

The LONDON MIDLAND and SCOTTISH RAILWAY



FOUNDED 1963

THE LMS
SOCIETY



LMS STEAM DRIVEN RAILCARS

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LMS Society Monologue No 14

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Introduction

The first steam driven railcar was introduced in the UK in 1903 on the London and South Western Railway, although the concept was not entirely new as two similar type vehicles had appeared much earlier. The first was built by William Bridges at Fairfield Works, Bow in 1848 and was a six wheeled carriage with a vertical boiler and used on the Bristol and Exeter Railway. The second was built in 1849 for the Eastern Counties railway had eight wheels and a locomotive type boiler. In 1869 The Great Southern and Western Railway in Ireland experimented with a double bogie steam rail motor coach built by George England at the Hatcham Ironworks, New Cross. This vehicle was followed by two classes of combined steam locomotive and coach designed by Alexander McDonnell and built in the Inchicore Works in Dublin. The first was in 1883 of the 0-4-4 type and the second an 0-6-4-type in 1880. Both were small locomotives with well tanks with the coach mounted behind the bunker and fitted with buffers front and rear.

The first phase 1903 to 1922.

There were two reasons for the 1903 revival the first being the constant need for railways to cut costs, particularly on the rural branch lines and secondly to combat the ever growing tramway networks in the cities and towns.

By the end of 1911 about 221 steam driven rail motor coaches had been placed in service by twenty six railways in Great Britain and Ireland of which ten had been withdrawn in that time. Table 1.indicates the Companies involved. The only major railways not using this type of vehicle were the Great Eastern, North Eastern, North British, Caledonian and Highland

There were two basic types - one having a small locomotive type traction unit with a coach pivoted immediately behind the bunker, (type 1). The second had the boiler, usually of the vertical pattern within the coach thus giving the general appearance of a coach, (type 2). Both vehicles could be driven from either end.

Generally speaking these first phase units were not very successful, no doubt due to the designs following too closely those of standard rolling stock resulting in heavy vehicles out of all proportion to the number of passengers carried. The small steam engines were not as efficient as the larger prototypes, being generally only able to cope with the vehicle to which it was attached. Should traffic exceed that of the one coach it was generally beyond their capabilities to add another vehicle. Considering the foregoing the economies envisaged were never realized. The larger railways such as the L&Y and the LNWR were in a position to relocate their vehicles resulting in two of the more successful designs lasting beyond WW2. See table 1.

The second phase 1923 to 1933, Sentinel Designs..

At the conclusion of WW1, the railways needed to compete with road transport, particularly the shorter passenger journeys and something therefore required developing for such traffic to oust the current conventional tank engine and cascaded down coaching stock generally used on such services. By this time the road haulage industry had developed a reliable steam road vehicle with a totally enclosed high speed engine using high pressure steam from small water tube boilers and geared down to the driving wheels. This principle was utilized in the design of railcars resulting in 126 vehicles being placed on UK railways in the ten years to 1933. The LNER was the largest user having eighty-one such vehicles including the one purchased in 1933 from the LMS that was used on the Axholme Joint Railway. Way back in 1905 a four-wheeled geared rail motor was designed for the Rother Valley Railway that was not a success

The Sentinel Wagon Works introduced the first railcar embodying these principles in 1923 in co-operation with Cammell Laird & Co. by building two 3' 6" gauge bogie vehicles for the Jersey Railways to run between St. Helier and Corbiere. The total weight was 15 tons 3 cwt 2 quarters that was less than half the weight of the earlier types. The engine was totally enclosed with 6.25inch diameter cylinder with a 9inch stroke having poppet valves and mounted horizontally above the floor of the engine room. The drive from the crankshaft was by roller chain to an intermediate shaft then by separate chains to each axle of the 7' 0" wheelbase bogie. The Sentinel vertical boiler with cross water tubes and super-heater supplied steam at 230lbs/sq. inch. Coal consumption was 5.37 lb per mile.

On February 21st 1924 a demonstration was given to a large assembly of railway engineers that resulted in six railways placing orders for similar vehicles over the following years. See table 2.

The thirteen LMS Sentinel/Cammell vehicles were authorized by LMS Traffic Minute 1040 dated 28th July 1926 at a cost of £3800 each and were allotted Diagram D1779 and ordered as Lot 312. The numbers first allocated are not known except one that was number 2232 with the 1932/3 renumbering scheme allocating numbers 29900-12 with all receiving the LMS standard coach livery in the first instance. See table 2.

These early models suffered from poor riding qualities and so in 1928 a gear driven 100 hp vehicle was designed. The boiler was on the mainframe and the vertical two cylinder engine was mounted over the rear axle of the power bogie with the axle driven through gearing. The LNER purchased the only one built (named Integrity) that suffered from severe vibration.

Also in 1928 an improved design appeared incorporating several new features particularly with regard to the engine which was a six cylinder single acting engine with 6inch diameter cylinders and a 7inch stroke suspended on the left hand side underneath the coach body. The engine retained the poppet valves actuated by a camshaft with three cut-off positions with all parts totally enclosed and pressure lubricated. For maintenance the engine could be removed in one hour. The drive was by a cardan shaft from the engine to a gear-box located on two bearings on the front axle of the leading bogie. The boiler was also improved working at 300lb.per sq. inch with a super-heater temperature of 750 degrees fahrenheit. Coal consumption was 13.9 lb per mile.

LMS Traffic Committee Minute 1929 dated 24th April 1929 refers to the proposed purchase of an improved Sentinel/Cammell railcar LMS.Diagram No. 1842. The vehicle was allocated running No. 4389 in the carriage stock series and given No. 29913 with 1932/3 renumbering scheme. As with the first vehicles the standard coaching stock livery was applied. The Axholme Railway was jointly owned by the LMS and LNER with the motive power supplied initially by the LYR and then the LMS after the grouping. The LMS supplied one of the thirteen steam railcars purchased in 1926/7 to the AJR.. In February 1930 a larger car was ordered from Sentinels numbered 44 in the LMS carriage list and carried a green/cream livery carrying the name "Axholme Joint Railway" on each side. On 15th July 1933 the passenger service ceased the car having done 53,786 miles was then purchased by the LNER and numbered 51915. The car was 65ft 8 in. over buffers with 64 seats and provision for ten more if required on tip-up seats in the luggage compartment. The weight of the car was 29 tons 5 cwt without coal or water or 33 tons 5 cwt with fuel and water. The LNER overhauled the vehicle at Gorton and fitted it with a second-hand boiler from CLC car 602 returning it back in traffic in January 1934. See table 3.

In 1930 an articulated railcar was introduced and supplied to the LNER. Articulated coach sets whereby coaches have the adjacent body ends residing on a common centre bogie was not a new idea as it was patented in the 1860s by Claxton Fidler. The GNR experimented with this method in 1907 following which many entered service on that railway. The GWR and LMS also used the principle to a lesser degree. This system was applied to a Sentinel railcar that was intended for use on the Scarborough to Whitby line having a seating capacity of 122 passengers. It was fitted with two 100hp six-cylinder engines, one driving the leading axle under the boiler room with the

other driving the trailing axle of the centre bogie. The standard boiler was replaced by a marine type Woolnough water tube boiler comprising of three drums, one steam and two water connected by banks of tubes spanning the fire space and grate. Behind the tubes and inside the casing of the side flues was the tubular super-heater. The working pressure was 300lbs/sq. inch.

In an endeavour to increase the maximum economy, Sentinel designed a new type of light railcar for the Southern Railway in 1933 that was placed in service on the branch from Brighton to Dyke. The vehicle had automatic stoking and boiler feed water supply and could therefore be driven by one man. The 100hp engine was a two-cylinder compound with one high-pressure cylinder 4.5 inches in diameter and a low-pressure cylinder 7.5 inches in diameter, the stroke being 6 inches for both. It was fitted with piston valves using Stephenson's link motion with all parts enclosed and running in oil. The compact engine was slung on one of the bogie axles to which it was geared not unlike the motor of an electrically driven coach. An interesting feature was the brake drums that were on the outside of the axles. The vertical water tube boiler was pressed at 325 lb per sq. inch and was fitted with an automatic feed water regulator that actuated a steam driven water pump and maintained the water in the boiler at a constant level. The mechanical stoker was also controlled from this same pump ensuring that the amount of coal supplied was commensurate with the amount of water delivered. The car had provision for 44 passengers and weighed 20 tons 4 cwt. It was delivered to the Southern under its own steam on 19th March 1933 recording a speed in excess of 60mph on the Birmingham to London line where a distance of 9.5 miles was run in ten Minutes. It was later transferred to the South East and Chatham section where it was apparently overloaded resulting in a fractured mainframe.

That was the last sentinel to be supplied to a UK railway although construction continued for export orders up until WW2. See Table 4.

Clayton Wagon Works Vehicles.

In 1927 a series of geared steam railcars was introduced by Clayton Wagons Ltd of Lincoln that was tested by the LNER. Trials were made between York and Whitby over the Scarborough Coast line and on the Newcastle to Ponteland branch. The design differed from the Sentinel vehicles in that the power bogie was four coupled with side rods with inside axle boxes. The boiler was at one end of the frame enclosed by the coachwork with a horizontal steam engine beneath the floor of the cab. The external water tank and coal bunker was at the front that had a certain amount of movement relative to the coach body. The boiler was similar to the Sentinel type except that it contained twelve rows of cross water tubes instead of eight. The Sentinel super-heater had five coils whilst the Clayton one had eight. The engine was a totally enclosed unit having two high-pressure cylinders of 6.75 inch diameter and 10inch stroke. The cylinders, crank case and the casting of the reduction gearing were bolted together to form one unit with the combined set supported at the gear end on bearings surrounding the main driving axle, while the other end was carried by a swinging link attached to a point midway between the cylinders and the crankcase, and fixed to spherical washers and rubber buffers to one of the cross bearers in the mainframe. This link was in such a position that it carried a large part of the weight of the engine that was thus spring borne. The engine had piston valves arranged below the cylinders to ensure drainage, and there were only two eccentrics, one for each cylinder that were mounted on a lay shaft driven by gearing off the crankshaft. To reverse the engine the eccentric was moved across the shaft from one side to the other. The lay shaft was hollow containing a sliding inner shaft in which notches were cut to form two inclined planes at right angles to each other, one for each eccentric. By moving the sliding shaft endways, the eccentric could be varied from full ahead to full reverse. The power bogies were directly related to the Clayton "under type" steam road wagon – the boilers and engines being the same. With the LNER trial of the first vehicle being successful, the Company ordered ten more, although all were withdrawn by the end of 1937. The Great Southern Railway of Ireland ordered six railcars in 1928. See table 5.

The Birmingham Railway Carriage and Wagon Company in conjunction with the Yorkshire Engine Company also constructed steam-powered railcars although none were used on UK railways.

When the railways were nationalized in 1948 only three remained – these were;-
Two LYR rail motors - LMS 10600 and 10617 of 1911.
One LNWR - LMS No. 29988 dating from the 1907-9 period.

Staffing of LMS Steam Railcars and Push/pull sets.

LMS Board Minute 2166 dated 19th February 1929 refers to the staffing of steam driven railcars following negotiations with the trade unions. It was agreed that on Sentinel and similar passenger cars the crew would consist of a driver and fireman only with no guard. On Sentinel and similar steam locomotives working trains on main lines the crew to consist of the driver and fireman, but when on shunting duties the engine was manned only by the driver with the rate of pay fixed at 12 shillings per day rising to 13 shillings. Petrol rail passenger cars were also to be manned only by a driver and petrol engines working in shunting yards also only with a driver, with a fixed rate of 12 shillings per day. Whilst on the subject of working arrangements the following minute 2167 dealt with “Push and Pull” trains not dissimilar to a steam railcar. Such trains would not carry a guard except in the following circumstances.

1. Where such a train is to work over important or busy sections of line.
2. Where such a train conveys luggage, parcels, mails etc should staff not be available at stations to undertake loading and unloading where those duties are necessary.
3. Where such a train is composed of more than three coaches, or of less than three coaches if any attaching or detaching cannot be performed by station staff.

It seems some designs were difficult to fire that could only be done when stationary, another class required a ‘passed fireman’ as the driver had no actual control over the engine when running in reverse consequently sending signals back to the engine for the fireman to carry out. A further difficulty was any maintenance required by the engine also took the coach out of service although some lines had spare traction units for the type 1 vehicles.

Routes served by LMS Steam Rail Motors.

The Axholme Joint Railway mainline ran from Marshland Junction, near Goole on the NER Hull-Doncaster mainline to Harvey Junction on the GN and GE Joint line between Doncaster and Gainsborough. The service was two 19½ mile round trips daily, with three on Wednesdays and five on Saturdays and ceased as stated on 15th July 1933.

So ended an interesting although not entirely satisfactory era of steam traction development to be easily eclipsed with the introduction of diesel and electric multiple units

Table 1. Pre-grouping allocation.

Railway	Year	No. Built	Type	Seating	Withdrawn
London & South Western Railway	1903	2	1	42	All withdrawn by 1919
	1904	2	1	40	
	1905/6	13	2	40	
Taff Vale Railway	1903	1	1	52	All out of use by December 1920 Inc. 2 spare engines
	1904	6	1	56	
	1905	6	1	44	
	1906	5	1	73	

Great Western Railway.	1903 1903 - 08	2 97	2 2	52 Varied 49 - 64	First in 1915. Last in 1935
Great Southern & Western Railway (Ireland).	1904	1	1	46	1912
Glasgow & South Western Railway	1904 1905	3	1	50	1916
Alexandra (Newport & South Wales) Docks Railway	1904 1905	1 1	2 2	52 58	1911 & 1917
Midland Railway	1904	1	2	?	?
Great Central Railway	1904/5	3	2?	56	Prior to 1923
Barry Railway	1905	2	2	50	1914
Belfast & County Down Railway	1905/6	3	?	?	1918
Furness Railway	1905	2	2	48	1918, one wrecked
Great Northern Railway	1905/6	2 2 2	1 1 1	53 57 50	1925/6
Great Northern Railway (Ireland).	1905	4	?	?	?
Great North of Scotland Railway	1905	2	1	45	1906
Lancashire & Yorkshire Railway	1905 1906 - 11	2 18	1 1	48 56	1909? 1928 to 1947
London, Brighton & South Coast Railway	1905 1905	1 1	1 1	40 48	Withdrawn & sold 1919
London & North Western Railway	1905/7	6 1	2 2	48 48	1948
Northern Counties Committee	1905	2	1	?	?
North Staffordshire Railway	1905	3	1	46	Sold in 1927
Great Northern Railway (Ireland)	1905 1906	3 4	2 2	? ?	1913 1913.
South Eastern & Chatham Railway	1905 1906	2 6	1 1	56 56	All out of use in 1919
Dublin, Wicklow & Wexford Railway	1906	2	1	55	Altered to Push/Pull within 12 months.
Isle of Wight Central Railway	1906	1	1	50	Withdrawn 1913 & sold.
Rhymney Railway.	1907	2	1	64	1910 & 1919
Port Talbot Railway	1906	1	2	66	Sold in 1920
Cardiff Railway	1911	3	2	64	c.1917
	Total	221			

Table 1 was prepared from many sources, some of which varied in detail, therefore accuracy cannot be guaranteed but it is sufficient to give a good indication of the pre-grouping situation.

Table 2 – Allocation of early Sentinel vehicles 1923 to 1929 – Chain Driven.

Railway	Year	No. Built	Seating	Withdrawn
Jersey Railway	1923	3	56	
Jersey Eastern Railway	1924	2	?	
London Midland & Scottish Railway LMS Dia. D1779.	1926/7	13	?	12 in 1935 1 in 1937

London & North Eastern Railway Dia.152 &153	1925	2	52	1940
LNER Dia. 88	1925	2	64	1942/4
LNER Dia. 89.	1928	20	20 had 59	1939/46
Cheshire Lines Committee	1929	4	?	10/1944
Great Southern Railway (Ireland).	1927	4	?	

Table 3 – Allocation of later Sentinel modified vehicles with gear or cardan shaft drive. 1928 - 1930.

Railway	Year	No. Built	Drive	Seating	Withdrawn
LNER Dia.90	1928	1	Geared	?	1947
LNER Dia 93, 96, 97, 98.	1928 to 1931	49	Cardan Shaft	49	1940 to 1947
LMS Dia. 1842	1928	1	Cardan Shaft	44	1939
LMS Axholme Joint Railway	1930	1	Geared	74	To LNER 1933 7/1944

Table 4. 1930 onwards.

Railway	Year	No. Built	Drive	Seating	Withdrawn
LNER Dia.100.	1930	1		122	5/1942
LNER Dia.98	1930	2	Gear & shaft	54	1941
Dia.159	1932	3		48	1939/41
Southern Railway	1933	1	Gear	44	Fractured Frame 1938

Table 5 – Clayton Built Steam railcars.

Railway	Year	No. Built	Drive	Seating	Withdrawn
LNER Dia. 91, 92 & 94.	1927/8	11	Geared	64	1932-37
Great Southern Railway (Ireland)	1928	6	Geared	?	?

Acknowledgments.

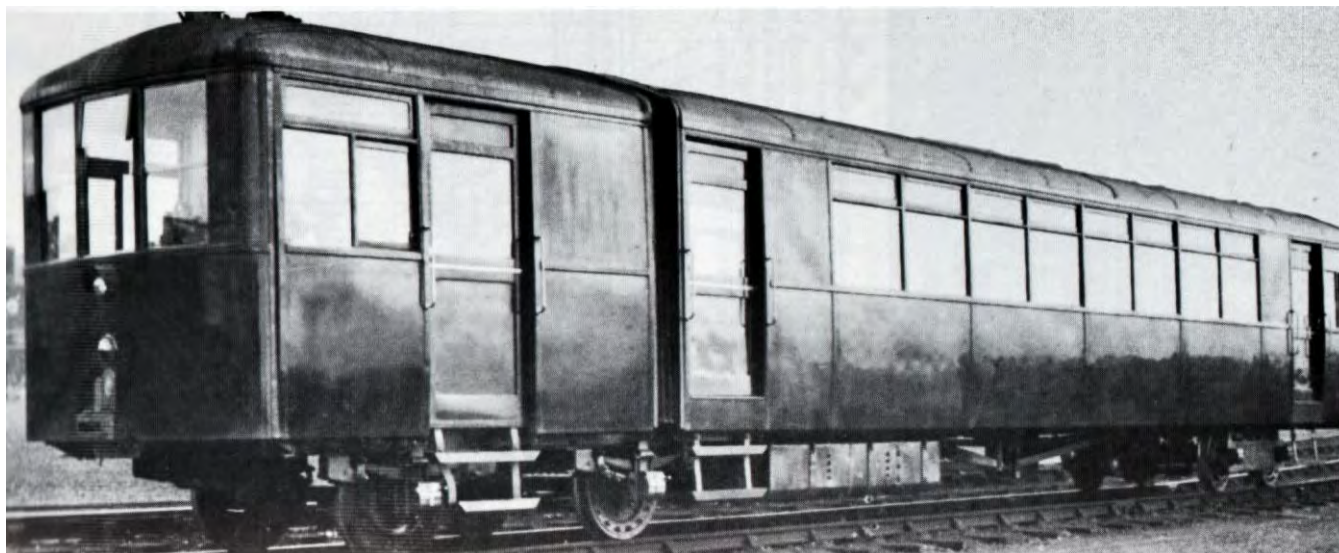
History of the Steam Driven Railcar by R. A. S. Abbott (The Engineer).

National Archives – Kew.

The LMS Coach – D. Jenkinson LNER. GWR and SR RCTS publications.

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Plate1.



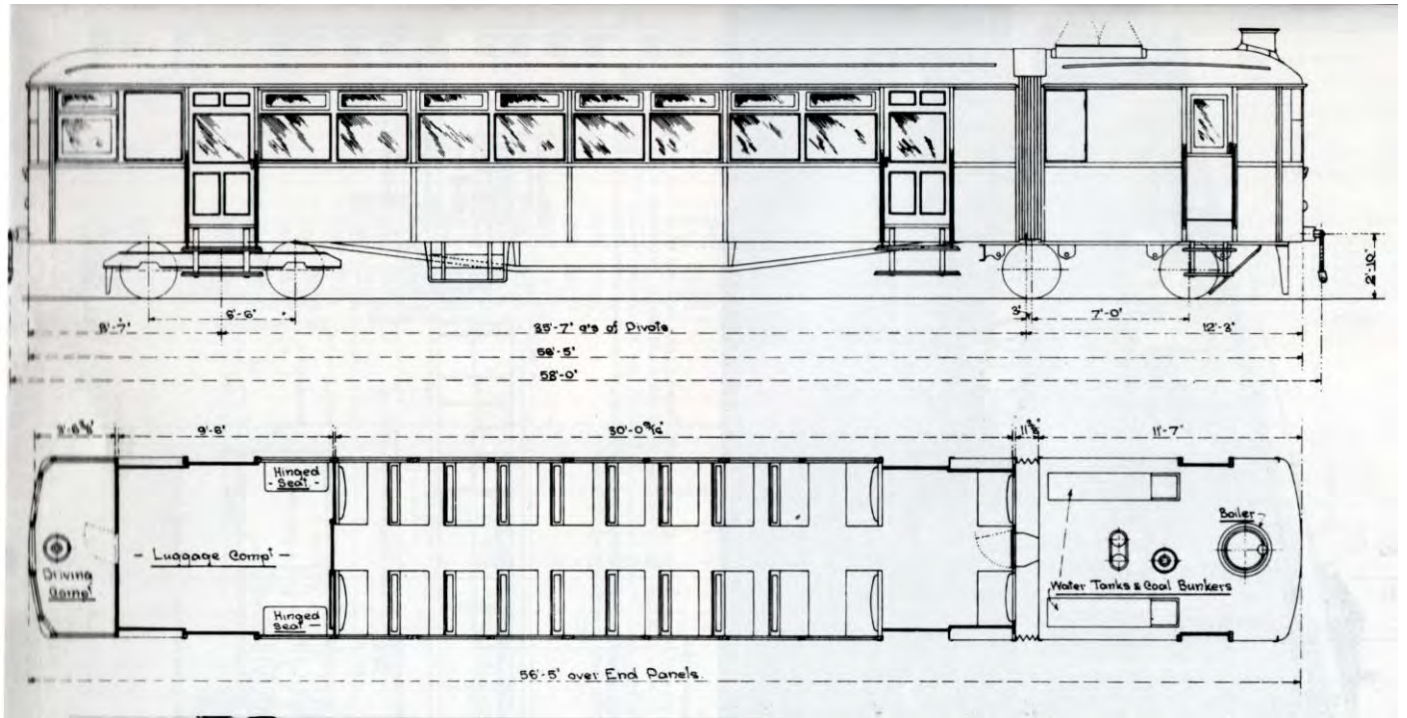
Sentinel / Cammell Steam Railcar D1778 of which thirteen were supplied to the LMS.

Plate 2.



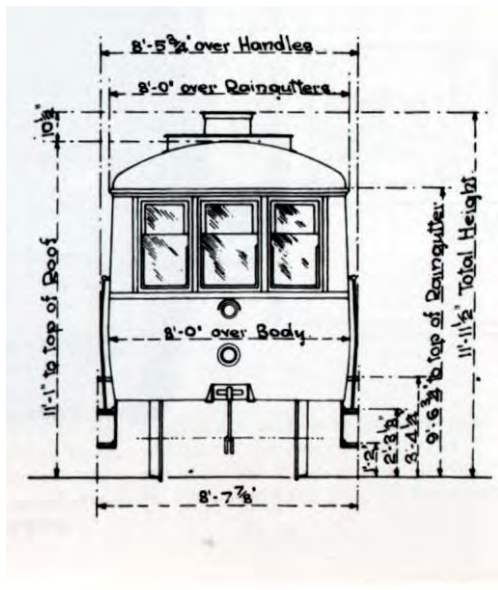
One of the first type of LMS railcar to Diagram D1779 at Perth in 1932 carrying the No. 2232.
T. J. Edgington Collection.

Fig. 1A.



LMS Diagram D1779. Side view and plan.

Fig. 1B.



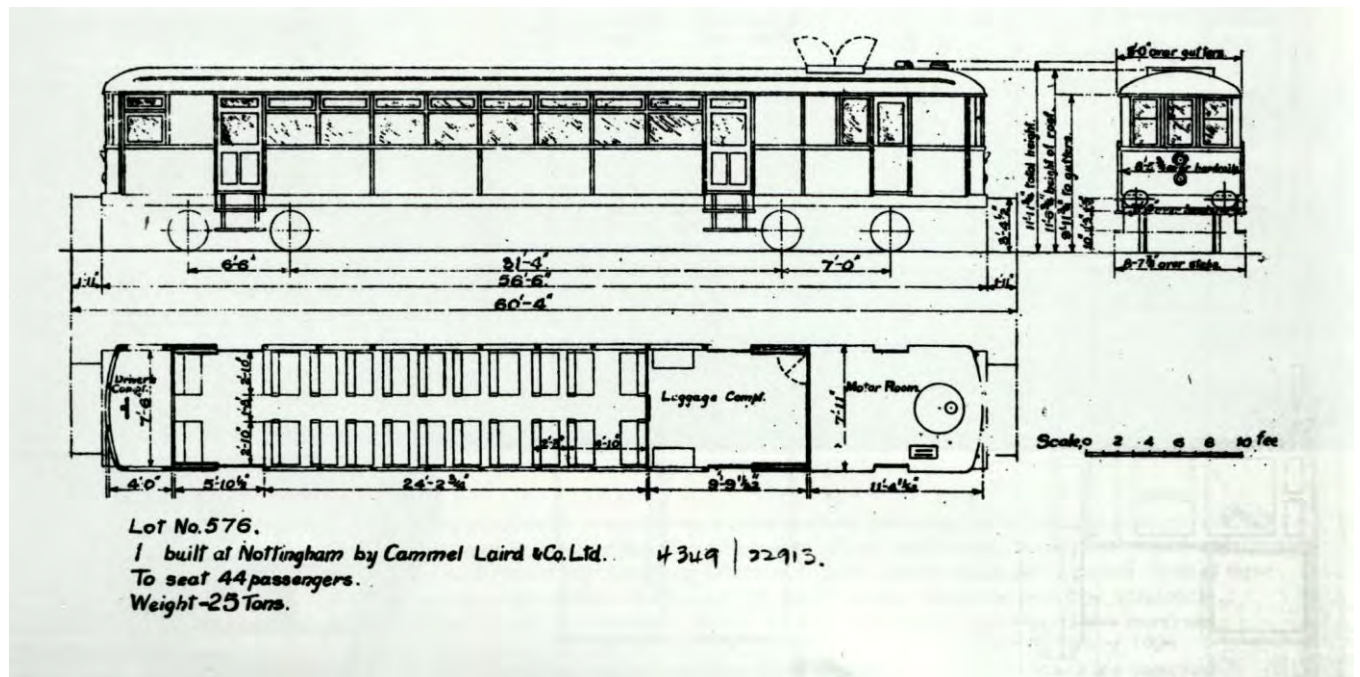
LMS diagram D1779. Front view.

Plate 3.



Improved Sentinel/Cammell Railmotor D1842, only one supplied.

Figure 2.



LMS diagram D1842.

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This monologue belongs to a series produced by members of the LMS Society to provide a background to the activities and achievements of the LMS Railway during its existence from 1st January 1923 to 31st December 1947

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*Published by
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"Aldbrough Cottage",
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Taunton TA2 8RF
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October 2017.

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