gency and service stops were made to test the brakes on a slippery rail, all of which were made with great success. The extreme smoothness of the stops, absence of shocks to rear car, the perfect control of the brakes both from the engine and caboose, were noticeable features in this test.

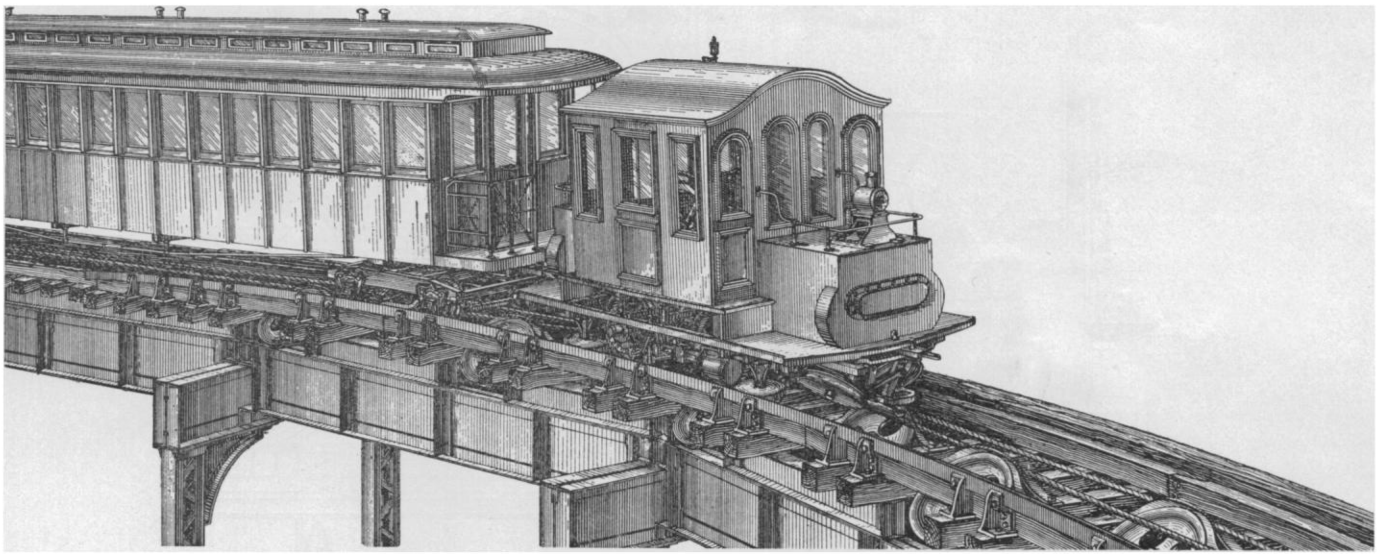

FIG. 1.—RAPID TRANSIT CABLE COMPANY'S GRIP MOTOR.

CABLE RAILWAYS.

CABLE railways have, where properly constructed, given great satisfaction, and the system has steadily grown in favor since its introduction on Clay Street, San Francisco, Cal., in 1873. The best example of a line of this character for heavy service is to be found on the New York and Brooklyn Bridge, over which passengers were first taken Sept. 24, 1883, from which time to May 1, 1888, 91,376,778 passengers were carried; and the delays to traffic due to the cable system amounted in the aggregate to but 20 hours and 46 minutes, — an average per month of only 23½ minutes, or less than one minute per day. This is on a road about 1⅛ miles long, having 3¼-per-cent grades, operating trains at from 4-minute to 1½-minute intervals (since reduced to 1¼ minutes), with a speed of 10 miles per hour. It may be doubted if any road in this or any other country can show a better record. The grips there used consist of two pairs of packed wheels or rollers, set in frames opposite each other. Between these is a pair of solid gripping-jaws. The cable is first brought into contact with the rollers, after which the jaws come into action, and serve as a lock. This grip has these great disadvantages, however: inability to take hold of the cable except at certain fixed points, or to operate on curved tracks; and too small contact of the rollers with the cable; and, to exert the requisite gripping-power on the cable, it must be applied with great force, especially at the time of starting the train, when the greatest power is required. This "pinch" on the cable

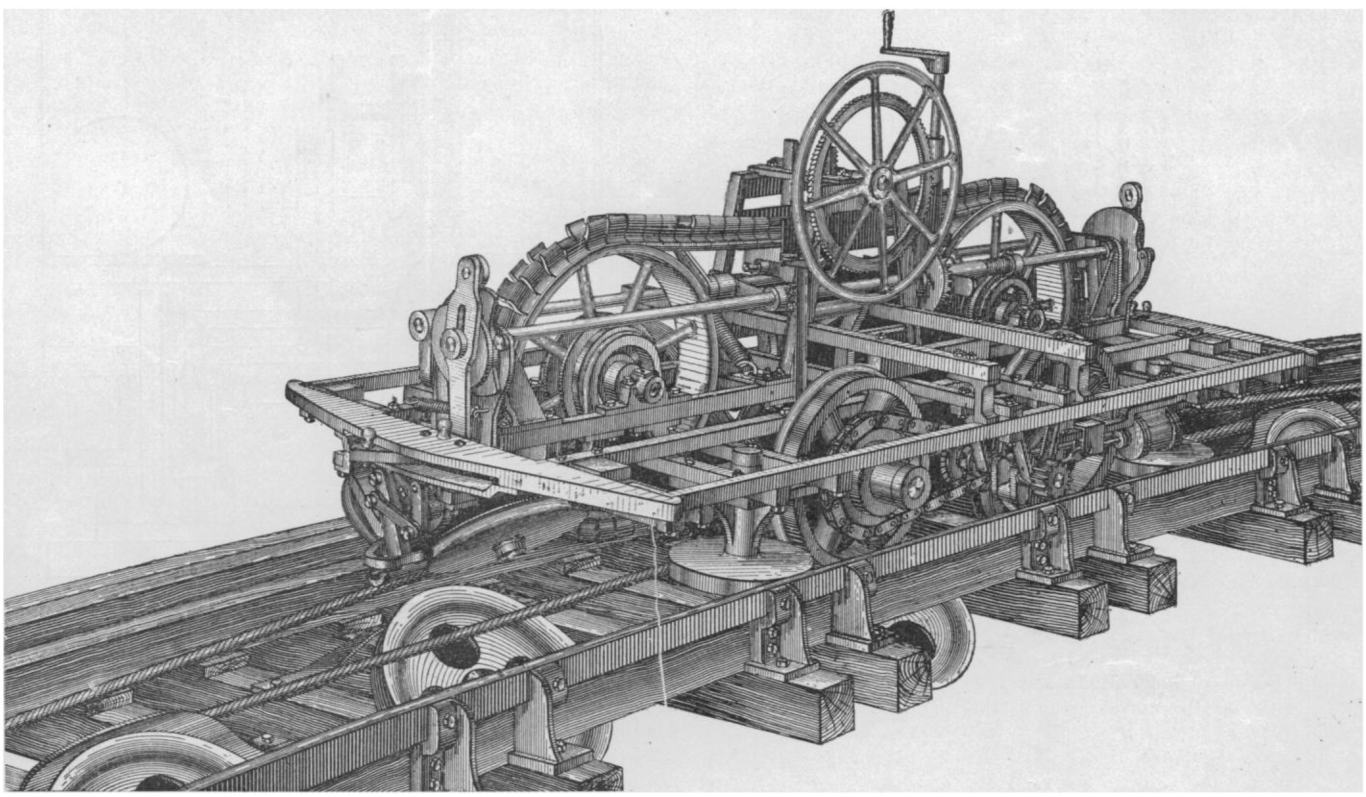

FIG. 2.—MOTOR WITH CAB REMOVED.

is destructive to the strands, and the solid jaws are brought into action too quickly; yet the first cable was in continuous use from the opening of the railway to Nov. 7, 1886, and the second was still serviceable in April, 1888, while the roller-packing gives a service of 20,000 miles.

But grips on each car, and ten miles per hour, regardless of its inapplicability to curved lines or inability to take hold of the cable, would not answer for elevated railways; and a cable moving at a greater speed would, if brought into contact with such rollers, very soon destroy the packing.

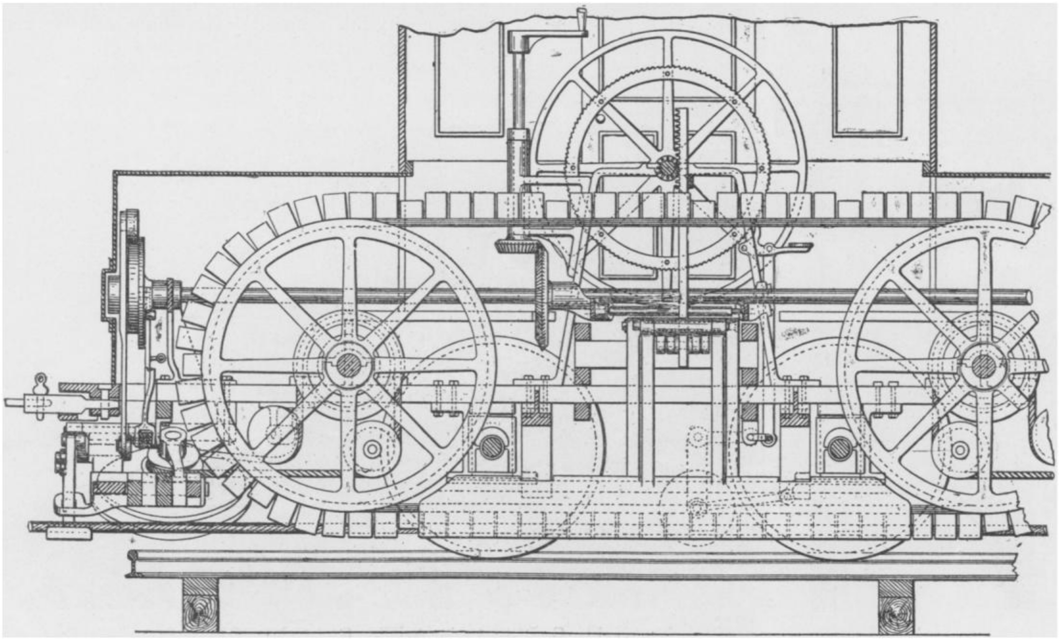

FIG. 3.

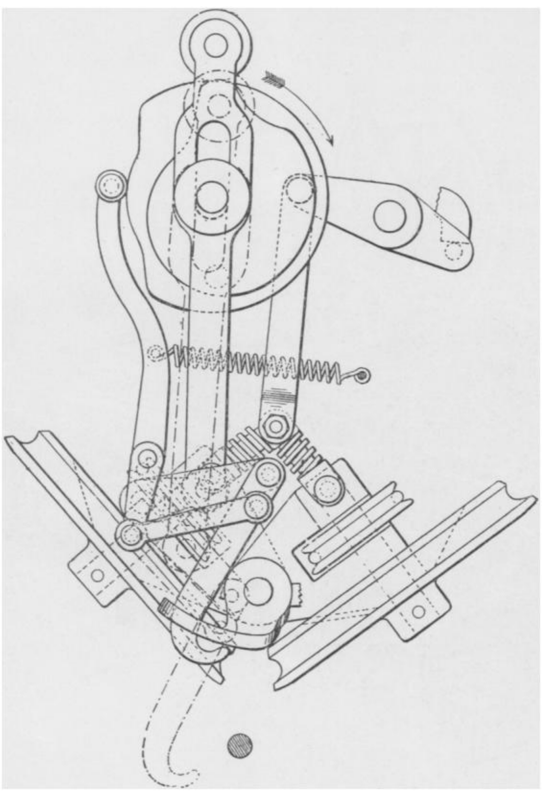

FIG. 4.

1. Is it, then, possible to run a cable at sufficient speed to provide rapid transit?

2. Is it possible, provided the required speed can with safety be obtained, to grasp the cable with any effective gripping-device without great destruction to either cable or grip, or both?

3. Can a sufficiently powerful grip be devised to haul the heavy trains in use on elevated railways, provided the ability to grasp the cable is demonstrated?

4. Will any saving be effected in operating expenses by substituting cable and stationary engines for the system now in use?

To each and all of these questions the Rapid Transit Cable Company of New York reply in the affirmative, and endeavor to prove their position as follows: —

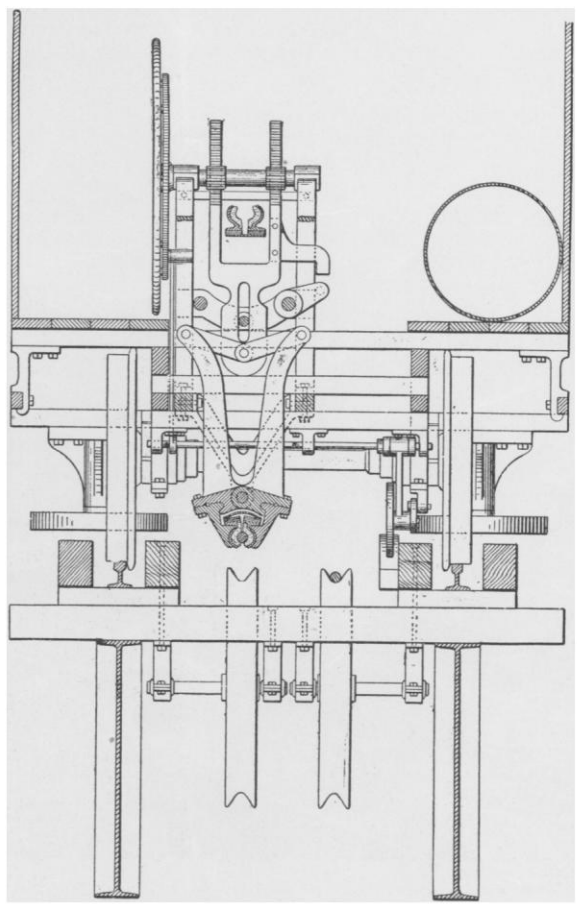

FIG. 5.

1. The present elevated railways in New York are operated at an average speed, including stops, of 12.18 miles per hour, or 17.86

feet per second; express-trains, 18.23 miles per hour, or 26.74 feet per second. Allowing for station stops, the maximum speed will be under 20.5 miles per hour, or 29.9 feet per second.

The speed at which a cable for the transmission of power can be run may be determined by the liability of the pulleys to burst under the action of centrifugal force, and this safe speed is determined by Professor Unwin, for cast iron of 4,500 pounds per square inch tensile strength, to be 215 feet per second; so that, if we adopt 25 miles per hour as the desired velocity, which is nearly one-fourth greater than now used, we shall have for our working speed 36.66 feet per second, or about one-sixth of the safe limit for cast-iron pulleys. Hence there can be no question as to speed.

2. To one familiar only with the cable grips at present in use, it is but natural that this second question should cause considerable apprehension, for there is not one which could be successfully used for such velocity as has been above assumed. But the Rapid Transit Cable Company have had this question of providing a gripping-apparatus applicable for heavy trains and high velocity constantly in view, and their experiments and labors have been largely devoted to overcoming the difficulties encountered; in fact, it may be said to have been a *sine qua non*, and they are at last prepared to claim a successful solution of the problem. Their grip for such service as is now under consideration is placed on a separate truck or car, and hauls the train as a locomotive; but instead of weighing $23\frac{1}{2}$ tons, concentrated as largely as possible on four driving-wheels, it weighs less than 10 tons; it is supplied with pumping-cylinders to provide compressed air or vacuum for operating train-brakes, and for moving itself about yards or switching from one track to another. Curves of any radii which are practicable for any other motive power are passed with equal facility, and the cable can be picked up at any and all points on the line. It is arranged for duplicate cables, as is also the driving-machinery, so that in case of any accident the idle cable may be picked up without a delay exceeding five minutes, wherever the trains may be. The gripping-device gives a very long contact, thus reducing the unit pressure on the cable for a given weight of train. The gripping surface is of leather; and, to still further protect the parts in contact from excessive wear, a very simple device sets the movable gripping-parts into motion automatically before they are brought into contact with the moving cable. Thus that which in all other grips would be speedily cut out by the cable is in this case preserved, and little or no cutting can take place. When the parts are moving at the cable speed, the pressure is applied, the grip-brakes are brought into action, and the pulling-power of the cable gradually overcomes the inertia of the train.

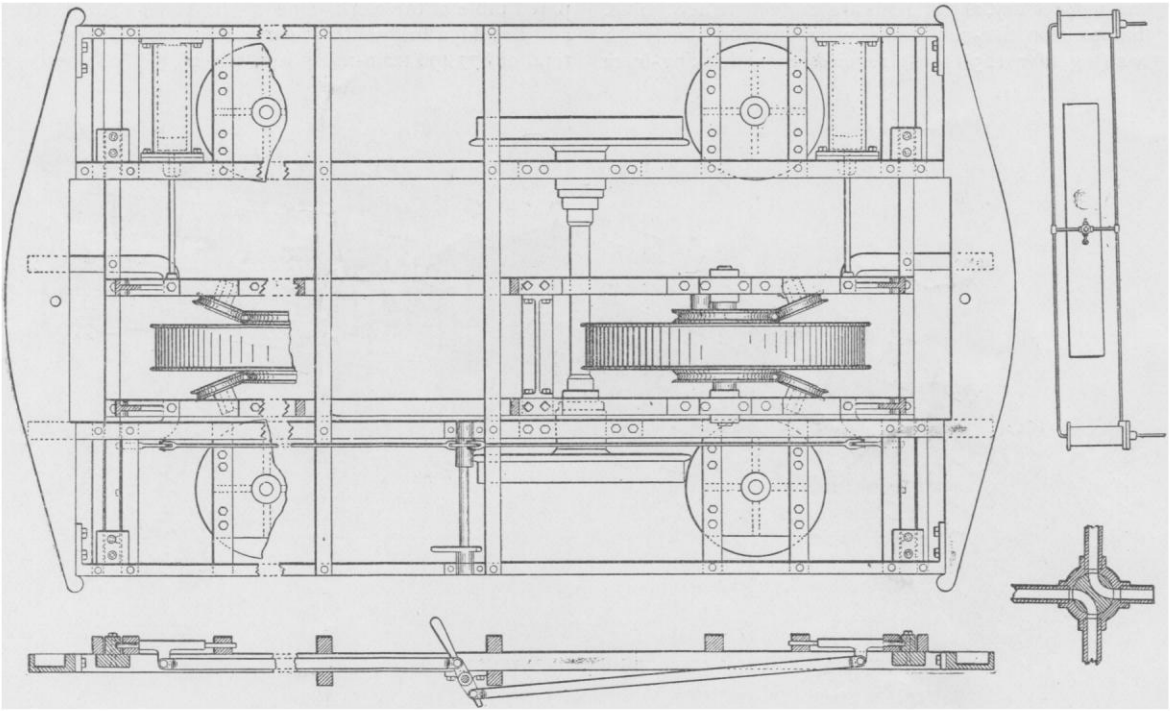

FIG. 6.

3. In answer to the third question it is sufficient to state that the length of the gripping-surface is 60 inches, which, used with a cable of $1\frac{3}{8}$ inches diameter, and assuming only three-fourths of the periphery to be subjected to the gripping-pressure, will give an available area of 246 square inches. The friction of leather on a cable may safely be taken as 0.6 of the pressure applied, so that for every pound of pressure there is 0.6 of a pound of pulling-power. An elevated-railway locomotive with 37,400 pounds on drivers, may, under the most favorable conditions, exert from one-third to one-fourth of this weight as tractive force, an average of 11,400 pounds, which this grip will produce with less than 78 pounds per square inch, which may be multiplied several times without injury to cable or grip.

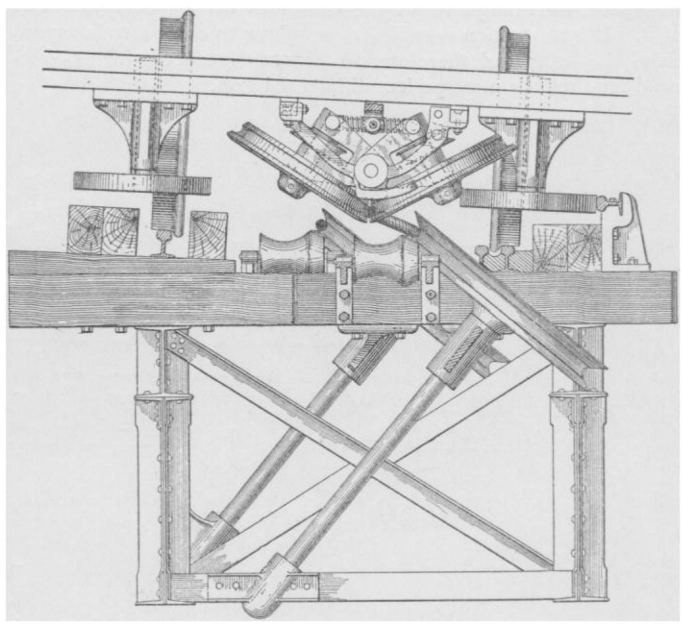

FIG. 7.

4. Next as to the question of economy. In a cable system,

water and coaling stations are unnecessary; less water is needed, less oil and waste, and from one-half to one-third the quantity of coal, which may be of an inferior quality, costing perhaps one-half of what is now paid. Grades cease to be obstacles, and expensive constructions like that in New York at 110th Street and Eighth Avenue become unnecessary, and stations are made more accessible. It is clear that to stop five-car trains weighing 100 tons, with engine 23½ tons (together 123½ tons), requires more braking-force than the same train of cable-cars with a 10-ton motor, a total of 110 tons; it is also evident that the lighter train will attain full speed more quickly. The horse-power of a locomotive is least at starting, just at the time when the greatest effort is needed; whereas with the cable-train the motive power (the cable) is already in full speed, with the power of the enormous driving-engines ahead of it. It is a question in cable-traction how to come into full speed slowly enough; and therefore, to be entirely successful, a cable-road requires the most perfect differential grip.

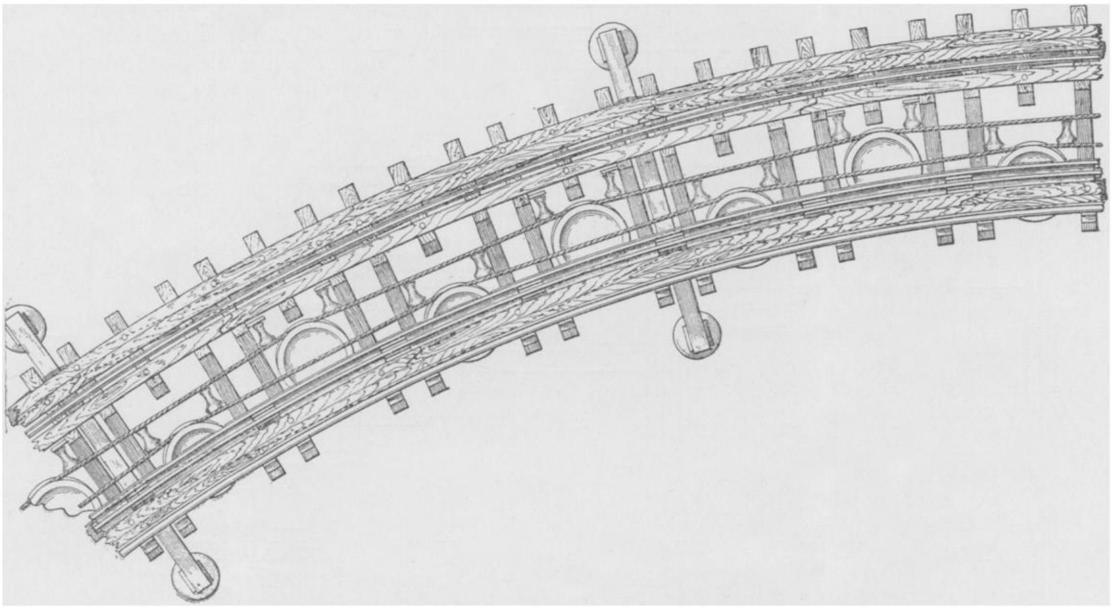

FIG. 8.

As to the amount of power expended in driving the plant, reference is made to Mr. Leverich's paper on the New York and Brooklyn Bridge, wherein it is stated that the highest horse-power developed by the engines was 394.5, and that to drive the plant alone, cable included, required 47.7 horse-power, which gives 87.99 per cent to be utilized for cars and passengers.

A comparison of the motive-power expenses of cable and locomotive roads may be made from recent reports. According to the report of the railroad commissioners of the State of New York, the trains of the Manhattan Elevated Railway of New York City travelled a total of 7,202,966 miles during the year ending Sept. 30, 1887, carrying 158,783,241 passengers. The expense of operating the road for the same period was $4,508,467, being 61.89 cents per train-mile run, or 2.79 cents for each passenger. A carefully prepared table of the work done by the cable-road on the New York and Brooklyn bridge for the year ending May 31, 1887, shows a total of 877,496 train-miles run, and 26,388,808 passengers carried. The operating expenses were $402,894, being 45.84 cents per train-mile, or 1.52 cents per passenger. In this particular instance it would appear that the cost of carrying each passenger on the cable-road was less than half that on the steam-road, while the cost per train-mile run was at least one-fifth less on the former than on the latter.

In Fig. 1 the Rapid Transit Cable Company's motor is seen perspectively, coupled to a train; and in Fig. 2 it is represented with the cab removed.

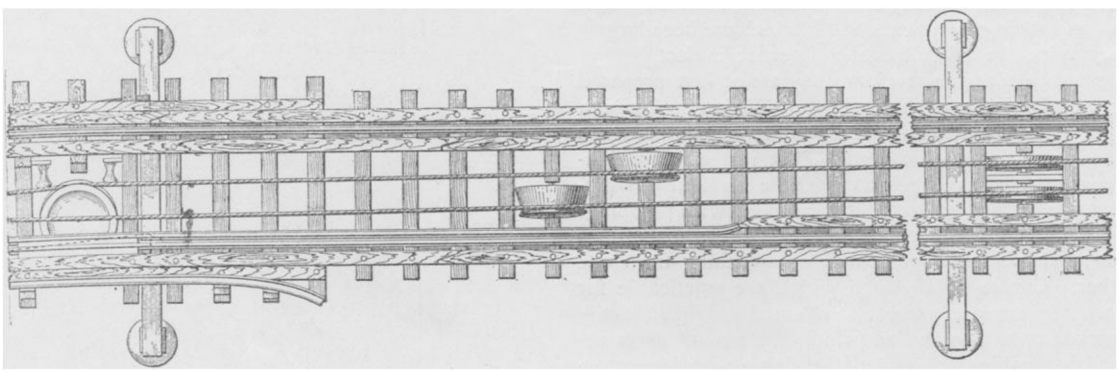

FIG. 9.

Fig. 3 is a partial longitudinal section on a broken plane, in which is shown the revolving belt of clips, with inner surfaces of leather, between which the travelling cable is held; and the large capstan-wheel for applying and releasing the gripping-jaws, through which the belted clips run (as shown in dotted lines), and are forced with greater or less pressure against the cable, thus retarding the belt proportionately from the consequent friction of the outer metallic plates of the clips in contact with the metallic guide and gripping-jaws. This produces a greater or less differential speed of the revolving belt and travelling cable to the speed of the motor, and thus enables a gradual start or variable train-speed without injury to the grip or cable. To the left of the capstan-wheel is a vertical shaft having on top a crank with handle or a wheel, and terminating below in a bevel-gear wheel which engages with another keyed to the long shaft, by means of which the pick-up is operated, as well as the carrying-sheaves at the end of the motor, which serve to properly guide the cable in its relationship to the revolving belt, and cause it to revolve at the same speed as the travelling cable, before their contact. These are all very simply and positively accomplished by the continuous turning of the one crank, which, being a uniform motion, precludes any confusion of the operator.

Fig. 4 shows the pick-up and supporting wheels in detail, and their transposition when operated. Though the pick-up is capable of being worked at any time, its use is seldom required, as the cable travels through the supporting wheels almost continuously, — during stops at stations and when varying the speed, — and is seldom dropped but at crossings, ends of sections, and the termini. In dotted lines below the capstan-wheel is the automatic tripping-device to release the cable at the end of a section or at any fixed point.

Fig. 5 is a cross-section showing the shape of the clip-belt in its position between the gripping and braking jaws, which get their force from the connected compound levers and toggle, actuated by the large capstan-wheel. This grip is seen holding the right-hand cable, but may be easily shifted on its movable supporting-frame, pneumatically with cylinders, as shown in plan view in Fig. 6 (or with a capstan-bar), by the engineer or grip-man, to the centre (as required with a single cable), or to accommodate the left-hand cable (as in this duplicate system); which cable is seen supported by the end guide-wheels (previously referred to in connection with Figs. 3 and 4) in Fig. 7 in their relationship with the guard-wheels to the guard-rail and curve-carrying sheaves, Figs. 8 and 9 respectively showing the same duplicate cables in plan of track on curve, and its approach. This motor is also provided with combined air-pumps and engine-cylinders, and reservoirs.

Being adapted to a duplicate cable system that provides against the delays which might possibly occur in the use of a single cable, the grip is shifted to a position directly over the cable it is desired to take (see Fig. 6), two methods being provided in case of accident to one or the other. The horizontal crank or wheel actuating the vertical shaft (see Fig. 3) is then revolved continuously in the same direction. This causes the pick-up at each end of the motor (see Figs. 3 and 4) to descend, pass under the cable, lift it, and throw in the carrying-wheels (see Figs. 3 and 4) to support the cable in an elevated position, to be gripped by the clip-belt after the same has been put into motion by contact of the same supporting-wheels with the travelling cable; following which the pick-up is lowered slightly, and withdrawn to one side of the cable. The train can now be started and speeded with a graduation exactly as the operator may intend by the turning of the large capstan-wheel that governs the powerful mechanical combination (see Fig. 4) which actuates the braking and gripping-jaws, increasing or lessening the required tractive power, and correspondingly regulating the speed of the train without any undue exertion of the operator.

If for any reason it should be necessary to communicate with or signal to the power-house, or stop one cable and start the other, it may be done direct from the trains or motors, at any point on the line of railway, by a patent electric device; and, in the event of thus transferring the power from one to the other of the duplicate cables, the grips are shifted conformably (see Fig. 6).

THE WORK OF THE PEABODY MUSEUM OF AMERICAN ARCHÆOLOGY AND ETHNOLOGY.

THE twenty-second annual report of Professor F. W. Putnam shows that the work of the Peabody Museum of American Archæology and Ethnology is constantly growing in importance. From the interesting contents of his report we glean the following facts.

The museum purchased for a moderate sum, from the Rev. Samuel Lockwood of Freehold, N.J., a collection of particular importance in supplementing the Abbott collection from the vicinity of Trenton. Over thirty years ago Mr. Lockwood investigated the great shell-heap at Keyport, and was the first to call attention to its character. This shell-heap, with many of the objects from it, was afterwards described by Dr. Rau, and has become historical in American archæology. From this large refuse-pile the most important part of the Lockwood collection was obtained. In addition, there are many stone implements from various places in Monmouth, Middlesex, Mercer, and Ocean Counties. Among them are several paleolithic implements, and a large number of argillite points, found under peculiar conditions, and showing a degree of weathering which is conclusive evidence of their extreme antiquity. As the shell-heap at Keyport, once covering a mile or more in length along a narrow strip, bordered upon one side by the ocean and on the other by Raritan Bay, is entirely obliterated, it is of importance that the materials obtained from it be now in the museum for comparison with the very extensive collections from the shell-heaps of New England. The fact that at certain places on this narrow strip between the bay and the sea the prevailing implements were of argillite and of great antiquity has a peculiar significance in connection with those from Trenton, and again points to an intermediate period between the paleolithic and the late Indian occupation of New Jersey. The collection also contains three Indian crania from Monmouth County, and a few objects from various places beyond the immediate region of Keyport. Mr. Lockwood has a considerable number of field notes, made during his long-continued explorations of the vicinity of Keyport, and it is his intention to prepare a full account of his observations and of the collection, for publication by the museum.

In the list of officers given in connection with the last report, it will be noticed that the name of Mr. Hilborne T. Cresson of Philadelphia is given as a special assistant in the field. Mr. Cresson, while studying abroad, became interested in the archæology of France and Switzerland, and while at home has devoted his leisure time to a study of American archæology, upon which he has published several important papers. About 1870 his attention was called to the existence of stakes or piles, observed by a fisherman, in the mud at the mouth of Naaman's Creek, a small tributary of the Delaware River. Circumstances at the time did not permit of more than a hasty examination and the taking of a photograph of the locality. It was not until Mr. Cresson's return from France, in 1880, that means were furnished, by a gentleman of Philadelphia, to prosecute the work. His examinations soon led to the discovery of three distinct localities, near to each other, which he designated Stations A, B, and C, and around which were found a very important and instructive collection of stone implements, a few points and fragments of bone, and a human tooth. At one station a number of fragments of rude pottery were found, and at this were obtained the several pile-ends now in the museum. This collection he has generously given to the museum, and proposes soon to prepare a full account of his discoveries for publication. The museum is also much indebted to Mr. A. B. Huey of Philadelphia for a number of specimens which he obtained while with Mr. Cresson during the examination of Station B, and to Mr. W. R. Thompson of Philadelphia, for several potsherds, and a large stone maul with a hole drilled through it, from the same station.

When it is recalled that this is the first indication in North America of any thing even remotely resembling the crannoge-like structures of the European bogs, the importance of Mr. Cresson's labors will be appreciated; and the museum is fortunate in having his co-operation in its work, — a co-operation which he states he freely gives from his appreciation of the objects and methods of the museum. The specimens are now exhibited in the museum, and are of great importance in the study of the periods of occupation of the Atlantic coast. The discovery by Mr. Cresson of the fact that at only one station pottery occurs, and also that at this station the stone implements are largely of jasper and quartz, with few of argillite, while at the two other stations many rude stone implements are associated with chipped points of argillite, with few of jasper and other flint-like material, is of great interest in connection with the specimens collected by Dr. Abbott and Mr. Lockwood in New Jersey, to which allusion has been made.

In connection with his studies of the river-stations, Mr. Cresson has examined the peat marshes and land along the shore of the