of life, he is far removed from any thing approaching assumption or conventionality. His disposition is amiable and retiring. He is now in the full vigor of health, and, at the age of thirty-eight, finds himself in possession of a well-earned and solid reputation. Should that long life — which seems to be a legacy in his family — be vouchsafed to him, very much more of discovery and invention may be looked for from him as the result of his maturer thought and larger experience.

THE ELECTRIC RAILWAY IN NEW YORK.

For several years past, the question of running the New-York elevated railroads by electricity has been agitated. This culminated in a meeting held in New-York City on the 18th of November, 1884, at which were present representatives of the Edison, Daft, Field, Siemens, Brush, and Bently-Knight electric railways, and also of the New-York elevated railway. At this, and five subsequent meetings, it was decided to test each system of applying electricity as a motive power for railways upon a certain portion of the elevated road. To pass judgment as to the relative values of the various systems, the following gentlemen were appointed to form a board of arbitrators: Sir William Thomson, Prof. Charles R. Cross, George B. Roberts, James H. Rutter, and Robert Harris. It was, moreover, decided to finish the test, if possible, within ninety days. This time has long since elapsed, and the waiting public have heard no report.

During this time, however, a vast amount of work has been done, and great difficulties surmounted. The great delays have been occasioned by the mechanical application of the electric-motor to the heavy and quickly moving trains. In the various systems to be tested, a third rail will be employed; and the laying of this, combined with its proper insulation, has consumed a vast amount of time.

In spite of all difficulties, the Daft company have completed their preparations, and are ready to start. As in other systems, the electric circuit is made from the dynamo to the central rail, through the collector to the motor, thence to the wheels and rails, and back to the dynamo. This company have laid their third rail upon the Ninth-avenue line, commencing at 14th Street. This rail is insulated by the Daft patent insulator, which prevents water from making a connection from rail to sleeper, thus insuring good insulation in all weathers. The road is further equipped by completing the electrical contacts at the joints of the outer rails.

At the end of this line the company have located their central station. They have placed in position a large William Wright engine, with the necessary boilers and shafting. Two fifty-horse-power Daft dynamos are now in position, and, later, a third will be erected to relieve the others, in case of accident. The wires are carried from the station to the rails through the streets upon poles.

The motor, Benjamin Franklin, has been foı some weeks finished, and has been thoroughly tested. The motor is fourteen feet six inches long, and six feet nine inches wide, and weighs nine tons. The schematic drawing (fig. 1.) will show the manner in which the motor is arranged. No attempt is made here to reproduce the proportions of the Benjamin Franklin. One of the largest-sized Daft mo-

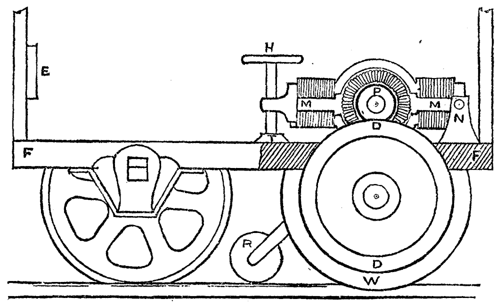

FIG. 1.

tors *MM*, is mounted upon the truck *FF*. The motor is hung so that it turns about *N* as an axis. The other end is supported by the screw *H*. The maximum capacity of this motor is three hundred ampères, with an electro-motive force of a hundred and eighty-five volts. The power is transmitted from the motor to the wheels by the grooved friction-gearing *P* and *DD*. *P* is keyed to the armature shaft, and *DD* to the drive-wheel shaft. The flange of the drive-wheel, on the farther side, is shown at *W*. These gears are duplicated on the other side of the motor. The amount of pressure upon the friction-gears is regulated by the screw *H*. This screw is also advantageous in case of repairs, for by means of it the motor may be moved completely off its friction bearings. The support *N*, of one end of the motor, is cushioned with heavy strips of rubber, as is also the cap *T*, upon which the screw rests. The trucks are likewise cushioned, thus allowing freedom of motion in any direction, and insuring perfect accommodation, on the part of the motor, to any irregularities in the road-bed.

The connection with the middle rail is made by means of a heavy bronze wheel fourteen inches in diameter *R*. This being fastened to an arm, may be raised or lowered, thus allowing discontinuities in the central rail, of which there are several in the Ninth-avenue line, to be safely passed. The wiring is all underneath the frame, and is enclosed in wooden sheathing. The device for controlling the motor is placed at the end of the cab at *E*. This is a device of sliding contacts, worked by a handle similar to the throttle in the locomotive-cab, which raises or lowers the resistance in the field-magnet circuit, thus varying the amount of current, and consequently the strength of field and speed of motor. There is also a complete cut-out in circuit. The motor is thus under complete control, it being possible to run fast or slow. The motor may be stopped either by the cut-out, or by lifting the contact-wheel. The system is further provided with an automatic cut-out, which breaks the circuit when the current reaches a certain strength, at the same time ringing a bell at the central station, warning the engineer at the central station that there is trouble on the road.

The reversing-gear is simply four brushes connected by suitable links, so that a movement in one direction applies one pair of brushes, while a movement in the other applies the opposite pair. In the motor Benjamin Franklin, the ordinary hand-brake will be employed; but later, some form of air or electric brake will be used. This motor is a very substantial affair, as its weight (nine tons) would show. The experiments will be performed as soon as Mr. Daft is at leisure to commence them.

The Edison and Field companies have combined, and are preparing to test their system upon the Second-avenue line. The length of this line from Chatham street to Harlem is 7.44 miles, only part of which, however, will be traversed by the electric railway. Although this company have not brought their work so near completion as the Daft company, still they have done a deal of hard work. They have located their central station upon 24th Street, and have provided there a two hundred and fifty horse-power Whitehill & Smith engine, with the necessary boilers and shafting. The Edison dynamos have not yet been set in position, nor has any wiring been done.

In this system, the central rail has to be very carefully insulated on account of the comparatively high electro-motive force employed (some six hundred volts). To this end, the rails will be insulated by resting upon glass shoes, which will be protected from the jar of passing trains by a thin strip of rubber. As the glass shoes have not been delivered, the rails have not been laid.

The work upon the motor has progressed slowly on account of the many difficulties offered. The original arrangement shown in the *New-York world*, April 26, 1885, has given way to several newer forms suggested by it. The latest form, and the one to be completed, is shown in the schematic drawing (fig. 2).

In this system, every truck will be provided with a motor, thus making every car independent.

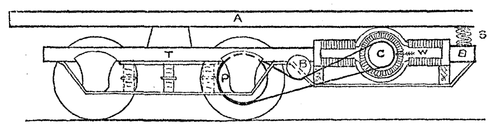

FIG. 2.

In fig. 2, *A* is the bottom of the car, *T* is the ordinary railway truck used upon any car. To apply the motor, the truck is prolonged to *B*, and is supported by the spring *S*. This spring is hung from a roller capable of side motion, thus allowing the truck to accommodate itself to curves. The motor used is a compound-wound Siemens, and is so designed that, with an external electro-motive force of six hundred volts, it will revolve at a constant speed of six hundred revolutions per minute. The power is transmitted from the armature to the pulley *C* by means of a Weston friction-clutch. This friction-clutch *W* is worked by a wheel similar to the ordinary brake-wheel, one wheel working both friction-clutches of one truck. The power is transmitted from the pulley *C* to the pulley *P*, keyed to the axle of the driving-wheels by means of a heavy leather belt of peculiar construction. In order to obtain more bearing-surface for the belt, it is carried around the pulley *B*. This same arrangement is reproduced on the other side of the truck.

The motor itself is movable, so that the tension of the belt may be varied at will. The contact with the middle rail is made by means of brushes sliding upon it. The brushes are mounted on the ends of a bar which prevents their dropping down when another road is passed, and thus short circuiting the track. The brushes are held in position by springs which allow them to turn, and thus insures a drag of the brushes at all times, instead of a push, thus allowing the joints in the rails to be smoothly passed. The reversing is accomplished as in the Daft, by employing an extra pair of brushes. The speed of the car will be controlled by the friction-brake, the motor running constantly at a uniform speed. The Eames vacuum brake will be employed, the pump of which will be run by the motor.

It will be seen from the above, that the Edison-Field combination are working upon a new principle. This system will have many advantages peculiar to itself. Each car will be independent, and the cars composing the train will start off simultaneously, thus relieving the elevated structure of the great strain caused by the locomotive when starting. The constantly revolving armature, on account of its high speed, and consquently great momentum, will help start the train, thus relieving the engine at the central station of sudden and great strains. As the load on the car increases, the traction likewise increases. The weight, moreover, of a train of this kind, is more evenly distributed than in one moved by a locomotive.

The electric motor, in general, possesses advantages which are of special value on an elevated road. It is possible to balance an electric motor, thus relieving the structure of the constant vibration caused by the quickly-moving locomotive. Its freedom from dust and smoke, as well as its economy, insure its immediate introduction.

Although the progress in introducing the electric motor on the New-York elevated railway has not been so rapid as had been anticipated by enthusiasts, still the progress has been steady, and in the right direction. It is, perhaps, remarkable, that more companies have not commenced operations ; but when the magnitude of the task is realized, and the patents held by a few parties are inspected, the reason is seen. However, several other companies intend to commence operations in the immediate future, the plans of which are now maturing.

F. A. PICKERNELL.

A SCHOOL FOR ELECTRICAL ENGINEERING IN BOSTON.

THE wonderfully rapid advances which have been made during the past fifteen years in the technical applications of electricity have taken place at so swift a rate, that the progress of invention has frequently been such as to outstrip the technical knowledge necessary to apply its results successfully and economically on a commercial scale. Within the period mentioned, the arts of quadruplex and multiple telegraphy, telephony, electric lighting on a large scale, and the electrical transmission and distribution of power, have come into being, while an enormous extension has taken place in many of those branches which, like ordinary land and submarine telegraphy, have been practically successful for a longer time. And almost simultaneously with this development of the practical applications of electricity, and largely on account of it, has come a correspondingly rapid and important development in electrical theory, and in the construction of accurate instruments for electrical measurement; so that engineers with an electrical training limited to the small amount which, until recently, was all that could be obtained in our colleges and scientific schools, have found themselves ill prepared to deal with the problems forced upon their consideration. In fact, a new profession, that of electrical engineering, had suddenly opened, and neither the civil nor mechanical engineer was well prepared to pursue it.

Up to the summer of 1882, no adequate provision appears to have been made by our scientific schools for the technical training of young men desiring to enter this profession ; but at that time the Massachusetts institute of technology, recognizing the need of such instruction, decided to establish a course leading to a degree in electrical engineering. This course has gradually been brought to a state of completeness, until at the present time, besides a few who have very recently graduated, there are about fifty students who are pursuing it.

The course requires four years for its completion. During the first year the time of the student is occupied with general preparatory studies in mathematics, chemistry, drawing, and the modern languages; and no one is allowed to enter upon any of the professional work of the later years who has not done very creditably in the two first-mentioned studies. The professional work, which extends through the three remaining years, is based upon a thorough study of general physics, mathematics, and mechanical engineering. The theory of electricity, and practice in electrical measurements, are pursued simultaneously in the lecture-room and laboratory, the student learning the use of the different forms of apparatus ordinarily used in electrical testing. A knowledge of the calculus, and of analytical and applied mechanics, is assumed in the professional studies of the course ; and works of reference, or, if desirable, text-books written in French and German, are freely used. A very con-