City & South London Railway

Brush Carriage No.163

REALIZATION REFERENCE BOOKLET

by Doug Rose

to be read in conjunction with

DRAWING 1 – EXTERNAL APPEARANCE

DRAWING 2 – INTERNAL APPEARANCE

DRAWING 3 – ROOF and UNDER-CARRIAGE

AND

DRAWING 4 – DETAIL ENLARGEMENTS

PUBLISHING DETAILS
This booklet and accompanying drawing set are unpublished on paper and produced in this form solely for the benefit of the London Transport Museum as a historical record of carriage no.163.

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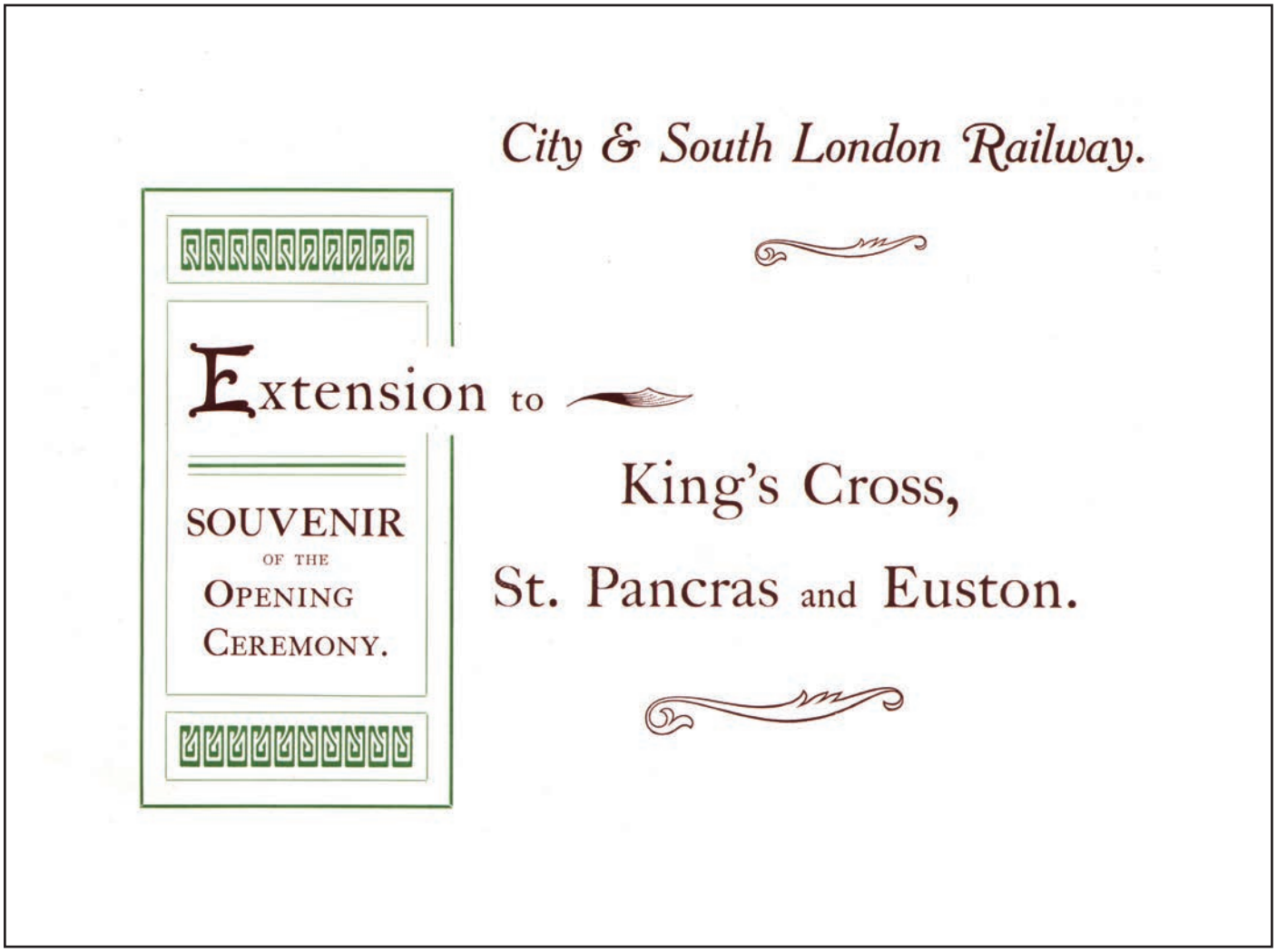
FURTHER READING
As mentioned above, the principal source of information on Brush carriage 163 is R J Greenaway, ' "Storiesend", or Just the Beginning? – the Saga of C&SLR No 163', *Underground*, the Journal of the London Underground Railway Society, Vol XIV No 1, January 1975, pp. 5-13. For further information on the C&SLR readers are referred to *The Amazing Electric Tube* by Printz P. Holman, published by the London Transport Museum in 1990 to commemorate the 100th anniversary of the opening of the railway. For a more detailed history of the Northern Line generally, including the re-construction of the C&SLR tunnels in 1922/23, readers are referred to *Reconstructing London's Underground* by HG. Follenfant (London Transport, 1974); *The Northern Line: A Short History* by MAC Horne (Douglas Rose, 1987); *The First Tube* by MAC Horne and Bob Bayman (Capital Transport Publishing, 1990); *Rails Through the Clay* by Desmond F. Croome and Alan A. Jackson (Capital Transport Publishing, 2ND edition 1993).



EXTENSION SOUVENIR

A 32-page promotional booklet 7¼ x 9½ inches (184x244mm), was produced for the opening of the extension of the C&SLR from Angel to Euston on 12th May 1907. The title page is reproduced here at three-quarters of published size.

THE CITY & SOUTH LONDON RAILWAY 1890-1923

Originally known as the City of London & Southwark Subway, the company received Royal Assent in July 1884 to build and operate a cable operated passenger service in tunnels between Elephant & Castle and King William Street. In July 1887, eight months after construction commenced, permission was granted to extend southwards to Stockwell. Following a decision to adopt electric traction and plans to extend the route even farther, the company changed its name to the City & South London Railway (C&SLR) shortly before opening on 18th December 1890.

Being the first deep-level 'tube' railway in the world, there were no established standards to adhere to. The tunnels from King William Street to Elephant & Castle were built to a diameter of 10 feet 2 inches, and Elephant & Castle to Stockwell 10 feet 6 inches. A subsequent extension allowed the service to be diverted northwards through new 11 feet 6 inch tunnels from Borough to Moorgate Street on 25th February 1900, following cessation of service to King William Street and the abandonment of that terminus on the previous day. Further extensions opened to Clapham Common on 3rd June 1900, Angel on 17th November 1901 and Euston on 12th May 1907; all had 10 feet 6 inch running tunnels.

The Euston extension was the last passenger carrying tube line to be built in London to a size below the minimum 11ft 8¼ inch diameter that became a standard on all other railways in the capital from 1900. This meant that locomotives and carriages had to be designed to fit the small C&SLR tunnels, and no rolling stock from other lines could be used on the railway.

Changes began in 1913, when the Underground Electric Railways of London (UERL) took the C&SLR into its ownership giving it control of most of the deep level railways in London. In order to create an integrated system, it planned to extend the C&SLR to join the Charing Cross, Euston & Hampstead Railway (CCE&HR) at Camden Town. Early attempts to enlarge the small C&SLR tunnels were halted by the First World War. Work re-commenced on 16th June 1922, eventually enabling the use of standardized rolling stock and joint operation of through services on both lines.

Though services ceased between Euston and Moorgate in 1922 an attempt was made to keep the rest of railway operational during the reconstruction, with trains running through the tunnels during the day and enlargement work taking place at night. However, the cave-in of a tunnel roof during traffic hours on the evening of 27th November 1923 caused the collapse of the roadway at street level. This forced the railway to cease passenger services completely the following day, spelling the end for existing C&SLR rolling stock.

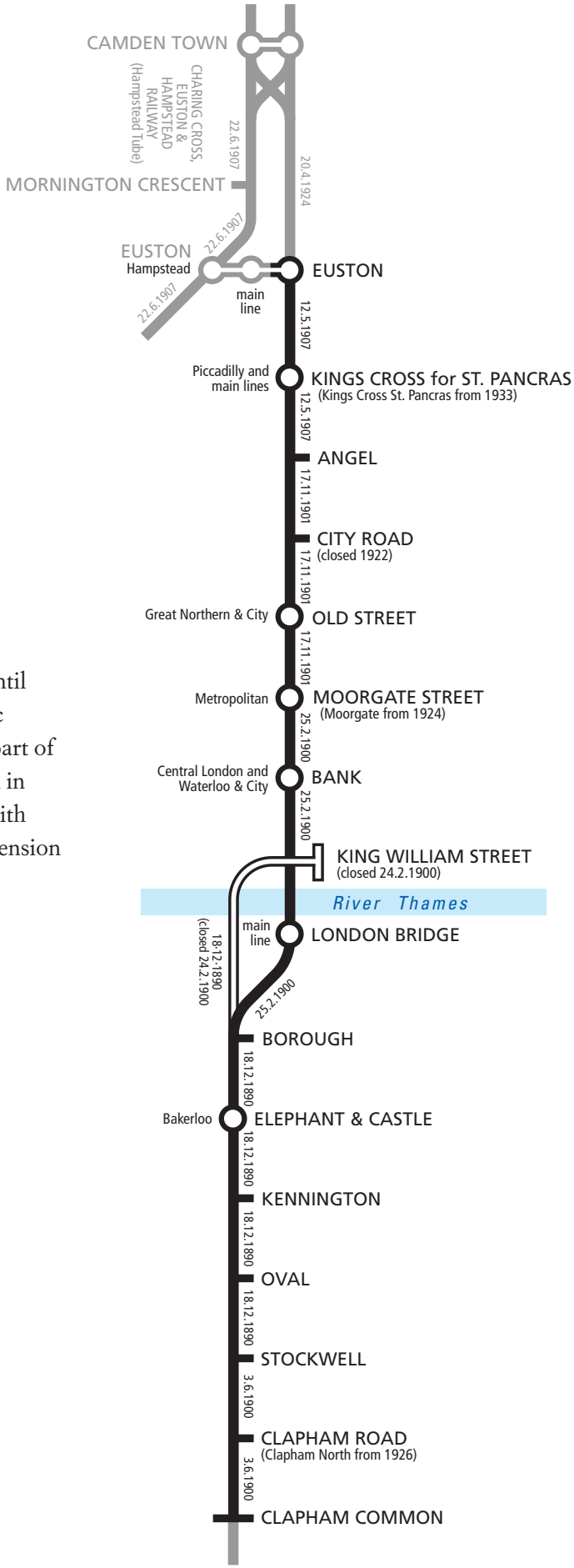
Many carriage bodies were lifted from their bogies and sold for use as garden sheds, summer houses, changing rooms and residences. They were replaced by new trains when the reconstructed tunnels and extension to Camden Town were opened on 20th April 1924, connecting the railway to the CCE&HR. Today the CCE&HR forms the Charing Cross branch and northern sections of the Northern Line, while the C&SLR forms the Bank branch and the line to the south of Kennington.

THE CARRIAGE FLEET

During the life of the C&SLR as an independent company, electric locomotives hauled trains of three carriages from 1890, four from 1900 and five from 1907. Being entirely in tunnel, conventional sidings and run-round loops were deemed impractical and so a different means

CITY & SOUTH LONDON RAILWAY HISTORICAL DIAGRAM

Extent of the railway from opening until takeover by the Underground Electric Railways of London Ltd, to become part of its London Electric Railways network in 1913. The diagram also shows links with other railways and the subsequent extension to Camden Town.



of reversing trains was adopted, enabling a locomotive always to be at the front.

The original plan was to build a cable operated line between King William Street and Elephant & Castle, ending at termini with a single track flanked on either side by arrival and departure platforms. Though more restrictive in operational terms, this was the most practical option for this form of motive power. With cable traction having been abandoned in favour of electrical operation, and with an extension beyond the Elephant & Castle approved and under construction before the line opened, it was possible to alter the design of the new, unbuilt terminus at Stockwell.

Although King William Street was still completed as a single track station, Stockwell was opened as an island platform with two tracks for greater capacity and flexibility. The limitations imposed by the layout at King William Street were rectified in 1895 when the station was altered to two tracks before being abandoned in 1900.

By the time the Brush carriages entered service in 1907, all of the stations on the railway where trains could be terminated were double track.

Hauled by electric locomotives, wooden framed trailer carriages came from a variety of builders: Ashbury Carriage & Iron Co. (numbers 1 to 30), G.F. Milnes & Co. (31 to 36), the Bristol Carriage & Wagon Co. (37 to 39), the Oldbury Carriage & Wagon Co. (40 to 46), a further batch from Milnes (47 to 54), Hurst Nelson & Co. (55 to 84), Milnes again (85 to 87), Milnes (88 to 108), Bristol (109 to 124), Milnes (125 to 132), and the British Electric Car Co (133 to 140).

For the Euston extension, the Brush Electrical Engineering Company supplied so-called ‘all steel’ carriages with a steel and teak flitched beam construction, sheet metal outer panelling painted brown and with teak mouldings. Brush carriages were built in two batches, during 1906/07 (141 to 155 for three 5-car trains) and 1907/08 (156 to 165 for two 5-car trains). Though substantially looking the same, there were detailed differences between the batches and this might be why the first batch cost £516 each and the second £632 4/-. (‘4/-’ was how four shillings was written and there were twenty shillings in a pound.)

BRIEF HISTORY OF CARRIAGE No.163

Little is known of what use, if any, carriage 163 had on the railway after its withdrawal from passenger service. However, in 1926 it was sold to a private individual and was transported, less bogies and gated platforms, from Stockwell to a field in East Molesey, near Hampton Court station. There it was mounted on the chassis of a Tilling-Stevens petrol-electric bus of about 1908, though it may possibly have been towed all the way from London on this chassis. At East Molesey the carriage had some significant modifications in the form of a balcony added at one end and a felt-covered pitched roof spanning the entire structure. Internally, various ‘home comforts’ were installed.

For nearly forty years 163 was used for weekend and holiday accommodation. The original owner sold it in 1935 to Mr J L Nayler who was still the owner when in 1974 the Thames Conservancy’s proposals for widening the nearby River Mole and River Ember to alleviate flooding in the area were approved. 163 had to be moved and Mr Nayler and his family, who did not wish to see it demolished, sold it to the London Underground Railway Society (LURS)

for a nominal sum. London Transport provided the resources for its removal and between 12th and 16th September it was transported to Ruislip depot.

In 1977 Ruislip depot also became home to an older C&SLR carriage acquired by the LURS, no 135 dating from 1902. Though the LURS made some progress with the restoration of 163 it proved too big a task. Both carriages left Ruislip for the Electric Railway Museum at Coventry on 29th June 2000. That museum unfortunately closed permanently in October 2017 and, with no new owner coming forward, the London Transport (LT) Museum assumed ownership of 163 and on 19th June 2018 took it to its final resting place, at Neasden depot.

DRAWINGS REALIZATION METHODOLOGY

Having endured a permanent outdoor environment for which it was not designed, for nearly one hundred years, it was in very poor condition. The basic framework and chassis were still in reasonably good repair but most of the rest was not. Despite being of historical constructional importance, its fate was sealed when Neasden depot wanted it removed by the end of April 2021. If the LT Museum could not find it a new owner, the alternative would be a visit from the angle grinder and a final trip to the re-cycling centre.

The Museum had the vehicle assessed by specialist consultant/conservator Tim Martin of Content Engineering, to determine possible options, but almost a hundred years of an open-air life for which it was not intended, showed it to be well beyond rescue. Before anything irreversible would follow, the Museum had the carriage 3D scanned at very high resolution, though it could only record what had survived – in reality not very much.

On 18th February this year I received a request from Katariina Mauranen, Senior Curator, Vehicles & Engineering at London Transport Museum (henceforth 'Kat', as she prefers to be called), asking if I could create a scale drawing of what 163 might have looked like in happier days when in service. She sent me a photograph of it taken at the Electric Railway Museum and told me that it had deteriorated further since then. I have quite a lot of experience of doing this sort of thing for LT buses but have not so far attempted railway rolling stock. This is not the place for a detailed description of the methodology I use, but if anyone is interested there is an explanation (and a lot of bus drawings) on my website at:
www.dougrose.co.uk/index_bus_drawings.htm

Fundamentally I need measurements. Vehicle manufacturers routinely produced general arrangement (GA) drawings before construction. Such drawings provided a general guide to the overall layout of all manner of buses and trains (and other vehicles). They were intended to be used in conjunction with larger detailed drawings of specific features. Though GA drawings were to scale, they did not need to be as large or as accurate as those used when producing parts. They could also fail to record some, or all, of the periodic revisions that could be introduced during the manufacturing process.

It is tempting to think that all I would need to do would be to trace over the top of one, but life is seldom that simple. As the term implies, a GA drawing is 'general'; there is insufficient detail from the uncoloured skeletal linework to do a detailed realization. With little hope of such a drawing surviving anyway I was resigned to having to take hundreds of measurements of the carcass at Neasden and effectively reverse engineer from that. The interior would be impossible to re-create as almost none of it had survived.

Before a visit to Neasden was arranged, and in fact even before I responded to Kat I rang my friend Printz Holman. Printz wrote *The Amazing Electric Tube*, has studied the Railway since the 1960s and has enough information, and far more importantly the ability to dissect and interpret it meaningfully, than anyone else on the planet. We hope for a massive tome on the subject one day; the 1990 book was produced somewhat hurriedly, but remains the definitive work to date.

I should not have been surprised when Printz said over the phone – 'carriage 163 you mean then?' I then got about an hour about 163, its personal history, and Brush carriages in general. It was quickly apparent that my knowledge was trivial compared with his and I was both delighted and relieved that he suggested he meet Kat and I at Neasden. This occurred on 16th April, when I took 133 detailed photographs

At the very far end of the depot where 163 was parked Printz reached into his bag and handed an envelope to me – it contained a pair of overlapping A3 microfilm printouts of a Brush carriage GA drawing. That was a surprise and would potentially save hours and hours of painstaking measurements. That said, I did take several measurements to check later against the GA drawing, as the scale was indecipherable.

Printz kindly lent me the drawing halves, which I scanned and re-assembled as one. From the check measurements I had taken on site and some of the discernable ones stated on the GA drawing I now knew the original was at a scale of one inch to the foot (1:12) and so I enlarged it to that to use as a base from which to start work.

I had briefly explained to Kat when at Neasden, that the 'by the end of April' deadline was going to make it all but impossible to draw anything meaningful. An average bus drawing, excluding research time to add the level of detail not on a GA drawing, takes about seventy hours. Furthermore, 163 in its present state had far more missing than surviving; filling in what was no longer there was going to take a lot of time and help from Printz. There was no way I was going to be able to complete an accurate drawing with just one visit to Neasden. As soon as the drawing got under way, all manner of minutiae became apparent that I simply didn't know about, and the list of queries gradually lengthened.

Owing to the time restriction I spent about fifty hours on the drawing and then arranged a return visit on 30th April to try and resolve the queries. A further 107 photographs were taken, as with first set, mostly close-up detail of metal and wood joinery.

As referred to above, the Brush carriages represented an important step in carriage design. Apart from the chassis of earlier carriages naturally being made of metal, the bodies were largely timber framed with metal panelling. The Brush carriages became known as 'all steel', though this was a bit of a misnomer, actually being of 'flitched beam' construction.

Flitched beams can be either square section 'U' or 'L' shaped steel, with timber inserts, in this case using teak hardwood. The overall structure is therefore very strong and lighter than if more substantial metal only was used. That said, it made the construction more complex in that the metalwork needed welding, riveting and/or bolting, as well as much timber joinery.

The second visit to Neasden on 30th April, and a further 107 photographs, helped resolve

most of my queries, though inevitably then raised a load more. There was so much missing. Fortunately I have some experience of woodwork and could understand how the joinery had been done on most of the carriage. The flitchwork did however complicate a lot of it as 2-inch 'U' shape was extensively used, as well as some aspects being both 3-inch, 2-inch and 1¾-inch 'L' shape. The clerestory 'U'-shaped beams added to all this where they met the 'L'-shaped upper horizontals of the main structure and the vertical 'U'-shaped verticals from roof to floor level.

Armed with more information work continued on the drawing, which by now had grown in to two, in order to clarify various joins at 1:6 scale. It was about to become three as Printz had now sent me some really useful historical photographs he had, of both exterior and interior views when in service. These enabled an attempt at a third drawing.

As all historical researchers soon find out, for every problem resolved new ones emerge. The photographs were helpful in so many respects, but all historical reference information must be interpreted very carefully, taking into account the purpose for which it existed in the first place, and the context of its time.

What we now had were: a GA drawing prepared before the two separate batches of Brush carriages were built; a good quality photograph of the exterior of a carriage from the first batch; a good quality photograph of the interior of carriage no.142, also from the first batch. However, carriage 163 was from the second batch and it is known there were differences between the batches, most notably in that the first batch cost £516 each and the second about £632. Furthermore, the GA drawing was in itself a contemporary tracing from the original and both Printz and I, coming from backgrounds of being draughtsmen, had spotted one or two errors in the draughting.

I had worked out most of the window and exterior mouldings joinery but really needed another visit. How much my request for this delayed things I don't know, or perhaps the end of April was as arbitrary as it sounded, but I went to Neasden again on 11th May and brought back another 119 photographs. I had asked Kat if I could remove some parts. As the whole thing was going to be scrapped the answer was 'take anything you like'.

Armed with tools I was able to remove most of the screws that were holding one of the better surviving window frames with a screwdriver, though a few needed rather less subtle methods. Printz requested I get a sample of the metal panelling below window level, which I did, though only two of the original sixteen were still there.

He also wanted samples of the 'lito-silo' floor. This is a form of concrete composite largely composed of whiting, cork dust, iron oxide and cement, and widely used by railway carriage and ship builders at the time. This was laid on top of the corrugated sheeting of the chassis floor. Carriage 163 had teak slats fixed on top of this, though the contemporary interior photograph of 142, from the first batch, did not. We don't know if this was one of the differences between batches or if 163 had the slats added later. It's all interesting stuff.

The visit to the Post Office to send Printz the samples the following day provided a little amusement. The only box I had suitable for the lito-silo samples had a 'Fragile' sticker on it, and the lady behind the counter wanted to know what was in the large stiff flat packet. My answer was 'It is a sheet of metal from 1907' – there was no reaction.

In the past Printz has had material samples analysed to try to establish the original paint colours. This was strongly thought to be brown on 163, though the exact colour and shade were unknown. As it transpired, the sample revealed several layers of modern coatings over rusted base metal and no original paint was found.

Also retrieved and sent to Printz were some of the few surviving strips of leather I had removed from a window frame. These were inserted either side of the glass, within the groove formed by the construction of the frames. As with buses of the time, rubber had not really made a widespread appearance and leather was both good for keeping the weather out and also reducing glass rattling.

After the line's final closure in 1923, the substantial parts of the carriages that had any monetary value, such as bogies, pipework and air tanks, were removed and sold. As happened to 163, a few of the bodies were disposed of to become farm dwellings, sheds and the like, which explains why the subsequent life of it, eventually finishing at Neasden, was resting on the ground with no wheels.

This provided another tranche of questions to be answered for the drawing. The bogie rollers (enabling a rigid body to negotiate bends in the track as bogies steered) were still in place, but the photograph of a first batch carriage showed a different arrangement – remember, the only evidence we had of a second batch carriage was 163, in its dilapidated state.

I was very keen to get the carriage turned on its side before disposal now, and hurriedly enquired if it had been cut up yet. Fortunately it hadn't and a fourth visit occurred on 21st May, the depot staff having obliged by tipping it over. Another 79 photographs (thank heavens for high-quality digital cameras), and more measurements were taken, this time capturing underside and roof detail and resulting in a fourth drawing being planned.

By the time the close-up detail second drawing had been progressing, it became clear that I needed to keep notes of why I had drawn things the way I had. Respectable history books state extensive references as to from which sources the author has interpreted the facts. I felt this was becoming essential for the drawings to have any credibility. This provided a worthwhile distraction from the analysis of the ever-growing source material gained from the four visits; I of course now had accumulated much photographic evidence as well as the historical material provided by Printz. A booklet started to emerge.

On each drawing, a reference number has been placed where clarification of a particular point of detail was needed (these reached 130). Also on each drawing is a panel of text explaining any overall points and where and why any detail has been deliberately omitted. An example of this is the pipework that ran along each carriage, and connected to the adjacent one, to feed compressed air from the locomotive to operate the brakes. It is known that the way the pipes were routed on carriages varied and all this had long since gone from 163. Also missing was the Westinghouse brake equipment and the auxiliary air reservoir. Rather than engaging in guesswork to add these features to what I hope is an accurate and authorative set of drawings, Printz and I quickly decided they should not be shown. We have only included what our consciences are comfortable with.

As noted, the bogie rollers still on 163 were quite different from the arrangement on the carriage in the photograph from the first batch. It is of course possible the two batches of

Brush coaches were built differently in this respect, and for the purposes of the realizations of 163 I suppose it doesn't matter. However, the GA drawing (pre-production) showed a similar configuration to 163 (second batch and as withdrawn from service) and the photograph from the first batch was very different from both, though the photograph of the first batch carriage (we don't know its fleet number) might have been modified, as the picture dates from 1921/22, right near the end of its life.

In order to try and shed some light on this, Printz visited the National Tramway Museum at Crich, Derbyshire, on three occasions, to look at some contemporary tram bogies. Although similar technology was identified, it appears to have been used in a different way on tramcars and it was therefore not possible to reach a definitive conclusion.

The project has taken me in excess of 300 hours and probably a similar amount by Printz. His subject knowledge and help has been truly invaluable and I could not have done it without him.

The carriage was cut up and scrapped during the week commencing 12th July 2021.

The result of this project are three orthogonal colour realization drawings at 1:12 scale. One shows side and doorway elevations, both as skeletal framework and as a finished exterior; the second is similar but of the interior; the third depicts the roof and underside; the fourth is of particular constructional detail with orthogonal aspects at 1:6 scale and some further depicted axonometrically. Accompanying these is this reference booklet which includes introductory text and over a hundred general and close-up detail photographs, as well as the historic ones used to make some interpretations. This booklet and four drawings have been presented to the LT Museum's library. It is also viewable in electronic form on my website: www.dougrose.co.uk

PHOTOGRAPHS AND DRAWING REFERENCE CODES

The following pages contain a selection of the photographs, that demonstrate particular aspects of the carriage's construction, and which provide evidence from which the realizations could be done. Also included is a selection of historical images that were used for reference, together with details of where they were sourced. As the trains were never turned on this predominantly north-south railway it is convenient to refer to the carriage sides by their compass point. At Neasden the west side was more accessible than the east, as can be seen in the photo on the front cover.

Each entry has a three-part code comprising: the Reference number (in a blue block); the **D**rawing number referred to (some to more than one drawing); my own **P**hotograph number.

Many areas of the carriage were not practical to inspect for detail of construction. Readers are encouraged to consult the notes panels on each drawing where areas of uncertainty are listed and explained.

GENERAL ARRANGEMENT DRAWING (see Ref 105)

The GA drawing we have is of the first batch of Brush carriages, whereas no.163 was from the second. It is known there were differences in the design and/or specifications of the two orders; furthermore, the GA drawing we have was produced before construction began, and there appear to be differences between it and the carriages as built. Also of important note is

that Printz and I both found a few minor draughting errors in that drawing, which was a contemporary tracing of an original. As with all source material for historical research, one has to interpret it with caution and understand its context.

CONTEXTUAL NOTES FOR REALIZATIONS OF CARRIAGE 163

A decision had to be made as to the time period in which the depiction of the carriage should be set, and it seemed sensible to use the date that it was withdrawn from passenger service. This was logical as the primary source was the *remains* of a carriage seen in *a* condition that it reached *sometime* after leaving *operational* service. Nevertheless, if I only drew what was seen at Neasden, any illustration created was going to be very strange. It was therefore necessary to add a number of features that were believed to be on the carriage while it was in passenger service. This list included the bogies, doors and handles, circular ventilators on the end doors, hand straps, light fittings, and the steel panelling and wood framing that had rusted or rotted away.

Though only on the GA drawing in sketch form, the bogies have been added as best my conscience allowed, interpreted from Reference 109. The carriage would also have required a brake cylinder, triple valve, auxiliary reservoir and associated pipework throughout its working life. As an amount of uncertainty surrounds the exact location of these, they have been omitted from the drawings, but see Refs 98 and 104.

The routeing of the pipework along the carriages is known to have varied, as may have the position and physical connection between the pipework and the hoses, but the actual connecting hardware between the carriages was standard. This was really important as all locomotives and carriages had to be able to connect to each other to form a continuous air line through the length of the train and that line was expected to function in a consistent way if a carriage or carriages broke away from the train during service. This was and still is a major safety requirement on all railways. As uncertainty surrounds the precise route that the pipes followed along 163 they have been omitted from the drawings.

For context, it is necessary to try to identify the date of removal of any fixtures and fittings that have disappeared. The bogies are relatively simple; these were in place for the entire operational life of the carriage. This is definitive: the carriage could not have functioned without bogies. We also know that the carriage bodies were sold after recoverable items and scrap metal was removed. Along with the bogies, this included the brake cylinder and some of the brass door handles although at least one of the door handles survived on this carriage. That door handle is a good example of something that stayed with the body only to be removed 'sometime' after leaving operational service. It was certainly on the carriage when the LURS acquired it. It had gone when Printz saw the carriage at the Electric Railway Museum in 2006, as had the ventilator grilles and the decorative frosted door glass. In the case of the glass, we know for certain that this was removed while the carriage was at Ruislip depot, because its loss was noted by the LURS.

Doorway glass etched with a company monogram.

Things are not so simple when it comes to the hand straps. While photo U821 (Ref 110) is not of 163, or from the second batch of Brush carriages, we can see that at least one strap is missing on a carriage that appears to have been prepared for the photographer. Closer inspection suggests that one of the straps is a replacement (or maybe that is an original and the others are replacements?). Also of note are the retaining brackets for the wooden bar from which the straps hung. These are significantly different in outline and mounting height on the photo when compared to the GA drawing. If, as is likely, items such as door handles and mounting brackets were manufacturers' standard stock fixtures, it is reasonable to assume that the brackets depicted in the photo may have been used on the second batch of carriages.

It is difficult to know what was added to the carriages, what was removed and/or when it happened. Printz is reasonably certain that the thin bar across the inside of two of the widows was a later addition. He saw it on earlier C&SLR carriage bodies from other manufacturers, which suggests that if it was standard across the fleet by 1907, it would have been on 163 from new, which appears not to have been the case. His thoughts are that it was for a non-stop board, which would date it to the introduction or post-introduction of non-stop trains early in 1913 and would explain why it is not on the GA drawing.

Printz does not think that there are many major items that were added or removed between 163 being introduced and its withdrawal around 15 years later. The Brush carriages marked the end of an evolutionary chain that started in 1890 at a time when there was no previous experience in designing rolling stock for use on tube railways or any concept of what would be required. By refining and improving the design between each order for carriages, and adapting ideas contributed by a number of different manufacturers, the template for the perfect C&SLR carriage was almost complete by 1906 when Brush came into the picture. No major changes were needed, except to introduce alternative materials that it was hoped would simplify construction and improve safety.

Although the Brush carriages marked the ultimate in design for locomotive hauled trailers on the C&SLR, the company would eventually be forced to fall in line with other tube railways who were following a completely different route in train development, thus ending the operational life of no.163.

1 D1: P0656

2 D1: P0598

3 D1: P0805

4 D1: P0687

Wooden slats fitted on top of lito-silo base above a corrugated metal floor. (Lito-silo is a pseudo concrete largely composed of whiting, cork dust, iron oxide and cement.)

5 D1: P0658

Floor slat end tread over lito-silo, also showing vertical teak moulding and lower door runner.

6 D1 D2 D4:

7 D1 D2 D4:

8 D1 D2 D4:

The overhead metal runner is clear of the teak mouldings and supported by six short horizontal metal posts secured from inside.

9 D1 D2 D4:

10 D1 D2 D4:

Collets were fitted around the bolts to a fix the distance for the runner clear of the mouldings.

11 D1 D4: P0760

12 D1 D4: P0651

Above: the mid-height door runners as seen from the exterior, with their related door stops above them. Below: the mid-height door runners as seen from the interior, showing the reinforced metal support plates.

13 D1 D2: P0767

14 D1 D2: P0763

15 D1 D4: P0854

16 D1 D4:

Oblique views of a pair of mid-height door runners. These metal runners guided a grooved wheel beyond the outer vertical of the door frame. The groove of the wheel sat with one flange inside the runner and one outside. The door stop bracket can be seen above the runners.

17 D1: P0647

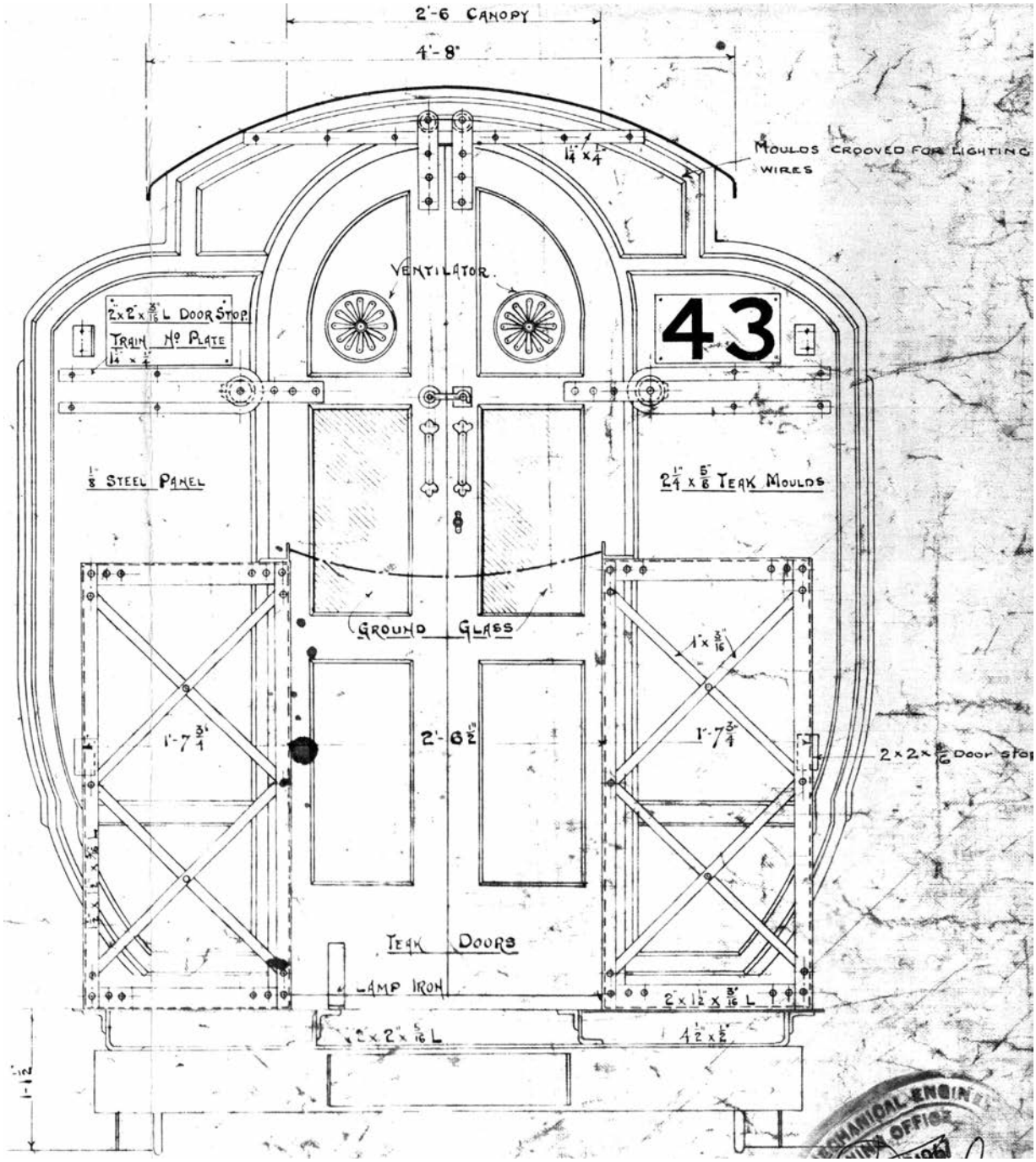
18 D1: P0753

19 D1: P0758

Three views of the lower runner. The teak doors had a groove along the undersides of their horizontal frames. It has not been established if these had any form of metal lining, though it is likely. It can be seen that this lowest guide runner is apparently uniformly distorted outwards in the middle, with what looks like a stabilizing metal plate behind. This might be a consequence of interference by later owners as the doors could not have slid properly like this. Both ends of 163 were like this at Neasden.

See also Refs 101 and 109.

20 D1



The doors had been removed by the time the carriage arrived at Neasden. The handles, hasp & staple and right-hand door lock detail have been derived from the general arrangement drawing.

The train number and set number (set '43' in the illustration above) only appeared on the end carriages, of which no.163 was not one. Note: The set number was a number given to each new semi-permanently coupled train of carriages. The number generally remained with a set throughout its life, although some changes were necessitated when sets were reformed to extend train lengths to offer extra capacity. See also Ref 105.

21 D1 D4: P0613

Flitched beams formed the main side structures. Below the window frames can be seen the square section upside-down 'L'-shaped 2-inch flitched beam. The lower beam, supporting the floor, was of 3-inch 'L'-shaped construction, also with its flat edge on top. The top beam (above the window and not in this photograph), was also 'L'-shaped, with its flat edge at the bottom. The verticals were a two-inch square section 'U' shape and all with teak inserts. The mid-height horizontal beam had corner brackets inside and fixed to the uprights. The lowest beam had three-dimensional brackets above it, serving the same purpose.

22 D1: P0775

23 D2 D4: P0776

Above: The internal square brackets can be seen securing the continuous vertical to the horizontals abutting either side. Very rusted metal fillets were apparent on all four sides between the window frames and flitches. Right: The same joint from the inside.

24 D1: P0613

The three-dimensional brackets, one each side of the vertical, above, seen from exterior and below, as seen from interior.

25 D2 D4: P0613

26 D1: P0635

27 D2 D4: P0844

Exterior and interior views showing the vertical outward upward curve from the floor. The steel floor reached the outer edge of the lower 'L'-shaped flitch beam and was cut around the brackets.

28 D1 D4: P0772

29 D1: P0586

30 D1: P0607

There was evidence of metal fillets between the flitched beams and all four outer edges of the window frames, though their purpose remains undiscovered. When mouldings were in place these were not visible.

31 D4: P0635

32 D4:

General view of window frame complete from inside for comparison.

Window frame, showing internal and external joinery and the resulting slot for window glass, which had a leather strip within the groove on both sides.

33 D4: P0833

Bottom right-hand of window frame as seen from outside, but showing the window ledge (dislodged) inside.

34 D4: P0655

Panelwork inside both doorways was largely in place and made inspecting the structural wood and metalwork behind them impractical.

35 D4: P0833

Detail of teak moulding outside and on inner doorway surround. The inner doorway frame and arch above were square section 'L' shaped mouldings of 1¾-inch width (seen from inner edge).

36 D2: P0813

37 D2: P0690

Above and right:
Joinery at upper corners, showing the interior of a window, the window ledge, and mirror frame fitted either side of the doorways.

38 D2: P0796

Below mirror frame level, showing metal cross member connecting the doorway upright and vertical 'L' shaped flitched beam; the joinery of the seat frame ends and leading edge are also shown.

39 D2: P0943

40 D2: P0944

The four interior corners of a doorway end mirror frame, showing the inside of the exterior metal panelling, and reinforced plate with its bolts for the exterior door runner. The external teak flitched framework created a void between the inside of the metal panelling and the rear of the mirror glass.

41 D2: P0942

42 D2: P0941

43 D2 D4: P0801

Detail of joinery showing internal window frame and window ledge at junction with the carriage's central draught screen.

44 D2 D4: P0796

Detail of joinery showing an internal window frame and window ledge midway along.

45 D2: P0932

Interior of a removed window frame. All four sides of the wooden frame were rebated to receive the 1/4-inch plate glass, with an internal wooden bead securing it all round. Strips of leather were in place, either side of the glass, within the resulting groove formed by the outer frame and the inner beading.

46 D2: P0802

Detail of joinery at junction of advert frame above the window with the central draught screen. A void existed between the substantial wooden upper horizontal above the advert frame and the outer metal curve of the roof.

47 D2: P0632

Detail of joinery where the seat frame meets the central draught screen.

48 D2: P0803

49 D2: P0804

50 D1: P0640

Bevel-edged moulding to doorway and ends of the carriage.

51 D1: P0716

Bevel-edged teak moulding at junction of horizontal and vertical flitched beams at window tops.

52 D1: P0795

Vertical teak moulding showing mitres with (missing) horizontal.

53 D2: P0792

Joinery where the advert frame meets the mirror frame at the corner of the carriage; note the triangular metal corner plate.

54 D1: P0839

Joinery where two advert frames meet. The contoured structural flitched beam supporting across the clerestory roof above may also be seen emerging from the horizontal upper wooden framework.

55 D2: P0899

56 D2: P0900

Vertical advert panel separators were held in place top and bottom by mortise & tenon joints.

57 D2: P0923

Junction of advert and doorway end mirror frames

58 D2: P0840

Junction of advert frame and central draught screen

59 D2: P0795

A complete advert frame, also showing the inside of the external roof panelling, severely rusted along its bottom edge. The top of the upside-down 'L'-shaped beam may be seen outside.

60 D2: P0808

61 D2: U821 (part)

What held the front glass of the advert frames in place has not been established. Looking at one to the left (where it meets a central draught screen) there appears to be a closely spaced row of round studs around the edges, though these were not apparent elsewhere.
See also Ref 110.

62 D2: P0885

Interior where the overhead 1 3/4-inch beam projects below the upside-down horizontal 'L'-shaped beam and sits inside the 2-inch flitched vertical beam. The vertical teak insert may be seen rebated to receive the roof beam.

63 D2: P0934

The same view but with the window frame and interior moulding removed.

64 D2: P0922

65 D2: P0902

With the vertical joinery removed the arrangement of the horizontal and vertical teak inserts are revealed; the shaped rear metal plate may also be seen.

66 D4: P0948

67 D4: P0949

68 D4: P0929

A void is created where the lower curve of the roof panelling passes the advert panels to meet the top of the window frame beam; the advert panels lean in as a result. The tenon referred to in Ref 55 is clearly visible as it is here.

LAMP ELECTRICAL FEED

Electrical power was fed from the locomotive through a series of conduit tubes along the roof, connecting with other vertical and horizontal pipes at each carriage end. Midway along each half of the carriage a lamp was fitted inside at the zenith and the junction box seen here coincided with the structural roof strap. The conduit along the west side fed its four seating lamps and also the two at the highest point of the ceiling. On the east side the conduit only fed its four seating lamps.

69 D1: P0709

70 D1: P0710

71 D1: P0710

A further horizontal air pipe ran along the underside of the main bodywork. It may be seen here above the bogies.

72 D2: P1064

All ten interior lamps had metal housings mounted on wooden roses. On no.163 one of the ceiling roses was blanked off. The other blanking sheet was missing from the rose, exposing the wiring. See also Ref 110.

73 D2: P0824

74 D2: P0822

75 D2: P0702

76 D2: P0626

77 D2: P0626

It is likely that tantulum incandescent lamps of this vacuum type were fitted, possibly with frosting on the outer half of the glass farthest from the bayonet fitting.
Source: Science Museum Group

78 D3: P1062

Seen from above, at the left is the edge of the canopy with the upper curved roof in the middle and the lower curved roof to the right. The teak mouldings above the doorway and metal upper door runner may also be seen.

79 D3: P1061

End roof strap, canopy fixings, various teak mouldings, upper and mid-level door runners (with the carriage lying on its side).

80 D3: P0993

The underside of the canopy seen from below (with the carriage lying on its side).

81 D3:

Contextual view of about half of the roof, taken after the carriage had been turned on its side.

82 D1 D4: P0588

Contoured flitched roof beams followed the shape of the clerestory roof. Panel join straps spanned the roof to reach the vertical drop for the ventilation panels where they were met by a horizontal metal bead; this can be seen here broken at one of its own joins — to the right it is in place but the left-hand section has dropped onto the lower part of the curved roof. From that point a further set of straps descended to just below the upside-down 'L'-shaped 2-inch flitched beam above the windows, where they tucked under the horizontal teak moulding.

83 D4: P0913

A short section of teak moulding, flipped about its horizontal to show the vertical rebate for the roof strap. A horizontal channel was seen on all other similar mouldings removed.

84 P0911

85 P0912

One of the horizontal mouldings, flipped to show the outside (left) and inside (right). This was removed from the east side of the carriage, south end, above the window line. The full-length channel is explained on the general arrangement drawing as being routed out to house electrical cables.

One of the vertical mouldings, flipped to show the outside (left) and inside (right). This was removed from between two window frames. From an ease of manufacturing point of view, it is likely that all exterior teak mouldings were routed out this way, whether needed or not in any particular location.

86 P0909

87 P0910

88 D2: P0895

Uncertainty surrounds if the contoured roof beams had teak inserts, though external capping may be seen to finish it off.

89 D2: P0898

At the central draught screen the external capping is also in place.

90 D1: P0619

91 D1: P0627

The 2-inch 'L'-shaped flitched verticals only had teak inserts above seat base level. These two photographs show three-dimensional internal brackets connecting the curved 'L'-shaped vertical corner beams to the 3-inch upside-down lower horizontal beam.

92 D1: P0786

One of the bogie rollers, seen square on. A vertical 'L'-shaped bracket is bolted to connect the vertical triangular plates either side of the roller to the seating under-tray and the upright of the main chassis.
[see also page 41]

93 D3: P1002

Seen from the underside, nearest the bogie roller is a triangular plate. It has a right-angle bracket bolted to it and bent at the top of the picture to fit the lower horizontal flitched beam (when the carriage is seen upright). At the other end, this right-angle bracket then turns along the carriage underside. On the outside of this is a flat 'L'-shaped bracket holding all three thicknesses of metal together. The latter has been outlined in yellow for clarity.

94 D3: P1011

95 D1: P0622

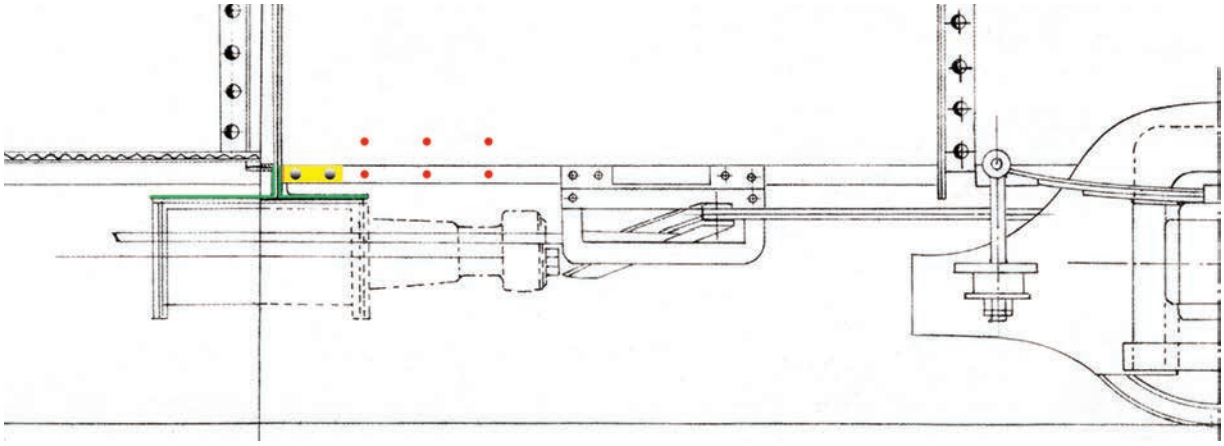
96 D3: P1005

The looped strap in these images is probably one of two that held the auxiliary air reservoir tank in place. The right-hand view from underneath shows a further set of four fixing holes to the right.

97 D1: P0771e

Seen square-on, a prominent looped strap is the remaining one of two that would have secured the auxiliary air reservoir. The three nuts to the right of the picture are thought to have played a role in supporting the brake cylinder and triple valve, though the GA drawing for the first batch of carriages shows those mechanisms installed on the east side of the carriage. Also visible along the underside and spanning the width of the chassis are several asymmetrically spaced wooden blocks. These are thought to be securing points for pipework and a way of keeping the pipes clear of other metal surfaces beneath the carriage on which they could be damaged. See Ref 100.

98 D1: General Arrangement Drawing



Extract from the general arrangement drawing with red dots indicating the location of the large bolts (top three dots) on the chassis side, and bottom three, which were fitted to the cross-member under the chassis — Ref 104. The drawing has been flipped to show it as almost certainly fitted to west side on the second batch of Brush carriages, though in reality most of the tank was underneath the seat base and not on one side. The two loop straps to the left (only one surviving on 163) supported the auxiliary brake cylinder, not included on the GA drawing and to the left of the above example. The yellow indicates a bracket fixing (see Ref 104).

99 D3: P1187

Taken when the carriage was at the Electric Railway Museum, this image shows the corrugated underfloor when it was is slightly better condition than in 2021. Source: Printz Holman.

100 D3: P0990

Contextual view of the over-turned carriage.

101 D3: P0996

The north end of the underside. The rusted corrugated steel floor has exposed the lito-silo.

102 D3: P0997

The carriage is on its side and the under-seat plate therefore to the right vertically here. At the top of the picture a three-dimensional bracket is holding the north side panel (to the right of its doorway seen from outside) to the 'L'-shaped corner vertical and lower 'L'-shaped horizontal flitched beam. The two horizontal teak inserts have been rebated to clear the bracket.

103 D3: P1034

See Ref 93. The right-angle brackets bolted to the triangular plates continue all along the underside of the chassis to support the bogie roller on the other side. This photograph also shows the bogie pivots midway along the underside.

104 D3: P1037

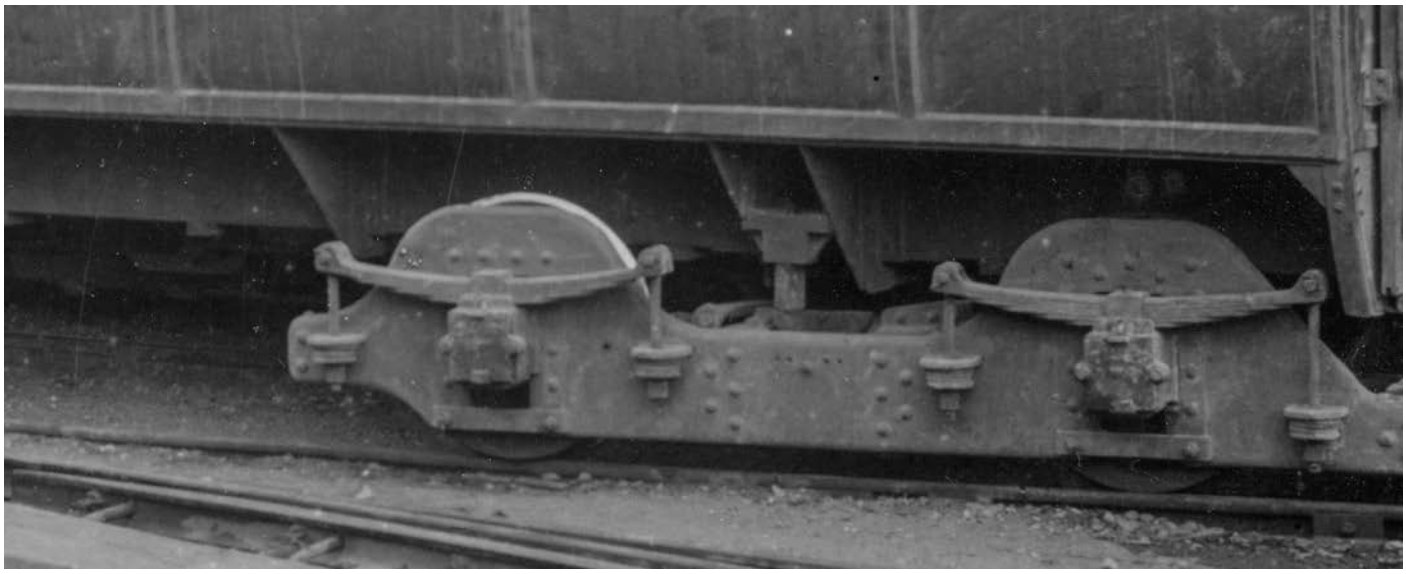
The three large nuts referred to in Ref 97 may be seen at the top of this photograph, along with the fixing bracket referred to in Ref 98.

92 D1: P0786

The requirement to make carriages as large as possible for the comfort of passengers, while also designing them to run through tubular tunnels as small as 10' 2" in diameter, introduced tighter tolerances than would be expected on surface railways. To restrict the carriages from swaying excessively, there was no springing between the bogies and the carriage bodies. The sole means of suspension was provided by leaf springs on the axle ends.

Each bogie rotated around a centre pin which secured it to the carriage [see Ref 103]. Rollers on the outer edge of the chassis and adjacent to each centre pin provided the freedom of movement required for the bogies to follow the trackwork while offering a firm support that prevented the carriage from leaning sideways and hitting the tunnel segments. [see also page 37]

109 D1

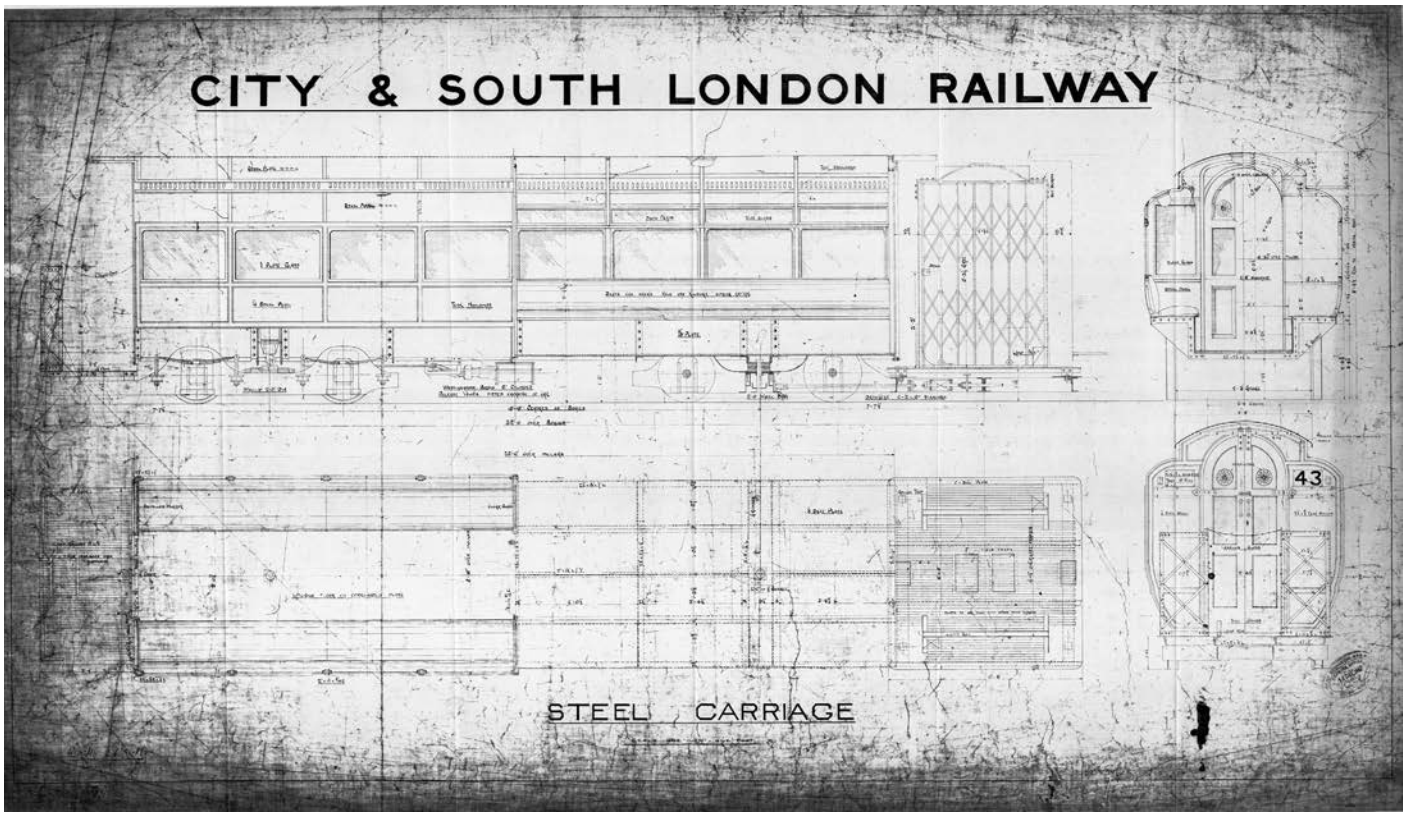


Carriage 163 was fitted with the stabilising roller mechanism and this was also shown on the pre-production GA drawing of the Brush carriages; however, it is missing from the photograph above.

The illustration shows a carriage from the first batch to be built by Brush (Nos.141-155) and was taken around the time of its withdrawal from service. There appears to be a square profile metal bar in part of the space that should be occupied by the roller mechanism, although little detail can be seen. It is uncertain if this was fitted from new, if it was a later modification or if represents something that is incomplete. [see also page 47]

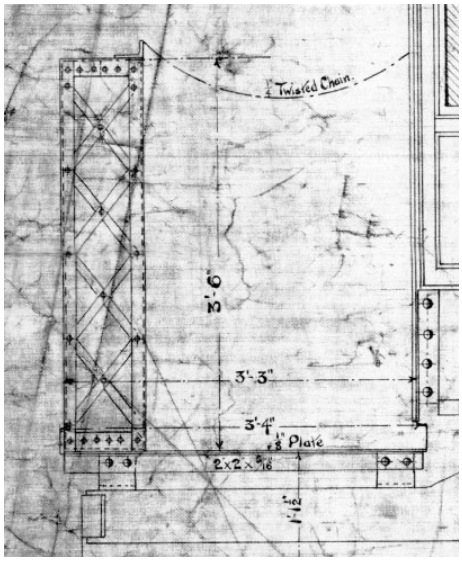
Source: London Transport photograph number 24709 from about 1921/22.

105



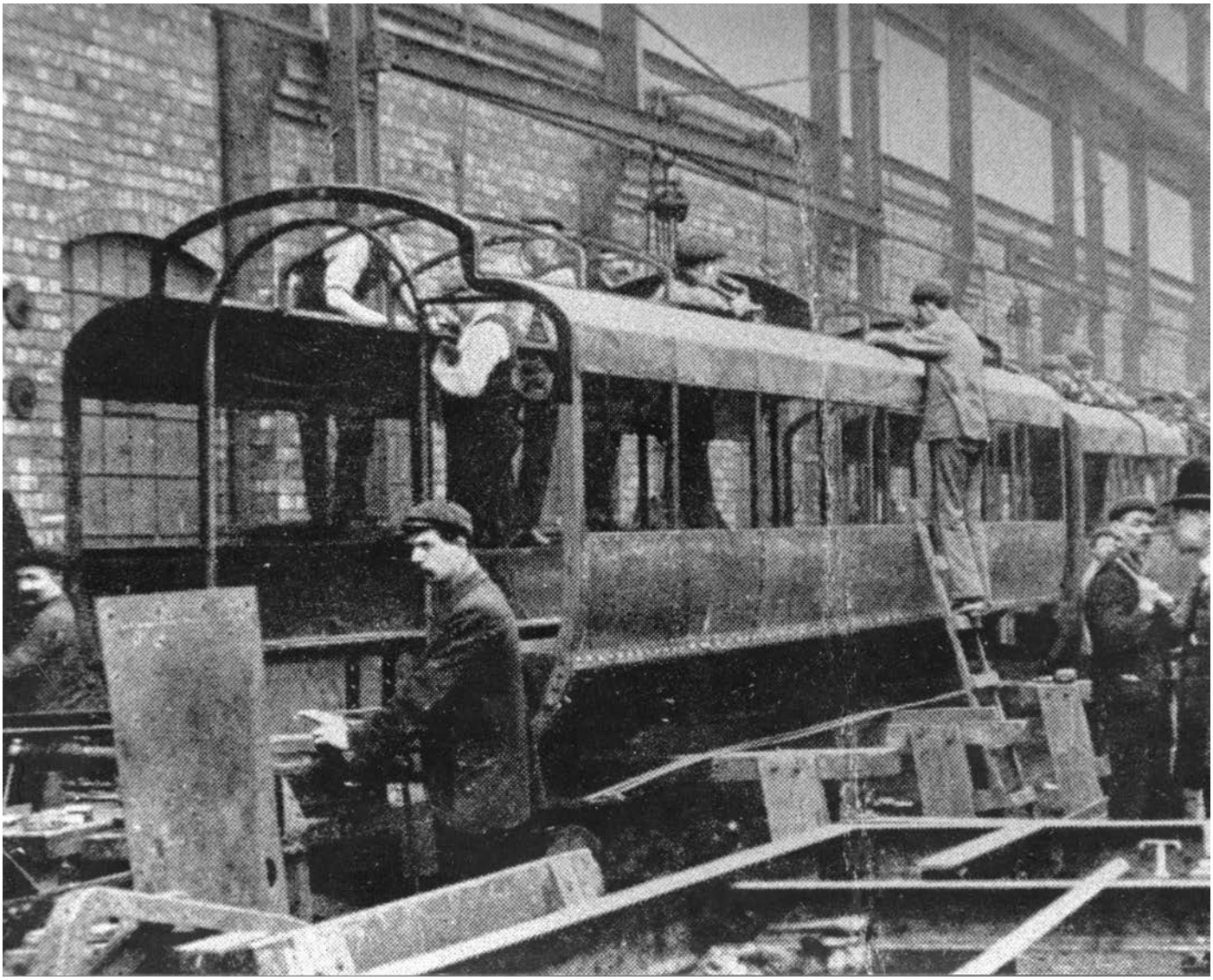
Contemporary tracing of a general arrangement drawing from 1905. The original was at a scale of 1:12. It is shown here for reference only and necessarily reduced to fit this page size.

105



Enlargement of north end showing the gateman's platform for the front carriage. No.163 was not a front carriage and would have had the wider entrance/exit platform enclosed by Bostwick gates, as at the south end on this GA drawing.

106



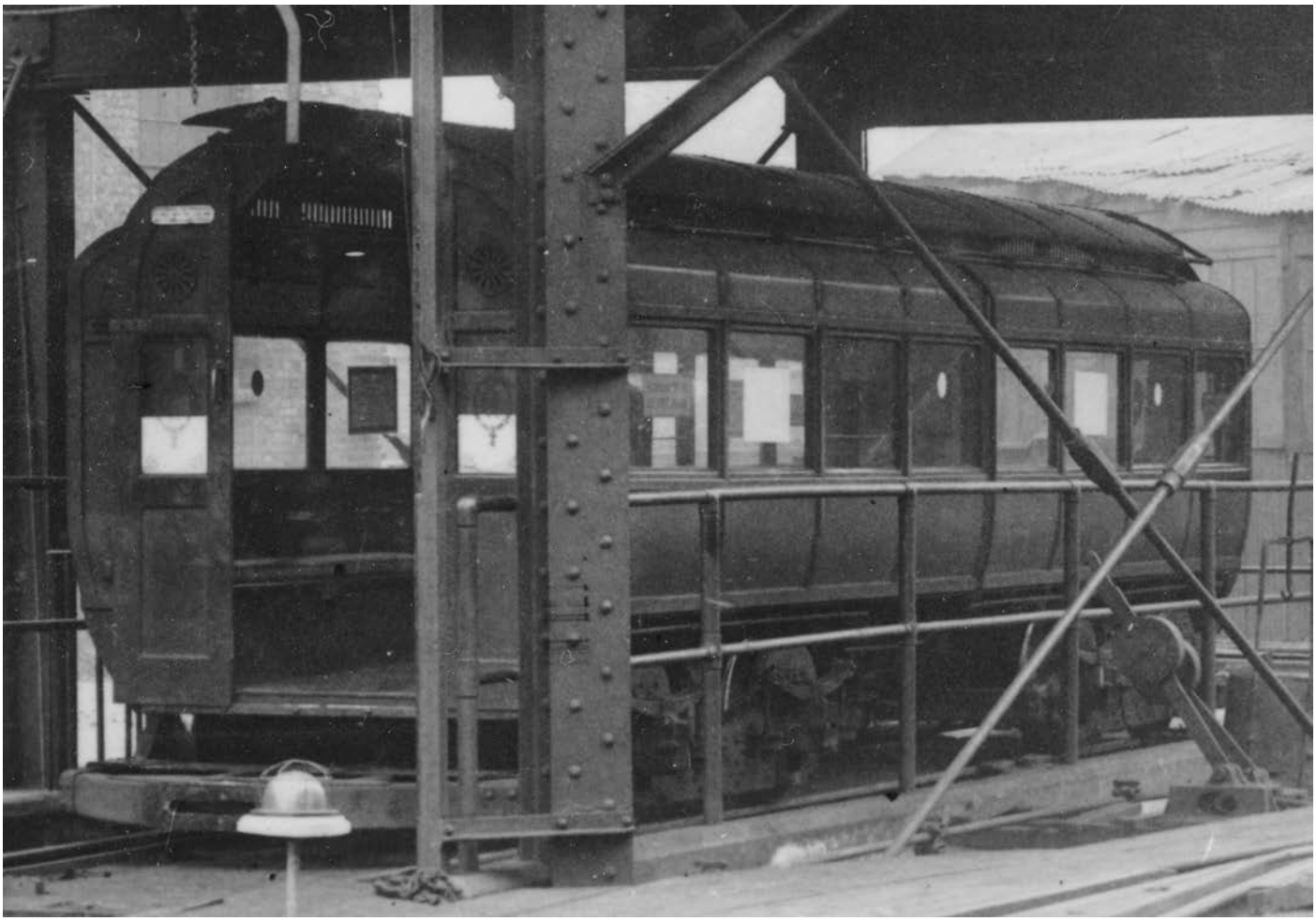
Construction at the Brush works.

Source: copied from a promotional photograph printed in a magazine or catalogue, probably between 1906 and 1908.

107

Euston station, probably at the time of opening in 1907, showing two of the new Brush carriages.
Photographer not known.

108



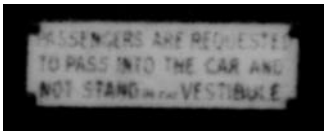
Brush carriage in the lift at Stockwell depot. Rail level was only accessibly from the depot by a steep incline initially; this lift was operational from 1907.

Source: part of London Transport photograph number U809, taken on 14th June 1922.

109

Brush carriage at Stockwell depot, probably from the first batch, showing bogies.
Source: London Transport photograph number 24709 from about 1921/22.

109a



A small sign was fixed near the top of the left-hand door. These have been observed in several photos, but the words are almost always burnt out as the exposure would be set to capture the detail of the darker carriage. If one looks at the way the sign was mounted, it may be seen that the edges are screwed onto the framing surrounding the window. There is a gap between the back of the sign and the glass which suggests that it was rigid; with no apparent fading or damage to the signs even after the carriages were withdrawn from service, the impression is that they were enamel — although we have no proof to validate that assumption.

This rather indistinct image is heavily manipulated from one of the very few capable of it. Intriguingly, very close inspection reveals that, in the word ‘CAR’ on the middle line, the ‘R’ is back-to-front.

110 D2

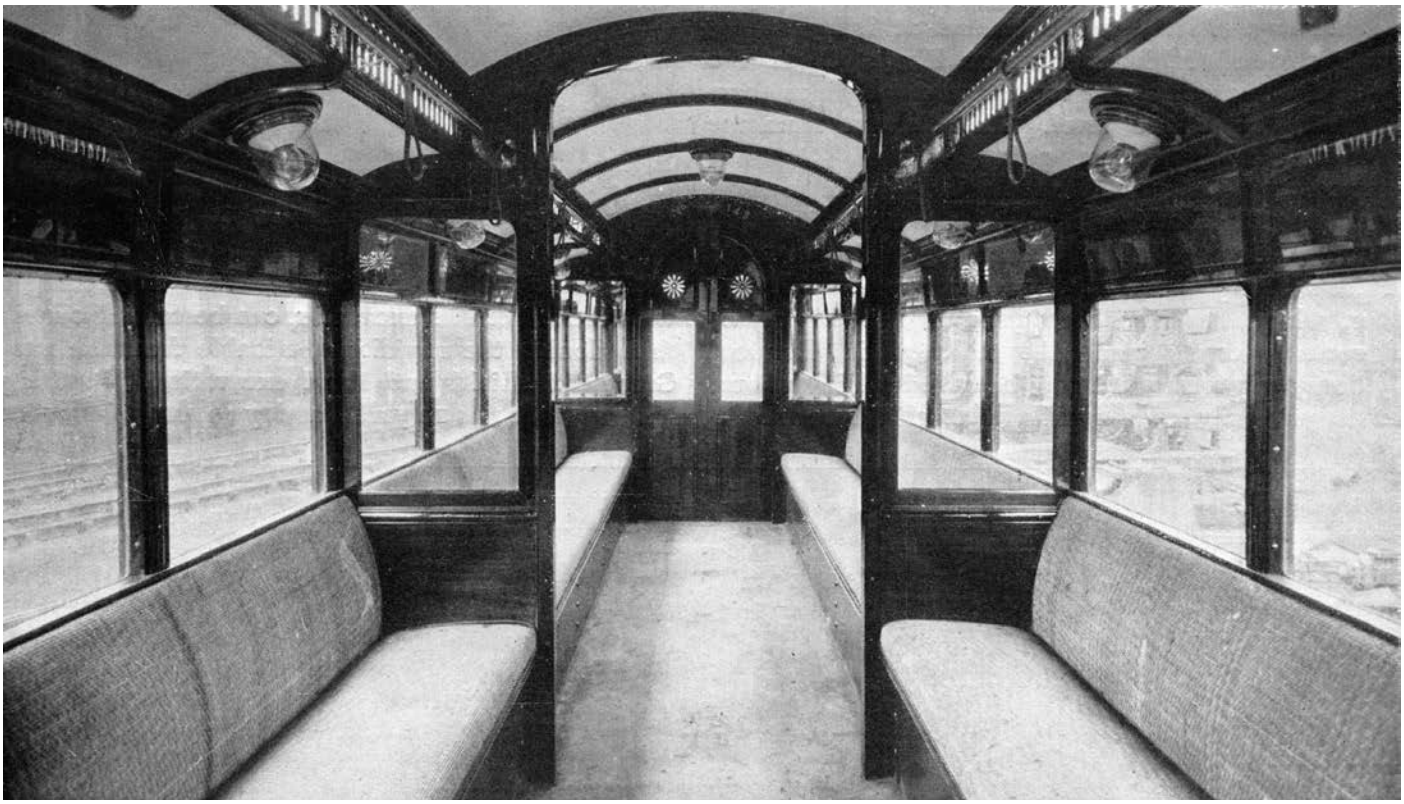
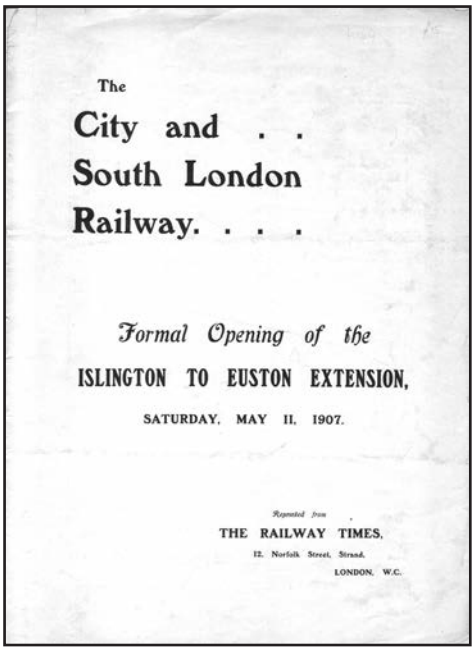


Fig. 2.—Interior of New All-Steel Car built by the Brush Company.

Interior of carriage 145 or146. Note the glass domes on the light fittings, the apparently smooth floor, and dark (brown) overhead beams and doorway panel surrounds.
Source: 1907 opening brochure reprinted from The Railway Times*; cover below reproduced at one-quarter original size.*



The
City and . .
South London
Railway. . . .

Formal Opening of the
ISLINGTON TO EUSTON EXTENSION,
SATURDAY, MAY 11, 1907.

Reprinted from
THE RAILWAY TIMES,
12, Norfolk Street, Strand,
LONDON, W.C.

111 D2

Interior of carriage no.142, from the first batch from Brush. The window bar in the right foreground window, and that on the other side beyond the draught screen, might have been used to place a 'Not Stopping at…' board, though this uncertain. This photograph was taken about fifteen years after introduction. Possibly of important note are the glass domes missing from the light fittings, the wooden slats on the floor not visible in Ref 110, and the now white overhead beams and doorway panel surrounds.

Source: London Transport photograph number U821, taken on 14th June 1922.

112

Borough junction, just north of Borough station, with the train heading north and the original track to King William Street station on the right.

The small round object by the guard's right shoulder is a dummy electrical socket. Electrical wiring was carried along the carriages in metal conduit tubing broken by intermediate junction boxes on the roof (Refs 69 and 70) to feed the lights. The cable emerged from this tube beneath the canopy at each end of the carriages before terminating in a plug. This allowed a continuous electrical line to be provided from the locomotive through the full length of the train. The connections between the carriages were made by inserting a plug from each carriage into a double ended socket on the roof above the intermediate gated platforms between the carriages. The plug on the cable on the front carriage was plugged into a live socket high on the end of the locomotive just to the side of the door. The cable that emerged beneath the canopy of the rear carriage carried 500v, but there was no carriage or locomotive to which it could be connected. It was therefore plugged into a dummy socket; presumably to stop it swinging around and getting damaged. These dummy sockets were only fitted to the end carriages and the one in this photograph is not in use as the electric cable has been connected to the locomotive to provide the feed to the train. Carriage no.163 was not an end carriage and so did not have this socket at either end.

Source: London Transport Museum photograph U1079.

113

Although supporting the day-to-day operation of LT's services was CDS's primary concern, there has always been scope for the occasional 'special' duty. One of the more unusual occurred in 1974, when the body of an ex-City & South London Railway car was transferred to Ruislip Depot on behalf of the London Underground Railway Society. Ford 'D600' prime mover 1665F was used together with a step-frame trailer and the combination is seen here entering the depot's driveway upon the completion of the move.
R.J. Greenaway

Photograph and caption reproduced from page 12 of *London Transport Service Vehicles* by Kim Rennie and Bill Aldridge, published by Capital Transport Publishing in 2003.

114 PICT0135

115 PICT0137

116 PICT0134

Members of the London Underground Railway Society at Ruislip depot removing the pitched roof and starting the (never completed) restoration.
Source: Steve Smith

117 PICT0156

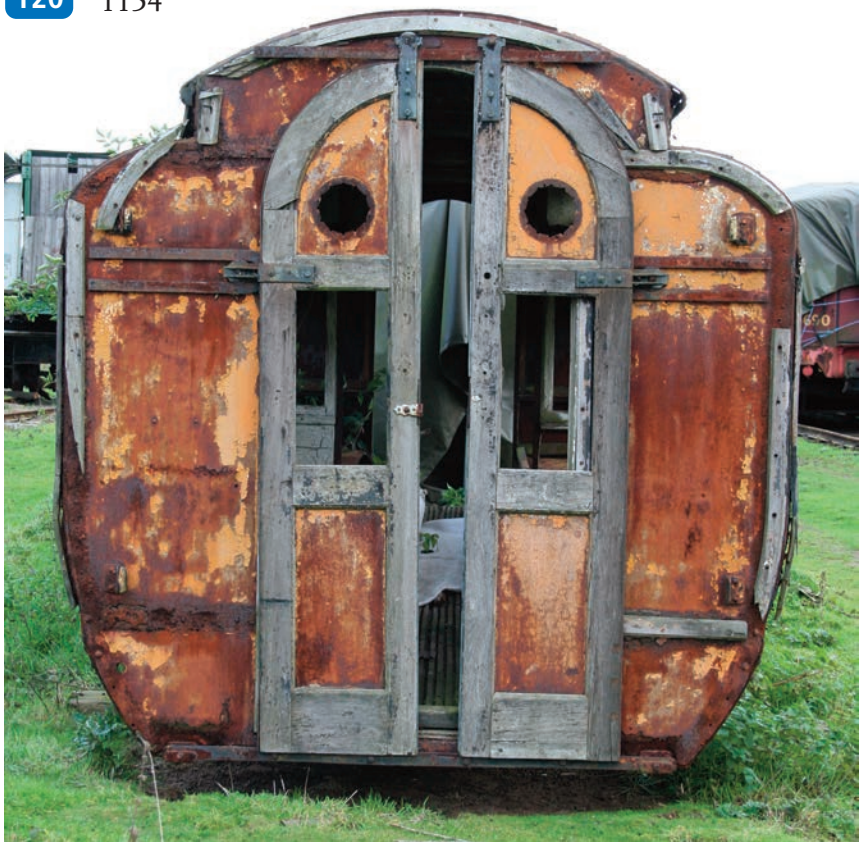
118 PICT0157

The carriage being lifted by crane to a new location at Ruislip depot, next to no.135.
Source: Steve Smith

119 P1135

Source: Printz Holman 11th November 2006

120 1134



Source: Printz Holman 11th November 2006

121

Evidence of re-paint primer preparation at the Electric Railway Museum.
Image from https://redoxidepaintlsmm.wordpress.com

122 P160212

Further evidence of re-paint at the Electric Railway Museum.
Source: Flickr posting dated 16th February 2012

123 P081017

Detail of door runners.

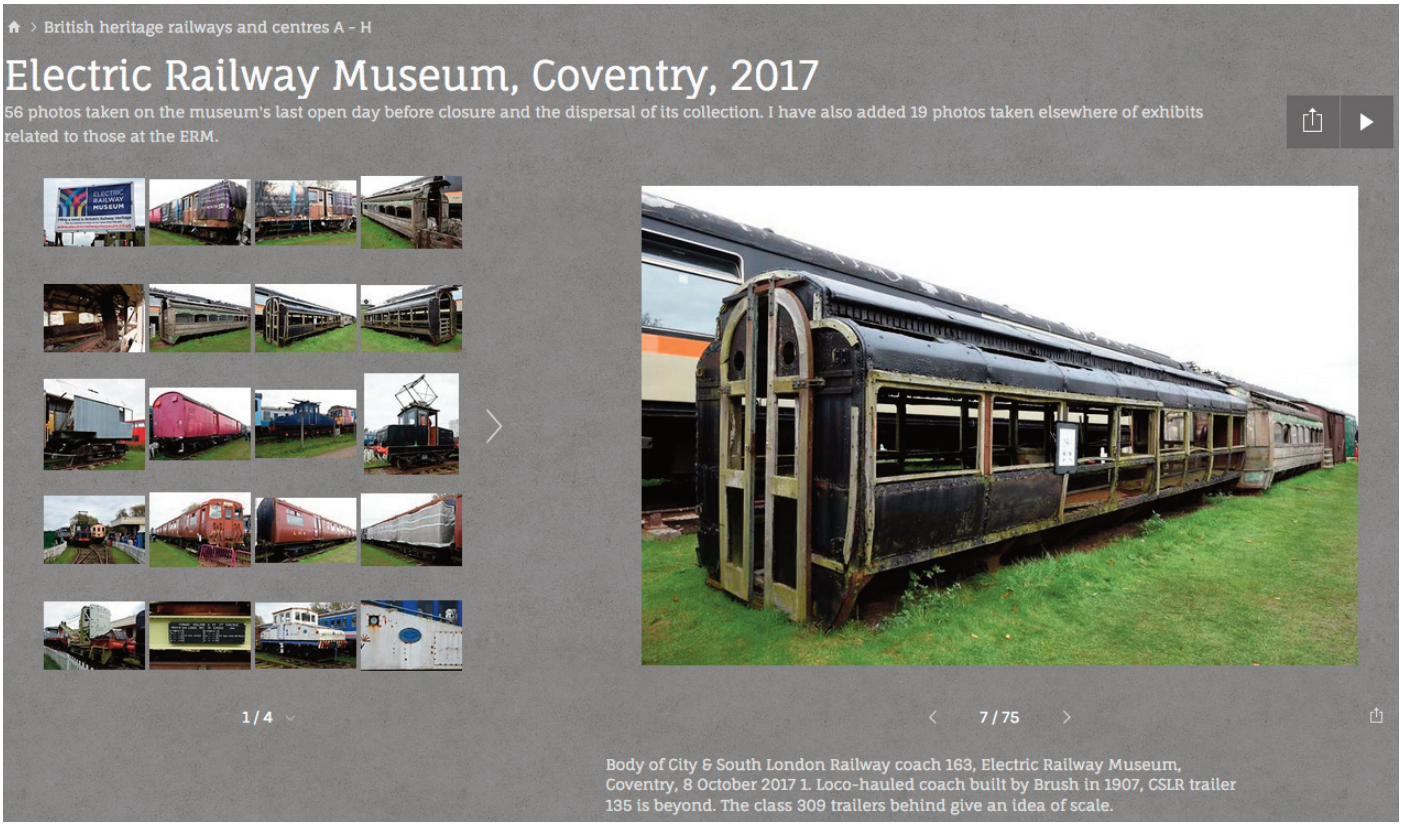
Source: Flickr posting from the Electric Railway Museum, Coventry, dated 8th October 2017

124 P0069

E-mailed to Doug Rose on 18th February 2021

Source: Katariina Mauranen of the LT Museum, Acton

125



126

Source: screenshots from the now permanently closed Electric Railway Museum

127 P00027

128 P00239

Arriving from Ruislip depot, No.163 is being unloaded on 19th June 2018.
Source: Steve Smith

129 P00240

130 P00241

…and lifted by fork-lift truck to its last resting place.

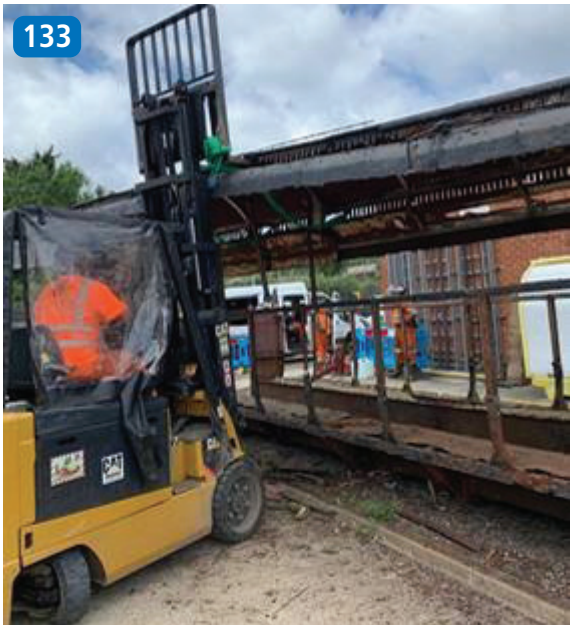
Source: Steve Smith

130a

Aerial photograph showing the location of the carriage when at Neasden depot.
Source: Google

130b

CUT UP TO BE PUT IN THE SKIP



Source: Parimal Mamtora, Neasden Depot Track Supervisor