

# THE LONDON ELECTRIC TRAIN

## 20 – NEW WORKS

by Piers Connor

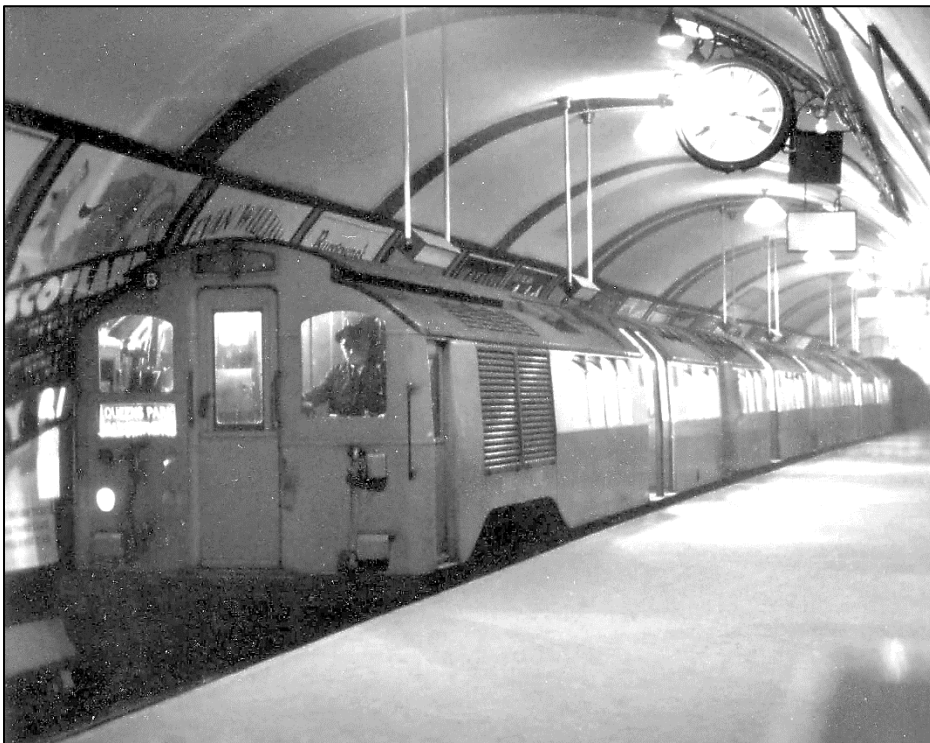
### LONDON TRANSPORT

On 1 July 1933, the London Electric Railway was, with the rest of the Underground group and a large number of bus and tram companies operating in the London area, taken over by the London Passenger Transport Board (LPTB). Not much changed at first, apart from the appearance of “London Transport” on the sides of vehicles in place of “Underground” but some big changes were afoot since the government had decided to provide money for a number of tube line extensions and for new stock to work on them. The development plans for the extensions and much additional work for new and existing fleets became known as the 1935-40 New Works Programme. Before looking at the new works programme in detail, we need to catch up with events on the LER.

### WATFORD

When the Watford Replacement Stock (WRS) was introduced on the Bakerloo Line in the summer of 1931 only 10 six-car trains and two spare motor cars were ordered for the service. This proved to be totally inadequate for the traffic that rapidly built up on the line and additional cars had to be transferred in from the Piccadilly Line. The fleet was rapidly increased to 26 six-car trains.

The Watford stock was delivered with electro-pneumatic (e.p.) brakes and automatic weak field operation for the traction control system. Weakening the magnetic strength of the field coils of the traction motors when they reached the upper end of their speed range provided a top speed increase of around 5-10%. The motor bogie design (Type Y<sup>2</sup>) reverted to the 40in wheel diameter fitted to the 1923-25 Stock motor cars. The larger wheels were provided in order to allow higher speeds. The 1926-29 Stocks and the 1930 experimental UCC train had Type Z bogie with 36 inch driving wheels.



*Figure 1: A 3-car Bakerloo Local stock train about 1937. Local trains only worked as far north as Queen's Park. The Bakerloo had a mixed fleet of Local and Watford trains. The local stock was itself mixed, some trains being all Standard Stock and some with Standard Stock motor cars and Cammell Laird trailers. The Local Standard Stock didn't get e.p. brakes until all the old 1920 Cammell Laird stock had been taken out of service. This three-car set is one of the all-Standard trains and is led by a 1927 Met. Carriage motor car. The rear car will be a control trailer. Photo: B.R. Hardy Collection.*

The additional trains transferred in for the Watford service were modified to have e.p. brakes and weak field control so that they matched the WRS and could be interchanged with it but there was nothing they could do about the wheel size without major expense. They remained as they were.

At first, when researching this, my instinct told me that they would not have allowed motor cars with 36in wheels to be mixed in trains with motor cars having 40 in wheels. However, the fleets operated on the Morden-Edgware Line had mixed wheel sizes (pre- and post-1926 Stock) and there was a

difference between the gearing of the two types that that would have compensated and therefore there was nothing to prevent mixing of the two types in the same train. In later years on the Central Line, cars with different wheel sizes regularly worked in the same train. One has to be careful about instinct in looking at history.

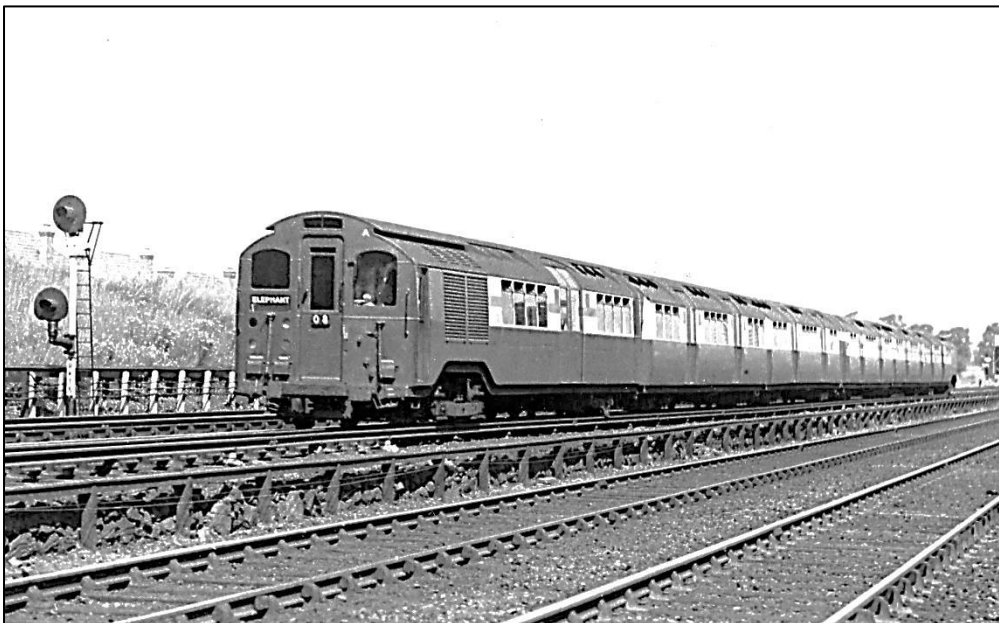


*Figure 2: Watford Replacement Stock motor car at the Metro Cammell factory. It is not yet fully fitted out, for example, shoebeams are not fitted because they were likely to get damaged in transit between Birmingham and the Underground's delivery depot at Lillie Bridge. Photo: Official Metro Cammell.*

## CASCADE

With the New Works Programme came a big rolling stock cascade schedule, with the LER's Standard Stock right in the middle of it. Modifications and improvements to the existing fleet were included in the plans. As with any programme of this scale, there were changes and adjustments but the original plan was simply referenced in the following statements dated 9 November 1936 in the first issue of Chief Mechanical Engineer's Instruction No.79 covering rolling stock improvements on the tube lines:

- "The Morden-Edgware Line will be equipped completely with new rolling stock" (which would become known as the 1938 Tube Stock).
- The "Central London Line will be completely equipped with existing stock from the Morden-Edgware line".
- The Bakerloo and "Northern City" lines were to use "existing stock, together with some new motor cars which will run with existing trailers".



*Figure 3: A 6-car train of mixed Watford Replacement Stock and UCC-built stock working a southbound Bakerloo train from Watford to Elephant in the mid-1930s. Between 1932 and November 1937 Watford trains were identified by a blue stripe painted along the car sides. Numerous car transfers into and out of the Bakerloo fleet meant that cars sometimes on Watford trains were without the stripe, as seen here on the second and third cars. Photo: B.R. Hardy collection.*

The final part of the statement was a little off the mark, since the existing stock on the Northern City Line was then surface stock (the original Great Northern & City Railway (GN&C) stock, plus some

Metropolitan Railway saloon stock) and the new motor cars were to be tube stock. What they tried to say was that the Northern City was to be equipped with tube stock that would replace the old surface stock. This would also require the traction current system used on the GN&C to be modified to match the standard Underground system.

The plans to extend the line north to cover the routes to High Barnet, Alexandra Palace, Edgware via Mill Hill and the extension to Elstree were not mentioned in the text and neither were the eastern and western Central London extensions but cars for these services were provided for in the plans.

Trying to make sense of the detail of how trains or cars were to be allocated is now impossible. Between October 1935 and October 1938, a total of nine different allocations of new and existing stock have survived in the records, none of which actually happened because, on 3 September 1939, the Second World War started and there was a rapid re-assessment of work that should be continued and what could be stopped. The main casualties were the Northern Line extensions to Elstree and Alexandra Palace and both the east and west Central London extensions. This resulted in much of the LER stock intended for the Central London being stored for the duration of the war. Before that though, a lot of the planned modification work was carried out and some LER stock was transferred to the Central London to replace the existing stock.

## CLR REPLACEMENT FLEET

By 1935, the Central London line was 35 years old and much of its stock was of a similar vintage. The newest vehicles dated from 1915. The cars were wooden bodied and had been much altered over the years, in particular in the mid-1920s for conversion to air operated doors. They were now due for replacement.

Although the Central London was part of the Underground group and had been since 1913, its infrastructure and its technology were non-standard. The traction current system used a third rail mounted in the centre of the 4-foot with the return circuit completed via the running rails and the bored tube tunnels were built to the same nominal diameter as other tube lines of the early 1900s but the construction was imprecise and there were places where the structure alignment was as much as 8 inches out of true. Trains working on the line were smaller than standard LER stock



*Figure 4: A 6-car train of LER stock leaves Ealing Broadway Central London station. The platform for the Central London was between the District station on the one side and the Great Western on the other side just as it is today. This is the only photo I recall showing LER stock running on the Central London 3-rail system. The photo dates from between November 1938 and May 1940 when the 4-rail installation was completed. Note the GW*

*3-position semaphore signals provided for the opening of the Ealing extension in 1920. These interesting signals are probably worth a story of their own. Photo: B.R. Hardy collection.*

Although the traction current supply question was a relatively easy problem to solve, either by getting trains to match it or by converting it to the standard LER 4-rail system, in terms of rolling stock

replacement options, the tunnel structure gauge meant that either the stock would have to be smaller than the standard LER tube car or the tunnels would have to be re-aligned. In assessing the options, the Chief Mechanical Engineer, W.A. Agnew, arranged for a special mockup of a new Central London car designed for the existing tunnels to be built at Acton Works. It was ready in late 1935 but it cannot have impressed Mr. Agnew or his deputy W.S. Graff-Baker who was shortly to succeed him for, in October 1935, a plan was drawn up for the replacement of the stock based on the tunnel enlargement option.

The tunnel enlargement work started in the autumn of 1936 and took two years to complete. In parallel, the original Central London platforms, originally designed for seven 45ft cars, were extended by 100ft to accommodate eight 51ft cars. The western extension to West Ruislip and Denham and the eastern extensions over the old Great Eastern Railway routes to Newbury Park, Woodford and Epping were expected to generate enough traffic to make eight-car peak hour trains essential. The enlargement work was carried out almost entirely without interruption to traffic, a feat unimaginable today<sup>1</sup>.

## 4-RAIL CONVERSION

Rather wisely, the conversion of the Central London's 3-rail traction current system to the standard LER 4-rail system was carried out after the tunnel work. It was arranged that the rolling stock cascade triggered by the delivery of the 1938 Tube Stock to the Morden-Edgware Line would require the LER Standard Stock delivered to the Central Line to be modified to operate on the 3-rail system until the conversion work was complete.

The transfer programme began with a trial run of a 6-car Standard stock train through the line on 12 November 1938. The first train entered service just three days later on 15 November in the formation 3540-7378-7503-3583+5214-3567. Trains coming to the Central London from the Morden-Edgware Line were sent to Acton Works first for modifications and an overhaul so the programme was devised with a lag between the arrival of a new 1938 Tube Stock train, its entry into service and the transfer of a Standard Stock train to Acton. The lag started off at about five months, which gave some time for training, modifications and the overhaul work.

The LER Standard Stock ran on the Central London in M-T-T-M + CT-M formation. This replaced the traditional Central London stock formation of M-T-CT+CT-T-M and meant that the proportion of motor cars on the train was increased from 33% to 50%. The power was also increased from 500hp on the 1903 Stock to 1,440hp on the Standard Stock, but this was too much for the existing traction power supply and the current draw was suppressed during the period before the upgrades were completed in 1947 with accelerating relays set at a lower than normal value. Also, to compensate for the poor power availability west of Wood Lane, one of the motor cars in each train running between Wood Lane and Ealing Broadway had its traction equipment cut out.

The last train of the original Central London stock ran on 10 June 1939. A total of 43 x 6-car trains (plus four additional motor cars needed to cover maintenance) had been brought over from the Morden-Edgware Line in a total of eight months. With this part of the programme in place, the additional current rail was added and a changeover date arranged for 20 April 1940 but it was delayed slightly and actually took place on 5 May. Even then, it was still forbidden to operate trains west of Wood Lane with all three motor cars under power and this remained in force until 9 March 1942.

## NORTHERN CITY LINE

The title "Northern Line" was applied to the Morden-Edgware Line<sup>2</sup> from August 1937 but the Northern City Line seems to have got its name some time before that. In planning the proposed extensions of the line northwards to Alexandra Palace, Barnet, Mill Hill, Edgware and Bushey Heath, the name "Northern City Line" seems to have been used throughout and probably as soon as the Metropolitan Railway, the owners on the GN&C line, had been absorbed into the LPTB.

<sup>1</sup> A description of the work is provided by H.G. Follenfant in his book, "Reconstructing London's Underground" (LT 1974).

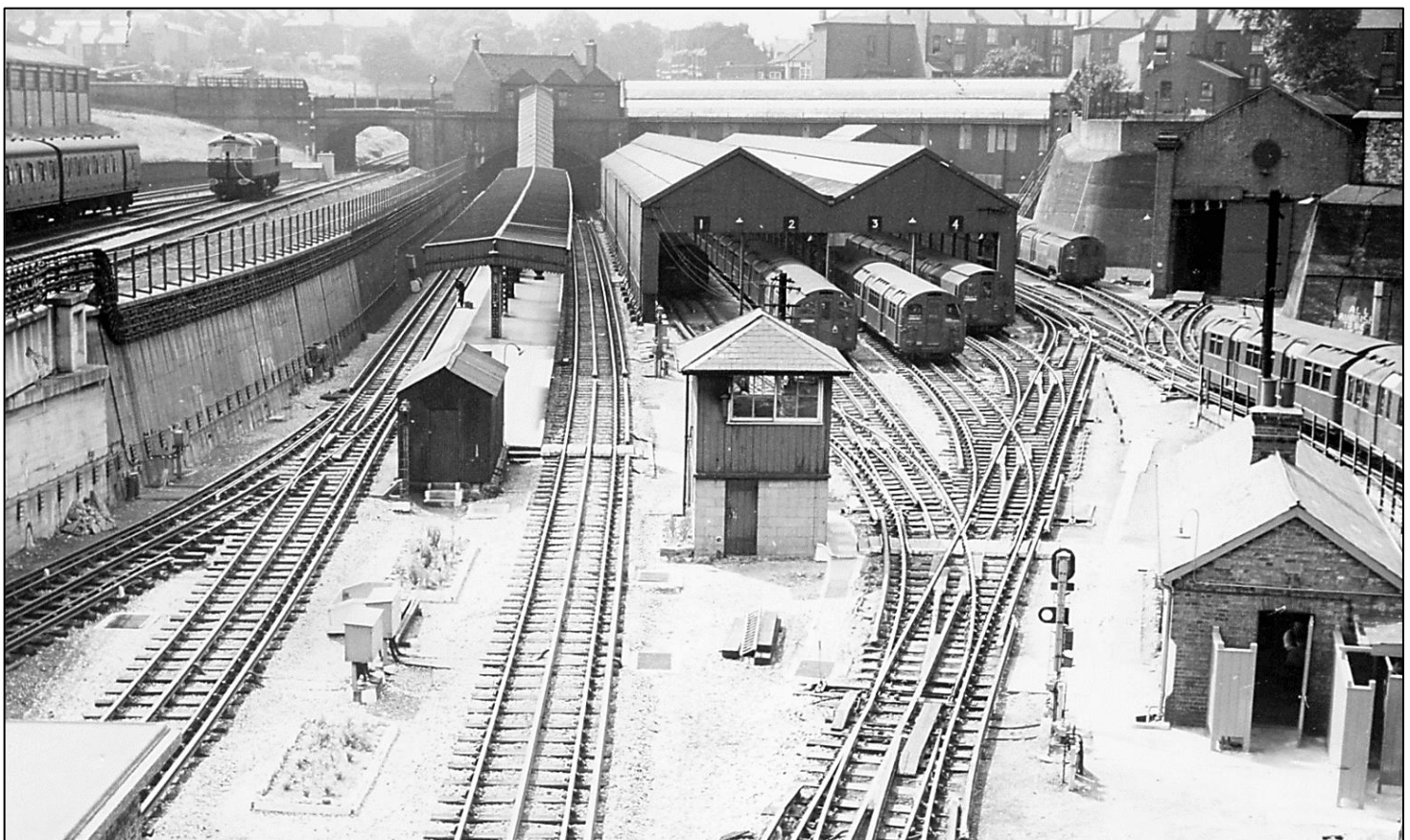
<sup>2</sup> The LPTB decided in November 1933 that the Hampstead & City Line should be retitled "Edgware, Highgate & Morden Line", or officially shortened to "EH&M Line". Within seven months, this cumbersome title was sensibly shortened to Morden-Edgware Line.

The estimates for trains required for the replacement of the original GN&C stock, which dated from 1904-06, and for new trains to work the extensions, seem to have assumed that the trains working into and out of the southern terminus at Moorgate would all be contained in a separate group of Northern City services working to Finsbury Park, Alexandra Palace and High Barnet. Train allocations, of which there were at least the nine iterations mentioned earlier, assumed in the later variations that Northern Line trains would be of 7-car formation and Northern City Line trains of 6-car formation and that some of them would be of existing LER stock and some of mixed new and existing stock trains.

The final plan had 7 x 6-car trains made up of five new cars and a 1927 Stock trailer in each train, and another 16 trains of LER stock which included 16 cars of 1920 Cammell Laird trailers modernised with e.p. brakes to enable them to run with e.p. fitted motor cars. The Cammell Laird cars were to be formed into 4 x 6-car trains each with a pair of LER motor cars. With the onset of the Second World War in 1939, these plans gradually collapsed and the 1920 Cammell Laird cars went into storage at Cockfosters Depot. The Northern City Line never got its extensions to Alexandra Palace and High Barnet and it didn't get 1938 Tube Stock until 1966. In the meantime, it was worked with LER Standard Stock.

Before tube stock could be used on the Northern City, the current rail system had to be converted from outside 3rd and 4th rails to the Underground's standard 3rd/4th rail system. The old GN&C stock was removed from the line over the days from Tuesday 9 May 1939 to Saturday 13 May and the line was closed from about 15.00 Saturday 13 May until start of traffic Monday 15 May. Trial running started at 00.30 Monday 15 May using 5-car LER Standard stock trains. It is interesting that test running was given only five hours before the start of traffic. Nowadays, it would probably take five weeks!

The plan was to do the modifications to the current supply and complete the first of the stock transfers before the civil engineering work for the extension was finished. Apart from the link between Highgate and High Barnet, work on the extensions was gradually run down between September and December 1939. They were never resumed. Getting the tube stock onto the line early was to get them off the Northern Line and make space for the incoming 1938 Tube Stock



*Figure 5: A view of the former GN&C station and depot at Drayton Park on the Northern City Line in the early 1960s. The trains are composed of pre-1929 Stocks of various types. What is apparent from this view is the neat and clean appearance of the track, something not always seen today around the system. Photo: Alan A. Jackson.*



## NEW WORKS MODIFICATIONS

The line extensions and increased mileages that train were expected to run led to a list of engineering upgrades and modifications to the existing fleet, in part so that the LER cars could match the new stock in performance. In summary, the modifications originally planned for the LER stock included:

- Fitting all Standard stock (not already fitted) with e.p. brakes.
- Fitting e.p. brakes to 16 cars of 1920 Cammell Laird stock.
- Converting 58 LER trailers to run with new 1938 Tube stock.
- Fitting “improved service braking” to all e.p. trains (retarder control).
- Fitting cab and saloon heaters to cars not fitted.
- Fitting passenger door control (except Piccadilly Line).
- Fitting weak field control to cars not fitted.

It had already been decided that the idea of having the line name provided on cars from shortly after the takeover by London Transport would be dropped as impracticable because of all the stock movements planned for the New Works Programme. I am puzzled as to why it was ever considered in the first place. After all, ever since the First World War, there had been regular transfers of cars between lines. To consider permanently displaying the line name on each car must have been the idea of a marketing person who had no idea of how the railway actually worked on a day-to-day basis. In some ways, not much has changed today. From November 1937, the blue stripe used on Bakerloo stock working on the Watford line was abandoned too.

## BRAKES

One of the major improvements to the LER’s Standard Stock included in the New Works Programme was the equipping of all 1923-28 cars with e.p. brakes and with what was described as “improved service braking”. Most cars already had e.p. brakes but there was a small group of Bakerloo motor cars that had not been equipped with them because they were working with the Cammell Laird stock on the local services between Queen’s Park and Elephant & Castle and these were to be brought into line with the rest of the fleet. The “improved service braking” was to be provided on all 1923-34 cars.

The e.p. brake system was a great improvement on the old Westinghouse air brake. It allowed drivers to get sharp and much more precise braking. Drivers had always been taught to try to get trains in and out of stations quickly and now they were taught to use the e.p. brake to help them do it by using the new brake system to its limits. But, for all its advantages, it did have a drawback – it provoked “flats”. Flats are the flat patches which appear on wheel treads as a result of skidding (or “wheel pick-up” as we call it) and they rose dramatically after the introduction of e.p. braking. As I described in my book “The London Underground Electric Train”<sup>3</sup> the main reason for flats was the variability of car loading coupled with the speed and strength of the new braking system. Loads on some cars varied by as much as 40% between empty (tare) and fully loaded (crush) conditions. The loading of individual cars could vary at any time and, as a result, adhesion between wheel and rail fluctuated hour by hour or even station by station. Trailer cars fared the worst, as they were lighter and could carry more passengers. A full car would be braked at the same level as an empty car and the result was that empty cars became vulnerable to flats when they didn’t have the passenger weight in the car, and therefore on the wheels, to prevent the wheels picking up. Wheel damage was endemic. So many cars were stopped with flats that it led to shortages of serviceable cars at times and much effort was put into finding a solution. The first idea was to restrict the air pressure in the brake cylinder to 55psi. This was the equivalent of what could be obtained with the Westinghouse air brake. This restriction helped but it didn’t completely overcome the problem of flats. In the early 1930s, some experiments were tried on an LER car with a variable load valve but it doesn’t seem to have worked well enough to have offered a complete solution.

<sup>3</sup> Published by The Crowood Press Ltd., 2015.



*Figure 6: A 1924 Met. Carriage motor car leading a Central Line train at East Acton towards the end of its days. It shows an overhaul date of September 1956 and most of this type was withdrawn during 1961-62. The front of the train shows the near final state of the 1923-25 batch of cars with modified marker lights, new offside destination plate box, new set number location, ventilator added over the end door, a window wiper, e.p. brakes and relocated emergency lighting cable. Photo: Alan A. Jackson.*

Eventually, in 1935, the “mercury retardation controller” (or retarder) appeared. This measured the deceleration of the train. Once deceleration – the “retardation rate” – reached a certain level, the brake cylinder pressure was held at this level, deemed sufficient to give a decent brake (i.e. pretty much as the old Westinghouse brake could do) but not so much that it would lock the wheels and cause flats. In measuring deceleration, the retarder was actually measuring the effect of the weight of passengers on braking so that, regardless of load, the brake cylinder pressure would never exceed a set level. Of course, it could not cater for variations in individual car loading but it gave a reasonable average for the train. The retarder was, in effect, a liquid pendulum.

The retarder system consisted of two retarders, known as the Application Retarder and the Blow-Down Retarder. Both worked in the same way but they were set at different angles. The blow-down retarder was added to compensate for the fact that a vehicle’s deceleration rate increases as speed reduces for a constant braking force. Put another way, with a constant brake cylinder pressure, the train brakes to a steepening curve. Because of this, just adding the application retarder would still not prevent the wheels from picking up at low speeds.

The blow-down retarder was set at a higher deceleration rate to that of the application retarder so that, when deceleration reached this higher level, its circuit opened in the same way as the application retarder. A blow-down wire was added and it was connected to a blow down valve piped to each brake cylinder. When the train’s deceleration reached the level of the application retarder setting, the air supply to the brake cylinder was shut off. As speed dropped and deceleration increased, the blow-down contact in the retarder opened and the blow-down valve on each car opened. The blow-down valves were set at 35 psi so that the brake cylinder pressure dropped to this level. It produced a characteristic buzzing noise as the train reached lower speeds during heavy braking. The whole of the Standard Stock fleet was eventually fitted with this system.

**To be continued .....**