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-

siderable portion of time is given to certain branches of mechanical engineering; so that, by his work in the laboratory of mechanical engineering, the student becomes familiar with the theory and practice of the steam-engine and other motors, and acquires skill in the use of the indicator and the different forms of dynamometer, and also takes part in numerous boiler and engine tests. He thus gains a knowledge, which, in case he enters upon any application of dynamo-electric machinery, will be very important to him.

Throughout the last year an extended course of lectures is given upon the technical applications of electricity, in which the theory and practice of telegraphy, both land and submarine, telephony, electric lighting, and the electrical transmission of power, are discussed. In order to add to the value of this course, the lectures and laboratory exercises given by the regular teachers of the school are supplemented by instruction from various gentlemen who are professionally engaged in the practical development of electrical science, who give courses of lectures, or single lectures, upon special subjects; so that the student has the opportunity of learning exactly what is considered as good practice among those actually employed in the profession which he has chosen.

In any course of this nature, very much depends upon the facilities which are furnished in the way of instruments for precise measurement. The importance of a proper supply of such apparatus has been recognized; and the Rogers laboratory of physics, in which the experimental electrical work is carried on, is well supplied with the necessary facilities. For line-testing, the student has access to actual telegraph-lines, and learns the methods of working most suitable for such purposes. Also an experimental study is made of dynamo-electric machinery, electrical motors, electric illuminating apparatus, and other similar appliances. The student is further required to undertake a certain amount of work of an original nature, and is thus stimulated to enter upon scientific research. A well-selected reference library, containing most of the physical and electrical journals, together with the leading works on these subjects, is accessible at all times.

The aim of the course, as a whole, is to give an education in which theory and practice shall go hand in hand. The pupil is taught, that, as science advances, the two become more and more closely allied; so that his professional success will be most probable, if, to as thorough a knowlege of theory as he can acquire in the four years of his undergraduate study, he adds a large amount of practice in the application of his theoretical knowledge to the solution of the problems with which the electrical engineers of the present time are especially concerned. And an attempt, at least, is made to give him such a preliminary training, that he will find himself well furnished with the necessary knowledge to continue his studies by himself, as opportunity may afterwards be furnished, or occasion require.

ELECTRICAL MEASURING INSTRUMENTS.

FOR the quantitative determination of an electrical current, any one of its effects may be employed, the law of which is known; and the choice of the effect to be utilized in the construction of a measuring instrument will be influenced by different considerations in different cases. The requirements of the practical uses of electricity necessitate, in general, instruments capable of measuring currents of great strength, varying through a wide range. The instruments must unite the characteristics of compactness and portability with simplicity of mechanism and manipulation, thus excluding many of the methods available in the permanent physical laboratory. The devices which have been employed are so various, and the forms of apparatus so manifold, that a mere catalogue of them would reach beyond the proper limits of an article. As they naturally fall into a comparatively small number of groups, however, the leading characters of certain typical forms may be indicated within a moderate compass, and the merits or defects of some of the more prominent pointed out.

The most common and obvious method of measuring an electrical current depends upon the deflection of a magnetic needle by the current itself. The simplest arrangement would be to use a straight vertical wire situated in the meridian of a very short magnetic needle, and at a moderate distance from it. Within certain limits of approximation, the tangent of the angle of deflection is proportional to the current strength. If the distance of the needle from the wire is made variable, an empirical scale can be experimentally formed, from which, in subsequent use, the current strength may at once be known from a single observation of deflection, the horizontal component of the earth's magnetism being supposed invariable, or its variation determined and allowed for in the reduction. In a permanent installation, such a plan would be feasible, and capable of giving useful results. But it involves some practical difficulties, the most prominent of which are the considerable length which must be given to the wire, and the fact that the wires bringing the current to the vertical portion of the circuit would themselves produce a disturbing effect upon the needle, unless particular