Of these, the forced water has been much longer in use, but is being supplanted in large plants by the oil type. With this latter arrangement we obtain much more efficient results, but require additional apparatus, necessitating additional floor space. To offset the cost of this apparatus we have an initial saving of from 15 to 25 per cent. in the forced oil cooled type. The general concensus of opinion seems to be that for large installations of 4,000 k.w. or over, composed of individual units of not less than 1,200 or 1,500 k.w., the forced oil cooling process is the most efficient and economical in the long run.

## GREAT BRITAIN'S FIRST SINGLE-PHASE RAILWAY.

(From Our Special Correspondent.)

A good deal of interest has been excited during the past two years by the work which has been in progress both in London and in the north of England in connection with single-phase electric traction. The latter installation, that of the Midland Railway Company, upon a storm swept branch of their large undertaking, takes the honour of being the first to be opened to the public and at the same time the first single-phase railway to be commercially operated in Great Britain. The line which is in the nature of a fork, has a very slight service—only about one train every 20 minutes—but the main object of the experiment is to determine upon a piece of track where the general conditions are undoubtedly severe, the suitability of single-phase electric traction to ordinary railway working as distinct from the very different conditions of rapid headway and calmer climatic surroundings of suburban lines near a great city. In a way this latter will be tested by the experiment by the London Brighton and South Coast Railway, which is converting one of its London suburban lines to the single-phase system, and this is expected to be in operation by the end of the present year. There are no very severe gradients upon the Midland experimental line, but there are a number of speed restrictions near the three terminal stations.

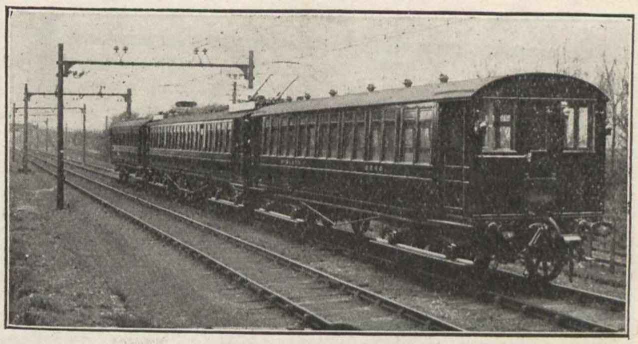
It is to be hoped that the result of the two experiments will be to instill some measure of confidence on the part of railway managers in electric traction for main line purposes which is now badly wanting.

Dealing first with the overhead construction, this has been designed and carried out under the direction of Mr. W. B. Worthington, the chief engineer of the company, in conjunction with Mr. J. Sayers, the telegraph engineer and Mr. Argyle, the northern divisional engineer. As regards the type of suspension, it is similar to that adopted upon the Hamburg-Altona Railway, the patents for which are held in England by Messrs. Siemens Bros., who are carrying out the work in this instance. This latter system has, however, been modified by a new type of catenary wire suspension, designed by Mr. Sayers. The line passes under a large number of over bridges, mostly of the arched shape, and the clearance of these has been a matter of considerable interest. The use of a single bow trolley for travelling in both directions necessitates the bow being symmetrical about the centre of the coach necessarily bringing it very close to the structure of the bridge. In order to get through at all, it has been necessary to take the contact wire well out towards the centre of the arch so that it may come down low and yet be clear of the loading gauge and so that the other side of the bow may clear the structure properly.

The contact wire is of figure 8 section and the height from rail level varies from 18 feet 3 inches in the open to 13 feet 3 inches under bridges. It is suspended from short loops about four inches long from a steel cable or auxiliary wire, upon which these loops are movable. On the other hand, the auxiliary wire is held by the main catenary cables, of which these are two clipped together throughout their length, except for about 3 feet on either side of the insulator, where they divide to pass through the grooves of a ring, the grooves being on opposite sides of the insulators. The catenary is thus free to move for this distance and this equalizes the strain due to unequal loading and experience has proved that it is at the same time secure in the case of the breaking of the wire. The section switches which are provided to isolate the up and down lines or the different sections, are of the double-break air pattern and are fixed on top of the poles supporting the gantries. Each section switch is in addition duplicated and the connection from one contact wire to the section ahead is accomplished by means of a short section of switch wire which requires to be connected to the two contact wires before the line is switched through at this point. In this way a duplicate break is obtained, and, more important still, there is a short length of line into which a car can run without bridging by means of its bow two sections, which it was supposed might require to be isolated.

A separate steel cable connects the gantries together, and this is earthed every half mile, the same earth plates being used for horn lightning arresters, thus diminishing the number of earth plates requiring attention, and at the same time giving better security from danger from leaky insulators so far as the poles are concerned. It is interesting to note that this earthed steel cable has been erected between the contact wires and the telegraph wires, which are open on one side of the line and it is believed that this has had a great deal to do with the reduction of electrostatic induction from the contact wire. The object aimed at has been to avoid putting underground all the overhead telegraph and telephone wires and the feeling at present is that all that will now be necessary to provide a high resistance leak on any wire parallel to the high tension traction system.

Although at one or two places it has been necessary to erect steel lattice poles and lattice girder gantries owing to the big spans, for the most part creosoted wooden poles have



**Three Coach Train, Midland Railway.**

been used, as seen in the illustrations. Where wooden poles are used the gantries are made of two angles brought together at the ends, but so fitted that there is a great range of adjustment of the insulator position without any necessity for drilling. The type of insulator was decided upon after ascertaining from experiments made by Messrs. Siemens Bros. & Company's staff, the minimum distance at which a 6,600 volt, 25 cycle circuit would maintain an arc in the heaviest weather from an insulator shed. In order to get what amounts to double insulation with one insulator, the steel bolts supporting the insulators are encased with ebonite, in addition to which, in order to get extra strength, the company preferred to make the insulators in two pieces. An interesting point arose in connection with the bonding of the track. Only the outer rail on each line is bonded throughout, the bonds being of the Forest City type, and, although, very great care was taken to prevent moisture getting into the holes whilst they were being drilled, and although after completion all the bonds were found to be first-class, yet the tests carried out afterwards showed a distinct difference in resistance between those bonds carried out during dry weather and those carried out during damp weather. The rails are earthed in the sea at Heysham Harbor by duplicate copper earth plates, whilst at Morecambe they are earthed at the pier by plates which have been dropped in a large cast iron caisson. At Lancaster they are earthed to the cast iron columns of the bridge which rest in the bed of the river. As already indicated the potential of the overhead wire is 6,600 volts, 25 cycles.