The LONDON MIDLAND and SCOTTISH RAILWAY

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AN INTRODUCTION TO COLOUR LIGHT AND POWER SIGNALLING

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LMS Society Monograph No 2

Contents

Acknowledgments

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Chapter 1 - Colour light signals and track circuits.

Colour Light Signals

In their book "Modern Railway Signalling", M.G.Tweedie and T.S.Lascelles stated "*The earliest light signal is by tradition reported to have been a candle burning in the window of a point watchers house, it having been agreed with drivers that the presence of a light meant they were to stop".* With the widespread availability of electricity it is generally considered that colour light signalling originated in America and that one of the first installations on a main line was on The Pennsylvania, Tunnel and Terminal Corporation in 1910. However in Britain, a system of colour and position lights was devised by Thomas Forsyth around 1845. From that date it was not until 1913 that the matter was seriously taken up again by A. E. Tattersall who experimented with light systems.

The case for colour light signalling is very strong and based on sound arguments.
The semaphore signal

- Shows different indications by day and night.
- Its location and background must be carefully considered if a good indication is to be seen.
- There is a multiplicity of moving parts to be affected by adverse weather.
- Little or no indication can be seen in such conditions as fog and falling snow.

Against this, colour light signals

- Have few or no moving parts.
- They give a better light against poor backgrounds,
- They can be sited at driver's eye level.
- They give a strong indication in fog and snow.
- They are easily adapted to 2,3,4 and 5 aspect systems.

There were various types of colour light signals with varying voltages and power, but by 1935 there were three types of colour light signals generally in use by the LMS :-

- (1) Multi unit 24 watts
- (2) Searchlight 12 watts.
- (3) Searchlight 3.3 watts.

Of these (1) gave the best dispersion and was therefore most suitable for use when the approach was on a curve, but each could be fitted with a "Spreadlite" lens to meet special cases but the use of such lenses considerably reduces the range. In order that fog signalmen could be dispensed with either (1) or (2) had to be used. When (2) or (3) were used the operation of the coloured vane within the signal head had to be repeated to the signalman or alternatively proved.

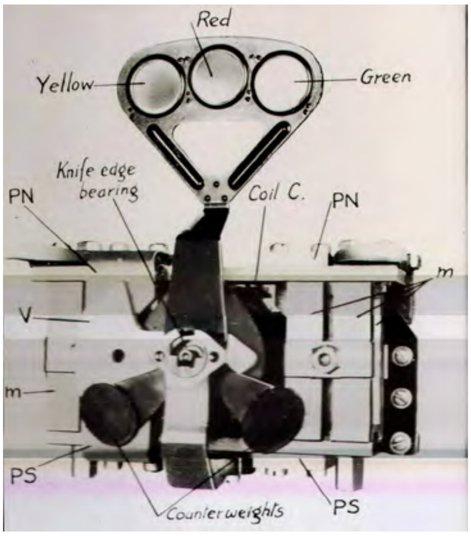


Plate 1

A searchlight signal movement showing the yellow, red and green moving vanes balanced on a knife edged bearing with counterweights ensuring the signal showed red in case of failure. The first searchlight signals to be installed in this country were by A.F.Bound when the new LNER loop from Neasden was constructed to serve Wembley Stadium. At this time the searchlight colour light signal was manufactured solely by the Hall Switch & Signal Co. of America. Later, they were manufactured, under license, by the Siemens and General Electric Signal Co. of East Lane Wembley. Multi-head signals had no moving parts and eventually superseded this design.

This was due to the “Searchlight signal consisting of a single lamp with moving spectacles for changing the aspect with the consequent disadvantage of having moving parts, although it had in its favour the ability to be trained and focused on a particular line to ease the driver’s recognition (Plate 1).
The multi aspect signal has separate lamps and no moving parts and it cannot be trained on a particular line of vision as the distance between the top and bottom light is too great.
One further big advantage colour lights have over the semaphore system is the ease with which automatic signalling can be installed using track circuiting, brought about by the aspects being determined by whether wheels are short circuiting across the rails.

It is probably fair to say that until Signal and Telegraph Departments were consolidated progress on power schemes would not have been easy as mechanical signalling came under the Civil Engineer and electrical matters were the responsibility of either the Electrical Engineer or the CME. This obviously meant two separate departments were involved with likely conflict of opinion and consider the scenario if an isolated semaphore distant signal was to be replaced by a colour light signal.
The first light signal was installed in the New York Subway in 1904 by the Union Switch & Signal Company. Apart from tube railways the first daylight colour light system in this country was by Westinghouse on The Liverpool Overhead Railway, which came into use on 27th April 1921 being a 2 aspect system that was approved by the ministry of Transport on 3rd august 1921. The only other examples of multi aspect signalling were three position semaphores on the GWR Ealing and Shepherds Bush section, GCR Keadby Bridge (eight signals), GNR Kings Cross (three signals) and SE&CR Victoria Station, London. In none of these schemes was there any special feature beyond the 3 aspect principle, whereby each signal was a repeater of the one next ahead, and, as only one installation was on each railway there was no risk of confusion with ordinary signalling.
The first 3 aspect colour light installation was brought into use on the GCR in April 1923 between Marylebone and Neasden although Marylebone and Neasden Junctions remained mechanically worked. Progress after that date was rapid, particularly on The Southern Railway which was the only system to have an overall plan and policy covering colour light installation, this being due to the complex lines inherited south of the Thames after the 1923 grouping. On other railways, colour lights only appeared at points where semaphores were definitely inferior, or required renewal, revisions to track layout were made or there was a need to increase the frequency of trains i.e. run more trains per hour.
The first 4 aspect system was introduced on The Southern Railway between Holborn Viaduct and Elephant and Castle in 1926, followed by other installations in the London Area. (See table for a listing of major company installations from 1921 to 1947). The first LMS 4 aspect installation was the Manchester Victoria and Exchange scheme of 1929.

Considering now the various colour light aspects ;-

2 Aspect

This arrangement simply substituted the indications given by semaphore signals. It did at least give the same indications by day and by night, eliminated signal wire runs, it made fog signalmen unnecessary and increased line capacity. The Bow Road to Barking scheme brought into use in February 1928 is an LMS example. A colour light can be operated mechanically by simply placing an electric light bulb behind the spectacle plate of a semaphore signal – as was done by the LMS. This may also involve removing the arm or fitting a shortened arm and replacing the spectacle glass with a form of lens, the LMS used a Corning Lebby Lens, the assembly being known as “Intensified lighting”.
Proceeding now to multiple aspect systems, defining “Multi–Aspect Signalling” as any system involving more than 2 aspects.

3 Aspect

Red, yellow or green is the same as the normal semaphore indications, i.e. Red/Stop; Yellow/ be prepared to stop at the next signal and Green/Proceed (Plate 2).

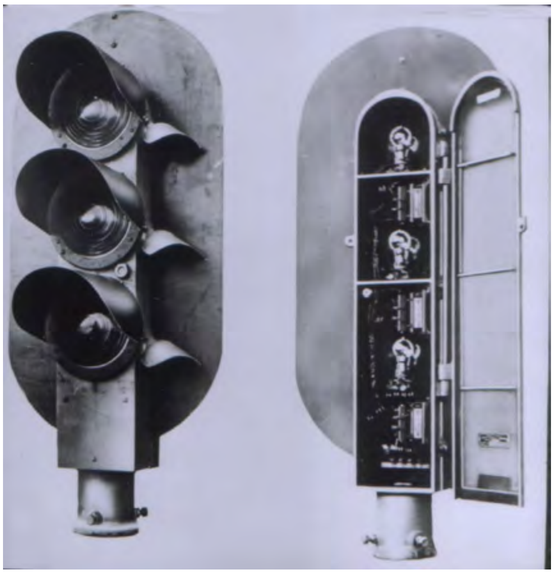


Plate 2.

A 3 aspect day colour light head having a range of at least 5000 feet. The signal also has sidelights (pig's ears) for ease of viewing by the driver at the end of a platform.

Westinghouse.

4 Aspect.

With this system the double yellow is introduced giving the indication "Attention run at medium speed". This is followed by a signal giving a single yellow indication, indicating the next signal is at danger, (red). It can be seen that with three or four aspect signalling every signal can be a distant or caution signal thus track occupation can be considerably increased. Now when considering the semaphore distant displaying green for "off" this means that not only is the next signal "off", but so too are several other successive signals so that generally the line clear is to the next signal box in the rear, which may well be five miles away. Put another way, there can only be one train between adjacent signal boxes with the block system, but with three or four aspect signalling track occupation can be considerably increased.

Plate 3.

The re-signalling of the Southern line between Waterloo and Hampton Court Junction in 1936 used three lamp position light high speed junction route indicators, (the LNER using five lamps) more usually known as "feathers". Also a first on this scheme was the use of sidelights on the colour light head allowing the driver to draw up alongside the signal and still see the indication displayed, referred to by railwaymen as "pigs ears".

Westinghouse.

The Southern Railway identified the four aspect system as particularly beneficial as its electric trains running at slower speeds and fitted with Westinghouse braking could run up to full speed up to the single yellow indication. On the other hand the faster running vacuum braked steam express running on the same line would need to commence braking on sight of the double yellow aspect. With close train headways it is quite possible to run long distances and never see a green signal aspect.

5 Aspect

This introduced the aspect of Yellow over Green indicating – Pass second signal at restricted speed. This was only used on the LMS Mirfield re-signalling scheme to be described in a later part of this series. However, Bound, the LMS Signal a &Telegraph Engineer, did point out that it may require further consideration should high speed running become normal, such as with "The Coronation Scot", due to the siting of many distant signals giving insufficient stopping distance to the stop signal ahead. That idea was not pursued but special signalling regulations were introduced for these trains to give greater clearance in advance for these expresses. These regulations were applied by signalmen on receipt of the "is line clear" special 4-4-4 bell code denoting the "Coronation Scot".

Position Lights

Position lights were adopted by the Pennsylvania Railroad in 1910 having horizontal, inclined and vertical rows of white lights for danger, caution and clear respectively, with the first one being tried on the Metropolitan Railway in 1918. The first position light ground signals were installed in the Cape Town re-signalling scheme in South Africa in 1928 (Plate 4), and were first used in the UK in connection with the re-signalling of the LNER York-Northallerton main line in 1932 (Plate 5).

Plate 4

Position light ground signals were first installed at Cape Town in1928 as seen here with CT43 & 44. The new signal box, built for the re-signalling, can just be seen at the far end of the wall that contained a Westinghouse Style "K" 143 lever power frame No L30, replacing the Bianchi & Servettas hydraulic power frame in the old box.

Westinghouse.

They consisted of two horizontal white lights indicating danger ("on") with two white lights inclined at 45 degrees indicating clear ("off"). The idea behind using white lights was that a driver could pass the two horizontal white lights when a main aspect was "off", the principle being that drivers should not pass red lights. Later when one red light was substituted as part of the "on" indication it became necessary for the main route to clear to clear any position lights in the route.

Plate 5.

A position light ground signal at Leeds East in 1936. Two white lights are exhibited horizontally for danger ("on"), with two diagonal white lights for proceed ("off"). They were equipped with backlights and those signals leading to trap points included one red light. Standard 110v AC high voltage lamps were used behind a lens combination including a pale blue glass giving an excellent indication by day, reduced to half voltage at night.

The position light featured here leads to a Westinghouse electro-pneumatic

derailer and therefore includes a red light. *Westinghouse.*

The inspecting officer Lt. Col. A. H. L. Mount was not impressed and neither were the opinions of other officers unanimous. Accordingly it was agreed that the forty or so position lights on this scheme be placed on a conditional trial for two years, at the end of which a standard would hopefully be agreed. Other ground signals in contention were - the colour light shunt signal used by the Southern Railway, shunting disc signals (red bar on a white disc), banner signals etc. In the event the position light won the day with disc type retained on mechanical installations. Position light high-speed route indication was again pioneered by the North Eastern Area of the LNER which used a chain of five white lights that were illuminated to indicate to the driver a diverging route was set. The Southern Railway soon followed suit using three lights. The five light arrangement is now the British standard often referred to as “feathers”.

Track Circuits

Before moving on to types power frames it is important to consider track circuiting, as although early power schemes such as Glasgow Central, in 1907, boasted the largest installation with 374 levers, it was devoid of any track circuiting. Track circuits have contributed more than anything else to the means of running a railway. The principle is very simple consisting of an electric current flowing in each rail with a relay connected across the rails energised by the current flowing. The presence of a train causes a short circuit, resulting in the relay being de-energized, thus closing contacts on the relay that can then, using lamps on the signal box diagram, indicate the presence of a train. In addition the track circuit relay will actuate an electric lock on the signal lever making it impossible to work the signal that would allow a train into the section should one already be there. It is also fail-safe, as should the electricity supply fail the relay will give a track occupied indication. Until the advent of full track circuiting it was necessary for a signalman to see all trains, which meant that a power box generally replaced a mechanical signal box. However once track circuits were proved to be totally reliable it became possible to construct a signal box diagram with sections of track illuminated by lamps lit by a train occupying that particular section. It then became possible for one power box to replace several mechanical signal boxes as the signalman could check the progress of a train without actually seeing it.

An American - William Robinson produced the first track circuit in 1871, and in Britain, following an accident in 1884 on the Great Eastern Railway at Stepney, the Inspecting Officer, Major General Hutchinson suggested the Company should install a track circuit, which was not done. The first British track circuit was installed at St. Paul’s by W. R. Sykes in 1886. Little progress was made in Britain until the Hawes Junction disaster on 24th June 1910 gave impetus for track circuit installation. Two light engines were stood at the signal, and, with a failure to carry out rule 55, the presence of the engines slipped the signalman’s mind, who then accepted a scotch express. The light engines moved off thinking the signal was for them, only to be hit in the rear by the express. The Midland Railway then identified some 2000 other places where similar accidents could occur and commenced track circuit installation, becoming the Company with the most track circuits installed. Track circuiting was later used for the simple control of purely automatic signals, and then refined for use at busy and complex junctions providing many additional safeguards to those found on a mechanically locked lever frame. Baker Street station on the Metropolitan Railway showed what could be done with its power interlocking installed in 1913. Track circuits controlled the signals that were provided with train stops. The signal box not only controlled the lines visible to the signalman but also those that were not, being the junction with the Inner Circle line which was in a tunnel at the far end of the station, achieved by indications on an illuminated diagram.

Chapter 2 - Power Frames.

Power signalling may be defined as "Any method of operating points and signals avoiding a mechanical system of rods or wires".
Not every installation of colour light signalling was necessarily a power scheme e.g. when the main running lines at Rugby were re-signalled in 1939 with colour lights by the LMS the existing six mechanical signal boxes were retained together with mechanical operation of all points, on the other hand Crewe was re-signalled about the same time in 1940, as a power scheme, with two new power boxes and Westinghouse style "L" all-electric frames. The Mirfield "Speed "installation of 1932 retained the signal boxes and the mechanical operation of points but with five aspect colour light signalling. All these schemes will be discussed in this book.

Power operation has many advantages over operation by conventional lever frames including :-

- No restriction in the distance a signal or point can be from the signal box. Mechanical limits were, in the first instance 180 yards for facing points (300 yards for trailing), gradually increased to 350 yards for points. Double wire working increased the distance points could be operated from the signal box to around 700 yards, LMS installations in passenger lines being at Blackwell, Stoke Works, Mansfield Colliery, Rufford Colliery. The maximum wire pull for signals was about 2000 yards, usually the distant signal.
- Unaffected by variations in temperature. Wire tensioners were often to be found in signal boxes to adjust signal wires affected by heat and cold - (expansion and contraction).
- Rodding and wire runs often needed protection to avoid trips and falls by staff as required by The Railway Employment (Prevention of Accidents) Act of 1901.
- Point rollers and wire pulleys required maintenance and adjustment.
- At complex installations or anywhere space was limited great difficulty could be experienced in arranging "lead offs" for signals and points adjacent to the signal box.
- With operating distance no longer a consideration it is possible to abolish signal boxes with the consequent saving in staff wages e.g. a triangular junction could be worked from one box instead of the usual three.

No physical effort is required is required to work the box, when previously a considerable effort could be needed for the distant signal or a point fitted with an economical facing point lock and locking bar.
A disadvantage maybe, that due to the complexity, more highly trained maintenance staff are required.
Many "power" systems have been used over the years, the main ones being electro-pneumatic, electro-mechanical and differing types of all-electric. A hydraulic system was devised by Bianchi & Servettaz and used in Russia, France, India and South Africa but not as far as I am aware in Great Britain.

These power systems utilized a miniature lever frame in conjunction with a conventional signal box diagram to activate points and signals, that is, until the advent of the "control panel" type of arrangement, whereby switches controlling points and signals were mounted on the diagram itself thereby eliminating any kind of lever, the interlocking being achieved by electrical means. The power operation of points and signals could also be affected by a conventional lever frame suitably modified to activate electrical switches, relays etc. A simple example of this is when an outlying distant signal was either motor worked or replaced by a colour light. In such cases the lever operating any power worked signal or point would be shortened to save the signalman falling backwards having expected a heavy “pull”.

Electro- Pneumatic

Patented by Westinghouse and first used in America in 1884, it was McKenzie and Holland who installed the first British installation on goods lines at Granary Junction near Bishopsgate on The Great Eastern Railway and brought into use on 15th. January 1899 displacing two older boxes (plate 6 and fig.1.). The frame was the second of two European imports manufactured by the Union Switch and Signal Co. of the USA (Westinghouse) following which frames were made by McKenzie and Holland. Points, facing point locks and detectors, signals, crossing gates are operated by compressed air by means of small cylinders or “motors” fixed on the apparatus to be worked. The valves admitting the compressed air to the motors are opened and shut by means of electro-magnets. Locking was achieved by switches interlocked by means of tappet locks, similar to an ordinary locking frame, the levers having 2½” centres. An air supply is required to points and signals for which a power house is necessary equipped with air compressors and motors to drive them. The Lancashire and Yorkshire Railway installed an electro-pneumatic system at Bolton in 1903 (plate 7), Southport in 1919 and Blackpool in 1921. Glasgow Central was re-signalled by the Caledonian Railway, using this system in 1908. The North Eastern, Great Western and Great Central Railways also had installations. In all cases the signals were semaphores.

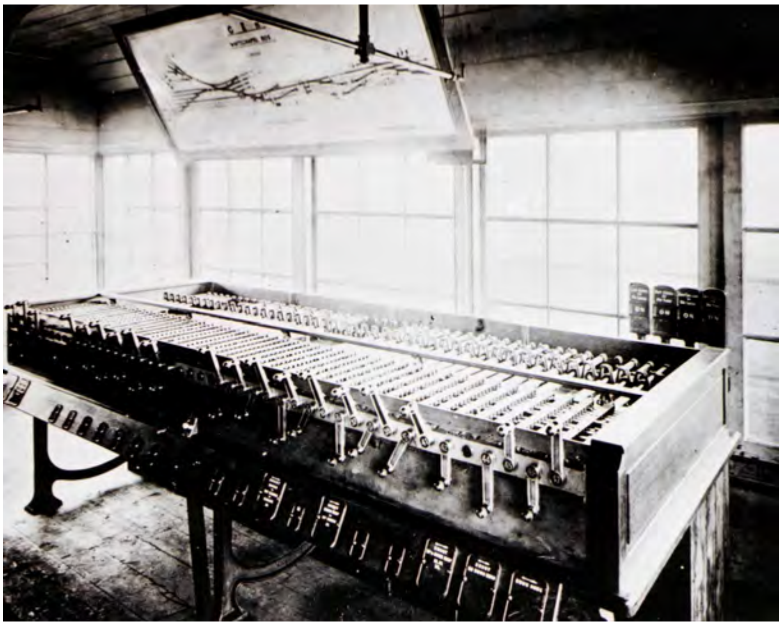


Plate 6.

Granary Junction Signal Box on the Great Eastern Railway containing a 38 lever electro-pneumatic frame, being the first such installation in Great Britain, albeit on goods lines. The mechanical tappet locking is immediately behind the levers with the electrical controlling contacts in the middle and the electric locks in the rear. The frame (No.4) was manufactured by The Union Switch and Signal Co. USA (Westinghouse) and installed by McKenzie and Holland Ltd. in 1898 and brought into use on 13Th.January 1899.
Westinghouse

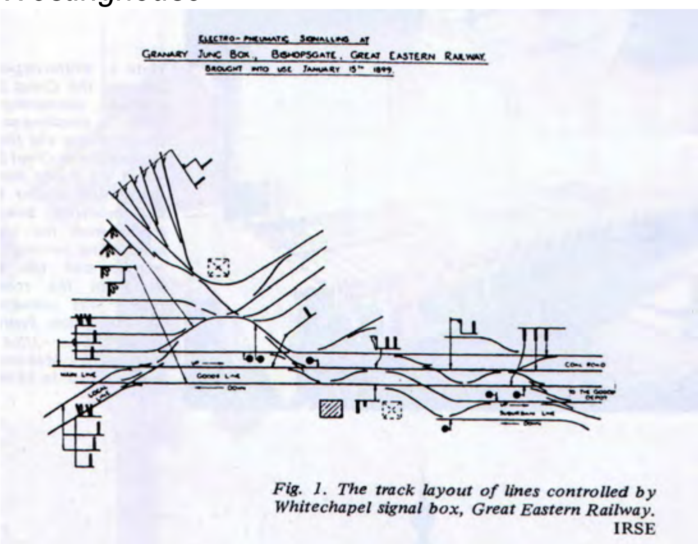


Fig.1.

The track layout of lines controlled by Granary Junction Signal box, Great Eastern Railway.

IRSE

The LMS did not utilize this system in any of its schemes, although electro-pneumatic was the method chosen when British Rail re-signalled Euston in 1952, using Westinghouse equipment including a style “L” all- electric frame.

Plate 7

Electro-pneumatic signals at Bolton, which brought into use on 27th September 1903, was the first installation on a passenger line and also the first instance of a triangular junction being controlled from one box - Bolton West. The box was equipped with an 80 working lever frame supplied by The Mckenzie and Holland & Westinghouse Power Signal Co. (Style "A" frame No.8). The signals and points were operated by compressed air at a pressure of 70/80 psi, controlled electrically from the frame, hence the term electro-pneumatic.
The scheme was designed by C.B.Byles, the L&Y signal Superintendent and obviously considered to be a success as Southport was re-signalled by the same Company in1919, using the same method.

Westinghouse.

Electric Systems

There were two basic methods of electrical operation of points and signals, one using solenoids, the other using electric motors. The advent of colour light signals obviously eliminated the need for any kind of motor for signal operation. Note the term all-electric is misleading in that the interlocking arrangements were still effected mechanically until the arrival of electric relay interlocking.

Crewe "All-Electric" System

This was designed and patented (12128 17th. May 1897) by Francis William Webb and Arthur Moore Thompson of the LNWR and whilst extensive layouts were provided at Crewe, Euston and Manchester London Road (now Piccadilly) only one installation was ever made elsewhere and that on the North Eastern Railway at Severus Junction, York. The system was manufactured by the Railway Signal Company of Fazakerly, Liverpool. It was a DC system of 110 or 220 volts. The locking frame consisted of two tiers of miniature levers at 1¾" centres. The mechanical tappet locking was carried out below floor level by light rods attached to the lever tails. Signals were operated by electro-magnets with points by electro magnets or electric motors. The first installation was at Gresty Lane Crewe consisting of 57 levers brought into use in December 1898. LMS Signal engineers Bound and Morgan hated the system, but nevertheless did not immediately replace it, and it was the pioneer all-electric system (Plate 8).

Plate 8

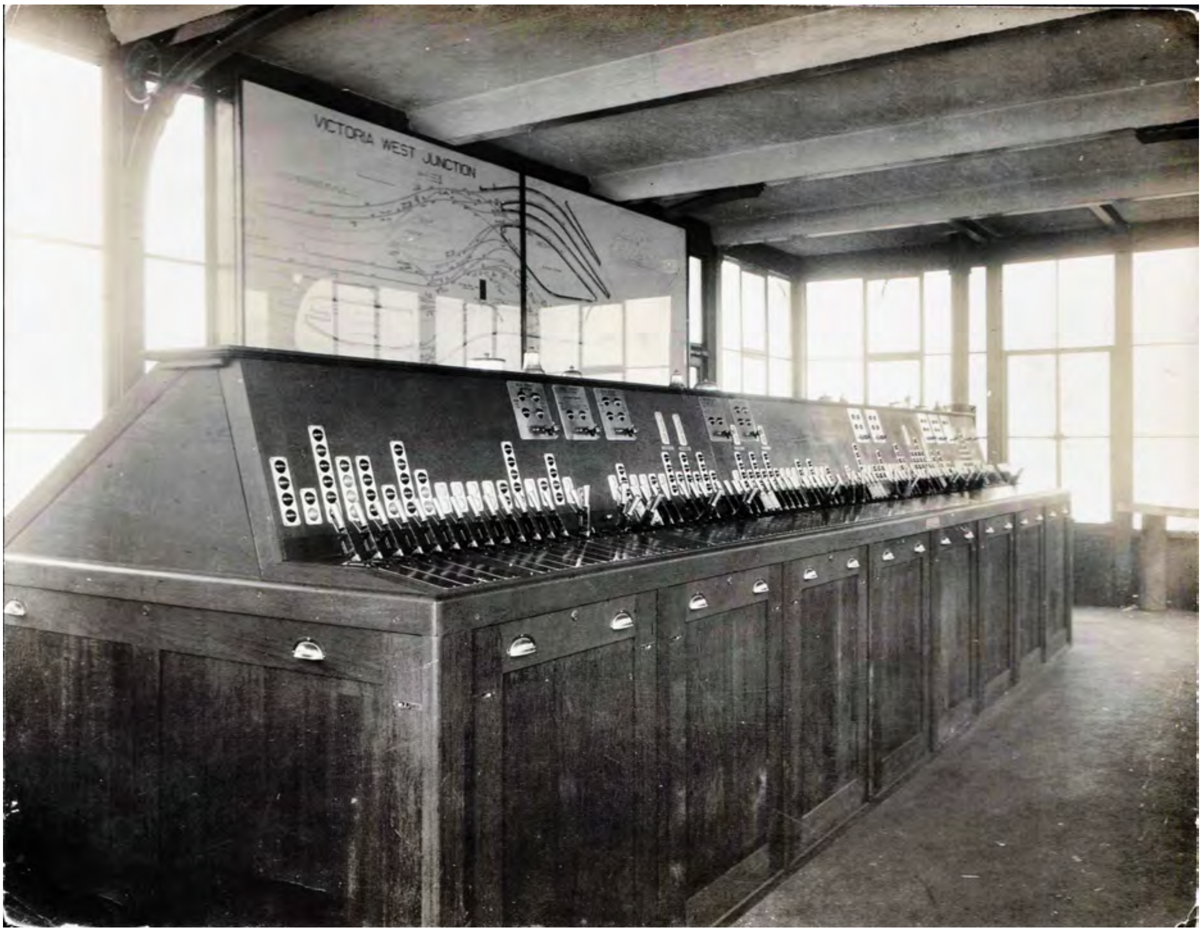
The "Crewe All-Electric" system.
An LNWR single post semaphore signal at Camden operated by a 220 volt DC solenoid motor mounted beneath the arm.

Photo BR D196

All-Electric

Manufactured by several firms such as Siemens, Westinghouse, British Power Railway Signal Company, General Railway Signal Company etc. all using miniature lever frames with interlocking carried out via mechanical tappet locking or later on electrically. The system could operate conventional semaphores using electric motors (as at Newport GWR in 1927) or more usually colour light signals with point operation by electric motors.
Westinghouse supplied their last mechanically locked "K" frame in 1935 with the last but one order by a British main line railway being used on the LMS Manchester Victoria and Exchange re-signalling brought into full use on 24th. March 1929 (Plate 9 Figure 2). Mechanically locked all-electric power frames remained the policy on the London Underground. The first truly all-electric frame in Britain (Plate 10 Figure 3), (e.g. dispensing with mechanical locking) was installed at North Kent East Junction on The Southern Railway and brought into use on 1st December 1929. Clearly a signalman is not concerned with how his frame is locked, as whether it is by mechanical means or through a de-energized electro-magnet, the lever cannot be pulled. The advantage of the all-electric frame was that levers were not required to be in one continuous row. Frames could be constructed in sections, resulting signal boxes of reduced size. The first use of such a frame on the LMS was at Glasgow St. Enoch commissioned on14th. May 1933.

Plate 9.



Victoria West Junction Westinghouse style 'K' power frame (K33) with the block bells and block indicators below them, a green light indicating "Line Clear" and a red light for "Train on Line", the "Line Blocked" is signified by no light being lit. Above the levers are the electrical repeaters for the points and signals. The points had a double indicator lettered N (normal) and R (reverse). Each signal has up to four indications R, Y, YY and G dependant on the signal.
Westinghouse.

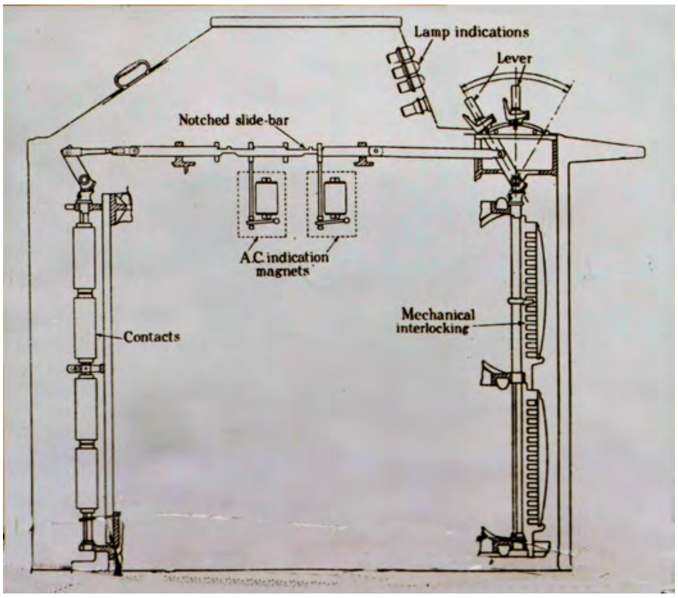


Figure 2.

Is an "N" style frame as used by London Transport and is basically an "L" style but with mechanical locking of the type used on the "K" style retained at the front. London Transport preferred to keep mechanical locking, only ever using one "L" at Wembley Park.

Westinghouse..

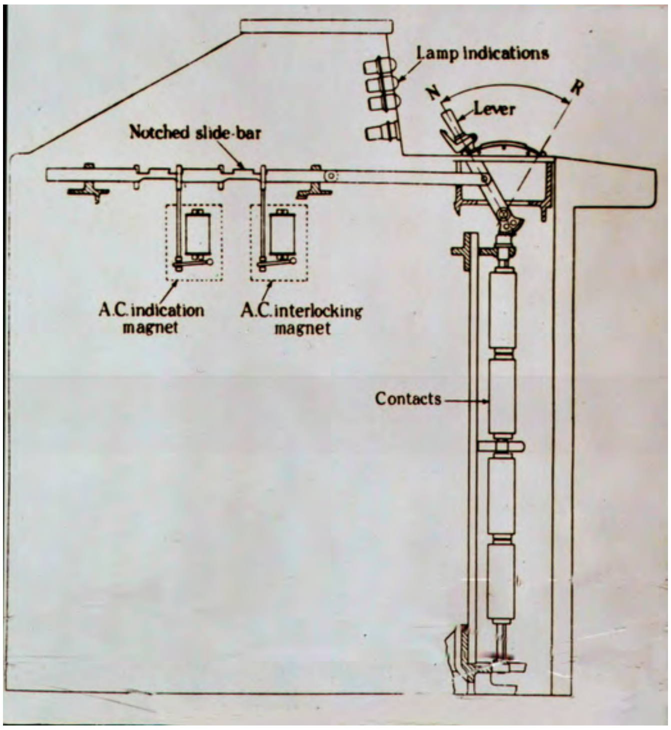


Figure 3.

Is an "L" style frame but of the variety with contacts at the front only (max 4x9=36). Larger frames had contacts at the rear too, the positions and connections were as in Plate 6.

Westinghouse.

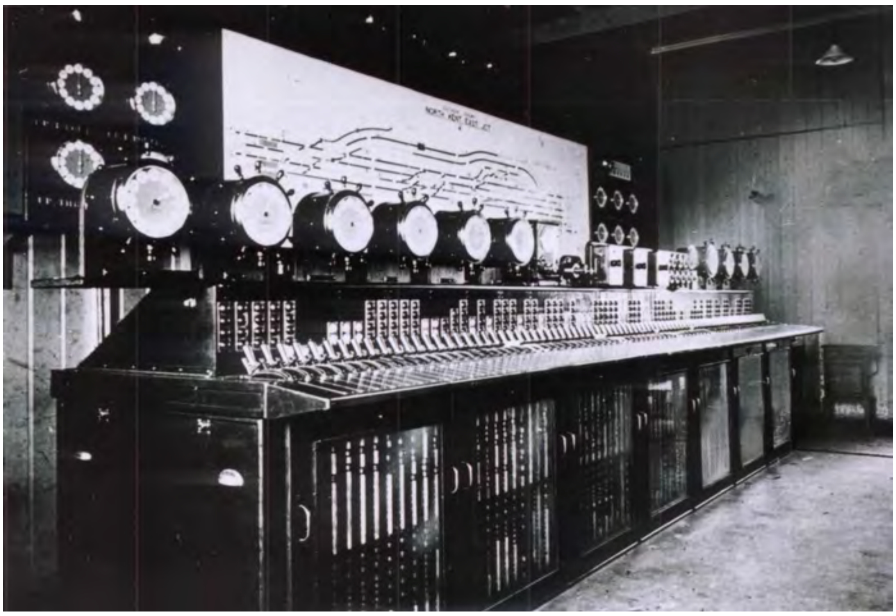
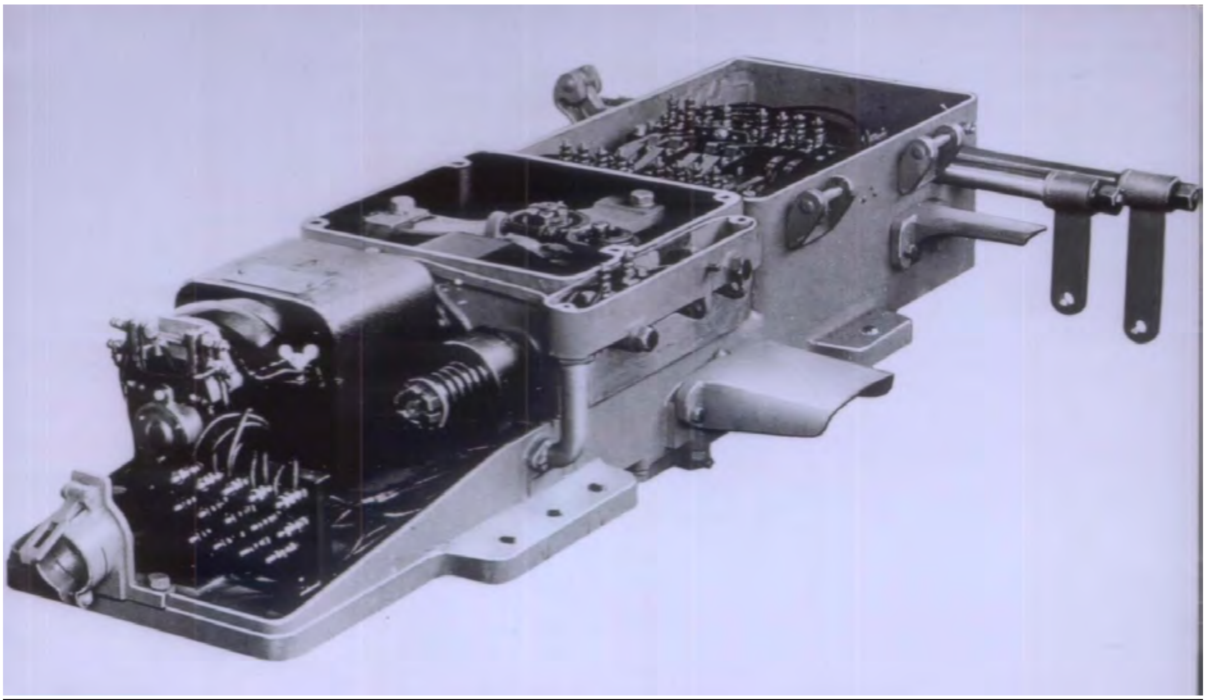


Plate 10.

North Kent East Junction Westinghouse Style "L" power frame (L37) being the first "All-electric" power frame to be installed in Great Britaln having 83 levers and commissioned on 1st. December 1929.

Plate 11

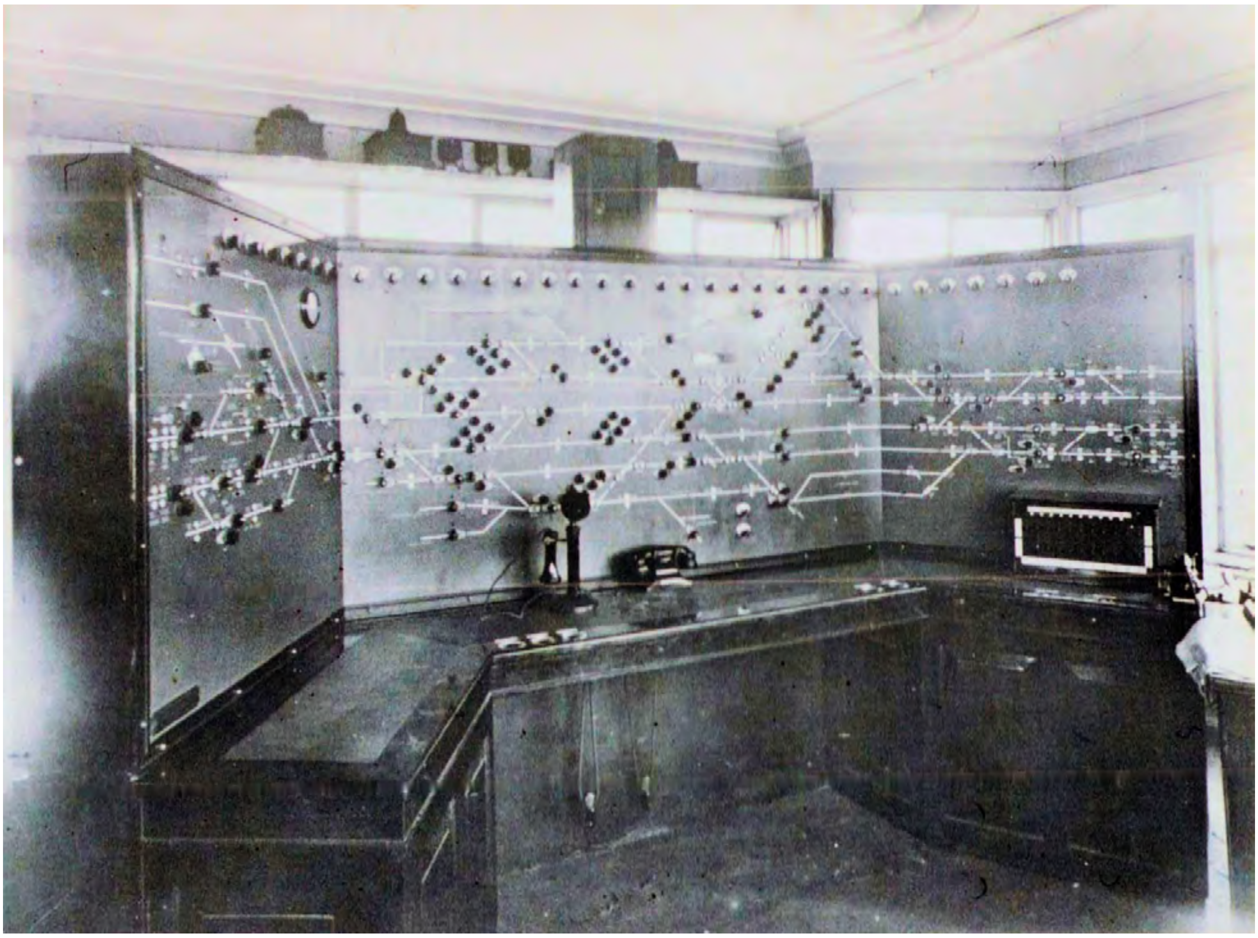


A Westinghouse Style "M3" electric point machine with the case removed. The M3 was developed from the M" of which over 1200 were manufactured from c1923 onwards. The standard voltages were 20/25v, 100/110v DC or 100/110v AC the operating speed being about 3.5 seconds.
Westinghouse

Control Panel
With the change from mechanical locking to electric locking, the next step was the elimination of the actual lock on the lever resulting in its replacement by a simple thumb switch, and whilst the switch could be turned, the electric relays prevented any response to the operation. Miniature levers were dispensed with, signals and points being operated utilizing a combined switch and diagram.

Route Relay Interlocking
Route relay interlocking was pioneered by A. E. Tattersall on the North Eastern Area of the LNER, the first scheme was small and controlled the approaches to the Goole swing bridge. The second, and much larger scheme was at Thirsk and covered 4½ geographical miles, the longest in Britain at the time. Even by 1939 no other country in the world had any route interlocking of the magnitude of Thirsk. A conventional power frame would have required 170 levers, about 24' 0" long, the Thirsk panel being some 12' 0" in length (Plate 12 & Fig.4.). With point switching, it was now possible, using just one thumb switch, to operate all relevant points on the route set, and when electrically proved, the appropriate signals also. In one case at Thirsk, 14 pairs of points and one signal were operated in 6 seconds by one switch, the switches being mounted on the actual signal box diagram.
Route relay interlocking was gradually enlarged in that Northallerton contained 129 routes, Hull Paragon 230 routes, and the 1939 York scheme had no less than 825 routes, although with war intervention it was not completed until 1951. With later installations such as Hull Paragon in 1938 it became desirable to separate the switches from the diagram, the switches being on a console with the illuminated diagram behind. With large installations covering numerous routes it was necessary to convey to other signalmen the route(s) set, which was achieved by a chain of white lights being illuminated for the route set, first used at Northallerton in 1938 (plate 13).

Plate 12.



Thirsk control panel was considered to be the first installation where miniature levers were dispensed with by a combined switch and diagram embodying the route system. The area covered was 4½ geographical miles, which was the largest in the UK at the time with five mechanical boxes being dispensed with. The British Power Railway Signal Co. were the main contractors others being Siemens and The General Electric Railway Signal Co. The panel was brought into use on November 19th 1933. *Westinghouse*

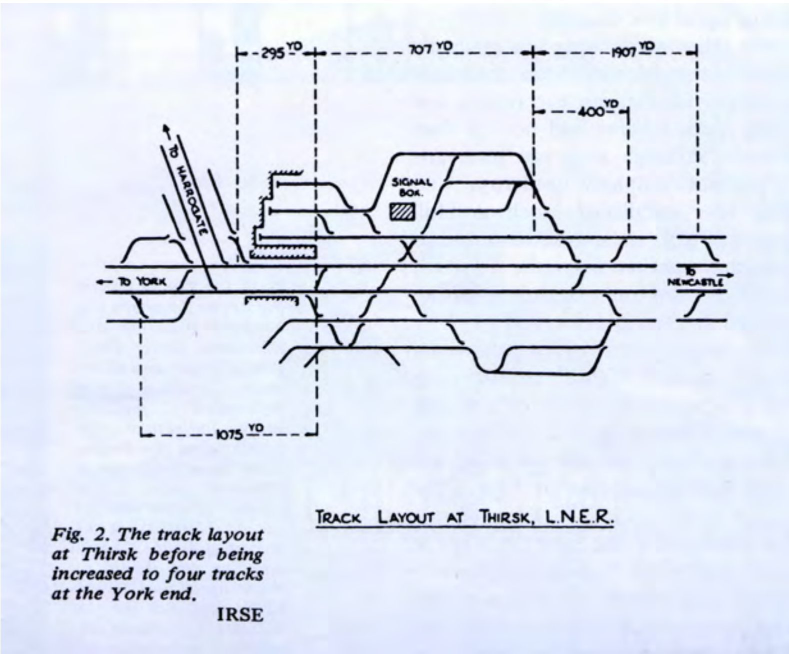


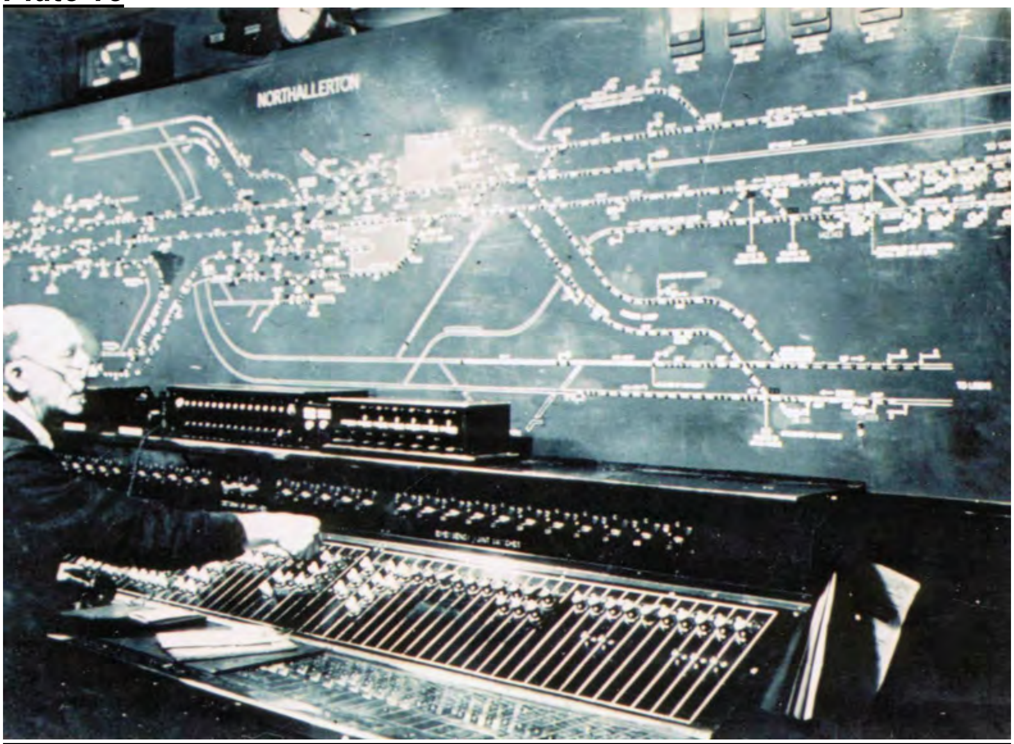
Figure 4.

The track layout at Thirsk before being increased to four tracks at the York End.

IRSE

The LMS used the idea in part at Wigan in 1941 where signals were operated using similar thumb switches but points retained conventional lever frames and the route relay system was not employed. As a matter of historical interest the Thirsk scheme was on the East Coast Main Line between Alne and Green Lane Signal Box (Thirsk) which was previously equipped with track circuit and automatic signals installed by the Hall Signal Co. in 1903. It was the second such scheme, the first being Andover – Grateley on 20 April 1902. As the latter was dispensed with in WW1 the Alne/Thirsk was the oldest. It had two original features – 1. Signals were operated by carbon dioxide gas (CO_2) at high pressure in cylinders at the foot of the post, which was released to put the signal "off" controlled by relays. 2. The signals normally stood at danger, and, providing the section ahead and its overlap were unoccupied, an approaching train put its own signals to "clear". The GWR first used route switching at Winchester in 1922 and later with a larger installation at Newport in 1927. In these installations the principal was incorporated in a power frame with interlocking between levers being mechanical. The signals were semaphores operated by electric motors as were the points.

Plate 13



The Northallerton control panel, which was similar to Thirsk, was the first to incorporate white route lights and brought into use on 3rd. September 1939.

Westinghouse.

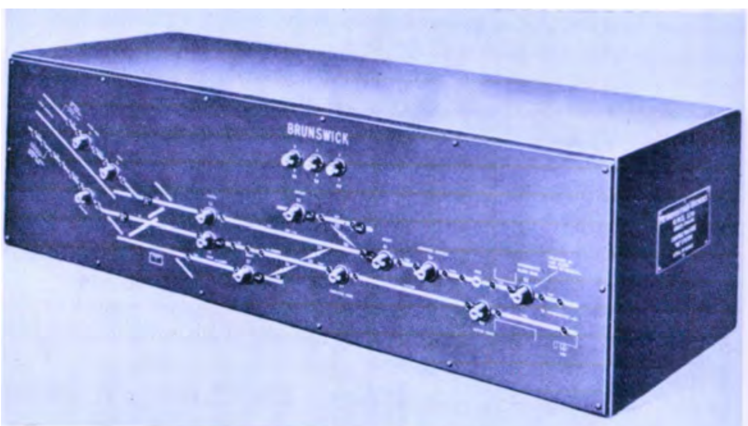
Entrance- Exit System

A different form of route relay interlocking was devised by the Metropolitan Vickers General Railway Signal Co. with the world's first installation being at Brunswick on the Cheshire Lines Committee (Plate14).

Plate 14

The worlds first entrance/exit panel manufactured by Metropolitan Vickers General Railway Signal Co. in 1939 for Brunswick on the Cheshire Lines Railway.

Photo IRSE.

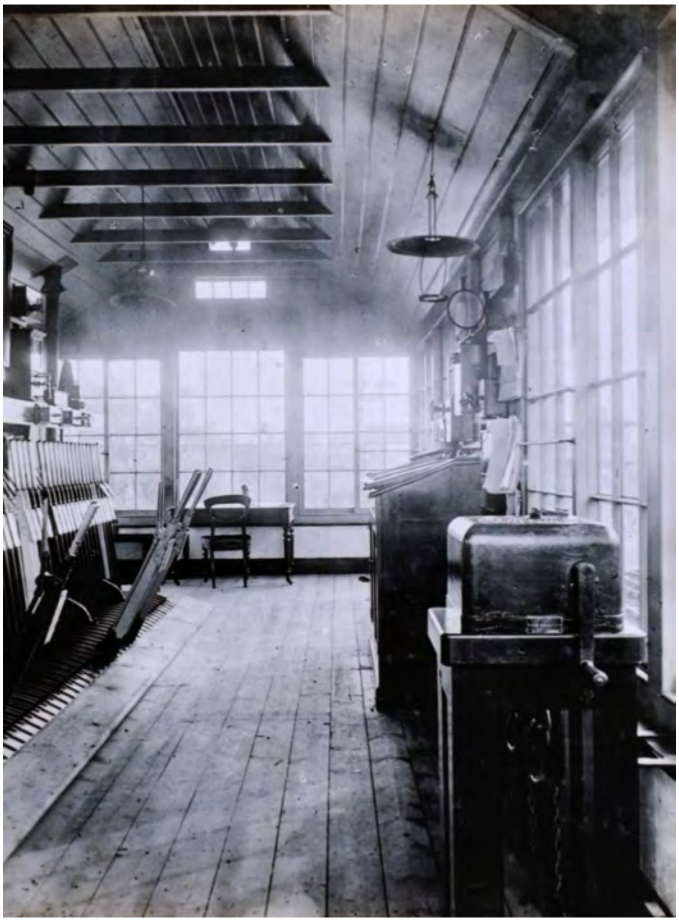


Two movements are required by the signalman to set up a route. Switches are placed at each signal on the illuminated diagram, and, to set up a route the signalman presses a button at the "entrance" and the button at the "exit". If the conditions are in order, with no conflicting routes already set and the track circuits unoccupied, the points are set for that route and the signal at the entrance cleared. Again the war intervened and the much larger installations at Stratford and Bow could not be completed until the war was over.

Hand Generation

Situations could arise where a manned signal Box was required, say a mile away from another signal box, simply to work a branch line, required only because the maximum run for point rodding was 350 yards. To obviate this and enable the junction signal box to be dispensed with a hand generator was devised and patented jointly by Messrs Nicholson and Roberts of The Great Southern Railway of Ireland making 100 volts available for the operation of points and semaphore signals. The first installation was at Charleville on The GSR.of I. where, as a result of political activity, the junction signal box to Limerick was not rebuilt but signalled from Charleville, a distance of 1850 yards. The LNER installed several sets (Plate15), the LMS generally preferring to use the double wire system.

Plate 15



The hand generator installed in Chesterton Junction Signal Box on the LNER that controlled three signals and three points, all were around 1000 yards or more from the box, the equipment being supplied by Westinghouse and commissioned in 1932.

Westinghouse

Summary

So where did the LMS fit into the development of colour light and power signalling? Arguably the Company was first in loco and carriage design but with regard to colour light and power signalling, probably third. Although it is fair to state that such schemes had to be financially justified with reasonable returns set against capital expenditure. As stated The Southern Railway was the only one with any form of policy. It installed the first 4 aspect system, the first all-electric frame, was the first to use side lights on signals enabling a driver to draw right up to the signal and still view its indication via side lights on the signal head (although a similar arrangement was incorporated on the Manchester Victoria and Exchange scheme).

The London and North Eastern Railway took a major leap forward with the installation at Thirsk, which was the first to dispense with levers, with operation being via switches on a diagram, the forerunner of today's "panel". The LNER also introduced white route lights on the Northallerton panel introduced on 3rd September 1939 and the position light ground signal as well as the five light high-speed route indicator. Both the above companies pioneered several things that were to become the standard, for colour light and power

signalling, e.g. a 4 aspect system on the Southern and the use of diagrams or panels in lieu of any kind of lever frames on the LNER.
The LMS was certainly not oblivious to the new technology bearing in mind it was Bound, who, as an employee of the Great Central Railway, put into place the Marylebone - Neasden 3 aspect scheme, also he was resident engineer when the London and South Western Railway installed automatic signalling on the line between Andover and Grateley. It must be remembered that there was no "code of practice" to follow and therefore railway companies were well aware of the cost savings etc to be made with the adoption of power signalling, it was simply a fact that various ideas had to be tried and tested with the best eventually becoming the standard. The LMS was quick to use 4 aspects at Manchester and an all-electric frame at St. Enoch, it also pioneered the 5 aspect Mirfield scheme and marker lights, but these latter two ideas proved not to be the way ahead. Once the 4 aspect standard was set the LMS pursued it vigorously with the re-signalling of Rugby, Wigan, Crewe North and South etc, all of which will be dealt with in later chapters. The LMS did pioneer such things as "last wheel replacement" and "sectional release route locking", to be described in the appropriate chapter within this book.

The LMS Signal & Telegraph Department

There was however another problem the LMS faced in the period from the 1923 grouping until 1929 as the four Divisional Signal and Telegraph Engineers were compelled to submit their signalling schemes for approval to the Chief General Superintendent at Derby. He and his staff obviously found their differing ideas very confusing, which was further aggravated by the fact that whilst mechanical signals and their maintenance was the responsibility of the Signal Superintendent, who reported to the Chief Civil Engineer, the telegraph and electric signals were the responsibility of the Telegraph Superintendent who reported to the Chief Electrical Engineer. There was, however, an anomaly with regard to the "Crewe Power" installations at Euston, Crewe and Manchester, which were maintained by signal assistants responsible for both mechanical and power signalling. The LMS Electrical Department had been created in 1925 combining the "telegraph" and "power" sections of the former companies, including Camden/Watford, Manchester/Bury, Liverpool/Southport and Heysham electrifications. To complete the picture regarding the LMS Electrical Department, the Board meeting held on 29th July 1937, made the Chief Mechanical Engineer responsible for the Electrical department with the appointment of C. E. Fairburn on 1st October 1937 as deputy CME under W. A. Stanier. Fairburn become Chief Mechanical & Electrical Engineer on 1st April 1944 on Stanier's retirement.
To resolve this situation Arthur Frank Bound from the LNER was appointed LMS Signal and Telegraph Engineer on 20th May 1929 on a salary of £2000, the Divisional S&T Assistants at Crewe, Manchester, Derby and Glasgow being retained. It is interesting to note that Bound's designation within the Board minutes never included the word "Chief" although on increasing William Wood's salary to £2750 0n 26th October 1945 "Chief" was used, being the one and only time. Lt. Col. Percy Douglas Michod OBE who was the District Electrical Engineer, Euston became Bound's Assistant.

Table showing the development of colour light and power signalling on the main line railways in the UK from 1921 to 1945.

Item	Company	Date	Scheme	Power Frame	C/L Head	Aspects	Remarks
1	Liverpool O/H Rly.	1921	Re- signalling	Automatic		2	The first in the UK.
2	LNER/GCR	1923	Marylebone - Neasdon		Hall Single Hd.	3	The "Hall" head was forerunner to the "searchlight"
22	Southern Rly.	1926	Holborne Via. - Elephant & Castle	Siemens 86L.	In-line	4	1st. 4 Aspect scheme in the world.
3	LNER	1926	Cambridge	BPRS	Semaphore	2	All-Electric (Mech. Locked); Cam.N. 72L; Cam.S. 128L;5 SB Abolished.
23	Southern Rly.	1926	Charing Cross - Cannon Street	West. "K"	In-line & cluster	4	Char.X.107L.; Met.J. 60M. Convtd.; Can.St.143L (K26).

Item	Company	Date	Scheme	Power Frame	C/L Head	Aspects	Remarks
24	Southern Rly	1926	Ditto-extended to London Br.		In-line & Cluster	4	
15	GWR	1927	Newport East & West	Siemens	Semaphore	2	79L. Working motor op. sem. sigs. & points. Ferreira/Insell Route system, closed 9/12/1962.
29	LMS	1928	Bow Road - Barking	None (Mech'l)	?	2	!st.application of West.Style"D"Lever Locks in mech SBs.
25	Southern Rly	1929	Lon.Br. - G'wich/L'ham/Parks Br.J.	West. "L"	In-line & cluster	4	N.Kent.E.J. 1st."L" Elec.Lock.83L (L37)oou16/4/76.; Lon.Br.311L"K"F(K31).; OtherSBs mech F.s.
16	GWR	1929	Old Oak Common	?	?	?	
30	LMS	1929	Manchester Victoria & Exchange	West. "K"	In-line & cluster	4	Vic.W.85L (K33).; Deal St.91L (K34).; Irwell Br. Sdgs.12L.(K35);
17	GWR	1931	Paddington - Southall	Gen.Rly.Sig. Co	Searchlight, 2 Heads	2	All-Elec.Lock'g.- Westbourne Br.88L(1st.on GWR).;Mech. Lock'g. Padd'n. Arr.184L.; Dep.96L.
4	LNER	1931	York - Northallerton	Panel BPRS	Searchlight	4	Thirsk SB - 1st.Panel with Thumb Switches: Northallerton 1st. Illum'd. Diag.& Pos.Lt. G.Sigs
44	Metropoliton Rly.	1932	Wembley Park & Stanmore Branch	West. "L"	In-line	3	3rd."L" frame in UK 95L.(L95) oou 29/10/81; 1st. Inst. of CTC in UK (4 1/2 Miles).
26	Southern Rly.	1932	Coulsdon - Brighton	West. "L"	In-line	4	Brighton 225L Elec. Lock.(L55) oou30/3/85; All other boxes Mech. Frames.
5	LNER	1932	Highgate Branch	?	?	?	
31	LMS	1932	Barking - Upminster	None (Mech'l)	Searchlight	2	Marker lights. Mech.SBs(mod).
32	LMS	1932	Mirfield	None (Mech'l)	Searchlight	5	Marker lights. Mech.SBs(mod).
18	GWR	1933	Cardiff East	West. "L"	Searchlight, 2 Heads	2	Elec.Lock'g-151L.(L56) oou 27/3/66;
33	LMS	1933	Euston - Watford	None (Mech'l)	Searchlight	3	Marker lights. Mech.SBs(mod).
6	LNER	1933	Bethnall Green - Enfield	None (Mech'l)	Searchlight, 2 Heads	4	Mech.SBs; (17SB Abolished).
8	LNER	1933	Kings Cross	Siemens	In-line	4	All Elec. Min.lever frame 232L; Motor Op. Ground Sigs. (1st.Track-circuit in UK in tunnel-1894).
34	LMS	1933	Glasgow - St. Enoch	West. "L"	Searchlight	3	Marker lights. 1st."L" frame on LMS 203 L(L45).2nd."L" frame in UK oou 26/11/67; 3 SB Abol.
7	LNER	1933	Gidea Park - Shenfield	?	Searchlight, 2 Heads	4	
19	GWR	1934	Cardiff West	West. "L"	Searchligh, 2 Heads	2	Elec.Lock'g-339L.(L57) oou 27/3/66;
9	LNER	1934	Hull Paragon	Panel	Searchlight, 2 Heads	?	Electro-Pneumatic Points & Signals.
10	LNER	1935	Fenchurch Street - Bow Rd.	Siemens .	In-line	4	140L. Elec. Locking.
20	GWR	1935	Bristol Temple Meads	Gen.Rly.Sig.Co	Searchlight, 2 Heads	2	T.M.East 368L.; T.M.West 328L.; B'tol.Loco.Yd.32L.; Largest in UK in No.of levers
45	Cheshire Lines C.	1935	Manchester Central	Gen. Rly Sig.Co	In-line	3	128L. All-electric; 4 SB Abolished;
11	LNER	1936	Edinburgh Waverley	Siemens	In-ilne	4	227L. All-electric; Sidelights; 90 banner signals;spliiting signals;
12	LNER/LMS Joint	1936	Leeds New (LNER Designed).	None (Mech'l)	Searchlight, 2 Heads	4	Leeds East.; E/P; Points Mech. Worked; Relay Locking Thumb switches for signals;:
13	LNER/LMS Joint	1936	ditto	Panel	Searchlight	4	Leeds West; Sig. & Point Op. by Thumb Switches.
27	Southern Rly	1936	Waterloo - Hampton Court Junc.	West. "L"	In-line	4	W'loo 309L(L66); Clap.Junc.103L(L67).; W.Lon.59L(L68).; 1st.use of 'Feathers' & 'Side lights'.
14	LNER	1937	Darlington South	West."L"	?	?	155L.(L81) oou 11/5/72;
28	Southern Rly	1938	Victoria - Clapham Junc.	West "L"	In-Line	4	Vic.225L(L84) oou 16/3/90; Vic.A. 200L. Adapted; Battersea Pk.31L(L83).
35	LMS	1939	Rugby	None Mech'l)	In-line	4	5 light Rl.s; 6 Mech.SBs (6 mod).
21	GWR	1940	Reading	Siemens	?	?	
37	LMS	1940	Crewe	West. "L"	In-line	4	5 light Rl.s; Crewe N.214L.(L96) oou 12/6/85; S 227L.(L95) oou 6/6/85; 1st use P.L.G'd Sigs;
36	LMS	1940	Preston.	West. "L"	In-line	4	Preston N.227L (L98); South 227L.(L99); (Scheme postponed due to WW2).
38	LMS	1941	Wigan	None (Mech'l)	In-line	4	5 light Rl.s; 3 New SBs with thumb switches & REC Frames; (7 SB Abolished).

Item	Company	Date	Scheme	Power Frame	C/L Head	Aspects	Remarks
39	LMS	1942	Willesden No.7 - North Wembley	None	In line	4	
40	LMS	1943	Camden No.2 - Willesden No.1	None	In-line	4	
41	LMS	1945	Camden No.2 - Euston No.2	None	In line	4	
42	LMS	1946	Liverpool Exchange	None	In-line	?	
43	LMS	1948	Liverpool Lime Street	West."L"	In line	4	5 light RI.S;95L.(L101);

The table may not include every scheme or be complete in every detail but is sufficient to give a good insight to the progress being made in this field and for comparisons to be made. The Liverpool Overhead Railway and The Metropolitan Railway is also included for historical interest. The Latter together with other London underground railways and later the London Passenger Transport Board also contributed greatly to the advancement of power signalling.

FOUNDED 1963 THE LMS SOCIETY

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

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