CHICAGO CABLE ROADS.*

By D. J. MILLER

THE cable railway system of our city has attracted considerable attention for the past year, not only in Chicago, but in nearly all the cities of the Union, if we may judge from the numerous inquiries made and the number of railway representatives who have visited Chicago for the purpose of obtaining information upon this subject. For a distance of over four miles we have a system of transit which is certainly

When the car is not in motion, the cable passes freely through the jaws of gripper, in which wooden blocks are placed. As these jaws are forced together the blocks are brought in contact with the moving cable, and the friction starts the car with an easy movement, provided the lever is held by a careful operator. Again referring to the drawing, the dotted line, *l*, represents the line of cable when not in grip, the gripper having a clearance of $2\frac{1}{4}$ inches above carrying pulleys, *P*. When held in the jaws, the cable is 13 inches below the surface of street, and

a cast iron tube; but it would be necessary to take into consideration the climate, nature of soil, and grade of streets, before deciding which might be best for any particular locality. In Chicago, the streets are nearly level, and drainage must be secured for tunnel; consequently a greater depth is needed than where streets are not of uniform grade. The tunnels here are from 3 feet and 4 inches deep at the summit to 3 feet and 7 inches at catch basins; and this, with grade of street, gives a fall of $3\frac{1}{2}$ inches in 100 feet. The catch basins are located every 300 feet, and connected with city sewers by overflow pipes. There is no objection to a deep tunnel, and, as in some of our severe winters it will be important to dispose of the water which may accumulate in the tunnel, if drainage be insufficient, trouble may be expected.

Wabash and Cottage Grove avenues will be in operation about the last of November of the present year. These lines are operated from the building at corner of State and Twenty-first streets, and the cables receive motive power from the machinery running State street lines. Cables for operating these avenues must be carried some distance from the building before they are brought into actual service. Cottage Grove avenue line commences at the intersection of Cottage Grove avenue and Twenty-second street, about 1,920 feet from the operating room. This line runs south 11,642 feet to wheel vault south of Thirty-ninth street, and then returns, making the total length of cable 27,124 feet. Wabash avenue cable is brought into use at the intersection of Wabash avenue and Twenty-second street, and will run north on Wabash avenue to the center of the block between Monroe and Madison streets, and then return, and the length of this cable will be 22,873 feet.

These cables are carried from the operating room to their respective lines through a third tunnel between the railway tracks, and where angles are made excavations are provided for the reception of 12-foot sheaves, around which the cables are passed, thus holding them in a direct line from one wheel vault to another.

To avoid shunting devices in connection with cable trains, a belt line has been adopted, on which State street cars pass east on Madison street to Wabash avenue, then north to Lake street and west to State street, then returning south making a circuit of three blocks.

This belt line is operated by an auxiliary cable, which is propelled by the end wheel, upon which the State street main cable reverses. This transmission of power is effected by carrying the main cable into a vault (see Fig. 3) and passing it around a 12-foot sheave to which a 6-foot sheave is coupled for operating the auxiliary cable at half the speed of main cable.

The arrangement of wheels in the vault will be understood from the illustration given. After the auxiliary cable is carried around the 6-foot sheave, it passes to the tension wheel, *T*, which keeps the cable taut by means of weight, *W*; cars moving north exchange cables at *B*, and those moving south at *E*. Wabash and Cottage Grove avenue cars are to be operated around the above-mentioned belt line by a similar auxiliary cable (driven by Wabash avenue main cable) and return to Wabash avenue by way of Madison street, then south on the return trip. A wheel vault

FIG. 1.—CHICAGO CABLE ROADS. (Scale, $\frac{1}{4}$ in. = 1 ft.)

a great improvement over previous methods of street-car locomotion. I am well aware that I am unable to do justice to a theme of such magnitude, and will only endeavor to give a brief description of some of the principal points connected with the work. With all motors the carrying power is of necessity limited, but with the cable system it is, comparatively speaking, unlimited, and the tractive power of the cable, when operated by a stationary engine, gives this system an advantage over all others, as no dead weight is required to procure adhesion to the rails. It seems almost incredible, but is nevertheless a fact, that

when on pulleys, *P*, is 8 inches lower, or 21 inches below the surface of street.

The greatest expense incurred in this system is in road-bed and tunnel construction, and although several cable roads have already been built, but few of them have cost less than one hundred thousand dollars per mile of double track. Probably this figure will be considerably reduced in time, as the system becomes more generally used and engineers more experienced in the work.

Fig 2 is a cross section of track at curve, as used in this city. The road-bed and tunnel construction is the same as

FIG. 2.—CHICAGO CABLE ROADS.—SECTION OF TRACK AT CURVE. (Scale, $1\frac{1}{8}$ in. = 1 ft.)

the State street road, now in operation, has a carrying capacity of ten thousand passengers per hour, and even this enormous traffic will not overburden the cable.

Fig. 1 is a drawing of grip and grip-car used by the Chicago City Railroad Company, and the position of the cable in the gripper, *G*, will be readily understood by reference to the same (I wish to give Mr. Oscar Lundquist credit for making this drawing for me).

for straight tracks, except that conical pulleys, *h*, are used on curves, for holding the cable on as direct a line with gripper, *G*, as may be possible. These conical pulleys are placed 8 feet apart on a radius of from 40 to 60 feet. The angle iron, *a*, is bolted to the slot rail inside of tunnel to assist in holding the gripper in position. There are various designs for road-bed and tunnel construction, no two roads having as yet been built exactly alike, and many designs are suggested by different individuals; some express a preference for a brick tunnel in place of concrete, and others advocate the use of

similar to the one on State street is located on Wabash avenue for transmission of power to the auxiliary cable, consequently two cables will pass around the belt line in the same tunnel, each operating its own line of cars.

It will be seen that two cables in one tunnel will be taken around the curves at corner of Lake and State streets, also corner of Lake street and Wabash avenue. Although an arrangement has been designed for this purpose, as it has not yet been tried I deem it best to omit a description.

Railway officials are generally interested, and seem aux-

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ious to ascertain the percentage to be saved by the use of the cable system.

Much depends on the manner in which a road is built, for if constant repairs must be made and the same number of horses maintained as if using animal power, it would be a difficult matter to find wherein a saving were effected; but if a road be properly constructed, there is every reason to suppose that a gain of from 30 to 50 per cent. would be made where from 200 to 300 horses were needed for the work, and from 60 to 70 per cent. could probably be realized on larger roads with heavier traffic by careful and judicious management.

I think the use of duplicate cables would materially assist in the perfection of this system, as in case of accident to one cable there need be no stoppage of the road. The use of a single cable necessitates having horses in readiness for an emergency, and a cable road is supposed to dispense with the use of animal power. If employing two cables, it is evident that no horses need be retained, for if

Objection has been made to the use of long cables on account of the sway or variation of speed; but if engines were well governed, I do not believe this would be sufficiently marked to be objectionable, and all moving cars would assist in keeping the cable at uniform speed. By doubling the length of the ropes and increasing the number of sheaves, State street could be operated with duplicate cables.

The cable system is not of recent origin, as might be supposed. We find by examining the United States Patent Office records that the first patent of importance was granted on improvements in tracks for a city railway to G. S. Gardner, of Philadelphia, in 1858, and as it may be of interest, I will give his claim in full, without the Patent Office drawing. The inventor says:

"I claim forming between the rails of a city railroad track, an underground tunnel, and hanging a series of pulleys within the same, said tunnel having a longitudinal slot near the level of the ground, and being otherwise so

schemethan may be supposed, as there were many obstacles to be overcome, and considerable outlay to be made in experiments, these roads differing in many respects from those previously constructed; but the originators of the project have reason for congratulation, and should receive the gratitude of the public in general for so successfully supplying means of comfortable and easy transit.

[The cable roads of Chicago are modeled after those that were put into use several years ago in San Francisco. A full account of the latter with thirteen illustrations will be found in SCIENTIFIC AMERICAN SUPPLEMENT, No. 298.]

IMPROVED SIZING MACHINE.

This machine, by Messrs. Atherton Bros., machinists, of Preston, follows the general construction of the "slasher" type. The makers claim sundry improvements in the different parts, not so much in arrangement as in details.

The duty done by the sizing machine is twofold—it not only, as its name implies, sizes the yarn, but it also produces the weaver's beam from the warper's beams. As a test of the efficiency of the machine, the sized warp should be compactly wound on the weaver's beam, and delivered for winding thereon in a cool, dry, and mellow condition, and not asky—yarn which is rough and hard because the size upon it has been baked. The achievement of these points has been the object in view of the makers of the machine. The course of the yarn through the machine is as follows: Leaving the creel it travels over the carrying rollers into the size box, thence under a copper immersion roller, which keeps it immersed in the size; it then passes between two pairs of squeezing rollers, the bottom ones of copper and the top of cast iron, and made heavy to obtain the desired weight for expelling superfluous size. Referring to the right-hand of the engraving, the warp now strikes the direction toward the top of the drying cylinder, round which it is carried in contact with about seven-eighths of the circumference, when it passes off and is taken in a circuitous direction round a series of carrying rollers placed between size box and cylinder. The circuitous route of the yarn at this part enables several fans (four actually) to be arranged to send a draught of air into both sides of the warp. Leaving this part, it passes underneath the cylinder to the beaming end of the machine, where it also passes over another series of carrying rollers so disposed as to admit of three fans being arranged to blow upon both sides of the yarn. The warp, after being divided or the ends separated by a number of splitting rods, passes between a pair of nipping rollers, thence on to the weaver's beam. Such in general terms is the working of this class of machine.

The yarn in the first instance is drawn off the beams in creel by the squeezing rollers in the size box, and afterward over the cylinders by the nipping rollers last mentioned. All these rollers are geared together and are proportioned relatively to each other to give the smallest possible tension on the ends. To obtain the last practicable strain is, of course, a matter of much importance, and from this point of view it is argued that large drying cylinders are to be preferred, because from the longer leverage they give the yarn they are easier to pull round. The large cylinder of this machine is 9 feet diameter, constructed on the cavity principle, and we understand that they are at work with warps of from 500 ends up to 4,000, some examples being with very fine counts. They possess a further important advantage in the fact that they give a large drying surface, and therefore for the same speed of production the yarn remains longer in contact with them, and a lower temperature will suffice for the work. As, for example, at Messrs. Hawkins' mill, with 3,200 ends of 32's, the large cylinder machines work with 5 lb. steam as against 10 lb. in small double cylinder machines, with a marked improvement in the mellowness of the warp, but with lighter work from 2 lb. to 2½ lb. steam is sometimes sufficient. That is to say, the risk of baking the yarn, hardening it, and making it asky, is reduced, and the quality of the cloth is, as a result, improved. The weavers also, we were informed, show a decided preference for the warps from the large machines. The softness of the warp is further promoted by the use of fans, which act as drying agents as much as cooling. The makers of the machine under notice claim to have a larger number than commonly employed.

Other points in the machine that may be noticed are: The presser arrangement for the warp beam, the object of which is to obtain a compact laying of the yarn. This, we believe, is accomplished in a novel manner. There are two presser levers, each operating on its own half length of beam, so that both ends of beam are pressed, although the yarn on one-half may be irregular. The driving of the machine is on the positive drag principle, regulated by strap cones working in connection with the nipping rollers. The weaver's beam is driven by a separate friction motion regulated by a hand-wheel screwed upon springs. The marking motion applied is on the faller principle, the construction of which has been

FIG. 3.—CHICAGO CABLE ROADS.—PLAN OF CURVES AND CROSSING

one cable be disabled the other could be called into immediate use, or both might be used simultaneously. A road can as well be built for using duplicate cables as for a single one, and the difference in cost of construction would be nothing compared to the benefit derived.

State street is now operated with two single cables, one running north and the other south from the engine house at Twenty-first street.

The indicated horse-power of the engines, divided by speed of cables, gives the strain on all the cables as 5½ tons, and if to this is added one-half of tension weight, we have 6½ tons load for the two State street cables.

If but one cable was used to do the work, it would require a rope eight miles long, and I should not consider this length objectionable, provided the cable was not overloaded, and, as in this case, the strain is but 6½ tons, and the proper working load of a steel cable of this size (1¼ inches in diameter) is 8 tons, I can see no reason why one cable would not be sufficient. The breaking strain of a steel cable 1¼ inches in diameter is 39 tons.

arranged that a rope may be used for drawing the cars along the track without impeding the passage of vehicles across the same."

There have been over 130 patents granted by the United States Patent Office on cable traction, but I have no knowledge of a patent which covers the system, and a cable road can be built without infringement, although it might not be advisable to ignore all patented improvements.

The numerous fatal accidents resulting from the introduction of this system are to be deplored, but from present indications we believe there will be no recurrence of these misfortunes, as people are becoming accustomed to the cable, and operators more skilled in its management.

No doubt, radical changes will be made in the system, and we may, in the near future, see cable cars operated with comparative safety in our cities at a speed of 10 miles per hour, which is certainly to be desired.

The conversion of these roads from animal traction to the cable system was certainly a gigantic undertaking, and required more fortitude on the part of the projectors of the

IMPROVED SIZING MACHINE.