Electric Railway Traction

Southern Electrification Figures

ONCE again Sir Herbert Walker has come forward with telling figures regarding the electrification of the Southern Railway lines, this time in an article on railway electrification which he has contributed to *Electricity*, a supplement to *The Financial News* for March 25. Commenting upon the possibility of operating economically a much more frequent service with electricity than with steam, Sir Herbert stated that on the Southern Railway in 1934 the electric train-miles amounted to 26,000,000, whereas the displaced steam services totalled only 10,000,000 train-miles. Electrified sections therefore cost more to operate than the steam sections they displace, though, of course, much less per train-mile, and the case for electrification is greatly strengthened if it can increase the receipts during the non-rush hours. The electrification of the Southern has certainly proved that this can be done, and Sir Herbert considers that it is in these relatively slack periods that the profits are made.

The cost of electrifying the 360-odd route miles on the Southern has been approximately £12,000,000, but the increase in the gross receipts has been most impressive. In 1934 the passenger receipts on the electrified sections were £6,211,374, representing an increase of £1,850,000 on the revenue for the last year of steam operation. On the other hand the working costs increased by only £164,000 (including allowances for repairs and for the maintenance of track equipment and rolling stock), so that the net increase in revenue was about £1,680,000. Even if the whole cost of electrification had been charged to capital expenditure, the results would still have been eminently satisfactory, but actually only £5,000,000 were charged to that account and £5,000,000 to the rolling stock renewal funds. Had steam operation continued, heavy annual expenditure would have been necessary for the renewal of locomotives, so that some of the cost of electrification may be regarded as normal replacements. The number of passengers carried on the electrified sections in 1934 was 242,400,000, an increase of 11,000,000 over the previous year, and on the Brighton division the number increased from 1,900,000 in 1932 (the last pre-electric year) to 2,500,000 in 1933 and to more than 2,600,000 in 1934. Moreover, the total number of passenger journeys on the Southern is now in excess of the total for the peak year of 1929. These figures certainly show the success of one of the main reasons of electrification, viz., to obtain more traffic.

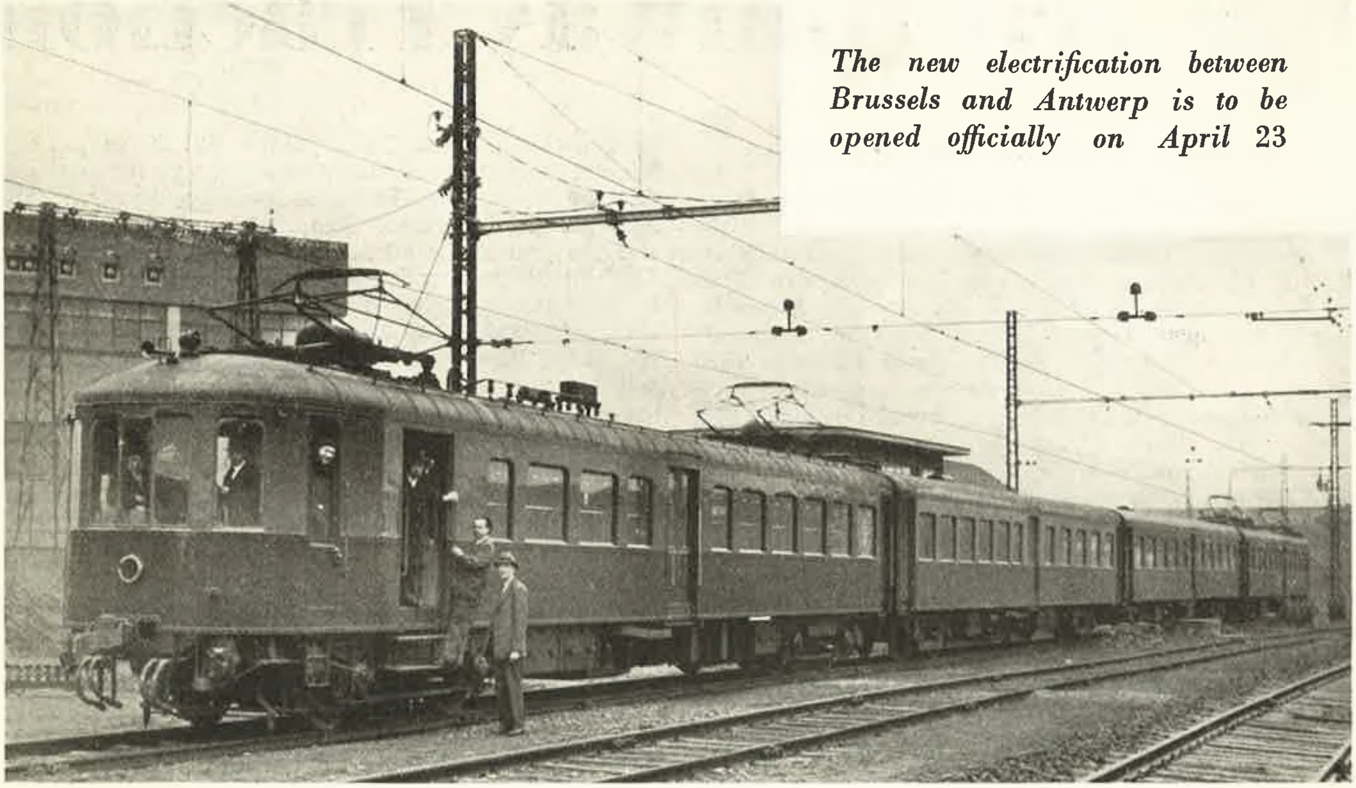
In view of the assumptions made in the Weir Report concerning current consumption and cost, the experience of the Southern Railway is of particular interest. The Weir Committee assumed that the cost of current, one of the most important single factors, would be 0·50d. per unit delivered to the track. During 1934 the Southern used 403,600,000 kWh. at a cost of 0·384d. *delivered to the substations*, but the cost of converting it from high-tension a.c. to low tension d.c. in the 67 substations concerned, raised the price to approximately 0·577d. per unit at the track. This is 15 per cent. above the Weir Report figure, and of itself brings down the 6·7 per cent. profit calculated by that Committee to 5·8 per cent. But the subject does not end there. The Southern obtains its power from three sources, its own power station at Durnsford Road, Wimbledon; the London Power Company's station at Deptford; and the grid at Croydon, Three Bridges and Brighton. The current consumption and cost from the three supplies in 1934 was as follows: Durnsford Road, 121,372,000 kWh. at 0·329d. per unit and at a load factor of 40·1 per cent.; London Power Company, 237,396,400 kWh. at 0·39d. per unit and at a load factor of 40·6 per cent.; the grid, 44,831,040 kWh. at just over 0·50d. per unit and at a load factor of 31·7 per cent. With a national electrified system, or even with a greater current demand and increased load factor, it should be possible to reduce the cost of current below the unit figure assumed in the Weir Report.

Brussels-Antwerp Electrification

ALTHOUGH possessing few, if any, outstanding features, the electrified line between Brussels and Antwerp is an example of thoroughly modern high-tension d.c. equipment. Perhaps the most surprising feature at first sight is the fact that only a fast interurban service will be operated as from April 23, the opening date, and that the suburban traffic out of Brussels and Antwerp will continue to be steam worked. At the moment, the rush-hour traffic of these cities is by no means great, and can easily be handled by the present means, but future developments have not been neglected and the electric line has been provided with stations corresponding to most of those on the adjacent steam section. During the day there is to be a service of three trains an hour, and a ten-minute service for a short time at peak periods. With the timetables which are to be followed from the inauguration on April 23, the yearly train-mileage will be approximately 1,350,000, and the estimated current consumption for all purposes (traction, station lighting, signals, &c.) is 15,000,000 kWh. There are several operating and technical points of interest which differ from English practice. For instance, the new electric service is being inaugurated on a Tuesday compared with the Sunday openings of the Southern Railway extensions, but this is mainly on account of the preceding week-end being the Easter holiday. Naturally, the Belgian authorities will not risk inaugurating electric traction on a day of abnormal traffic during a holiday period. A further point of difference compared with Southern railway practice is that the incoming high-tension lines to the substations are owned by the power supply companies, and not by the railway. Another method of creating railway traffic and revenue was discovered by the Belgian National Railways during the electrification. The work required the construction of a big embankment at Malines, and as all the material for this could not be obtained from the cuttings, it was necessary to excavate the necessary filling from a site nearby. Water rose in the excavations from some underground source, and with commendable promptitude this was turned into a pleasure lake complete with boats and beer halls, and a substantial traffic has been developed.

FIRST BELGIAN MAIN-LINE ELECTRIC RAILWAY

The new electrification between Brussels and Antwerp is to be opened officially on April 23



Four-car 3,000-volt d.c. electric train as used on the new electric railway between Brussels and Antwerp on the Belgian National Railways system

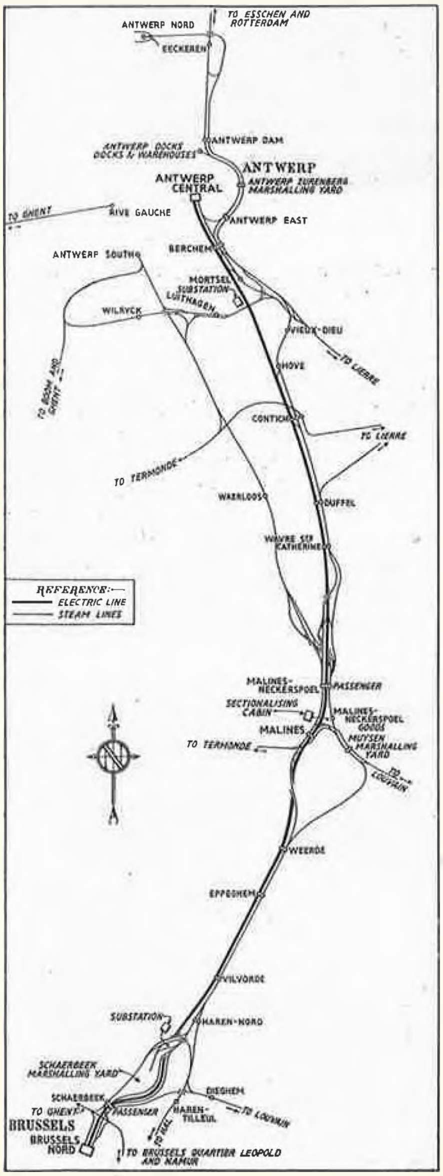
ONE of the most important electrification schemes on the Continent in recent times is that of the Belgian National Railways between Brussels and Antwerp, public service over which is to be inaugurated on April 23. As may be seen from the map accompanying this article, the new line runs from the Nord station at Brussels to the Central station at Antwerp, and closely parallels the existing steam line. Although the distance between the termini is only 44 km. (27·4 miles) it is not intended at the moment to run anything but a fast interurban service with certain trains stopping at Malines. The suburban traffic out of both Brussels and Antwerp is still to be worked by steam trains, but future electric suburban services seem to be foreshadowed by the double stations at such places as Eppeghem, Weerde, and Contich.

The electrified lines, which are partly new construction, are double throughout, and the track mileage amounts to 90 km. (56 miles). The rails are in 18 m. (59 ft.) lengths weighing 50 kg. per m. (100 lb. per yd.); the maximum grade is 0·9 per cent. (1 in 111) and the sharpest curve 800 m. (2,610 ft.) radius. The principal civil engineering works necessary were the elimination of 20 level crossings, and the erection of large steel bridges near Schaerbeek and Malines. The level crossings were replaced by ten over-

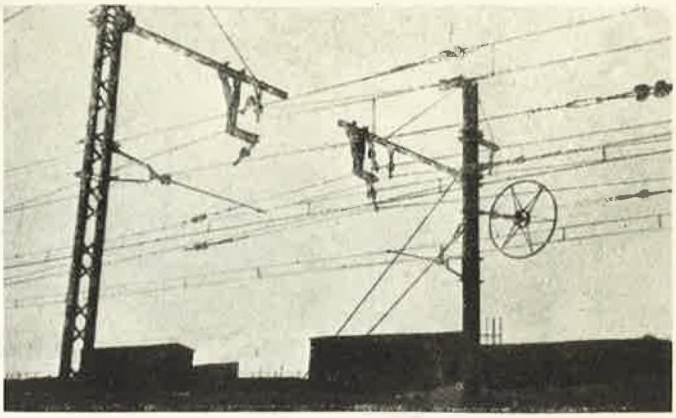
Steel bridge spanning the steam lines to the north of Malines station, Belgian National Railways bridges, four underbridges, and three footbridges. The bridge near Schaerbeek has a span of 93 m. (304 ft.) and carries the railway over the lines and road to Louvain. At Malines are two bridges, the first (north of the station) carrying the electric lines over the steam track, (as shown in one of the accompanying illustrations), and the second, with a span of 65 m. (213 ft.) carrying the line over the canal with a headway of 7 m. (22 ft. 10 in.). The approaches to this bridge are along embankments, the material for which was taken from the cutting between Hove and Berchem which had to be excavated to eliminate the level crossings. The embankment on the northern side extends through Malines, where two new platforms for electric trains have been built at a higher level than the steam station. South of Malines the material for the new embankment was dug out of adjacent land which gradually filled with water and is now used as a lake for pleasure purposes. Four tracks at the eastern side of Brussels (Nord) station and three tracks at Antwerp (Central) are equipped for handling electric trains.

Power supply and distribution

The power required for the electrified lines is supplied by the Schaerbeek power station of the Interbrabant company, and by the Antwerp plant of the Centrale de Schelle de l'Interescaut. The former delivers 11 kV. 50-cycle three-phase current to Haren substation, and the latter 15 kV. 50-cycle three-phase current to the Mortsel substation. These are the only substations on the line, the wide spacing being possible by reason of the 3,000-volt direct current which is used in the contact wire. The high-tension current is received into the substations through three 1,880 kVA., 3/6 phase oil-cooled transformers, which, contrary to British practice, are located under cover. They are mounted on rollers so that a complete unit, weighing 22 tons, can be removed when desired; in the event of an explosion or other untoward incident, the oil in the transformer can be dropped into a trough and led away to an underground tank.



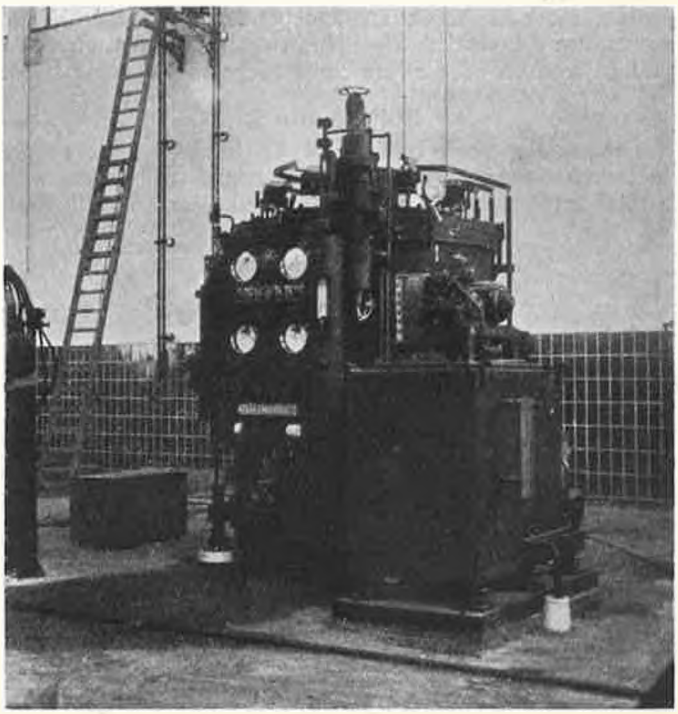
Map of Brussels-Antwerp lines



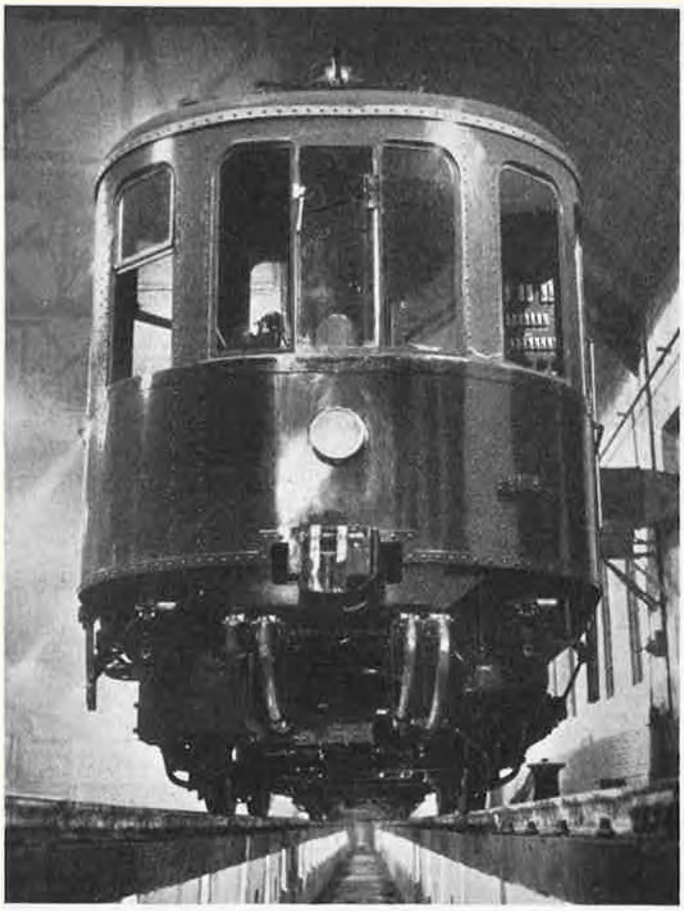
Tension-adjusting device for overhead lines, Belgian National Railways

From the transformers the current is led in six-phase form to metal-clad mercury-arc rectifiers, of which there are three in each substation. The rated capacity of a rectifier is 1,500 kW. (3,000 volts 500 amp.), and the overload capacity is 1,850 amp. for 45 sec. The rectifiers at Mortsel substation are fitted with polarisation grids, and together with the remainder of the substation equipment were made by the Soc. d'Electricité et de Mécanique, (S.E.M.), whereas the apparatus at Haren substation was built by the Ateliers de Constructions Electriques de Charleroi (A.C.E.C.).

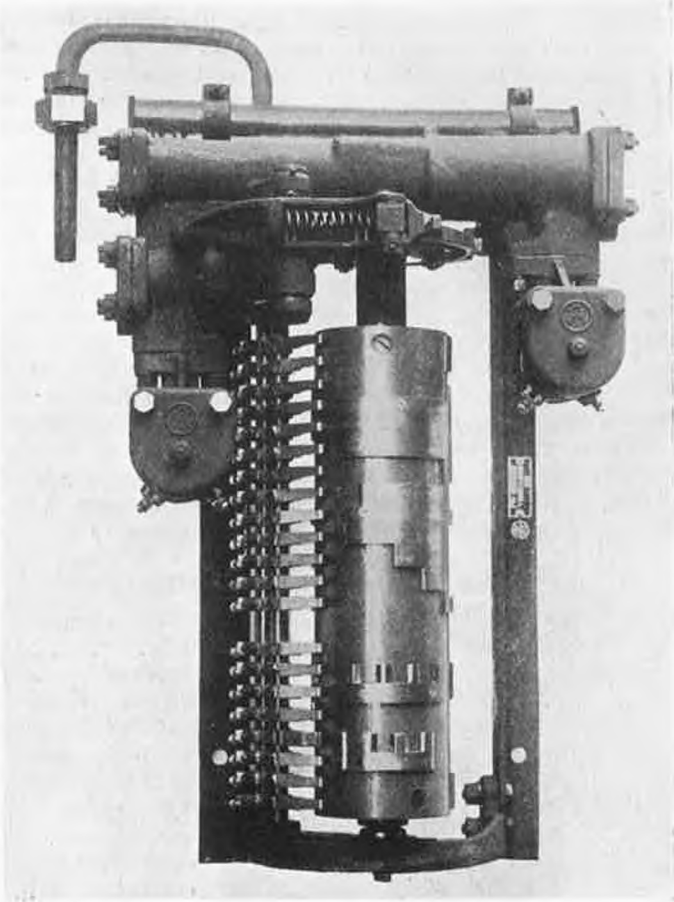
A compound catenary system is used for the suspension of the overhead contact lines, and comprises a main catenary cable of 94 sq. mm. (0·15 sq. in.) cross section and an auxiliary catenary of 72 sq. mm. (0·115 sq. in.) area. There are two contact wires above each track with an aggregate area of 100 sq. mm. (0·16 sq. in.), and they



A.C.E.C. 1,500 kW. mercury-arc rectifier in Haren substation



End view of a motor-coach on the Belgian National Railways

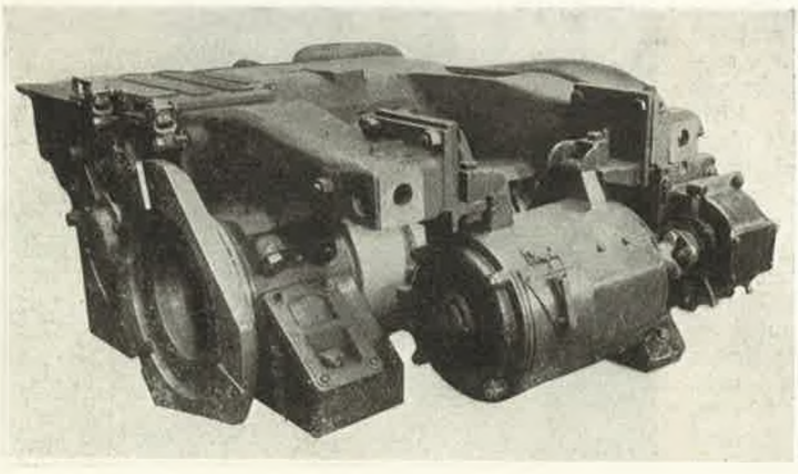


Electro-pneumatic controller as used on the 820 h.p. motor-coaches

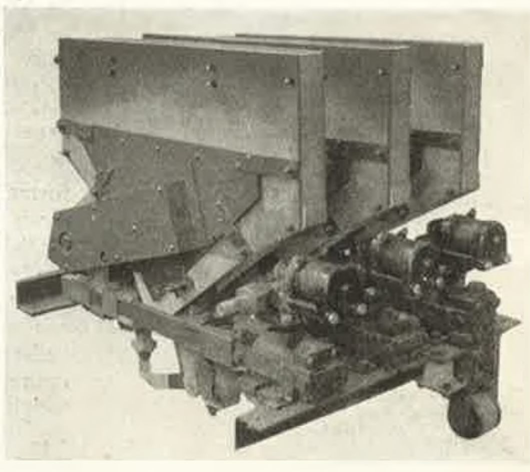
are kept at a constant tension of 1,000 kg. (2,204 lb.) by counterweights. The tension in the catenaries is 1,235 kg. (2,730 lb.). Out on the line the masts and suspension system for each track are independent; in general, the masts are of welded steel lattice construction, but on certain sections of the line concrete posts are being tried.

Rolling Stock

The rolling stock consists of 12 four-car steel trains, each comprised of two motor-coaches and two trailers with a total seating capacity of 116 second class and 243 third class. Both motor-coaches and trailers have an overall length of 22·15 m. (73 ft.), a breadth of 2·835 m. (9 ft. 4 in.), and a bogie pitch of 14·85 m. (48 ft. 8 in.). The driving bogies have 1·118 m. (43-in.) wheels spread over a base of 2·85 m. (9 ft. 4½ in.), and the trailer bogies 1·010 m. (39·75-in.) wheels spread over a base of 2·3 m. (7 ft. 6½ in.). The axles of all bogies run in S.K.F. roller bearings. Each motor-coach weighs 71 tonnes and each trailer 44 tonnes, the total weight of a four-car train seating 359 passengers being 230 tonnes. The maximum permissible speed in normal service is 120 km.p.h. (74·6 m.p.h.);



205 *h.p.* 1,500-*volt traction motor, with the low tension auxiliary generator which is driven from the axle*



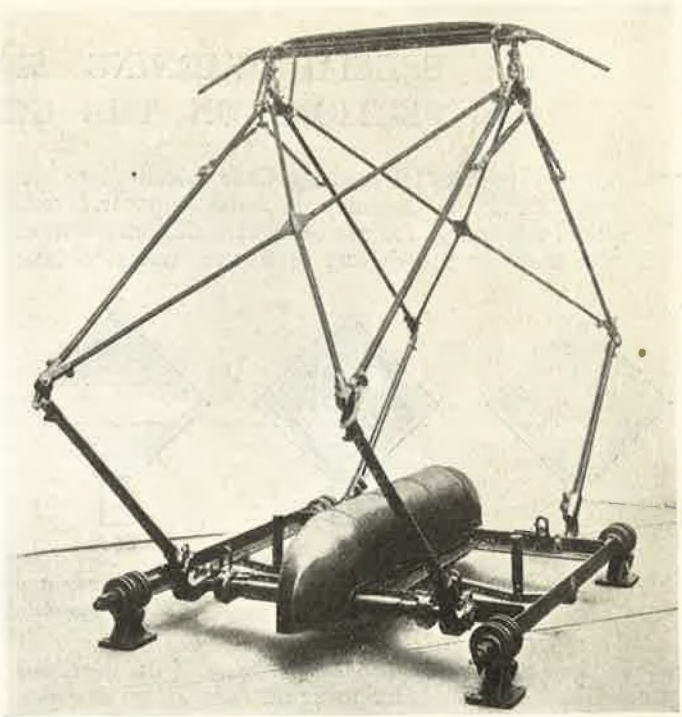
View of the main circuit-breaker as used in the Brussels-Antwerp motor-coaches we have had the opportunity of travelling in the driver's compartment at this speed, and found the riding quite smooth.

Woods from the Belgian Congo have been used for the interior panelling of the cars, and the fittings generally are of chromium-plated bronze. The second class seats have small ledge tables between them. The heating and ventilating systems are integral, air being drawn in by a fan and passed along perforated aluminum-alloy ducts at the bottom of the side panels. In cold weather the air is passed over resistances fed directly by the 3,000-volt line current, and the heating is regulated by thermostat to a temperature of 18°-19° C. (64°-68° F.). All the windows of the second class compartments are of the drop type. Lighting is effected by two rows of lamps down the roof, and the lighting of each car can be operated independently at full or half strength. The sliding doors in the side panels are operated by compressed air on the Jaspar system, and are under the control of the driver for opening and under that of the guard for closing. The mechanical portions of the trains were built by the Ateliers de Nivelles and the Ateliers de La Dyle (Louvain). The electrical equipment for the former was built by A.C.E.C. and for the latter by S.E.M., but A.C.E.C. built all the pantographs and traction motor drives, and S.E.M. all the controllers. A certain amount of the electrical equipment was designed and built by A.C.E.C. in collaboration with the Ateliers de Secheron, of Geneva.

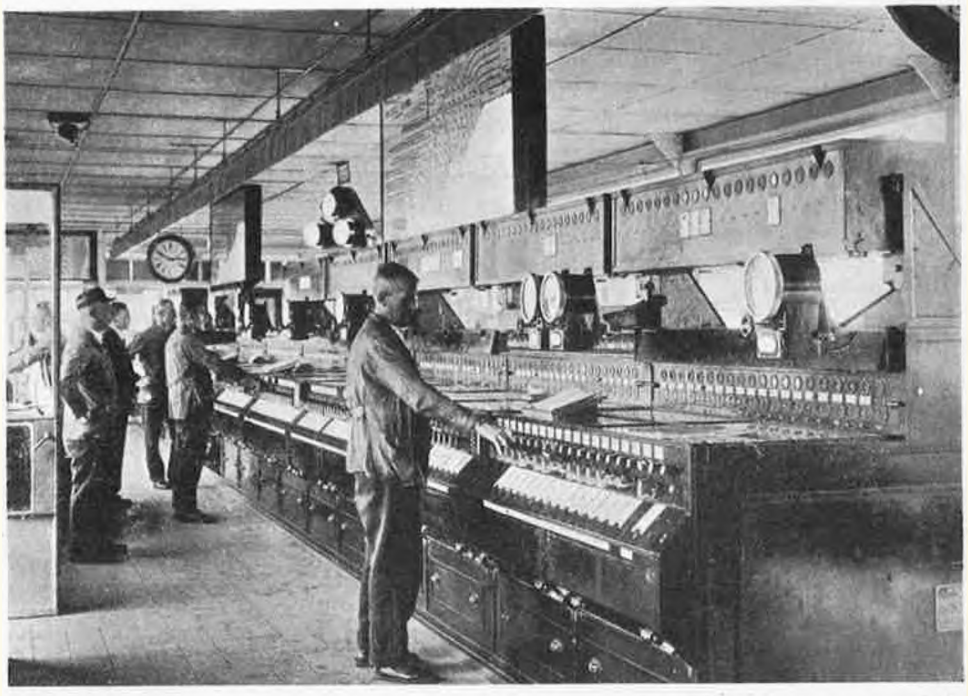
Electro-pneumatic semi-automatic control equipment is incorporated in the trains, and permits of the four motors of each coach being grouped in series, series-parallel, and series-parallel with shunted field. The two motors on each bogie are wound for 1,500 volts and coupled permanently in series. The traction motors have an hourly rating of 205 h.p. and transmit their torque to the wheels through the Secheron individual axle drive. The driving pinions and wheels are of nickel-chrome-molybdenum steel, the material of the wheels having an ultimate strength of 100 kg. per sq. mm. (64 tons per sq. in.) and that of the pinions 80 kg. per sq. mm. (50·5 tons per sq. in.) before casehardening. A dead-man handle is incorporated in the control and has a two-second delay before the current is shut off and the brakes applied.

The pantographs are of a light tubular design evolved by A.C.E.C. in conjunction with Secheron. The complete pantograph weighs about 9 cwt.; it is raised by springs and lowered by compressed air. The control and auxiliary services are supplied with low-tension current by a generator driven from the axle. Braking is effected on the Westinghouse system, and the air is furnished by two compressors driven by 3,000-volt 10 h.p. motors.

Automatic three-aspect colour-light signalling is used over the whole distance between Brussels and Antwerp. The contract was placed with the Belgian Westinghouse Company, but the apparatus was manufactured by A.C.E.C. at its Ruysbroek works, near Brussels. In connection with the re-arrangement of tracks at Brussels (Nord) consequent upon the electrification, a new electric signalling system has been installed at the terminus. The electric service is to consist of 67 trains a day in each direction, of which approximately half will make a one-minute stop at Malines. The non-stop time for the 44 km. (27·4 miles) between the termini will be 30 min., giving an average speed of 54·9 m.p.h.; the stopping trains are to have an overall schedule of 33 min. No main contractor was employed for the electrification, the work being carried out by the Belgian National Railways under the direction of the Chief Electrical Engineer, M. Em. Duquesne, whom we have to thank for facilities granted us.



Two of these pantographs are mounted on each motor-coach



New electric power signal box installed at the Nord station, Brussels, by the Ateliers de Constructions Electriques de Charleroi