

# THE LONDON ELECTRIC TRAIN

## 11 – CATCH UP

by Piers Connor

### NEW INFORMATION

One of the benefits of writing a series like this is that from time to time some new information comes to light. Recently, a reader passed on a copy of a drawing that I had thought was missing. This was a drawing showing the result of the conversion by Cammell Laird of two 1906 Piccadilly Line French-built gate stock motorcars. My thanks to Mike Miller for access to a copy of the drawing. I have produced a new drawing as a result and this is shown in Figure 3 on page 434.

Another correspondent who contacted our editor was Paul Wheeler. He asks about the guard's door controls on the 1920 Cammell Laird Stock and the Piccadilly gate stock motor cars converted to run with them. He notes that there have been several photos printed over the years of the guard's control positions on the 1920 stock and he thought that there weren't enough buttons/levers/switches to allow the guard to do his job. He considered that there ought to be switches for lighting (on and off) and a push button for the bell signal to the driver. Although I had implied in Article 9 of this series that I was not going to do a full description of the 1920 Stock door control system, in view of Paul's questions, I thought it would be useful to do a description, if only to provide a more current record. My original description appears in my book 'Air Door Equipment on the London Underground Train', published in 1981. What follows is an updated version.

### 1920 STOCK DOOR OPERATION

First, I should recap on certain information I have already mentioned in this series. The 1920 Stock trains were normally formed of six cars for peak hour operation but they could be split into two three-car sets for off-peak operation. It was therefore considered necessary to provide door controls at both ends of each three-car portion. So, on a six car train (M-T-CT+CT-T-M), controls were provided at the trailing end of each motor car and at the non-driving end of each control trailer. A combined drawing of the layout at the two positions is shown in Figure 2. For some reason not entirely clear, the door controls on the control trailers were mounted on the end bulkhead of the car whereas, on the motor cars, they were mounted sideways on, next to the draught screen separating the guards position from the passenger saloon. The difference may have had something to do with the fact that the motor car end bulkheads were added as part of the conversion from an open platform to an enclosed platform and were not purpose-built as they were on the control trailers.

In normal operation during peak hours, the doors and lighting on a six-car train were split into two 3-car sections, one controlled by a guard on the leading car and the other by a guard on the rear car. This meant that lighting and door control wiring had to be split at the middle coupling point between the two control trailers. A special jumper was provided for this but on later deliveries (the 1923 Stock and subsequent 'Standard Stock' varieties) the function was incorporated into a 'control trailer conversion switch' provided in the driving cabs. This switch was normally left open and was only closed to allow the control trailer to be used as a trailer car.

In designing the door control system, a number of factors had to be taken into consideration. Firstly, guards had to be able to separate control of their own doors from that of the passenger doors. On the 1920 Stock, the guard's doors were sliding and air operated and could be used by passengers when not in use by the crew. Doors at the driving ends of control trailers were also available for passengers when the position was not occupied by the driver. This implies that there must have been some sort of isolating cock that had to be operated by the driver when he set himself in the cab, although I haven't found a reference to it.

Secondly, the guard's door control equipment had to be rendered inoperative at vacant positions to prevent unauthorised use by passengers. This was achieved through the use of keys. Thirdly, a system was needed to see that all doors were closed before allowing the train to start. This was achieved through a mechanically operated visual system, consisting of black and yellow striped flipper arms attached to each door leaf, which stuck out when the door was open and lay flush with the door when it was closed (for an example, see Figure 2, Article 9 in this series). I will describe the controls in a moment but first let me describe the door operating equipment. It was rather clever.

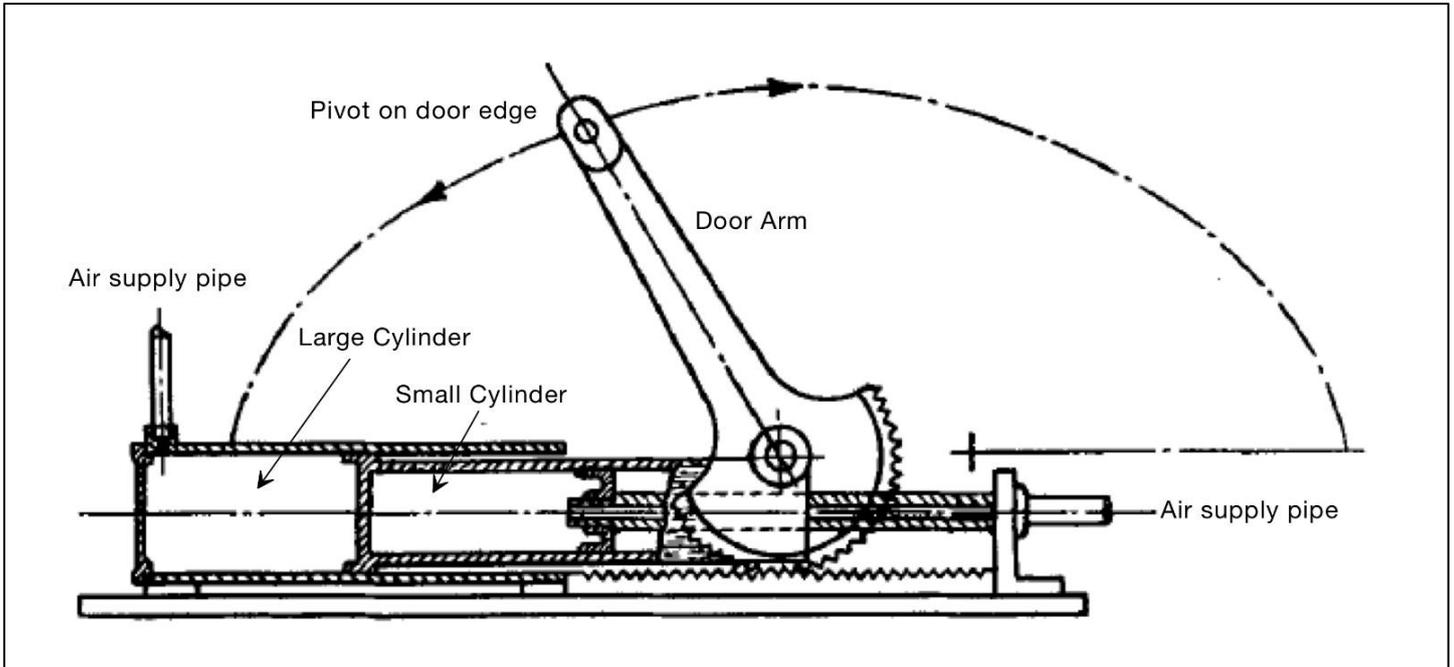


Figure 1: Schematic of air operated door engine, known on the LER as Type B, as fitted to the 1920 Stock. There were two air cylinders, a small one fitting inside a larger one. Movement of the small cylinder caused the door arm to rotate. Drawing from Collins (1945).

## DOOR ENGINES

Each door leaf was fitted with what was described at the time (and still is on air-doored trains) as a door engine. In a paper presented to the Institution of Locomotive Engineers by A.F. Collins on 22 February 1945, 'Power-Operated Doors for Railway Rolling Stock' that I referred to in Article 9, there is a drawing of the door engine used on the 1920 Stock. It was known as the B type (Figure 1). It is not known now what happened to the A type. Collins described the operation of the B type engine as follows:

*"[It] was designed to give cycloidal-movement to the engine arm roller which reduced the length of the engine arm and was an advantage when the engine had to be housed at the back of the seat with restricted space under the window sill. This engine had the small cylinder arranged to slide into the large cylinder on a fixed piston rod, which, being hollow, carried the air supply to the small cylinder. The geared sector was attached to the small cylinder by a cross-head shaft which also carried the engine arm. The rack was stationary and attached to the bed plate. It will therefore be seen that as the small cylinder moved it carried the centre of the arm backwards or forwards at the same time as the arm rotated."*

Collins also describes the automatic door re-opening device supplied on this stock, which I described in Article 9. He then noted that the provision of a 180-degree rotation arc to the door engine arm actually provided a natural anti-slam feature for doors no wider than 2ft 6ins. Experience showed that wider doors needed some form of specific cushioning system to prevent slamming. This is likely to be one reason why a standard 2ft 6in door was retained on all new designs until the appearance of the D78 Stock. Nowadays for modern, screw driven electric doors, anti-slam controls have to be specially provided on all doors.

In Article 9, I mentioned that the door engines were mounted between the bodyside panels and the doors, making access difficult. Reference to a later photo shows that this wasn't done on all cars. If I was to look at the evidence from photos and recorded dates and then speculate on what actually happened, I might come to the conclusion that the two Cammell Laird motor car conversions and the first two Gloucester conversions were like this, together with some of the trailers but that later cars were reorganised to have the door engine inboard of the door leaf. Maybe the alteration was another reason for the very long delay before the trains started going into service.

## DOOR CONTROL

Each door engine was controlled by an electrically operated air valve. A control wire was provided down each side of the train so that when the wire was energised the valves would lift and open the

doors on that side. De-energising the wire closed the doors. One difficulty with this system was that, since it was the custom to leave the doors open at terminals while the crew changed ends, a means to be found to keep the doors open. This was because guards were required to shut down the controls and remove their keys when they left their position in order to change ends. If the guard removed the keys from the operating position, the door open wire became de-energised and the doors would close. In order to prevent this, a special switch known as the 'door opener' (Figure 2) was provided at each position. The switch, which could only be operated by one of the guard's keys, was used to maintain a feed to the door wire while the crew were changing ends. It was cancelled by operation of the guard's controls once the new position had been switched in.

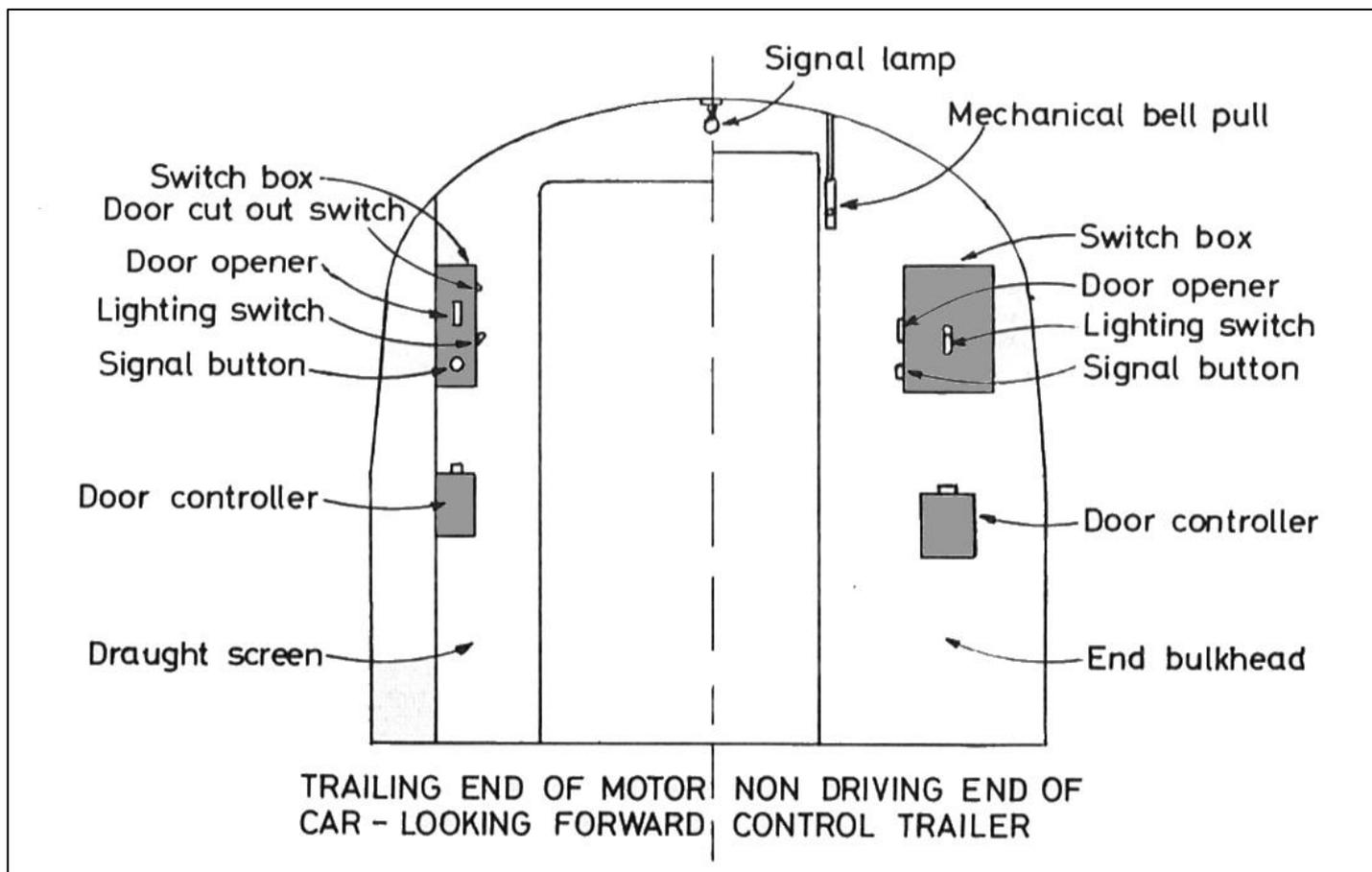


Figure 2: A schematic of the guards' positions on the 1920 Stock, with the location of the equipment at the trailing end of the converted French motor car on the left and the trailing end of the control trailer on the right. The various controls are described in the text. Drawing: Author.

The guard had to have two types of keys. One type was used to unlock each of the two door controllers at the position so the guard had to have two of them. The other type was used to operate the door open/close control and had to be swapped from side to side as dictated by the positions of the platforms. The door controllers themselves were actually pneumatic rotary valves that controlled the operation of the guard's own door but they also had electric switches to energise the train 'doors open' wire. When the rotary valve was shut down by removal of the guard's key, the guard's door came under the control of the electric valve in the same way as the passenger doors.

## TRAIN STARTING

The new door control system brought with it a new train starting system. Instead of a bell signal, the driver now received a lamp starting signal. The lamp lit when the front guard pressed a 'signal button' (Figure 2) at his position. The train starting process began when the rear guard of a six car train pressed the signal button once he had seen that all the flipper arms along his half of the train had disappeared from sight as an indication that all doors were closed. Pressing the button lit the lamp mounted in the car roof at the front guard's position. The front guard, having seen the lamp lit and that all the doors were closed on his half of the train, pressed his signal button to light the lamp in the driver's cab and give the driver permission to start the train. Since there was no interlocking of the signal lamp circuit with the closure of the individual doors, safe operation was totally reliant on the observation of

the guards. In the event of the failure of the lamp in the driver's cab, the mechanical bell signal was retained so that the front guard could still give the driver the starting signal.

Experience with the first train during trials in 1921 showed that the use of the flipper arms was unreliable. The arms were easily broken off and it was thought that it was necessary to have some form of positive indication that doors were closed before starting the train. The flip out arms were removed and were replaced by electric interlocks mounted on the door engines. The interlocks were switches fitted into a round-the-train circuit which, provided all the doors were closed, closed a circuit to a single lamp at the operative guard's positions. As before, the lamp indication was passed to the driver when the signal button was pressed by the guard.

The introduction of the new signal circuit and door interlocks included the addition of switches in the control trailer driver's cabs and interlocks on the door controllers. The interlocks on the door controllers ensured that the signal circuit was broken when 'all doors open' was selected. Additional contacts also insured that door controllers in non-operative positions were correctly shut down. The additional switches in the control trailer cabs were fitted in a box near the offside cab window, together with a set of fuses. These switches supplied the signal circuit for each half of the train from the lighting bus lines and were always left closed while the train was in service.

## **MORE MODIFICATIONS**

Although 10 six-car trains of 1920 stock had been ordered, delivery was stretched out and not all of them had entered service before further modifications were carried out late in 1923. It was decided that the starting signal should revert to the bell system originally used on the gate stock, but that the bell would now only ring when the signal circuit was complete throughout the train. This innovation was based on the same principle being adopted on the centre entrance cars of the Bakerloo at this time to ensure that the middle doors were locked before the train was started. It was also arranged that the bell would only ring in the operative driver's cab by passing the bell circuit through a switch fitted to the driver's brake valve isolating cock. This switch was only closed when the drivers brake valve isolating cock was open thus ensuring that the starting bell only rang in the operative driver's cab.

A further modification introduced at this time was the conversion of the guard's doors on motor cars to hand operation. They were still sliding, but could not now be used by passengers at any time because they were locked out of use when the guard vacated the position. It is likely that, at the same time, the door controls at the trailing of the control trailers were moved to new positions in the cabs, but there is no confirmation of this.

## **LIGHTING**

One final innovation for the 1920 Stock was in the lighting control. It was normal up to this time for lights on individual cars to be switched locally. A knife switch was provided in a box on the entrance platform at one end of each car. It was part of the gateman's duties to ensure that lights were switched on when necessary. The lighting on the car was fed through the switches from a pair of lighting bus lines.

With the loss of the man-on-every-car operating system, it was necessary to provide through control of train lighting, so a switch was provided at the guard's position and this appears to have been designed to allow lights on each 3-car portion to be switched from there.

## **FOUNDATION**

As might be expected with the first attempts to provide a new and complex door control system, there were many minor modifications, apart from those mentioned above, and many new drawings were prepared and altered between 1919 and 1924 which do not indicate the state of all the 10 trains at any one time, nor whether the proposals on the drawings were actually applied to the trains. The true course of the progress of this early installation has been lost in the mists of time. I was privileged to be able to review these drawings in the early 1980s, hence the details in my description. It would be interesting to know whether any of them still exist.

Despite its early troubles, the development of the door control system on the 1920 Stock was a prototype for the door control systems provided on all subsequent trains of the London Underground. Almost all the basic principles adopted then were continued through to the present day in one form or another. It had proved to be a difficult start but, once it settled down, it became an important and reliable part of the Underground's capability in carrying large numbers of people.

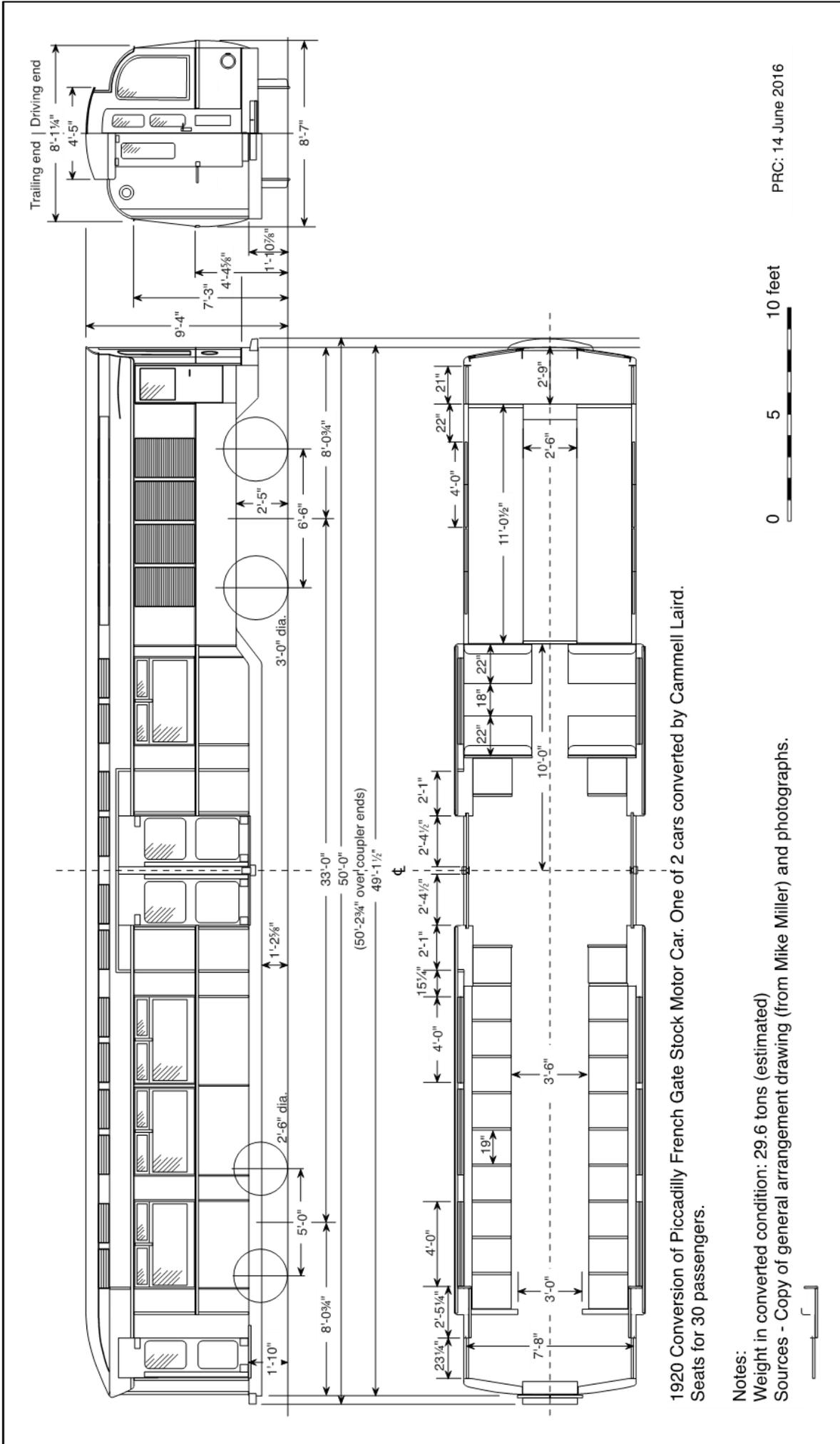


Figure 3: Scale drawing of 1920 conversion by Cammell Laird of 1906 French-built Piccadilly motor car used with the 1920 Cammell Laird Stock.  
Drawing: Author.

To be continued .....