 and 4. This was done by putting on the outside a course of vertical timbers, 12 x 12 ins., letting them extend down about 12 ins. below the other side timbers, and bolting them through into the working chamber; putting in extra through rods, etc., etc. We got no. 3 to bed rock and filled with no more than the to be anticipated amount of trouble. This, however, was the calm before the storm. We started in on no. 4, the last of the caissons, and which was known as the "Z. I. Fowler," named after the Chief Engineer of the Midland Ry. This caisson was launched and taken down to the bridge site in good time and without accident, getting it out into position, and leaving it about 12 ft. above the direct centre line of the bridge. We did this to enable us to put on the first lot of concrete as the flotation of the timber in the caisson was so great, and the time between the tides so short, we could not get weight enough on it in one tide to hold it down. We used two day-light tides to do this work. We put in all the concrete we wanted on the first tide, the caisson riding safely over the night tide. The next morning we located it exactly in position and were anxiously watching it settle. At this time the water was passing freely over the sand-bar directly above us; this seemed to stop instantly and the bar was exposed; this caused the water to strike the west bank of the river, concentrating the full force of the falling tide against the upstream west side of the caisson, which parted the three steel cables and forced the caisson out of position, and in five minutes it was hard aground 8 ft. out of position toward the east. All the moving cables were rigid except the broken ones. These we had to renew and the others to slack up before the tide came again to allow the caisson to rise with the incoming tide. This it did successfully; but before we could get down to renew the broken side cables, the sand-bar had been removed, due to the presence of the caisson above it, causing a very great concentration of tide under the working chamber. This caused the structure to roll over, bottom side up, and I thought, perhaps, the concrete which had been put in would roll out, but in this I was disappointed. You will notice there are times when it does not pay to use an extra quality of concrete. I knew the caisson could be rolled back, but the same conditions would exist, and the momentum of rolling would have to be cared for. I concluded to try, as we might succeed. We put on the purchase and rolled it back, but it kept rolling. At once I decided to remove the caisson to the shore, if possible. All the cables except the inshore upstream one were cast loose and allowed to drag on the bottom, and thus steady the caisson as it flanged to the bank. It did all I anticipated it would, until the mooring gear, which was now on the under side, caught in one of the large anchors, which brought too much strain on the cable and parted it. The caisson then floated up the river on the strong flood tide, and we followed it in our yawl boats and with strong manila lines. We rowed much faster than the caisson drifted, and securing a 1,000-ft. line to a tree on shore, we rowed out to meet the caisson, and in this way navigating it into slack water, then landing it until the returning tide, when, with the assistance of our tug boat, we took it on the early ebb tide to our building yard, there taking out the concrete, using dynamite. We then wrapped four 1⅝ inch steel hawsers around the caissons, two each way, and led these on shore. Putting a heavy purchase on to each, and taking the hauling parts to separate engines, we rolled the caisson back into position. Notwithstanding that this caisson had endured such hard usage, it was but very slightly damaged. We at once made the necessary repairs and prepared to get it into position, which we did with perfect success. We experienced a new difficulty in filling this crib on this caisson. Every pier put in, reducing the opening for water passage in the river, seemed to act like so many wedges, and made the current more violent in the openings. During the spring tides it seemed next to impossible to keep the new concrete from being washed away. This happened several times, and we would lose the result of a day's hard work. We finally abandoned the use of canvas and used woolen blankets. Those seemed to conform more to the concrete, and in this way we manged to get above the tide. We

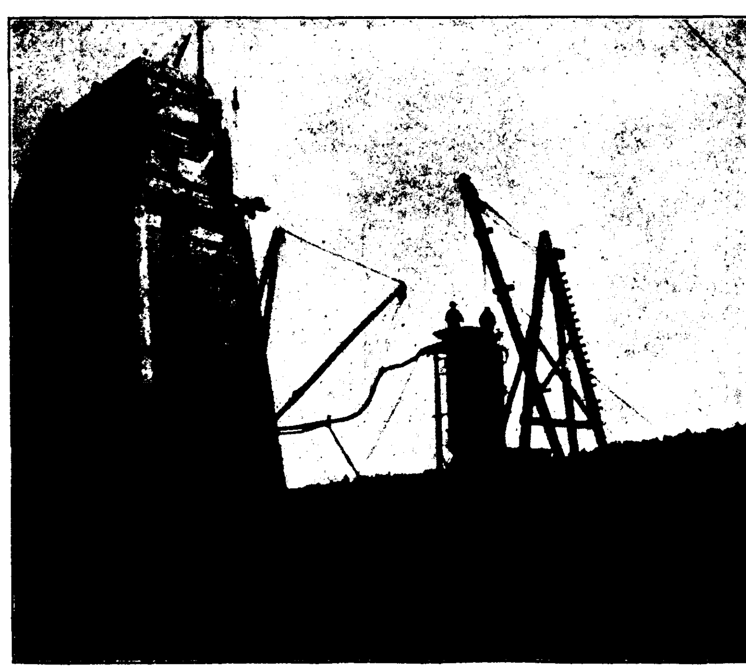


FIGURE 2.—PIER 1, SHUBENACADIE RIVER BRIDGE.

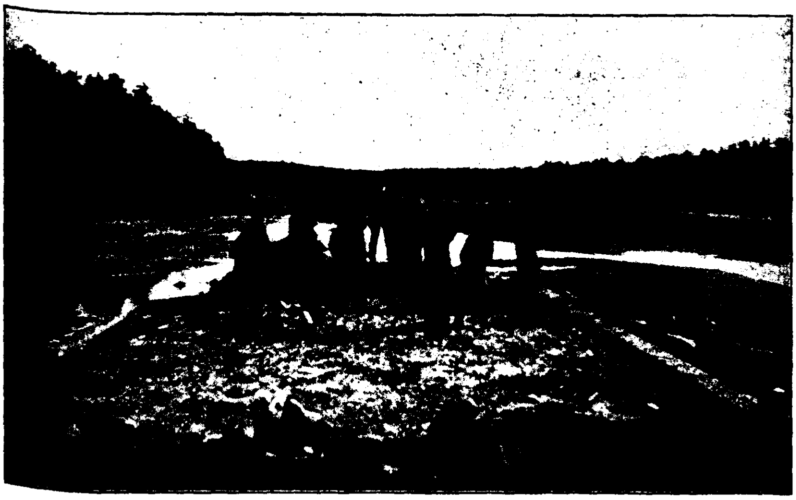


FIGURE 3.—PIER 6, TEMPORARY ROOF REMOVED.

found it was better to keep the concrete close up to our cribbing, thus preventing the scouring action of the water falling over the top of the crib. By watching the changes of the current in the river, I was enabled to so place my direct cables as to hold this caisson that had once got away from me. It certainly was a very trying and anxious time. The men who stood by me through the placing and sinking of those caissons did their full duty, and I assure you it was a very nerve-trying position. The plan adopted by me to locate those caissons was, first, to take the caisson down from the building yard to the mouth of the five-mile river, which was about 300 yards above the centre line of the bridge. In order to do this, we had to start at certain periods on the tide, there being so many changes of the current in this river. The distance from the building yard to the bridge site was only a mile, but there were so many swirls and eddies we had to keep lines on shore the whole distance and check up on the cable at the lower end. Another strange feature of those tides is, that the body of water would be falling and still a very strong current on the surface running up; and at a certain time of each tide, without any notice, the whole river would be running out with apparently irresistible force, and if not prepared for this you would move down stream with it. We were taught more than one lesson this way. There is absolutely not over 30 minutes on the top of high water when you can handle any floating stock at the site of the Shubenacadie bridge. I saw this upon my first visit to the bridge site, and concluded to use a cableway across the river, the distance being about 1,400 ft. I put up two towers. The one on the west side was built on the marsh bank, and was about 85 ft. above low water, while the one on the east side was built on the bluff, and was about the same height above the water, though the tower being on higher ground was shorter in the posts. Those towers were very strongly built. I also took the precaution of putting some wire guys to the heads of the towers. We did this to guard against the wind strain which came up with the flood tide, sometimes with considerable force. We used a 2½-in. diameter cable with the ordinary working steel wire ropes. The main cable was anchored back in the ground, the end on the west side being held in marsh mud. With this we had to be very careful, and to overcome any possible chance of its giving way, we used as an anchor four very large hemlock logs buried in a deep trench, the front of the trench being planked up with 3-in. plank. The main sheave for passing the main cable through was securely lashed to those four logs with ⅞-in. flexible steel wire rope, each part being brought to a proper bearing, and giving each part its share of the load. We loaded the surface of the ground with field stone. This cable never moved or gave me any trouble, and we have handled between tides as high as 116 buckets of concrete, each bucket containing 32 cubic feet.

The machinery never gave me any trouble further than the ordinary wear and tear of machinery driven under such hard work as this was. I cannot speak too highly of the cable system. I would not say this work could not have been done in any other way, but I would not like to try any other way known to me. We had quite a time getting the main cable over, as the ever-present tide came on us when we were about two-thirds way across; but we completed our task without accident. We also experienced great difficulty in getting our supplies for the work. The stone for concrete was quite a problem. We used large quantities of small boulders which had been washed down the river, and we also found a vein of about 5 ft. of quartzite on the river bank, which we quarried when the tide would allow. You see the tide enters into all our arrangements.

The cement selected by the Dominion Government engineer was manufactured in England and shipped to Halifax by steamer, and from Halifax to Stewiacke siding by rail, unloaded again and taken down to the bridge site in small scows, the distance being about 12 miles.

The sand-bars are so numerous and change so often one cannot take up a boat with more than 2 ft. draft, and this has to be handled with sweep oars and only make from three to four trips per week, up on one tide and down on the next, if you are not nipped or caught. You see the tide is omnipresent. The sand for our concrete was another problem for the same reason. We had to go 50 miles to Five Island Point to get a good and acceptable sand; and this we had to get in schooners, as it is sometimes very rough on the bay. The gravel which entered into the concrete largely had to be boated on the tide from De Bert beach, about 16 miles down the bay, and only small barges could go after this on account of sand-bars. We had a small tug we sent several times, but we generally had complaints from the captain about the risk. Our coal was quite an item, as this had to be brought either from Passboro or over the Intercolonial Ry. to Stewiacke, and then barged down to the bridge site. It was a common occurrence to see the barge with coal or cement pass the site, going down stream, the tide being so strong it could not make a landing. Even the water for the boilers had to be boated to the site, about 2 miles, in barges, and only one trip could be made with each barge on a tide. We had to stop sinking the caissons on more than one occasion on account of lack of fresh water for the boilers.

We moored the caissons with not less than six steel wire cables on each, those being not shorter than from 600 to 1,000 ft. each, and fastened to either large anchor cribs filled with rock on a sand-bar, or to anchor bolts put into the rock in the river bed. The cables were fastened with clips to those and attached to the caisson by a specially devised mooring gear. After the caisson had been properly weighted with concrete we would put our machinery barge alongside, mooring it in a similar manner. We would take our water barge alongside the machinery barge and pump the water out as rapidly as possible. We lost all of the barge load of fresh water on several occasions by the tide breaking in over the water scow. We tried on one occasion to bring coal off on a barge and use it from this barge, but the incoming tide settled this point by standing the barge on end, dumping the coal, then fouling the moorings and breaking the barge into two parts. After this I ran all the coal out by the cable way, which added much more work to our already hard worked cable.

Machinery, derricks and barges were built by us as strong as wood and iron could make them, knowing as I did the rough usage they would have to encounter. In the barges I used hardwood frames and spruce sides, strongly trussing them throughout; they were 80 ft. long and 22 ft. wide, and 7½ ft. deep, with a good flare at each end. The mooring timbers were very strong, of 14 by 14 in. hardwood, and with a very heavy warping chock on each end. All of which

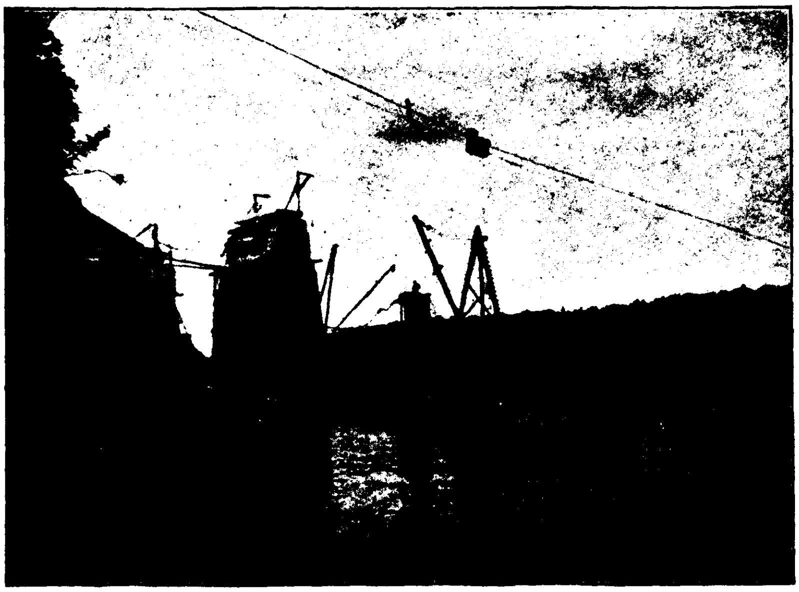


FIGURE 4.—PIER 1 AND WORKING ON PIER 2 FOR DRAW SPAN.

FIGURE 5.—CAISSON FOR PIER 4 BEING ROLLED OVER.

was necessary, as we not only had the racking of the machinery, but the sandbars were so changeable that, generally, at low water, the barges would be on the bottom and very unevenly landed. Our machinery consisted of an ordinary pneumatic plant, viz.: compressors, pumps, boilers, electric lighting machinery, etc. We also had in the hold of the machinery barge a large number of barrels connected with pipe, which we used for water storage, the plant being very compact. Our derrick barge was a duplicate of the machinery barge; it was surmounted with a very strong derrick and carried an 8¼ by 10 in. double winding engine. The coping stones for those piers were quite heavy, four on each pier weighing over 8 tons each. Setting those stones with a long boom was no child's play, with the strong running water that was there. We also had several derricks along the wharf on shore, also at the shipyard where we built the caissons and one up the river at Stewiacke. This work called for more machinery than ordinary work does, due to the time of still water being so limited for loading or unloading supplies.

Our caissons were built of 12 by 12 in. white hemlock and were 62 ft. long, 26 ft. wide, and had 8 ft. of working chamber. The sides were 3 ft. thick, all drift and through bolted, lined on the inside with 3-in. spruce and calked, also braced across and through with 1½-in. rods put in from side to side. A hemlock roof 3 ft. thick was planked over and the seams calked. From this point we started our crib work, this also being calked on the outside. They were built sharp on each end, and each of the ends was faced with hardwood 6 in. thick, which was fastened on with ⅝-in. steel drift bolts; then the nose and shoulders were faced with ⅜-in. steel plates, fastened on with ¾-in. iron rag bolts. The cribbing was 12 by 12 in. bay shore spruce. We did not use any timber ties, but in place used 1¼-in. through rods with turn-buckles. There were four of these put in every third course of timber.

Our concrete was of two classes, viz., hearting and facing; this was mixed on a platform on the west side of the river under the cable way and transferred out to the various piers. In all cases Portland cement was used. We also built into the concrete hook rods made of ¾-in. round iron, which overlapped each other, thus making a continuous bond. These were put in vertically and horizontally. This work was designed by the Chief Engineer of the Midland Ry., Z. I. Fowler, of Ottawa, Ont. He is a very able engineer, and of whom I cannot speak too highly. I found in Nova Scotia a warm-hearted and energetic people, ever ready to extend the hospitality of their homes and hearts to us. The work was done under the supervision of Dr. M. Murphy, the Nova Scotia Government Engineer, whom I found a very able and competent engineer. Mention should also be made of Mr. Douglas, assistant to the Dominion Government Engineer, and J. J. Taylor, resident engineer, Truro, who were concerned in the work and to whom due credit should be accorded.

The foregoing paper was read before the Western Society of Engineers at Chicago, the reading being followed by the discussion given below:

Mr. Finley—In describing the foundations for one of the piers Mr. Thomas mentions that there was a hard material that was very difficult to remove. Why was it necessary to remove it?

Mr. Thomas—I will simply say that what has been might occur again, and it was very evident that at some time the river bed was down at bed rock, and at some time in the future the water might go down again to the bed rock. I can never do my work too well, for I realize that human life is concerned in the integrity of the foundations of these piers.

Gen. W. Sooy Smith—What appears to me most singular, in Mr. Thomas' talk this evening, and what might perhaps invite criticism (which would not be in good taste in the absence of those who designed the work), in the light of American engineering, is the fact that the bridge should have been planned as it was, and that there should have been such a lack of knowledge of the conditions under which these foundations have been built, and even the material itself upon which they were to rest was not well known. The soundings also proved deceptive. It would certainly appear that that, of all situations, was one in which a long span would have been advisable, first, on account of the extreme difficulty of putting in the piers, and, second, because of the obstruction of the piers themselves. Great ingenuity was called for on the part of those conducting this work, as has been made evident to us. The greatest difficulty was imposed upon them, and it seems to me to have been, to some extent, unnecessary, if a thorough knowledge of the work had been obtained in the first place. If a plan of substructure had been made, adapted to the superstructure and adapting itself to the existing conditions, the difficulties would have been very largely reduced, and the final result, it seems to me, very much better.

Mr. Thomas—With regard to the proper soundings being taken, it was what we have all met with and will meet with again, namely, they did not allow the engineer, in the first place, sufficient money to make the necessary examination, and more than that, the man who did make it had evidently never done any of that class of work before, as in place of making "borings" he made "drivings." He drove a rod down; he said he could not turn his pipe down. I made some surveys for the Roberts-Corbin syndicate when I was in the employ of Sooy Smith & Co. It is not generally known, but I made all the borings and all the surveys in New York harbour, from Cortlandt street to Ft. Tompkins, and up the Kill von Kull for the proposed tunneling, etc., which is to be done under New York city. I went down over 266 ft. to rock, using only a 1¼-in. pipe. I went down 104 ft. through boulders and very hard material, and there is no use telling me a man cannot put a pipe down where he wants to, if he understands his business.

Mr. Strobel—I would like to ask what are the dimensions of these piers?

Mr. Thomas—Size under coping, 24 ft. long by 8 ft. wide; coping, 2 ft. thick, of granite.

Mr. Strobel—What batter?

FIGURE 6.—TOWER SUPPORTING CABLE RAILWAY.

Mr. Thomas—On the lower part on the first, 12 ft. 6 ins. in 12 ins. on the ends, and on the sides, 1 in. in 12 ins. for the first 12 ft., and ½ in. in 12 ins. from there up.

Mr. Finley—Is it not a matter of fact that we have always had considerable difficulty in borings and soundings on account of the inaccuracy of locating rock?

Mr. Thomas—I do not know that it is. I did some work for Mr. Morison, and I do not think I varied ¼-in. there. I think a man should ascertain, as General Smith has said, the exact location of the rock. I have never heard of any of Mr. Morison's borings being found faulty. The borings that were made across the Colorado river, at The Needles bridge, were made by competent engineers, but they did not strike it correctly by 40 odd ft.

Gen. Smith—As there are a good many young engineers here this evening, I will say that there is nothing, it seems to me, more important, in preparation for the building of any bridge, than to ascertain, with the greatest accuracy, all the conditions and surroundings not only with regard to the difficulty of doing the work, but the good judgment to be exercised in planning it. Very often economical methods can be used when you know perfectly the conditions with which you have to deal. Those of us who are gray-headed have learned these things by sad experience, and here is a notable example of a very great deal of difficulty growing out of the want of knowledge of the conditions and want of adaptation of the plans to the conditions.

Mr. Thomas—I would like to say that some time ago I put up a lighthouse on the coast of the Bay of Fundy, near the New Brunswick line, and the specifications read something like this (it was for the Government): Seventeen feet of water; cylinder was to be landed and then dredge out about 5 ft. of soft material on the surface, when there was to be 18 ft. of concrete put in and then pumped out. I went up there to find out all I possibly could in regard to the conditions, and from the condition of the material I found there I concluded that it was no place to put a lighthouse, 75 ft. above water. I called the Government's attention to it, but they simply ignored me and thought I did not know what I was talking about. I finally decided to write to my firm in New York, and had no further trouble, as I received instructions to go ahead and do what I had proposed. In place of going down 5 ft. I drove piles in that cylinder 76 ft. long, driving piles which I had to splice. Some days we would drive one pile, and some days not any, but I put the lighthouse up, complete to the lantern.

Mr. Finley—I recall a case of a foundation, a few years ago, where the engineers located rock within 6 ft. of the bottom of the river; this was done by two engineers at different times, so we thought we had a pretty sure check on it, and yet we drove 30-ft. piles in each foundation.

Mr. Gerber—I would like to ask the chairman why he thinks the Missouri river is a particularly easy place to locate rock. I have had a little experience there and in one place we failed to locate it.

Mr. Finley—I think so by comparing it with other places. I was under the impression that in the Missouri river it would be somewhat easier to definitely locate rock.

Mr. Gerber—In about '87 there were some borings made in the Missouri river near Sioux City, which were made in pretty good shape. I saw the work being done at various times, and I think they went down 130 ft. and did not find any rock. Two years after, I made some more borings at the same bridge. My predecessor, who made the first borings, found clay at a depth of 40 ft., and after going through 5 or 6 ft. of clay he encountered sand until he got to the bottom of his borings. I did not find any clay at 40 or 50 ft.; I did find clay at 90 ft. The only thing in which our borings agreed was that we had no rock at 140 ft., and subsequently we put down four caissons, and then the difficulty with the borings was very easily explained. When we got down 50 ft. we found plenty of clay, some of it in chunks 15 ft. square, but in between these pieces of clay there would be fissures of sand 6 or 8 ft. wide, and as to rock, when we got down about 70 ft. we found plenty of large boulders on which we could have landed with our pipe and found what we might have supposed to be rock.

The American Association of Travelling Passenger Agents meets for its 30th annual convention at the Windsor hotel, Montreal, Sept. 15 and 16. The programme of the convention states that the special train carrying the great proportion of the members will leave Dearborn st. station, Chicago, at 1 p.m., Sept. 12, and, travelling over the G.T.R., will reach Muskoka wharf at 6 a.m., Sept. 13. The party will be entertained at Muskoka during the day, and will leave Muskoka wharf station at 8.30 p.m., reaching Kingston at 5 a.m., Sunday, Sept. 14. One of the R. and O. Navigation Co.'s steamers will then be boarded, and the party carried to Montreal through the Thousand Islands and the rapids, reaching Montreal at 6 p.m. The business session of the convention will open Sept. 15, at 10 a.m., when, after the members have been formally welcomed by the Mayor, there will be a discussion on "The benefits derived from convention meetings by the Travelling Passenger Agent and the company he represents." At 2 p.m. the party will be driven round the city, and in the evening there will be a ball. On Sept. 16 the business of the convention will be concluded, and the afternoon will be devoted to sightseeing. On Sept. 17 there will be a trip to Ottawa via the G.T.R. and Canada Atlantic Ry., returning via the C.P.R.; then via R. and O. Navigation Co.'s steamer to Quebec, where Sept. 18 will be spent; on Sept. 19 the party will leave by R. and O. N. Co.'s steamer for the Saguenay river, returning to Quebec on Sept. 21, when the C.P.R. route will be taken for the return train trip to Chicago. Members may travel by other routes if it is not convenient to take the special from Chicago, those from the eastern states being able to travel by Quebec Central or Central Vermont routes, and others may reach Toronto and join the special there by the G.T.R. from Detroit or Suspension Bridge, or by Niagara Navigation Co.'s steamers, while the Pacific coast members may return home all the way by C.P.R.

The Eugene F. Phillips Electrical Works, Ltd., Montreal, has issued an up-to-date catalogue of its bare and insulated wires, cables and cordage.

FIGURE 7.—ICE FORMATION, SHUBENACADIE RIVER BRIDGE.

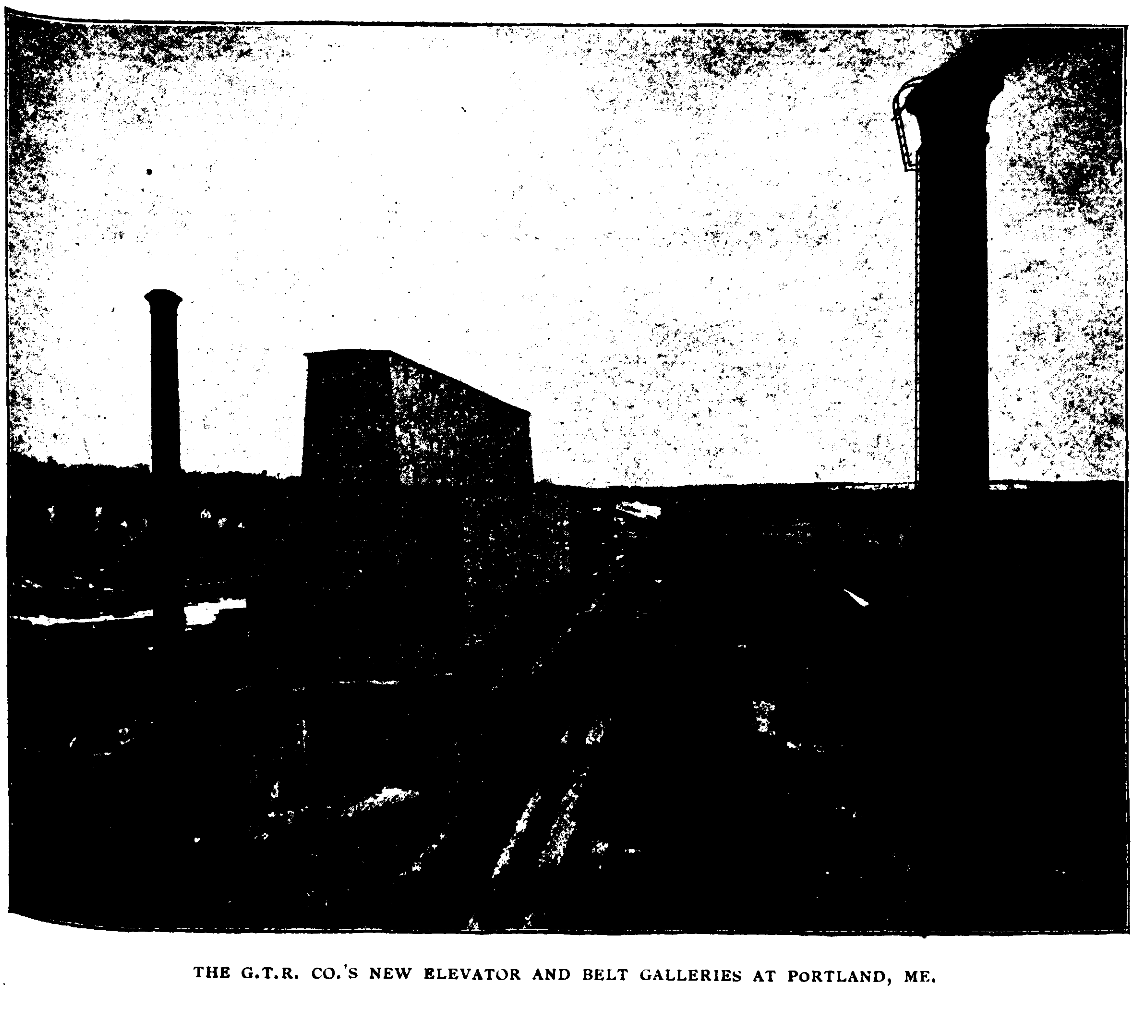
The G.T.R. Elevators at Portland, Me.

The G.T.R. management several years ago saw the advisability and necessity of having a terminal equipped for grain export, and Portland, at the eastern end of the railway, was the choice for location. In 1875 an elevator of 150,000 bush. capacity and a short conveyor system were built. Until C. M. Hays became General Manager of the road in 1896, this small elevator was considered sufficient to handle the Co.'s export business. The new management, however, inaugurated a vigorous policy of increased equipment all through the G.T.R., and the Portland grain exporting facilities received new impetus. It was decided to construct a 1,000,000 bush. elevator and a large conveyor system, which were expected to be adequate for all emergencies for many years to come; this work was completed in 1897. But the development of the Canadian Northwest, with its increased grain traffic, and the completion of a new receiving house at Chicago, soon rendered even this system entirely unable to take care of the great volume of business required of it. It was accordingly decided by Mr. Hays' successor, G. B. Reeve, who was General Manager during 1901, and who continued the policy of his predecessor, to increase the storage capacity of the terminal by an elevator of 1,500,000 bush. capacity and to more than double the extent of the wharf conveyors. The new work was started last year and was completed last spring.

A description of the completed system properly leaves out of consideration the small elevator built in 1875, which, although still operated by the G.T.R., is worked independently of the newer houses. Again, although the latest elevator deserves special mention, neither house can well be described alone, as the two elevators and their wharf conveyors are so connected as to form one system. The system, therefore, as now operated, consists of one elevator of 1,000,000 bush. capacity, 98x219 ft. in size, known as New England elevator no. 2; the new elevator of 1,500,000 bush. capacity, 101x299 ft. in size, known as New England elevator no. 3; and an extensive belt conveyor system which connects the two elevators and sends out six shipping galleries, each 560 ft. long, along the wharves where ocean steamers are loaded.

The belt conveyors are the most striking part of the system. From the west end of the side gallery of elevator 3 a belt gallery runs 132 ft. across the yards of the G.T.R. toward the ocean. This gallery ends at a distributing tower from which one gallery runs straight out 560 ft. along one side of the ocean steamers' wharf, and one runs east along the bulkhead for 600 ft., sending out a shipping gallery 560 ft. long on each side of a large wharf just built by the G.T.R. From the third side of the distributing tower a gallery runs 300 ft. across the tracks to the east end of the side gallery on elevator 2. In this way connection is made with the conveyor system of that elevator. This system, almost a counterpart of the other, consists of a long conveyor on the ocean steamers' wharf, and two on the Atlantic wharf, with the necessary connection along the bulkhead.

Thus it will be seen that on both sides of each of three wharves a shipping gallery runs out along the water, and from any one of these galleries the largest steamer may be loaded. The total length of the conveyor is over a mile, making a system without question the most extensive in existence. Over three miles of rubber belt is used in the belt conveyors of the elevator system. Each conveyor along the wharf is equipped with eight vessel-loading spouts, and elevator 2 has also a spout for loading directly into small coasting vessels lying alongside the house. Seven vessel-loading spouts are placed on the side of each gallery and one at the extreme outer end, so that vessels may load in either position. With this elaborate system of elevators and belt conveyors grain can be taken from any bin in either of the two elevators, and with but one elevation can be loaded into any hatch of any one of six ocean steamers lying along the wharves.



THE G.T.R. CO.'S NEW ELEVATOR AND BELT GALLERIES AT PORTLAND, ME.

Each gallery conveyor has a capacity of 15,000 bush. an hour, making the total carrying capacity of the wharf conveyors 900,000 bush. a day. About 100 ft. of the connecting gallery between the two elevators is built of steel, with fireproof bulkheads, thus making it impossible for a fire to be communicated from one house to the other through the galleries.

Turning our attention now to the elevators themselves, we find an unloading and handling equipment fully in keeping with the shipping facilities described. Ten pairs of power shovels in elevator 2 and seven pairs in elevator 3 give an unloading capacity of 400 cars a day. The elevating capacity of the 24 legs is almost 2,000,000 bush. in 10 hours. The elevator legs in elevator 3 are equipped with 7x7x20-in. buckets on 22-in. belt, and in elevator 2 with 7x7x18-in. buckets on 20-in. belt. There are ten 1,200 bush. and fourteen 1,400-bush. hopper scales, having an aggregate weighing capacity of 31,600 bush. or 1,896,000 lbs.

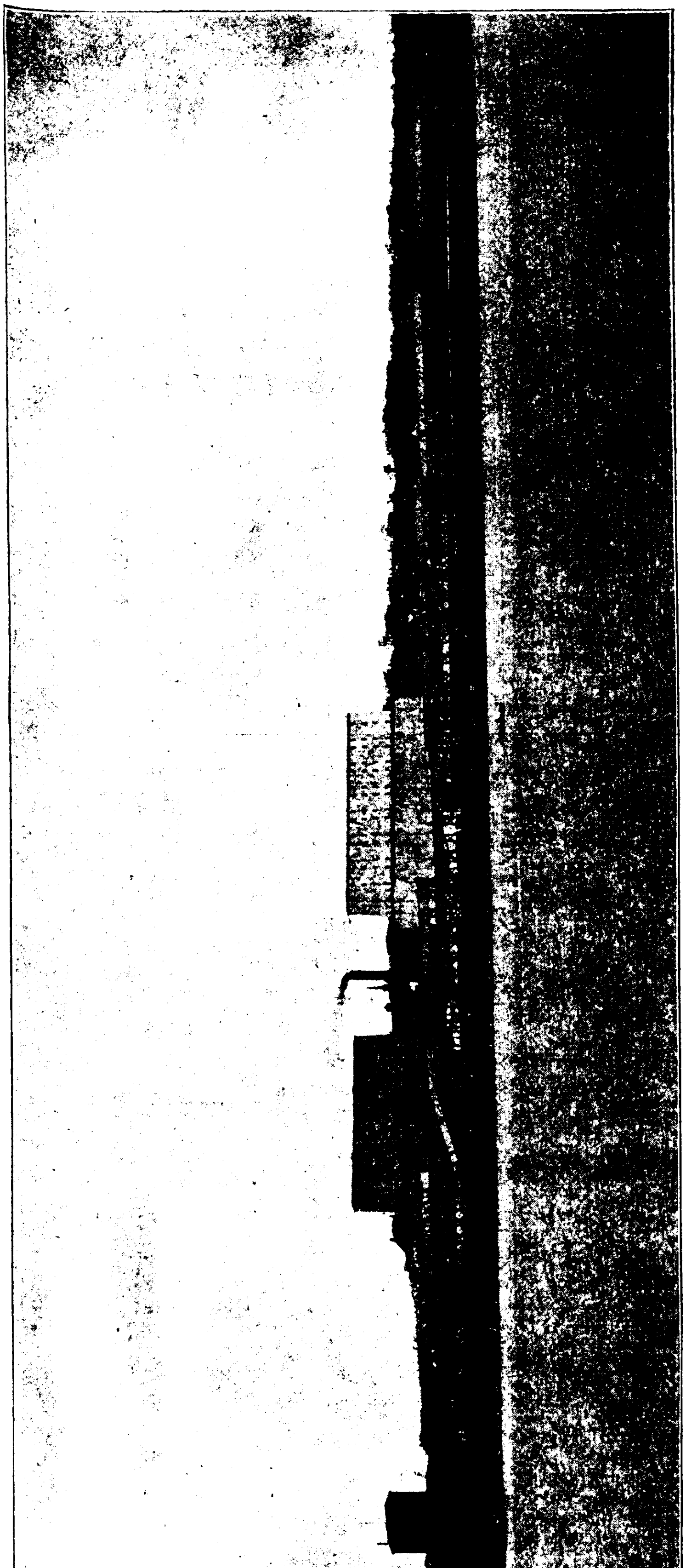
Each elevator has the usual reversing belt conveyor in the cupola for distributing grain longitudinally of the house, while in elevator 3 these belts are loaded by special loading spouts hung on revolving shafts to be swung out of the way of the trippers. The trippers are of a new design with ring-oiling dust-proof bearings, and are probably the most efficient machines now in use for this work. Seventy-six distributing spouts discharge grain from the scales into 370 bins, each 13 ft. square, of which elevator 2 has 148, each 61 ft. deep, and elevator 3, 222, 70 ft. deep. Ample facilities for loading into freight cars by means of bifurcated spouts are also provided. Elevator 2 is equipped for five cross-house basement conveyors and elevator 3 for seven. A very complete system of dust collectors and floor sweeps discharges the dust from the two elevators into the boiler furnaces. Each house has a first-class passenger elevator running from the first floor to the cupola.

The power plant for elevator 2 includes two 24x42 horizontal Atlas Corliss engines of 700 h.p. combined capacity, and four 150 h.p. vertical tubular boilers. In the power house of elevator 3 are two 24x48 girder-type condensing Corliss engines of 1,000 h.p., running independently, and four 250 h.p. vertical tubular boilers. Electric current for lighting is taken from the Portland City Electric Co.'s wires. Both stacks are of steel, lined with brick. One is 175 ft. high and has a 6½ft. flue; the other is 156 ft. high, with a 5½ ft. flue. Power transmission throughout the whole system is by rope drives. An idea of the extent of the drives may be had from the fact that 14½ miles of rope were used in these transmissions.

Special attention is called to the foundations. About 6,000 piles were used in the entire system. Above these on grillage caps are concrete piers, and in elevator 3 the retaining walls are also of concrete, reinforced with steel rods. By the use of these rods the thickness of the wall could be very materially reduced, so that there was a large saving in the amount of concrete necessary. All of the concrete for piers under elevator 3 was prepared with a concrete mixer designed especially for mixing the concrete for these foundations. Handwork is used only for unloading the cars of unmixed materials, after which all handling is done by a series of belt conveyors, elevators and derricks. The materials fed in are sprouted out as thoroughly mixed concrete, ready to be swung away in great buckets by a boom derrick swinging the full width of the building, and to be dumped into the wooden forms for the piers. The mixer is mounted on cars, together with the engine which runs it, and can be hauled along the track beside the elevator excavations as the work progresses. All of the concrete for elevator 3 and its power-house, amounting to some 3,500 cubic yards, was mixed in this manner.

A very complete fire protection system has been provided for the elevators and galleries. The houses and the exposed galleries are snugly covered with galvanized corrugated steel, and, as already mentioned, a section of the connecting gallery is entirely fireproof. A thorough system of fire pumps, fire-service piping and hose is calculated to extinguish any fires that might occur.

A unique feature of this elevator system, but one made necessary by its great extent, is the telephone and signal system running to all parts of the elevators and galleries. At each vessel-loading spout in the wharf galleries and at two points in each of the side galleries are stations for attaching a portable telephone which connects with a switchboard in the office of the superintendent of the elevators. This switchboard also connects with a telephone in the foreman's and the weighman's offices of each elevator, and with the operators controlling the spouts in the side galleries and the distributing tower. There are 66 telephones in the system.



GRAND TRUNK RAILWAY COMPANY'S SYSTEM OF GRAIN ELEVATORS AND CONVEYORS AT PORTLAND, MAINE.
John S. Metcalf Company, Chicago, Engineers.

In addition to the telephones, an electric signal system for starting and stopping the shipping of grain from either elevator has been provided. In each side gallery is a signal box with glass front, displaying in red the numbers of the various wharf conveyors, and containing an incandescent lamp behind each number. When an order is being sent in from any loading point along the wharves, an electric bell warns the spoutman in the side gallery that a number is being displayed in the signal box. The number of the conveyor which is displayed informs him from what gallery the order is coming, and the number of flashes gives him the order for starting, stopping, full speed or slow speed. This telephone and signal system was especially designed for these elevators and conveyors, and is the only one of its kind in existence. These signals and telephones are not merely for convenience, but the extent of the galleries is so great that an installation of this character had to be devised in order to make the sending and receiving of signals prompt and certain.

From the foregoing it will be seen that the system is remarkable not only for its extent, but for its completeness in every detail. It is evident that the G.T.R. has worked with the sole object in view of handling the grain traffic at Portland quickly and in large quantities. Both of the elevators and the entire conveyor system were built from the plans and specifications and under the supervision of John S. Metcalf Co., Chicago.—American Elevator and Grain Trade.

A Hudson's Bay Craft.—The steam barge Inenew, built by the Polson Iron Works, Toronto, for the Hudson's Bay Co., left for her station on the Labrador coast on July 29. She is a trim and staunch craft, and is in every way admirably adapted for the trade in which she is to be engaged. The hold has a capacity for about 100 tons of freight, and the bunkers will hold 20 tons of coal. A cargo of coal was carried from Toronto, and bunker coal will be obtained at one or two points until the Inenew is beyond supply points, when wood will be used. She will carry five or six of a crew, including the captain and mate, engineer and fireman. Two staterooms are provided on the bridge deck, each containing one berth; five berths are fitted up in the fo'castle, and three in the stern. The deck fittings include a steam capstan and a derrick. On her trial trip over eight miles an hour were made, the engines not being worked to their full capacity, as the contract speed had been more than reached. The present destination of the Inenew is Rigolet, on Hamilton Inlet, Labrador, on reaching which point she will commence making trips to the different posts of the H.B. Co. on the coast and up the rivers. The Inenew reached St. John's, Nfld., Aug. 19, after a stormy trip; fourteen days being occupied in steaming from Montreal. On the trip her machinery became disabled and repairs were made in St. John's. Capt. Hayes reports that from Rigolet he will proceed to Hudson Bay, where the Inenew will replace a schooner as a supply vessel on the run between Moose Factory, York, and Fort Churchill.

"**The Manual of Statistics and Stock Exchange** Handbook," for 1902, the twenty-fourth year of its issue, has recently been published by the Manual of Statistics Co., 220 Broad St., New York. It has been enlarged to 912 pages, 100 more than the issue for 1901, and the thumb index provided enables reference to be made at once to the particular class of stock on which information is desired, or to the exchange to which it is wished to make reference. The Canandian companies included in the manual, and referred to in the index, show an increase over those mentioned last year, the additions under railway securities including the Canadian Northern Ry., Quebec Central Ry., and the Cape Breton Ry., whilst among general securities are the Northern Navigation Co. and the Dominion Securities Co., of New York. Information relating to Canadian electric railways will be found under the heading of the Detroit

United Ry. Co., which controls the Windsor city Electric Ry. Co., and the Sandwich, Windsor and Amherstburg Ry. Co.; the International Traction Co., controlling the Niagara Falls Park and River Ry., the Niagara Falls and Suspension Bridge Ry., Clifton Suspension Bridge Co., Queenston Heights Bridge Co., and the Niagara Falls Suspension Bridge Co. ; Montreal Street Ry. Co. Among the companies dropped from the list this year is the Toronto Ry. Co., which appears to be strange.

American Association of General Baggage Agents.—At the recent annual meeting at Chicago the draft of the fundamental rules recommended by the committee appointed at the 1901 meeting was adopted. The following officers were elected: President, J. A. Osborn, Illinois Central Rd.; Vice-President, C. C. Denton, N.Y.C. & St. L. Rd.; Secretary-Treasurer, J. E. Quick, G.T.R.; Executive Committee, G. T. Spilman, C.G.W. Rd.; F.H. Ellis, C.B. & Q.Rd.; W. Dyar, St.L. & S. F. Rd. The next meeting will be held at the Royal Muskoka Hotel, Lake Rosseau, Ont., June 17, 1903.

"Intercolonial Tours to Summer Haunts" is the title of a new guide issued by the I.C.R. It gives details of 128 trips over portions of the I.C.R., or in conjunction with other railways and steamship lines; a list of summer fares from different points of its line, and over 50 pages of illustrated descriptive matter relating to the points to be reached. The new publication is up-to-date in everything except its map, which fails to show the completed Midland Ry., and the Inverness Ry. and Coal Co.'s line, while it shows the Halifax and Yarmouth Ry. as being completed from Yarmouth to Shelburne. The map is also incomplete or misleading in regard to projected lines and lines under construction.

The C.P.R. folders descriptive of the Yoho Valley, and the glaciers of the Selkirks, and of Banff and the lakes in the Canadian Rockies, serve to introduce tourists to beautiful and romantic regions, the attractions of which are only beginning to be known and appreciated. The enterprise of the Co. in building hotels, constructing trails and wagon roads, and in providing experienced Swiss guides to conduct tourists through the country is inducing increased tourist travel to the districts described.

This notice appears on a Flushing steamboat: "Passengers should obtain a receipt for all provisions taken on board this boat, and are requested to retain the same." Easier said than done. It reminds one of the old Limerick:

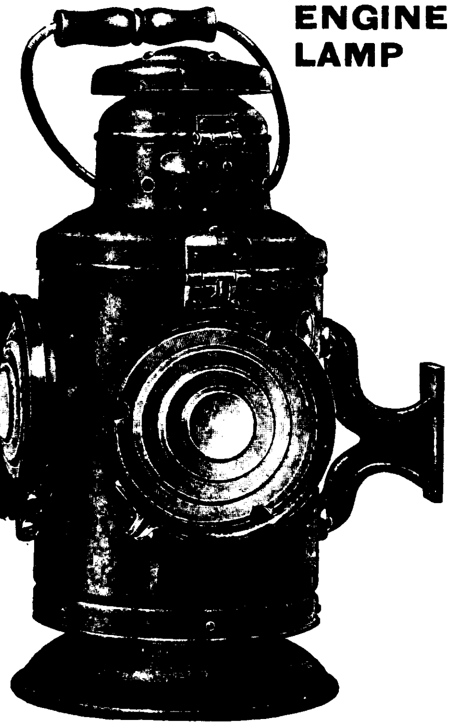
"There was a young man of Ostend,
Who said he'd hold out till the end;
But when half way over
From Ostend to Dover
He did what he didn't intend."

G. C. Metcalfe, who was arrested at Hartford, Conn., on a number of charges of stealing from the C.P.R. and the Dominion Ex. Co. in Canada, pleaded guilty to a charge of stealing from the C.P.R. at Sault Ste. Marie, and was sentenced to five years' imprisonment.

The Hudson's Bay Co.'s annual report shows a profit of \$690,000 as compared with \$340,000 in 1901. This good showing is due to the higher prices now obtained for furs and increased land sales. A dividend of 15 shillings was declared.

The C.P.R. passenger department established a camp at Desbarats, 30 miles east of Sault Ste. Marie, Ont., for the summer, where the Ojibway Indians produced a play founded on "Hiawatha." The object is to attract visitors to the country.

The G.T.R. will provide transportation over its line for the members of the American Association of General Passenger and Ticket Agents, on the occasion of the annual convention at Portland, Me., Oct. 14.



Economics of Railway Improvements.

By W. W. Colpitts, M.Sc., A.M. Can. Soc. C.E.

The question of the most advantageous methods of improving existing railway lines, and the effect of such improvements upon operating expenses, is one to which the attention of the railway engineer of the present day is frequently directed. The object of this paper is to outline methods by which the most economical results may be obtained in operation, and to define a basis upon which the yearly value of railway improvements may be quickly and accurately estimated ; at the same time to epitomize a vast and varied subject into such brief space as to facilitate its ready application in practice.

The profession of civil engineering has been defined as "the art of making a dollar earn the most interest," a definition which in no branch of the profession should be more closely adhered to as a maxim than in railway engineering. Evidences are to be found on every hand of enterprises in which the financial aspect has been largely lost sight of by engineers who were desirous of building works of monumental excellence rather than of structural utility. The result, in many instances, has been the impoverishment of the company before the line could be equipped for economical operation, or even completed. The promoters of railway projects, on the other hand, in their zeal to reduce first cost, have, in many cases, constructed lines of such a character that the expense of operation has bankrupted enterprises that might otherwise have proved financially successful. Between these extremes there is always a happy mean which will give the largest return for the money invested, and upon the engineer's ability to discover the wisest middle course may depend the success of the venture. Generally speaking, the most economical line to adopt may be defined as that on which the sum of the operating expenses and the interest charges on the total expenditure are least.

Many existing lines, built under limited financial conditions, in the expectation of a sufficiently large traffic in the future to warrant radical improvements, have been greatly handicapped because of the failure of the promoters to recognize the paramount importance of adopting the lowest rate of grade which the country would afford. Unfortunately, engineers are prone to work to the extreme limit of grades and curves, even to the extent of adopting a maximum grade in localities where a minor gradient might as easily have been obtained. The result of such lack of foresight is that any attempt to improve the grades involves practically the reconstruction of the whole line. Until the traffic has developed sufficiently to justify such radical changes the line is operated under most unfavorable conditions, which, in numerous instances, has resulted in the appointment of a receiver. However favorable the conditions under which a line is projected, there is but a

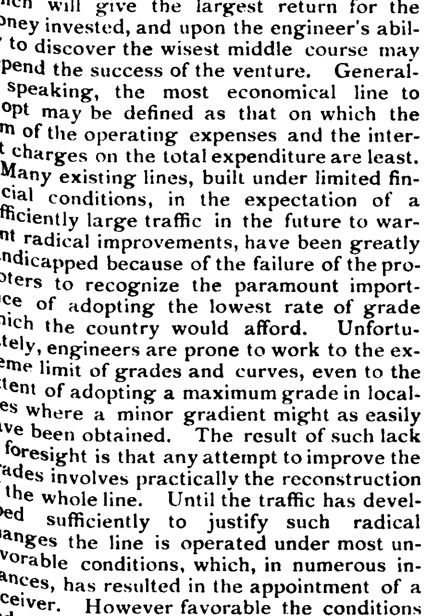


FIGURE 1.

small margin for error either during construction or in later improvements. Mistakes in alignment may be rectified, structures rebuilt and local sags removed, but the ruling grade of a line, once established, is the limiting feature which governs largely the expense of operation.

Many lines and particularly transcontinental lines, have largely by their own agencies, developed the traffic which they carry, and with little hope of immediate return have been built in the cheapest possible manner with heavy grades and sharp curvature. Later on, with the development of traffic and the impetus of competition, the line is inadequate to the business, and means must be sought for increasing its facilities. Railways constructed under such conditions should seldom, if ever, be double-tracked without the intermediate step of reducing the grades. This is particularly true of lines with but little more traffic than can be handled economically and expeditiously. The convenience and rapidity with which trains can be operated on a double track line, and the sentimental bias of the public in their favor, have been incentives towards the double-tracking of many lines, when to have reduced the grades would have involved a much less expenditure of money. Viewed from a financial standpoint, the latter course will usually pay a greater percentage of interest on the investment, at the same time facilitating the economical handling of a larger volume of traffic than was previously possible.

In the case of lines with a heavy passenger or suburban traffic, the conditions are quite reversed. The question becomes one rather of the number of light trains which can be operated rapidly and in quick succession, and without danger of delay, than of the number of tons that can be handled in a train. To increase the number of tracks as the business justifies is evidently the solution of the problem.

The cost of double-tracking will seldom be less than 50% of the first cost of construction; and in rough country, where it may be necessary to completely divert the second track, it will more often approach 75%. Rails and fastenings, ties and ballast, will be approximately 100% of the cost of such items in first construction. The cost of grading may vary from 40 to 60% of the first cost, depending upon the topography of the country ; the cost of bridging from 75 to 90%. From this it is evident that the traffic of a line must be very considerable, and greatly congested, if the heavy expenditures thus entailed cannot be postponed for a number of years by a reduction of the grades. As an illustration of the advantages of the latter course, a reduction of a ruling gradient from 1% to 0.4% practically doubles the haulage capacity of locomotives and reduces the number of freight trains about 50%, and the expense of operation about 25%—a course which, on lines with a moderate traffic is usually warranted by the consequent reduction in operating expenses alone, aside from the advantages afforded for handling an increase of business.

Simultaneously with grade reductions, many other improvements may be effected without adding materially to the cost, at the same time placing the line in a fit condition to be double-tracked in the future. At no time is a better opportunity offered for putting in transition ends to curves which have not been previously eased. Objectionable features of alignment may be removed and curvature eliminated. In many cases it will be found possible to consolidate a number of heavy grades in one section, which may then be operated with comparative economy, but which the traffic would not warrant reducing, and thus full benefit may be derived from improvements in adjoining sections. It will usually be found more economical to operate heavy grades in the vicinity of divisional points with the assistance of the yard engines,

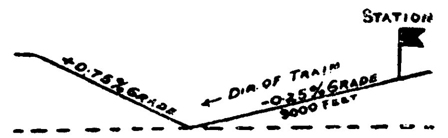


FIG.2.

reducing the grades on the remainder of the section ; and at points where it would be necessary to construct several miles of new line, to avoid a short heavy grade, it will often be found more economical to double the train.

Little advantage is to be obtained in operation from improvements which are not calculated to increase the engine rating for the whole section. An excessive ruling gradient at one point, the necessity for stopping on a grade, or insufficient compensation for curvature on a ruling gradient, may appreciably limit the rating of the section. In order, therefore, to obtain the most economical results in operation, improvements should be designed to make the rating uniform on all ruling gradients.

The extent to which freight and passenger receipts will be affected by minor changes in distance depends largely upon the nature of the traffic, and upon the geographical position of the line in relation to its competitors. The relative proportions of the different classes of traffic vary greatly on different roads or on different parts of the same road, so that each case must be carefully studied with reference to the peculiar conditions which obtain on that particular section. It is evidently impossible, in a general discussion of the subject, to obtain results which may be applicable in all cases. We may, however, define a basis upon which to proceed intelligently to estimate the effect of such changes upon freight and passenger revenue, as well as upon operating expenses, which latter we are able to determine with considerable accuracy. For this purpose we divide the traffic into three distinct classes. Traffic of any other nature will, so far as this estimate is concerned, be found to belong to one or the other class :

Class 1.—Local and exchange traffic, non-competitive, between points on one line, or passing over two or more lines, but having no option as to route.

Class 2.—Local traffic, competitive, between points on one line, but having an option of two or more routes.

Class 3.—Through exchange traffic, competitive, passing over several lines, with an option of two or more routes.

Non-competitive traffic, class 1, usually represents the major proportion of the total on all roads, and a shortening of the line will at once result in a direct loss of revenue. This loss is proportional to the amount by which the line is shortened, and may be obtained as follows : Multiply the total number of revenue tons and passengers passing over that portion of the line in a year by the average revenue per ton, and per passenger mile, from such traffic, and by the number of miles by which the line is shortened.

The rates on local competitive freight traffic, class 2, are usually arranged on a mileage basis, unless arbitrarily fixed on account of boat or other competition, with a more or less disregard of the actual distance traversed. In the latter case the revenue will be neither increased nor decreased by slight changes in the length of the line. In the case of local competitive passenger traffic, the rates are determined by the mileage of the shortest line. If based on the mileage of the home line, the revenue from this traffic may be materially reduced by shortening the line, which loss may be estimated, as in the case of class 1. If the home line is one of the longer routes, the receipts will not be affected by changes of distance.

The revenue from through exchange competitive traffic, class 3, may be seriously reduced by shortening the line. The rates on such traffic, as in class 2, are usually established in the case of freight with a more or less disregard of distance, and in the case of passengers by the mileage of the shortest line; but the division of the total between the lines participating in the business is in the proportion of the mileage of each, or on a pro rata per rate basis. It is evident, thereof, that so far as this class of traffic is concerned, if the line be shortened, its proportion of the revenue will be correpondingly decreased. Some lines, on account of physical advantages or for various reasons, may be given "differentials" or "reconstructive mileage," or "arbitraries" for terminal bridge transfer, or other expenses, in addition to their proportion of the remainder of the revenue. To estimate the loss that would result to this class of traffic by shortening the line, we first deduct the amount of the arbitraries from the total yearly revenue for such traffic, and if the receipts are pro-rated on a mileage basis we multiply the balance by the difference between the ratios of the home mileage to the total average mileage before and after the contemplated changes. If the revenue is apportioned on a pro rata per rate basis, this latter multiple is determined accordingly.

Summarizing the foregoing, from classes 1 and 3, it is seen that a direct loss of revenue will result from shortening the line; the revenue from class 2, which at most is but a small proportion of the total, will be affected injuriously or not at all, according as the home line is shorter or longer than its competitors. Thus it might appear that there is no credit side to eliminating distance other than would result from the saving in operating expenses. This, however, is true only of such traffic as has been actually obtained. The shortest line between competitive points is, other things being equal, in much the most advantageous position for securing the largest proportion of the traffic, and anv improvements tending to shorten the longer line will prove decidedly beneficial in that respect, but once the business is secured the advantage is wholly in favor of the long haul.

To the ordinary passenger, time is the first consideration. Distance is largely a technicality which no more concerns him than the grades or curves of the line, and the quickest route to his destination is the most likely to receive his patronage. Whatever the character of the improvements, therefore, whether of the nature of grade and curvature reductions or the elimination of distance, if they are such as will facilitate the running of faster trains, they will tend to increase the volume of traffic, and consequently the revenue.

The exenses of operation will be more or less affected by minor changes in distance which may be necessitated by grade reductions. If the agreements between the company and its employes are not based on mileage, train wages will not usually be subject to modification because of a slight change in the length of the section. Track force and maintenance of way expenses will depend upon the extent of the change.

The following estimates of the effect of slight alterations in distance on operating expenses are based on Wellington's results, and are figured for an average train mile cost of 85 cents. Having determined the actual train mile cost on any particular section, these amounts should be adjusted proportionately.

	If train wages are affected.	If train wages are not affected.
Changes aggregating from 0 to 2 miles ..	33.7c.	21.1c.
Changes aggregating from 2 to 15 miles ..	43.7c.	31.0c.

The above figures, multiplied by the total number of trains each way in a year, give the value of one mile increase or decrease in distance. The number of trains to be used in this calculation will be that operated on the old line, or necessary to handle the same volume of traffic on the new line, according as the length of the section is reduced or increased by the improvements.

At a station at which freight trains may be required to stop for water or other purposes, the engine rating may be materially reduced below what it otherwise would be if at that point a grade at the same rate as the ruling grade were adopted. The rating for the whole section is thus limited to that which the locomotive can start on the ruling grade on which it is necessary to stop. It is the criterion of economical operation that, so far as possible the engine be working with uniformity, and at its full capacity on all parts of a section. Yet instances are to be found, to a greater or less extent on all railways, in which the full power of the locomotive is demanded only at one or two points in an engine stage, where stations have been located on grades which have not been compensated for stopping. The consequent reduction in the rating for the whole section thereby greatly increases the expense of operation, but not usually to such an extent as to warrant the use of assistant engines. The arbitrary method of compensating such grades two-tenths per cent. at stops is, as will be seen from the following, much too little:

Fig. 1 gives, in lbs. per ton, the train resistance curve and the traction power curve of a modern locomotive for speeds from 0 to 10 miles an hour. At the point of starting the resistance is much greater than at 5 or 7 miles an hour, when it reaches a minimum of about 4½ lbs. a ton. The tractive power, on the other hand, remains practically constant between these speed limits. Compound engines, by being thrown into simple, may increase their tractive power at low speeds, and thus possess a reserve force for starting or surmounting short, heavy grades.

With the old form of link couplers trains could be started from rest on much heavier grades than is possible at present with automatic couplers. The slack between the cars was much greater, and the locomotive had acquired a considerable speed before the caboose began to move. The very great starting resistance was thus overcome in the forward part of the train when but a small proportion of the road was being acted upon.

Taking 3 ins. as the average draw bar extension in freight cars, in a train loaded for a 0.5% grade, or say 41 cars, there is 20 ft. slack. In that distance, the engine working under full steam, without its train attached, can acquire a speed of 7.5 miles an hour. In order to simplify the following calculations, we will assume that the full amount of slack is taken up by the engine before the train begins to move, and the momentum thus acquired in the locomotive is transferred to the train instantly, instead of gradually, as is actually the case. The error introduced by this assumption is inappreciable, and is on the right side. The velocity with which the train moves at the instant of starting is given by the momentum equation $130 \times 7.5 = 2018 \times V$, from which V = .48. The level tangent resistance at this speed is 13 lbs. a ton; the engine tractive power at this speed is 15.4 lbs. a ton, from which we deduct 2 lbs. for acceleration, or 13.4 lbs. a ton. The force, therefore, available for overcoming grade resistance is 0.4 lbs. a ton, equivalent to a 0.02% grade.

The distance in which the train on this grade will acquire a speed of 10 miles an hour is determined from the formula deduced for momentum grades, $d = \frac{(V_1 - V_2)\ 2000}{f - 20\ r}$, and should be calculated for increments of increase in velocity of one mile an hour.

The following table has been compiled in this manner for lines with ruling gradients from 0.5% to 1.5%, giving in each case the actual grade to be adopted at the stop, the length of such grade, and the time required to acquire the minimum allowable speed of 7 or 10 miles an hour. For lines with other ruling gradients than those given in the table, the same information may be obtained with sufficient accuracy by interpolation.

TABLE OF COMPENSATION FOR GRADES AT STATIONS.

Ruling Grade of Line	0.50%		0.75%		1.00%		1.25%		1.50%	
Actual Allowable Grade at Stop	0.02%		0.31%		0.60%		0.88%		1.15%	
Amount of Reduction	0.48%		0.44%		0.40%		0.37%		0.35%	
Minimum Allowable Speed.	Dist. Feet	Time Secs.	Dist. Feet	Time Secs.	Dist. Feet	Time Secs.	Dist. Feet	Time Secs.	Dist. Feet	Time Secs.
7 m. per hour	353	67	375	71	392	75	407	77	417	79
10 m. per hour	763	100	834	108	909	116	991	124	1064	130

The length of the grade given in the table is the clear distance which the train must have after starting in order to acquire the necessary speed. At important stations at which the train must stop after leaving the siding to permit of closing the switch, the grade must be lengthened accordingly.

The intelligent and consistent use of momentum grades may prove a great source of economy, either during construction or in improving the grades of old lines. Few railways have been built, even in recent years, in which the quantities might not have been greatly reduced by the adoption of a virtual profile in localities where its use would not have impaired the efficiency of the line. The strict adherence to the maximum gradient, particularly on lines with short undulating grades, which could be surmounted by the assistance of momentum on a grade much greater than the ruling grade, has added greatly to the cost of such lines without a corresponding reduction in the cost of operation.

On lines with long ruling gradients, the saving thus effected may be inappreciable, but it is seldom that such great reductions in the grades of a line are contemplated that from 30 to 50% cannot be operated as momentum grades, whereas, if the ruling grade were strictly adhered to, much heavier work would be necessitated as well as the reduction of many grades from which no advantage is obtained in operation.

In adopting a momentum grade, great care should be taken that it be located only at a point where every assurance is to be had that the train will have acquired the speed necessary to surmount the grade. The method generally followed, of using a grade such that the total rise is equal to that of the same length of ruling gradient, plus the difference between the velocity heads of the train at its initial and final speeds, is greatly in error, assuming, as it does, that the locomotive power over and above that required to overcome the frictional and grade resistances is constant for all speeds. A grade located upon this assumption might be such as to materially limit the engine rating of a whole section, and thus defeat the purpose it was intended to serve.

A momentum grade which could be barely surmounted by one engine with a full load between certain initial and final velocities might, within minor limits, be too long for an engine of another class with a different tractive power curve. For this reason, that grade should be adopted which can be surmounted by the most unfavorable class of engine likely to be run on the section. Generally speaking, an engine in which the ratio of the tractive power at low speeds to that at high speeds is greatest is the most unfavorable in this respect, and should therefore form the basis of calculation.

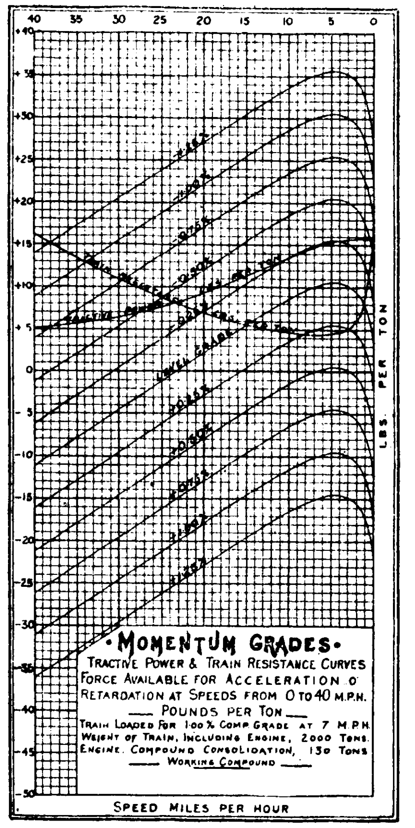


PLATE 4.

The engine herein used is a 130-ton Baldwin, compound, consolidation, with a cylinder tractive power of 29,000 lbs. at 7 miles an hour. The distance which a train will run on a grade within certain narrow limits of velocity, the engine working under full steam, is given by the following equation of work :

$$d\ F = (V_1 - V_2)\ 2000$$

$$\text{or} \quad d = \frac{(V_1 - V_2)\ 2000}{F} \quad \ldots\ldots\ldots\ldots\ldots \ (1)$$

in which d = distance in feet through which train moves between the limits of velocity.

F = average force available for acceleration or retardation in lbs. per ton.

V_1 = Velocity head at initial speed.

V_2 = Velocity head at final speed.

The cylinder power is exerted to overcome frictional and other resistances and the grade resistance. The force F is therefore the algebraic difference between the tractive power per ton and the total resistance per ton.

$$F = (t - r) - 20\ R$$

$$= f - 20\ R \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

in which t = tractive power per ton at any given velocity.

r = resistance other than grade, per ton, at any given velocity.

R = rate per cent. of grade

f = (t—r)

From this equation, plate 4 was plotted, which gives the net force available for acceleration or retardation on grades from + 1.25% to — 1.25%, at speeds from 0 to 40 miles an hour. The maxi-

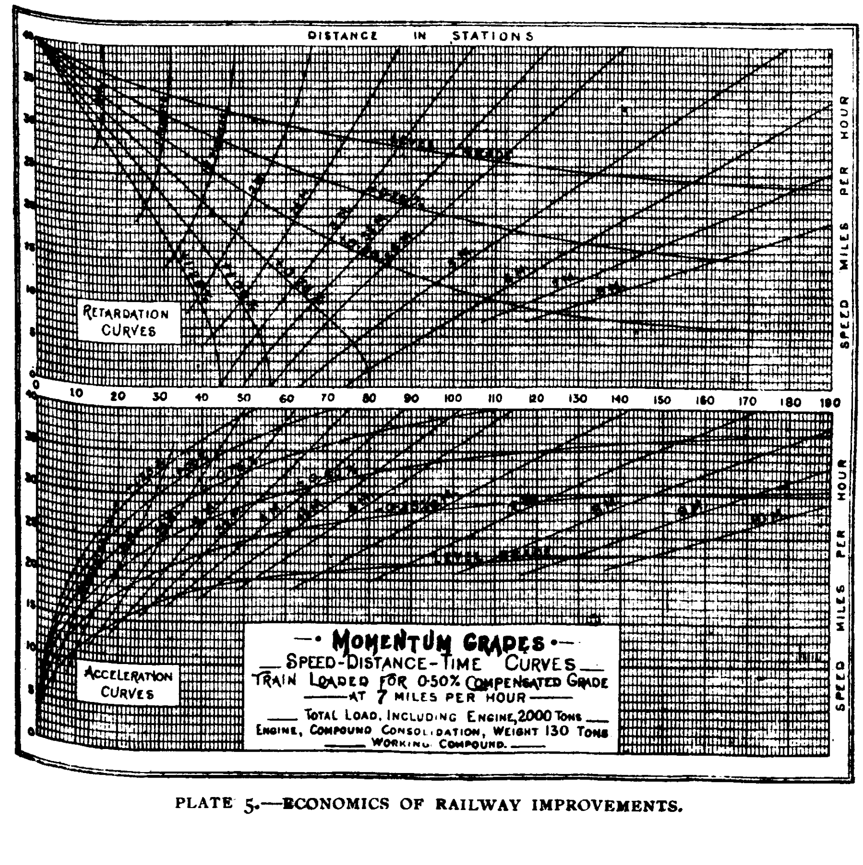


PLATE 5.—ECONOMICS OF RAILWAY IMPROVEMENTS.

mum speed which a train loaded for a 0.5% grade can acquire on any other grade is given in the intersection of the curve representing that grade with the zero line of tractive power.

Substituting the value of F in Equation 1, we obtain

$$d = \frac{(V_1 - V_2)\ 2000}{f - 20\ r}$$

from which plate 5 was plotted.

For short increments of 2.5 miles an hour increase or decrease in velocity, we may, without sensible error, take the average of F at the beginning and end of the increment.

Similar curves have been plotted for trains loaded for 1.0% and 1.5% grades. For other grades, sufficiently accurate results may be obtained by interpolation.

The following example will demonstrate the use of the diagrams: It is advisable, on account of a heavy increase in traffic, to reduce all the grades on a certain section of line to 0.5%. There are at present several 0.75% grades which limit the engine rating, and which must therefore be reduced. One of these is situated as shown in fig. 2, and we desire to know what length of the 0.75% grade can be surmounted by momentum before the speed of the train is reduced to seven miles an hour.

From the acceleration curves, plate 5, we find that 9,000 ft. on the −0.25% curve corresponds to 28 miles an hour—the speed acquired at the foot of the grade. From the retardation curves, we find that 28 miles an hour on the + 0.75% curve corresponds to 2,650 ft., and 7 miles an hour to 7,300 ft. (7.300—2,650)=4,650 ft. is the distance which can be surmounted before the speed is reduced to 7 miles an hour, and beyond this point, therefore, the grade must be reduced.

To find the time required to traverse the distance from the acceleration curves we find that 9,000 ft. on the 0.25% curve corresponds to 5.7 minutes. From the retardation curves, 2,650 ft. on the + 0.75% curves corresponds to 0.83 minutes and 7.30 to 4.40 minutes. The total time from the station to the point at which the grade must be reduced is therefore 5.7 + (4.40 − 0.83) = 9.27 minutes.

When a grade is so long that it cannot be surmounted by momentum, but not of such a length that a new line must be built, it will generally be found more economical to reduce the grade both at the foot and the summit, thus avoiding unduly heavy work at either point. The length to be reduced at the foot or the summit to give the most economical results depends entirely upon the topography of the ground, and can only be determined by a series of trials.

The time lost in operating a momentum grade is seldom so great as to be worthy of consideration in freight transportation, but the exact amount may be directly ascertained from the diagrams, and its yearly value estimated.

Improvements made in the physical features of a line, unless of a very extensive character, affect but little the expense of conducting passenger transportation. To within certain limits, the size of passenger trains is seldom governed by the grades, and time lost in ascending is regained in descending. The tonnage of freight trains, on the other hand, is wholly limited by the ruling grades, and any improvements which may be made in the way of eliminating curvatures and rise and fall, or grade reductions, will decrease at once the cost of handling freight traffic.

To estimate, therefore, with any degree of accuracy, the yearly saving which may be realised by such improvements, we must first determine the average cost per freight train mile on that section of the road. The expenses of freight and passenger transportation are not usually subdivided in the accounts of the company and cannot be readily ascertained without adopting a more or less arbitrary basis of subdivision. The cost of a passenger and freight train mile is not usually widely different, and for rough preliminary calculations we may ordinarily use for either unit the average cost per train mile on that portion of the line under consideration. On many lines, however, the variation is considerable, and in order to accurately estimate the yearly value of improvements in grades or curves, we must first subdivide the freight and passenger expenses, covering a sufficiently long period of time, and determine the average freight train mile cost.

A few items in the cost of transportation are directly chargeable to freight and passenger; the basis of subdivision of others is indicated by the character of the expenditure. Many items are so intimately associated with both classes of transportation that they can only be apportioned on some arbitrary basis, and it remains to adopt in the case of each such item the fairest and safest basis of distribution. For this reason it is evidently impossible to so divide the different items of railway expense as to obtain absolute results. We may however, obtain final units of freight and passenger train mile cost, which, though not in themselves absolute, are within a permissible limit of error, and which, for our purposes, or as a basis for comparing one division of a road against another, or a division against itself, are quite sufficiently accurate.

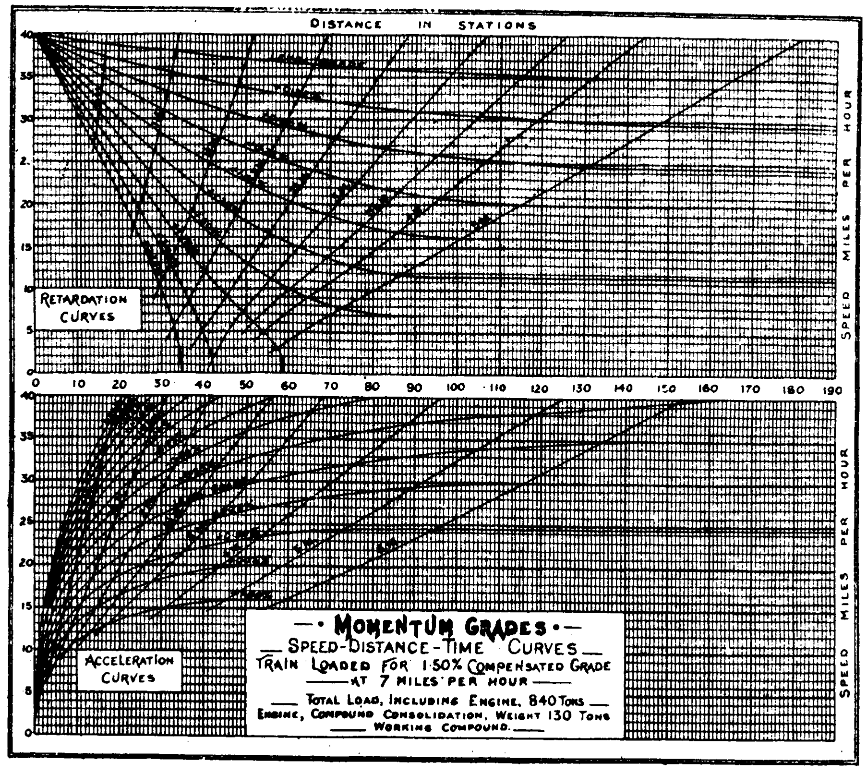


PLATE 7.—ECONOMICS OF RAILWAY IMPROVEMENTS.

The several items of railway expense are given in detail in the following classification, and, although different roads have different systems of accounting, the items are in the main similar :—

GENERAL.

1. Expenses of general offices.
2. Salaries and expenses of officers.
3. Salaries of clerical force.
4. General expenses, rentals, stationery and printing.

PRODUCTION OF MOTIVE POWER.

5. Wages of engineers, firemen and roundhouse men.
6. Oil, waste and water.
7. Expenses of shops and machinery.
8. Fuel for locomotives.

MAINTENANCE OF EQUIPMENT.

9. Repairs of locomotives.
10. Repairs of passenger, sleeping and parlor cars.
11. Repairs of freight and other cars.

LOSS AND DAMAGE.

12. Wrecking.
13. Injuries to persons and stock.
14. Loss and damage to freight.

STATION SERVICE AND SUPPLIES.

15. Agents, clerks and labor.
16. Dispatchers and telegraph operators.
17. Station expenses and supplies, heating, lighting, etc.
18. tock yards and elevators.
19. Yard rentals and terminal charges.

TRAIN SERVICE AND SUPPLIES.

20. Conductors, baggagemen and brakemen.
21. Care, heating and lubricating cars.
22. Train supplies.
23. Wages and supplies, parlor and sleeping cars.

MAINTENANCE OF WAY.

24. Maintenance of buildings, docks, wharves, telegraphs, fences, etc
25. Maintenance of stockyards and elevators.
26. " bridges and culverts.
27. " road bed.
28. Repairs of track, switches and frogs.
29. Renewals of ties.
30. Renewals of rails and fastenings.
31. Incidental expenses.

We will now proceed to apportion the several items above between freight and passenger, according to the following measures, when they cannot be directly charged to one or the other account.

In the proportion of the freight and passenger revenue.

In the proportion of the freight and passenger train mileage.

In the proportion of the freight and passenger engine mileage.

In the case of the train and engine mileage of mixed trains, which is at most but a small proportion of the total on all roads, when more accurate data is not obtainable, they may be divided in the proportion of two-thirds to freight and one-third to passenger. Switching engine mileage is divided in the proportion of 80% to freight and 20% to passenger.

Items 11, 14, 18 and 25 are chargeable directly to freight.

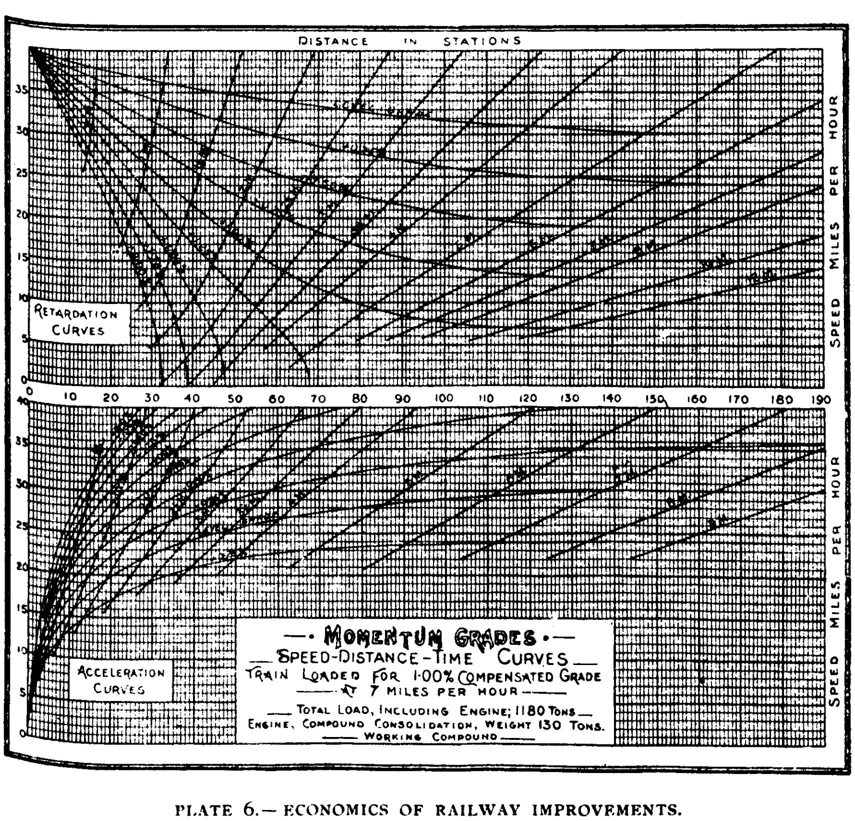


PLATE 6.— ECONOMICS OF RAILWAY IMPROVEMENTS.

Items 10 and 23 are chargeable directly to passenger.

Items 1, 2, 3, 4, 15, 17, 19 and 24 are divided in the proportion of the freight and passenger revenue.

Items 12, 13, 16, 26, 27, 28, 29, 30 and 31 in the proportion of the freight and passenger train mileage.

Item 9 in the proportion of the freight and passenger engine mileage.

Items 20, 21 and 22 are directly proportional to the train mileage, but the cost of these items per train mile varies from 50 to 70% more in freight than in passenger service. In the absence of more accurate data, therefore, we add 60% to the freight train mileage, and distribute the items in the proportion of the freight train mileage thus obtained, to the actual passenger train mileage.

Items 5, 6 and 7 vary directly with the engine mileage, but their cost per freight engine mile is from 60 to 100% greater than per passenger engine mile. To apportion these items, therefore, when more accurate data is not obtainable, we increase the freight engine mileage 80%, and adopt this and the passenger engine mileage as the basis of subdivision.

The item "Fuel for locomotives" 8 is one of the largest of railway expense, and should be very carefully distributed. If access is to be had to the company's accounts, the relative amounts chargeable to freight and passenger may usually be readily ascertained. Generally, this item may be apportioned arbitrarily with considerable accuracy. The cost of fuel per engine mile varies from 50 to 100% greater in freight than in passenger service. To the freight engine mileage, however, has been added the switching mileage, which reduces the increase to an average of about 50%. The item is therefore divided in the proportion of the freight engine mileage, increased 50%, to the actual passenger engine mileage. Having now apportioned the total expenses between freight and passenger, these divided respectively by the freight and passenger train mileage give the average cost per freight and passenger train mile. We may proceed further and divide these expenses respectively by the total number of revenue ton and passenger miles, and obtain the average cost per ton and per passenger mile—the main transportation units.

The cost of freight and passenger train mileage is found to vary from 75c. to $1.50, and from 65c. to $1.40 respectively, according to conditions, but a fair average for each may be taken as 85c. and 75c. Having obtained these results, we are in a position to estimate the yearly value of improvements by which the engine rating is increased. Proceeding upon the lines laid down by A. M. Wellington, it will be found that from 50 to 60% of the expense varies with increased train mileage. This percentage, multiplied by the cost per freight train mile, and by the number of train miles saved in a year, gives the yearly saving in operating expenses.

When the tonnage of a train is not governed by the speed or other limiting conditions, the haulage capacity of a locomotive on different grades may be determined from the following formula:

$$T = \frac{c}{4.5 + 20} r - E$$

in which
T = tonnage of train.
C = cylinder tractive power of engine at a minimum allowable speed of 7 or 10 miles per hour.
R = rate of grade.
E = weight of engine in tons.

The engine rating may be greater in one direction than the other, and at the same time the traffic may be of such a nature that the average train tonnage may be less in the former direction than in the latter, consequently although the rating may be considerably increased in one direction, it does not necessarily follow that the average train tonnage in that direction will be increased in a like proportion. In estimating, therefore, the number of train miles saved by an increase in the engine rating, care should be taken to ascertain the actual number of properly balanced trains necessary to operate on the new line to handle the given traffic.

The question of the most suitable grades to adopt is usually complicated by an unequal balancing of the grades to the traffic. If the tonnage is greater in one direction the return tonnage will consist partially or wholly of unloaded cars. It is usually estimated that 30% additional power is required to haul empty cars than a like tonnage of loaded cars, and the locomotive haulage sheets are compiled on that basis. The frequency with which trains of empty cars are stalled would indicate, however, that this is not a sufficiently large allowance. Wellington's experiments on loaded and empty cars tend to confirm this belief, giving 45% at 7 miles per hour as the additional power required, a percentage which decreases slightly as the speed increases. In reducing grades to balance the traffic, therefore, that portion of the return tonnage which consists of empty cars should be increased by at least 35 or 40%, and proportionately for partially loaded cars, and grades adopted which will suit this equivalent tonnage and the actual tonnage in the opposite direction.

On lines traversing a river valley with a low ruling gradient of a practically continuous rise, the scheduled speed may be such as to greatly reduce the train tonnage below that which could be hauled at low speeds on the ruling grade. In such cases, the horse power may be calculated from the following formula:

$$T = \frac{375\ P}{S \times R} - E$$

in which

T = tonnage of train.
P = horse power of locomotive at average speed.
S = average speed in miles per hour.
R = average resistance of train in lbs. per ton.
E = weight of engine in tons.

The cost of the different classes of rise and fall depends upon the rate of grade which is surmounted and the ruling grade of the section. If the ruling grade is equal to, or less than the grade of repose, which is taken as 0.5%, it is not considered that rise and fall adds appreciably to the ordinary cost of operation, since such grades (unless of great length) can be operated under uniform steam, the speed alone varying. The cost of wear and tear is but slightly affected, and the cost of fuel is practically uniform; the potential energy stored in ascending a grade is given out in descending, and except as wasted by stops the kinetic energy of the train, due to the speed acquired in descending a grade, assists in ascending the next. On such grades, the cost per foot of rise and fall is estimated at 24c. per daily train per year.

On grades from 0.5 to 0.8%, which do not require the use of sand in ascending and which in descending are neither operated under steam nor require the use of brakes, a foot of rise and fall is estimated to cost 71c. if on a minor grade, and $1.42 if on a ruling grade.

On grades greater than 0.8% which are of too great length to be operated as momentum grades, and which require the use of both brakes and sand, a foot of rise and fall on a minor grade is estimated at $2.27, and if on a ruling grade $2.98.

The above figures are on the basis of an average train mile cost of 85c., and should be increased proportionately to the actual train mile cost on any particular section, and represent the yearly cost of one foot of rise and fall per daily train each way. If the rise and fall on the new line is less than that of the old line, the number of trains used in the calculation will be that operated on the old line, and vice versa.

In estimating the amount of rise and fall which may be avoided by a change of line, care should be taken to allot each to its proper class, which does not necessarily depend upon the actual rate of the grade. A grade of short length, but of a rate much greater than the ruling grade, may be in such position as to be operated by momentum, and the value of its rise and fall will, therefore, be reduced to that of a minor grade.

The most serious objection to curves is the sentimental prejudice of the public against them. To a large extent the distinctive feature which has enabled the rapid growth and development of American railways has been the recognition of the fact that curvature, consistently introduced, was not a disadvantage. When of ordinary sharpness, properly elevated, lined and surfaced, curves may be traversed with as great a degree of comfort and safety as tangents, and if provided with easement ends, the transition from the tangent to the curve is imperceptible.

The actual cost of operation is but slightly increased by additional curvature up to the limit when sharp curves necessitate a reduction in the speed of fast trains due to the slighty increased liability to derailment. Excessive curvature should, however, be avoided wherever possible, and the necessity for using a maximum curve at one or more points in an engine stage is not, as in the case of maximum grades, sufficient justification for its general adoption.

At the most, the money value of eliminating curvature is of but minor importance from the standpoint of economical operation only. Wellington estimates that 36% of the working expenses vary with the curve resistances, which average about ½ lb. per ton per degree. Taking the average level tangent resistance as 6 lbs. per ton, this is equivalent to a continuous 12° curve, or 633° of curvature in a mile. Assuming the cost of a train mile as 85c., the yearly value per daily train each way for eliminating 1° of curvature is:

$$\frac{85c. \times 36\%}{633} \times 365 \times 2 = 35.3 \text{ cts.}$$

The number of daily trains used in this estimate will be that operated on the old line, or necessary to handle the same volume of traffic on the new line, according as the curvature is greater or less on the old than on the new line.

A reduction of curvature, unlike a reduction of grades, always involves the construction of more or less new line, so that from the smallness of the above figure it is evident that the elimination of curvature alone, unless attended by a reduction in the ruling grade or a shortening of distance, is seldom, if ever, warranted by the consequent saving in operating expenses.

Having now estimated the yearly value in operation of each of the several kinds of the proposed improvements, the amounts in favor of or against the alterations may be summarized for comparison as follows:

ESTIMATE OF ECONOMIC VALUE OF IMPROVEMENTS.

From.............................. To..............................
Description of work..............................

Nature of Change		Present Line	Proposed Line	Difference	Yearly Value
DISTANCE					
" Effect on operating expenses					
" " passenger receipts					
" " freight "					
Actual Grade......compensated......bound					
" " ...... " ......bound					
Virtual " " ......bound					
" " " ......bound					
Rating of......class locomotive......bound	Tons				
" ...... " " ......bound	"				
Rise and Fall, on maximum grade	Feet				
" " medium "	"				
" " minor "	"				
CURVATURE	DEGREES				
Time Saved by passenger trains......bound	Min.				
" " " " ......bound	"				
" " freight " ......bound	"				
" " " " ......bound	"				
Improvements in alignment					
Total yearly saving in favor of improvements					

When radical changes of this character are contemplated it is usual at the same time to improve the standard of the track. The cost of such work is not, however, properly chargeable to the improvements, and for the purposes of comparison should be deducted from the total estimated cost of the proposed changes. The balance, chargeable to improvements, divided into the estimated yearly saving gives the rate of interest on the expenditure.

In this manner a number of suggestions for improving a line may be reduced to their money equivalents and that proposition adopted which, consistent with other requirements, will pay the largest percentage of interest on the investment.

C.P.R. Earnings, Expenses, Etc.

The statement for the year ended June 30, shows:

Gross earnings	$37,503,054
Working expenses	23,417,142
Net earnings	$14,085,912
Income from other sources	958,827
Total net income	$15,044,739
Less fixed charges, including interest on land bonds	7,334,825
Less amount applied against ocean steamships	150,000
Net revenue available for dividends	$7,559,914

After paying half-yearly dividends to Dec. 31, 1901, and providing for a half-yearly dividend of 2% on the preference stock and 2½% on the common stock for the half-year ended June 30, there will be a balance of $3,063,074 to be carried forward from the year's operations.

Gross earnings, working expenses, net profits, increases or decreases over 1901-02, from July 1, 1902:—

	Earnings.	Expenses.	Net Profits.	Increase or Decrease
July	$3,246,620.51	$2,070,909.26	$1,175,711.26	$79,844.32+

Approximate earnings for Aug. $3,448,000 as against $3,057,000 for Aug., 1901.

DULUTH, SOUTH SHORE AND ATLANTIC RY.—Comparative figures for 1900-1 and 1901-2:

	1901-2.	1900-1.
Gross earnings	$2,690,569	$2,484,210
Operating expenses	1,688,818	1,654,931
Net earnings	$1,001,751	$829,279
Other income	6,285	5,900
Total income	$1,008,036	$835,179
Fixed charges	859,700	860,023
Taxes	128,009	88,249
Balance	+$20,327	—$113,193

+Surplus,—deficit.

Gross earnings for July, 1902, $267,216.84; net earnings, $115,540.42; against $255,627,50 gross and $110,308,94 net for July, 1901. Approximate earnings for Aug., $263,443 against $243,619 for Aug., 1901.

MINERAL RANGE RY.—Approximate earnings for Aug., $44,970, against $32,211 for July, 1901.

MINNEAPOLIS, ST. PAUL AND SAULT STE. MARIE RY.—Gross earnings for July, $592,278,76; net earnings, $275,806,36; against $445,919.53 gross and $203,361 net, for July, 1901. Approximate earnings for Aug., $529,025, against $430,224 for Aug., 1901.

Canadian Pacific Railway Land Sales.

	Acres. 1902-03	Acres. 1901-02	Amount. 1902-03	Amount. 1901-02
July	155,344.93	49,089.96	$562,876.50	$154,646.84

Grand Trunk Ry. Earnings, Expenses, &c

The accounts for the half-year to June 30, show the following results:

Gross receipts	£2,377,200
Working expenses	1,603,500
Net receipts	£ 773,700
Net revenue charges for ½-year, less credits	511,400
Balance	£ 262,300
Deduct Detroit, Grand Haven and Milwaukee Ry. deficiency for ½-year	14,800
Surplus	£ 247,500

This surplus added to the balance of £8,200 from Dec., 1901, makes £255,700 available for dividend, which will admit of the payment of the dividends for the ½-year, on the 4% guaranteed stock and 1st and 2nd preference stocks, leaving about £2,600 to be carried forward. The accounts of the G. T. Western Co. for the year ended June 30, 1902, show a surplus sufficient to provide for the interest on the 1st mortgage bonds, and leave a balance of about £2,800 to be carried forward.

The following statement of earnings, supplied from the Montreal office, includes the G. T. of Canada, the G. T. Western, & the Detroit, Grand Haven & Milwaukee Rys.

	1902.	1901.	Increase.	Decrease.
Jan	$2,278,978	$2,242,117	$36,861	....
Feb	2,018,926	2,005,341	13,585	....
Mar, ...	2,537,873	2,386,090	151,783	....
April	2,436,756	2,365,491	71,265	....
May	2,574,198	2,343,535	230,663	....
June	2,503,824	2,333,204	170,620	....
July.......	2,589,422	2,365,970	223,452	....
Aug........	2,719,303	2,645,340	73,963	....
	$19,659,280	$18,687,088	$972,192	....

The following figures are issued from the London, Eng., office :

TRAFFIC RECEIPTS OF THE SYSTEM.

Aggregate from July 1 to July 31 :

	1902.	1901.	Increase.	Decrease.
Grand Trunk....	£437,654	£401,607	£36,047	......
G. T. Western...	74,761	63,201	11,560	.....
D., G. H. & M..	19,658	21,349	......	1,601
Total.......	£532,073	£486,157	£45,916	.....

Canadian Ticket Agents' Association.

E. De La Hooke, Secretary-Treasurer, issued a circular to members on Aug. 16, from which the following extracts are made : For the first time in the history of our association we are to hold our annual meeting this year on foreign soil, and in connection with our so doing it is necessary that certain conditions which must govern our trip from Suspension Bridge, N.Y., to Washington, D.C., and return, should be clearly set forth. We shall be travelling in what may be termed anti-pass territory, as a special party by special train, no transportation being issued, and any member of the party voluntarily or otherwise getting separated from the crowd will have to bear the consequences. The stringent agreement disallowing the interchange of passes by roads operating in this territory renders it impossible for the companies (no matter how willing they might be) to come to the rescue, and any one that is not satisfied to adhere to the party from start to finish, or to pay fare while so separated, is advised to forego the trip. This injunction and the penalties attached to its infringement have been so strongly impressed on the executive that they would fail in their duty did they not make an effort to present it to all concerned in an equally forcible manner. The several railway companies who have at all times been ever ready to grant us the privileges of their lines have again agreed to issue free transportation to members and their wives on their way to and from Suspension Bridge, N.Y. For our trip from Suspension Bridge to Philadelphia and Washington and return we shall be indebted to the Lehigh Valley, Philadelphia & Reading and the Baltimore and Ohio ; for the trip to Richmond, Va., to the Richmond, Fredericksburg & Potomac, and to the Philadelphia & Reading for the day at Atlantic City.

The Pullman Car Co. has agreed to furnish the required number of sleeping-cars to accommodate the party, the arrangement being that members will pay tariff fare on going journey, take receipt for fare paid, which receipt will be exchanged for pass to carry the holder home free in the same or similar accommodation to that occupied on outward trip. The charges therefore for the service from Suspension Bridge to Washington and return will be as follows : Upper or lower berth, $2.50 ; section, $5 ; drawing-room, $9. It will be the duty of the executive to allot the space, and every effort will be made to please, preference being given to married couples and early applicants. If, however, in their anxiety to satisfy all with centre lowers, two or three married couples or otherwise are assigned the same cubicle, it is hoped that a trifle of that kind will not be allowed to upset the equanimity of those interested. It is to be regretted the new pattern cars, having all lowers and all in the centre, will not be in commission until on or after April 1.

Arrangements for hotel accommodation have been made with the Ebbitt House, Washington, and the Hotel Hanover, Philadelphia, the terms being on the American plan, $2.50 a day, with an extra charge of 50 cents per day for rooms with bathroom attachments.

Itinerary : Friday, Oct. 17, p.m., meet at

Suspension Bridge, N.Y.; Saturday, Oct. 18, p.m., arrive at Washington, D.C.; Sunday, Oct. 19, at Washington; Monday, Oct. 20, at Washington, annual meeting and dinner; Tuesday, Oct. 21, at Washington; Wednesday, Oct. 22, members will have the option of continuing their stay at Washington or taking trip to Richmond, Va., returning to the capital to sleep; Thursday, Oct. 23, at Philadelphia; Friday, Oct. 24, early start for Atlantic City, there to spend the day, returning to Philadelphia at such time as to take special to ensure a connection at Suspension Bridge on Saturday morning at 7.05. with trains west, and Toronto and east.

Mainly About People.

Capt. A. Taylor, for many years deputy harbor master of Toronto, died there recently, aged 86.

Dr. Ickes, of the Von Echa Construction Co., has recently been in ill health, but is now recovering.

F. Grundy, General Manager of the Quebec Central Ry., has returned to Sherbrooke, Que., from Eng.

W. G. Robertson, Division Freight Agent of the I. C. R., at St. John, N. B., died suddenly there, recently.

J. Kelly, travelling passenger agent of the I.C.R., St. John, N.B., died after a short illness in Halifax, Aug. 4.

J. Crathern has been re-elected as the representative of the Montreal Board of Trade on the Harbor Commission.

Capt. T. Crawford, of Wolf Island, Ont., a well-known mariner on the Great Lakes, died recently in Chicago, Ill.

Geo. Hanna, Passenger Traffic Manager for the Allan Steamship line at Montreal, is in Great Britain on a holiday trip.

W. Basham, Chief Train Dispatcher G.T.R., Montreal, was drowned while bathing at Old Orchard, Me., Aug. 7.

G. M. Bosworth, 4th Vice-President, C.P.R., has returned to Montreal from a vacation in the French River district.

F. W. Bevan, Chairman of the board of the Anglo-American Telegraph Co., London, Eng., is touring in Canada and the U.S.

E. G. Russell, who recently resigned as Manager of the I. C. R., at Moncton, has removed to Buffalo, N. Y., temporarily.

C. Pelletier, C. P. R. agent and operator at Point Rouge station, Que., was accidentally killed there by a pile of lumber falling on him.

D. Murdoch, of Murdoch Bros., railway contractors, Markdale, Ont., was married at Owen Sound, Aug. 19, to Miss E. L. Moore.

J. N. Beckley, President of the Toronto, Hamilton and Buffalo Ry. Co., is expected home from a European trip during this month.

R. G. Reid, President of the Reid Newfoundland Co., has been in ill health for some time, and is not expected in St. John's for the present.

Capt. John Pitritte, a well known lake mariner, and until four years ago collector on the Welland Canal, died in Toronto, recently.

C. M. Hays, 2nd Vice-President and General Manager G.T.R., and his daughters, have returned to Montreal from a trip to England and France.

Capt. R. C. Adams, who died recently at Sedwick, Me., aged 63, lived in Montreal for many years, and was a well-known master mariner and author.

The memorial fountain to the memory of the late Sir Geo. A. Kirkpatrick, President of the Dominion Express Co., at Kingston, Ont., has been completed.

C. F. Hanson, who was Mechanical Superintendent of the London and Port Stanley Ry., and later with the G.T.R., died in London, Ont., Aug. 17, aged 83.

A. H. MacLeod, I.C.R. ticket agent at Mulgrave, N.S., was presented with a suit case recently on leaving for Calgary, Alta., to enter the service of the C.P.R.

Capt. T. A. Brown, Port Dalhousie, Ont., died there Aug. 15, from blood-poisoning, caused by a scratch in the throat inflicted by the " beard " of a stalk of barley.

F. A. Heinze, who built the Columbia and Western Ry. between Robson and Rossland, B.C., and sold it to the C.P.R., has been elected a director of the Alaska Central Ry.

H. Darling, consulting engineer and marine surveyor, Vancouver, B.C., has been appointed Surveyor there for the British Corporation for the Survey and Registry of ships.

F. P. Brady was recently presented with an address by the C.P.R. employes at the Union Station, Toronto, on leaving to take up his new duties as Superintendent at Fort William, Ont.

Capt. S. Carter, Port Colborne, Ont., has gone to Prince Edward Island, to take charge of M. J. Haney's vessels engaged in connection with the building of the bridge over the Hillsboro' river.

Capt. E. Gatfield, of Amherstburg, Ont., master of the str. V. H. Ketchum, disappeared at the end of July, and nothing has been heard of him since. He was last seen in Cleveland, Ohio.

F. A. Miller, Superintendent of the Galena Signal Oil Co.'s branch office, Toronto, and nephew of General Miller, President of the Co., died at his residence, St. Clarens Ave., Toronto, Aug. 3.

Sir Wm. Van Horne has been entertaining a number of guests at his summer residence, St. Andrews, N. B., among them being Senor Gonzalo de Quesada, the Cuban Minister at Washington.

Jas. McMillan, U.S. Senator from Michigan, who died at Manchester-by-the-Sea, Mass., Aug. 10, was born in Hamilton, Ont., 1838, and established the Ontario Car Works at London, Ont., in 1872.

R. B. Van Horne, son of Sir William Van Horne, Chairman of the Board, C. P. R., and President of the Cuba Co., is in New York recovering from an attack of typhoid fever contracted in Cuba.

Geo. H. Palmer, station agent of the Halifax and Yarmouth Ry., at Yarmouth, N. S., was presented with a gold chain and locket by the employes of the line, on leaving to enter the C. P. R. service.

The engagement is announced of A. M. Jones, of the Baltimore and Ohio Rd. engineering staff, and formerly of Toronto, to Miss Marion Barker, daughter of R. W. Barker, Cecil St., Toronto.

A. Kingman, a director of the Dominion Coal Co., of the Montreal Transportation Co., and of the Halifax Electric Tramway Co., has been elected a director of the Sun Life Assurance Co. of Canada.

J. A. Sheffield, who recently resigned as Superintendent of Sleeping, Dining and Parlor Cars, and Hotels, C. P. R., has been presented with a silver and gold loving cup by the employes of the department.

W. H. Price, formerly of the I. C. R. passenger department at Montreal, has been appointed Assistant Passenger Agent of the Eastern Steamship Co., Boston, Mass., which operates a line to Nova Scotia ports.

P. S. Archibald, C.E., who has been appointed third arbitrator for the adjustment of the Reid Newfoundland Co.'s claims against the Newfoundland Government, spent a month in B.C. before proceeding to St. John's, Nfld.

L. Coste, of the engineering section of the Dominion Public Works department, will be appointed to take charge of a new office, to be created for the purpose of looking after transportation problems on the Great Lakes.

Prior to leaving Vancouver, B.C., to take up his new duties as Superintendent of Sleeping, Parlor and Dining Cars, and Hotels, of the C.P.R. at Montreal, G. Mc. L. Brown was entertained at a dinner by the citizens of Vancouver.

J. Cochrane, Mayor of Montreal, who in early life was a telegraph operator in the employ of the Montreal Telegraph Co., attended the telegraphers' convention, in Salt Lake city, early in Sept.

Mrs. Dunsmuir, wife of the Hon. J. Dunsmuir, President of the Esquimalt and Nanaimo Ry., and Premier of B.C., and Miss Dunsmuir, were recently presented at a Court held by the King and Queen, at Buckingham Palace, London, Eng.

T. R. Price, at one time connected with the I. C. R. engineering department, has been appointed General Manager of the Central South African railways in the Transvaal and Orange River colonies, by Sir Percy Girouard, who is in charge of the railways of the colonies for the Imperial Government.

Thos. McDowell, who was one of the contractors for the construction of the old Northern Ry., the old Suspension Bridge at Burlington Beach, the International Bridge for the C.P.R. at Sault Ste. Marie, Ont., and the Wellington, Grey and Bruce Ry., died at Owen Sound, Ont., Aug. 23, aged 84.

M. P. Kelly, chief clerk in the C.P.R. car shops, Montreal, and Secretary of the Canadian Railway Club, has resigned these positions, and has entered the service of a railway supply house with headquarters at Chicago, Ill. W. H. Rosevear, jr., chief clerk of the G.T.R. car department at Montreal, succeeds him as Secretary of the Canadian Railway Club.

A. Torrey, Chief Engineer of the Michigan Central Ry., died Aug. 20, in the Harper Hospital, Detroit, Mich., from injuries received in an accident on the line at Albron, Mich. Mr. Torrey, who was making an inspection, was riding on a gasolene motor, when it was run into on a sharp curve by a local freight. Jumping from the motor, he fell on a pile of rails and received internal injuries from which he died.

P. E. Ryan, who has been appointed Secretary-Treasurer of the Ontario Government Commission to build the Temiskaming and Northern Ontario Ry., was born at Ottawa, July 26, 1876, and entered railway service in Oct., 1892, since which his record has been: Oct., 1892, to June, 1895, clerk stores department, Canada Atlantic Ry., at Ottawa; June, 1895, to Oct., 1897, secretary and general clerk in superintendent's office, same road; Oct., 1897, to Dec., 1899, clerk in General Purchasing Agent's Dept., C. P. R., Montreal; Dec., 1899, to July, 1902, private secretary to the Minister of Public Works for Ontario.

T. McHattie, Master Mechanic of the G.T.R. at Montreal, whose portrait is on page 293 of this issue, was born at Dufftown, Banffshire, Scotland, Aug. 8, 1854, and entered railway service Oct. 2, 1870, since which he has been consecutively to 1878 in locomotive shops, Great Western Ry. (now part of the G.T.R.) at Hamilton, Ont.; June, 1878, to Aug., 1886, locomotive engineer, same road; Aug., 1886, to April, 1889, locomotive foreman, G.T.R. at Palmerston, Ont.; April, 1889, to April, 1898, general foreman in charge of locomotives, same road, at London, Ont.; April, 1898, to date, Master Mechanic, Eastern division, same road, at Montreal.

E. P. Hannaford, for 30 years to 1896 chief engineer of G.T.R., died suddenly in Montreal, Aug. 18, aged 68. He was born at Stoke Gabriel, Devonshire, Eng., in 1834, and entered railway service in 1851 in England, under Sir I. K. Brunel, and was particularly engaged on the engineering staff of the South Devon Ry., a 6 ft. gauge line, from Exeter to Plymouth, designed to be operated on the "Atmospheric" system. This system was operated on the first section in 1844, but was soon abandoned, and the line completed as a steam railway soon after Mr. Hannaford joined the staff. The big bridge over the Tamar at Saltash, Cornwall, was designed and mainly constructed during the time Mr. Hannaford was with Sir I. K. Brunel. Coming to Canada, Mr. Hannaford was appointed assistant engineer of the G.T.R. in 1857, and Chief Engineer in 1866. In 1873 he was appointed Chief Engineer of the International Bridge Co., and superintended the construction of the bridge over the Niagara river at Fort Erie. He was also Chief Engineer of the Montreal and Champlain Jct. Ry., and of the Jacques Cartier Union Ry., and United States and Canada Ry.

TRANSPORTATION APPOINTMENTS.

Algoma Central and Hudson Bay Ry.—W. Apps, formerly Master Car Builder of the C.P.R., has been appointed Master Car Builder of the A.C. and H.B. Ry., vice H. M. Perry, resigned.

J. C. Urich has been appointed Superintendent at Michipicoten Harbor, vice J. R. Patterson, resigned.

G. A. Montgomery has been appointed Superintendent at Sudbury, vice J. C. Urich, promoted.

Brockville, Westport and Sault Ste. Marie Ry.—W. H. Cole has been appointed Vice-President.

Canadian Northern Ry.—J. M. Robb, heretofore with the Virginia and South West Ry., has been appointed Superintendent of Motive Power of the C.N.R. Office at Winnipeg.

W. S. R. Cameron, heretofore City Freight Agent at Winnipeg, has been appointed Travelling Freight and Passenger Agent.

R. Crawford has been appointed City Freight Agent.

D. Jelly, heretofore Roadmaster of the C.P.R. at Schrieber, Ont., has been appointed Roadmaster of the C.N.R. at Port Arthur, with jurisdiction from Port Arthur to Rainy River.

Canadian Pacific Ry.—G. Mc. L. Brown, who was recently appointed Superintendent of Sleeping, Dining and Parlor Cars, also has jurisdiction over the Co.'s hotels in the same manner as his predecessor, J. A. Sheffield, had. This includes the Banff, Field, Glacier, North Bend, Sicamous and Vancouver hotels, and the Emerald Lake and Lake Louise chalets, but not the Chateau Frontenac and Place Viger hotels. He also has jurisdiction over the news department.

The reorganization of the engineering department has been completed. The Chief Engineer, E. H. McHenry, is in general

GRAND TRUNK RAILWAY COMPANY OF CANADA

NOTICE is hereby given that the Ordinary General Half-Yearly Meeting of the Grand Trunk Railway Company of Canada will be held at the City Terminus Hotel, Cannon Street, London, E.C., on Monday, the 13th day of October, 1902, at Two o'clock, p.m., precisely, for the purpose of receiving a Report from the Directors, and for the transaction of other business of the Company.

Notice is also given that the Transfer Books of the Company, will be closed from Thursday, the 18th day of September, to the day of Meeting, both days inclusive.

By order,

C. RIVERS WILSON, President.
H. H. NORMAN, Secretary.

Dashwood House,
9 New Broad St., London, E.C.,
5th September, 1902.

charge of the construction of new lines and of the engineering on operated lines. W. F. Tye, heretofore Chief Engineer of Construction, has been appointed Assistant Chief Engineer, in charge of construction of new lines. F. P. Gutelius, formerly resident engineer at Nelson, B.C., and latterly attached to the General Manager's office, has been appointed Engineer of Maintenance of Way; H. E. Vantelet, formerly Assistant Chief Engineer, and latterly acting as Chief Engineer, has been appointed Engineer of Bridges; and H. Goldmark, whose biography will be found in our May issue, pg. 167, has been appointed Assistant Engineer in charge of construction of Hochelaga shops. The division engineers are located at general superintendents' headquarters, as heretofore, but now report direct to the Chief Engineer on engineering matters. The resident engineers remain located at superintendents' headquarters, reporting to the division engineers.

J. Paul has been appointed Locomotive Fuel Inspector. Master mechanics, locomotive foremen, road foremen, engineers and firemen will observe his instructions in reference to the draft appliance and the firing and running of locomotives, and render him the assistance required to obtain a more economical fuel record.

J. W. Kelly, heretofore foreman of car repairs and inspector of new work on the Minneapolis, St. Paul and Sault Ste. Marie Ry., has been appointed General Car Inspector, to inspect new car construction and repair work.

The territory assigned to the District Freight and Passenger Agent, F. W. Salsbury, with headquarters at Pittsburg, Pa., is defined by the south shore of Lake Erie from the Pennsylvania-New York state line to and including Sandusky, Ohio, thence south by the Columbus, Sandusky and Hocking Ry. to Columbus, Ohio, and thence Hocking Valley and Baltimore & Ohio South-Western railways to Parkersburg, W. Va., including points on and east thereof, the State of West Virginia, and points in the State of Pennsylvania, west of the Northern Central and Cumberland Valley Rys.

A. Price, Superintendent of districts 8 and 9, has been transferred to districts 10 and 11, comprising lines west and north of Toronto Jct., vacated by Superintendent Brady transferred. Office at Toronto.

J. Manson, heretofore Superintendent of district 20 at Winnipeg, has been appointed Superintendent of districts 8 and 9, which include lines east and south of Toronto and Toronto terminals. Office at Toronto.

F. Dillinger having been transferred, R. Chapple, hereto Superintendent of district 18 at Schrieber, Ont., has been appointed Superintendent district 17. Office at Chapleau, Ont.

G. Erickson, heretofore roadmaster at Cranbrook, B. C., has been appointed acting Superintendent district 18, vice R. Chapple, transferred. Office at Schrieber, Ont.

The western division has been divided into seven districts, instead of six as heretofore. They are as follows :

District 19.	Miles.
Port Arthur to Winnipeg Junction	429.1
Molson to Lac Du Bonnet	22.0
Dyment to Otto mine	6.9
	458.0

District 20.	
Winnipeg Terminals	3.4
Souris Sec. Jct. to Napinka	218.3
Winnipeg Jct. to Emerson	64.3
Winnipeg Jct. to Winnipeg Beach	50.1
Air Line Jct. to Teulon	37.7
Rosenfeld to Gretna	13.7
Wood Bay to Snowflake	16.3
Deloraine to Waskada	17.2
	421.0

District 21.	
Souris to Souris Sec. Jct	147.6
Elm Creek to Carman	12.1
Kemnay to Estevan	156.2
Menteith Jct. to Arcola	94.8
	410.7

District 22.	
Air Line Jct. to Brandon	130.8
Portage la Prairie to Yorkton	222.9
Minnedosa to Rapid City Jct	18.2
Binscarth to Russell	11.3
Chater to Miniota	71.0
MacGregor to Wellwood	26.1
	480.3

District 23.	
Brandon to Moose Jaw (exclusive)	265.6
Regina to Prince Albert	249.3
	514.9

District 24.	
North Portal to Pasqua	160.3
Moose Jaw to Medicine Hat (not including Medicine Hat)	262.1
	422.4

District 25.	
Medicine Hat to Laggan	296.1
C. & E. Jct. to Edmonton	296.2
	592.3

District 26.	
Dunmore Jct. to Kootenay Landing	393.9
Fernie to Mines	5.0
North Star Branch	19.1
Marysville Branch	1.5
	419.5

F. J. Brady, heretofore Superintendent of districts 10 and 11, at Toronto, has been appointed Superintendent of district 19, with office at Fort William, Ont., vice D. G. Ross "on sick leave."

J. T. Arundel, heretofore Car Service Agent at Winnipeg, has been appointed Superintendent district 20. Office at Winnipeg.

R. Peard, heretofore Superintendent district 22, at Brandon, Man., has been appointed Superintendent district 21. Office at Souris, Man. Press dispatches say that he is about to resign.

J. G. Taylor, of Montreal, has been appointed acting Superintendent district 22. Office at Brandon, Man.

Winnipeg papers state that C. W. Milestone, Superintendent of old district 24, at Moose Jaw, Assa., who has been on leave of absence for some months, during which he visited Japan, has resigned, and that he will go into banking business at Moose Jaw. A. Allan, Chief Train Dispatcher at Calgary, has been acting as Superintendent at Moose Jaw during Mr. Milestone's absence.

C. S. Maharg has been appointed Trainmaster at Toronto Jct., Ont., succeeding D. H. Bell, transferred to the western division.

J. K. McNeillie has been appointed Car Service Agent of the western division, at Winnipeg, succeeding J. T. Arundel, appointed Superintendent.

J. B. McTaggart has been appointed Bridge and Building Master between Swift Current and Laggan, vice W. M. Cross assigned other duties, and will have full charge of bridges, buildings and water supply.

E. S. MacFarlane, heretofore clerk in the office of Superintendent of Rolling Stock, has been appointed chief clerk in the Master Car Builder's office at Montreal, vice M. P. Kelly, resigned.

R. J. Lydiatt, heretofore chief clerk in the office of the Superintendent of district 8 and 9, at Toronto, has been appointed to a similar position in the office of the Superintendent at Fort William, Ont. P. D. Shand succeeds him at Toronto.

A. Hutchinson, heretofore chief clerk in the C. P. R. yard office, at Winnipeg, has been appointed chief clerk in the office of the Superintendent of district 20 at Winnipeg, vice J. Franks resigned.

Chicago, Rock Island and Pacific Ry.—Press reports say that A. Jackson has been appointed District Passenger Agent in charge of Canadian territory, with headquarters at Montreal.

Duluth, South Shore and Atlantic Ry.—H. D. Smead has been appointed Travelling Passenger Agent, with headquarters at Duluth, Minn., to succeed J. A. Michaelson, transferred to eastern territory.

Great Northern Rd., U.S.A.—J. F. Stevens, heretofore Chief Engineer, has been appointed General Manager.

G.T.R.—C. E. Dewey, heretofore Division Freight Agent at Stratford, Ont., has been appointed Division Freight Agent at Toronto, vice A. White, "who after a long and faithful service has resigned on account of impaired health."

J. P. Gay, heretofore chief clerk to the Division Freight Agent at Detroit, Mich., has been appointed Division Freight Agent at Stratford, Ont., succeeding C. E. Dewey.

C. Clarke, Division Freight Agent at Detroit, will in future also act as Manager of the Milwaukee and Michigan fast freight line, which duties were heretofore performed by his chief clerk, J. P. Gay, who has been promoted.

A. D. Huff, heretofore Travelling Freight Agent at London, Ont., has been appointed chief clerk to Division Freight Agent Clarke, at Detroit, Mich., succeeding J. P. Gay, promoted.

F. Porter, heretofore soliciting freight agent at Hamilton, Ont., has been appointed Travelling Freight Agent at London, Ont., succeeding A. D. Huff.

E. Larkin has been appointed Agent at Detroit, vice J. Caldwell, jr., transferred.

The following agents have been installed : Bryant's Pond, Me., D. E. Hayes ; Lewiston Jct., Me., C. S. Patterson ; Pownal, Me., F. Wood ; Arthabaska, Que., N. Morrill ; St. Johns, Que., W. S. Rollo ; Brockville, Ont., freight, T. King ; Deseronto Jct., Ont., F. B. Allison ; Whitby Jct., Ont., C. E. Ravin ; Bethany, Ont., J. H. Bateman ; Sarnia Tunnel, Ont., passenger, T. W. Midforth ; Chicago, Ill., freight, J. Caldwell ; Elsdon, Ill., J. Caldwell ; U.S. Yards, Ill., J. Caldwell ; Detroit, Mich., freight, E. Larkin ; Milwaukee Jct., Mich., E. Larkin ; West Detroit, Mich., E. Larkin ; Harvard, Mich., E. Lanning ; Moorland, Mich., N. A. Cook ; Rochester, Mich., W. C. Tuttle ; Stockbridge, Mich., G. L. Knight.

Halifax Electric Tramway.—T. H. Burgess has been appointed Inspector.

Intercolonial Ry.—E. G. Russell, Manager, having tendered his resignation, J. E. Price has been appointed General Superintendent, with headquarters at Moncton, N.B. He will have charge of the maintenance of way and works and of the station and train services.

Evan Price, heretofore Chief Dispatcher at Campbellton, N.B., has been appointed Superintendent of the Moncton and Ste. Flavie district, succeeding J. E. Price.

H. H. Bray has been appointed Chief Dispatcher at Campbellton, N.B., succeeding E. Price.

E. S. Smiley, heretofore chief clerk in the Assistant General Freight Agent's office at Montreal, has been appointed Division Freight Agent at St. John, N.B., succeeding the late W. G. Robertson.

N. L. Rand has been appointed Master Mechanic, with office at Moncton, N.B. His jurisdiction is over the division from Moncton to Halifax and St. John, including Moncton and Truro terminals.

D. M. Condon, heretofore secretary to the General Manager, has been appointed Travelling Passenger Agent. He has been succeeded as secretary by H. Thomas.

Inverness Ry. and Coal Co.—J. L. Brass has been appointed General Manager, suc-

ceeding N. McKenzie. Mr. Brass was assistant to the 2nd Vice-President and General Manager Virginia and South Western Ry., when C. Shields occupied the latter position.

N. McKenzie, heretofore General Manager, has been appointed Manager of the Co.'s mines.

Lotbiniere and Megantic Ry.—Revised official list to date: President, F. M. McCrea; Vice-President, B. Quinn; Secretary-Treasurer, J. Begin; Superintendent and General Agent, G. W. Robins; Accountant, J. A. Barrie.

Michigan Central Rd.—W. S. Kinnear, heretofore Assistant to the General Superintendent, has been appointed Chief Engineer, succeeding the late A. Torrey.

E. H. Millington has been appointed Superintendent of the Telegraph. Office at Detroit, Mich.

Mount Sicker Ry., B.C.—J. W. McCready is reported to have been appointed Superintendent.

Pontiac Pacific Junction Ry.—Ottawa Northern and Western Ry.—F. Dillinger has been appointed Trainmaster. Office, Union Station, Ottawa. Until recently he was acting Superintendent of the C.P.R. at Chapleau, Ont.

Quebec Southern Ry.—G. H. Sargeant has been appointed Car Accountant, with headquarters at Montreal, vice Mr. Duchesne, assigned to other duties. Mr. Sargeant will also have charge of car service and car distribution.

Richelieu and Ontario Navigation Co.—M. Cussen has been appointed Auditor of Passenger Receipts.

Temiskaming and Northern Ontario Ry.—A. E. Ames has been appointed Chairman of the Ontario Government Commission to build this line. P. E. Ryan has been appointed Secretary-Treasurer; D E. Thompson, K.C., Toronto, acting Counsel; E. S. Senkler, North Bay, Solicitor, and W. B. Russell, Chief Engineer.

White Pass and Yukon Ry.—D. S. Wagstaff is reported to have been appointed Superintendent of Transportation. He was formerly District Passenger Agent of the C., H. and D. Rd.

RAILWAY FINANCE, MEETINGS, ETC.

Canada Eastern Ry.—Press reports state that this line has been sold to the C. P. R. and that the transfer will be made at an early date. J. Oborne, General Superintendent of the Atlantic Division, C. P. R., went over the line in company with the C. E. R. officials on Aug. 20. (July, pg. 229.)

Canadian Northern Ry.—Gross receipts for July, $132,300, against $82,300 for July, 1901.

C. P. R. Land Grants.—R. R. Angus, G. M. Clarke and J. Turnbull, trustees under the C. P. R.'s 5 % land grant mortgage, have given notice that in pursuance of the provisions for the redemption of the same, the whole of the remaining bonds, not heretofore called in for redemption, amounting to $1,314,500, are called for redemption at 10 % premium and accrued interest to date of redemption, provided that it be presented for that purpose at the office of the Treasurer of C. P. R. before the end of 60 days. On June 30, 1901, the Co. also had outstanding $15,000,000 of 3½ % land grant bonds, the interest on which is guaranteed by the Dominion Government. At June 30, 1901, the Co. had 15,071,916 acres unsold out of its original grant of 25,000,000 acres. It had also 857,831 acres out of the Manitoba and North-Western Ry. land grant and 174,656 out of the Columbia and Kootenay land grant. In addition it is entitled to receive about 3,350,000 acres through the B. C. Southern Ry., about 2,500,000 through the Columbia & Western Ry., and about 320,000 through the G. N. W. Central Ry.

Halifax Electric Tramway Co.—Gross receipts from railway:

	1902.	1901.	Increase or Decrease.
Jan	$10,674.58	$9,543.14	$1,131.44+
Feb	8,408.39	8,042.11	436.28+
Mar	9,761.57	9,448.32	313.25+
Apr	10,025.66	9,370.08	655.58+
May	11,126.66	9,467.15	1,650.51+
June	11,528.19	11,339.52	188.67+
July	14,834.69	14,203.82	630.87+
Aug	17,177.12	16,330.23	846.89+
	$83,536.86	$77,744.37	$5,792.49+

London Street Ry.—Traffic receipts:

	1902.	1901.	Increase or Decrease.
Jan	$ 9,980.93	$ 9,255.74	$ 725.19+
Feb	8,740.45	8,145.76	594.69+
Mar	10,108.54	9,294.54	814.00+
Apr	6,646.42	9,495.68	150.74+
May	11,970.88	10,003.16	1,867.72+
June	12,819.56	13,917.23	1,097.67—
July	15,215.04	14,214.13	973.91+
	$78,481.58	$74 353.24	$4,128.58+

Montreal Street Ry. Co.—Comparative statement of earnings and expenses for July:

	1902.	1901.	Increase or Decrease.
Passenger earnings	$194,194.35	$177,583.25	$16,611.10+
Miscellaneous "	4,461.97	597.06	3,864.91+
Total "	198,656.32	178,180.31	20,476.01+
Operating expenses	93,966.90	90,464.20	3,502.70+
Net earnings	104,689.42	87,716.11	16,973.31+
Fixed charges	19,929.76	14,141.53	5,782 23+
Surplus	84,759.66	73,574 58	11,185 08+
Expenses % of car earnings	48.39	50.94	2.55 —

Oct. 1, 1901, to July 31, 1902:—

	1902.	1901.	Increase or Decrease.
Passenger earnings	$1,618,377.01	$1,526,797.17	$91,579.84+
Miscellaneous "	25,459.54	6,408.90	19,050.64+
Total "	1,643,836.55	1,533,206.07	110,630.48+
Operating expenses	940,859.81	931,933.43	8,926.38+
Net earnings	702,976.74	601,272.64	101,704.10+
Fixed charges	164,228.46	104,409.48	59,818.98+
Surplus	538,748.28	496,863.16	41,885.12+
Expenses % of car earnings	58.14	60.97	2.83 —

South Shore Ry. Co.—In the end of 1901 the control of this Co. was purchased by a new syndicate generally referred to as the Webb syndicate, of which A. L. Meyer, broker, appeared to be the principal representative. Subsequently the Quebec Southern Ry. took over the line from A. L. Meyer, and the necessary steps were taken for the amalgamation of the two companies under the title of the Quebec Southern Ry. An action has been commenced in the Quebec Superior Court, at Montreal, against the Q. S. Ry. Co., the S. S. Ry. Co., the National Trust Co., W. Seward Webb, A. L. Meyer, B. P. Moore, P. W. Clement; F. D. White, H. A. Hodge, of Rutland, Vt.; and F. X. Choquet, Montreal; by R. Sutro, W. F. Harrity, C. E. Kimball, and B. W. Loeb, to have the agreement and sale of the S. S. Ry. to the Q. S. Ry. Co., set aside, and to prevent the National Trust Co. from issuing any bonds to cover the purchase price of the S. S. Railway. The plaintiffs in the action are a committee claiming to represent a majority of the members of the syndicate which purchased $299,000 of the $300,000 capital stock, all the $270,000 first mortgage 4% bonds of the S. S. Ry. Co., besides a large amount of its indebtness, and in their statement allege that A. L. Meyer was the syndicate's agent in purchasing the shares, etc., but had no right to dispose of the bonds, stocks or claims, or to exchange them for securities of any other company or to vote on them without the consent of the members of the syndicate, which was never given. In connection with their suit, the syndicate has registered the mortgage deed executed by the S. S. Ry. Co., June 1st, 1900, to secure $468,000 first mortgage 4% bonds, and deposited it with the Minister of Railways. The statement recites all the resolutions passed and the agreements entered into about the amalgamation and asks that the amalgamation be declared illegal and non-existent, and that the defendants named be declared non-shareholders, and that Messrs. Hodge and White, who have acted as officers of the South Shore Co., be enjoined from continuing so to act, as the transactions complained of are prejudicial to the interests of the plaintiffs.

Toronto Railway Co.—Car earnings compared with previous year:

	1902.	Increase or Decrease
January	$137,135.21	$15,478.01+
February	127,981.01	18,468.50+
March	141,681.22	17,182.23+
April	132,946.56	9,940.56+
May	145,595.54	17,634.60+
June	132,265.85	5,888.74—
July	162,472.12	12,840.88+

Newfoundland Railway Arbitration.

A claim amounting to $2,000,000 against the Newfoundland Government in connection with the building and operation of this railway is now before a board of arbitrators at St. John's, Nfld. The arbitrators are the Hon. Alfred Lyttleton, K.C., M.P., for Warwick, Eng., in behalf of the Government, C. C. Gregory, K.C., of Antigonish, for the contractor, and P. S. Archibald, ex-Chief Engineer of the Intercolonial Ry., third arbitrator, appointed by the Supreme Court. The claimant is the Reid Newfoundland Co., successor to R. G. Reid, contractor, of Montreal. The claim arises out of a number of contracts made between the Newfoundland Government and Mr. Reid since 1890. The first contract was for an extension of the railway north from near St. John's to Hall's bay, about 250 miles. Before this contract was completed the Government changed its policy and decided to stop this extension at the River Exploits and build west across the island to Port-aux-Basques, and another construction contract was entered into in 1893 for this extension of about 280 miles. In the same year a third contract was entered into with Mr. Reid for the operation and maintenance of the completed portions of the road, and also for the operation of the extensions then under construction, for a period of ten years. In the operating contract a provision was made that the contractor should provide, if the demands of the traffic warranted it, additional rolling stock, equipment, accommodation, etc., and upon the termination of this contract the Government was to take over this rolling stock, etc., and pay for it at a fair valuation. Under the construction contract of the same year the contractor was to build stations, piers, wharves, fences, etc., for which he was to be paid over and above his contract price per mile. For the next four or five years Mr. Reid continued to operate the completed portions of the railway and finished the projected extensions. In 1894 a panic overtook the colony, and within a few months every bank on the Island had closed its doors. For the next three or four years there was great financial stringency throughout the Island. So severe was it that the salaries of the judges of the Supreme Court and all other government officials were reduced about 20%. In the meantime Mr. Reid went on with the construction of the railway and completed the main line across the Island, together with a number of branches, making in all a system of about 650 miles, and costing the colony about $10,000,000. In 1898, the Government having changed in the meantime, a feeling had got abroad that the road when completed would not pay the expenses of operation and maintenance, and that in addition to the interest on the cost of construction, the colony would be further burdened with taxes to meet the deficit between the earnings and expenses at the expiry of Mr. Reid's operating contract for the 10 year period ending in 1903. At this stage, the Government being in financial straits, Mr. Reid offered, in consideration of further land grants and liberal annual subsidies, to secure steamers which he would furnish at his own cost to ply between outports all over the Island and points on the railway, and also other important concessions in connection with the dry dock and street railway in St. John's, to take over and operate the road for fifty years. He was to gurantee efficient operation for that period, and to pay the Government $1,000,000 in cash. At the end of 50 years the road was to be his. The Government accepted his offer, a new arrangement was entered into, and an Act was passed by the Legislature confirming it. Shortly after this Mr. Reid made application to the Legislature for the incorporation of a company to which he proposed to transfer all his interest in the colony. This was refused by a new Government that had come in subsequent to 1898. An appeal was made by the Government to the country in 1900, and the action of the Government was sustained by the popular vote. After negotiations extending over a year an agreement was reached between the contractor and the present Government whereby a new company was incorporated under the title of the Reid Newfoundland Co. The Government repays the $1,000,000 with interest and also takes back about one-half the lands granted under old contracts for which it pays $850,000 cash. The Government also agreed to refer the claims arising out of the operating and construction contracts of 1893 to arbitration. The contractor agreed to re-sell the road to the Government, and entered into a contract to efficiently operate and maintain it for 50 years. At the end of that period the Government will own the road.

Both parties are to be congratulated on the solution of this much-vexed question.

Notices to Mariners.

The Department of Marine has issued the following notices :—

No. 55. July 11.—British Columbia—205. Burrard inlet, North Vancouver, magnetic range established. 206. Burrard inlet, Brocton point, lighthouse established and fog-bell tower moved.

No. 56. July 12.—Ontario—207. Lake Huron, Kincardine, lighthouse on north pier burned down. 208. River St. Mary, Rains' dock gas buoy. 209. Chart, east side of Lake Huron, from Chantry island to Cove island, numbered 3,257, prepared from hydrographic surveys made by the Department of Marine, has just been published by the British Admiralty.

No. 57. July 17.—New Brunswick—212. Gulf of St. Lawrence, Shippegan gully, buoyage and hydrographic notes. Prince Edward Island—213. East coast, Cardigan bay, Panmure shoal, change in charac'er of buoy.

No. 58. July 19.—Ontario—216. Lake Erie, Port Colborne, change in color of light.

No. 59. July 21—Nova Scotia—217. Gulf of St. Lawrence, St. Paul island, Atlantic Cove, beacons. New Brunswick—218. Chaleur bay, Bathurst harbor, buoyage and hydrographic notes.

No. 60. July 23—Quebec—220. River St. Lawrence above Quebec, Point Nicolas, establishment of semaphore. 221. River St. Lawrence above Quebec, Cap Sante, semaphore discontinued. 222. River St. Lawrence above Quebec, Port St. Francis, back range light tower changed.

No. 61. July 23—Ontario—223. Lake Erie, position of wreck to the eastward of Middle island.

No. 62. July 24—British Columbia—225. Burrard inlet, Vancouver harbor, Burnaby shoal, clearing marks. 226. Strait of Georgia, Malaspena strait, Slimmon, position of church, etc. 227. Bute inlet, uncharted rock.

No. 63. July 26—Nova Scotia—228. South coast, Cape Sable, change in character of light.

No. 64. July 26—Ontario—229. Lake Superior, east end, Mica shoal, buoy.

No. 65. July 31—Quebec—230. River St. Lawrence, Traverse of St. Roch, lower end, lighthouse foundation, established and marked by lights. 231. River St. Lawrence, Traverse of St. Roch, removal of lightship.

No. 66. Aug. 1—Quebec—232. River St. Lawrence, south shore, Bécancour beacon removed.

No. 67. Aug. 2—Quebec—233. Gulf of St. Lawrence, off Cape Rosier, dangerous wreckage. Newfoundland—234. Hogo island, Tilton harbor, Sloan's hill, light established. 235. South coast Ramea islands, light established.

No. 68. Aug. 5—Ontario—237. River St. Mary, St. Joseph island, Stribling point, range light buildings.

No. 69. Aug 5—British Columbia—241. Queen Charlotte sound, off Foster island, uncharted rock. 242. Trincomali channel, Victoria rock, erratum. 243. Erratum.

No. 70. Aug. 6—Quebec—244. River St. Lawrence, Father point, change in lighthouse illuminant. 245. River St. Lawrence, mouth of Saguenay river, Prince shoal, gas buoy established. 246. River St. Lawrence, south traverse, Port Joli shoal, gas buoy established. 247. River St. Lawrence, Beaumont reefs, gas buoy established. 248. River St. Lawrence, Platon point, gas buoy established.

No. 71. Aug. 12—Ontario—249. Lake Erie, wreck to the eastward of Middle island marked by buoy. 250. Georgian bay, west side, Cape Croker, temporary change in character of light. 251. Lake Superior, east end, shoal off Corbay point. 252. Lake Superior, east end, shoal south of Montreal island.

The following notices have been issued by the U.S. Hydrographic office :

No. 33. Aug. 16 - Lake Superior—1131. Thunder bay, shoal reported. 1132. Duluth and Superior harbors, shoal spots removed. 1133. Duluth harbor basin, warning signal tower established.

No. 34. Aug. 23 - St. Mary's river—1174. Rains' dock, gas buoy No. 20 established.

September Birthdays.

Many happy returns of the day to

W. D. Barclay, ex-Manager, Alberta Ry. & Coal Co. and Great Falls and Canada Ry., now a contractor at St. Paul, Minn., born at Campbellton, N.B., Sept. 23, 1852.

G. T. Bell, General Passenger and Ticket Agent, G.T.R. at Montreal, born there Sept. 7, 1861.

F. R. F. Brown, ex-Mechanical Superintendent, Intercolonial Ry., now at Montreal, born at Helensburgh, Dumbartonshire, Scotland, Sept. 29, 1845.

M. H. Brown, Assistant General Freight Agent, C.P.R., at Toronto, born at Victoria Square, Ont., Sept. 2, 1866.

W. G. Brownlee, Superintendent, G.T.R., Western Division, at Detroit, Mich., born at Lawrenceville, Ill., Sept. 9, 1858.

J. R. Bruce, Traffic Auditor, Intercolonial Ry., at Moncton, N.B., born at Portsoy, Banffshire, Scotland, Sept. 23, 1848.

W. B. Bulling, Assistant Freight Traffic Manager, C.P.R., at Montreal, born there Sept. 16, 1858.

R. L. Burnap, Commercial Agent, Central Vermont Ry., and Agent, National Despatch Fast Freight Line at New York, N.Y., born Sept. 20, 1872.

G. B. Colpas, Auditor, New York & Ottawa Rd., and Ottawa & New York Ry. at Ottawa, Ont., born Sept. 28, 1858.

A. W. Ecclestone, Southern Passenger Agent, Central Vermont Ry., at New York, born at Hamilton, Ont., Sept. 25, 1858.

F. A. Folger, Jr., General Superintendent, Kingston & Pembroke Ry., at Kingston, Ont., born Sept. 17, 1865.

L. A. Hamilton, ex-Land Commissioner, C.P.R., born at Penetanguishene, Ont., Sept. 30, 1852.

L. B. Howland, President and General Manager, Irondale, Bancroft & Ottawa Ry., at Irondale, Ont., born at Lambton Mills, Ont., Sept. 2, 1869.

W. H. Kelson, General Storekeeper, C.P.R., born at Bath, Eng., Sept. 5, 1850.

H. D. Lumsden, C.E., engineering department C.P.R., born at Belhaire, Scotland, Sept. 7, 1844.

J. McNaught, Second Vice-President, Great Northern Ry. of Canada, at New York, born at Lexington, Ill., Sept. 9, 1842.

G. S. MacKinnon, Division Master Mechanic, C.P.R., at Winnipeg, Man., born at Melbourne, Que., Sept. 16, 1854.

H. L. Maltby, Secretary and Treasurer, Pontiac, Pacific Jct. Ry. and Ottawa, Northern and Western Ry., at Ottawa, born at Derby, Eng., Sept. 8, 1852.

G. A. Mountain, Chief Engineer, Canada Atlantic Ry., at Ottawa, Ont., born at Quebec Sept. 28, 1860.

J. E. Muhlfeld, Superintendent of Machinery and Rolling Stock, I.C.R., at Moncton, N.B., born at Peru, Ind., Sept. 18, 1872.

E. D. Nash, Assistant Superintendent, Central Vermont Ry. at New London, Conn., born at Shelburne Falls, Mass., Sept. 24, 1852.

J. Oborne, General Superintendent, Atlantic Division, C.P.R. at St. John, N.B., born at Montreal, Sept. 19, 1861.

E. D. Parker, Assistant General Freight Agent, Minneapolis, St. Paul & Sault Ste. Marie Ry. at St. Paul, Minn., born at Granville, Ohio, Sept. 20, 1839.

W. H. Rosevear, General Car Accountant, G.T.R., at Montreal, born at Wadebridge, Cornwall, Eng., Sept. 26, 1837.

D. Sutherland, General Freight Agent, Newfoundland Ry., at St. John's, Nfld., born at Niagara Falls, Ont., Sept. 21, 1873.

W. R. Tiffin, Superintendent, Northern Division, G.T.R., at Allandale, Ont., born at Hamilton, Ont., Sept., 1844.

W. Whyte, Assistant to the President, C.P.R., at Winnipeg, Man., born at Charleston, Scotland, Sept. 15, 1843.

The Northern Routes to the Pacific.

In connection with a number of railway projects having for their object the construction of new lines with terminals on the Pacific coast, for which parliamentary powers were obtained at Ottawa in 1901 and at the last session—two of them being extensions of old charters—it is interesting to recall the surveys made for the building of the C.P.R. through the Rocky mountains by the Dominion Government prior to 1880. The report of Sandford Fleming, now Sir Sandford Fleming, dated April 8, 1880, sums up the whole of the work previously done, and gives a mass of information relating to the districts of Saskatchewan, northern Alberta and northern B.C., that is undoubtedly of great value to the promoters of the railways now claiming attention. Three passes were surveyed through the Rocky mountains, viz., Yellowhead, Pine river, and Peace river, and the terminal points to be reached by them were Port Essington and Port Simpson, near the Skeena river, and Bute inlet. Of these passes the Yellowhead, crossed at a height of 3,738 ft., was looked upon with the most favor, the language of Sir Sandford's report being : "It was early seen that the Yellowhead pass offered more than usual advantages for a line of railway crossing the Rocky mountains, and that according to the information we possessed, that pass might be held to be a definite governing point by which the whole location would be controlled. The most persistent efforts were made for several years to discover a line running directly west from Yellowhead pass to the coast. They were fruitless. It was eventually established, that on the railway reaching Tête Jaune Caché, some 50 miles west of the Yellowhead pass, two routes only could be advantageously taken. The one, following a north-westerly course to a point near Fort George, turned south-westerly to gain the valley of the Homathco, by which it found a passage through the Cascade range to tide water at Waddington harbor. From

Waddington it was projected to follow the rocky and precipitous side of Bute inlet, and it was proposed to form a connection with Vancouver island across the strait of Georgia. Three subsidiary lines were suggested in connection with this route. One to leave the line near Fort George, and to run to Dean channel, the second on a more westerly course to reach the Pacific at Gardner inlet, a third following a north-westerly direction to find an outlet by the valley of the river Skeena. Of these four lines, the location which led to Bute inlet, as giving assurance of a possible railway connection with Vancouver island, was the only one which obtained any general local support. The second line on leaving Tête Jaune Caché, followed the valley of the Albreda and Thompson rivers to Kamloops, and proceeded by Lytton at the junction of the Thompson with the Fraser to Burrard inlet."

This pass is the one through which the Edmonton, Yukon and Pacific Ry. Co. has been authorized to construct a line by the Dominion Parliament. The charter of the E. Y. and P. Ry. has passed into the hands of Mackenzie, Mann & Co., and the Co. has been reorganized under Canadian Northern Ry. auspices. The two companies will ultimately be amalgamated, but it is as the E. Y. and P. Ry. Co. that Mackenzie, Mann & Co. have entered into a contract with the B. C. Government to construct the line from Bute inlet, on the Pacific coast, to the Alberta boundary of the province, via Yellowhead pass. In Alberta the E. Y. and P. Ry. has constructed about five miles of line from Strathcona, on the Calgary and Edmonton Ry., into the town of Edmonton, and purposes carrying on the construction westerly. Probably nothing more will be done on this portion of the line until the B.C. section is completed, as the contract with the Government calls for the commencement of construction from Bute inlet.

"Although," said Sir Sandford Fleming, "the Yellowhead pass was recognized as an important objective point affording an easy entrance from the east into B.C. through mountains previously pronounced impenetrable, the more northern passes of the Peace and Pine rivers attracted attention, and opinions were expressed that they offered a more natural passage for the railway through a fertile district with a salubrious climate. This territory had been partially explored. Sir Alexander Mackenzie discovered the Peace river, and traced it to its source in 1793. Sir George Simpson followed it in 1828. Its general features accordingly were to some extent known. The first examination under my direction was made in 1872, when I passed over the line from Lake Superior to the Pacific. In August of that year, when at Fort Edmonton, I detailed Mr. Horetzky and Prof. Macoun to proceed by way of Peace river to the Pacific coast to investigate, as far as practicable, the physical character of the region. . . . A second exploration of the northern district was made in 1877. The river Skeena was followed by Mr. Cambre from its mouth to a country drained by its south branch, the Watsanquah. The examination terminated at Fort George. The mountains themselves were crossed by Mr. Hunter in the same season by the Pine river pass." The result of these several explorations and surveys was that it was well established that a railway could be economically constructed through the country, which was reported to be fertile, and containing large mineral areas. When the building of the C.P.R. was entrusted to a company, the southern route via the Kicking Horse pass was chosen with a terminus at Vancouver, and it was left for other companies to exploit the northern passes.

The most promising of the projects reaching out in this direction is the Canadian Northern Ry., the evolution of which from a local line in Manitoba to a transcontinental line is proceeding apace under the ægis of Mackenzie, Mann & Co. One charter after another has been acquired, lines have been leased, others have been constructed, and with the passing of the Canadian Northern Ry. Act of 1902 by the Dominion Parliament, it is possible to map out the route of the new transcontinental line with a degree of accuracy hitherto impossible. In reading the act it is necessary to remember that the C.N. Ry. has its operating center in Winnipeg, and that all the work in connection with the extension of the line is referred to as being easterly towards the Atlantic, or westerly towards the Pacific. At the present time what is looked upon as being the main line starts at Port Arthur, Ont., runs through the Rainy river valley, through a portion of the state of Minnesota into Manitoba, and on via Winnipeg to Erwood, Sask., 810 miles; the whole system, including branches, extending over about 1,250 miles. The new lines authorized this year include a line easterly from a point between Fort Frances and Port Arthur, northeasterly and south-easterly to Quebec, with branches into Port Arthur, Ottawa and Montreal; a line westerly from the narrows of Lake Manitoba to Edmonton, Alta., and thence to the Pacific coast, near the Skeena river by way of the Pine river pass, with branches to Pas Mission, Sask., and Red Deer river, Alta. This will make the eastern end of the line at Quebec, and the western end at Port Essington or Port Simpson. So far as the eastern section of the line from near Port Arthur is concerned, nothing is likely to be done for some time, perhaps years, as a railway to follow the line suggested would tap an entirely undeveloped and partially unexplored country, south of Lake Nepigon and north of Lake Temiskaming, in Ontario; and through an equally little known country until within a few miles of Quebec.

Of the other lines reaching out to the Pacific coast, the Trans-Canada Ry. Co., with which officials of the Quebec and Lake St. John Ry. Co., and the Great Northern Ry. of Canada are associated, has commenced operations at Roberval, Que. Its objective point is Port Simpson, and it purposes reaching there by the Peace river pass. Two other charters exist for lines through these passes, the Pacific, Northern and Omenica Ry. Co. having B.C. and Dominion charters to construct a line from Kitamaat inlet on the Pacific coast, via Peace River pass, to Edmonton; and the Canada Central Ry. Co. having a charter for a line from French river, Ont., through northern Canada to the Yellowhead pass, and then southerly to Kamloops, Princeton, and into Victoria.

Following are the altitudes of the principal passes:—C.P.R. main line, Kicking Horse pass, Rocky mountains, 5,329 ft.; Rogers pass, Selkirk mountains, 4,351 ft.; Crow's Nest pass line, 4,449 ft.; Yellowhead pass, 3,738 ft.; Pine river pass, about 2,800 ft.; Peace river pass, 2,000 feet.

In the U.S. the Rocky Mountains are crossed by the principal lines as follows:—Northern Pacific Rd., Echo pass, 5,804 ft.; Santa Fee Pacific Rd., Whipple pass, 7,208 ft.; Southern Pacific Rd., Summit pass, 7,107 ft.; Union Pacific Rd., Sherman pass, 8,242 ft.

Canadians in U.S. Railway Service.

Among the Canadians occupying prominent positions in the United States railway service are the following:

C. T. Ambridge, Assistant Auditor, Mexican Northern Ry., at Mexico city, born at Hamilton, Ont., 1854.

W. C. Ambrose, Chief Engineer, Birmingham, Chattanooga & Atlantic Ry., at Birmingham, Ala., born at Princeport, N.S., 1857.

A. Andrews, General Agent, Atchison, Topeka and Santa Fe Ry., at St. Louis, Mo., born at Kincardine, Ont., 1865.

C. C. Annett, Assistant Superintendent Telegraphs, Illinois Central Rd., Chicago, Ill., born in Ont, 1845.

J. Bagley, General Manager, Tacoma, Eastern Rd., Tacoma, Wash., born at Quebec, 1850.

R. Ballance, General Foreman, Car Dept., Burlington and Missouri River Rd., at Denver, Colo., born at Kingston, Ont., 1850.

W. D. Barclay, ex-General Manager Alberta Ry. and Coal Co., and Great Falls and Canada Ry. Co, St. Paul, Minn.; born at Campbelltown, N.B., 1852.

J. A. Barnard, General Manager Cleveland, Cincinnati, Chicago and St. Louis Ry., and President Peoria and Pekin Ry., at Indianapolis, Ind., born at Grenville, Que., 1861.

W. G. Barnwell, Assistant General Freight Agent Southern California and San Francisco and San Joaquin Rys., and Santa Fe Pacific Rd., at Los Angeles, Cal., born at Danville, Que., 1865.

Thomas F. Barton, Master Mechanic, Illinois Central Rd., at Paducah, Ill., was a G.T.R. call boy and machinists' apprentice in Canada, born 1867.

W. R. Bascom, First Assistant General Freight Agent, Illinois Central Rd., at Chicago, Ill., born at Halifax, N.S., 1848.

G. S. Bally, General Passenger and Ticket Agent, Iowa Central Ry., at Marshalltown, Ia., born in 1857, and educated in the Paris, Ont., public schools, and was an office boy on the G.T.R.

J. D. Beardsley, General Manager Louisiana and North West Rd., at Gibsland, La., born at Woodstock, N.B., 1837.

J. M Bennett, Supervisor Bridges and Buildings, Oregon Short Line Rd., at Pocatello, Idaho, born at Spencerville, Ont., 1844.

J. Berlingett, Superintendent St. Joseph and Grand Island Rd., at St. Joseph, Mo., born at Renfrew, Ont., 1862.

J. Birse, Division Master Mechanic, Chicago Great Western Ry., at St. Paul, Minn., born at Montreal, Mar. 23, 1863.

E. H. Blossom, Assistant Superintendent St. Johnsbury and Lake Champlain Rd., and General Manager Hardwick and Woodbury Rd., at St. Johnsbury, Vt., born at Compton, Que., 1852.

R. M. Boyd, Commercial Agent, Chicago, Milwaukee and St. Paul Ry., at Seattle, Wash., born at Brockville, Ont., 1868.

J. P. Bradfield, Superintendent Western Division New York Central & Hudson River Rd., at Buffalo, N.Y., born in Canada.

T. J. Brennan, Secretary Chihuahua and Pacific Rd., at New York, N.Y.; born at Montreal, 1853.

J. E. Brittain, General Agent, Passenger department Chicago and North Western Ry. at Boston, Mass., born at St. John, N.B., 1862.

D. Brown, Assistant Superintendent of Motive Power, Delaware, Lackawanna and Western Rd., at Scranton, Pa., born in Canada in 1838.

M. Burpee, Chief Engineer, Bangor and Aroostook Rd., at Houlton, Me., born at Sheffield, N.B., 1847.

J. J. Byrne, General Passenger Agent Southern California Ry., Santa Fe Pacific Rd. and San Francisco and San Joaquin Valley Ry., at Los Angeles, Cal., born at Hamilton, Ont., 1859.

S. R. Callaway, President American Locomotive Co. and ex-President New York Central and Hudson River Rd., at New York, born at Toronto, 1850.

A. Cameron, General Agent, Oregon Rd., and Navigation Co. at Hong Kong, China, born 1864, and educated in Toronto.

W. D. Campbell, General Agent, Chicago and North Western Ry., at Los Angeles, Cal., born at Drumbo, Ont., 1859.

W. W. Campbell, General Baggage Agent, Texas and Pacific Ry., at Dallas, Texas, born at Pictou, N.S., 1846.

A. D. Charlton, Assistant General Passenger Agent, Northern Pacific Ry., at Portland, Ore., born at Hamilton, Ont., 1859.

G. J. Charlton, General Passenger Agent, Chicago and Alton Ry. at Chicago, Ill.; born at Hamilton, Ont., 1860.

M. J. Clark, Secretary and Auditor Chicago and Western Indiana Rd. and Belt Line of Chicago, born at Hamilton, Ont., 1841.

W. Cockfield, Master Mechanic San Luis Division Mexican Central Ry., at San Luis Potosi, Mexico, born at Montreal, 1859.

J. B. Conners, Division Superintendent Norfolk and Western Ry., at Portsmouth, Ohio; born at Toronto, 1856.

M. S. Connors, General Superintendent Hocking Valley Ry., at Columbus Ohio, born at Toronto, 1858.

W. G. Crabbe, Freight Accountant, Central Vermont Ry., at St. Albans, born at Summerside, P.E.I., 1859.

D. Crombie, Jr., Superintendent Transportation, Pere Marquette Rd., at Detroit, Mich., born at Hamilton, Ont., 1864.

H. A. Culloden, Assistant Auditor Sonora Ry. and New Mexico and Arizona Rd., at Guaymas, Mexico, born at Milton, Ont., 1853.

E. Curry, Treasurer Staten Island Rapid Transit Rd., at New York, N.Y., born near Peterboro', Ont., 1843.

W. C. Cushing, Superintendent Eastern Division, Pennsylvania lines, Northwest System, at Allegheny, Pa., born at St. John, N.B., 1863.

D. Davies, General Manager, Virginia and South Western Ry. and Virginia Iron, Coal and Coke Co., at Bristol, Va-Tenn., born at Charlottetown, P.E.I., 1858.

C. K. Dixon, Superintendent Illinois Central Rd., at Fort Dodge, Ia., born at Granby, Que., 1846.

J. W. Donald, District Passenger Agent, Chicago and Alton Ry., at Buffalo, N.Y., born at St. John, N.B., 1857

J. Donohue, Assistant General Passenger Agent St. Louis and San Francisco Rd. at Kansas, Mo., born at Waterdown, Ont., 1857.

W. Douglas, Vice-president, Secretary and General Superintendent, Manistee and Northeastern Rd., at Manistee, Mich.; born at Chatham, Ont., 1848.

W. E. Dowle, Division Freight Agent, Delaware, Lackawanna and Western Rd., at Buffalo, N.Y., born 1870, educated at Hamilton, Ont., and was office boy in the freight department of the G.T.R.

A. W. Ecclestone, District Passenger and Ticket Agent New York, Chicago and St. Louis Rd., and Southern Passenger Agent, Central Vermont Rd., at New York, born at Hamilton, Ont., 1858.

J. C. Eden, Assistant General Traffic Manager, Great Northern Ry., U.S., at Seattle; Wash., born at Goderich, Ont., 1864.

R. W. Edwards, Superintendent Eastern Division Chicago Great Western Ry. at Dubuque, Iowa, born at Toronto, 1865.

T. Edson, Freight Accountant and Freight Claim Agent, Michigan Central Rd. at Detroit, Mich., born at Niagara, Ont., 1842.

E. E. Ellis, General Freight and Passenger

Agent, Dansville and Mt. Morris Rd., at Dansville, N.Y., born at St. Thomas, Ont., 1858.

J. B. Flinders, General Superintendent and Purchasing Agent, Cincinnati Northern Rd., at Van Wert, Ohio, born at Hamilton, Ont., 1848.

S. B. Floeter, Division Superintendent, Cincinnati, Hamilton and Dayton Ry., at Lima, Ohio, born at Chatham, Ont., 1853.

D. T. Forbes, Vice-President and General Superintendent, New York, Texas and Mexican and Gulf, Western Texas and Western Rys. (Southern Pacific System), at Victoria, Texas, born at Stratford, Ont., 1856.

J. Forster, ex-Superintendent, Motive Power, Colorado and Southern Ry., at Denver, Col., born at Hamilton, Ont., 1857.

J. Francis, General Passenger and Ticket Agent, Burlington and Missouri River Rd., at Omaha, Neb., born at Montreal, 1854.

A. L. Graburn, Superintendent Shops Great Northern Ry., at St. Cloud, Minn., born at Gatineau Point, Que., 1870.

J. A. Graham, Master Mechanic, Cleveland, Loraine and Wheeling Ry., at Loraine, Wis., born at Watford, Ont., 1859.

F. Greene, Assistant Superintendent, Pacific Coast Co., Rd. department at Port Townsend, Wash., born at Garafraxa, Ont., 1847.

F. H. Greene, Purchasing Agent, Lake Shore and Michigan Southern Ry. and Lake Erie and Western Rd., at Cleveland, Ohio, born in 1868, educated at London, Ont.

P. M. Halloran, Auditor and Treasurer, Butte, Anaconda and Pacific Ry. at Anaconda, Mont., born at Hamilton, Ont., 1860.

W. F. Herman, General Passenger Agent, Cleveland and Buffalo Transit Co., at Cleveland, Ohio, born at Hamilton, Ont., 1856.

P. A. Hewitt, Auditor, Cleveland, Cincinnati, Chicago and St. Louis Ry., Dayton and Union Rd.; Kankakee and Seneca Ry., and Peoria and Eastern Ry., at Cincinnati, Ohio, born at St. John, N.B., 1848.

C. B. Hibbard, Passenger Traffic Manager, Rutland Rd., at Rutland, Vt., born at St. John's, Que., 1858.

Geo. W. Hibbard, General Passenger Agent, Duluth, South Shore and Atlantic Ry.; Hancock and Calumet, and Mineral Range Roads, at Marquette, Mich., born at St. John's, Que., 1852.

A. Hilton, General Passenger Agent, St. Louis and San Francisco Rd., at St. Louis, Mo., born at Hamilton, Ont., 1863.

W. Hogg, Passenger and Ticket Agent, Missouri Pacific Ry., at Pueblo, Col., born at Montreal, 1851.

J. F. Holden, 2nd Vice-President and Traffic Manager, Choctaw, Oklahoma and Gulf Rd., at Little Rock, Ark., born at Prince Albert, Ont., 1861.

E. E. Holton, Ticket Auditor, Southern Pacific Co. (Pacific System) at San Francisco, Cal., born at Hamilton, Ont., 1853.

T. Hume, Division Superintendent, International and Great Northern Rd., at Antonio, Texas, born at Aultsville, Ont., 1843.

R. H. Innes, Superintendent, Transportation, San Antonio and Aransas Pass Ry., at San Antonio, Texas, born at Kingston, Ont., 1852.

H. A. Jackson, General Freight and Passenger Agent, Spokane Falls and Northern Ry., and Commercial Agent, Great Northern Ry., at Spokane, Wash., born 1869, educated at Upper Canada College, Toronto.

W. J. Jackson, Assistant General Superintendent, Chicago and Eastern Illinois Rd., at Chicago, Ill., born at Toronto, 1859.

H. B. Jagoe, General Eastern Passenger Agent, West Shore Rd., at New York., born at Hamilton, Ont., 1857.

T. N. Jarvis, Assistant General Traffic Manager, Lehigh Valley Rd., at New York, born at Stratford, Ont., 1854.

J. T. Keith, Superintendent Wyoming Division, Lehigh Valley Rd., at Wilkesbarre, Pa., born 1853, educated at Simcoe, Ont.

W. A. Kellond, Assistant General Passenger Agent, Southern Lines Illinois Central Rd., and Yazoo and Mississippi Valley Rd., at Louisville, Ky., born at Montreal.

H. A. Kennedy, New England Agent, Minneapolis, St. Paul and Sault Ste. Marie Ry., at Boston, Mass., born at Morrisburg, Ont., 1870.

W. E. Lee, Auditor Kansas City, Watkins and Gulf Ry. at Lake Charles, La., born at Cedar Springs, Ont., 1864.

J. Leeming, General Freight Agent, Erie Rd., at New York, born at Brantford, Ont., 1857.

N. T. Lynskey, Baggage Agent, Minneapolis Union Station, Minneapolis, Minn., born at Cornwall, Ont., 1862.

E. Lyons, Manager Northern Pacific Terminal Co., at Portland, Ore., born at Hamilton, Ont., 1850.

W. E. McCarthy, Master Mechanic Carabelle, Tallahassee and Georgia Rd., at Tallahassee, Fla., born at Quebec, Que., 1868.

J. C. McCaul, Secretary Manistique Ry., at Detroit, Mich., born in Ontario, 1842.

M. McDermott, General Manager Mason and Oceana Rd., at Butterville, Mich., born at Ottawa, Ont., 1855.

E. McFadzen, Assistant Superintendent Manistee and Northeastern Rd., at Manistee, Mich., born in Canada, 1849.

W. McIntosh, Superintendent Motive Power Central Rd. of New Jersey, at Jersey City, N.J., born at Franklin, Que., 1849.

K. McKenzie, Superintendent Telegraph, Mobile and Ohio Rd., at Jackson, Tenn., born at Wallace, N.S., 1828.

W. J. McLean, Master Mechanic, Bellingham Bay and British Columbia Rd., at New Whatcom, Wash., born in 1858, entered the G.T.R. service at 14 years of age.

H. G. McMicken, European Traffic Agent, Great Northern Ry. (U.S.), at London, Eng., born at Queenston, Ont., 1846.

J. McNaughton, Superintendent Brook's Locomotive Works, at Dunkirk, N.Y., born at Queensville, Ont., 1859.

J. H. McWilliams, General Passenger and Ticket Agent, Atlanta, Knoxville and Northern Ry., at Knoxville, Tenn., born at Sandwich, Ont., 1865.

W. G. MacEdward, Division Passenger Agent, Erie Rd., at Elmira, N.Y., born at Ottawa, Ont., 1868.

E. E. MacLeod, Chairman Western Passenger Association, at Chicago, Ill., born at Newport, N.S., 1866.

J. F. Masters, New England Superintendent, Dominion Atlantic Ry., at Boston, Mass., born at Kentville, N.S., 1868.

J. D. Melville, Superintendent of Construction, Coahuila and Pacific Ry., at Saltillo, Mexico, born in 1858, entered the G.T.R. service as a brakeman.

J. A. Middleton, Assistant General Freight Agent, St. Louis and San Francisco Rd., at St. Louis, Mo., born at Kingston, Ont., 1856.

A. Mitchell, Division Master Mechanic, Atchison, Topeka and Santa Fe Rd., at Chanute, Kan., born in Canada, 1840.

N. Monsarrat, President, Hocking Valley and Kanawha and Michigan Rys., and Vice-President, Toledo and Ohio Central Ry., at Columbus, Ohio, born at London, Ont., 1839.

H. Morris, Auditor, St. Louis, Kansas City and Colorado Rd., at St. Louis, Mo., born 1856, and educated at Whitby, Ont.

R. S. Mosscrip, Chief Engineer, Nashville and Knoxville Rd., at Cookville, Tenn., born at Oshawa, Ont., 1844.

J. J. Mossman, Division Freight Agent, Wabash Rd., at Buffalo, born at Quebec, Que., 1860.

J. R. Peachy, Assistant General Freight Agent, Illinois Central Rd., at Chicago, Ill., born at Toronto, 1856.

D. M. Philbin, Second Vice-President and Superintendent, Eastern Ry. of Minnesota, at Duluth, Minn., born at Montreal, Que., 1857.

F. G. Prest, Purchasing Agent, Northern Pacific Ry., at St. Paul, Minn., born at Queenston, Ont., 1854.

S. L. Prest, Comptroller, Chicago Terminal Transfer Rd., at Chicago, Ill., born at Queenston, Ont., 1863.

C. M. Rathburn, Superintendent, Western Division Missouri Pacific Ry., and Central Branch Union Pacific Rd., at Atchison, Kan., born at Lower Horton, N.S., 1846.

M. J. Redding, Superintendent Motive Power, Jonesboro, Lake City and Eastern Ry., at Jonesboro, Ark., born at Toronto, Ont., 1852.

F. C. N. Robertson, Auditor the Pullman Co. at Chicago, Ill., born at Toronto, 1848.

G. T. Ross, Superintendent Missouri Pacific Rd. at Sedalia, Mo., born at Truro, N.S., 1866.

F. C. Salber, General Agent Freight Department, Northern Pacific Ry. at New York, N.Y., born 1863, educated in Canada, and was clerk in the old Northern Ry. of Canada, Toronto.

W. R. Scott, General Superintendent, Fort Worth and Denver City Ry., at Fort Worth, Texas, born at Richmond, Que., Nov. 8, 1860.

J. C. Shields, Superintendent, Hancock and Calumet Rd. and Mineral Range Rd. at Hancock, Mich., born at St. Mary's, Ont., 1853.

H. J. Small, Superintendent Motive Power and Machinery, Southern Pacific Co. at Sacramento, Cal, born at Cobourg, Ont., 1849.

G. O. Somers, General Freight Agent, Great Northern Ry., Chicago, Ill., born at Barrie, Ont., 1860.

C. E. Spooner, Auditor in Kansas for Missouri, Kansas and Texas Ry. at Parsons, Kan., born at Toronto, 1856.

H. J. Sterling, Freight-Auditor, Union Pacific at Omaha, Neb., born at St. Joseph's Island, Algoma, Ont., 1856.

R. B. Stratton, Chief Engineer, Portland and Rumford Falls Ry. and Rumford Falls and Rangeley Lakes Ry., at Rumford Falls, Me., born at Fredericton, N.B., 1868.

A. W. Street, General Freight Agent, Northern Steamship Co. at Buffalo, N.Y., born at London, Ont., 1847.

S. G. Strickland, Superintendent Chicago, St. Paul, Minneapolis and Omaha Ry., at Omaha, Neb., born 1859, educated in Port Hope, Ont.

H. T. Thomas, Master Mechanic, Detroit and Mackinac Ry. at East Tawas, Mich., born at Chatham, Ont., 1848.

W. Thomson, Vice-President, Kansas City, Watkins and Gulf Ry. at Lake Charles, La., born at Lanark, Ont., 1841.

A. Turling, General Agent, Northern Pacific Ry. at Tacoma, Wash., born at Waterloo, Ont., 1861.

P. R. Todd, Second Vice-President, New York, New Haven and Hartford Rd., at New Haven, Conn., born at Toronto, 1859.

W. G. Tubby, General Storekeeper, Great Northern Ry. at St. Paul, Minn., born at Acton, Ont., 1855.

H. E. Tupper, General Agent, Denver and Rio Grande Rd., at New York, N.Y., born in Canada, 1850.

J. M. Vance, President and General Manager, Eel River and Eureka Rd., at Eureka, Cal., born in New Brunswick, 1846.

J. A. L. Waddell, ex-Chief Engineer Omaha Bridge and Terminal Rd., at Kansas City, Mo., now in private practice as consulting engineer, at Kansas City, Mo., born at Port Hope, Ont., 1854.

W. W. Walker, General Freight Agent, Duluth, South Shore and Atlantic Ry., at Duluth, Minn., born at St. Catharines, Ont., 1868.

F. E. Ward, General Superintendent, Great Northern Ry. at St. Paul, Minn., born 1867, educated at Montreal.

A. G. Wells, Acting Manager, Santa Fe Pacific Rd., Southern California Ry. and San Francisco and San Joaquin Valley Ry., at Los Angeles, Cal., born at Guelph, Ont., 1861.

E. W. White, General Western Agent, Central of Georgia Ry. at St. Louis, Mo., born at Prescott, Ont.

H. C. Whitehead, General Auditor, Atchison, Topeka and Santa Fe Ry. System at Chicago, Ill., born at Brampton, Ont., 1853.

R. C. Wight, Secretary, Chicago Great Western Ry. at St. Paul, Minn., born at Montreal, Que., 1861.

W. E. Wolfenden, District Passenger

Agent, Pere Marquette Rd. at Grand Rapids, Mich., born at Port Hope, Ont., 1862.

G. B. Wyllie, Travelling Passenger Agent, Illinois Central Rd., at Buffalo, N.Y., born at Toronto, 1851.

The Electrical Equipment of an Ordinary Street Car.

By A. B. Lambe, Toronto.

(Continued from last issue)

The question of brakes does not properly enter into the electrical equipment of a car, except those which are electrically operated, though it is interesting to note the various styles and classes which have become more or less standard. There are in use to-day three main types, the manual, mechanical, and electrical. The greater part of the equipments in ordinary city work belong to the first division, being equipped with spring or gravity release, and occasionally being reinforced with the safety device of a plunger arranged to act as a block behind the rear wheels, used only on systems running over numerous heavy grades on which stops have to be made. In the mechanical class are grouped those types whose braking mechanisms are actuated by the motion or momentum of the car through the medium of a clutch mounted on one of the axles. The air system would also come under this head ; there are two distinct methods, one in which the car reservoirs, comparatively small, are charged from a motor and pump carried on the car itself, and the storage system, in which the cars are replenished from a common pump situated at some convenient point on the line, in which event the car storage tank is relatively larger. The electric types operate either by friction discs, one revolving with the axle and the other mounted on the motor, or by a solenoid pulling a plunger on to the rail head and at the same time, through a suitable system of cams and levers, setting the shoes on the wheels in the ordinary manner. In both types the current, which is obtained by operating the motors as generators, is controlled by the main cylinder, which is then provided with additional steps and turns backward from the off position. There is also the emergency electric brake, which, while not commercial, may occasionally be of great service ; it will be discussed later.

The lighting of practically all our modern cars is by means of incandescent lamps, and presents no special features ; they should in all cases be equipped with reflectors, whether mounted in groups or singly. Cars built lately are usually equipped with either bullseyes or illuminated signs to indicate the route to which they belong ; these are furnished with light by either a series of lamps of their own, or else by some of those which also light the car.

It is now usual in the case of double-ended cars to arrange the headlight so that when one is in use the vestibule light on that platform is extinguished, and vice versa ; this is accomplished either by means of a removable headlight, in which case the action is automatic, the transferring of the lamp itself accomplishing the switching ; or else if the headlights are stationary, one on each end, switches are used to light either them or the vestibule lamp as desired.

The headlight most frequently consists of an incandescent lamp, mounted inside a weatherproof case, which also contains a reflector, more or less efficient according to the money put into it, though very frequently, especially for interurban work, where cars are run at a fairly high speed and therefore require a somewhat greater length of road in which to stop, arc lamps are used for this purpose. Being on a 500 volt circuit, they require a rheostat in series; sometimes the incandescents in the inside of the car are used for this purpose, though it is more usual to employ a dead resistance. In the more temperate climates this is occasionally used as part of the car-heating system, being mounted under the seats and arranged with radiating facilities, so that the hot air coming from them assists in warming the car. Occasionally the cars are equipped with arc lamps for inside lighting as well as for the headlight, in which case they are all run in series.

On those systems which require artificial heating of the cars, the method by which it is to be accomplished is a very moot point, coal, hot water and electric all being available, the advantages, from the passenger's point of view, being all with the latter ; there is also much to be said in its favor from the operator's standpoint. In the first place, it is absolutely clean as compared with any form of stove, there being no ash to cause dust, nor fuel of any sort to carry along with the car ; if properly built they present no source of fire risk ; they give off no noxious fumes, ready for instant service, they do not occupy the conductor's attention which might profitably be employed elsewhere, and if properly arranged they distribute the heat all along the car in the place where it is most needed, namely, near the floor. On the other hand, any form of coal stove placed in the car body is notoriously deficient on all of the above points, scratching the frame when being taken in and out, a source of dust and dirt it is unanimously voted a nuisance by everybody ; the only thing to be said in favor of any of the various forms of heating, opposed to electric, is that they are cheaper. Roughly speaking, it costs something like seven times as much to heat a car electrically as it does by coal, or, to put the matter in another way, seeing that the average horse power consumption of an ordinary city car will be somewhere in the neighborhood of 20 h.p. per hour, and that of the heaters from 5 to 10, it will at once be recognized that if the cars are to be heated electrically that the generating equipment, with the engines and boilers or water-wheels to operate it, must be materially increased over that necessary for the work of propelling alone. It is usual in electric heating to provide means for varying the temperature and correspondingly the current consumed, by dividing the heaters into sections and connecting these in various combinations of series or parallel.

The rheostats of modern equipments are usually built of some form of iron resistance, coiled iron wire, iron ribbon, or cast iron girds, the latter being the latest form. They are required to dissipate considerable energy in the form of heat, and therefore have to be kept more or less away from the car body, usually being mounted on insulated supports to the under side of the framework where they can be got at for inspection, and still not be in the way of water and dirt from the wheels and street.

The usual equipment is not designed to remain in circuit for any appreciable period longer than that necessary to start the car, which is the reason for marking only certain of the controller steps as running positions ; if the cylinder be left too long on those which have the whole or part of the rheostats in circuit, they are likely to be damaged. Commercial requirements, which are the limiting features of all apparatus, seldom call for continuous running on any of the rheostatic steps ; if desired it is only a matter of money to put in sufficient capacity to be able to do so. In locomotive work, where shunting at slow speeds is a necessity, the rheostats are made much larger, the equipment for a pair of motors used for this class of work being in some cases as much as four to five times as large as that necessary to control it for ordinary traction duties.

We next come to the consideration of the motors themselves ; they constitute that part of the equipment in which the electrical energy, conveyed from the stationary trolley wire to the moving car by means of the trolley pole, is converted into mechanical power, the machine which forms the actual source of motion of the car. The electric motor, as we have so often been told, was more or less accidentally brought to light ; it being discovered that an ordinary dynamo if supplied with current would rotate and deliver mechanical power from its shaft ; similarly the first street railway motors were dynamos, arc machines it is generally reported, coupled to the axle by means of belting or chains ; these were soon followed by machines designed for this particular work, the first types being bi-polar, with high speed armatures and double reduction gearing (two pinions and two gears), the electrical parts being absolutely unprotected from the weather. The motors of to-day, irrespective of their makers, all have the same general features ; four poles, two sets of brushes, single reduction enclosed gears running in grease, and a practically water-tight cast steel motor case, usually parted horizontally. Between the first more or less experimental forms and the machines now standard there were a tremendous variety of ideas and forms brought out ; it is impossible to go into details here, though it will be of interest to touch on the main features.

The first gears, as above, were double reduction, that is, there were two pinions driving two gears, made of rawhide, brass and steel ; cast iron also was used ; to-day cast steel for gears and hammered iron or steel for pinions is the usual standard. It was soon found that the open gears wore very rapidly on account of the dust and dirt which they encountered, and therefore with the introduction of the single reduction type came the gear case ; this at first was of sheet copper with a cast brass frame riveted and soldered together, passing in turn through a number of stages to cast iron, malleable iron and pressed sheet steel ; experiments are now being made on a type composed of a canvas cover on a brass frame with a spring sheet steel lining on the lower half.

Both ring and drum windings have been used for the armature, made sometimes with round wires and again with those of oblong section, the coils wound on to the body by hand, or again being machine formed before winding. For the commutator cast brass and cast and wrought copper have all been tried ; to-day standard construction uses machine wound coils, drum windings and wrought copper bars equipped with carbon brushes.

The first machines were bi-polar, and when it was found desirable to cut out one set of gearing there came the consequent struggle to reduce the armature speeds ; the most obvious method was to increase the number of fields from two to four, and a number of forms were brought out for that purpose. The first types had two consequent and two salient poles ; if arranged with the former horizontal, they made the depth of the motor too great, seeing that the standard 33-inch wheel allows but little room to keep clear of the roadbed ; if placed vertically the machine could not be parted along the horizontal plane, which latter was an extremely desirable feature. Finally there came the four pole salient type arranged with the poles set 45 degrees from the vertical, which allows convenient horizontal parting and is the form which has been adopted by practically all manufacturers.

Practically nothing but cast steel, or some one of its nearly allied compositions, has been used for the motor frame proper. The original machines were entirely open, and the first attempt at protection from water and dust was a pan placed underneath and partially up the sides of the machine ; then canvas was hung down from the car body ; next the frame itself

was extended so as to afford more protection to the parts inside, and finally it was made in two bowl-shaped halves, completely enclosing the armature and fields, which is the style standard to-day for moderate sized machines of all makers. The field poles are cast as part of the frame, or sometimes cast steel machined separately and bolted to place; again there is the laminated type, either with the frame cast round them or held in position by bolts; as compared with the solid pole this construction produces a lighter machine for a given output, and one somewhat more efficient. In this totally enclosed type of case the ventilation is practically nil; on elevated systems and in some interurban roads advantage is taken of the comparative absence of dust and dampness to put openings in the frames which, partially closed by screens, allow more or less air to circulate through the windings.

The lubrication of all moderate size motors is by means of grease, held in pockets cast in the frame over the bearings; these latter are generally outside the machine proper, being provided with channels underneath so that any overflow or drippings are thrown outside, lubricants of all descriptions being fatal to good insulation. Occasionally there is provided an auxiliary oiling wick underneath the bearing, the grease then being more or less of a reserve intended to be used only if the journal gets hot, in which event it melts and thus provides extra lubrication. On the heavier motors for elevated works, oil is depended upon almost entirely, though it has the disadvantage of causing much more drip than the greases.

The foregoing covers the general outline of the standard moderate sized street railway motor of to-day; there naturally are many modifications, such as the type in which the frame, instead of being split horizontally, is cast in one piece, cylindrical in form, the armature and fields being removed through openings in the ends, normally filled by cast iron shields carrying the bearings; there is also the gearless motor, a type which has found much more favor on the continent than it has over here, though it should be noted that the Baltimore and Ohio locomotives, the largest electric traction machines ever built, weighing nearly 100 tons each, are of this type.

Equally a curiosity, at any rate on this continent, is the alternating traction motor, though it has been used to some extent in Europe; those built over here follow to a great extent the general lines of the D.C. machines, except of course in their internal arrangements. It should be observed that they can be run in series parallel, the armature of one machine supplying the fields of the next, somewhat similarly to the standard series parallel controller.

All street railway motors to-day are series wound, that is, the same current after passing through the armature goes on through the field coils, or vice versa. Shunt machines are unsuitable for several reasons, one is that being essentially constant speed apparatus they would tend to drive the car at the same rate irrespective of the load or the grade. In climbing hills this would result in a greater current consumption than the motors could stand, on the other hand the series motor slows down with an increase in load, and consequently takes less current than would be needed if the same speed were maintained.

The field coils are sometimes connected in front of the armature, in which case they are said to act as a choking coil, and to thus lessen the chances of lightning damaging the latter; in other systems they are connected next to the ground in order to lessen the chances of trouble in themselves. If wired in this manner, when the motors are in parallel the maximum potential between the fields and ground is about 30 volts, when they are in series this is increased on no. 1 machine to 250 volts, no. 2 remaining as before.

The next point to be considered is the method of using the motors as an emegency brake. If the motors are driven by some outside force, such as momentum or gravity, they tend to generate current the same as any other dynamo, and if the connections of the field be reversed with respect to the armature, they will gradually produce more and more voltage, or build up, as it is termed. Further, if they now be connected in parallel, any slight difference in voltage between the two will start a current flowing which still further changes the field strengths and thus produces an increase in the current. This means that one machine becomes a generator with a heavy load, which tends to pull it up, this in turn through the gears tending to stop the car. The other machine becomes a motor with a heavy current forced through it and consequently a heavy torque, but being reversed instead of tending to drive the car forward, as does current from the trolley wire, this tends to drive the car backwards. It will thus be seen that the action of both machines is to stop the car, which will pull up quite sharply. Now, as soon as this has taken place the current ceases, and if the car be on a down grade it will immediately start again, and after it attains some slight speed the process will repeat itself; it is thus possible to take a car down hill without the aid of either brakes or current from the trolley wire. It should be noted that this method of stopping is quite distinct from that of using the main current with the machines reversed; further, that on a two motor controller the throwing of the reversing switch does not put the motors in parallel, they can only be connected in this way by means of the main cylinder which has to be turned to some one of the parallel positions, which is immaterial; with the current breaker open or the trolley off there is no closed circuit on any of the series steps. On the other hand, with a four motor controller, there being two pairs of machines permanently in parallel (except when equipped with a commutating switch set for series connection), all that is necessary to obtain the desired connection is to throw the reverse handle. Occasionally there are found two motors which are so nearly alike, or give results so closely allied that this action will not take place, though it is probable that 99 per cent. of the cars in service to-day will act as described above.

The foregoing covers, in outline only, the principal parts comprising the modern electric car equipment of medium capacity; it is obviously impossible, within the limits of this paper, to go to any extent into detail; there remains but to glance at its general properties compared with electrical apparatus designed for radically different service.

Compared with commercial stationary direct current machines having about the same armature speed, we find that the street railway motor, horse power for horse power, weighs somewhat less than half as much as does the former, direct current machines of the lower speeds averaging 110 to 135 lbs. per h.p.; the street railway motor somewhere about 65. You must further note that the latter machine has a momentary maximum output of two or three times its normal capacity, that is, a machine rated at 30 h.p., according to the methods adopted by standard practice to-day, will for short periods give an output of 80 to 100 h.p., in fact there is to-day no other machine which, weighing but one ton and contained within the three dimensions of about 30 inches, will produce from 25 to 50 h.p. and this with a high degree of economy; obviously this result is obtained only by having a machine of the greatest simplicity composed of the very finest materials obtainable and built with the utmost attention to every detail.

Further, it is to be observed that some of the machines made for this purpose are by no means small. The first cars put into service were equipped with two motors of about 12 to 15 h.p., each weighing in the neighborhood of 2,300 pounds; to-day the ordinary car in city service has two 35 or 40 h.p. motors, weighing with the controlling mechanism about 3½ tons, the complete car averaging about 12 tons. The average car on interurban high speed service, equipped some with two motors and some with four, varying from 50 to 80 h.p. each, will weigh somewhere in the neighborhood of 25 tons, 8 to 12 tons of this being accounted for by the 200 to 300 h.p. of electrical equipment with which they are provided. Cars for elevated roads will average somewhere about 30 tons each, and as they are frequently run in trains of two or three, the complete outfit will weigh in the neighborhood of 100 tons. The Baltimore and Ohio Railway Company's locomotives are the largest electrical traction machines in use to-day; they weigh about 100 tons each, the motors, of which there are four, being rated at 325 h.p. each, the normal current input of the complete machine reaching the large total of 2,000 amperes.

It is obvious that, having such a fine equipment as the modern railway motor, we should make every effort to keep it in good shape, to get from it the maximum of service with the minimum of cost and to maintain a schedule free from the most annoying of troubles, road breakdowns. One of the most essential points to this end is a thorough system of inspection; without some such procedure it is hopeless to expect anything but that the repair accounts will be unduly large, and your customers far from satisfied with the service they receive. It is usual in modern railway practice to have two and sometimes three distinct times of inspection for each car, every road having a night man who makes a visual and more or less superficial examination each night, and a barn repair crew who dismantle and thoroughly overhaul every equipment at stated intervals of 6 to 12 or 14 weeks. To these some roads add the day inspector who visits each car when in service, examining the operation of the commutators and the controllers, and receiving reports from the crews as to any incipient defects which they know should receive attention.

The greatest aid to such a system of inspection, and in fact a prime necessity of its existence, is a set of books, as simple as possible, but nevertheless complete in that they show the date of every operation, both day and night, on each car, and the names of the men performing them. From records such as these you will be able to determine and accurately keep track of the date on which any car is due to come in for general overhauling. Having determined, from the class of equipment and the amount of work it has to do, the safe running limits of the machines, that is, the longest time which it is practicable to leave them on the road and still not run into danger of having breakdowns, it is highly desirable to keep the system in such shape that the cars come in very close to the periods set for them. Such a system as this, apart from lessening the cost of repairs and reducing the number of street breakdowns, has great value in another direction, namely, the question of damage suits. Accidents, as we have all been told so many times, will happen; happy is the man who, in the hour of trial, can produce complete records and show that the car equipment in question was inspected and overhauled on a certain specified date by men competent and familiar with this class of work, and pronounced by them to be in thorough workmanlike condition; he has gone far towards acquitting his company of that bugbear and foundation for so many claims, alleged negligence.

[NOTE.—The foregoing paper was presented at the recent meeting of the Canadian Electrical Association in Quebec, and was illustrated by a car equipment provided by the Quebec Ry. Light and Power Co. at its car shed. The Co. also furnished power to operate the equipment.]

PURCHASING AGENTS' GUIDE.

(Continued from third page of Cover.)

Steel Buildings
Dominion Bridge Co. .... Montreal.

Structural Metal Work
Dominion Bridge Co. .... Montreal.

Switches
Canada Switch and Spring Co. .... Montreal.

Switch Lamps
The Hiram L. Piper Co. .... Montreal.

Switch Locks
N. P. Macmullan & Co. .... Montreal.

Switch Targets
Acton Burrows Co .... Toronto.

Telegraph and Telephone Office Signs
Acton Burrows Co .... Toronto.

Tobacco and Cigars
The Hudson's Bay Company..................

Toilet Paper
The Hudson's Bay Company..................

Tools
Rice Lewis & Son...................... Toronto.

Track Jacks
James Cooper.......................... Montreal.
Duff Manufacturing Co. .... Allegheny, Pa.
N. P. Macmullan & Co .... Montreal.
W. H. C. Mussen & Co. .... Montreal.
A. O. Norton .... Coaticook, Que.

Track Tools
Canada Switch and Spring Co. .... Montreal.
James Cooper.......................... Montreal.
Rice Lewis & Son...................... Toronto.
W. H. C. Mussen & Co. .... Montreal.

Tramway Equipment
James Cooper .... Montreal.
J. J. Gartshore .... Toronto.

Trucks (Electric Car)
Baldwin Locomotive Works.............. Philadelphia, Pa.
Canada Switch and Spring Co. .... Montreal.

Trucks (Warehouse and Express)
Rice Lewis & Son...................... Toronto.

Turntables
Dominion Bridge Co. .... Montreal.

Varnishes
McCaskill, Dougall & Co .... Montreal.

Vessels
Polson Iron Works .... Toronto.

Waste
Rice Lewis & Son...................... Toronto.
N. L. Piper Ry. Supply Co. .... Toronto.
The Queen City Oil Co .... Toronto.

Wheelbarrows
James Cooper.......................... Montreal.
Rice Lewis & Son...................... Toronto.

Window Blinds
The Hudson's Bay Company..................

Wines and Liquors
The Hudson's Bay Company..................

Wire & Wire Rope
Dominion Wire Rope Co .... Montreal.
Rice Lewis & Son...................... Toronto.
W. H. C. Mussen & Co. .... Montreal.
The Wire and Cable Co. .... Montreal.

Wire, Copper
E. F. Phillips Electrical Works, Ltd. ...... Montreal

Wire, Electric
E. F. Phillips Electrical Works, Ltd. ...... Montreal.
The Wire and Cable Co. .... Montreal

Wire, Insulated Copper
E. F. Phillips Electrical Works, Ltd. ...... Montreal.

Wire, Telegraph and Telephone
E. F. Phillips Electrical Works, Ltd. ...... Montreal.
The Wire and Cable Co. .... Montreal.

Yachts
Polson Iron Works..................... Toronto.

The Purchasing Agents' Guide

To the Manufacturers of & Dealers in Steam & Electric Railway, Steamship, Express, Telegraph & Telephone supplies, &c.

Accident Insurance
Travelers' Insurance Co.......Montreal.

Aerated Waters
E. L. Drewry.......Winnipeg.

Air Brakes & Fittings
Westinghouse Mfg. Co.......Hamilton, Ont.

Ales
E. L. Drewry.......Winnipeg.

Anchors
Rice Lewis & Son.......Toronto.

Axles
Rhodes, Curry & Co.......Amherst, N.S.

Babbit
Rice Lewis & Son.......Toronto.

Blankets & Bedding
The Hudson's Bay Company.......

Block & Tackle
Dominion Wire Rope Co.......Montreal.
Rice Lewis & Son.......Toronto.

Boat Fittings & Hardware
Rice Lewis & Son.......Toronto.

Boiler Covering
Mica Boiler Covering Co.......Montreal.

Boilers
Polson Iron Works.......Toronto.

Bolsters
Simplex Railway Appliance Co.......Montreal.

Bolts
Rice Lewis & Son.......Toronto.

Brake Beams
Simplex Railway Appliance Co.......Montreal.

Brass Castings
St. Thomas Brass Co.......St. Thomas, Ont.

Bridge Numbers
Acton Burrows Co.......Toronto.

Bridges
Dominion Bridge Co.......Montreal.

Buoy Lighting
Safety Car Heating and Lighting Co., New York

Cables, Electric
E. F. Phillips Electrical Works, Ltd.......Montreal.
The Wire and Cable Co.......Montreal.

Cables, Feeder
E. F. Phillips Electrical Works, Ltd., Montreal.

Car Heating
Safety Car Heating and Lighting Co., New York

Car Jacks
James Cooper.......Montreal.
W. H. C. Mussen & Co.......Montreal.

Car Lighting
Safety Car Heating and Lighting Co., New York

Carpets
The Hudson's Bay Company.......

Car Pushers
N. P. Macmullan & Co.......Montreal.

Cars
Rhodes, Curry & Co.......Amherst, N.S.

Car Wheels
Rhodes, Curry & Co.......Amherst, N.S

Castings
Canada Switch and Spring Co.......Montreal.
Rhodes, Curry & Co.......Amherst, N.S.

Chains
Rice Lewis & Son.......Toronto.

Concrete Mixers
W. H. C. Mussen & Co.......Montreal.

Contractors' Plant
M. Beatty & Sons.......Welland, Ont.
James Cooper.......Montreal.

Cross Arms, Top Pins & Side Blocks
The Firstbrook Box Co.......Toronto.

Curtains
The Hudson's Bay Company.......

Cuts
Acton Burrows Co.......Toronto.

Ditchers
M. Beatty & Sons.......Welland, Ont.

Derricks
M. Beatty & Sons.......Welland, Ont.
James Cooper.......Montreal.

Door Signs
Acton Burrows Co.......Toronto.

Dredges
M. Beatty & Sons.......Welland, Ont.

Dry Goods
The Hudson's Bay Company.......

Electric Car Route Signs
Acton Burrows Co.......Toronto.

Electric Cranes
Dominion Bridge Co.......Montreal
W. H. C. Mussen & Co.......Montreal.

Enameled Iron Signs
Acton Burrows Co.......Toronto.

Engines, Stationary & Marine
Polson Iron Works.......Toronto.

Engraving
Acton Burrows Co.......Toronto.
Toronto Engraving Co.......Toronto.

Expanded Metal
Expanded Metal and Fireproofing Co...Toronto.

Express Office Signs
Acton Burrows Co.......Toronto.

Fencing
Page Wire Fence Co.......Walkerville, Ont.

Fireproofing
Expanded Metal and Fireproofing Co., Toronto.

Flags
Rice Lewis & Son.......Toronto.
The Hudson's Bay Company.......

Foghorns
Rice Lewis & Son.......Toronto.

Gates
Page Wire Fence Co.......Walkerville, Ont.

General Supplies
The Hudson's Bay Company.......

Grain Elevators
John S. Metcalfe Co.......Chicago, Ill.

Groceries
The Hudson's Bay Company.......

Hardware
Rice Lewis & Son.......Toronto.
The Hudson's Bay Company.......

Headlights
N. P. Macmullan & Co.......Montreal.
N. L. Piper Railway Supply Co.......Toronto.

Hose
Gutta Percha and Rubber Mfg. Co. of Toronto.
Rice Lewis & Son.......Toronto.

Illustrations
Acton Burrows Co.......Toronto.

Interlocking Plants
Canada Switch and Spring Co.......Montreal.

Iron
Rice Lewis & Son.......Toronto.

Iron Signs
Acton Burrows Co.......Toronto.

Japans
McCaskill, Dougall & Co.......Montreal.

Journal Bearings
St. Thomas Brass Co.......St. Thomas, Ont.

Lager Beer, &c.
E. L. Drewry.......Winnipeg.

Lamps & Lanterns
The Hudson's Bay Company.......
Rice Lewis & Son.......Toronto.
N. P. Macmullan & Co.......Montreal.
The Hiram L. Piper Co.......Montreal.
N. L. Piper Railway Supply Co.......Toronto.

Launches
Polson Iron Works.......Toronto.

Life Insurance
Independent Order of Foresters.......Toronto.
Travelers' Insurance Co.......Montreal.

Lights, Contractors and Wrecking
James Cooper.......Montreal.
W. H. C. Mussen & Co.......Montreal.

Linoleum and Floor Coverings
The Hudson's Bay Company.......

Locomotives (Compressed Air)
American Locomotive Co.......New York, N.Y.
Baldwin Locomotive Works...Philadelphia, Pa.
N. P. Macmullan & Co.......Montreal.

Locomotives (Electric)
American Locomotive Co.......New York, N.Y.
Baldwin Locomotive Works...Philadelphia, Pa.
N. P. Macmullan & Co.......Montreal.

Locomotives (Steam)
American Locomotive Co.......New York, N.Y.
Baldwin Locomotive Works...Philadelphia, Pa.
Canadian Locomotive Co.......Kingston, Ont.
James Cooper.......Montreal.
N. P. Macmullan & Co.......Montreal.

Locomotives (Rack)
American Locomotive Co.......New York, N.Y.
Baldwin Locomotive Works...Philadelphia, Pa.
N. P. Macmullan & Co.......Montreal.

Machine Tools
John Bertram & Sons Co.......Dundas, Ont.

Matches
The Hudson's Bay Company.......

Milepost Numbers
Acton Burrows Co.......Toronto.

Mohair
The Hudson's Bay Company.......

Numbers
Acton Burrows Co.......Toronto.

Oakum
Rice Lewis & Son.......Toronto.
The Hudson's Bay Company.......

Oils
Galena-Signal Oil Co., Franklin, Pa., & Toronto.
The Imperial Oil Company.......
The Queen City Oil Company.......Toronto.

Office Signs
Acton Burrows Co.......Toronto.

Packing
Gutta Percha and Rubber Mfg. Co.......Toronto.

Pinch Bars
The Hiram L. Piper Co.......Montreal.

Pipe Covering
Mica Boiler Covering Co.......Montreal.

Plushes
The Hudson's Bay Company.......

Pneumatic Tools
N. P. Macmullan & Co.......Montreal.

Porter
E. L. Drewry.......Winnipeg.

Portland Cement
Rice Lewis & Son.......Toronto.

Printing
The Hunter, Rose Co.......Toronto.
The Mail Job Printing Company.......Toronto.

Pumps
Rice Lewis & Son.......Toronto.

Rails (New)
James Cooper.......Montreal.
Drummond, McCall & Co.......Montreal.
J. J. Gartshore.......Toronto.
Rice Lewis & Son.......Toronto.

Rails (for relaying)
James Cooper.......Montreal.
J. J. Gartshore.......Toronto.

Roof Trusses
Dominion Bridge Co.......Montreal.

Rope
Rice Lewis & Son.......Toronto.
The Hudson's Bay Company.......

Rubber Goods
Gutta Percha and Rubber Mfg. Co. of Toronto.

Semaphore Arms
Acton Burrows Co.......Toronto.

Semaphores
The Hiram L. Piper Co.......Montreal.

Shafting
Rice Lewis & Son.......Toronto.

Shipbuilders' Tools & Supplies
Rice Lewis & Son.......Toronto.

Ship Lamps
The Hiram L. Piper Co.......Montreal

Ships
Polson Iron Works.......Toronto.

Shovels
James Cooper.......Montreal.
The Hudson's Bay Company.......
Rice Lewis & Son.......Toronto.

Side Bearings
Simplex Railway Appliance Co.......Montreal.

Signal House Numbers
Acton Burrows Co.......Toronto.

Signals
The Hiram L. Piper Co.......Montreal.
N. L. Piper Railway Supply Co.......Toronto.

Signs
Acton Burrows Co.......Toronto.

Snow Ploughs
Rhodes, Curry & Co.......Amherst, N.S.

Spikes
Rice Lewis & Son.......Toronto.

Springs
Canada Switch and Spring Co.......Montreal.

Station Name Signs
Acton Burrows Co.......Toronto.

Steamboats
Polson Iron Works.......Toronto.

Steamboat Signs
Acton Burrows Co.......Toronto.

Steam Couplers
Safety Car Heating and Lighting Co., New York

Steam Shovels
M. Beatty & Sons.......Welland, Ont.
James Cooper.......Montreal.
W. H. C. Mussen & Co.......Montreal.

Steel
James Cooper.......Montreal.
Rice Lewis & Son.......Toronto.

(Continued on preceding page.)


THE BEST FLOUR
HIGHEST AWARDS
AT HOME AND ABROAD.
Winnipeg & Paris Exhibitions
HUDSONS BAY CO'S
ROLLER MILLS
STRONG BAKERS
WINNIPEG
MANITOBA
THE FLOUR MANUFACTURED BY THE HUDSON'S BAY COMPANY HAS RECEIVED THE GRAND PRIZE AT THE PARIS EXHIBITION, AND THE HIGHEST AWARDS AT THE WINNIPEG INDUSTRIAL EXHIBITION.
HUDSONS BAY CO'S
ROLLER MILLS
PATENT
HUNGARIAN
WINNIPEG
MANITOBA
ALL THE FLOUR MADE BY THE COMPANY IS FROM SPECIALLY SELECTED WHEAT.
HUDSON'S BAY COMPANY