UNDERGROUND ELECTRIC RAILWAYS ABROAD.

BY FRANK C. PERKINS.

Underground electrically-operated railways have been running in Europe for a number of years, and at the present time the large cities in this country are taking up this problem with a great deal of energy and with every prospect of great success. The New York Rapid Transit Tunnel is well under way and when completed will give this city one of the finest express electric railway services in the world, greatly relieving the crowded down-town elevated and surface systems. The Boston subways are now being extensively used and a new tunnel under Boston Harbor will serve both the elevated and surface electric lines. In London and Paris underground electric roads have been in use for quite a long period with great success, and although some of the disadvantages of the small-tube tunnels have been quite serious, they are now being overcome in the larger subways and tunnels being constructed in this country as well as in Europe.

The terrible collision in the tunnel of the New York Central, where steam locomotives are employed (due to the smoke and inability to distinguish signals), shows up the advantages of electric propulsion for this class of travel so well that undoubtedly this and other tunnels now using steam will soon be equipped with electric apparatus.

The Liverpool catastrophe, where a train was burned and several lives lost in one of the tubular tunnels operated by electricity, also shows that accidents are possible, unless the greatest precautions are taken, in the electrically-operated tunnels. The creosoted sleepers were burned and the train, although a low-tension current was used, was destroyed. It is stated that the Liverpool line has its motors at the ends of the train connected in series, the whole current passing from one end of the train to the other, while the Central London trains are operated by electric locomotives, or by motors, also at the ends of the trains, but worked in parallel, only a small controller current passing the length of the train. The small-tube railways are criticised as most dangerous when a breakdown occurs in the tunnel, as the trains fit the tunnel so closely. In order to allow the passengers to get out at the side in case of a breakdown, a much larger diameter is required, which increases the cost by many millions of dollars, since the amount of excavation increases rapidly as the size of the tunnel increases in diameter.

The tendency is to use larger tunnels in this country as well as in Europe in the most modern construction, even at an enormous increase in cost. The subways and tunnels in Buda Pesth and Berlin are of particular interest as the former represents an installation which has been in successful operation for some time, while the latter is just being completed and is of much importance on account of the close connection it has with the elevated railways in that city, the combination of an underground and overhead structure proving a most practical solution of the rapid transit question in Berlin.

Our illustrations of the Buda Pesth underground electric railway show the street entrance as well as the interior of one of the subway stations, one of the electric motor cars, and the entrance to the tunnel with the overhead electrical conductors in view. The entrance and stairway herewith shown, are located at the station Franz-Deak-Platz, and the underground station is situated at Octogonplatz. The tickets are sold at the stations and collected on the trains, which make a complete run in about 10 minutes, the speed being from 20 to 30 kilometers per hour. The cars are constructed of a height to best utilize the size of the tunnel, fitting the same with as little clearance as possible with safety. The overhead devices for conveying the current from these conductors to the motors of the cars are seen in the illustrations. These devices, which take the place of the trolley pole and wheel, are mounted one at each end of the car, the springs and levers as seen being placed at the side of the car frame. Along certain parts of the underground line bare feeders are run on insulators on the roof of the tunnel.

There are special circuits run for signals, light and telephone service, all of which are carefully laid to insure safe running of the trains. Electric incandescent lamps with double reflectors are used throughout the subway at distances of from 10 to 20 meters apart.

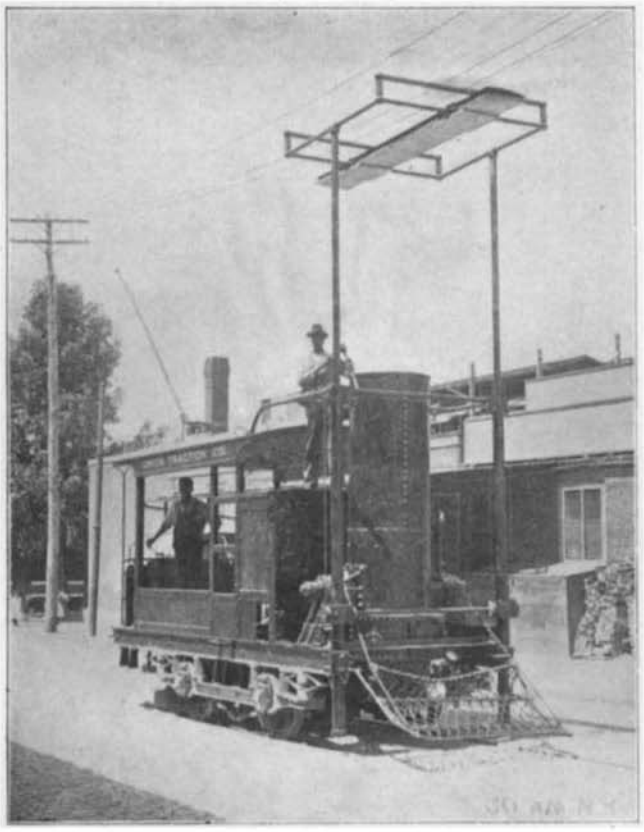
The line of tunnel is about 4 kilometers long, the inner clearance breadth being 6 meters and height not quite 3 meters, iron columns separating the tracks, as in the case of the Berlin tunnel. These iron columns rest on stone foundations and are about 4 meters apart.

As will be seen from the illustrations, on the top of the columns and running along the tunnel are placed I-beams from 0.32 to 0.35 meter high, these supporting the transverse I-beams, which have their ends resting on the side walls. These I-beams are placed 1 meter apart. The space between the beams, as seen in the illustration, is filled in with beton, and the whole tunnel is surrounded with asphaltum felt. The cars seat 28 passengers and have standing room for nearly as many more. They are 12 meters long, a trifle over 2 meters wide, and each is equipped with motors of 100 horse power.

This construction of motor cars contrasts very strongly with the latest type of underground motor cars used on the Berlin elevated and subway line. The trains in the Berlin tunnels consist of three coaches, the two end ones only being equipped with motors. The total number of passengers per train is 120 to 130, and the whole train weighs 72 tons, each car weighing about 24 tons. The cars are mounted on two trucks of two axles each, the motor axles being connected by single reduction motors wound for 750 volts. These motors take a current of 1,000 to 1,200 amperes at this potential, driving the train at a rate of 30 kilometers per hour. The cars are 12.7 meters long, 2.36 meters wide and 3.18 meters high. The trains have a 5-minute headway and pass through the city of Berlin nearly east and west from the Zoological Garden to the Warsaw Bridge.

Some of the details of construction of this subway were given in the SCIENTIFIC AMERICAN, page 84, vol. lxxxiv., No. 6, as well as information in reference to the route. The stations are reached by means of stairways which are supplied with ornamental balustrades, and as the depth is only 3.5 meters the stations are easily reached without fatigue. The stations are well equipped and agreeable, being brilliantly lighted by electric lamps and lined throughout with cream-colored porcelain tiling. The height of the Berlin tunnel is 3.3 meters above the rails, while the total width from wall to wall is 6.25 meters; at the curves the tunnel is much wider.

The gage of the rails in the Berlin tunnel is 4 feet 8½ inches, and the current is taken off from the third rail by means of a shoe indicated in Fig. 5 showing one of the cars.



REPAIR CAR.

The tunnel is constructed of cement, with 1-meter walls. It is made water-tight with asphalt felting, which has proved so effective in the Buda Pesth subway. The roof is supported by iron I-beams 1 meter apart resting on the side walls and iron columns in the center similar to the construction described above for the Buda Pesth tunnel. Between these beams cement arches are constructed and leveled off on top by means of a layer of cement, above which is laid a water tight covering of asphalt felt, and above this the pavement.

The Boston Harbor tunnel is an arched monolithic concrete structure for two electric railway tracks and is much larger than the Berlin or Buda Pesth subways. The Boston Harbor tunnel is 20 feet 6 inches high and 23 feet 4 inches wide inside, and a 2-inch space has been reserved inside for a porcelain or other finishing treatment to give a more pleasing appearance. The arches and walls of this tunnel are 33 inches and the invert 24 inches thick.

The rails used in the Berlin tunnel are 180 millimeters in height and weigh 43 kilogrammes per meter length. The rails are laid directly on the girders without the use of sleepers, and are unsupported for 1.5 meters. Hardwood blocks are used to insulate the rails from the iron structure, and between the rails and the wooden blocks layers of felt are used.

A pumping engine in a Birmingham Canal station was recently removed after having been in continuous use for 120 years.

Engineering Notes.

The effect of machinery on wages is well exemplified by the following figures: At one time in the United States a roller in a rail mill, rolling iron or steel rails, received about 15 cents per ton, turning out from 75 to 100 tons per turn. To-day, on some of the modern steel rail mills less than 1 cent per ton is paid for doing the same work, and yet by the end of the year the roller in the rail mill can make as much money as he did under the old method of working. At one time 45 cents per ton was paid for heating iron for making iron rails. To-day, through the use of the improved methods, very little more than ½ cent per ton is paid for doing the same work, and yet the wages received are better than they were at that earlier time.

In a dispatch to the British Foreign Secretary, dated December 31, covering a number of reports received from railroad officials, the British diplomatic agent and consul-general in Egypt, Earl Cromer, draws the general conclusion that the main reason why so many orders for railroad plant have recently been given to the United States is that the American firms have been able to execute them with extraordinary rapidity. Where special designs are required Earl Cromer finds that the British firms can hold their own. In quality of workmanship the British locomotives are said to be superior to those of America and Belgium, while in the consumption of coal they are superior in economy to the American engines, though not over the Belgian. It is said that a series of trials of American and British freight passenger engines conducted by a representative of the Baldwin Locomotive Company and a locomotive inspector of Egyptian railroads show that the American freight engines consume 25.4 per cent more coal than the British, while the latter drew 14.2 per cent more load. With the same load the American passenger engine consumed 50 per cent more coal than the British. No doubt these figures are correct. But the question always remains, have the American locomotives been operated as they would be operated in America, to their utmost capacity?

Nickel-steel alloy of 36 per cent nickel has the least coefficient of expansion of any known metal, being only one-thirteenth that of iron, or about 0.0000005 for 1 deg. F., says Machinery. This remarkable freedom from variation of length under a variation of temperature has caused the quite general adoption of nickel-steel of about the stated percentage of alloy for the pendulum rods of high-grade clocks. With the nickel-steel rods no means of compensation for variation of temperature is necessary, the slight changes in the brass bob compensating for the changes in the length of the rod. Nickel-steel also has the valuable property of resisting oxidization or rust to a remarkable degree. It may be exposed for weeks to conditions which would quickly coat ordinary iron or steel with a thick coating of rust, without showing more than minute specks of rust. If nickel should ever be discovered in quantities sufficient to greatly cheapen its present cost, it would have an important influence on future steel construction, as nickel-steel would be generally used because of its toughness, superior strength and freedom from rust, the great disintegrator of modern steel structures. Railway rails having an alloy of 36 per cent of nickel would require practically no allowance for expansion between the ends, since the total expansion of a mile of track from 20 deg. below zero to 100 deg. F. would be only 3.8 inches.

The Current Supplement.

Little enough is known of the engineering work done in the Far East. For that reason an illustrated article in the current SUPPLEMENT on the headworks of the Mandalay Canal built for irrigation in Burma should prove of considerable interest. Mr. Walter F. Willcox, chief statistician of the methods and results of the Twelfth United States Census, tells how the United States government estimates the millions by which our population is numbered. How accidents are scientifically studied has been made the subject of an article by Dr. J. Howe Adams. Some curious types of bicycle brakes are described in an article which is illustrated very fully. A discussion of the sanitary condition of New York streets is a matter that deserves attention; for that reason an article on the subject is rather timely. Perhaps the most important article in the current SUPPLEMENT is an admirable account of electrical furnaces by Bertram Blount. The article comprises several installments which will appear serially in the SUPPLEMENT, and is very fully illustrated by the best known types of furnaces. A very elaborate account of artificial limb-making narrates curiously and interestingly the history of a strange craft. The usual Consular Notes will be found in the SUPPLEMENT.

The German Naval Department has contracted with the Vulcan and Germania shipyards for two battleships, each of 13,000 tons displacement, which must be ready for service in 1906.

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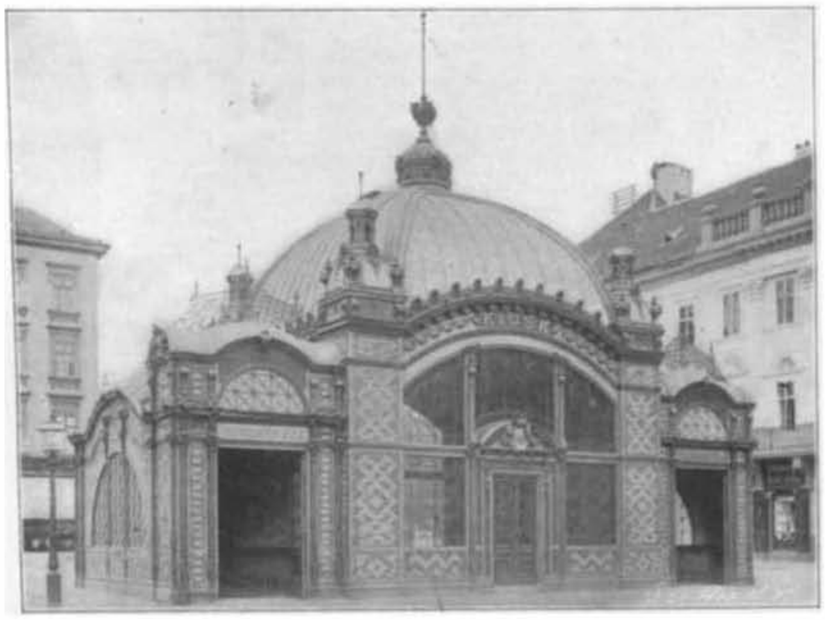
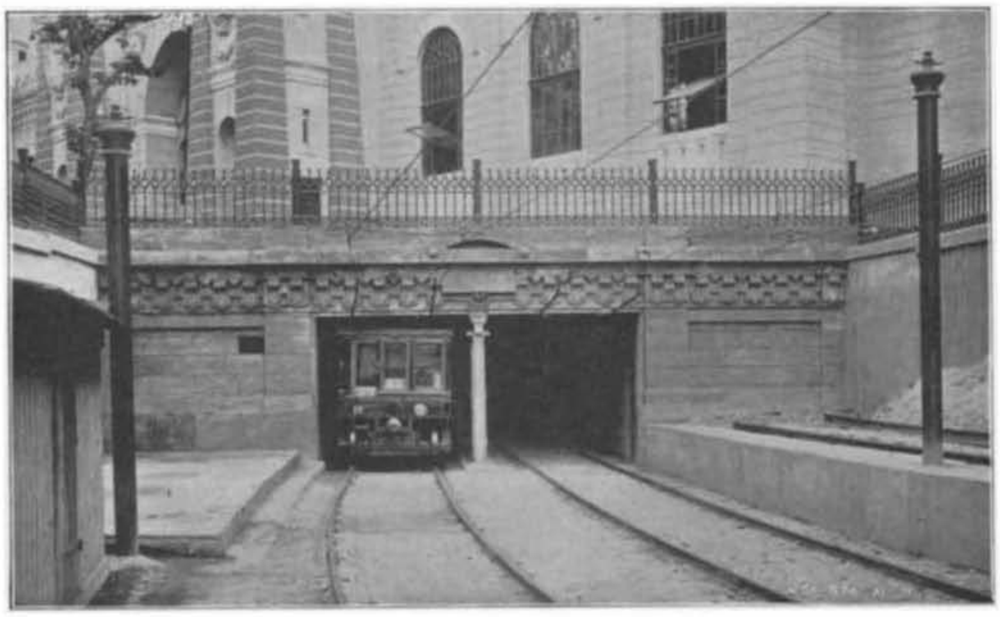
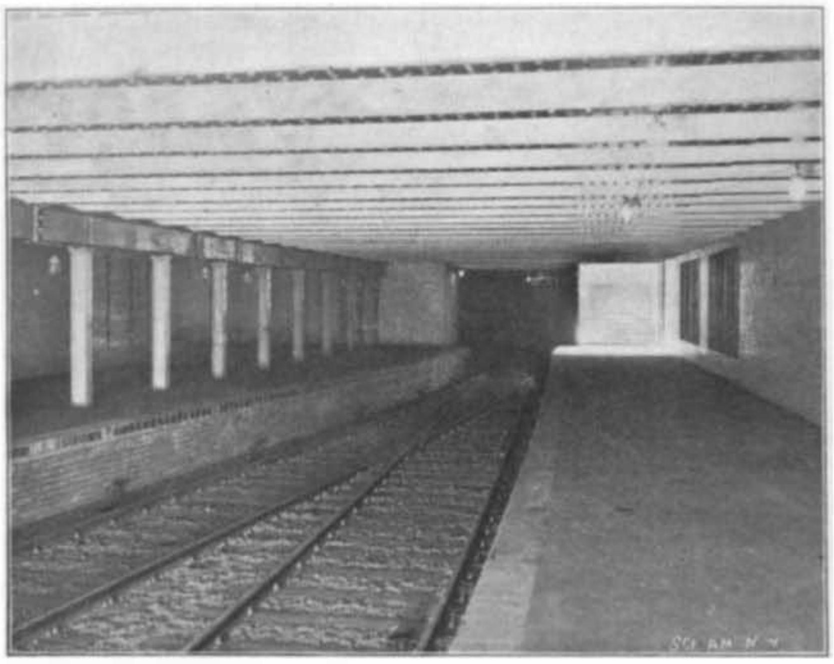


Entrance to Station, Buda-Pesth Underground.

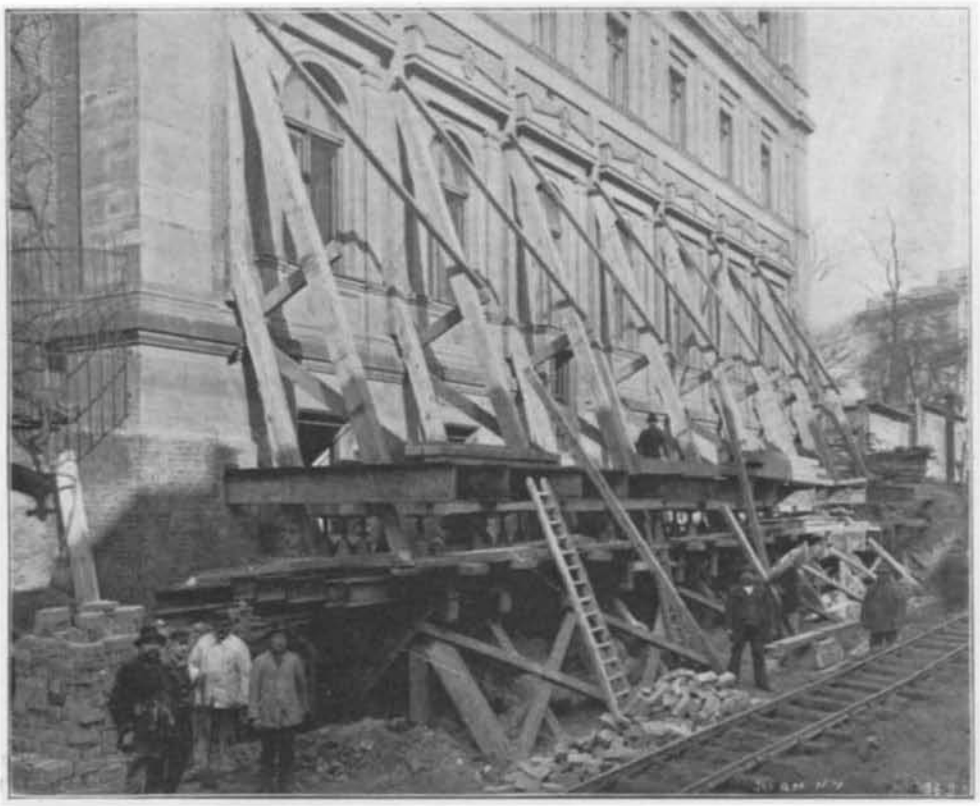


Entrance to Tunnel, Buda-Pesth Underground.

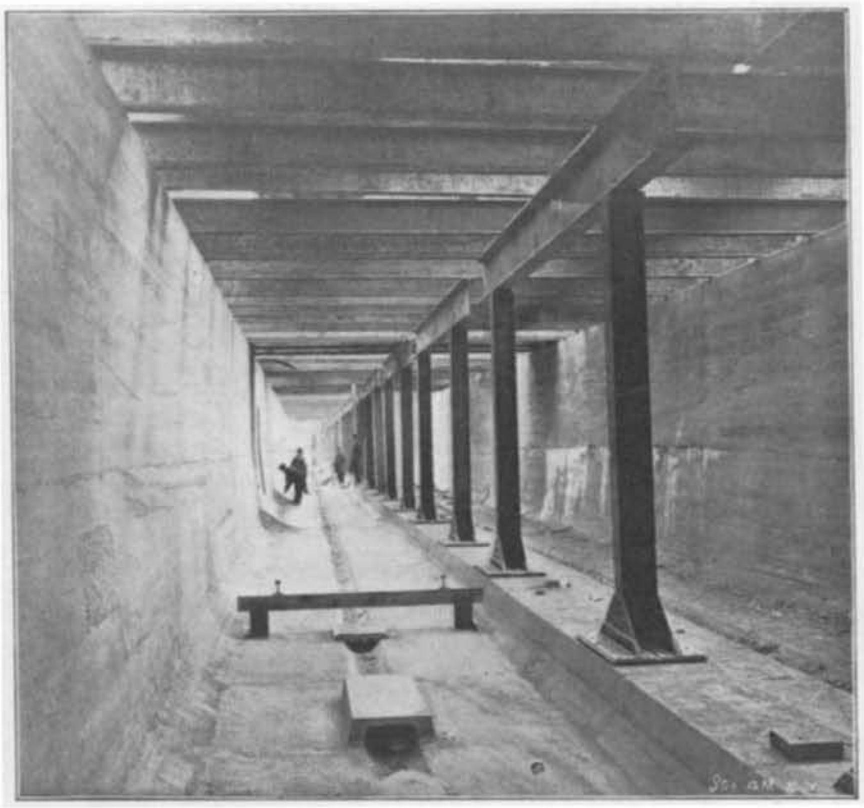


Subway Station, Berlin Underground Road.

Buda-Pesth Underground Electric Motor Car.



Underpinning of Large Building, Berlin Electric Railway.



Putting on Roof, Berlin Subway.

SOME CONTINENTAL UNDERGROUND ROADS.--[See page 311.]