SCIENCE.—SUPPLEMENT.

FRIDAY, NOVEMBER 5, 1886.

CABLE STREET-RAILWAYS.

IT is proposed to 'gridiron' New York City with cable street-railways. The network, as projected, embraces about seventy miles of double-track road, consisting of a number of distinct routes, with branches, all connected together so as to form one comprehensive system. Of this, fifteen miles will be elevated, the rest surface roads, but all

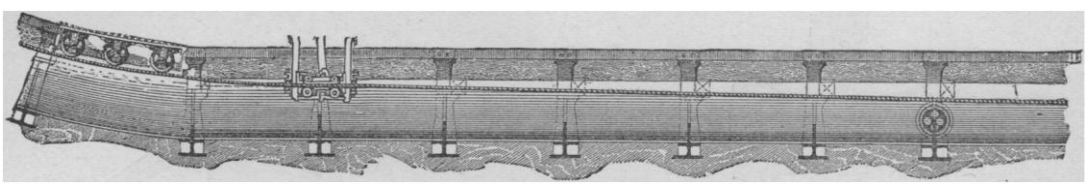

FIG. 1.

operated by cable traction. That this comprehensive scheme will be carried through to completion is not yet certain. There is much opposition to it, not only from property-owners along the proposed routes, but also from railroad companies with whose interests it would conflict. Cable-railways have been in use in San Francisco for thirteen years, giving better satisfaction for street

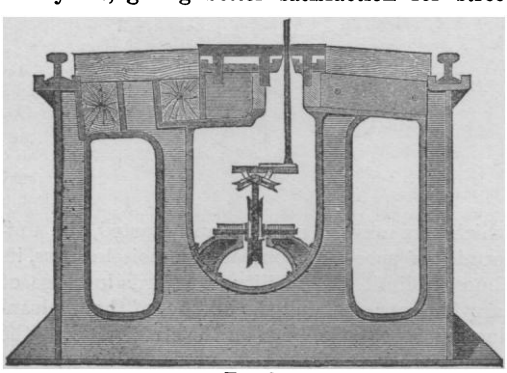

FIG. 2.

purposes than either horse or steam railways. Many other cities, in both Europe and America, have given cable traction a fair trial, and with results satisfactory to the travelling public as well as to the owners of the roads. There are already several miles of cable-road completed and running in the northern part of this city; and, even if the contemplated network throughout the city should never be constructed, there will be a sufficient number of cable-railways in the city and suburbs, before many years, to enable the general public to judge of their merits.

The history of cable traction as applied to street-railways dates back only a few years, though cables moved by stationary engines had been used on tramways in the principal collieries of England and Germany long before the advent of the locomotive. In 1830 a railway between Liverpool and Manchester, in England, — the second of the kind constructed, — was approaching completion, and George Stephenson, the eminent engineer, was one of four commissioners appointed to decide whether the road should be worked by stationary engines and wire cables, or by locomotives. It

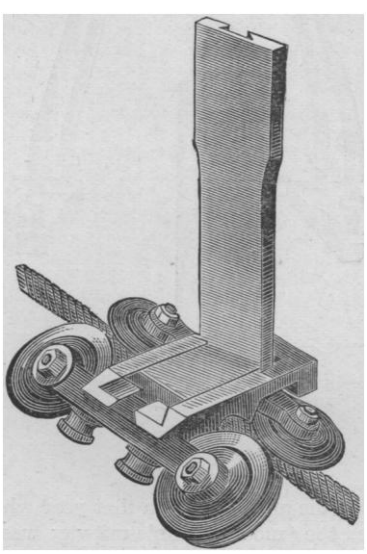

FIG. 3.

was decided to use locomotives, though two of the commissioners strongly favored the cable system, as the locomotive was still in its infancy. In his report to the officers of the road, Mr. Stephenson said, "Fixed engines with ropes are most suit-

able for hilly countries, where the gravity of the horse as well as of the locomotive engine becomes a material part of their whole power." The use of wire cables for haulage purposes on inclined planes, especially in mining regions, had steadily increased as necessity demanded, but no special adaptation of the cable system to street-car traction was made until 1873. In that year what may be termed the 'modern' cable-railway was introduced, the first application of it being made on the Clay Street hill road in San Francisco, Cal. This road was about half a mile long, on a narrow street, with grades of one foot in five and a half feet. That road has been in continuous operation ever since.

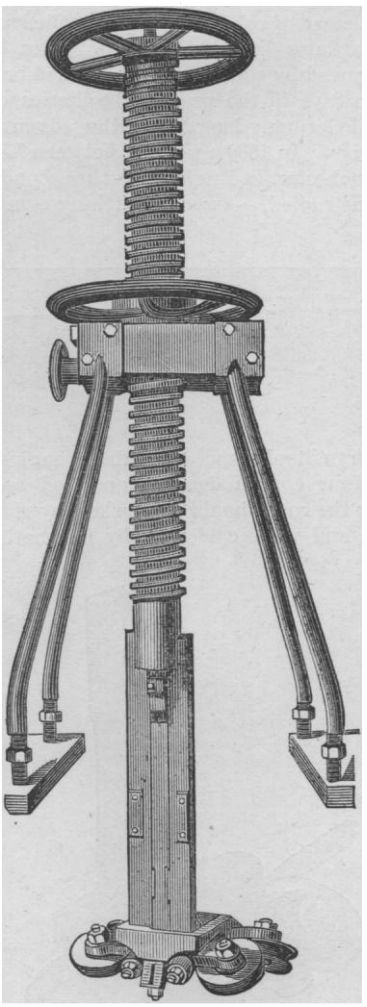

FIG. 4.

It will be seen that this first application of the cable system to street-cars, on a grade too steep for the economical use of either horses or locomotives, was in accordance with the views advanced by Stephenson thirty-three years before; but so many and so obvious are the advantages of cable traction, as demonstrated by the Clay Street and other roads, that it is rapidly taking the place of horses on level streets; and it is even being urged as a substitute for the locomotive on the London underground railways, as well as in other places where the smoke, noise, and gases of the locomotive are objectionable. Among the advantages of the system are, its applicability to steep grades as well as to levels, the ease and gentleness with which cars may be stopped and started, the uniformity of speed, its comparative noiselessness, its almost unlimited capability as regards increase of carrying capacity, and the absence of the uncleanliness, unavoidable, both on the streets and at the stables, wherever horses are used. Although the use of horses for many purposes in cities can never be entirely dispensed with, — unless in such a place as Venice, — the more general use of a mechanical motive power for street-railways would greatly lessen their number.

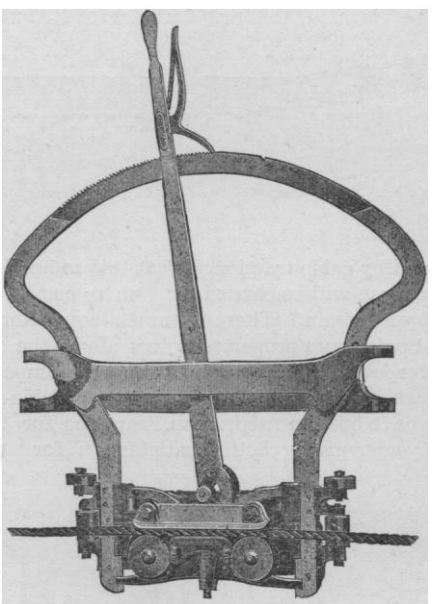

FIG. 5.

The cable system consists of an endless steel or iron wire rope, moving continuously in a slotted tube placed beneath the surface of the street and between the rails. The rope is supported at intervals by pulleys, depressed by smaller pulleys at

points where steep grades are crossed by level streets, carried around curves by guide-rollers, and kept in motion by a steam-engine located at any convenient point on the line of the road. A gripping device at the end of a thin vertical steel plate, or combination of plates, connected with the car and passing through the slot in the tube, transmits the motion of the cable to the car, the speed of the car being determined by the speed of the cable, and usually not exceeding about eight miles per hour in city streets. The action of the grip is controlled by a grip-man, who, by the movement of a lever or hand-wheel, can start or stop the car as gently or as suddenly as may be desired. Fig. 1 is a longitudinal section of the slotted tube in use on the Clay Street hill road. At the extreme left are shown the depression pulleys at the intersection of a level cross-street with an ascending grade. The weight of the car on the grip keeps the latter sufficiently depressed at such points to clear the pulleys. At the right is shown a supporting pulley. A transverse section of the tube, with its surrounding framework, which supports the rails, is shown in fig. 2. The gripping device in use on the Clay Street road is shown in fig. 3, and its operating mechanism and supporting framework are shown in fig. 4. The gripping-jaws, which close on the rope between the pairs of guide-sheaves, are moved by the upper hand-wheel, while the grip may be raised or lowered bodily by the lower wheel. The guide-sheaves, which are kept in contact with the cable by springs when the gripping-jaws are released, guide the cable smoothly between the jaws when the car is not in motion, holding it in position for gripping when it is desired to start the car. Many modifications of the grip have been devised, in most of which the jaws move vertically instead of horizontally; but with the exception of the Paine grip, used on the East River bridge, the essential features in all are the same, and they differ only in detail from a grip described and illustrated in a technical journal nearly fifty years ago. Figs. 5 and 6 show two varieties of lever-grip now used on many roads.

As frequent and careful inspections of cables and machinery are required, and as on many roads cars are run continuously night and day, a duplicate or duplex system has been found necessary, of which the Tenth Avenue line in this city may serve as an example. In this system two cables run side by side through the tube, each supported by a separate set of pulleys, and provided with a separate engine. While one cable is running, the other is held in reserve; and, in case of accident to one cable or engine, the other may be immediately started up, the grips, which are made double for the purpose, releasing one cable and taking up the other. The engine-room of the Tenth Avenue line is shown in fig. 7, and the arrangement of duplex cables and pulleys may be seen in fig. 8. The cables may be run alternately, and for any desirable length of time, giving ample

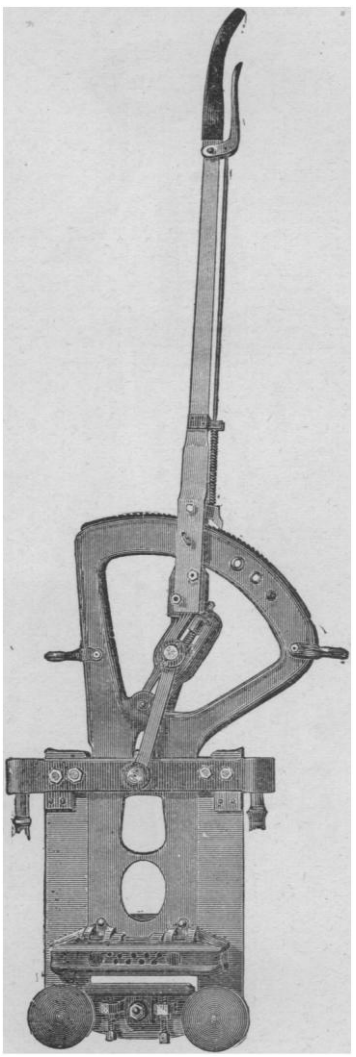

FIG. 6.

opportunity for inspection and repair without interruption of travel. As will be seen in the engraving, there are two complete plants of machinery; and as they are duplicates, a description of one will suffice for both. The motive power for each plant is a Wright automatic cut-off engine of three hundred horse-power. A six-foot wheel on the engine-shaft gears into a thirteen-foot

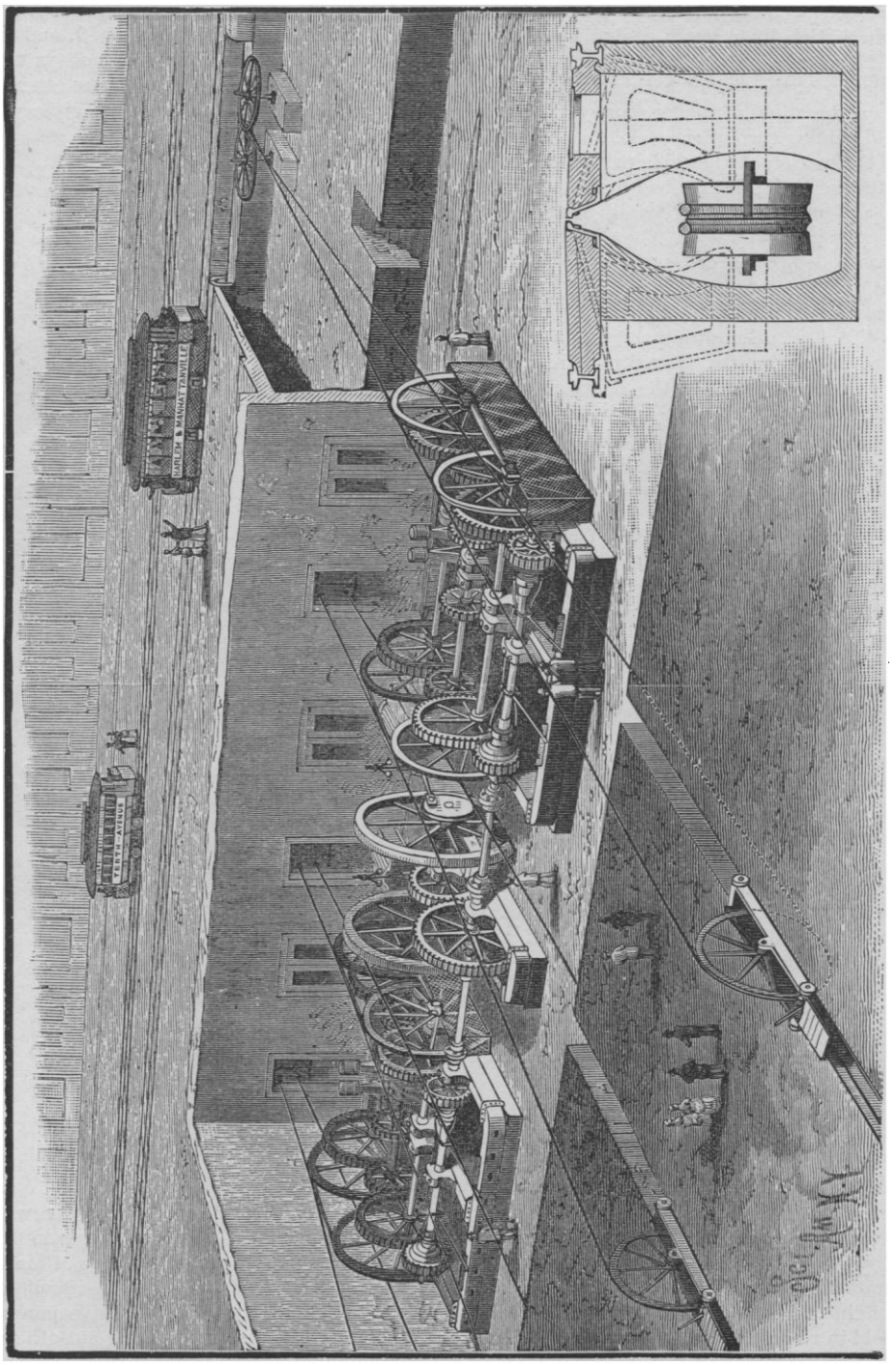

FIG. 7. — ENGINE-ROOM OF THE TENTH AVENUE CABLE-RAILWAY.

FIG. 8.

wheel on the line-shaft, which is a foot in diameter and about fifty feet long. The line-shafts of both plants may be coupled together, so that either engine may be used to drive either section. Each section carries two pairs of cable-drums, either pair of which may be thrown into or out of action by clutches. Thus either engine may be

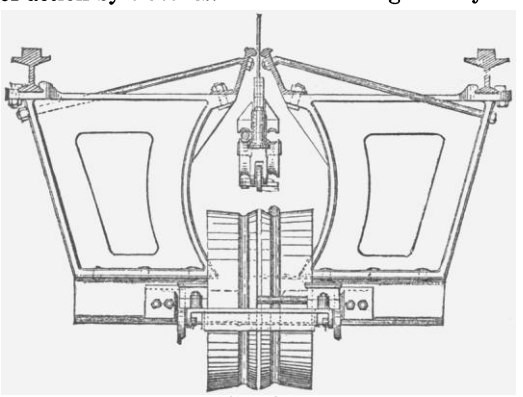

FIG. 9.

used to run any of the four cables shown in the engraving. The section at the right actuates the duplex cables running out Tenth Avenue; that on the left will be used for the 125th Street branch of the company's line.

The cable, coming from one of the guide-pulleys in the street, shown at the right of the en-

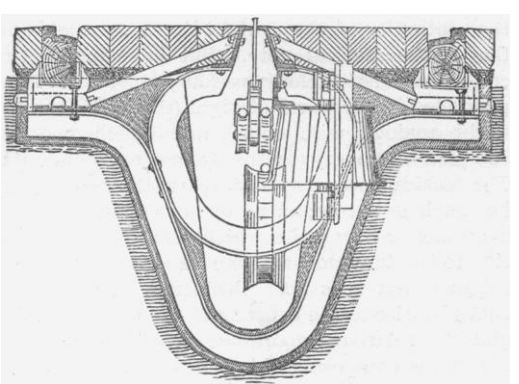

FIG. 10.

graving, passes several times around both cable-drums, thence around a 'slack-pulley,' shown in the foreground, from which it passes back around one of the guide-pulleys in the street, and back on its way through the tube. The 'slack-pulley' is mounted on a car which is moved by a differential lever in such a manner that the cable is always kept at a uniform tension. Thus the lengthening and shortening of the cable through variations of temperature, etc., is compensated for.

The grip used for the duplex system, as well as the tube, pulleys, and track-supporting framework, is shown in fig. 9, which is a transverse section of the Tenth Avenue road. The framework and tube used on the Chicago cable-railway is shown in transverse section in fig. 10, which also shows one of the guide-rollers for carrying the cable around a curve. The road-bed of the cable-railway in this city has a framework of iron, as shown in fig. 9, concrete forming the sides and bottom of the conduit or tube. The transverse trusses are placed five feet apart, with the slot-rails and track-rails bolted to them. The slot-rails form the sides of the longitudinal slot of the tube, and they are held firmly in place by tie-rods which connect them with the outer edge of the truss. Pulley-vaults are provided at intervals of thirty-five feet, affording access to the carrying-pulleys. A system of drainage-pipes connects these vaults with the city sewers, thus securing perfect drainage, which cannot be affected by any dirt that may accumulate in the conduits. The carrying-pulleys are twenty-two inches in diameter, and are placed in pairs, one a little in advance of the other, to support the two cables independently.

The first cable street-railway, that on Clay Street hill, San Francisco, was looked upon as an experiment to a great extent; but after a satisfactory trial of three years, the system having proved itself a mechanical and financial success, a second road was constructed, also in San Francisco. This was followed by others in rapid succession, until that city has at present upward of twenty miles of cable-road in operation. Other cities followed the lead of San Francisco, St. Louis with sixteen miles, Philadelphia with twelve, Chicago with ten, Kansas City with eight, and many more with shorter lines, so that at present the total length of double-track cable street-railway in the United States will not fall far short of one hundred miles. Taking into consideration with this the fact that cable-roads are making rapid headway in Europe, Mexico, Australia, and New Zealand, it will be seen that the new system of street-car traction has proved its right to a prominent position in railroad economics.

THE PHYSICAL BASIS OF AESTHETICS.

AESTHETIC impressions may be conveniently divided into two classes: in the first it is the appreciation of qualities furnished immediately by sensation that gives rise to beauty, while in the second class the sense-impressions are interpreted and made significant by a guiding thought or emotion. Though the two often go together, there is