UNDERGROUND

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UNDERGROUND

If you read Bob Greenaway's Editorial in the last issue of "Underground", then you will have noted that Bob was looking for someone to take over the Editor's job for this and subsequent issues. Well, I read Bob's request as well, and volunteered for the job. By 'volunteered' I do mean that I accepted the job voluntarily! However, because of the efforts of the members of the Publications Sub-Committee, and Piers Connor, who I thank especially, I have managed to produce this issue, which I hope will be followed by more issues on a more-or-less regular basis now.

By the time you read this, I will be swotting hard for my exams at Bristol Polytechnic. In the meantime, before I return, the work on the next issue will be continuing in my absence, and I hope that we shall be able to keep "Undergrounds" rolling off the production line. I personally feel that "Underground" must prove to the membership at large that it is worth its existence, and the large proportion out of your subscription that pays for the production costs. I hope that "Underground" will be seen as more of a magazine than "Underground News", with articles and photographs which are not suitable for "Underground News" by reason of their length, etc., and articles which one might expect to find in the monthly periodicals on general sale. Ultimately, I hope that we shall be able to produce a magazine with a great deal more scope, not only distribution-wise, but also content-wise. However, this is for the future, but the thoughts are there nevertheless.

Looking ahead to the future again, I would just like to add that any offers of help with the production of further issues of "Underground" will be appreciated. Also, I would like to thank the two gentlemen who have written to me with their offers of help: your names have been noted, and no doubt my temporary successors will be contacting you further. Furthermore, any articles for future issues will likewise be welcome.

David Hayward

LETTER TO THE EDITOR

Sir,

I saw the enclosed article about the British Rail-owned section of the District Line in a recent edition of my local paper - the Wandsworth Borough News - and thought that the article might be used for publication, as I thought it had quite a lot of useful and interesting information in it.

Yours faithfully, P. Devivo, Roehampton.

"MIXED OWNERSHIP MUDDLE

East Putney (and Southfields and Wimbledon Park) stations are owned and operated by British Rail though none of their trains ever stop there. The lines are owned by British Rail as are the loop lines from the main Clapham Junction-Richmond line joining at East Putney station. The British Rail passenger service from Waterloo to Wimbledon via East Putney ceased in 1941, but they still use the line to get stock into sidings at Wimbledon. Passenger services are now provided exclusively by London Transport's District Line.

Local people believe this mixed ownership means that they lose out both ways. London Transport have less incentive to invest in stock for the Wimbledon branch and British Rail spend virtually nothing on the stations. The ticket issuing facilities are inconvenient for the staff and frustrating for the passengers. On Mondays particularly the queues for tickets often mean a wait of 10 minutes.

Putney Liberals agree that the line is an asset to British Rail. It is presumably easier to get one's rolling stock into one's sidings over one's lines; but, surely, they say, the stations could be transferred to London Transport while the tracks themselves remain with British Rail."

Editor's Note: The above is reproduced with permission of "Wandsworth Borough News" but presumably the contributors of the original article were not aware of the introduction of the C77 stock, etc.

Front Cover Ex-Metropolitan Railway electric locomotive No. 12 'Sarah Siddons' at Acton Town, 19th July, 1972 *R.J. Greenaway*

Back Cover Ex-G.W.R. and B.R. pannier tank L.90 at Lillie Bridge, 27th March, 1971. *R.J. Greenaway*

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SHEPHERDS BUSH DEPOT AS BUILT

BY PIERS CONNOR

One of the smaller depots on the London Underground is that at White City on the Central Line. Although small it is by no means the least interesting as it was originally the main depot and works for the Central London Railway. The depot was altered to its present form in 1948 when the Central Line was extended to West Ruislip and Hainault. At these places new depots were built and White City became an overnight stabling point for only a small percentage of the total stock.

Prior to the building of the Central London Railway in the late 1890's the site which was to become Shepherds Bush Depot was occupied by a large house called Woodhouse Park. The site was bounded by the West London Railway on the east side and Wood Lane on the west side. The road entrance was on the south side in Caxton Road. As built for the opening of the line in 1900 the depot was laid out as in Figure 1.

The main buildings consisted of a Power House, Loco Shed, Overhaul Shop and Carriage Sheds. The power house, still in use by LT's Chief Electrical Engineers Testing Section, provided the main high tension feeds for the sub-stations along the line and, as coal fired boilers were used, needed some sidings for storage and a single track ramp down to a discharge point. In order to provide rail access for coal delivery a single track connection was laid to the West London which was also used for rolling stock delivery.

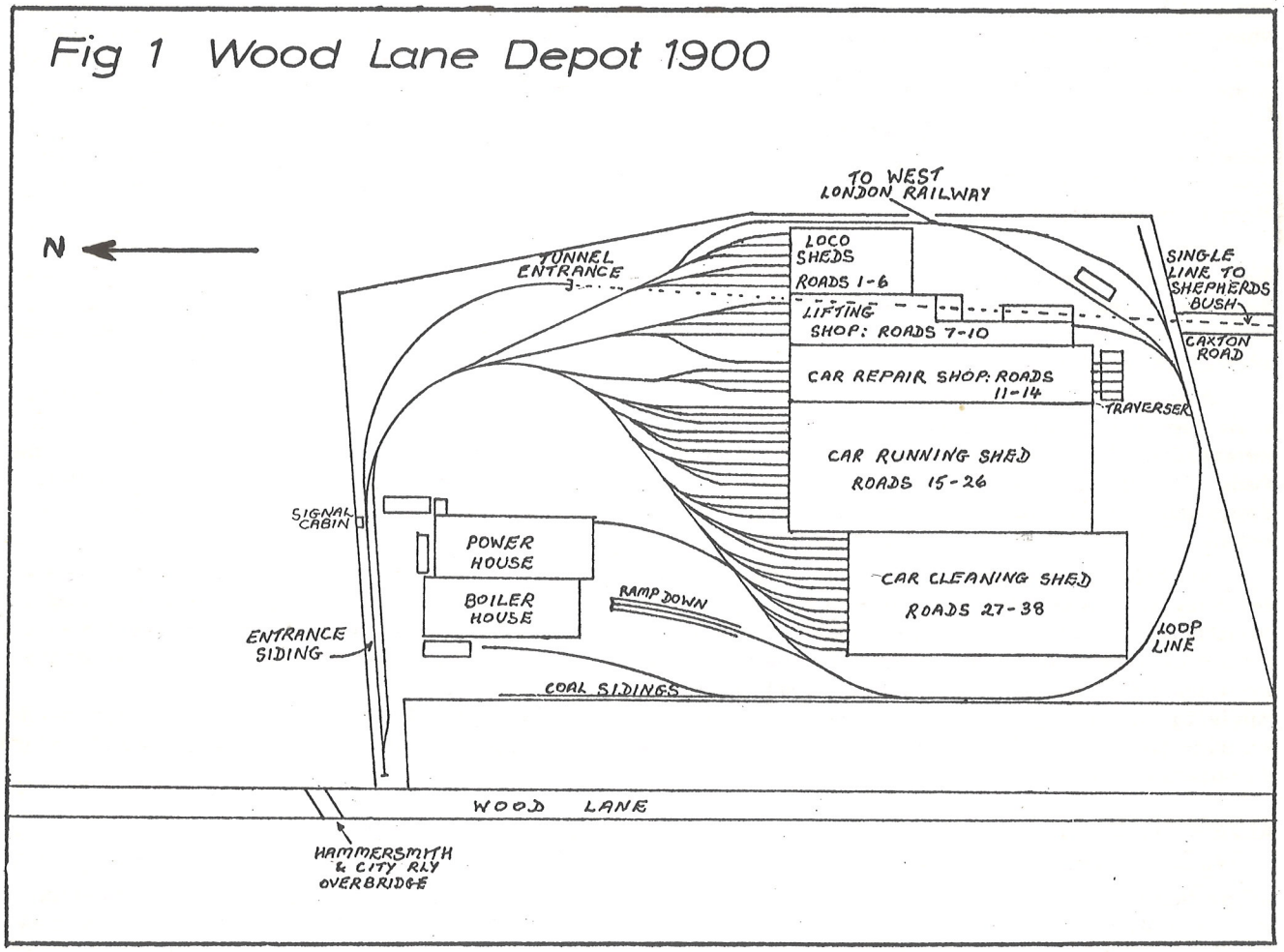


Figure 1. Original layout at Shepherds Bush Depot as built in 1900. Note the boundary fence set well back from Wood Lane. All trains had to reverse on the entrance siding in order to reach the sheds.

Access from the Central London line to the depot was via a single track from Shepherds Bush Station. The station was provided with a scissors crossover at each end. That at the west end allowed access from either platform to the depot road, which was actually an extension to the westbound road. The eastbound line was also extended back, into a siding long enough to take a complete train. The two lines ran parallel to each other until the end of the siding, at which point the depot road curved sharply north and climbed up to reach the surface within the depot confines. This four chain curve was to become notorious for its restriction on the standard tube loading gauge and was known as the Caxton Curve, from Caxton Road which was above.

When the access road reached the surface it turned sharply west and ended in a siding at right angles to Wood Lane. A run round loop was provided next to this siding and the connection to the depot was made at its east end. Every train entering the depot could only do so by reversing in this siding. A signal box was provided at the exit to the siding to control movement in and out of the depot and over the block section towards Shepherds Bush.

The entrance siding was connected to a fan of sidings running in a north to south direction, most of which entered the various depot buildings. The easternmost siding was laid outside the buildings and was extended to form a loop which ran all the way round the depot and connected with the western side of the main fan of sidings. The eastern side of this loop was where the connection to the West London Railway was provided. In later years, trains which travelled round this loop were said to be 'going round the farm'.

Next to the 'East Road', the name given to the eastern part of the loop, was the locomotive running shed. This was a six road shed, some 140 feet long, which was just large enough to accommodate all the 28 electric locomotives purchased by the Central London. These roads were known as No 1 Shed to No 6 Shed. Next to these were two roads which ran into the Machine Shop, where such work as armature rewinding took place. Two more roads, Nos. 9 and 10, were in the Lifting Shop, where overhead cranes and a traverser were provided. No 9 road was extended to the south end of the shop and continued on to connect with the depot loop road.

Nos 11 to 14 roads formed the carriage repair shop. This was a 360ft. long shed which had a carriage traverser connected to all four roads at its south end. Photographs of the Central London locomotives under construction which appeared in 'Underground No 4' show this shed, which was used for this work while equipment of the locomotive and lifting shops was carried out.

The remainder of the covered accommodation consisted of a 12 road car running shed and a 12 road car cleaning shed. These two sheds were both 360ft. long and together they brought the total number of covered roads to 38. When the line was opened to public traffic in July 1900 only the depot entrance road and the tracks leading up to the loco running shed were provided with the current rail. Shunting in any other part of the depot was by means of the two steam locomotives owned by the Central London.

A complicated set of movements was needed to get trains into and out of the depot. To allow a train to be stabled in the sheds when it arrived on the entrance road from Shepherds Bush, it had to be back shunted by its locomotive. The current rail on the entrance siding allowed sufficient speed to be obtained by the loco to enable it to coast its train into the sheds. The loco could then be collected by a steam loco and returned to its own shed at a later time. Steam locos were always needed to take trains from the sheds to the entrance siding when an electric loco would make its own way to the east end of the train and couple, ready for departure to Shepherds Bush.

Just before the line was opened a scheme was drawn up which would provide overhead trolley wires for the whole depot, and this was installed by R.W. Blackwell & Co. late in 1900. At least one of the electric locomotives, No 4, and probably another one, were fitted with a pair of trolley poles, one either side of the centre cab. These locos could now perform the same shunting movements as the steam locos. The overhead wires were continued into the car sheds and the loco running shed, but not into the machine and lifting shops. From 1903 the wires were gradually replaced by current rails being laid in the open sections of the depot. By 1908 a number of alterations had taken place in the yard and the wires had all been removed. Many of the original support pillars remained and some of these were used as lamp standards to light the outside areas of the yard.

ALTERATIONS

Between March and June 1903 the Central London's electric locomotives were replaced by multiple unit trains using new motor cars with the existing trailer cars. All but two of the electric locos were sold, the others being kept for shunting in the depot. The original accommodation in the 24 car shed roads, each capable of taking 7 cars, allowed room for all the 168 trailer cars owned. With the arrival of the new motor cars, 64 in all, additional accommodation was needed, so a new car shed was built on the west side of the depot. As the new shed was next to Wood Lane it became known as the Wood Lane Sheds. (See Figure 2).

Nine additional roads (Nos 39 - 47) were provided in the Wood Lane Sheds but these could only be reached via the south side of the loop road. From that time that part of the loop road, which ran round the rear of the original sheds, was known

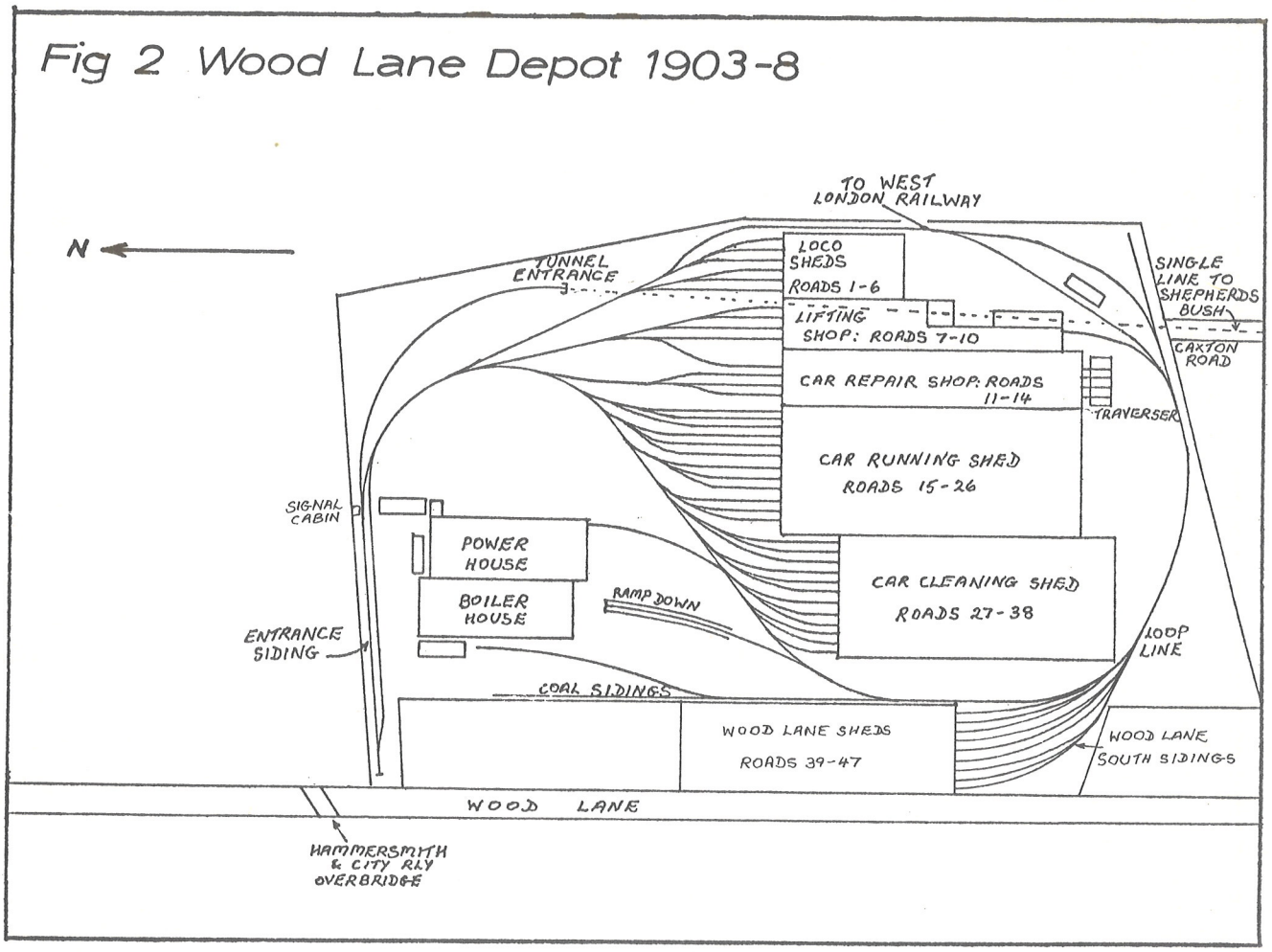


Figure 2 Shepherds Bush Depot 1903. The Wood Lane Sheds were added and were connected to the 'South Road' by the Wood Lane South Sidings. At this time, any trains requiring to enter these sheds could only do so by running round the depot loop road or by running past the old sheds onto the South Road and then reversing onto the Wood Lane South Sidings. A Fan House was added near the Tunnel entrance to provide ventilation inside the tunnel. Note that the Wood Lane Sheds were provided with pits, like the car running sheds.

as the South Road. It had connections to the fan of sidings which led to the Wood Lane Sheds. This fan of sidings, although not capable of being used for anything other than connecting the South Road to the Wood Lane Sheds, were called the Wood Lane South Sidings. The curious way of naming these roads is contrary to the usual definition of a siding - a road used for storing rolling stock or a short dead end.

With the loss of the bulk of the electric locomotives the loco running shed was reduced in size to three roads (Nos 4 - 6), while the other three roads (Nos 1 - 3) became the paint shop. At some time the loco roads were extended through the south end of the shed to connect with the loop road, as was No 2 road of the paint shop. To the rear of the paint shop a connection from the loop gave access to a weighbridge.

The next development to affect the depot was the plan to build an exhibition site on the opposite side of Wood Lane. In order to serve the new exhibition, powers were obtained by the Central London, in July 1907, to build a new station called Wood Lane, and an extra line to connect it with the original terminus at Shepherds Bush. The plan involved a number of changes to the depot because the new station was to be built on the site of the depot entrance siding.

The idea was simple in theory, but rather more complicated in practice. The depot entrance siding was to be re-aligned and connected, at the Wood Lane end, to a new line to be built under the Wood Lane Sheds. This new line was to continue in a curve round to meet the end of the original reversing siding at Shepherds Bush. This allowed trains to

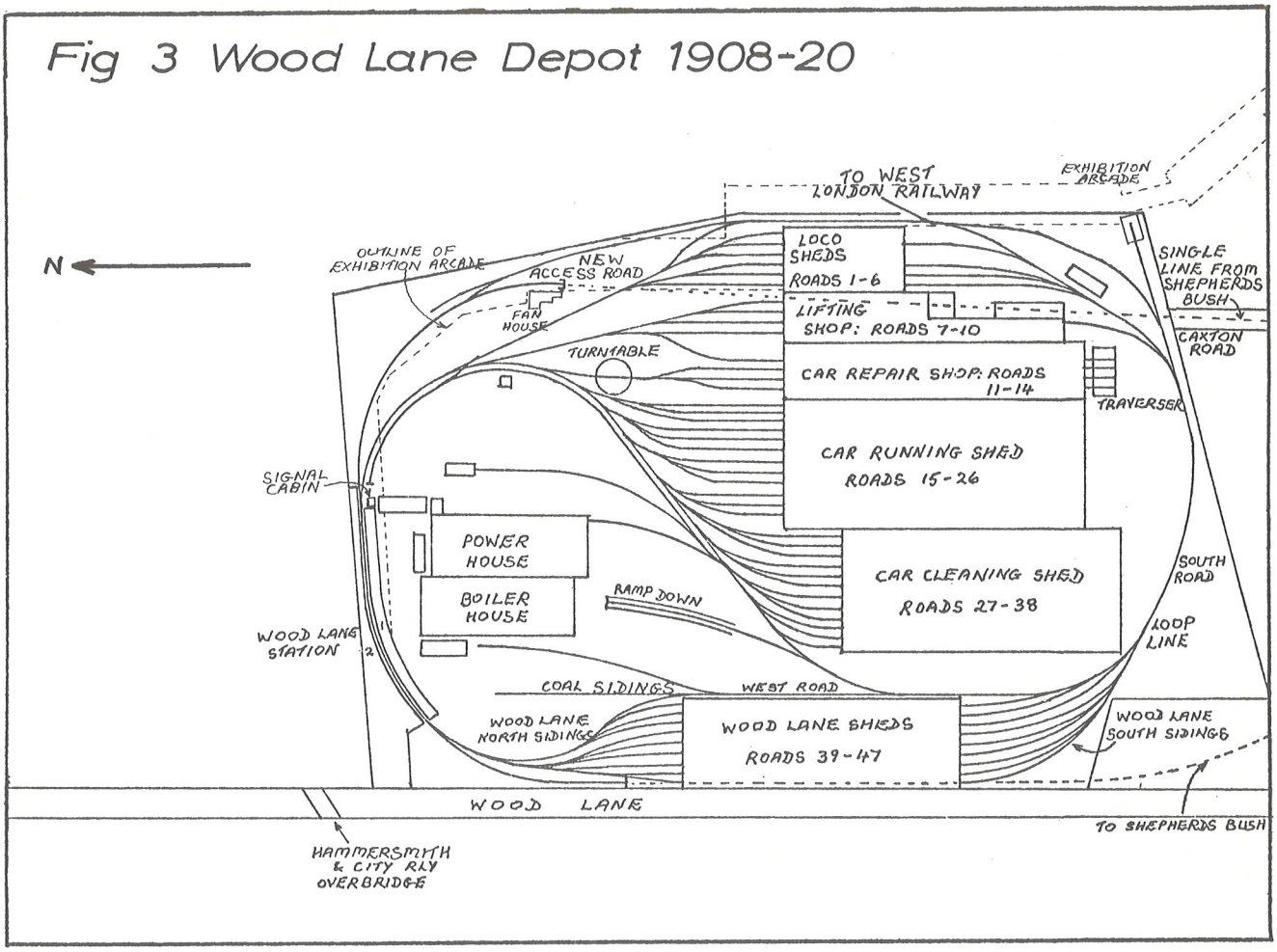


Figure 3 Depot with Wood Lane Station, Terminal Loop, Wood Lane North Sidings and Exhibition Arcade, 1908. The Station, with two platforms built either side of a single track, was built at a lower level than the original depot entrance road and there was now a slope up towards the sheds. Another connection, the 'West Road', was built to connect the west end of the new station with the depot loop road. Trains could now enter the depot from either end of the platform. Another set of connections was also put in at this time to give access to Wood Lane Sheds from the west end of the platforms. This was known as the Wood Lane North Sidings. The turntable was also added at this time. Note the Exhibition arcade covering the east and north side of the site, and the new position of the signal cabin. Also a new access road was laid from the eastern side of the depot loop road to the new platforms. This line joined the line from Shepherds Bush just north of the tunnel entrance.

leave Shepherds Bush, run up the 1 in 44 of the original access road, round into the new Wood Lane station and then turn into the new tunnel which ran south, curved east, dipped below the original Caxton Curve tunnel and joined the original reversing siding to return to Shepherds Bush. Some complications arose during the construction work because of the need to lower the depot entrance road, and to allow access to the depot from the new platforms. The new running line was laid out as shown in Figs 3 and 7.

The first alteration took place late in March 1908 when the depot entrance siding was re-aligned to the position of the new platforms. This involved lowering the track by about 6ft. and connecting the Wood Lane end of the siding, by a very sharp curve, to the depot. This new connection to the depot was made necessary because the original connection at the east end of the entrance road had been temporarily removed because of the track lowering work. The new connection ran round to the east side of the Wood Lane Sheds (it was called the West Road) and joined the South Road. For the next few weeks all movements to and from the depot had to be made by way of this connection. In order to get to Wood Lane Sheds, trains ran via the West Road to the South Road, reversed, and then ran into the sheds via Wood Lane South Sidings. To get to the original sheds the same route to the South Road was taken, followed by reversal, then proceeding past the carriage sheds to a new shunting neck, put in next to the original depot connecting line at this time. The new shunting neck was known as No 2 road. Another reversal allowed access to roads Nos 1 - 38.

The connection to the new tunnel was made with the new platforms, and the new station opened, on 14th May 1908 the opening day of the Franco-British Exhibition. By this time a new exit route from the depot to the station, actually the original depot access road, had also been opened. Trains now entered the depot from the Wood Lane end of the platform road, and left the depot via the original access road to reach the platform. Another alteration which was done at the time was the connection of the north end of the Wood Lane Shed roads to the new depot entrance road. The connection allowed the roads in the Wood Lane Sheds to be reached from the new station without the necessity to reverse on the South Road. The new connections were known as the Wood Lane North Sidings.

Because of the lowering of the level of the original depot access road when it became the platform road both entrance and exit roads had to be laid with steep gradients. The new Wood Lane North Sidings were also steeply graded. The Wood Lane end of the station platform had a 300ft. radius curve so the depot entrance road, which diverged inside this curve, was even sharper. Movement in the depot was, not surprisingly, restricted to 4 m.p.h.

LOOPS AND NUMBERS

Once the loop line from Shepherds Bush to Wood Lane to Shepherds Bush had been opened the necessity for the driver of a train to change ends occurred only once on each trip - at the Bank terminus of the line. At Shepherds Bush a train arrived on the Westbound line, passed round the loop via Wood Lane Station and returned to the Eastbound platform at Shepherds Bush. In this way each train was turned round once on every trip. Because of the need to keep the cars on the line facing in the same direction when coupling, to allow correct connection of the main air supply pipe and brake pipe hoses, it was desirable to keep all trains 'right way round'. This could be accomplished by ensuring each train completed an even number of trips each day before returning to the depot, but this might not be convenient. Trains or cars could be shunted around the depot to get them turned, but this was time consuming. To overcome these problems, therefore, a turntable, capable of turning one car, was installed on the road leading to Nos. 12 to 14 Shed Roads in 1908.

Cars did not have any means of distinguishing which way round they faced at any particular time, except motor cars, until the conversion to air doors took place in the mid-1920's. In the case of the motor cars two numbers were allocated, the individual car number as usual, and a 'Train Shed Number'. The Train Shed Number, as its name suggests, was apparently intended to indicate the road in the depot where the train was supposed to be stabled. It was allocated to pairs of motor cars, which normally ran together either end of a set of trailer cars to form a train. The total of 64 motor cars allowed the formation of 32 of these pairs. Room for all 32 sets to be formed into trains and stabled in the depot was available in the Running, Cleaning and Wood Lane Sheds. Train Shed Numbers however, did not correspond with the road numbers of the available stabling space, and there may well have been another stabling road numbering system about which no more information has come to light.

The system of distinguishing which way round motor cars faced, mentioned in the previous paragraph, happened accidentally in 1905 when the letters A and B were allocated to each car of a pair of motor cars involved in experiments with battery emergency lighting. The car lettered A faced towards the Bank, the B car faced west. When control trailers were introduced in 1908 they were also given A and B letters, but no identification mark was provided on the cars at the time. The whole system was revised in 1926 when the stock was converted to air worked doors and the LER identification system was introduced.

The opening of the loop line and new station which caused all these numbering oddities was the result of the opening of the Franco-British exhibition. In addition to the building of the exhibition site on the other side of Wood Lane from the depot, a huge elevated arcade was built around the north and east sides of the depot, and was connected to the main entrance next to Shepherds Bush Station. At the Wood Lane end of the arcade a bridge was built across Wood Lane to provide a covered walkway to the main exhibition. The arcade dominated the depot and large parts of it are still in existence. The only part since removed is the section which covered Wood Lane Station and the north east side of the depot.

THE EALING EXTENSION AND THE WHITE CITY

On the 3rd August 1920 the Central London opened its new service over the Great Western Railway's Ealing and Shepherds Bush line. As a result additional platforms were built at Wood Lane and some extensions to the covered accommodation were put in at the depot to accommodate the extra trains required. Because of the need to provide connections from the existing loop line to the new line, which ran in a northerly direction parallel with Wood Lane for the first few hundred yards of its length, an unusual triangular layout was adopted for the new Wood Lane station platforms, as shown in Fig. 4.

In order to provide covered accommodation for the extra trains required for the new services shed roads 15 - 20 had extensions built at either end of the original building. The extra length added by this means enabled 2 x 6 car trains to be stabled on each of these roads instead of the 1 x 7 car train as before.. The depot had now reached its maximum size and remained substantially unaltered until it was rebuilt in 1948.

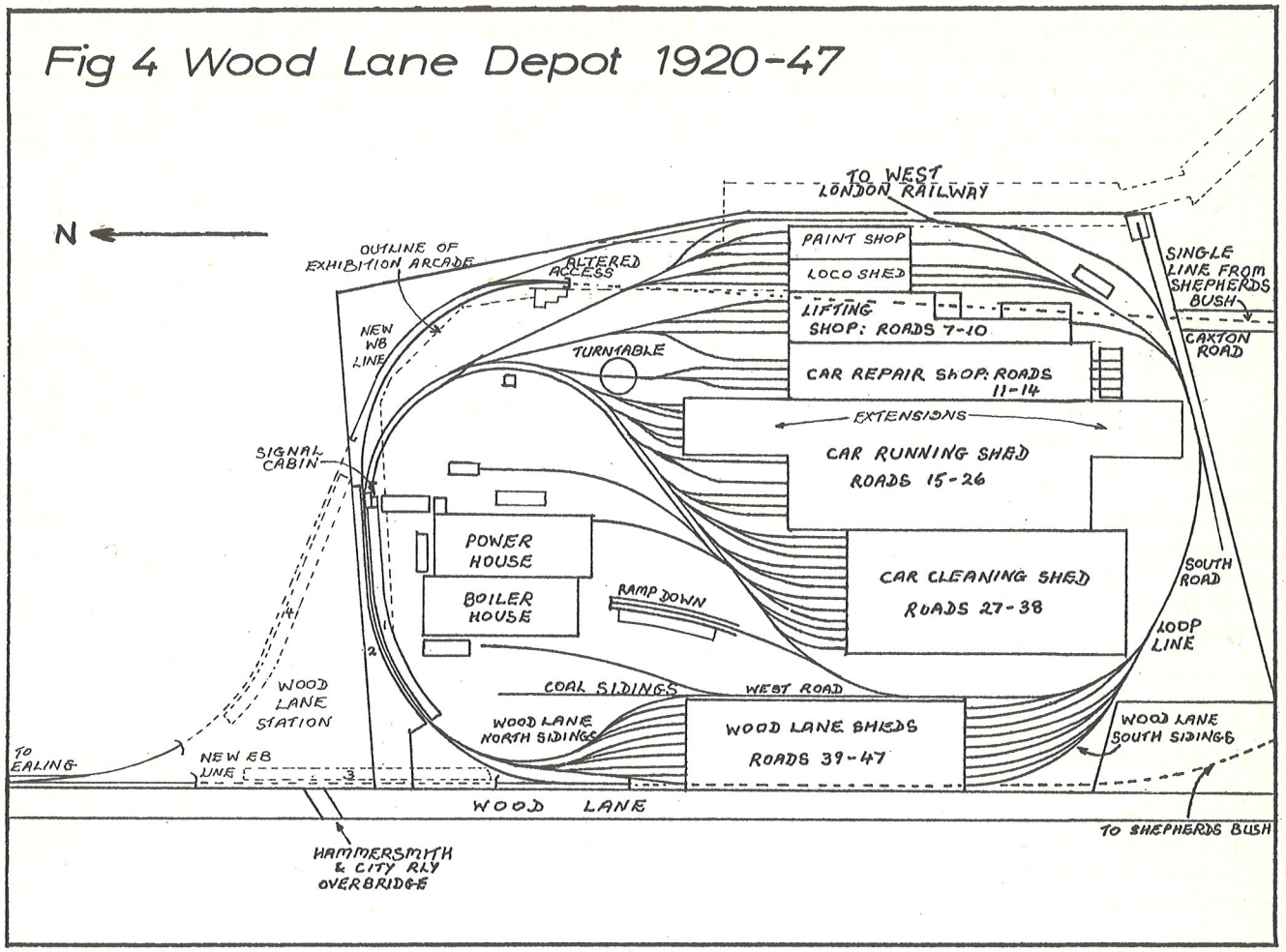


Figure 4 Wood Lane platforms 3 and 4 added in 1920 for the Ealing extension. The access road from the eastern side of the depot loop road was now connected to the new westbound line. This was the only route by which trains coming from Ealing could enter the depot. Because platform 4 was for westbound running normally, a crossover was put in between the eastbound line from Ealing and the westbound line to allow trains to run 'wrong way' through the platform to reach the depot by the new access road. Extensions to Nos. 15 to 20 sheds were built at this time to accommodate the extra stock needed for the Ealing service. No. 22 road was removed at this time for some unknown reason. Because trains entering the depot from Ealing would always run onto the east side of the loop road it became the usual practice to reserve the Wood Lane sheds for them to avoid reversal in the depot.

One alteration was made to the station in the 1920's which was to become the best known feature of the site. This was the movable platform extension installed at the east end of Platform 1 in 1928. Up to that time Platform 2 had always been used as it was on the outside of the curve and the end gate entrances of the cars were closer to the platform edge. With the introduction of air worked doors, which were generally nearer to the centre part of the cars, the inner edge of the curve became safer for the passengers. Because of the connections to the depot at each end of the inner platform face, a 6 - car train could not be accommodated. Hence the movable platform extension, which was operated from the signal cabin and was fully interlocked with the points leading into the depot at the east end of the platform. The installation of this unique system also allowed better handling of increased passenger traffic which arose from the dog and cycle racing which had started at the White City Stadium in 1927.

WOOD LANE TO WHITE CITY

Apart from the alteration to the Underground 4 rail current collection system and the introduction of Standard Tube Stock between 1939 - 40, there was little change in the depot until the extensions to the Central Line, as the

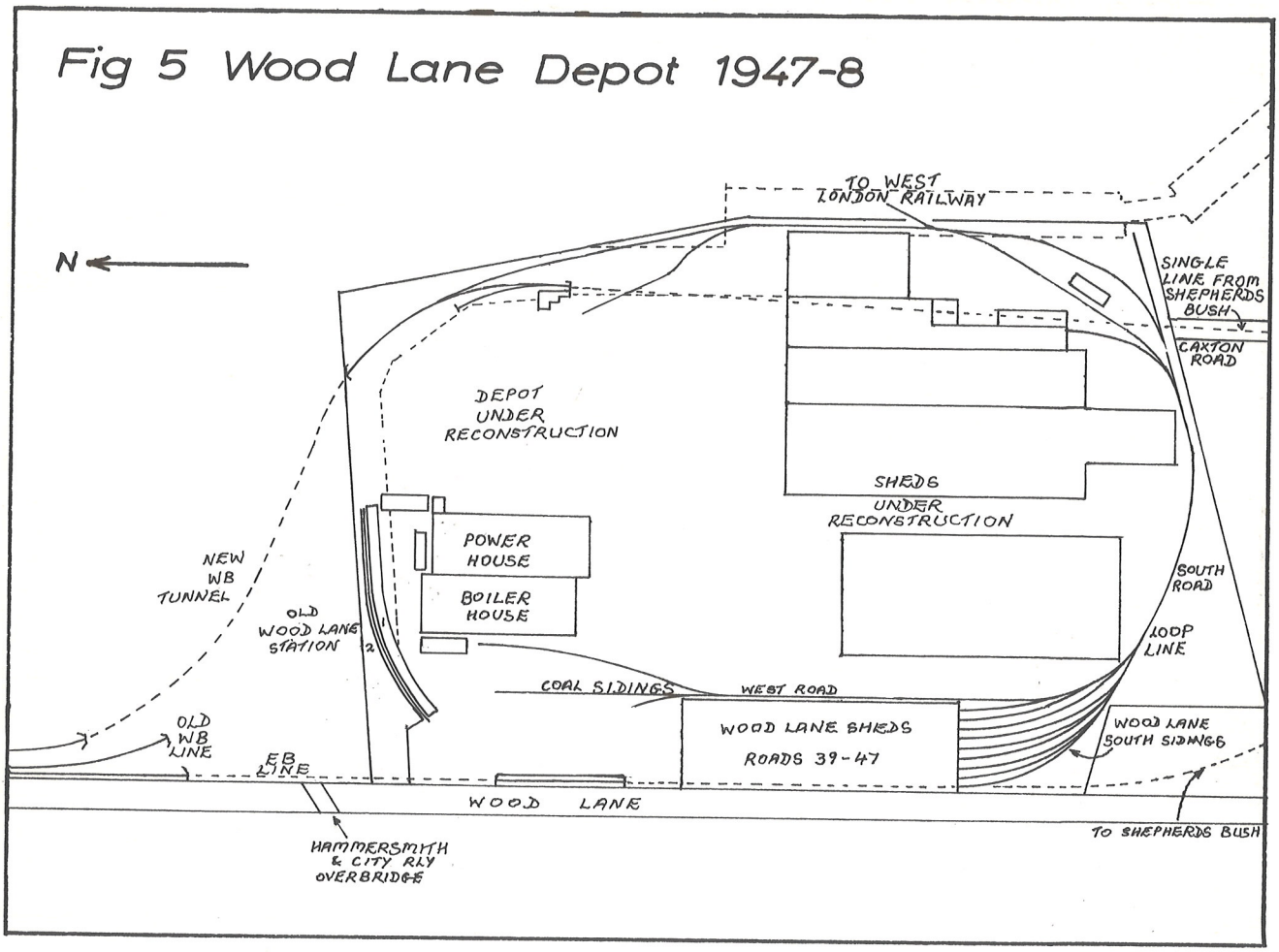


Figure 5 New covered way for the WB line opened in July 1948. All connections to the depot were removed except for the easternmost connection to the loop line. All the original sheds were closed for rebuilding except the Wood Lane Sheds, which were now the only ones in use.

Central London was now called, were opened in 1947. The depot at Wood Lane was too small to accommodate all the stock needed for the greatly enlarged line and the layout was too cramped to take the 8 car trains intended to operate the new services. It was therefore to be relegated to the status of an overnight stabling point when new depots were opened at West Ruislip and Hainault. In addition, the triangular layout at Wood Lane was to be replaced by a new station to be built nearer to the White City Stadium and which was to take its name.

The new White City station, together with a reversing siding, was opened on 22 November 1947. No alteration was made to the layout at Wood Lane at this time and trains merely ran through the old platforms to the new station. Work had begun, however, on diverting the Westbound line through a new tunnel built north of the old tunnel housing Wood Lane Platform 4. This new tunnel was opened on 17th July 1948 and the layout became as shown in Fig. 5. The connections to the depot had all been removed except the one running from the depot loop line to the Westbound road. All the depots original sheds were closed down and only the nine roads of the Wood Lane Sheds were left available for stabling. Work then started on rebuilding some of the original sheds and providing new links to White City Station. When the layout was completed on 6th August

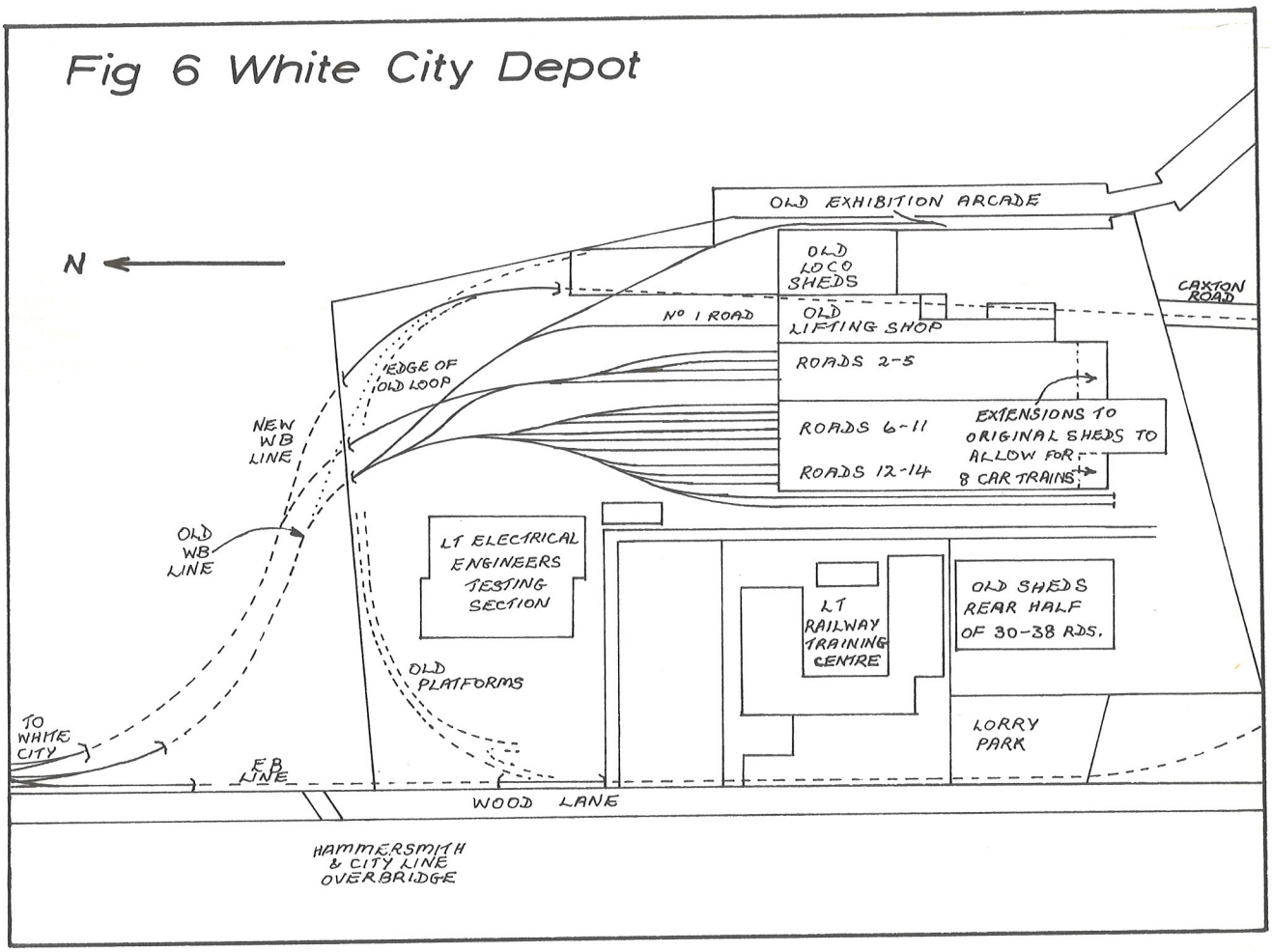


Figure 6 New layout as opened in August 1949, and still in use today. Road Nos 11 - 14 became Nos 2 - 5 roads Nos 15 - 23 became Nos 6 - 14. The sheds housing Nos 2 - 5 roads and Nos 12 - 14 roads were extended to accommodate 8 car trains. Two outside roads, Nos 15 and 16, were laid on the site of the former 25 and 26 roads. The Railway Training Centre was laid on the Wood Lane side of the depot in 1963, and the Wood Lane Sheds and part of the car cleaning shed had to be demolished to accommodate it. The remainder of the car cleaning shed is still standing, and is used for storing bus shelters. The open space left near the depot entrance in Caxton Road is used for turning buses terminating at Shepherds Bush Green. The connection to the West London line was disconnnected when the goods yard was closed. Two new rail connections to the depot were provided, one from the new WB line and one from the original WB line. The one from the original WB line ran along the old platform 4 for ¾ of its length and then curved south towards the depot. The connection from the new WB line ran almost parallel to the other one.

1949 it was as shown in Figure 6. The Wood Lane Sheds now became disused and two new access roads to the depot were opened, one via the old Westbound platform 4, the other via a new connection built between the Westbound line and the depot. In 1963 the new London Transport Training Centre was opened on the site of the Wood Lane Sheds, and the only parts of the depot area which remain are the old loco sheds and,lifting shop, part of the exhibition arcade, a small section of the old car cleaning shed and the derelict station platforms. The old station entrance hall is now used as an office and the power station buildings are still used by London Transport.

SIGNALLING AND OPERATION

The layout of the signalling controlled from the signal cabin at Wood Lane (G) was as shown in Fig. 7 after the installation of the movable platform in 1928. In fact, apart from the movable platform, little had changed since the opening of the Ealing line platforms in 1920. At that time an additional depot access road had been provided to connect the depot loop road and platform 4. Trains required to enter the depot from the Ealing direction did so by crossing from the EB to the WB line via No 21 crossover, running 'wrong way' through Platform 4 and, under the control of signal G 23, round the depot loop road to the Wood Lane Sheds. It became the practice therefore, to stable trains which were scheduled to enter or leave the depot via Platform 4 in the Wood Lane Sheds.

It was possible for trains to enter or leave the depot via either end of the loop platforms. It was preferred however, to use the east end road as this avoided reversal on the depot loop road to obtain access to the old sheds roads Nos 1 - 37. Because of the short length of the platform berth, it was necessary to stop at signal G 4, detrain passengers, draw forward so that the rear of the train cleared signal G 24 and then reverse into the depot 'East Yard'.

It was soon found that the depot loop road was useful to restore services to normal after late running. A train entering the Wood Lane platforms late from Shepherds Bush could be diverted into the yard instead of making its next scheduled trip to Liverpool Street and back. The driver was told to 'go round the farm' (the nickname for the depot loop road) and wait by the pump house, which was close to the outlet signal G 7. At the time due for his scheduled return from Liverpool Street he would be signalled into the platform so that he could start his next trip on time.

PHOTOGRAPHIC REFERENCES

A number of published photographs are of interest as they show various parts of Wood Lane and the Depot:

Tube Trains Under London by J. Graeme Bruce, Photo No 12: CLR loco and train standing on the original depot entrance road. Note the run round siding. The roof of the original signal cabin can be seen behind the third car. Photo 47: 6 car train standing on the access road to the main siding fan. Behind the camera are the car cleaning sheds, behind the leading car is the power house, and in the background are the old exhibition halls.

The Central Line by Charles E. Lee, Photo 3: CLR loco and train under the wires on the road leading to the loco sheds. Note no exhibition halls. Photo 4: loco in the loco shed. Note the inspection pits. Photo 8: Motor car in 1903 at the entrance to the car cleaning sheds. Behind is the power house and one of the two cooling towers, now demolished. Note the overhead wires. Photo 9: Trailer car, about 1927, in front of the power house. The overhead wire support pillars are still to be seen. Photo 17: Standard Tube Stock in the same place as the train in Photo 47 of Tube Trains Under London.

LT Railways Album by Chris Heaps, Photo 58: Train on entrance siding looking west in 1903. Opposite end of view of loco and train in Photo 12 of Tube Trains Under London.

Handling London's Underground Traffic by J.P. Thomas, Fig 91: Loco outside car cleaning shed standing on 'West Road'. Behind the camera are the Wood Lane Sheds. Fig 126: Platform 1 looking towards the movable portion. Above are the exhibition halls, to the right the signal cabin. Behind the railings in the background is the WB line to Ealing via Platform 4.

WOOD LANE 1928

Diagram of Signalling Fig 7

NOT TO SCALE

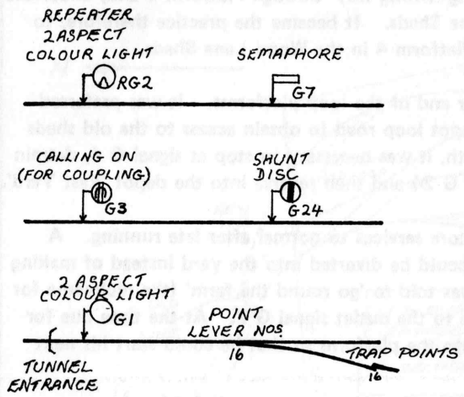
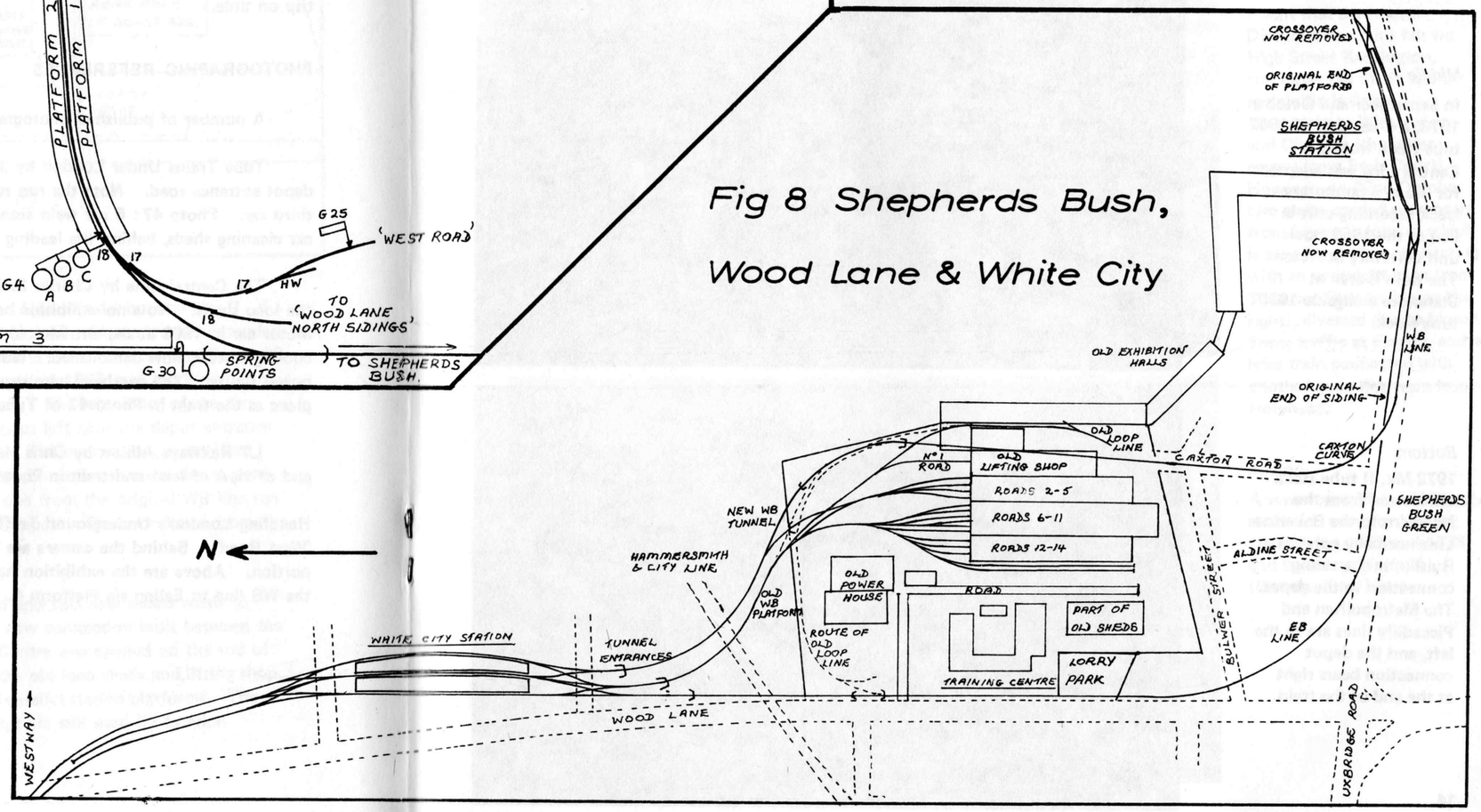


Fig 8 Shepherds Bush, Wood Lane & White City

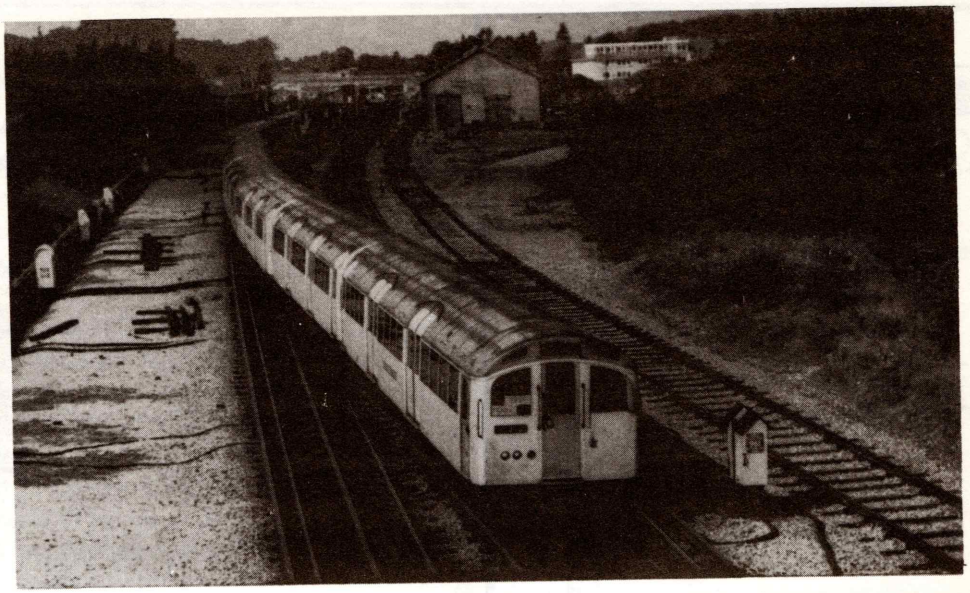


STRANGERS

All photographs : Brian Hardy

Top

In September 1978, a 7-car train of 1959 tube stock worked on braking tests between Rickmansworth and Amersham. The train is seen leaving Amersham.

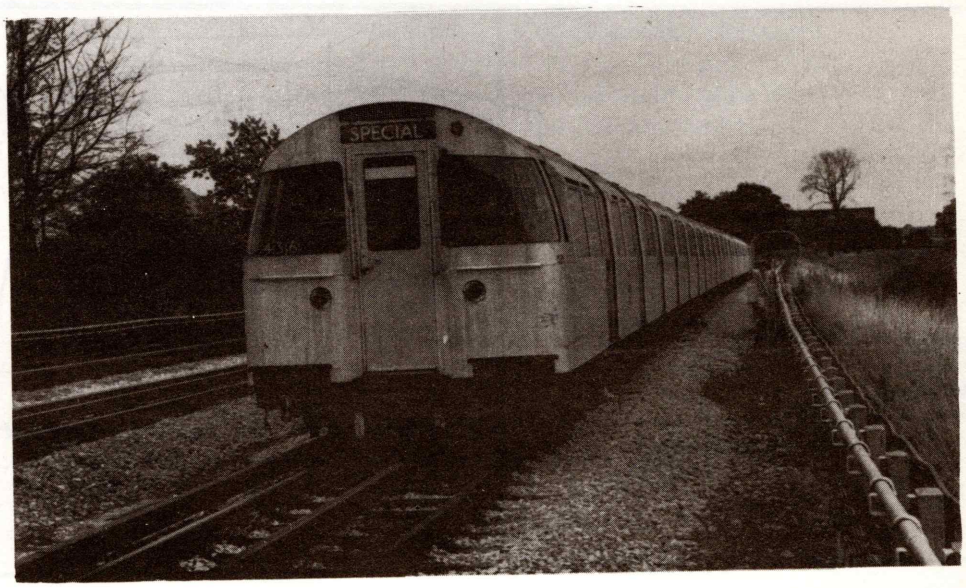


Middle

In September and October 1978, a 4-car unit of 1962 tube stock from the Central Line was adapted for use as a temporary track recording unit in lieu of the 1960 stock unit currently at Acton. The train is seen at Stanmore alongside 1938 tube stock.

Bottom

1972 Mk. II tube stock transferred from the Northern to the Bakerloo Line normally reverses at Ruislip, in the siding connection to the depot. The Metropolitan and Piccadilly lines are to the left, and the depot connection bears right at the end of the train.



Top

Before surface A stock started working on the East London Line in June 1977, crew training on the stock took place in Barking sidings. The train is seen immediately after transfer, still showing 'Wembley Park' and a Metropolitan Line 'set' number.

Middle

On Sundays 15th and 22nd October 1978, the diamond crossing west of Gloucester Road was renewed, which meant that eastbound District Line trains ran via High Street Kensington, and outer rail Circle trains ran via Earls Court alternately to Wimbledon and Olympia (the latter empty from Earls Court). However, on 22nd October two trains carried passengers from Olympia (one of which is seen here) after connecting with an overnight train from Stranraer (just visible on the right), diverted due to Motor Show traffic at Euston, and a later train connected with another main line train from Holyhead.

Bottom

A seven car train of 1938 tube stock was used for braking tests during 1977 and 1978 and is seen at Watford (Metropolitan Line)

THE WESTCODE BRAKE

INTRODUCTION

It is a legal requirement in Great Britain that all passenger carrying trains should be provided with a 'continuous brake'. The term 'continuous brake' arose because of the need to ensure that, should a train become uncoupled whilst running, anywhere along its length, both portions of the train should stop automatically. The brake could therefore be said to be continuous throughout the length of the train. It is also required that the driver or guard, or even the passengers, are provided with a means to stop the train in an emergency. Additional safeguards are provided in the case of trains having only one man in the cab – the 'deadmans handle' – and, on many railways, a device to stop the train overrunning a danger signal – on LT railways, the tripcock.

Until recent years the continuous brake has relied upon either compressed air, or the lack of it. The Vacuum brake has been popular on many main line railways in Britain, but the air brake - the Westinghouse brake - has reigned supreme on the London Underground since the turn of the century. Both systems use a pipe (often referred to as the Train Line pipe) to connect the brake equipment on each vehicle and the loss of air pressure, or vacuum, in the pipe will cause the brake to apply. Rapid loss of pressure causes an emergency application of the brakes on all vehicles. A gradual, controlled loss produces a normal, or 'service' application. This latter form of application is always done by the driver operating a valve in his cab.

In order to speed up the operation of service applications of the Westinghouse brake, electrical control of braking was introduced on the Underground in 1928, and was standard equipment on all trains by the Second World War. The Westinghouse air brake, with its Train Line Pipe, was retained (normally released) for the legal safety functions, while this new electro - pneumatic brake (e.p.) provided electrical control of air pressure to and from the brake cylinders on each car which applied or released the brake blocks at the wheels.

With the recent rapid increase in technological developments, it was only a matter of time before a system was devised which would allow electrical control of emergency braking as well as of service braking. Such a system would allow the abolition of the Train Line Pipe, with its tendency to leak or rupture and its varying degrees of efficiency according to its length, and allow the introduction of a wire in its place. The wire could perform all the safety functions required by law, loss of current in the wire replacing loss of air pressure from the Train Line Pipe. The basis of the system was already in use with the e.p. brake, which had one of its operating wires running the length of the train specially connected to interlocks on the brake valves on each car. Loss of current in this interlock wire caused a magnet valve in the drivers cab to drop open and allow an escape of air from the main supply pipe. The noise of this escape alerted the driver to the existence of a fault in his e.p. brake electrical system.

During the early 1960's the Westinghouse company devised a system which could be used to provide electrical control of both emergency and service braking and marketed it under the name of Westcode. An early version of it was introduced on the Toronto Subway in 1964 and it was later tried in London on a 1960 Stock unit and on 1967 Stock unit No 3006.

THE REQUIREMENTS

For the London Underground version of the Westcode brake it was decided that, apart from the safety functions, the new system should include all the functions of the service brake and, in addition, should provide means of monitoring individual car loading, preventing locking of the wheels and monitoring the performance of the dynamic braking now being fitted on the motor cars of modern stocks. Dynamic braking on the Underground now takes the form of rheostatic braking, whereby the traction motors are used as generators during braking, the current generated being disssipated as heat through resistance banks mounted under the car floor. The new system was also to be capable of use, without major alteration, if Automatic Train Operation (ATO) was fitted in the future.

In order to achieve all these aims it is necessary to have the following equipment :-

1. 'Round the Train Wires' which would carry an electric current at all times unless lost by operation of a passengers', guard's or driver's emergency brake device, operation of a tripcock or deadmans handle, loss of supply current, breakage of the wires or uncoupling, which amounts to the same thing.

2. A valve on each car which will admit air to the brake cylinders if the 'Round The Train Circuit' is lost, but which can also supply a controlled flow of air to the brake cylinders for the service brake. It is known as the Seven Step Valve.

3. Another valve on each car which will limit the air pressure available for braking according to the weight of the passengers. There are actually two valves for this, the Variable Load Valve and the Variable Load Control Valve.

4. A relay on each motor car which will prevent air being admitted to the brake cylinders if sufficient braking effort is being provided by the rheostatic brake.

5. Valves on each car which will release air from the brake cylinders if wheels begin to skid during braking. These are called Dump Valves.

6. Three train wires which can be used to provide control for up to seven different rates of air braking according to the drivers requirements.

7. Separate circuits to allow for Manual or Automatic driving, and to provide for some additional safeguards, as will be seen.

THE ELECTRICAL CIRCUITS

At first glance it would seem simple enough to attach all the safety features to the Round The Train Wires. In fact, because of the need to provide separate circuits for Manual or Automatic driving, the system is rather more complex than that. Fig 1 shows a simplified layout of the Round The Train Circuits and how service control of braking is achieved.

In order to keep the brakes released it is necessary to maintain an electric current to the Seven Step Valve on each car. Loss of current will cause the valve to let air from the supply pipe to the brake cylinders. To maintain the current to the valve two relays, BSA and BSB (the Brake Safety relays) must be kept energised. BSA is supplied from a '10 mph Safety Circuit', BSB from a 'Full Speed Safety Circuit'. The 10 mph circuit would be used with ATO for Manual driving, the Full Speed Circuit for Automatic driving. At present, without ATO, either circuit can be selected by means of a push button in the cab. Both circuits monitor the operation of all the safety equipment on the train. They check that the front tripcock has not been operated, that the deadman has not been operated and that the driver has not selected the Emergency brake position on his controller. If Full Speed has been selected a contact is provided to prevent the driver from releasing the brakes for a period of three minutes after the tripcock has been operated. He must select the 10 mph circuit which will allow the brakes to remain released unless the train speed exceeds 10 mph. A contact is provided in the 10 mph circuit which remains closed provided the train speed remains below 10 mph.

Both the 10 mph and Full Speed Safety circuits require that a relay, known as BPM (Brake Passenger Master), is kept energised. This relay monitors the condition of another circuit, the Passenger Alarm Circuit, so that any break in this circuit will cause the BPM relay to open both the Safety circuits. Because there has been a great deal of malicious operation of Passenger alarms in recent years, a By - Pass switch has been provided on the 10 mph circuit so that the driver may proceed at 10 mph to the next station if he is stopped by operation of the BPM. This allows him to investigate the cause at a station rather than in a tunnel where no help is available.

The BPM relay is supplied by the Round The Train Circuit. A supply wire runs from the front to the rear of the train, where it monitors the position of the rear tripcock. It then returns to the BPM on the front car via a set of contacts on each car. These contacts are kept closed by a BPA (Brake Passenger Alarm) on each car which receive a feed from the supply wire via passenger and guard's alarm switches. Operation of any of the switches will cause the BPA to de-energise and break the circuit to the BPM on the leading car. It will also cause a lamp to light up over the end door of the car concerned to tell staff which car needs investigation.

The whole of this electrical system is supplied at 50 volts DC from the operative cab, but in order to prevent a brake application disabling the train if the supply is lost, each circuit has its own protective devices and various means of isolating defective equipment. These are not included in the diagram.

SERVICE BRAKE CONTROL

In order to keep the brake released the Seven Step Valve must receive a supply of current. This supply is provided by three wires lettered A, B and C. The wires pass through contacts on BSA and BSB relays (which are fed

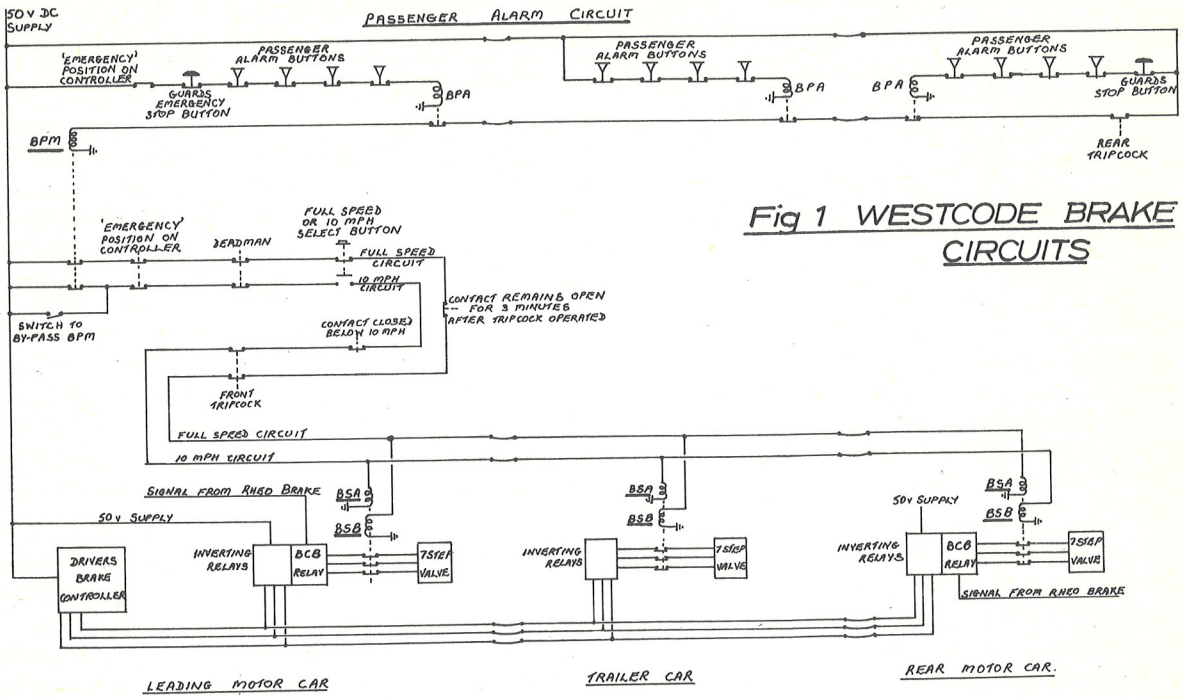


Fig 1 WESTCODE BRAKE CIRCUITS

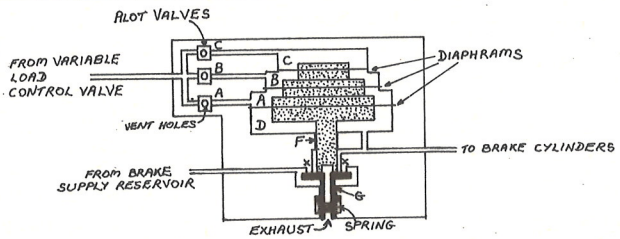


Fig 2: 7 STEP VALVE

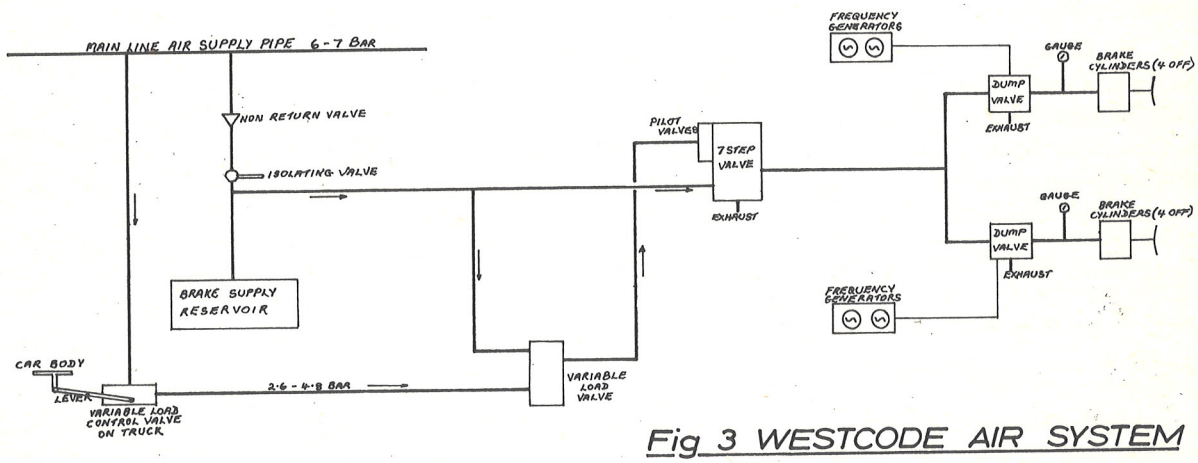


Fig 3 WESTCODE AIR SYSTEM

from the 10 mph and Full Speed circuits) and are connected to three pilot valves (A, B and C) inside the Seven Step Valve. The pilot valves are normally kept energised to release the brake, but if all are de-energised the Seven Step Valve will cause a full emergency brake application. Service braking is obtained by de-energising one or two pilot valves at a time in different combinations. The effect of these combinations is to vary the amount of air pressure admitted to the brake cylinders by the Seven Step Valve. As its name suggests the Seven Step Valve can give seven different proportions of brake cylinder air pressure, or eight if you count 'release'. The Combinations of the three pilot valves are as follows:-

Step	Pilot Valves De-energised	Proportion of Brake Cylinder Pressure
Release	None	Nil
1	A	1/7
2	B	2/7
3	A & B	3/7
4	C	4/7
5	A & C	5/7
6	B & C	6/7
7	A & B & C	7/7

From this table it can be seen that the three pilot valves must be energised and de-energised by their control wires in such a way that there is never any overlap when changing from one step to the next. If an overlap was to occur, allowing any of the pilot valves to become energised out of sequence, the brake cylinder pressure would be lost for a moment until the correct valves had de-energised. To eliminate this possibility a system has been devised whereby a separate 50 volt supply is fed to A, B and C control wires through 'Inverting Relays'. These inverting relays are energised, in sequence, from the drivers brake controller by Code Control Wires Nos. 10, 11 and 12. As London Transport has decided not to use the two lowest braking steps the system works as follows :-

Brake Controller Position	Westcode Step	Code Control Wire Energised	Pilot Valves De-energised	Proportion of Brake Cyl. Pressure
Release	Off	None	None	Nil
Service 1	3	10	A & B	3/7
Service 2	4	10 & 11	C	4/7
Service 3	5	11	A & C	5/7
Service 4	6	11 & 12	B & C	6/7
Emergency	7	11 & 12	A & B & C	7/7

Note that in 'Emergency' Code Control wires 11 and 12 remain energised as for Service 4, but pilot valves A, B and C are all de-energised of course, by loss of feed to BSA and BSB relays.

As rheostatic braking is provided on Motor Cars, air braking will not be required on these cars if the rheostatic brake is providing sufficient braking effort. If a signal from the traction equipment, indicating adequate rheostatic brake, is present, a 'BCB' relay is energised and supplies a 50 volt feed to A, B and C wires. This causes the pilot valves to remain energised and the air brake released. It will however, still be applied on the trailer cars in response to the brake command selected by the driver.

THE WESTCODE AIR SYSTEM

The heart of the Westcode air system is the Seven Step Valve fitted to each car (fig 2). The Seven Step Valve has the three pilot valves, A, B and C, which are each connected to a chamber, also A, B and C. The chambers are separated from each other by flexible diaphrams with varying effective areas. These areas are equivalent to 4/7, 6/7 and 7/7 of possible brake cylinder pressure. Another chamber (D) is connected to the brake cylinder pipe and can therefore monitor brake cylinder pressure. All the diaphrams are connected to a valve assembly F. It can be seen from the diagram that if Valve F is lifted, the exhaust passage (inside another valve G) is connected to the brake cylinders and the brakes will release. Alternatively, if Valve F is lowered, it will push against the spring loaded valve G, dislodge it from its seat (X) and allow air from the brake supply reservoir into the brake cylinders and chamber D. The raising and lowering of Valve F therefore, releases and applies the brake. In its normal 'Running' position, brake released, it is as shown in Fig 2.

In order to explain the operation of the Seven Step Valve the example of the 'Service 1' brake being selected can be used; When Service 1 is selected, pilot valves A and B will de-energise and allow compressed air into chambers A & B. As the top diaphram has an effective area of 4/7 and the middle diaphram an effective area of 6/7, the air entering chamber B will be registered by these diaphrams and will cause Valve F to move downwards with a pressure equivalent to 2/7 (6/7 -4/7). The air pressure admitted to chamber A will cause further downward pressure of Valve F equivalent to 1/7 (7/7 - 6/7). The

total downward pressure now equals 3/7. The downward pressure of Valve F against Valve G causes Valve G to open the connection between the brake supply reservoir and the brake cylinders. This connection will remain open until the pressure in chamber D, which is the same as brake cylinder pressure, becomes equal to the downward pressure on Valve F. When this state of balance is reached, the spring at the bottom of Valve G will push it back onto its seat and prevent any more air entering the brake cylinders.

The brake can be released only if the balance of the Seven Stop Valve is upset by removing the downward pressure on Valve F. This is done by energising the pilot valves, in our example valves A and B. When each pilot valve is energised a vent hole opens in the valve which allows the air from the corresponding chamber to escape. The downward pressure on Valve F is therefore removed and the brake cylinder pressure present in chamber D will push Valve F upwards away from its seat on Valve G. Air in the brake cylinder and chamber D will escape through the exhaust passage in Valve G. Once the pressure has all been lost a small spring at the top of Valve F allows it to reseat.

The beauty of this system is that the brake cylinder pressure will always be maintained equal to the downward pressure on Valve F. It is possible to apply any air pressure required to the three chambers, and the brake cylinder pressure will be a proportion of it, depending on which of the chambers is used. If the air pressure applied to the pilot valves is made proportional to the weight of the car, the Seven Step Valve will allow a corresponding brake cylinder pressure. Braking can therefore be made to vary with the load.

To provide a means of load weighing one truck on each car is equipped with a Variable Load Control Valve (VLCV). This is connected to the car body by a lever, which will move down with an increase of weight in the car. The VLCV receives air from the main supply pipe (fig 3), registers the downward pressure on the lever and supplies an output pressure in proportion. This output is passed to a Variable Load Valve which, in turn, supplies exactly the same pressure to the pilot valves. The range of pressure supplied to the pilot valves varies between 2.6 and 4.8 bar. A bar is the metric equivalent of 14.5 lb/in^2. The brake cylinder pressure would therefore be between 2.6 and 4.8 bar if emergency brake is called for. If 4.8 bar was available for emergency braking regardless of car weight, the lighter cars would probably skid, increase the braking distance and damage the wheels. Service braking pressure will be a proportion of emergency pressures, in 7ths, as under :-

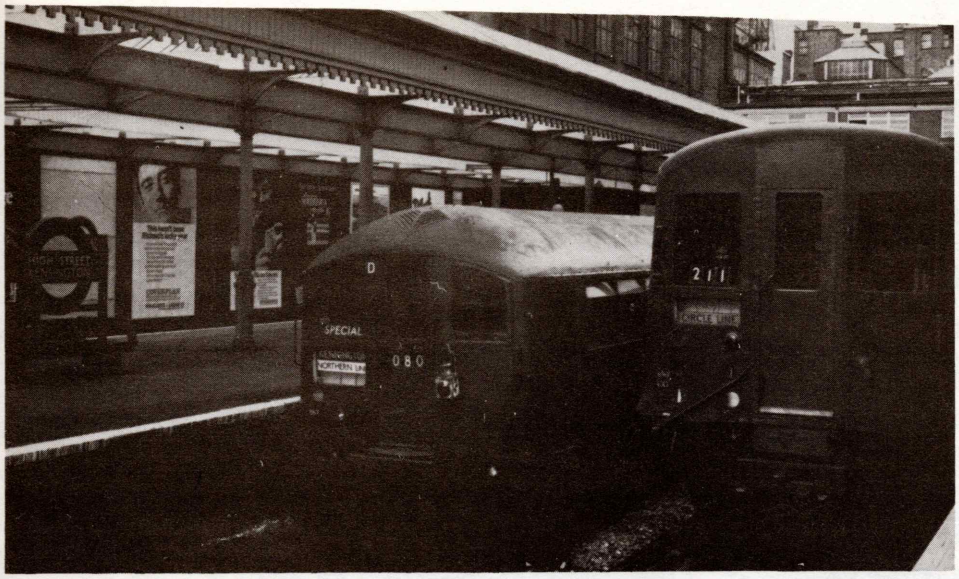
Brake Controller Position	Pilot Valves De-energised	Proportion of VLCV pressure in 7ths	Brake Cylinder Pressure Range
Release	None	Nil	Nil
Service 1	A & B	(7–6) + (6–4) = 3	1.1 – 2.0 bar
Service 2	C	4	1.5 – 2.7 bar
Service 3	A & C	(7–6) + 4 = 5	1.8 – 3.4 bar
Service 4	B & C	(6–4) + 4 = 6	2.2 – 4.1 bar
Emergency	A & B & C	(7–6) + (6–4) + 4 = 7	2.6 – 4.8 bar

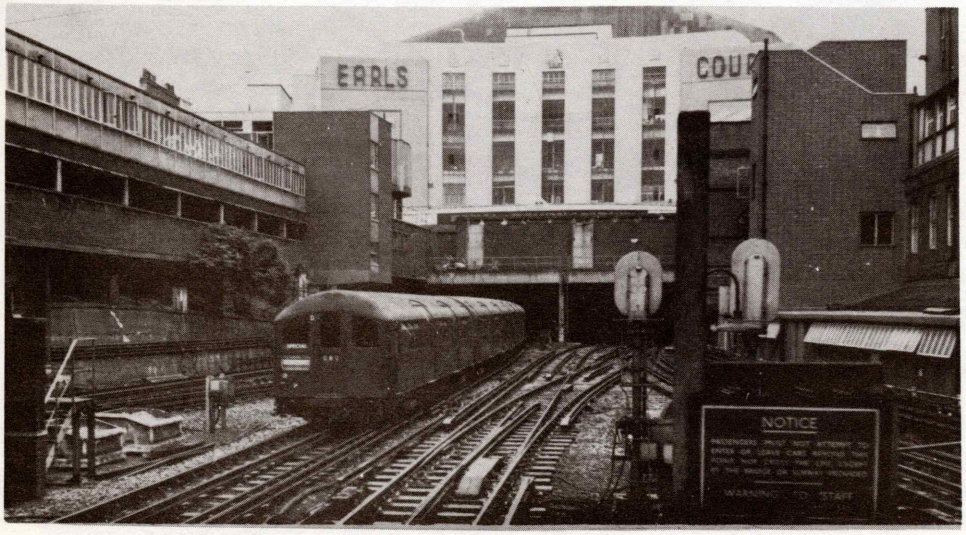
THE WESTCODE ON THE UNDERGROUND

The Westcode brake is fitted to the 1973 Tube Stock, and to the new D78 Stock substantially as described in this article. However the need to provide wheelslide protection to avoid skidding wheels has meant the fitting of Dump Valves to each truck set of brake cylinders. Normally these Dump Valves remain de-energised to allow air from the Seven Step Valve to pass unhindered to the brake cylinders during an application. If the Dump Valves are energised the air supply from the Seven Step Valve to the brake cylinders is shut off and the brake cylinder air is released to atmosphere on the truck concerned. The Dump Valve will energise when it receives a signal from special electronic equipment mounted on the truck. Part of this equipment consists of a pair of frequency generators, one mounted on each axle. If the axles both rotate at the same speed the generators will both produce the same current and the Dump Valve will remain de-energised, If one of a pair of wheelsets locks during braking the generator outputs will vary. The variation will be detected by the electronic equipment which will send a signal to the Dump Valve which will energise and release the air from the brake cylinders on that truck. The release of air will now allow the wheelset to begin rotating again, the generators will both produce the same current again and the Dump Valve will de-energise. Air will now be restored to the brake cylinders to re-apply the brake on that truck. The sequence will be repeated every time a wheelset locks, except in the emergency mode, when the system does not operate at all.

The Westcode system as used on the London Underground involves another new feature known as the Train Equipment Panel (TEP). This panel is provided in the drivers cab to give an indication of the state of the various pieces of equipment on the train. Among the indications are two which denote: "Brakes All On" and "Brakes All Off". In addition, push buttons allow for the selection of 10 mph and Full Speed Safety circuits. A device is installed in the TEP which ensures that before beginning each trip both 10 mph and Full Speed circuits must be tested to see if full application and release of brakes can be obtained.

Aside from variations imposed by Rheostatic braking the Westcode brake works well enough. Some teething troubles, mostly connected with Train Equipment Panels, have been experienced, and more gentle stopping could be achieved by restricting the exhaust passage orifice to allow a more gradual release of brakes. However, the system is efficient, compact and provides all the safety functions required by law. It is now unlikely that stock built after the D78 stock will incorporate Westcode braking as another new system has been developed for use on the 1983 Tube Stock. Such is the pace of modern rolling stock technology.





1938 TUBE STOCK ON THE DISTRICT

During the maintenance workers' strike of 1969, a number of 1938 tube stock trains were lent to the Northern Line from the Piccadilly Line. However, when they returned, at least one came back the wrong way round, and had to be turned using the Gloucester Road-High Street Kensington-Earls Court triangle.

Top

1938 tube stock and CO car 53029 (the first of the Gloucester built cars) at High Street Kensington 26.7.1970. *R.J. Greenaway*

Middle

The same 1938 tube stock train at High Street Kensington 26.7.1970
G. Jasieniecki.

Bottom

Another view of the same train, this time heading west through Earls Court, 26.7.1970. *G. Jasieniecki.*

METROPOLITAN ELECTRIC LOCOMOTIVES

Top

No. 5 with an Aylesbury train approaching Rickmansworth. Although named 'John Hampden' it is shown here in the grey 'wartime' livery which this loco. retained until August 1955, and without nameplates.

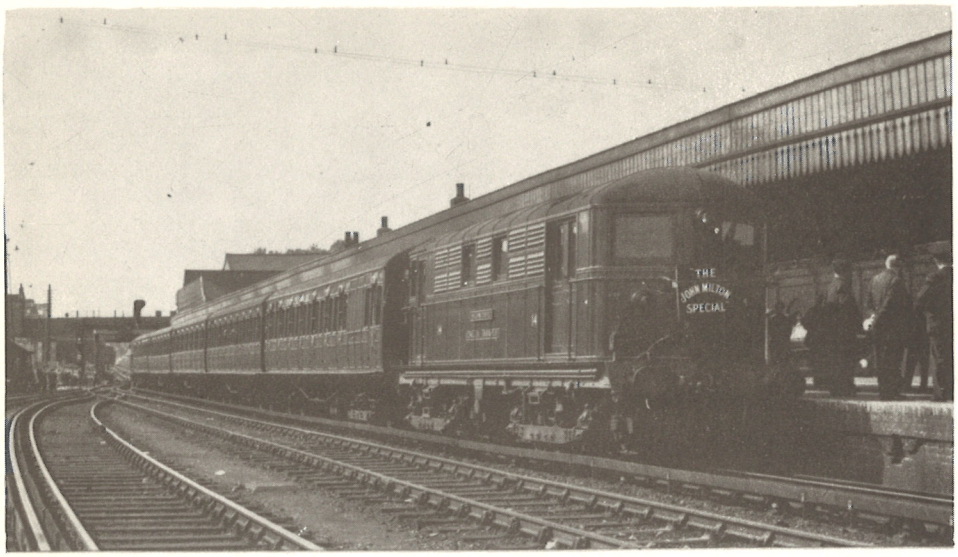
Middle

Locos. 4 'Lord Byron', 18 'Michael Faraday' and 2 'Thomas Lord' in the sidings at Rickmansworth waiting to take southbound trains onto Baker Street. The steam loco. on the right has just come off a southbound train and is about to run round to the steam loco sidings at the north end of the station.

Fred Ivey / L.T.P.S.

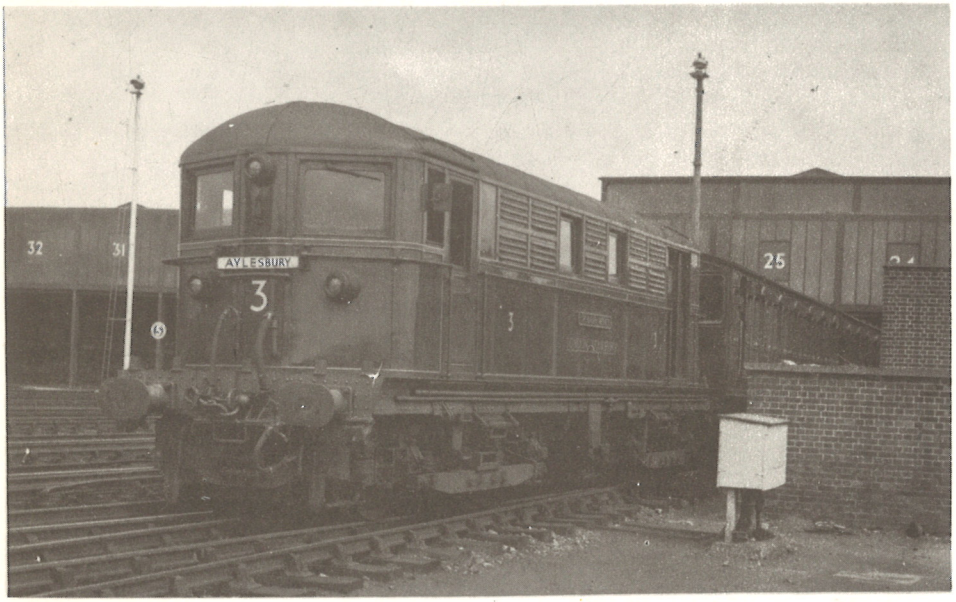
Bottom

No. 11 'George Romney' being disconnected from its train at Rickmansworth before handing over to a steam loco. for the train's journey north. No. 11 is also in grey livery, but this was one of four which received its post-war nameplate before it was repainted maroon.



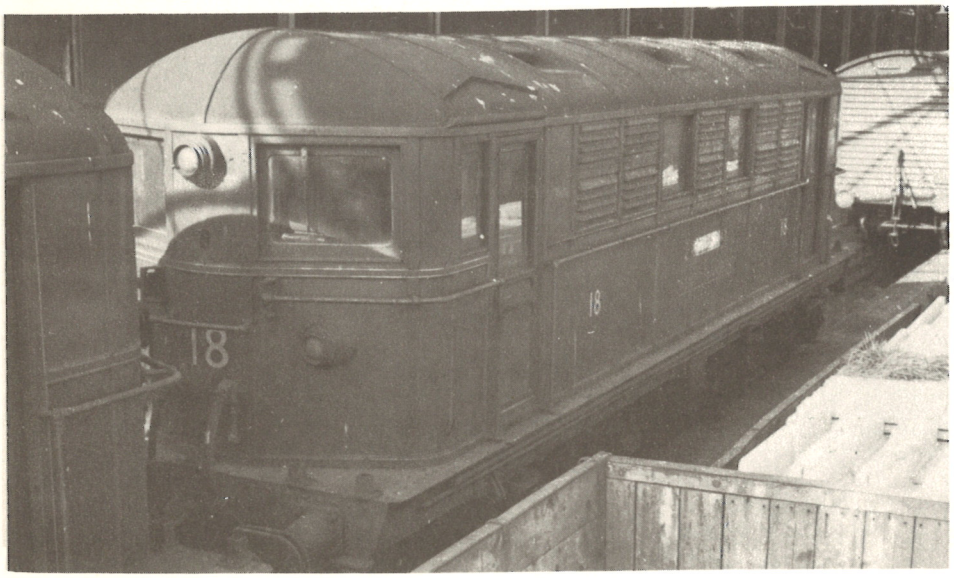
Top

No. 14 'Benjamin Disraeli' heading 'The John Milton Special' at New Cross Gate.



Middle

No. 3 'Sir Ralph Verney' and a set of Chesham Shuttle coaches at Neasden depot. This loco. was retained in the service fleet at Ruislip depot mainly for shunting the old and new stock with the aid of a match wagon.



Bottom

No. 18 formally named 'Michael Faraday' at the L.M.R. depot at Mitre Bridge, Willesden, after purchase by B.R. Four locos. at least were so treated, and some were seen at Rugby in about 1965/6. Further information as to the purpose and subsequent history of these locos. would be much appreciated.

Lens of Sutton.

All photographs from R.J. Greenaway's collection unless otherwise credited.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