

THE LONDON ELECTRIC TRAIN

1 – THREE-LINE WHIP-ROUND

by Piers Connor

ANOTHER SERIES

Following readers' interest in my various previous series of articles on the development of rolling stock on the London Underground, our editor has asked me to write something in the same vein about the rolling stock of the London Electric Railway (LER), so this the first in a new series – The London Electric Train.

First, a bit of background: The LER was the company that ran the three tube railways opened between 1906 and 1907 known as the Bakerloo, Piccadilly and Hampstead tube lines and, during the lifetime of the company between 1910 and 1933, they operated two significant fleets of rolling stock, the so called Gate Stock and its replacement fleet, the Standard Stock. It is intended, as I write this, that the story will cover both fleets.

The London Electric Railway company was formed in 1910 under an Act of Parliament (The London Electric Railway Amalgamation Act, 1910) where the assets of the Charing Cross, Euston & Hampstead Railway (CCE&H) and the Baker Street & Waterloo Railway (BS&W) were taken over by the Great Northern, Piccadilly & Brompton Railway (GNP&B), which was then renamed The London Electric Railway. All three companies had been owned by the same organisation, the Underground Electric Railways of London Ltd. (UERL), which also owned the District Railway. On 1 January 1913, the UERL also took control of the City & South London Railway (C&SLR) and the Central London Railway (CLR), although both these companies retained their separate status until all the Underground group companies were wound up for the formation of the London Passenger Transport Board (LPTB) in 1933.

'STANDARD' STOCK

One important feature of the three LER tube railways was that they were all built to the same standards. They were all acquired by the UERL separately between 1900 and 1902 but, of the three, at takeover, construction had only been started on the Bakerloo. It was thus natural that the construction of the other two lines and the purchase of equipment would be to the same basic designs and standards across the group. The lines were all built with single-track running tunnels of the same 11ft 8¼in nominal diameter and using the same 4-rail traction current system as adopted for the District Railway. The lines were signalled under the standard District Railway, fixed block, track circuited arrangement, using trainstops and tripcocks as the train protection system. The Piccadilly and Bakerloo lines still use the same system today. Station designs and layouts were similar on the three new lines, lifts were supplied by the same manufacturer (Otis), rules and regulations were the same and the staff were trained and supervised to the same standards.

A significant standard adopted across the LER was for rolling stock design. Although there were slight variations in details between the fleets bought for each line, the design was basically the same throughout. Indeed, when more cars were bought from 1914 onwards, the original cars were often referred to as the 'Standard Stock'¹, since they all had the same equipment, they all looked similar and they were all operated in much the same way. Today however, we accept the term 'Standard Stock' as referring to the large fleet built for the LER lines between 1922 and 1934, even though this was not the first use of the term. Even the District sometimes used the term 'Standard Wooden Stock' when referring to its 1905 B Stock cars². The original LER stock was never officially referred to as "Gate Stock".

MAKING A START

When you're building a new railway, it's a good idea to see if anyone has tried before to do what you want to do. In the case of the partly-built Bakerloo, they didn't have to look far for models for tube railways in London because these already existed in the form of the City & South London Railway and the Central London Railway. Both these railways started with locomotive haulage but, by the time the Bakerloo team were ready to consider their new trains in 1901, the Central London had progressed to

¹ For example, LER Mechanical Engineer's Drawing No.183D dated 28.04.20.

² See my series of articles on the District Electric Rolling Stock, which appeared in *Underground News* Issues 567-597, March 2009-September 2011.

trial operation of a multiple unit train and they had a design that seemed to be suitable for the Bakerloo type of operation. The Bakerloo got advice from them and adopted the design.

As I described in article No.4 of my series 'The Central London Electric Train'³, the CLR suffered serious vibration troubles with their locomotives and, in an attempt to overcome the problem, they developed a 6-car experimental train in 1901 consisting of a motor car at each end of a set of four trailer cars, using the newly invented multiple unit control system⁴. Their trials showed that this arrangement worked reasonably well and they went ahead and ordered enough new motor cars to make up 32 multiple unit trains. As part of this scheme, they ordered six additional trailer cars. These were unusual for the time in being built with all-steel bodies – the first in Britain. At this time, passenger cars were normally built with wooden framed bodies on wooden or wood and steel underframes. With both the multiple unit system and the all-steel car body construction turning out to be successful, it was natural for the Bakerloo to follow the same path and specify all-steel construction and multiple unit equipment for their trains and so they did.

TRAIN FORMATION

The Bakerloo also adopted the Central London's original 6-car train formation with a motor car at each end of a set of four trailer cars, as shown in Figure 1. However, it was already becoming clear on the Central London that train lengths should be varied to match the expected traffic. Indeed, it was regarded as an important energy saving strategy. Energy was expensive then, as today and running short trains during off-peak periods was seen as a good way of saving money. The idea was to retain the performance of the 6-car train whilst operating less cars and a simple division of the train into two 3-car portions was the obvious solution. The motor car in the 3-car portion provided motive power and, while it was running with the motor car at the rear, the driver controlled it from a set of controls provided on the platform of the trailer car at the other end of the train. This car became known as a "control trailer" (CT).

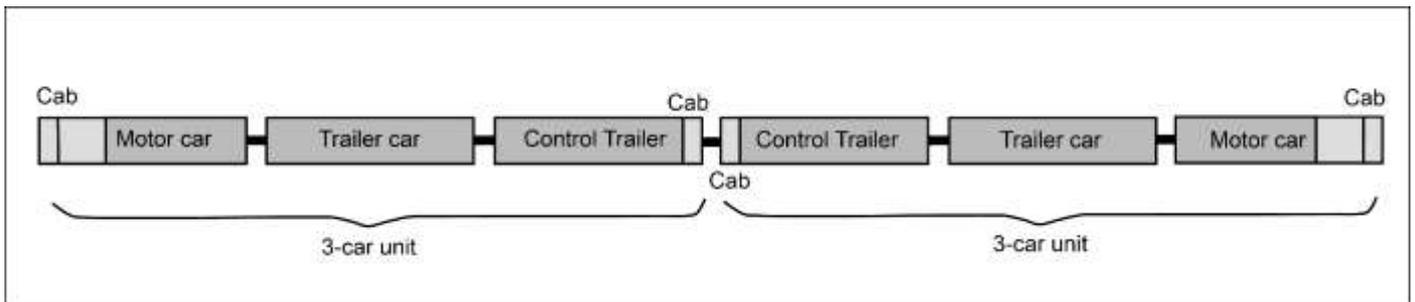


Figure 1: Schematic of the basic 6-car formation adopted by the LER for the Bakerloo and Piccadilly fleets. The formation was reduced to a 5-car consist for the Hampstead by the removal of a trailer. Five of the Hampstead's 30 trains had trailers in place of the control trailers to form "block trains".

Diagram by author

The trains purchased for the Bakerloo and Piccadilly lines were ordered with the 6-car M-T-CT+CT-T-M formation in mind for all trains but the Hampstead fleet was originally ordered as 5-car trains, without control trailers. The UERL "Works, General Purposes and Parliamentary" committee meeting of 13 June 1906 tells a story of how they ordered 30 x 5-car trains, allowing 25 of them for service at a 3-minute headway, leaving 25% for spares. At the meeting, it was decided to order 50 extra sets of driving controls to allow the trains to be provided with control trailers so they could run short trains "during light traffic hours", as they put it. The 50 sets ordered only covered the 25 x 5-car trains required for service, not the remaining five trains left for maintenance. This suggests that the committee really didn't understand train operations but it is likely that they recognised that some peak hour trains would be stabled rather than split up for the off-peak service.

I suspect the decision to operate trains in 5-car sets instead of six was due to the Hampstead line having two branches at the northern end, one to Highgate, the other to Golders Green, thus dividing the traffic into two flows and reducing the load on individual trains. With the reduced formation, the Hampstead got 150 cars, with 25 x 5-car trains having control trailers and the remaining 5 without. The

³ *Underground News*, issue 614, February 2013,

⁴ I describe the background to this and how its inventor, Frank J. Sprague introduced the system in Chicago in 1898 and how it spread to London and elsewhere in the world in Article 2 of 'The Underground Electric Train', *Underground News* No.524, August 2005.

Bakerloo got 18 x 6-car trains (108 cars) and the Piccadilly got 36 x 6-car trains (216 cars). In the case of the Piccadilly Line, the original allocation was for 30 trains but another 6 were ordered in September 1905, some five months after the main order. As we shall see, in the early years, none of the lines operated their fleets in the manner intended.

BUILDERS

The American money that was invested in the building of the LER tube railways came with a price – buy American equipment. The notion wasn't popular in Britain but it was the only way the projects were going to be completed. After all, the Bakerloo ran out of money before the tunnelling was completed and it was the American consortium led by Charles Tyson Yerkes that rescued it. Apart from that, the technology was American. Rapid transit was invented there while, back in London, we were dabbling with it in the form of the City & South London Railway. Almost all of the ideas about running high volume urban transport were developed in the cities of Chicago, Boston and New York in the late-19th Century and were adopted here with little change. It was only in later years that London altered some of the ideas to suit our particular conditions.

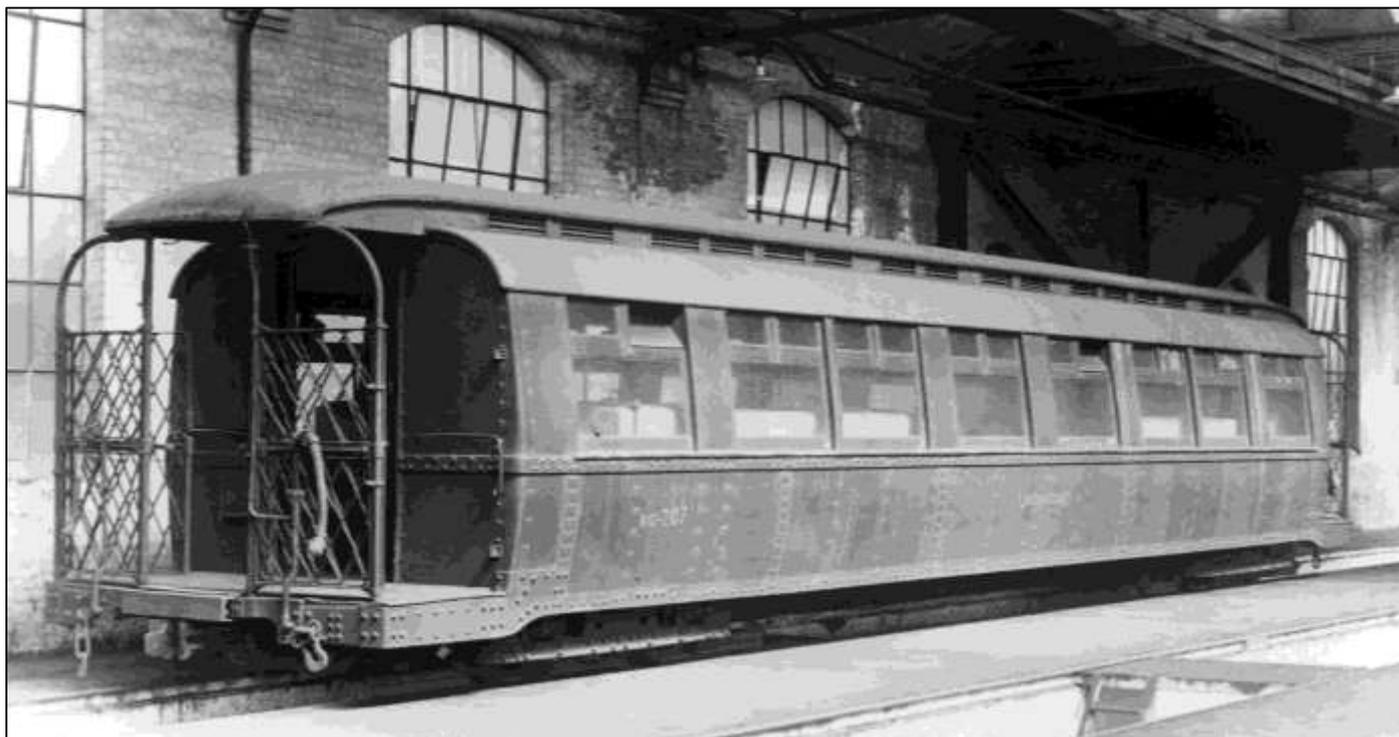


Figure 2: Bakerloo 1906-built steel Gate Stock trailer car photographed in Lillie Bridge depot after its conversion to a rail-grinding car in 1936. It was originally numbered 209 and became RG207 upon conversion and later RG801. It is still in near original condition externally at least, apart from repainting in (probably) LT service vehicle livery. The original Gate Stock of each of the LER lines varied slightly in details, partly due to being built by different suppliers and partly, perhaps, because of experience with the design. Photo: Brian Hardy collection.

The LER Gate Stock was built overseas. The American Car & Foundry (ACF) built the Bakerloo and Hampstead cars at a factory in Berwick, Pennsylvania, while both the Piccadilly orders (the 30 train order and the 6 train order) were split equally between Les Ateliers de Construction du Nord de la France of Blanc Misseron and the Hungarian Railway Carriage & Machine Works of Győr, a place also known as Raab in German.

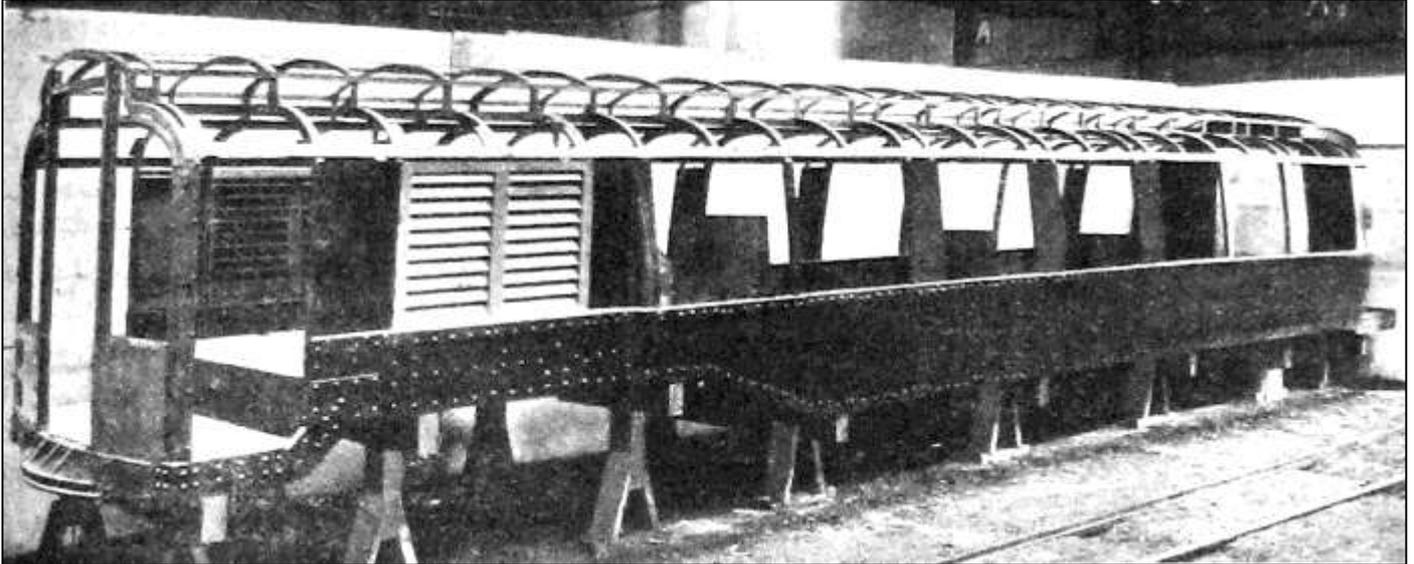
The ACF cars were sent to Britain as a kit of parts and these were assembled in a large shed in Trafford Park, Manchester (Figure 3). Groups of cars were formed up and hauled to the Camden depot of the London & North Western Railway. They were then transferred by road to the Bakerloo depot at London Road or the Hampstead depot at Golders Green for fitting out and commissioning. The road haulage originally used horses but, in later years, traction engines were used (Figure 4).

Cars built in France and Hungary were shipped to Tilbury docks, east of London, and then towed, via the District Railway, by a steam locomotive to the Piccadilly Line's depot at Lillie Bridge. The Piccadilly had taken over the District's former depot there and a new 6-road car shed was built on the site. New cars were fitted out with electrical equipment, finished off internally and commissioned in this shed.

Some cars were sent to the Ealing & South Harrow line on the District for staff training. Some cars were also stored there for a time during the commissioning phase.

CAR DESIGN

The design adopted for the LER cars was as shown in the photo of a Bakerloo trailer car in Figure 2 and the scale drawing of a motor car in Figure 5. The general arrangement of the vehicles was the same for the later batches of stock built for the Piccadilly and Hampstead lines but there were external variations in details, both visually and in certain dimensions.



*Figure 3: A Bakerloo motor car under construction at Trafford Park, Manchester. The cars were manufactured by ACF in Berwick, Pennsylvania and shipped over to England as a kit of parts. After completion in Manchester, the cars were hauled to London by the London & North Western Railway. This photo shows clearly the vulnerable front-end construction with the cab floor 1ft 1in below the equipment floor. The design of the side cills at the front was vulnerable to a rough shunt where the cab floor would bend down under the impact of the collision. Photo from *The Electrician*, 23 February 1906.*

Back in May 2006⁵, I told the story of how Brush of Loughborough and the Metropolitan Carriage & Wagon Co. were each asked to build a sample tube car for the Piccadilly Line and that both were too wide. I suggested that were I a conspiracy theorist, I might think that, as they had both complained to the Underground group about the amount of work being given to foreign companies, they were asked to (or offered to) build sample cars. I proposed that the Underground group, anxious to shut them up, gave them the wrong dimensions so that it could be said they couldn't provide satisfactory work *and* their prices were higher and delivery times longer than those of American, Hungarian and French firms. For this series, I carried out a fresh examination of various official or published drawings, which show a number of differences between dimensions for the same vehicle. In the case of the Bakerloo, the overall car width is variously reported as 8ft 11ins and 8ft 8ins. Since the Hampstead and Piccadilly cars were 8ft 6ins or 8ft 7ins wide, the 8ft 11ins might have been too much. Such differences cast doubts on the story I relate above about the two British built cars. Perhaps it was just a “cock-up” rather than a conspiracy. In my drawing of the Bakerloo car however, I have used the 8ft 11ins width, because on all the photos I have examined, the Bakerloo cars look wider at the waist than the others. It is worth noting too, that the Bakerloo cars are also widest at roof level.

I did have another theory. Perhaps the original Bakerloo car dimensions were fixed with a width of 8ft 11ins and the cars were built to this but it was found to be too wide at some points in the tunnels, so later batches of cars were reduced in width, while the pinch points on the Bakerloo were adjusted to take the extra width. If this was the case, the British-built cars, which were delivered a year before the rest of the Piccadilly fleet, were built to the wide dimension and were considered too wide for the Piccadilly tunnels.⁶

⁵ “The Underground Electric Train”, 11 – Tube Car Bodies” *Underground News* No.533, May 2006.

⁶ The two cars languished at the Piccadilly Line’s depot at Lillie Bridge until about 1918 when they were scrapped.

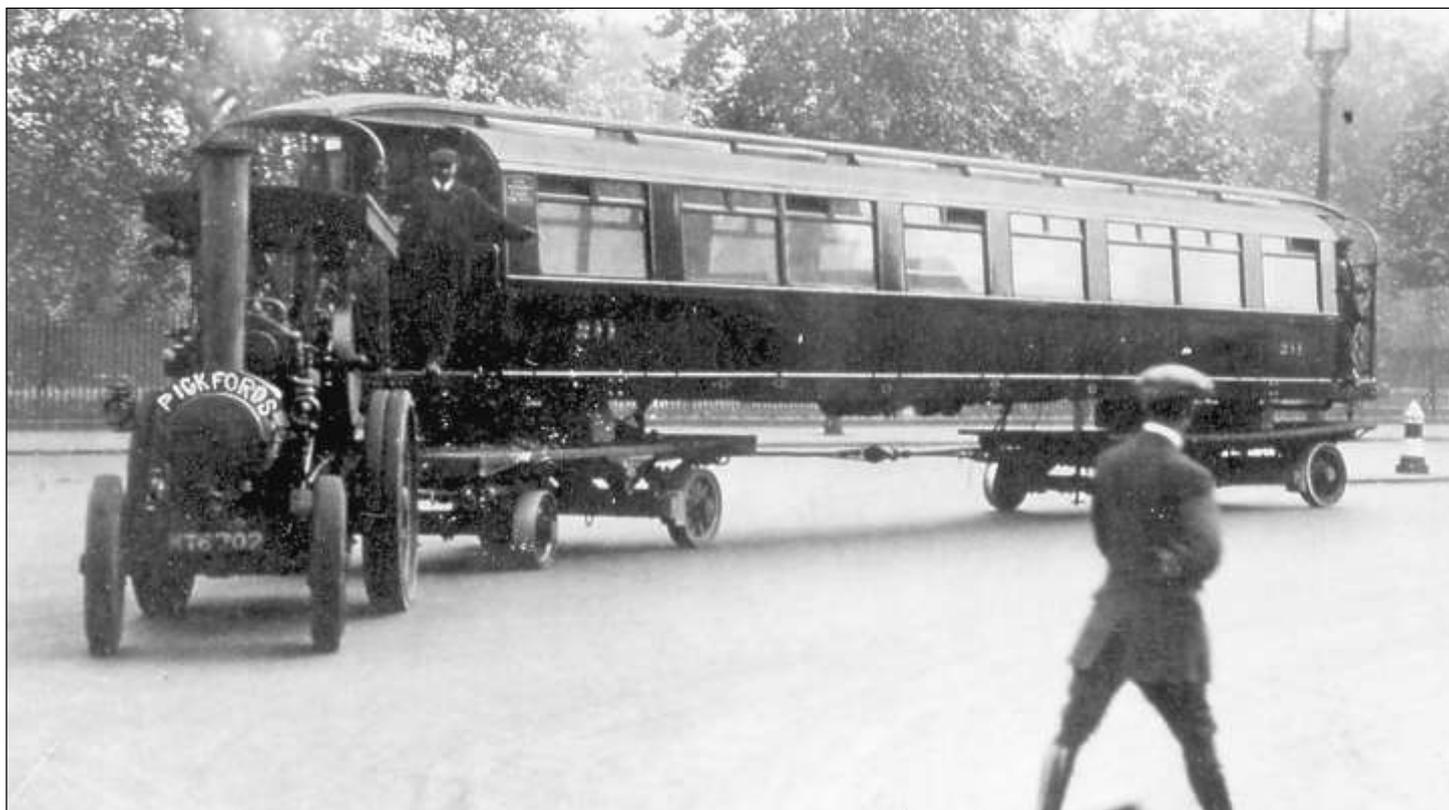


Figure 4: A Piccadilly Line French-built trailer car (No. 211) being transferred by road, perhaps on its way back from wherever it was fitted with experimental clerestory ventilator covers as part of trials for new tube car designs in the early 1920s. This car was also involved in trials to test conversion to air doors. Note the road bogies, which rotate under the car and which are coupled under the car to assist steering round corners.

Photo: Brian Hardy collection.

The basic design for the trailer consisted of a steel body-shell mounted on a steel underframe and carried on two 4-wheeled bogies. The body interior was in a saloon-style with a pair of sliding entrance doors at each end giving access to the open end entrance platforms. The platforms were protected by lattice-work gates on each side and similar-looking screens on the ends. A central gap in the fencing allowed access between cars. Through access was essential to allow evacuation from trains trapped in the tube tunnel and it provided a space for the gate operator or 'gateman', who was expected to operate the two gates on the adjacent ends of two cars.

The Bakerloo motor car design copied the original Central London experimental motor car. Indeed, Jackson & Croome in "Rails Through the Clay", record that Granville C. Cunningham, the Central London's general manager, acted as advisor to the Bakerloo. The switch compartment, containing all the traction control equipment, was behind the driver's cab and measured 7ft 8ins in length.

The American Car and Foundry (ACF) Company were probably sent photos and drawings of the CLR experimental motor cars and were told that this was how tube car design was going so they should use this as a guide. Unfortunately, the CLR switch compartment proved to be too small and experience soon showed that it was necessary to increase the space for the electrical equipment, on the Piccadilly and Hampstead cars as had to be done for the production CLR cars.

The short switch compartment of the Bakerloo motor cars allowed four more seats to be squeezed onto the raised platform over the rear axle of the motor bogie but these were quite close to the ceiling and, as I have noted in an earlier article⁷, they must have been rather claustrophobic for the timid passenger, stuck as he was next to the "clack, clack, clack" of the contactors, the loud bang when they opened under load and the thumping of the compressor next door. It was not the place for an intimate chat.

The extra seats were sacrificed on the Piccadilly and Hampstead cars for longer switch compartments measuring 13ft 9ins, including the driver's cab. This became the approximate dimension for all future tube passenger cars with switch compartments. The Piccadilly and Hampstead motor cars had 42 seats instead of the Bakerloo motor cars 46. All trailer cars had 52 seats.

⁷ Ibid.

