

in order to overcome vibration troubles, and are also being introduced on the Great Northern and City Railway.

Each train will be composed of three motor-cars and three or four trailers, all being under the control of one driver, and the motor-car portion will be separated from the passenger part of the car by means of a fireproof steel partition.

New Metropolitan Trains.

Cars, 52½ ft. long. Approximate weight, 39 tons. Each motor-car, of which there are two in a train of six coaches, is equipped with four 150-horse-power British Westinghouse railway motors, one for each axle of the truck. There will be the unusual amount of 1,200-horse power available for propelling each train. System, third-rail; 11,000 volts three-phase current, transformed to direct current at 600 volts by rotary converters.

Liverpool and Southport Line.

Length of line, Liverpool to Southport, 18½ miles.

Steepest grade, 1 in 85.

Sharpest curve, 7 chains.

Electrical energy is generated at three-phase alternating current of 7,500 volts pressure, and transmitted direct to substations, and transformed by rotary converters into direct current of 650 volts pressure, the maximum voltage at the train being 600.

Machines installed, four 1,500-kilowatt units, three of which under normal conditions meet the requirements. In addition there is a fifth unit of 750 kilowatts.

Motive power, four main engines of horizontal-cross-compound type, and one vertical-cross-compound type, running at seventy-five revolutions per minute. Nominal load of each engine, 2,310-horse power, with a pressure of steam of 150 lb. per square inch.

Total weight of four-car train, 140 tons. Each motor weighs 44 tons, and trailer 26 tons.

Electrification of the Long Island Railway: New York City and Suburban System of 97½ Miles of Track.

System adopted, third-rail contact; direct current of 600 volts for propulsion, and alternating current at 11,000 volts for transmission to the substations.

Current generated by three Westinghouse-Parsons turbine units of 5,500 kilowatts capacity each.

Trains are of three, five, and eight car-units, the number of motors to each being two, three, and five respectively. Each motor-car has two propelling motors of 200-horse power each; the car weighs 83,000 lb. (37 tons), and is capable of maintaining a speed of fifty-five miles an hour.

TRAIN-SERVICES, ETC.

Among the advantages gained by electrical operation is the better use which can be made of terminal facilities during rush hours.

As an example of this, Mr. Aspinall, of the Lancashire and Yorkshire Railway, instanced what he called the platform operations required for steam-trains and for those electrically driven when entering or leaving a terminus. With steam-trains, the first platform operation consisted in the train coming in, the second was the following-in of the locomotive which was to take out the train, the third was the departure of the train, and the fourth was the backing-out of the locomotive which had brought the train in. These four platform operations required eight signal operations.

The same train, if handled electrically, would require only two platform operations and four signal operations: the train comes in—that is one operation; the motorman then goes to the other end of the train and takes it out—that is the second operation.

Not only was the terminal of the Liverpool and Southport used to greater advantage by the employment of electric traction, but a very important gain was made by the very possession of the facility to handle traffic—more traffic was offered.

It would almost seem to be an axiom in railroad operations that the more a line can do the more it will be expected to do. This road had four tracks for a certain distance out of Liverpool, and when electrification first took place the business offered was such that it could be handled over two of these tracks, and the other two were set aside for freight service with steam locomotives. The passenger-travel, however, soon became so large that it necessitated the equipping of the two freight tracks with the third rail, and the use of them for passenger traffic in the rush hours. One might fairly apply Hamlet's words to the travelling public, for it seemed as if increase of appetite had grown by what it fed on. In this way the greater cost per ton-mile run under the electrical system was more than offset by the larger paying volume of traffic which the road was able to handle.

Mr. Wilgus, in his remarks in the discussion of Mr. B. G. Lamme's paper dealing with the electrification of a part of the New York Central, also had in mind the ability of the electrically equipped road, under certain circumstances, to attract passenger traffic, and so to augment the company's receipts. This, it seems, is the *raison d'être* for electrical equipment, and, failing this, the alteration from steam to electricity would be probably a costly and useless experiment. In concluding his remarks he said, "It appears that the purpose of a change of motive power for heavy railway service from steam to electricity is to abate the smoke-nuisance and improve the passenger service so as to make travel more attractive. The electric system which is adopted, whether direct or alternating current, must employ the safest appliances known to the art, it must have all possible safeguards against interruption due to trouble in the power-station and on the