The LONDON MIDLAND and SCOTTISH RAILWAY

FOUNDED 1963 THE LMS SOCIETY

The 'CREWE ALL ELECTRIC' SYSTEM of POWER SIGNALLING.

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LMS Society Monologue No 11

Contents

Acknowledgments

Many years ago I raised the question of the "Crewe" power system with John Sadler, a prominent LMS S&T Engineer who was the adviser to John Scholes, the Curator of Historical Railway Relics on signalling matters. Information also came from the Railway Gazette, The LMS Magazine article by Alfred Oldham who was Assistant S&T Engineer, Crewe from 1923 to 1927. Mention must also be made of Bill Hardman, the Crewe Signal engineer who knew the system backwards Also signal engineers A. Hodson, Trevor Moseley and John Currey together with SRS colleagues Richard Foster, Reg. Instone and Roger Hennessy and finally John Edgington, the ex Euston PRO.

Reader's attention is drawn to the book "*A Pictorial Record of LNWR Signalling*" by Richard Foster where more photographs and information may be found.

John Sadler was born on 5th August 1897 commencing employment on the Midland Railway as a Privileged Apprentice in 1914 in the Signal Drawing Office. Following Commissioned army service he resumed employment in the Derby D.O. In 1929 he transferred to Mr. Bounds Derby Office as Statistical, Technical and Signal Sighting Assistant and in 1935 to Euston. In 1944 he was appointed Divisional Assistant (Signals) Derby on £600pa and in 1947 Assistant Divisional S&T Engineer Derby on £900pa. In 1949 he became Signal Assistant S&T Engineers Dept. Euston.

Introduction.

At the end of the nineteenth century the vast Crewe Works manufactured almost all of the equipment required for the operation of the London and North Western Railway, and was the largest and most celebrated railway establishment in the world, employing some 8,300 men. Webb controlled the signalling at Crewe as he did everything else and he stated that pneumatic power was not to be used for working signals. Other companies, such as the NER and GWR had experimented with compressed air, but it would not do for Webb who called on his Signal Superintendent, Arthur M. Thompson, to design an electric power system of point and signal operation.
It is difficult for us in this day and age to appreciate the task that Webb had set – in 1897 AC power had not been accepted, leaving only a raw system of DC available which itself was only an infant, and with primitive carbon filament lamps it is very hard to visualise the electrical era of the mid 1890s and the difficulties in designing an all electric, or perhaps it is better to call it an electro-mechanical system of point and signal operation. Rather ahead of his time, but it has been said, that Webb even forecast 100 mph electric traction, and according to some sources, drew up a plan for electrifying the LNWR

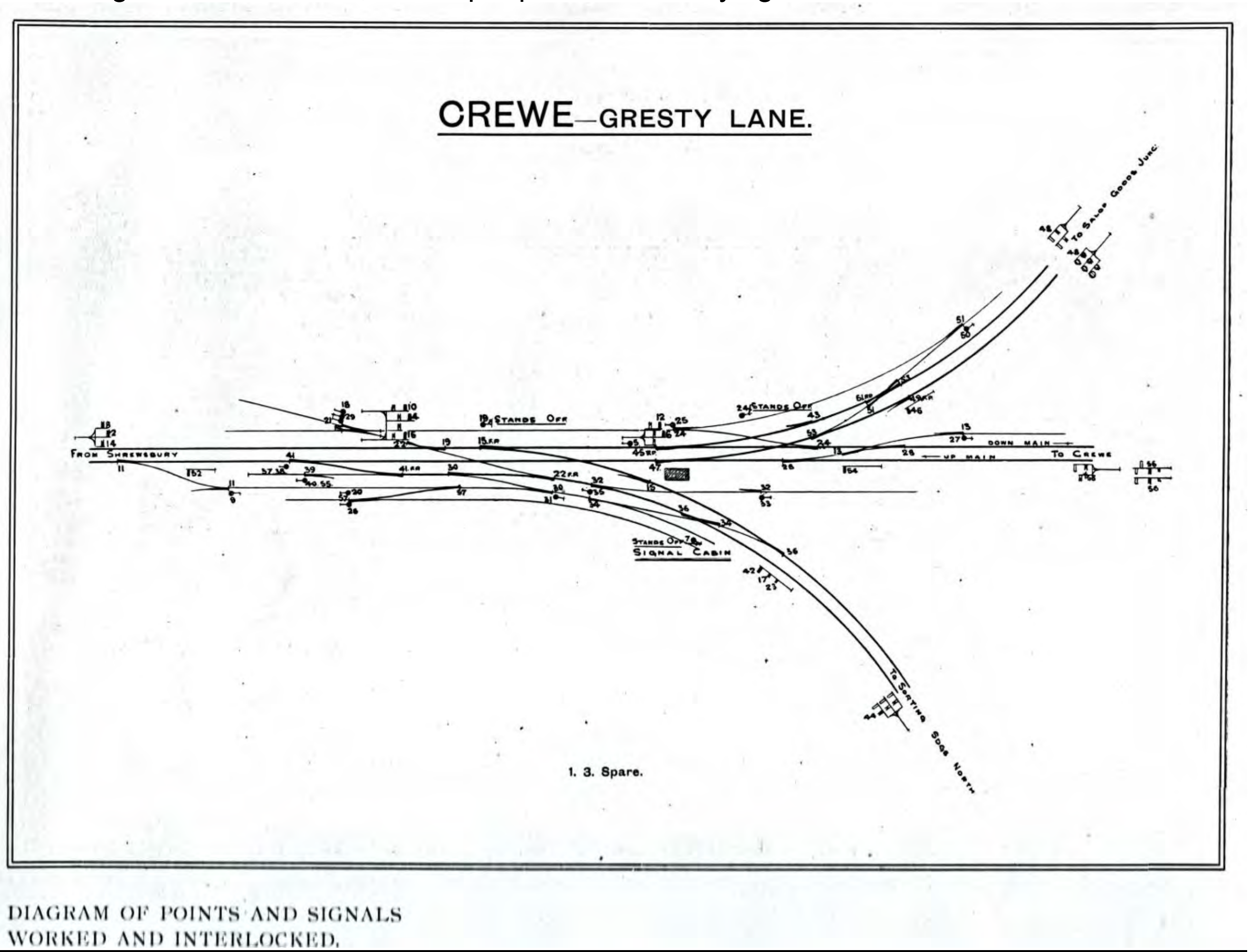
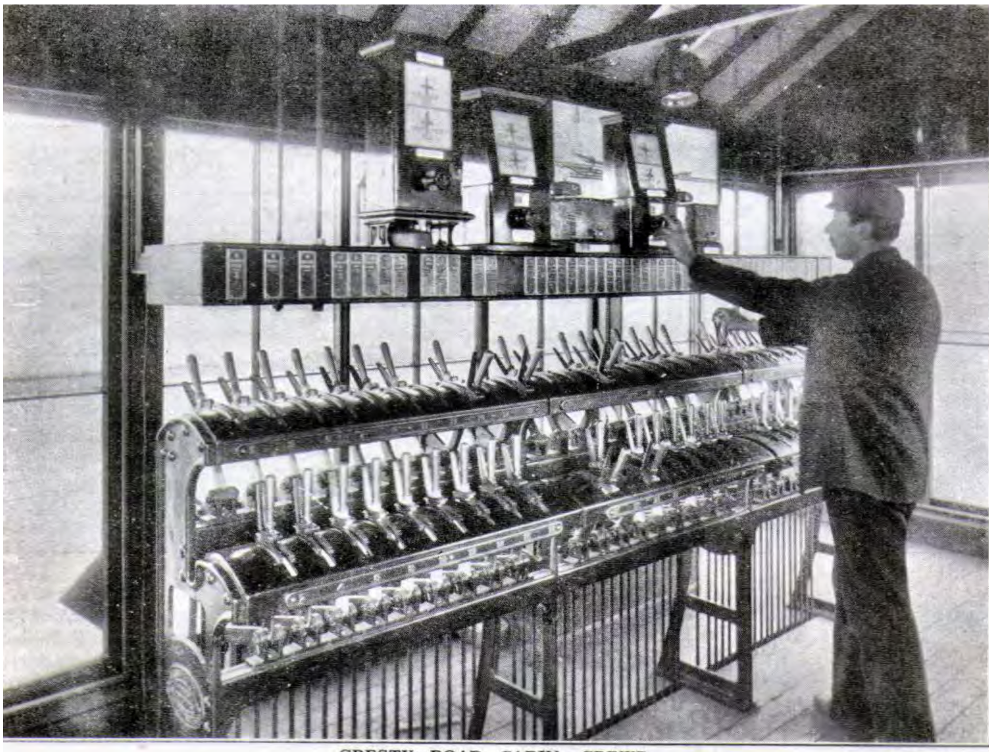


Fig. 1. *The Gresty Lane installation. A Diagram of the signals and points controlled by Gresty Lane Signal Box, Crewe, brought into use in December 1898, 57 levers, 2 spare, 110volt dc working.*

R. S. Co. Catalogue, c.1902

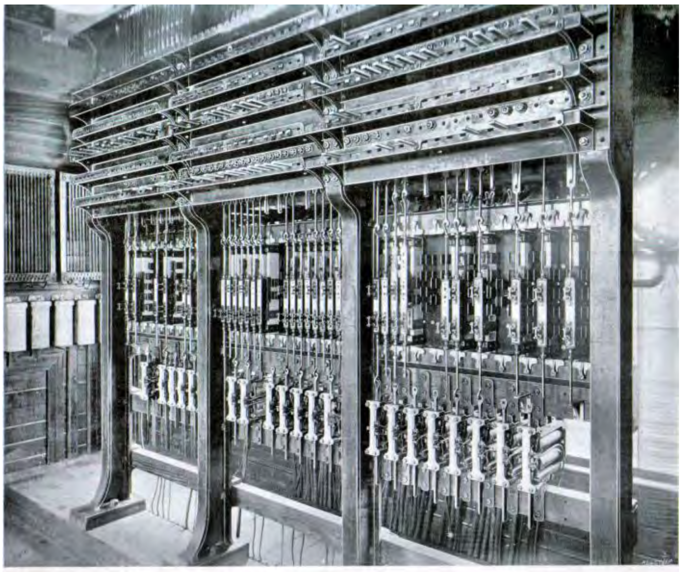
In 1897 patents (see appendix 2) were taken out to develop this all-electric system, the first installation being installed at Gresty Lane, Crewe in December 1899 having 57 levers (plates 1, 2 & figure 1). Four signal boxes were built for the Crewe marshalling yards having a total of 357 working levers followed by Crewe North Junction in November 1906 with 232 working levers (266 in total) and Crewe South Junction Box in 1907 with 222 working levers (247 in total). In addition two small boxes were provided at the scissors crossings in the centre of the platform lines. When the Euston – Camden widening took place about 1905, four boxes using this system were constructed totalling 267 working levers, the largest, Camden No.2, having 95 working levers, mechanical signalling being retained at Euston Station. A further installation of three boxes was made at London Road, Manchester in 1908/9 having a total of 244 working levers. The total number of working levers was1420 – see appendix 1.



GRESTY ROAD CABIN, CREWE

Plate 1.
The interior of Gresty Lane Signal Box opened in December 1898 having 57 levers, two of which were spare. The box controlled a busy junction on the Crewe and Shrewsbury main line. The upper tier of levers was generally used for points with the lower tier for signal operation. The compactness of the system can be appreciated as it occupied only about one third of what would be required for a conventional frame. With the advent of full track circuiting and colour light signals a Westinghouse Style 'M' circuit controller was provided on practically every lever at the back of the frame just above floor level. . S. Co. Catalogue, c.1902.

Plate 2.
The lower floor of Gresty Lane Signal Box showing the interlocking switches and check-locks. The mechanical tappet interlocking is in the upper portion of the picture, below this are the switches by which means the electric current is transmitted from the supply source to the points and signals and below the switches are the check-locks provided only on point levers to prevent the complete movement of the levers until the points they operate have moved over to the right position and bolted.
R. S. Co. Catalogue, c.1902



BOTTOM FLOOR OF GRESTY LANE SIGNAL CABIN, CREWE.
INTERLOCKING ELECTRIC SWITCHES AND CHECK LOCKS. *Fig. 2.*

The "Crewe" or Webb and Thompson system was also manufactured by the Railway Signal Company of Fazakerley, Liverpool and marketed by them with a well-produced catalogue issued for the purpose. The catalogue states "*the system may be seen at work at the Crewe Station of the LNWR and it was selected by that Company after most exhaustive trials of all the most important power systems".* It might have added except compressed air! Before going further it will be as well to familiarise the reader with the design and function of the "Crewe" system which can be broken down into four convenient parts – signals, points, lever frames and power supply.

For the first installation during the reconstruction of the Crewe area, such was the demand for signal parts that the LNW Signal Works could not supply them quickly enough with the result that the Railway Signal Company, were granted a licence to manufacture parts for the Webb and Thompson Power Signalling System. It seems that their sales were confined only to the LNWR as apart from an installation on the North Eastern Railway at Severus Junction, York that was quickly abandoned following a fire in the signal box and many burnt out solenoids, no other Company used it. A trial was arranged in the cellars of Glasgow Central station on the Caledonian Railway in 1907 when various types of power signalling were tried, but it was rejected in favour of an electro-pneumatic scheme, resulting in what was for many years the largest power frame in one row in the world. Apart from the three major LNWR installations, a one-doll wall mounted bracket solenoid operated signal was utilized in Wolverton Carriage Works, plate 3**.**

Plate 3.
A Crewe' power type solenoid operated signal at Wolverton Carriage Woks.
R. J. Essery

Chapter 1. Signals.

Running Line Signals. The signals used on the power scheme were of the standard LNW type operated by a solenoid fixed to the face of the post close under the spectacle and operated by a 5/8th diameter rod some 3'6" long connected to a weighted "T" crank at one end and the signal arm at the other. The coil or bobbin was stationary and bolted to a fixed bracket which was in turn bolted to the face of the signal post, over the coil was fixed a rain hood or cover, see figure 2. The coil was wound on a cast brass bobbin in which slid a soft iron armature connected to the weighted "T" crank by a link. The stroke on the armature being approximately 1 5/8th" giving an increased stroke at the end of the "T" crank of 2½" to which the signal-driving rod was connected pushing the arm "off" to 45 degrees. The counterweight on the "T" crank was used to balance the weight of the armature and down rod meaning that the solenoid had only the weight of the arm to move, taking a flash current of some 15 amps in the process. Half wave rectification was used on solenoid signals for magnetic field voltage decay, reducing the breakdown of the windings. A fixed resistance of 70 ohm for 220 volt working and 24 ohms for 110 volt working was provided to reduce the current to about 2 amps once the arm had been pulled "off", the resistance being brought into use by a switch operated by the weighted "T" crank. No colour coding existed in wiring the original installations but when re-wiring was required standard nomenclature was introduced. John Currey noted that the Gresty Lane workshops "*always had at least 50 signal solenoids under repair".*

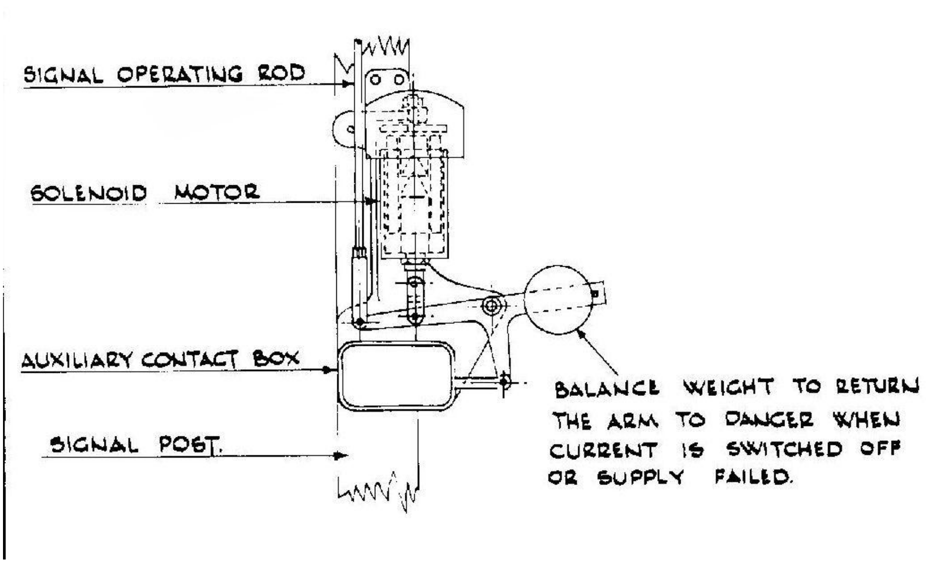


Figure 2.
A drawing showing the solenoid motor designed for the operation of signals. This comprised of an electro magnet combined with a solenoid, a switch with carbon contacts and a small resistance frame. A current of approximately 15 amps at 100 volts was required for a fraction of a second to pull the signal arm to the 'Off' position, this was reduced to about 2 amps once the current is switched through a resistance. With the current was cut off by the signal box lever the arm returned to the 'on' position. *R. S. Co. Catalogue, c.1902*

Plates 4 & 5 show the prototype signal magnet and the prototype signal with the magnet much further down the post, later raised to reduce the length, and therefore the weight of the operating rod that in turn reduced the "hold off" current. There was an arrangement whereby 'Crewe' magnet could operate signals in both the normally 'On' and 'Off' [positions. The normally 'Off' was rare and may not have been used.

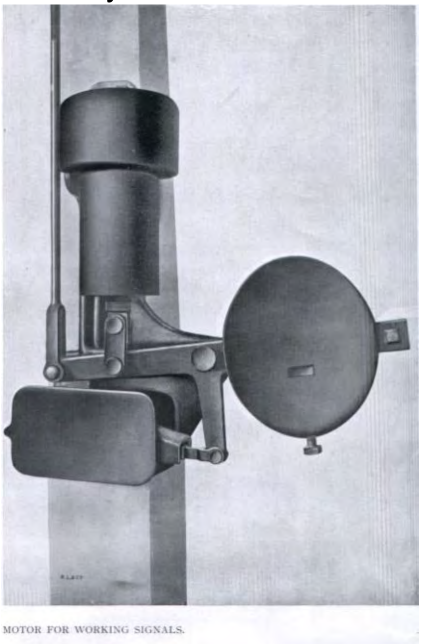


Plate 4.
A signal solenoid.
R. S. Co. Catalogue, c.1902.

Plate 5.

The prototype main line and ground signals erected in front of the main Locomotive offices where they were designed. The steps with the lamps mounted either side were the main entrance to the offices. The lines on the right of the signals were the original main lines to Chester but when the new works, or steel works as they were called, were constructed the Chester line was relocated outside the works boundary. The main line signal has the operating magnet fitted well down the post and in order to reduce the operating weight the final positioning was 3' 4½" below the centre line of the arm. The large baulks of timber on the wagons on the right are destined for the saw mills of the joiner's shop where the signal boxes, level crossing gates and signal posts were made.

R. S. Co. Catalogue, c.1902.

Ground Signals. The ground signal was of the revolving disc type similar to the standard LNWR mechanical type and worked by a similar although smaller solenoid with a cut-in switch and wire resistance for hold off of 50 ohms for 220 volt working and 5.8 ohms for 110 volt working, see plate 6. The original type is portrayed on plate 5. The ground disc lamp was electrically lit (as indeed all "Crewe" power signals were) the aspects being a 6" diameter solid red and green lens with a 2" diameter solid white lens fitted on the rear of the lamp case behind the red lens, the purpose of which was to enable the signalman who could only see the rear of the signal, to satisfy himself that it was in fact lit, light repeaters not being provided. A red face-plate was fixed around the lens to give a good daylight indication, no face plate being provided for the green aspect. Calling-on arms utilized the smaller solenoid similar to the ground signal. Ground signals could be found in the normally 'Off' position as signals No. 19 and 24 at Gresty Lane No.1.

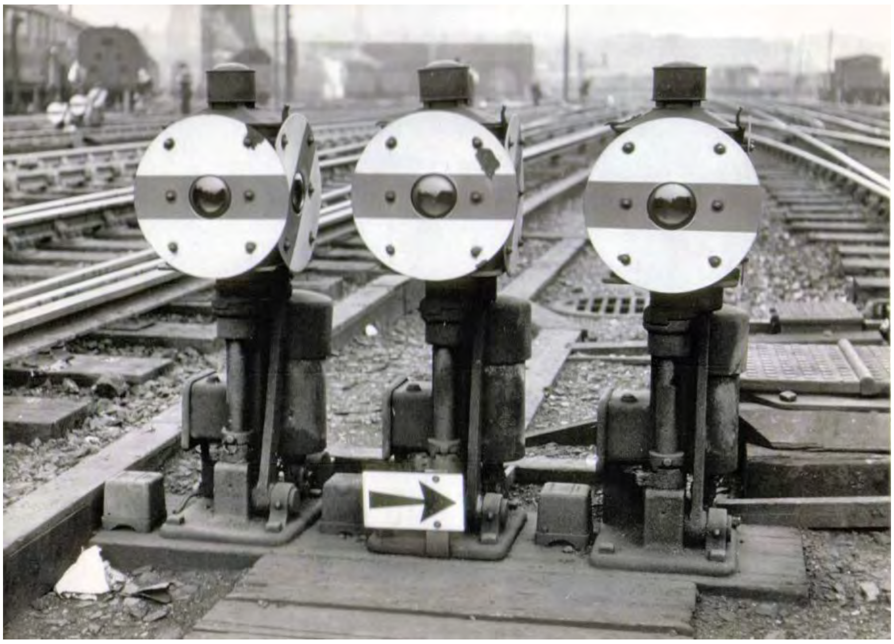


Plate 6.
LNWR solenoid operated ground signals at Camden on 4th May 1953. These signals now have circular face plates on both the red and green aspects not just the red aspect as originally. The circular plates were fitted on all such signals on the introduction of the LMS standard dwarf signal about 1934. The arrow is also a later addition. To the right, behind the signal can be seen a Crewe type point machine and electrical detector box.

British Rail D195.

Signal Lighting.
The signal lighting was 110 volt DC for the sorting siding boxes and 220 volts for the main line boxes and even with the carbon filament lamp of the early days the signal lighting was every bit as good as the oil variety and when metal filament lamps became standard, the lighting was exceptionally good. The lamp of a main line signal was housed in a standard LNWR main line outer case with the lens fitted to it, similar to the fixed distant arrangement, the normal oil lit LNW signal had the lens fitted to the inner case. Signals lit electrically were readily recognisable when "off" by having a distinct blue tinge as the filaments were white, the green signal glasses having a blue tinge to counteract the yellow light of an oil flame as laid down by the British Standards Association

Route Indicators.
A route indicator signal operated by the solenoids was also designed which consisted of a 2½" x 2½" angle frame measuring 5' 2½" x 3 2'¾" with 16 – 4' 6" lengths of 1½" x 1½" U section steel pivoted top and bottom at 2¼" centres, see figure 3. The bottom pivots ran on ball bearings. At the bottom of the shaft just above the bearing was a pinion actuated by a rack. Normally the white painted trough of the U section was displayed and by moving the rack certain distances any of the other three sides could be displayed, each of which was also painted white, but with a number or other indication painted on such as 'C'- Chester, 'LS' - Liverpool Slow, 'LF' - Liverpool Fast. The three various distances were transmitted to the rack by three identical ground disc solenoids mounted behind the rack about half way up, the

distances being varied by two sizes of operating angle cranks varying the throw of the solenoids, each of which had switches to bring in the reduced “hold off” current. At night the whole indicator was floodlit, a large hood being provided to shield the device from the sun and to house the lamps. It certainly was a very ingenious idea and by all accounts it worked well although all indicators of this type were replaced c.1921 by the “music hall” type, the reason undoubtedly being that three indications are generally speaking insufficient especially when considering such complex layouts as London Road, Camden and Crewe, a point born out by the fact the LMS mechanical indicator gave nine indications if required. When more than three indications were required two indicators were placed side by side.

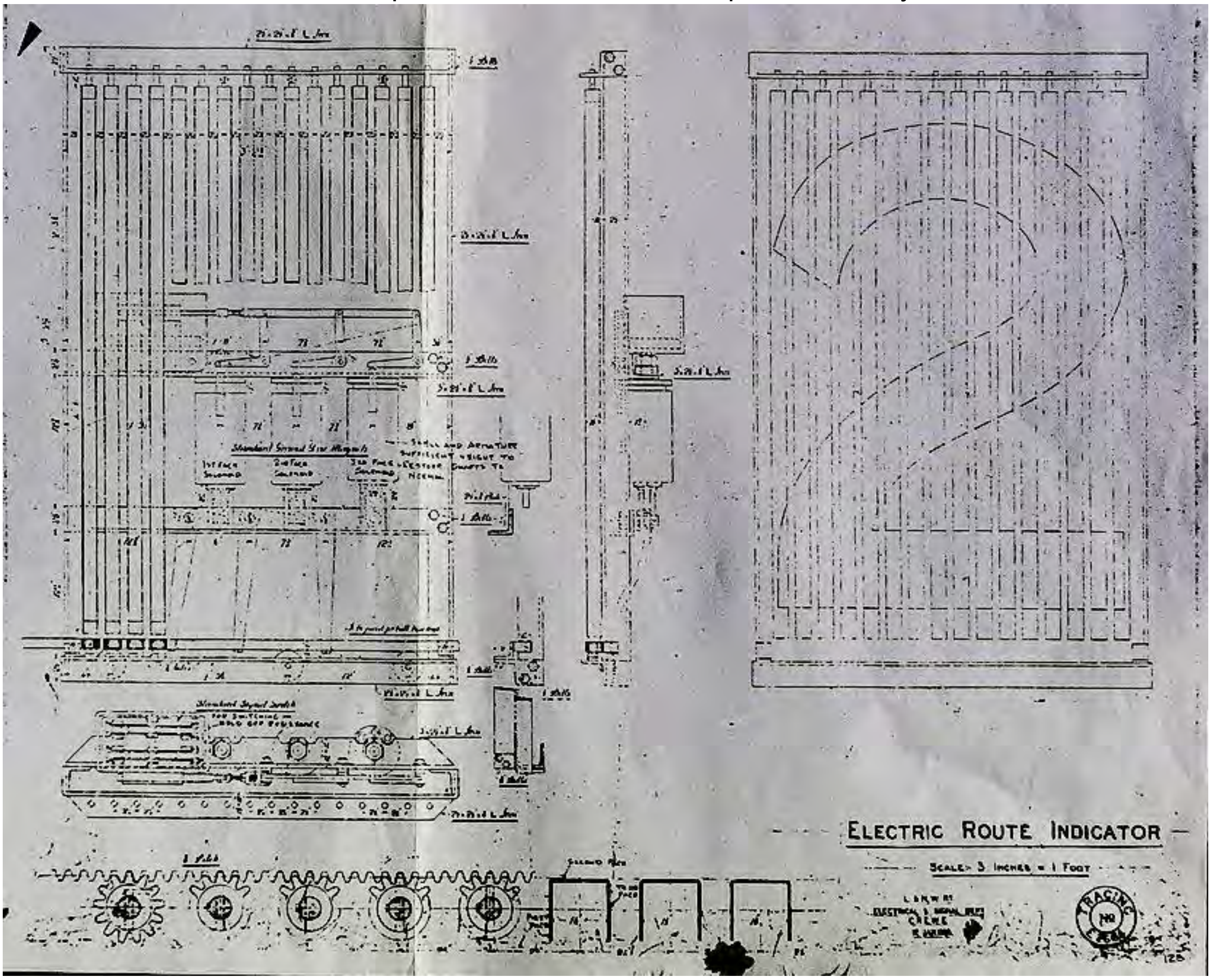


Figure 3. *LNWR General Arrangement drawing E 2664 dated 12th January 1905 detailing the Crewe ‘All Electric’ 3 way route indicator*

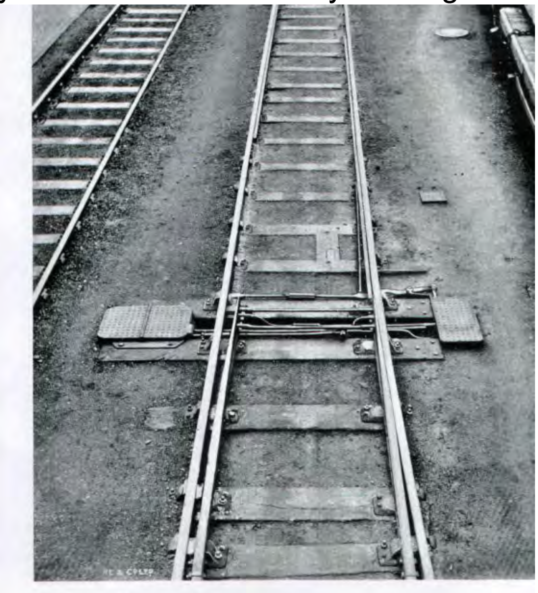
LNWR

Upper Quadrant Signals.

The upper quadrant signal did not become standard on the “Crewe” Division of the LMS Signal & Telegraph Department until after A. F. Bound became the LMS Signal and Telegraph Engineer in 1929. Experiments were carried out to operate an upper quadrant arm by solenoid and many bobbins were wound with varying numbers of ampere turns to create sufficient flux density to operate the arm. It was found that whilst a solenoid could be wound to raise the arm to 55 degrees using a reasonable current, the current required to “hold off” the arm was excessive due to the increased return torque of the upper quadrant design, meaning that the coils overheated. The only way to reduce this current was to reduce the return torque by counter weighting the arm, which of course was very undesirable and counteracted one of the main reasons for the introduction of upper quadrant signals. The idea of operating upper quadrant signals by solenoid was therefore abandoned. There were some upper quadrant signals in the sorting sidings, but these were worked by 110volt dc Westinghouse machines. It was because of the difficulty of obtaining urgent delivery of such machines that just one upper quadrant signal (Up Home No. 54 at Gresty Lane No.1) was retained as a solenoid operated signal. The signal had the arm counterweighted reducing the return torque that in turn reduced the "hold off" current to a nominal figure. As mentioned this was not considered a very satisfactory arrangement, but being a Home Signal in clear view of the signalman it was not considered dangerous should the arm "stick off", although as far as is known this never happened. This signal was removed during the electrification scheme.

Chapter 2. Points

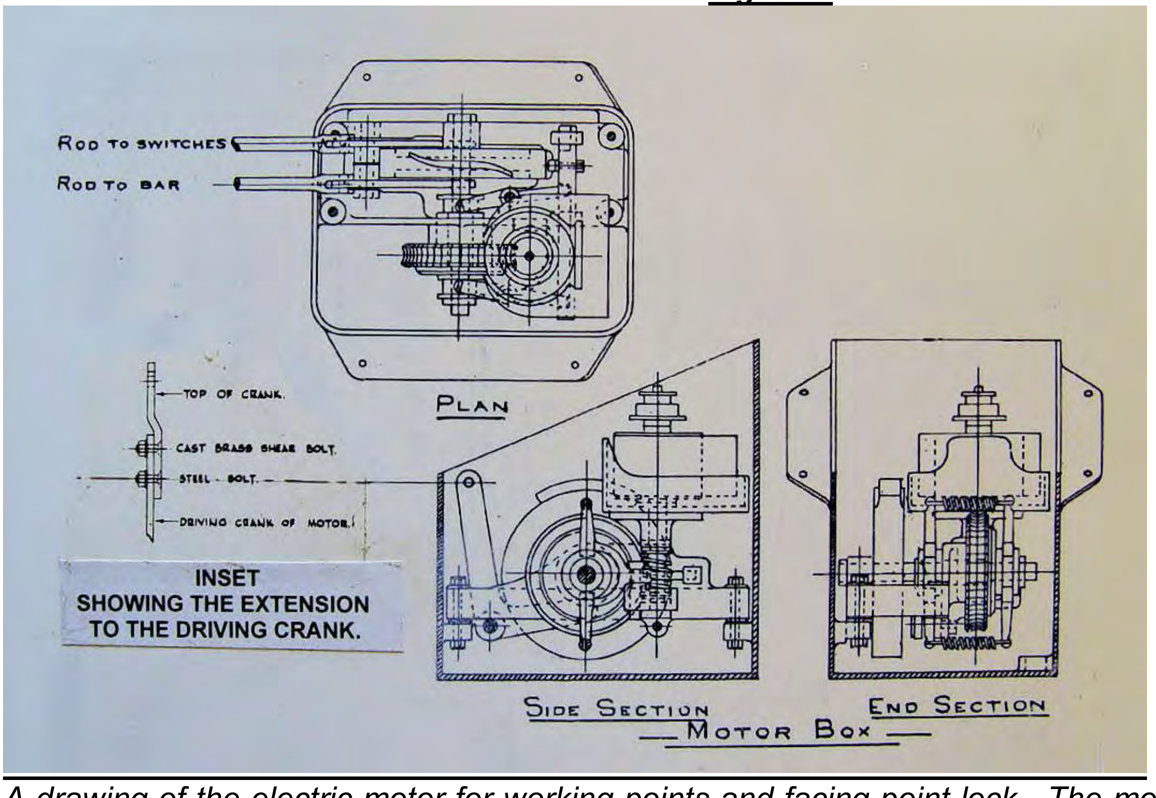
Point Operation. There were three basic methods of operating points with the "Crewe" power system, the first being an all magnet or solenoid system as detailed on LNWR drawing E1367 dated 19th April 1899, see figure 4 & plate 7 and used only in the Crewe marshalling yards that were certainly the largest in Britain at that time.



GRESTY LANE, CREWE,
FACING POINT WITH MOTOR AND CHECK LOCK, &c.

Plate 7.
The prototype facing point layout point layout installed for test purposes showing the locking bar and the covers of the cast-iron boxes containing in one case the point movement, and in the other case the check lock switches and signal detectors, which, in addition to the check lock were provided to ensure that a signal reading over the points cannot be lowered until the points are accurately in position and bolted. The location is outside the locomotive works.
R. S. Co. Catalogue, c.1902

***Figure 4*.**



A drawing of the electric motor for working points and facing point lock. The motor is stated in the catalogue to require 20 amps and 100 volts running at a speed of 800rpm thus *enabling a point to be moved over in about 3 seconds. The armature was formed on a tube that fitted over the armature shaft that could be lifted off and replaced in a few moments. The armature shaft was provided with ball bearings and drove a worm and worm wheel. The worm wheel was loose on a cross shaft and its movement was transmitted to the cross shaft by means of two clutches, one either side. These clutches were right and left handed, so that if the worm wheel was turned in one direction one clutch was engaged turning the cross shaft to the left. When the point was been moved over and bolted, a striking gear was operated which disengaged the clutch, and the motor then ran free. Keyed to the cross shaft was a cam wheel, on either side of which was formed a cam shaped slot of an irregular contour, in each slot there works a roller attached to a bell crank, the one crank working the point and the other the locking bar and bolt, the locking bar and bolt was only required on facing points, in the case of trailing points only one crank was needed. The motor and its mechanism was placed in a cast iron box with a cover that was level with the sleepers. The box was filled with thick mineral oil to cross shaft level thus the mechanism was automatically and continually lubricated with one charge of that normally lasted for 18 months. In the side of the box was a siphon, so that in the event of any water finding its way into the box it would fall to the bottom of the oil, the level of which would rise and the water siphoned away. Very little water was found to enter but in the event of a box being filled by accident, and the siphon became inoperative, no harm would be done providing the water is removed within twenty-four hours. The operating lever was later modified to incorporate a cast brass shear bolt as shown on the inset and figure 5 due to the driving cranks or rods being damaged in the event of an engine standing on the points or other obstruction. If excessive pressure was applied due to an obstruction, the shear bolt would break stopping the travel of the point rod. This modification has been added as an inset on the LHS of the drawing.*

R. S. Co. Catalogue, c.1902.

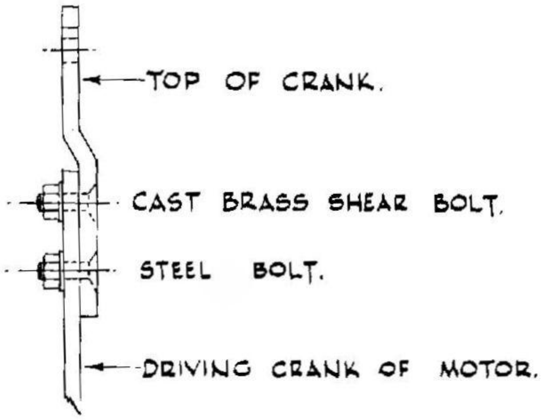


Figure 5.
The shear bolt was fitted to an extension of the driving arm on the motor to safeguard against damage to the driving cranks of the motor and also the driving rods should an engine stand on the lifting bar at the commencement of the motors run before the clutch was released.

These yards required the use of five power signal boxes and required some 438 levers to operate them. The south end of the yard was controlled the Crewe Sorting Sidings South Signal Box with 76 levers. Crewe Sorting Sidings Middle marshalled the trains having two lever frames at the front and back of the box with a total of 152 levers, the mechanical locking of which was cross connected under the floor. Crewe Salop Goods Junction had 57 levers. Crewe Sorting Sidings North had 95 levers, while Gresty Lane No.1 dealt with the West of England traffic (both passenger and goods) had 57 levers that was the last to remain working as originally installed. All these boxes were operated at 110volts dc with the goods lines points solenoid operated and the points where passenger trains ran being motor operated. The solenoid or magnet points were operated by two large electro magnets, one for moving the points from normal to reverse and another for moving them from reverse to normal, a third magnet being provided to lock them in either position in a separate box with combined lock and detector. The magnet operated points were designed to work in conjunction with 95lb per yard rail of the old LNWR standard in conjunction with loose heal switches, that is short hinged switch blades, requiring some 30 amps to move them. The main line installations at Crewe North and South Junctions, Crewe A and B Boxes, Manchester London Road and Camden all used a 220 volt dc supply with the points operated by the second type of “Crewe” point machine, see plate 8 & figure 6. This machine was in fact a motor being set at ground level, and in conjunction with a clutch drove a crank that was connected to the point blade tie bar, the other end of which was a crank that changed the direction of movement through 90 degrees and operated the 40’ 0” locking bar via a scale beam.

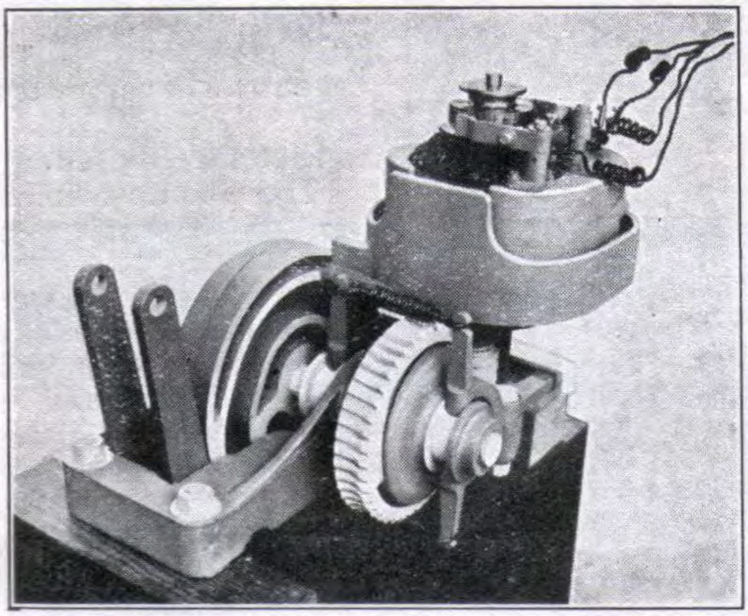

ELECTRIC POINT MOTOR MOVEMENT

Plate 8.
Shows the electric motor for working facing points. The driving crank was later modified to include a shear bolt Figure 5. Power was supplied by means of a cable some ¾” in diameter that was laid in the ground or carried on supports.
R. S. Co. Catalogue, c.1902.

Extension pieces were fitted at the end of the point blades with a detector rod fitted having an extension that slid into and out of the detector box mounted alongside the point motor, figure 6. The armature was so designed that it could be replaced in a few minutes in the event of failure. The worm wheel was lose on a cross shaft, its movement being transmitted to the cross shaft by two clutches that were right and left-handed. This meant that only one clutch engaged dependent upon which way the worm wheel was turned. When the point blades had moved over and had been bolted, a striking gear was operated that disengaged the clutch letting the motor run free. Keyed to the cross shaft was a cam wheel on either side of which was formed a cam-shaped slot of irregular contour and in each slot there was a roller attached to a bell crank, one crank working the point and the other the locking bar that was only used on facing points.
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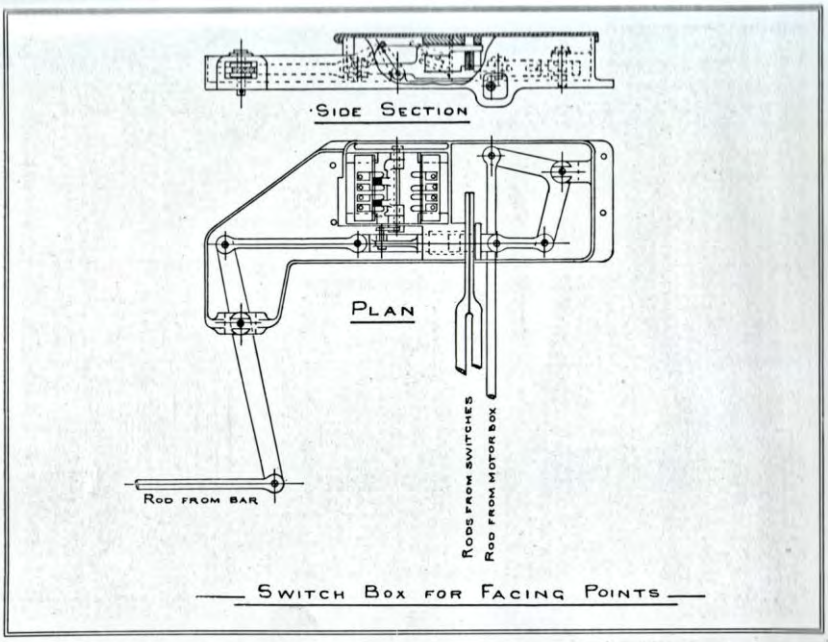


DETECTION FOR POINTS AND POINT LOCK,
AND RETURN CONTACT FOR CHECK LOCK.

Figure 6.
Drawing showing the switch box for facing points with the detection for points and point lock and return contact for the check-lock.
R. S. Co. Catalogue, c.1902.

With the introduction of the revised British Standard in 1923, it was found that the point blades were too heavy to operate by the magnets. Accordingly 110volt dc Siemens motors were substituted, the layout being similar to the Crewe North and South Junction points, except the motor worked a 40’ 0” lifting bar (If required) as track circuits were not used for holding the points at that time. The standard facing point lock and Crewe type detector were also utilised, figure 7.

The change from magnet to motor in the yards was frowned upon by the signalmen as the motors took some five seconds at their fastest to operate points, instead of one second or less as required by the magnets.

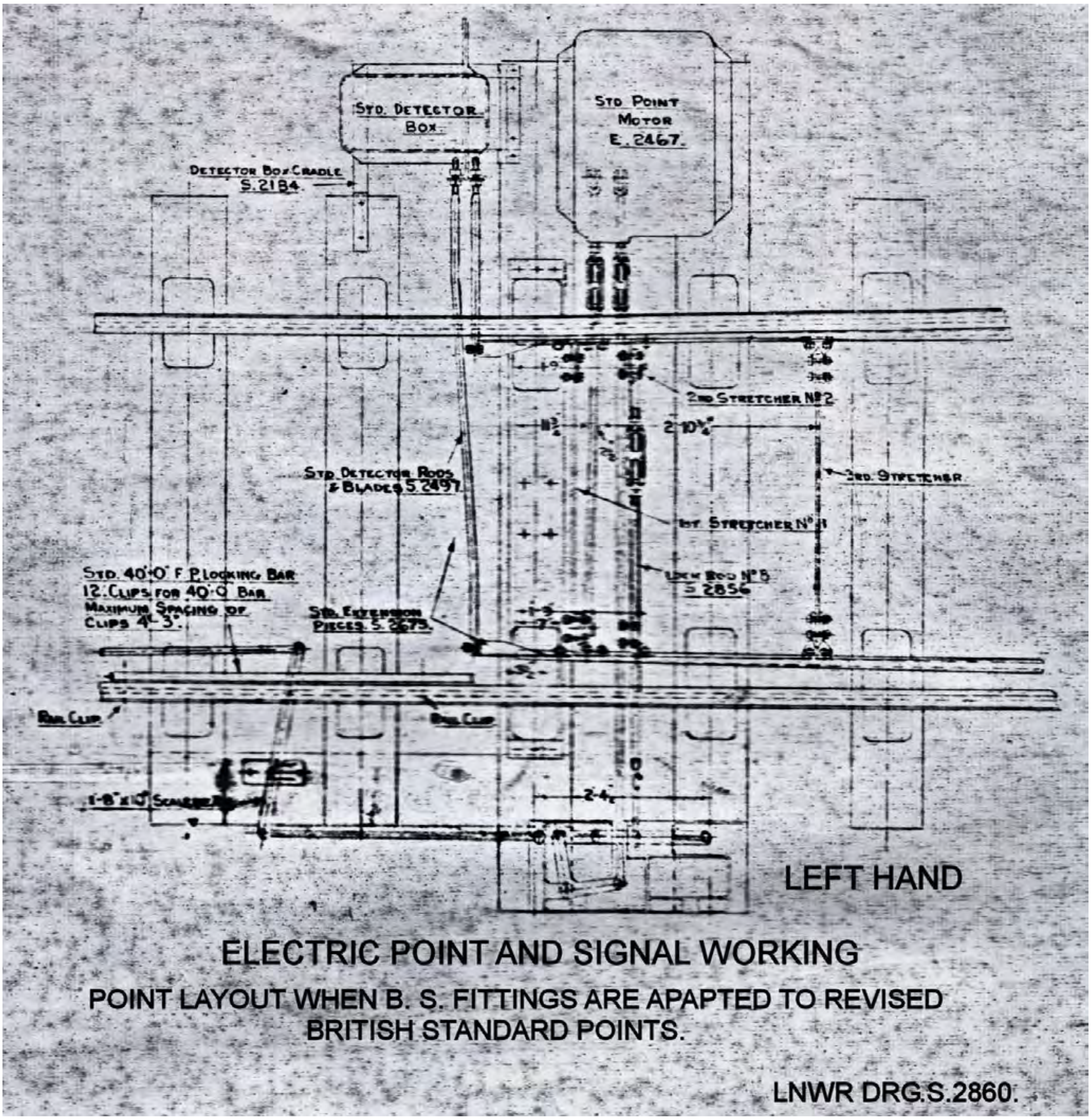


Figure 7.
Shows the original point layout for LNWR points that required three detector boxes as used before the introduction of the Prince and Langley Movement.

Portion of LNW Drg.S.2860.

The change from the LNW standard to the revised British Standard also brought problems to this method of point operation, particularly the shear bolts that will be referred to later. It was therefore decided to modernise the point layout, improve the detection and operate the points through a Prince and Langley facing point lock figure 8 for the trailing arrangement and figure 9 for the facing point lock arrangement.

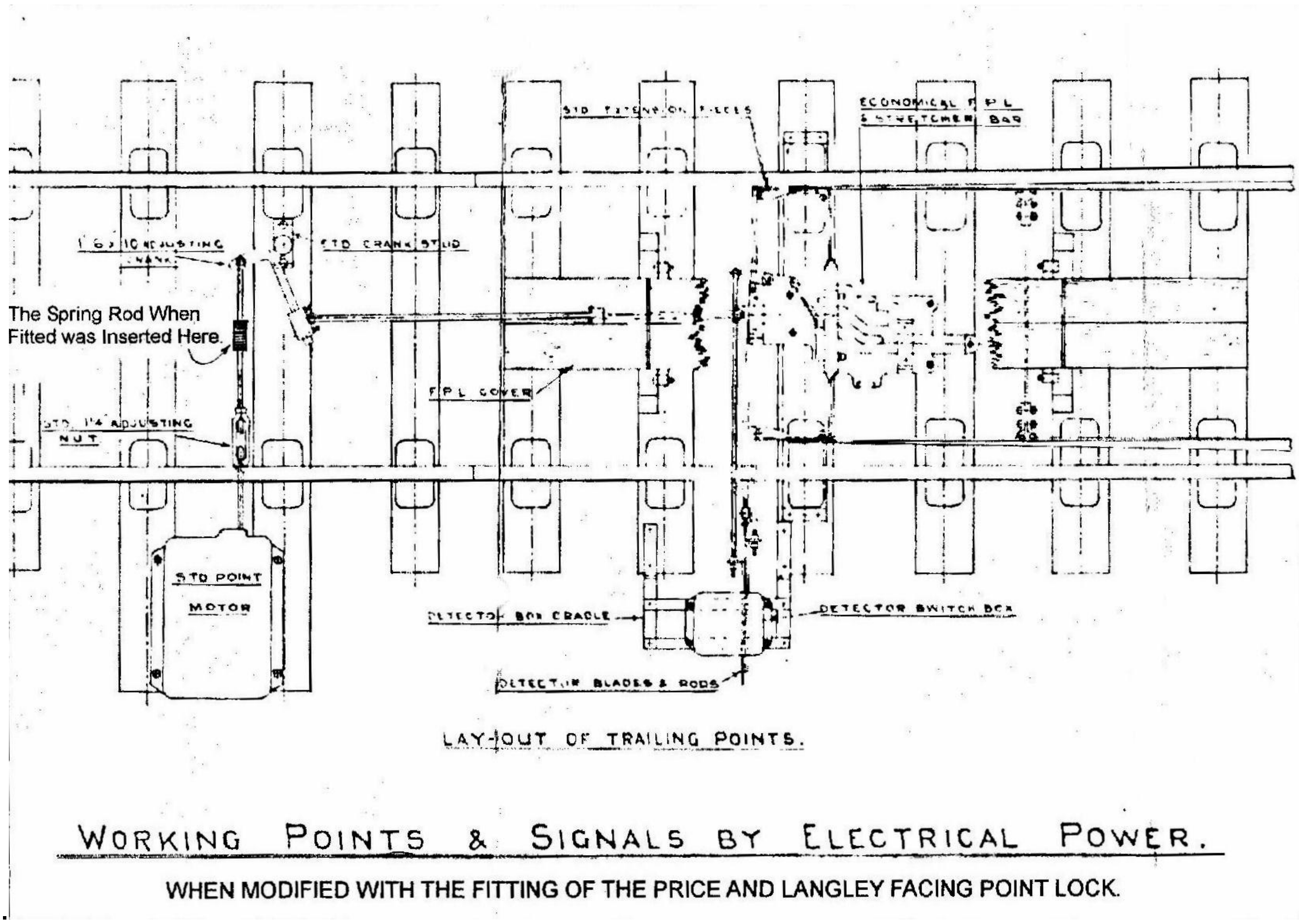


Figure 8.
The increased load on the point machines brought about with the introduction of the revised British Standard about 1926/7 resulted in the change to the Prince and Langley point layouts, this drawing shows the trailing point arrangement.

This arrangement simplified the detection, one detector box being used for both the points and the facing point lock instead of the three boxes used hitherto. The point machine was also modified and was mounted approximately 30’ 0” from the point blades to operate a 40’ 0” facing point lifting bar through a 1’ 6” x 10” adjustable crank and hinged driving rod. Near the end of the lifting bar adjacent to the fourth sleeper from the point blades was a rocking shaft fitted to the rails which was actuated by the lifting bar as it moved over and back. Near the centre of the rocking shaft (that is approximately half way between the rails) a crank was fitted to which a rod was pivoted connected to the end of the Prince and Langley “Z” slot – meaning that as the rocking shaft went over or back so too did the Prince and Langley slot, thus operating the point blades having the usual detection rods fitted on extensions of the point blades with the switch box outside the rails. The lifting bar facing point lock was retained as track circuits were still not considered safe enough for such purposes and only used for advising the signalman of the position of a train. The facing point lock was not required with trailing points, the motor being fitted outside the rails driving the Prince and Langley slot via an 18” x 10” adjustable crank, the detector being exactly the same.

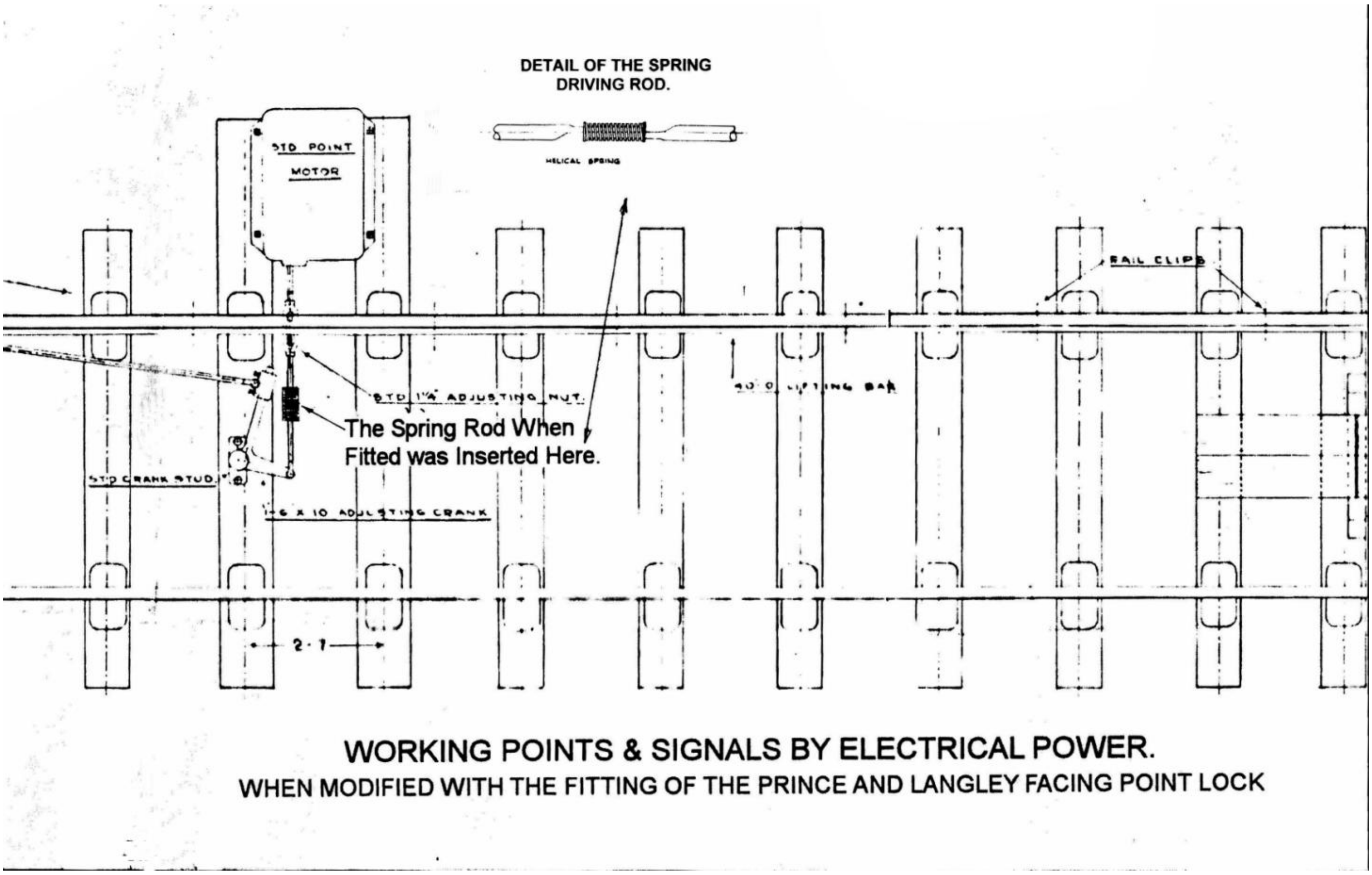


***Figure 9**. The prince and Langley facing point arrangement*.

Reference was made earlier to the fact that the breaking of the shear bolt was one of the chief causes of failure of the points that were operated by "Crewe" type motors, this particular failure increased with the revised point layouts necessitated by the introduction of the revised British Standard Rails.

The shear bolt, figure 5, was a safety device preventing damage to the driving cranks in the point machine and also the driving rods. The driving crank of the motor was extended a further few inches by bolting an extension piece to it with two bolts, one of which was a cast brass shear bolt, the other being of steel, see inset on figure 10. It can be seen that if an engine was stood on the lifting bar or should there be an obstruction between the point blades and the rails stopping the points from moving over, the force transmitted by the point machine would act on the brass bolt eventually shearing it. The reason for this being that the clutch could not slip like a clutch plate until the pressure was eased between the two faces which was done by a disengaging cam on the rim of the cam wheel in the normal/reverse position of the points.

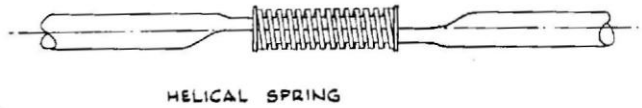


Figure 11.
Sketch showing the spring in the divided drive shaft inserted in the motor drive shaft on Fig.6. The springs were initially 700 lbs compression later increased to 2500lbs and even then not entirely satisfactory. This resulted in a reversion back to a shear bolt of larger diameter.

With the introduction of the Prince and Langley movement the shear bolts were breaking more than ever, and a decision was made to do away with them by substituting a second steel bolt in lieu of the shear bolt and providing a helical spring figure 11, in a divided drive shaft from the motor. This meant that should there be an engine on the lifting bar then the drive would continue by compressing the spring as the divided drive rod connected to the point was drawn towards or away from the point machine with the point operating rod stationary, The spring rods were provided by Henry Williams of Darlington under an initial compression of 700 lbs and functioned very well in good weather, but during the frost and snows of winter the springs would not take the extra load, the rod closing with no movement being transmitted to the points, causing failures. Fresh springs were ordered with various increases in pressures and it was not until a figure of 2500lbs was reached were failures effectively reduced and even then not to an acceptable number. The shear bolt was then re-introduced of larger diameter and made of phosphor bronze and as such the problem was solved. This exercise certainly showed the great power transmitted by the Crewe type point machines that must have transmitted over 2500 lbs of thrust for the spring rods to fail.

Signal Inspector J. Fisher in charge of the Manchester London Road installation and based at London Road and Heaton Norris, designed a spring loaded clutch that would slip under excessive working conditions, thus rendering the shear bolt unnecessary. This was portrayed on Drawing No, PD36001 prepared by Reg. Davey. Indicating the date as 1936 although Bill Hardman stated the date of this modification to be 1925/6. A. Hodson, a Heaton Norris S&T Department fitter, took over the London Road duties in 1934 and recalled only two or three machines having been modified at that time. The clutch was fitted to all the "Crewe" motors working unaltered point layouts at Manchester and Camden but not Crewe, with three fitters being detailed for the execution of the work. Fisher also patented an electric power signalling system of his own design, which as far as is known, was never used, although he did receive a monetary award and a cash allowance for his experimental work. At Manchester, no S&T fitters were on duty between midnight and 05.00 so any bolt that sheared caused considerable delay to traffic. The London Road fitters shop was situated in Mayfield Station where the alterations were made. The fitters also maintained the locking frames, point machines etc. In earlier days the dog clutches, bevelled gear wheels, cam wheels etc. were altered and fitted to the machines in Mayfield depot but as work progressed these parts were manufactured at Crewe and then fitted at Mayfield Depot. Bill Hardman stated the original Crewe point machine took currents up to 80 amps with the Fisher type only requiring 7-10 amperes. Point machine servicing was undertaken by Mr. Pierce and with the conversion to the Fisher type resulted in much greater efficiency.

Before moving on to lever frames, a final point of interest concerning the point motors, lock boxes etc was the fact that they did not protrude above ground level due to the danger of staff working on the line falling over them. In this respect A. M. Thompson could be said to have been before his time as the Board of Trade eventually issued rules, one of which stipulated that point and signal; connections must not constitute an obstruction, and where this was impractical they must be boxed in. It could also be said that as the Crewe Yards and Junctions were lit by overhead arc lamps, raised motors would not be the same hazard as in unlit yards, although of course it would undoubtedly have been Thompson's aim to get the "Crewe" system universally adopted.

Chapter 3 - Lever frames.

The lever frame was the same for both the 110 and 220volt installations consisting of two tiers of levers. The top tier carried the even numbers and was used for points having three notches in the quadrant for normal and reverse positions plus a centre notch to hold the lever when the points failed which cut off the power. The bottom tier levers carried the odd numbers and were notched only for normal and reverse and due to the shorter travel compared with the top tier levers required a longer lever tail to give the same 4½" stroke to the down rods. The bottom levers generally operated signals, but in exceptional cases they too operated points. The levers were spaced at 3½" centres on both tiers and being staggered gave a spacing of 1¾" between all levers. See figures 11 & 12.

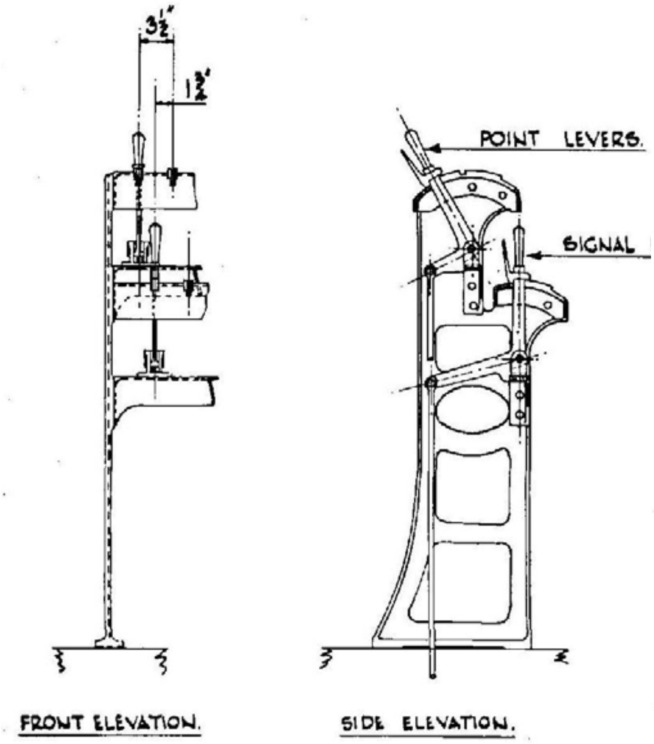


Figure 11.
The interlocking frame fixed to the signal box upper floor.
Railway Signal Co catalogue c. 1903.

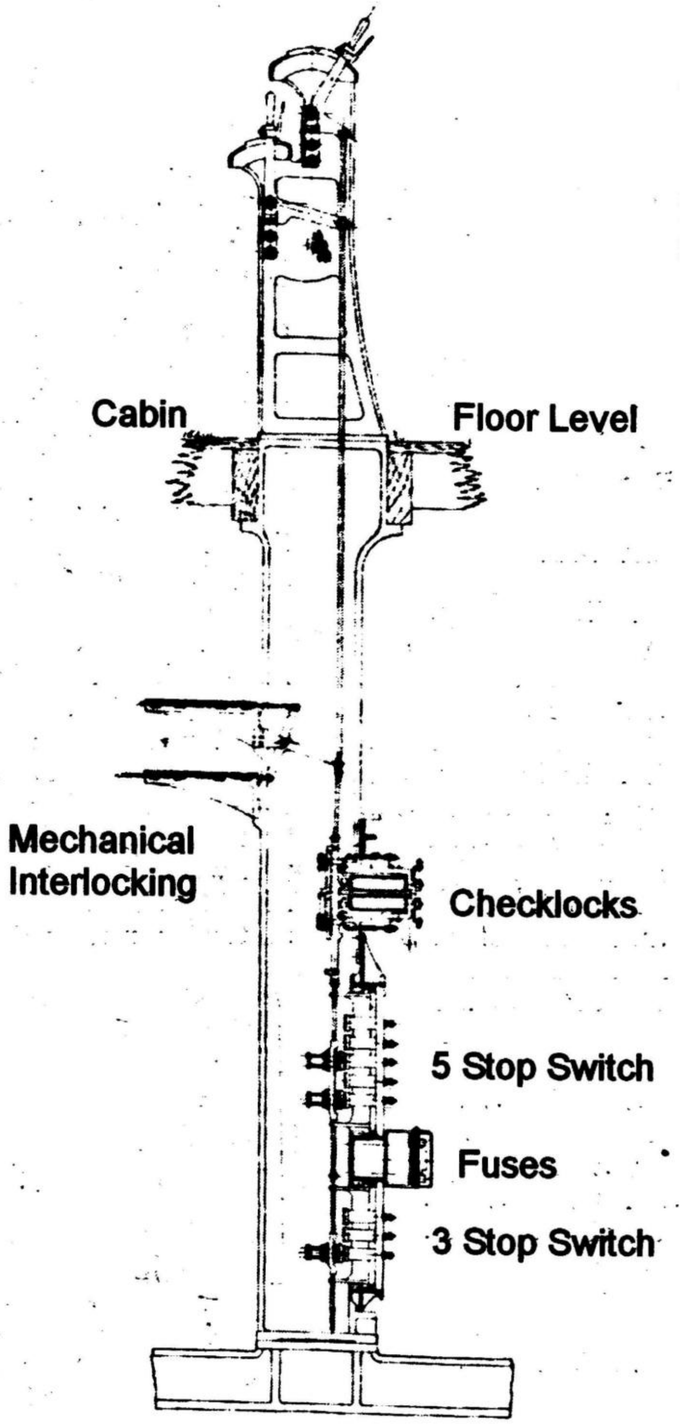
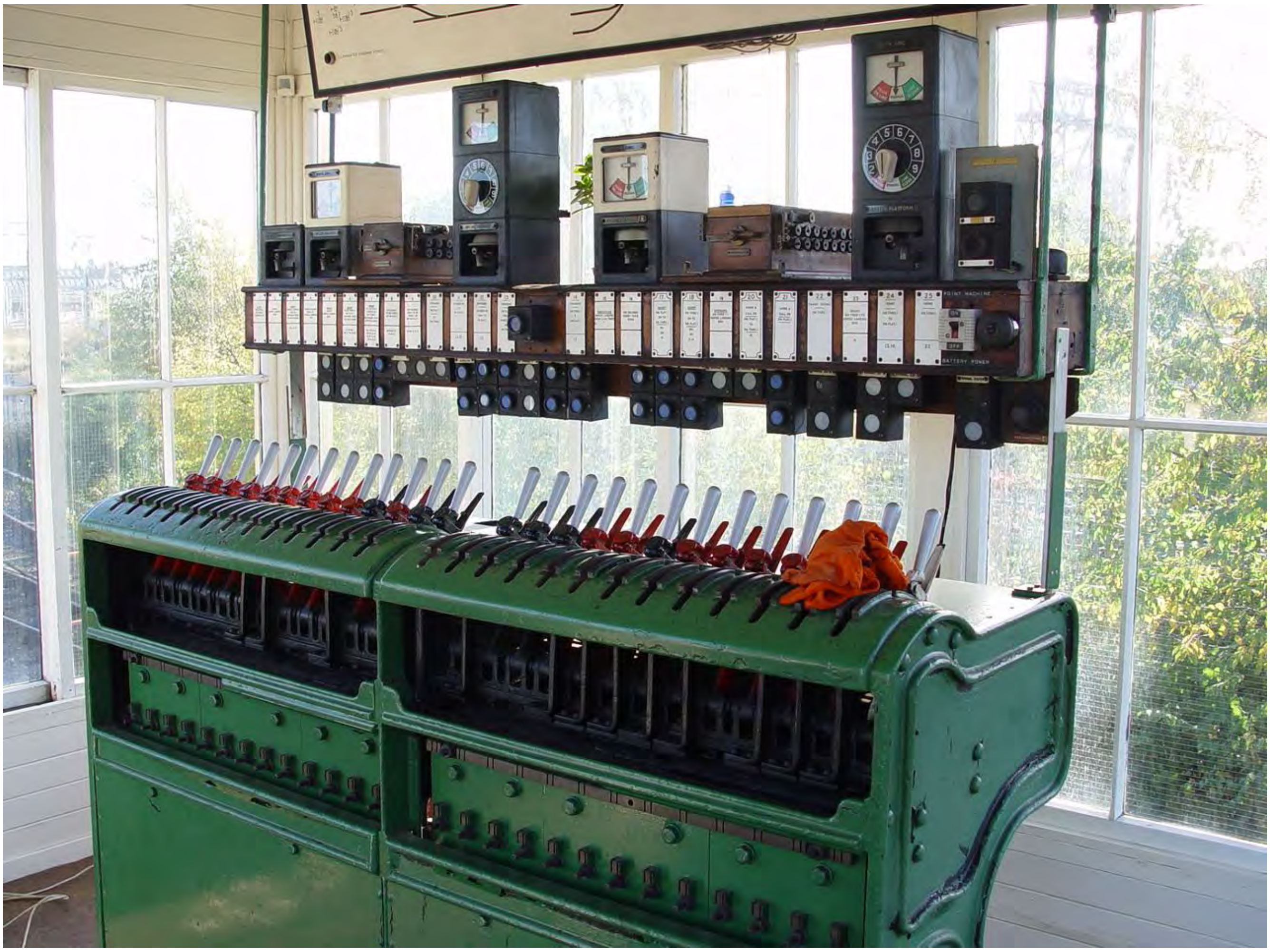
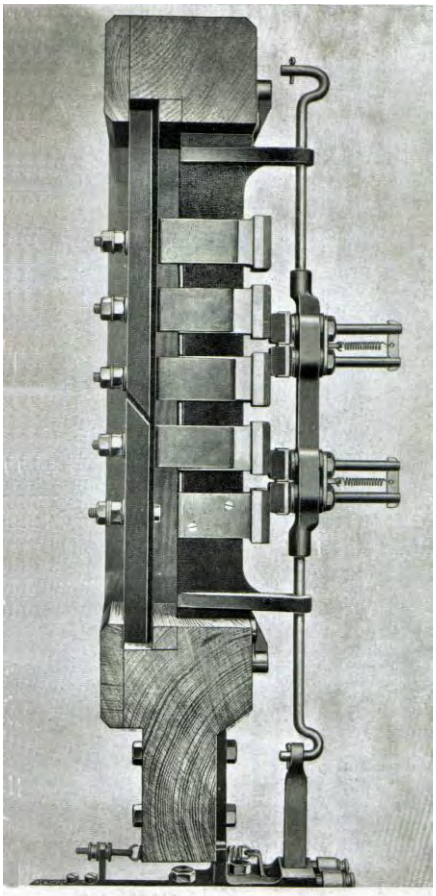


Figure 12
Arrangement of the lever frame showing the normal position of the five and three stop switches, the check locks and the interlocking. Overhead boxes had a different arrangement.
Railway Signal Company Catalogue c.1903.

The signal boxes at Crewe Station ‘A’ and ‘B’, Euston No.3, Camden No.1, London Road Nos. 1, 2 & 3 and Severous Junction, York were all of the overhead type requiring a second design of frame for overhead boxes that had no basement. The overhead box frame had a single row of levers at 2½” centres and all operated at 220volt dc, Plate 9 Both types of frame worked direct tappet locking, the locking boxes were mounted horizontally in tiers with the tappets driven through a crank off the down rod of the lever. Below the locking boxes the 5/8th diameter down rod was attached to five and eight stop carbon switches being used for signals and points respectively. The eight-stop switch was made up of a five plus three switch for working the point machines. The five-stop switch, plate 10 & figure 13 had a two contact switch meaning that two circuits were made or broken at a time, the three stop switch having only a one contact switch.





SWITCH FOR DIRECTING CURRENT TO POINT OR SIGNAL. *Fig. 6.*

Plate 9. *The 'Crewe' Station 'A' frame preserved in the Crewe Heritage Centre. The signal box was of the overhead type and contained the second type of power frame having but one row of levers at 2½" centres. The other overhead boxes were Crewe Station 'B', Camden No.1, Euston No.3 and the three Manchester London Road boxes together with SeverousJunction,York.*

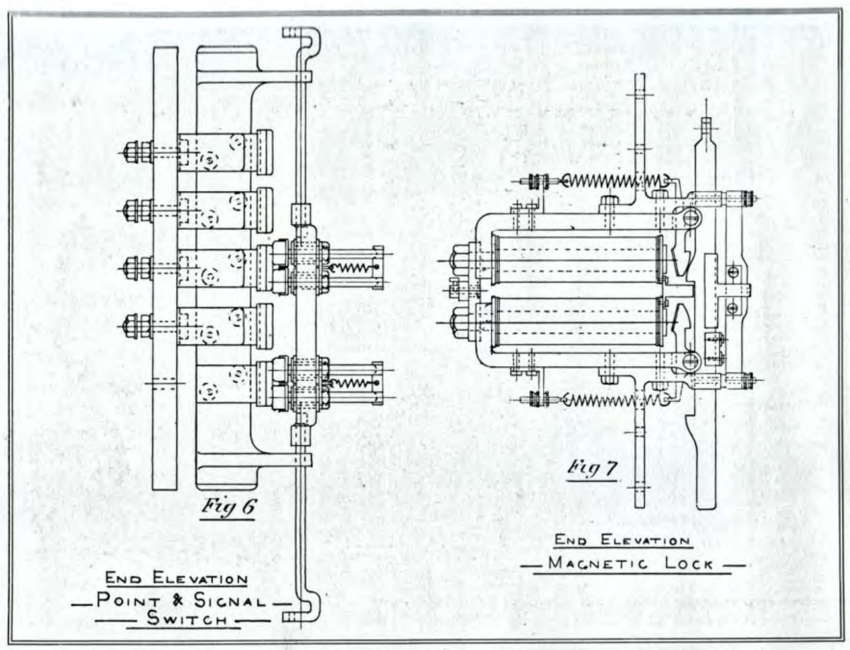
L. G. Warburton

Plate 10.

Carbon switches for directing current to points or signals. The contacts were of carbon, the contacts on the moving part being carried on plungers that were duplicated to ensure good contact if the surface under the carbons is irregular. The connections between the supply cables and the switch were made using metal jaws, and in case of a failure the complete switch could be changed in a few seconds.

R. S. Co. Catalogue, c.1902.

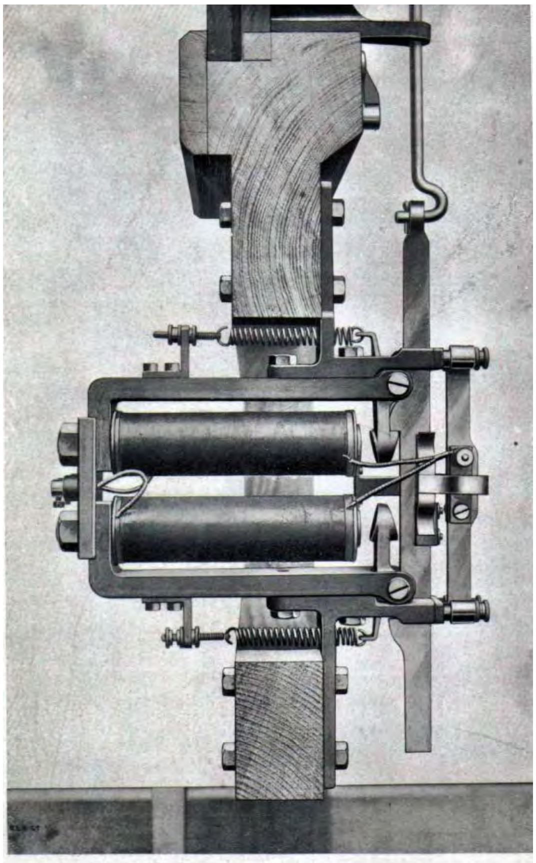
In order to guarantee that the points followed the lever, a normal and reverse check-lock was used on all levers working points with a single coil reverse check-lock on those for signal operation, plate 11 and fig.13. These check-locks prevented the levers being put fully normal or reverse until the coil was energised holding down the locking pawl on top of the coil so allowing the lever to be fully restored. The normal and reverse check-lock was wired through the 'On' contact on the switch worked by the signal ‘T’ crank proving that the arm had returned to the ‘On’ position before the check-lock coil was energised to release the lever to allow it to go into its normal position. The holding of the lever stopping it from going fully normal or reverse ensured the points and signals had operated correctly for the route set up and that all protecting signals had returned to normal before the mechanical locking was released. An interesting fact worthy of note is, that it was not the standard practice of all railway companies to detect their facing point locks, but it did become compulsory about 1921 with the Railway Executive Committee lock. The Crewe power installation electrically detected the facing point lock through a switch in the lock box. The solenoids of the signals were wired through the switch and detector boxes on the toe of the point switches thus preventing the signal coming “off” unless the facing points were locked and the point switches fitting correctly. All check-locks were serviced in the Crewe workshops with tension adjustment sealed to prevent wrong side failures. Figure 13 shows the assembly of lever, switches and check-lock.



ELECTRIC SWITCH AND CHECK LOCK,
FIXED IN BASEMENT OF SIGNAL CABIN.

Figure 13.
Side views of the electric switch for point and signal operation and the check lock.
R. S. Co. Catalogue

Plate 11.
Check locks were only provided on point levers. A signalman must not be able to actuate a signal until the point has been moved over and bolted, the check lock being provided for this purpose. This consisted of two electro magnets, one being energised when the point was pulled over, and the other when the point was reversed. The coils were energised by a shunt current that was switched on when the bolt lock securing the point in position was fully home. The rod working across the face of the magnets was provided with two projections, one of which engaged with the pawl that formed the armature of the left hand magnet. In this position the lever in the box was pulled over through about three-quarters of its stroke, and so soon as the points had moved over and locked, the left hand magnet was energised, the armature pawl was drawn down and the rod released, thus enabling the lever in the box to be fully pulled over.
R. S. Co. Catalogue, c.1902.



CHECK LOCK FOR DETECTING
MOVEMENT OF POINTS.

The original ‘Crewe’ system check-lock was fed by the 240volt dc power supply system and series wired for signal circuits proving signal normal and points correct, according to the route set. With the advent of colour light signalling ac detection was used. Westinghouse lever locks, normal/reverse, also check-locks on signals at Camden No.2 being introduced in 1932 in connection with the Euston/Watford re-signalling followed in 1938/9 by Camden/ Euston colour light signalling embodying Camden No.1, Euston No.4 and part Euston No.2. Consequent with the renewal of Euston No.2 Down Starters and Up Home signals the original battery operated dc detection was scrapped and ac relay detection installed that greatly improved the conditions at Euston No.2. The Up Home gantry was taken out of the 440 yards approach, with the outer home control on Euston No.4 and Camden No.1 starters plus track circuits and ultimately track circuits through Primrose Hill tunnel.

Chapter 4. Power supply and maintenance.

Power Supply.
The Crewe power supply for the system was provided by the LNWR owned power station situated close by North Junction. The power station not only generated power for the signalling system, but also for the yard lighting and railway offices. There were six sets of dc generators with two chain grate fired boilers supplying steam to high-speed reciprocating engines that drove the generators. Two engines were the Willans and Robinson triple expansion type with wood lagging round the cylinders, another pair were from Bellis and Morcom. There was also a large capacity 220volt lead acid standby battery used for signalling only. The sorting sidings were supplied from a substation in which a 110volt standby battery was installed.

The original Crewe power supply was a 480/240 volt dc 3 wire supply under the control of the Chief Mechanical and Electrical Engineer to the signal box switchboard. Being a 3 wire system it was unreliable as Imbalance frequently occurred and the 240volt equipment was subject to voltages between 240 and 480 resulting in the burning out of whatever apparatus was in use at the time i.e. check-locks, point motors etc, figure 14. This was later superseded with the installation of Nife batteries with a rectified trickle charge from the Signal & Telegraph Engineers own 650volt ac ring main. This proved to be entirely satisfactory with a reliable system that more importantly was fully under the control of the S&T Engineers.

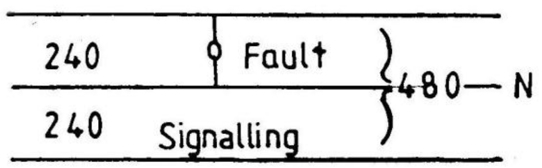


Figure 14
Diagram showing how a fault between one wire and the neutral would raise the voltage to 480 in the signalling wire thus burning out equipment.

The Manchester power supply was provided from a power station underneath London Road Goods Station, the cables being carried under the arches to location cases at the rear of the old turntable, the cases housed the switchgear for isolation and ring mains, the supply being 250/220 volts dc. The generators and transformers in the power station were the responsibility of the Outdoor Machinery Department.

The power supply for the London installation was initially from the company's own Camden power station that utilized gas-engines and supplied Euston station etc. This was rebuilt as a sub-station when Stonebridge Park power station was commissioned in 1914 which supplied power at 11,000 volts, 25cycles. Generation was by four turbine driven alternators and one turbine driven house set supplying power station equipment. Rotary convertors and batteries supplied 650 volts for traction purposes. Rotary converters at 480 volts dc, 3 wire supplied the signalling, and it was this fact that if a defect occurred on any circuit on the opposite half of the 240 supply, then the 480 volts was developed, on the signalling supply (see fig 14). In 1945, after Stonebridge Park changed over to the National Grid standard of 50 cycles it was found that the mercury rectifiers produced peaks of fairly high voltages, and it was this plus the previous difficulties that decided the Signal Engineer to use trickle charged batteries as already referred to No interference was experienced from faulty electric trains or traction current.

Maintenance.

We have referred to the fact that electricity was only in its infancy and strange as it may seem, probably the main reason for the success of the system was the speed in which faulty apparatus could be replaced and the ease in which faults could be found because of the simplicity of the electrical circuiting. A reconditioned signal solenoid could be fitted in five minutes and a point machine armature in a few seconds. The maintenance men were well trained as most of them had been employed in the installation work. All the outside circuits were wired with separate stranded insulated wire and run in timber boxing at ground level. If it was necessary to join wires it was done with porcelain connectors, the connection then being taped up, the whole of the ground level boxing was then filled with compound. Very few failures were caused by bad joints and as the maintenance staff knew the position of these joints faults were quickly found. The use of ground level wire runs was discontinued about 1923 when it was found ground vibration caused by passing trains had caused the brittle compound to crack allowing ingress of water to the wire runs with consequent increase in the number of faults. The most serious failures were caused by fires, particularly in the 220 volt working installations due to overheating etc. The largest fire was in the Crewe South Junction Signal Box about 1922. Fires also occurred in the Crewe North Junction, Manchester London Road and Camden signal boxes, in fact all the main boxes had fires, although the 110volt signal boxes were never quite so seriously affected. The North Eastern Railway installation at Severous Junction was also affected by fire.

During the early 1920s the whole of the 220volt working signal boxes were fireproofed by using fireproof cable attached to iron frames by porcelain insulators. One of the main causes of the fires was attributed to rats gnawing through the lead sheathing resulting in many methods to prevent this being tried. Cable entries were blocked with wire netting and cable ducts packed with glass fibre that the rats loved using it to make their nests. Finally it was realised that the best way to stop the rats gnawing the cable was to give them a clear run in and out of all cable and duct runs.

Once a signal box fire started it was undoubtedly helped by the chimney like aperture in which the cables entered the box, causing flames to roar up through. It is also said that on some of the runs there was so much cable and wire to dispose of that some man-holes were full of coiled wires, no doubt due to the reluctance to cut and make joints, and, although possibly not appreciated at the time, could possibly bring induction problems. With regard to fires, the LMS Land & Works Committee, Minute 419 dated 26th November 1940, related that when signals were restored to danger at all the main line installations a sudden surge of power had caused a number of fires by breaking down cable insulation. At Manchester the trouble had been remedied by the provision of metal rectifiers that acted as surge absorbers and it was recommended that the 191 signals at Crewe and the 131 in the London area that could not be converted to colour light signalling be provided with the surge absorbers manufactured by the Westinghouse Brake & Signal Co. at an estimated cost of £775. Pity Mr Webb, who, looking down from above saw the eventual involvement of George Westinghouse. It may well be that the Crewe installation was not all modified as the Colour Light scheme together with the construction of ARP signal Boxes at Crewe North and South Junctions was approved in Board Minute 3936 dated 25th May 1939.with the work commencing in June 1939 and completed in September 1940 also involving the Westinghouse Company.

A further cause of failures was water getting into ground level motor housings that were filled with oil up to cross shaft level. A siphon was formed in the side of the box to allow water to fall to the bottom of the oil, the level of which would be raised by the water at once being siphoned away with no harm coming to the motor providing the water cleared within 24 hours. In practice the motor boxes did flood during storms and had to have the water pumped out which could be a lengthy job.

Chapter 5 – Personnel notes.

F. W. Webb, being the Chief, probably said *'yes'* to the detailed ideas put forward for this system but that was most likely all he did, so perhaps we should consider those who did the work. Firstly John Bean who was the foremost Electrical Engineer of his day on the LNWR. He was a quiet little man who retired around 1920 and the design of the switches, motors, solenoids wiring etc were all his brainchild. Secondly an employee by the name of Birchenough did the mechanical design. When the design stage was complete he left the service of the LNWR and joined the Railway Signal Company of Liverpool to possibly supervise the manufacturing of the system by that Company.

In March 1912 Arthur M. Thompson retired from the position of Electrical and Signal Engineer but the position was not filled as the Signal Department was transferred to the Chief Civil Engineer with John Troughton Roberts becoming Signal Assistant. The Telegraph Assistant to the Chief Electrical Engineer being J. N. C. Kennedy, both officers being based in the Gresty Road offices at Crewe. The Assistants had separate offices with the Signal Assistant to the right of the main doors and the Telegraph Assistant on the left. Lawrence Webster Swainson replaced Kennedy and in 1923 he was Senior Assistant to the Electrical Engineer, Crewe with a salary of £800 per annum. On 1st November 1925 he was appointed District Electrical Engineer, Crewe on £1000 per annum and in 1928 he is listed in the same position job but located at Euston. He retired to Berkhamstead on 30th November 1929, aged 50, with 32 years service still on £1000 pa with an annuity of £648/6/8d He apparently became interested in the preservation of the red squirrel and broadcast on the subject.

On the formation of the LMS in 1923 J. T. Roberts was the Signal Superintendent at Crewe, responsible for all the 'Crewe' power installations until 1928 when he retired with Herbert E. Morgan succeeding him. The LMS Electrical Department was formed in 1925 taking responsibility for telegraphs and power and ceasing to be responsible to the Chief Mechanical Engineer, although all the 'Crewe' power installations remained the responsibility of the Signal Assistants, both for mechanical and electrical disciplines. In 1929 the LMS consolidated Signal and Telegraph Department was set up under A. F. Bound with Morgan the Divisional Signal & Telegraph Engineer at Crewe but with boundary changes, the Midland Signal & Telegraph Engineer, Alfred Oldham, took responsibility for Euston, so that installation became under his charge. Oldham, retired in 1935 to be succeeded by F. J. Dutton who was succeeded by D. R. White in 1944 with Morgan of Crewe retiring in 1948.

Finally.

LMS Board Minute 3404 on 28th May 1936 authorised the conversion of Salop Goods Junction and Sorting Sidings South (which it stated were "*installed experimentally over 30 years ago*"), be converted *"into mechanical operation in order to obviate an immediate expenditure of £6900 on renewal work in connection with the existing installation, together with a further renewal expenditure of £9000 in the near future".* Both boxes required extending to accommodate mechanical frames. The estimated net annual saving was stated to be £624. In his book *"A Pictorial Record of LNWR Signalling*", Richard Foster stated this was done to provide spares to help with the remaining installations and also in case of bomb damage, but there is no mention of this requirement in the LMS Board Minute. However, Richard does go on to state that part of one frame was used as a temporary installation at Manchester Mayfield in connection with the 1960 rebuilding and re-signalling of the London

Road area, and also when Camden No.2 was replaced by an ARP type concrete signal Box in 1940, one of the two spare frames was utilised. What must have been the final decision made by the LMS with regard to "Crewe" power signalling was recorded in Works Committee Minute 303, dated 23rd July 1947. This recommended that the "*obsolete*" machines operating the points worked from Gresty Lane No.1, Sorting Sidings North and Middle Signal Boxes be replaced by new machines of the type provided in the re-signalling scheme around Crewe Station at a cost of £8239. The new machines were of Siemens manufacture.

The Camden/Euston installation was removed following a multiple aspect signalling scheme c1953. With the exception of Crewe Station 'A' box, the main line installations at Crewe North and South Junctions were removed with the colour light scheme of 1940, being replaced by Westinghouse Style 'L' all electric frames in new ARP signal Boxes. The Crewe marshalling yards were modernised in 1961 with the 'Crewe' power installations replaced by panels. The Manchester installations were removed in 1960 as part of the Euston/Manchester 25Kv electrification.

In conclusion it can be said that the electrical efficiency was very low and that it would give a present day accountant nightmares if maintenance costs had been kept, but against that it was simple and extremely robust in design. The LMS Magazine article, written by Alfred Oldham (Plate 12) in January 1927 stated - "*that during the busy period of August 1925, 70,000 lever movements were made in Camden No.2 box and only five slight failures were recorded",* the box having 105 working levers. It is also a fact that A. F. Bound and H. E. Morgan, (who was the Crewe Divisional Signal and Telegraph Engineer for 19 years) hated the system and the subsequent LMS Chief S&T Engineer, W. Wood, labelled it a "*Heath Robinson"* system. John Currey considered it to be "*sledge hammer*" work. However to offset this it should be remembered that it was the pioneer '*all electric'* power scheme and that it served for nigh on half a century at three of the busiest locations in the country and accordingly we must hand the bouquet to Francis William Webb and Arthur M. Thompson and all the other pioneers who designed, installed and maintained it.

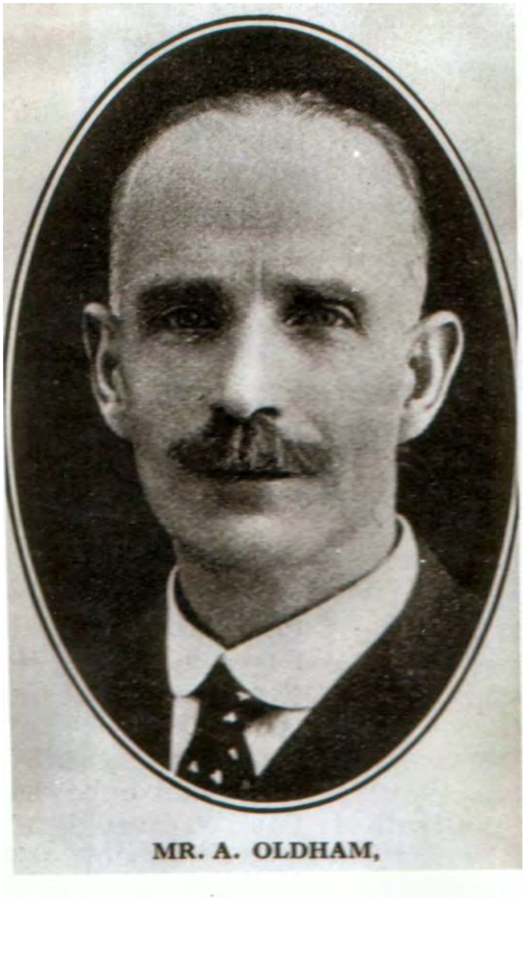


Plate 12.

Alfred Oldham was born at Upton, near Chester, joining the Crewe Works of the LNWR in March 1890 before transferring to the Signal Dept. as a draughtsman, rising to Chief Draughtsman in 1903. In 1913 he became Signal Assistant to J.T Roberts and in 1927 he became Chief Signal Superintendent, Crewe on the retirement of Roberts. In 1928 moved to Derby as Signal Assistant. He retired in 1935 as Divisional S&T Engineer Derby on £1350 after 45½ years service, and was succeeded by F. J. Dutton

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Appendix 1 - Table detailing all the 'Crewe' power signal boxes.

Signal Cabin	Number of Levers	Frame	Date Opened	Remarks
Gresty Lane No.1.	57	2 tier	1/1899	
Salop Goods Junction	57	2 tier	3/1901	Both frames removed at
Sorting Sidings South.	76	2 tier	6/1901	Beginning of World War 2.
Sorting Sidings Middle.	152	2 tier	8/1901	
Sorting Sidings North	56	2 tier	10/1901	
Crewe North Junction.	266	2 tier	11/1906	
Crewe Station 'A'.	26	Overhead	2/1907	
Crewe Station 'B'.	26	Overhead	2/1907	
Crewe South Junction.	247	2 tier	6/1907	
Euston No.3.	52	Overhead	5/1905	
Euston No.4.	76	2 tier	5/1905	Later Euston Carriage Sidings
Camden No.1.*	52	Overhead	7/1905	Replaced by an ARP cabin
Camden No.2.**	95	2 tier	8/1905	Replaced by a new cabin
London Road No.1.	117	Overhead	12/1908	
London Road No.2.	143	Overhead	11/1909	
London Road No.3.	26	Overhead	11/1909	
Camden No.2 **.	114	2 tier	7/1920	For new junctions
Severous Junction, York.	133	Overhead	1903	North Eastern Railway.
Camden No.1*	57	2 tier	6/1940	S/H frame from Crewe
Manchester Mayfield.	38	2 tier	4/1960	S/H frame from Crewe - temporary Installation, closed 9/1960.

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Established 1881.

GOLD MEDALS.

LIVERPOOL, 1886.
EDINBURGH, 1886.
DIPLOMA OF HONOUR, PARIS, 1887.

Highest Awards for Railway Signals and Safety Appliances.

Contractors for TELEGRAPH AND TELEPHONE INSTRUMENTS, BELLS, BATTERIES, AND EVERY DESCRIPTION OF ELECTRICAL APPARATUS FOR RAILWAYS.

The Railway Signal Company, Limited,

SOLE LICENSEES AND MAKERS OF WEBB & THOMPSON'S PATENT ELECTRICAL STAFF INSTRUMENTS.

Manufacturers of RAILWAY SIGNAL CABINS, SIGNALS, INTERLOCKING LEVER FRAMES, LEVEL CROSSING GATES AND SIGNAL WORK OF EVERY DESCRIPTION.

Works: Fazakerley, Liverpool.

London Office: Sanctuary House, Westminster, LONDON, S.W.

The frontispiece of the Railway Signal Company catalogue.

Appendix 2 - The patents

12,128. Webb, F. W., and Thompson, A. M. May 17.

FIG.15.

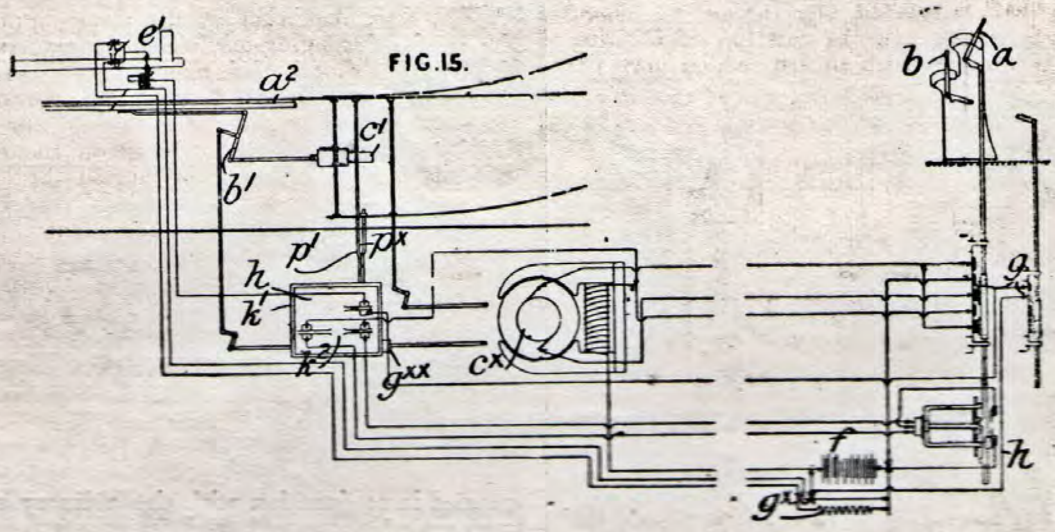


FIG.4

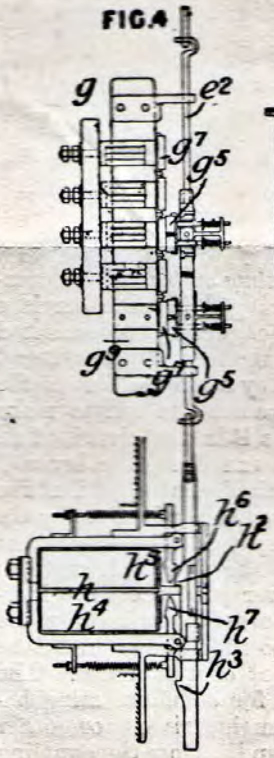


FIG.8.

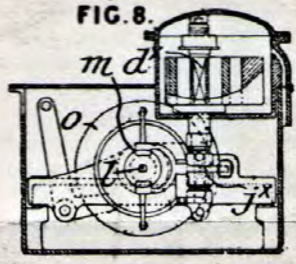
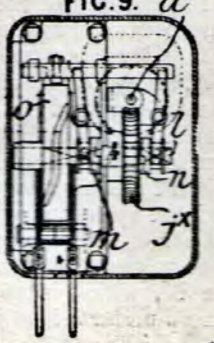
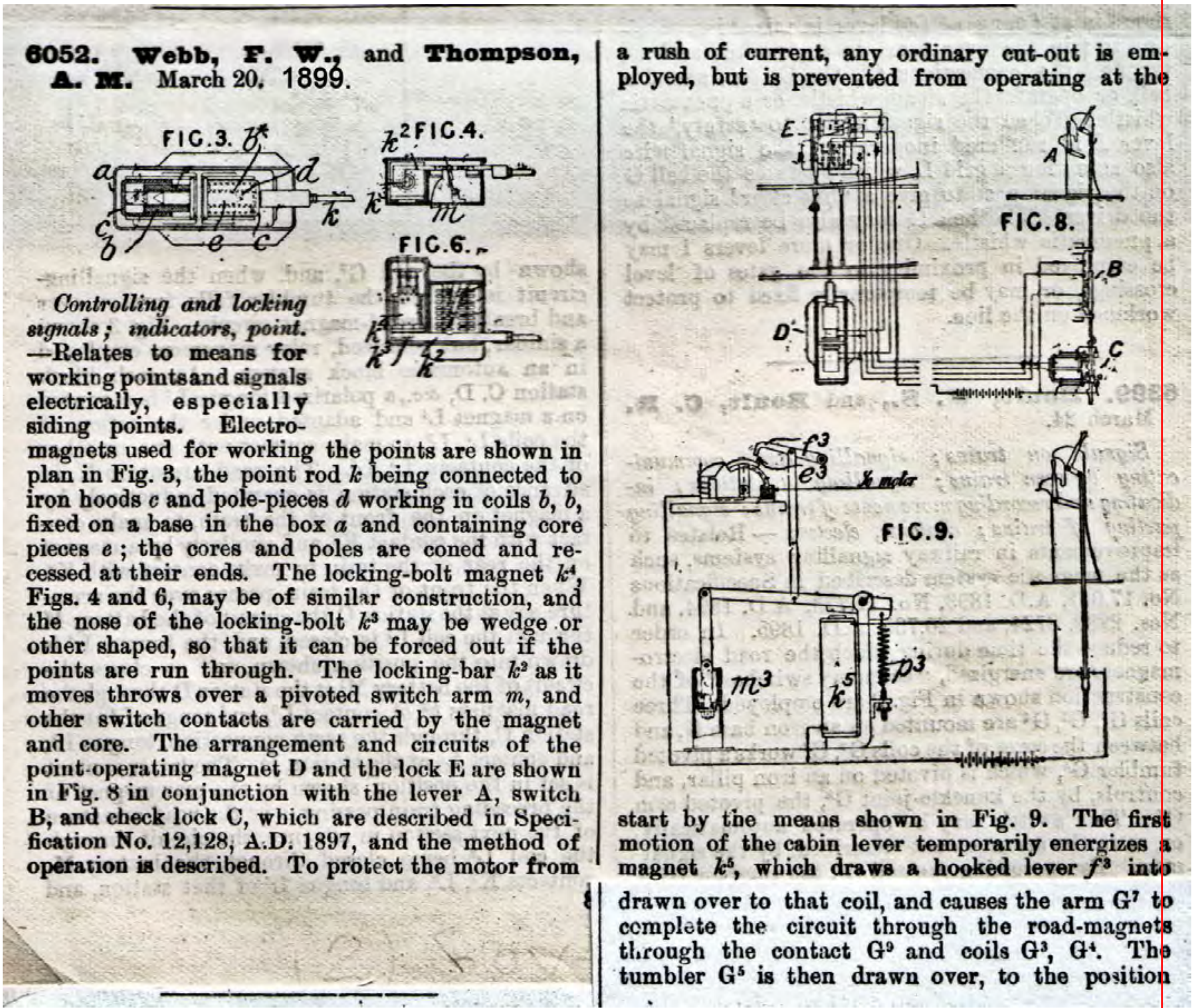


FIG.9. d×



Interlocking; indicators and repeaters, point; semaphore signals.—Two tiers of levers a, b, for the points and signals respectively, are connected to tappet locking-arrangements and also to the switches g and check lock h, as indicated diagrammatically in Fig. 15, where f is a battery, $c^{\times}$ a motor for operating and locking the points, k^1 a detector switch, and e^1 a signal switch. The point switch g and check lock h are shown in detail in Fig. 4. Pairs of carbon blocks g^5, spring-carried on a detachable section of the rod e^2, rub over the carbon blocks g^7, which are insulated from the frame g^9 and are readily removable therefrom. The check lock h consists of pawls h^6, h^7, which are liberated from tappets h^2, h^3 on the continuation of the rod e^2 by electromagnets h^4, h^5. The point-operating motor is seen in Figs. 8 and 9. The motor shaft $d^{\times}$ drives the shaft l through worm gearing $j^{\times}$ and two clutches m, n which act in opposite directions. These clutches are thrown in and out by a cam-wheel o on the shaft l, and are arranged to let the motor run free after one revolution of this shaft l in either direction. On the side of this wheel o are two cam-grooves, shaped to act through bell cranks at proper intervals on the rods which move the points and lock them. The point lock may also be connected with a safety bar. Squared shafts and connections are employed so that the armature and its shafts may be readily replaced. Fittings for a facing-point are indicated in Fig. 15. The locking-bolt c^1, which acts at both ends of its travel, and the safety bar a^2 are worked by a three-armed crank b^1 and rods which are connected to a detector bolt $g^{\times\times}$ which engages two detector bars p^1, $p^{\times}$. A lever switch, operated from the bolt $g^{\times\times}$, closes the circuits at k^2, which are connected to the check lock h and the signal switch e^1 respectively. The signal itself is operated by a long-pull magnet, which at the end of its stroke operates a switch to throw in a return circuit including a resistance $g^{\times\times\times}$, so as to diminish the current to that required for holding the signal. The arrangement of the circuits and connections for a facing-point and one signal are also shown in Fig. 15. The first movement of the point lever a sends a current to the motor which operates the switch, which in turn, by the detector mechanism, sends a return current to the check lock h, and allows the movement of the point lever a to be completed. The signal lever b may then be operated.

Figure 16 *An extract detailing Patent Class 05 number 12,128 dated 17th May 1897 by F. W. Webb and A. M. Thompson concerning the 'Crewe' all-electric power system of working signals and points.*



6052. Webb, F. W., and Thompson, A. M. March 20. 1899.

FIG.3. FIG.4. FIG.6.

Controlling and locking signals; indicators, point. —Relates to means for working points and signals electrically, especially siding points. Electro-magnets used for working the points are shown in plan in Fig. 3, the point rod *k* being connected to iron hoods *c* and pole-pieces *d* working in coils *b*, *b*, fixed on a base in the box *a* and containing core pieces *e*; the cores and poles are coned and recessed at their ends. The locking-bolt magnet k^4, Figs. 4 and 6, may be of similar construction, and the nose of the locking-bolt k^3 may be wedge or other shaped, so that it can be forced out if the points are run through. The locking-bar k^2 as it moves throws over a pivoted switch arm *m*, and other switch contacts are carried by the magnet and core. The arrangement and circuits of the point-operating magnet D and the lock E are shown in Fig. 8 in conjunction with the lever A, switch B, and check lock C, which are described in Specification No. 12,128, A.D. 1897, and the method of operation is described. To protect the motor from a rush of current, any ordinary cut-out is employed, but is prevented from operating at the

FIG.8. FIG.9.

start by the means shown in Fig. 9. The first motion of the cabin lever temporarily energizes a magnet k^5, which draws a hooked lever f^3 into

drawn over to that coil, and causes the arm G^7 to complete the circuit through the road-magnets through the contact G^9 and coils G^3, G^4. The tumbler G^5 is then drawn over, to the position

Figure 17

An extract detailing Patent Class 105 number 6052 dated 20th March 1899 by F. W. Webb and A. M. Thompson detailing the controlling and locking of signals; indicators, point.

The patents were in the name of Webb and Thompson and below are some details of Webb but no details of Thompson are to hand.

Francis William Webb was born on 21st May 1836 and on leaving school became a pupil of Francis Trevithick from 1851 to 1857. He became Chief Draughtsman in 1859 and in 1861 he was appointed Chief Assistant to Ramsbottom and Crewe Works Manager. He left the LNWR in 1866 becoming Works Manager and a partner in the Bolton Iron and Steel Company but he returned to the LNWR on 1st October 1871 as Locomotive Superintendent. Webb retired on 31st July 1903 and moved to Bournemouth where he died on 4th June 1906, aged 70.

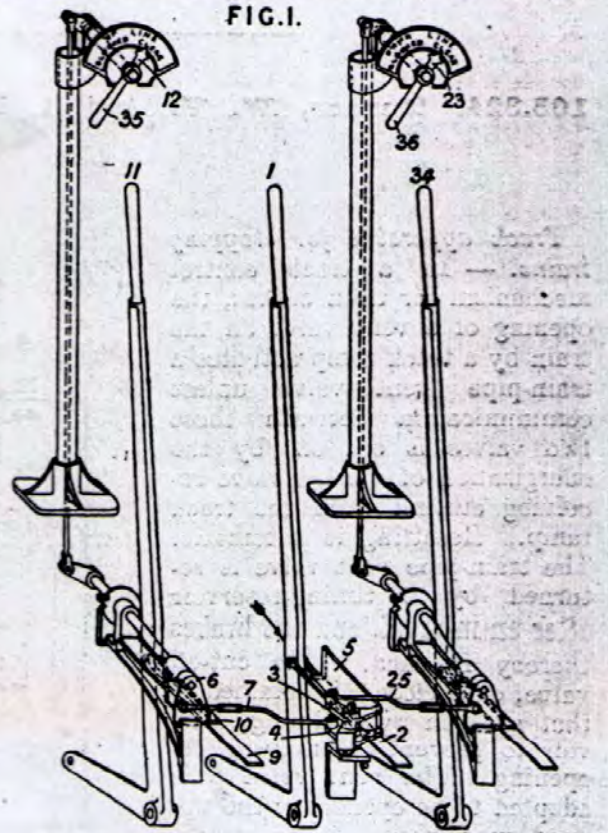
Figure 18

An extract from Patent Class 105 dated 25th September 1916 by J. T. Roberts detailing 'Hand-levers and hand gearing and signalling instruments, interlocking.

107,489. Roberts, J. T. Sept. 25, 1916.

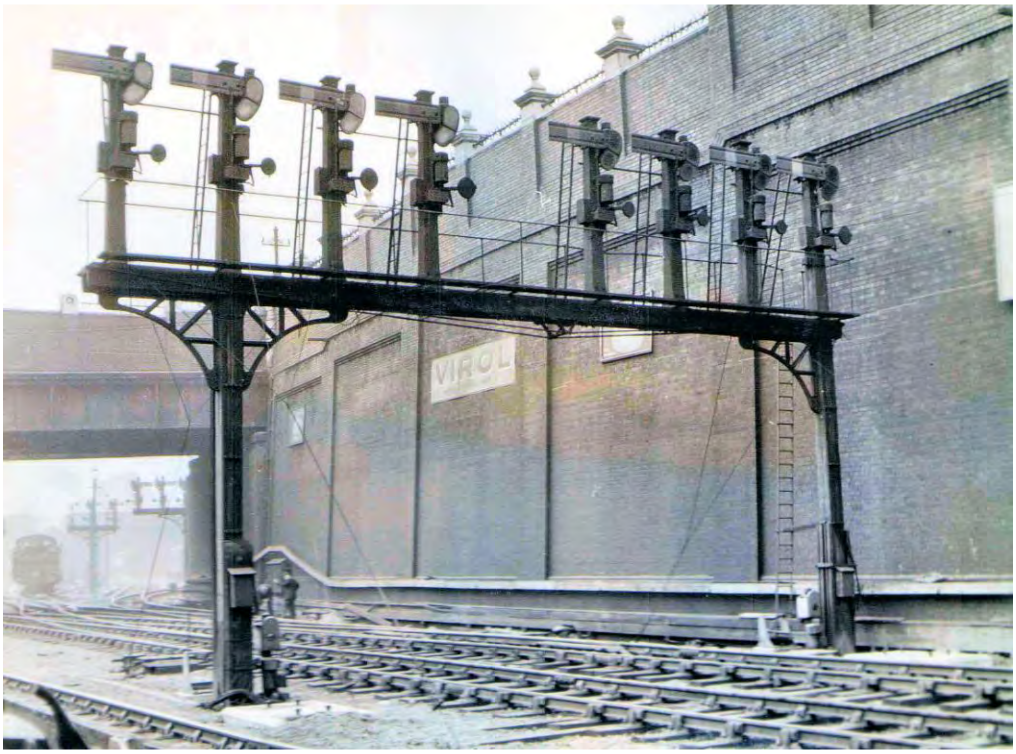
Hand-levers and hand gearing and signalling instruments, interlocking.—Locks on hand-levers, indicators, and electric switches are put in action by operation of a hand-lever, as for a cross-over wad, but are not removed by resetting the hand-lever; special handles are provided for resetting the locks. Fig. 1 shows one construction of apparatus in which the cross-over road lever 1, is connected to a tappet 2 carrying an angle-iron 5 which engages the bell-cranks 3, 4 so as to cause them to move the links 7, 25 to the right when the cross-over road lever is pulled. The rod 7 rocks the locking-piece 6 to obstruct the angle-bar 10 on the tappet 9 of the up signal lever 11, and to set the up line indicator 12 to " blocked." The

FIG. 1.



rod 25 acts similarly on the down line lever 34 and indicator 23. By means of electric switches, block instruments in other cabins may be controlled and signals locked at danger. When the cross-over road lever is replaced, the bell-cranks 3, 4 are not moved but the apparatus on each lever 11, 34 may be reset by the handles 35, 36. This action is prevented whilst the cross-over lever is pulled over by the abutment of the bracket 5 against the bell-cranks 3, 4. Modified means for moving the rods 7, 25 are described.

Appendix 3 – Gallery.

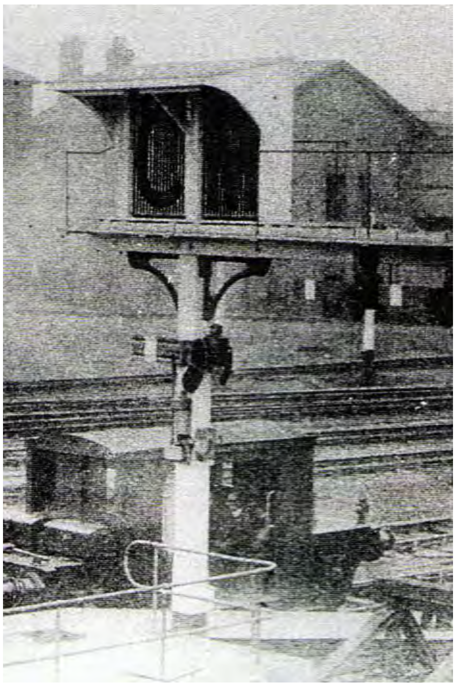


Camden.
BR D190

Camden.

Camden No.1 Signal Box.

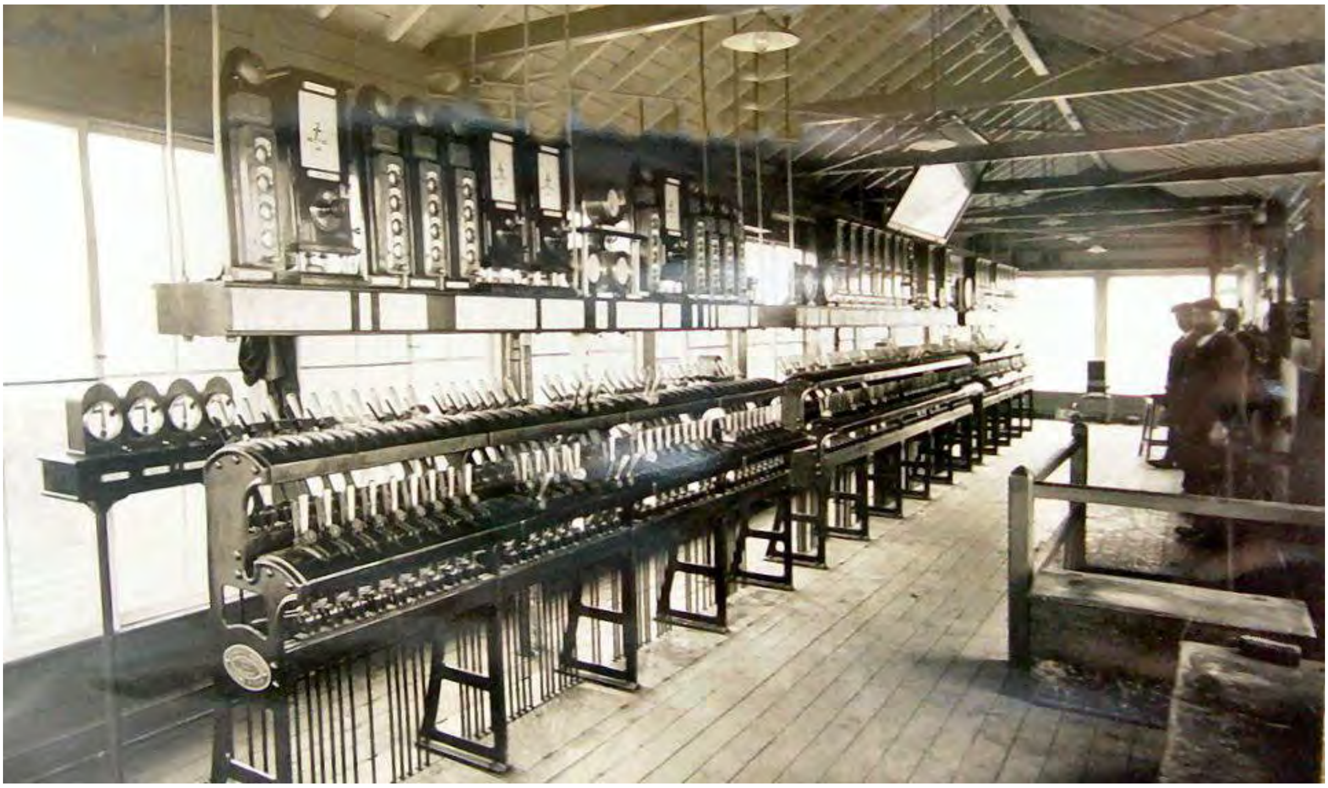
Basford Hall Sidings, Crewe.



Route indicating signal.
Richard Foster.

A Miniature arm Signal at Camden. BR D197.

Crewe North Signal Box.



Crewe North lever frame.

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