Technical Meeting of the Institution

held at

The Institution of Electrical Engineers

Wednesday, February 4th, 1959

The President (Mr. J. F. H. TYLER) in the chair

The minutes of the Technical Meeting held at the Institution of Electrical Engineers, London, on Wednesday, January 14th, 1959 were read and approved.

The **President** introduced and welcomed to the meeting Messrs. J. Hallett and G. T. Rowe (Associates), Mr. W. A. Cooper (Technician Member), and Messrs. K. Bowdell, W. G. Boddy, J. G. Dykes, D. A. Evans, C. Hale, B. D. Heard, C. A. Hobson, A. Jones, A. P. West and A. T. Williams (Students) all of whom were present for the first time since their election to membership.

The **President** announced the names of those who had been successful in the Institution's examination held in October 1958, viz.; Messrs. N. F. Reed (Passed with distinction), D. M. Hall, P. G. Law, M. W. Heaton, V. C. Jessani and S. C. Yip (Passed).

The **President** requested that, in order to assist the stenographer, contributors to the discussions at technical meetings should first give their names an also that congratulations and compliments to the author should be confined to the first speaker.

The **President** then requested Mr. O. S. Nock (Member) to read his paper entitled " The Protection of Facing Points—A Survey of Practice at Home and Overseas."

The Protection of Facing Points

A Survey of Practice at Home and Overseas

By O. S. NOCK (Member)

In railway operation today facing points are so numerous and so commonplace a feature that it is hard to conceive of a time when engineers and railway operating men alike did all they could to avoid the need for installing them, and the traffic departments accepted as normal inconveniences in working that would be regarded as well-nigh intolerable today. To find such a period one does not need to go back to the time of the first railway pioneers, to the Stephensons, Locke, and Brunel. In 1876, fifty-one years after the opening of the first public railway in the world, the last of the trunk routes from England to Scotland was completed by opening of the Midland Railway Settle and Carlisle line. It was then considered the last word in railway constructional practice, and yet in its length of 73 miles, between the point of divergence from the Leeds to Lancaster line and the immediate approach to Carlisle there was not one pair of facing points. It is true that there was only one branch from this new main route, but with the expectation of much new traffic the intermediate stations were laid out with comprehensive siding accommodation. Through the absence of facing points, however, if freight trains had to be berthed clear of the main line, clearance could be obtained only by the cumbersome process of drawing ahead, and then setting back into one or other of the sidings. As recently as 1945 it was not unusual on that route to see freight trains propelled back over a trailing crossover to stand on the main line for the opposite direction in order to clear the way for a faster train.

While the attitude of many high-ranking railway officers was to avoid the use of facing points, there were others who realised that the problem could not be evaded indefinitely. In any case, while it might be possible to avoid their use on long stretches of fast running main line such tactics were quite impossible in busy suburban areas, particularly in such complicated groups of passenger lines as those running immediately south of the Thames, in the London area. By the year 1880 apparatus for the protection of facing points was being designed in considerable variety, and a chronological record of inventions for this purpose is to be found in the most interesting paper presented to this Institution in 1936 by the late Ralph S. Griffiths. Modern practice has progressed a long way beyond the purely mechanical devices covered in this earlier paper, and the present author has attempted to give a broad survey of practice at home and overseas, with some account of the steps that led to present standards and the marked trend of future practice. Clearly, it would be impossible to describe in detail the apparatus used on all railways, on many of which there are variations upon the general practice prevailing, designed to suit local conditions. But an endeavour has been made to emphasise the major differences of outlook, principle and practice that exist today, without coming down upon one side or the other over various features that known to be definitely controversial. The historical background is unusually interesting just now, in view of modern tendencies to move away from the simple plunger lock; and in beginning this survey it is worth taking a look at a few of the more outstanding of the early arrangements.

Early Point Locks

The design of points and crossings, and the maintenance of the road in good order is the province of the Civil Engineer —"The Engineer," as the officer was known in earlier railway days, when not even the locomotive department had the dignity of a man styled "engineer" at its head. All the earliest work on signalling was done under the supervision of the civil engineer, and at that time signals and point working formed no more than a minor part of his responsibilities. Yet on the other hand, it is very interesting to find that the first patent that can be traced appertaining in any way to the protection of facing points was filed by a locomotive man, in 1866, by William Stroudley, the Locomotive Superintendent of the London Brighton and South Coast Railway. How this came about is a matter for conjecture; but Stroudley was a man who took an almost personal interest in every locomotive on his line, and it may have been the frequency of derailments, and the damage caused to his machines that led to this invention. Derailments at points were caused by the points not closing properly, and apart from every other consideration the most logical thing to do was to hold the switch in its correct position in relation to the stock rail. Stroudley used a cup-shaped slider, mounted on the rail, and when this was moved towards the switch it fitted snugly over the blade and held it tight against the rail (see fig 1).

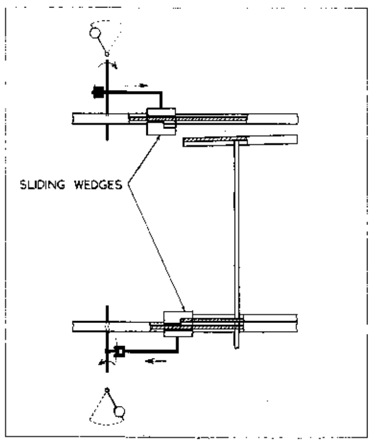
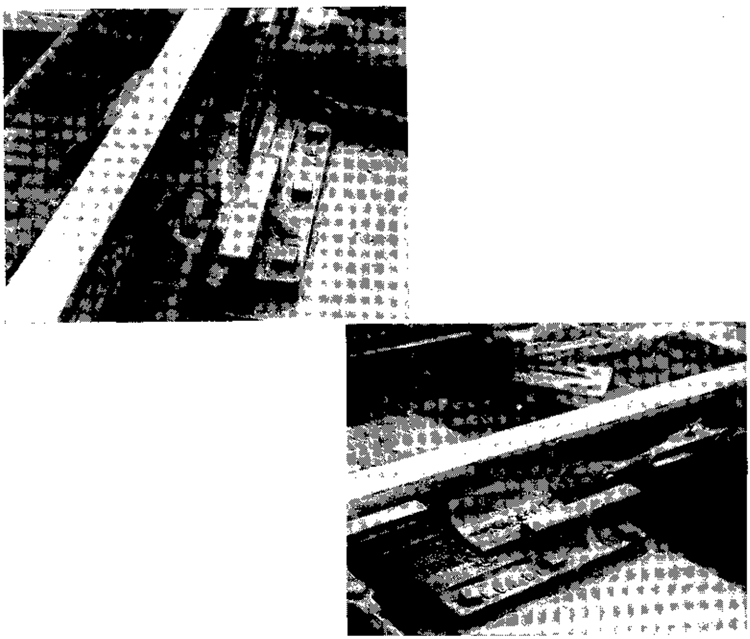


Fig. 1 Stroudley Point Lock

This device appears to have had no connection of any kind with the signalling apparatus; one form of it had separate levers for each switch, with the rocker shafts for actuating the sliders on the same axis, and one working inside the other. Another early device in which the switches were locked individually against their respective stock rails was brought out a few years later by the firm of McKenzie, Clunes & Holland; this included a rotating cam, linking up with the locking bars, which pressed against the switch blade and held it locked against the stock rail.

The year 1874 found the Institution of Civil Engineers discussing the matter, and the President, Mr. T. E. Harrison, then Chief Engineer of the North Eastern Railway, said: "There is nothing more urgently needed than a complete facing point lock protection by wedges, or by other mechanical contrivance which would enable trains to run over it at full speed. I have so great a horror of facing points, knowing the accidents occurring at them, that on the run between York and Berwick for many years, except at the stations of Darlington and Newcastle, there were only three facing points in a distance of 160 miles." Harrison himself was later responsible for a design of facing point lock that could be broadly described as a variation of the Stroudley arrangement. It is still to be seen in one or two locations in the North Eastern Region of British Railways today. In this arrangement however, both wedge locks are moved simultaneously by one bolt lever. The accompanying slides, figs. 2 and 3, show the action and how, when the wedge is moved forward it locks the closed switch, but passes clear of the open switch. It is indeed noteworthy that this early form of facing point lock has survived so long, and is still in use on passenger lines.

These devices and some others of contemporary origin involved mechanisms that might be thought intricate and elaborate, that is, judged by the crude standards that sufficed for most signalling of the period. They were designed to hold the switch against its own rail, regardless of the position of the other switch, and regardless of whether the rail gauge at the points was accurate. But as the quality of British permanent way improved the apparatus used for facing point locking tended to get simpler. Many varieties of facing point lock were evolved in the latter years of the nineteenth century, for use in this country and on overseas railways where British interests then predominated.



Figs. 2 and 3 Harrison's wedge lock—N.E.R. only.

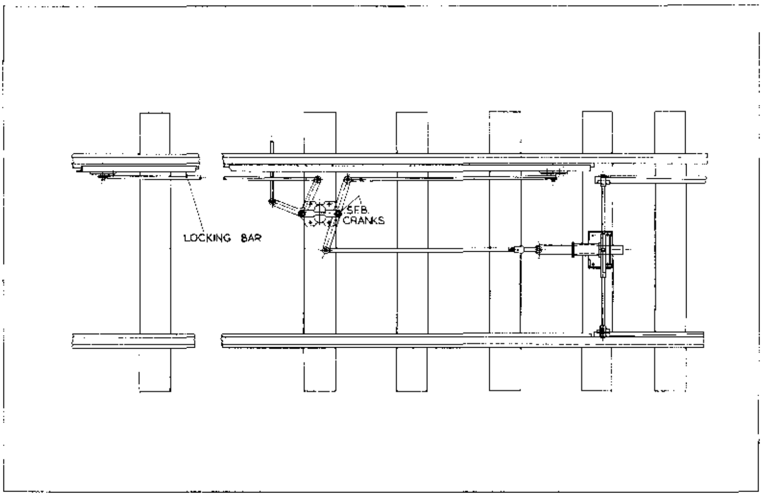


Fig. 4 Simple Plunger Lock with S.F.B. cranks

Some were weird and wonderful; but none was more generally accepted, or more typical of the best contemporary practice than the simple plunger lock. One of the earliest of these was due to Kirby, brought out in 1886. As with subsequent arrangements by the firms of Saxby & Farmer Ltd., by McKenzie & Holland Ltd., and others, it required the use of a lock rod, rigidly connecting the two switch blades, and the switches were bolted in one position or the other by the insertion of a locking plunger. A separate lever was used for operation of this bolt. A typical version of the plunger lock is seen in fig. 4.

An analysis of the mechanism shows that the switches are positively locked only in relation to their position in respect of the plunger box in the middle of the four-foot; their position in relation to the stock rails is determined indirectly, through the sleeper and the chair fastenings. The integrity of the switch position against the stock rail thus depended to a major degree upon the maintenance of the permanent way in first-class order. It might be argued that such a practice was unsound, since by so doing the signal engineer is depending upon the work of another department for the safe working of his own equipment. But the safety record of the railways of this country over the past fifty or sixty years in the negotiation of facing points is ample evidence that maintenance has been of the highest standards and has fully justified the continued use of a form of facing point lock that is extremely simple, and low in first cost. This argument can well apply both ways, in that the simpler the signalling gear in the four-foot, the easier it is to sustain high standards of permanent way maintenance.

While British practice in the eighties and nineties of last century was moving towards completeness, and a high standard of performance the situation abroad was very different, and we can only recall the notice that was at one time to be found in signal cabins on the former Central South African Railway. Far from having any form of facing point protection the administration thought it desirable to post this notice in signal cabins:

"THINK OF THE DANGER.
IT IS PROHIBITED TO PULL
POINTS UNDER A TRAIN."

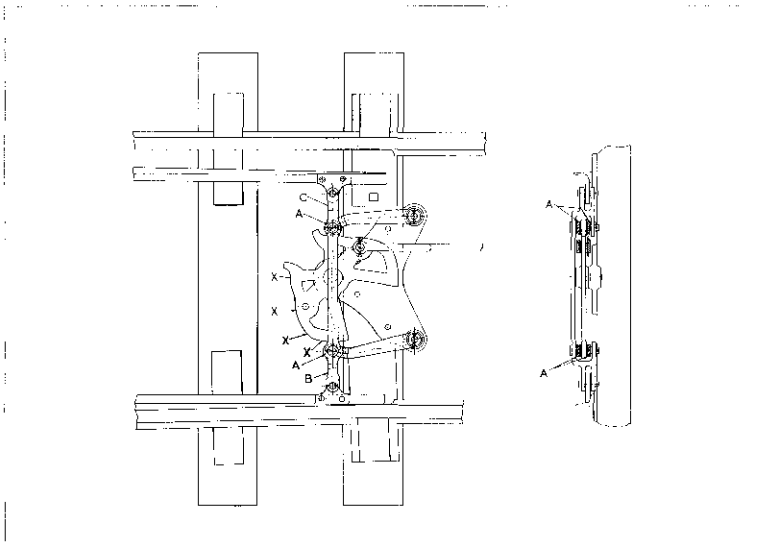


Fig. 5 Black's Economical F.P. Lock

Economical Working

In this country it was appreciated from an early date that it was not enough to lock the points through the agency of a lever in the signalbox, even though that lever was itself locked by the pulling of the signal lever, lowering the signal for the appropriate route. It was desirable to hold the road once the train was approaching, and this was done through the agency of facing point lock bars (fig. 4). It was not long also before inventors turned their attention to means for avoiding use of two levers for working the complete facing point mechanism—one for the bolt, and one for the job of shifting the points. An interesting example of one such device was the Black's economical facing point lock, shown in fig. 5. It was termed a "lock," though as can be seen from the illustration it includes the mechanism for shifting the points.

The central feature of this device is the rotating " butterfly " member having the composite cam path X X X X. The driving rod from the cabin acts through the locking bar, and the well-known S.F.B. crank assembly that was shown in fig. 4, to rotate the butterfly. The first part of the lever movement has no effect on the switch blades, since the first portion of the cam path traversed by the rollers AA is radial. This is the phase of removing the lock. Further rotation of the butterfly brings in the change of cam profile that throws the points through the rods B and C. These rods form an integral part of a solid connection from one switch blade to the other, acting as the stretcher bar. After the points have been thrown further rotation of the butterfly brings in the final phase of radial cam path and provides the lock in the reverse position.

An alternative arrangement, seen in fig. 6, brought out by McKenzie & Holland Ltd.—a joint patent of Messrs. Holland, William Griffiths, & C. H. Griffiths included the use of an escapement crank, which has been very widely used not only in mechanical operation but in all electro-pneumatic mechanisms in this country since 1898. It is also interesting to find at the relatively early date

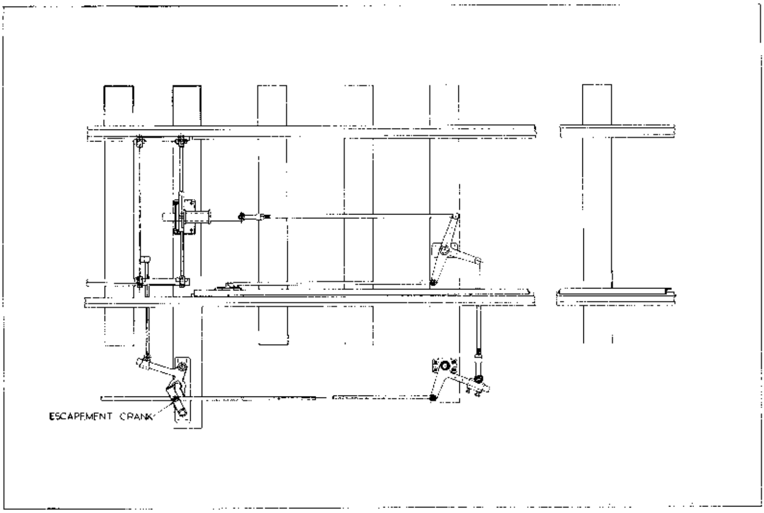


Fig. 6 McKenzie Economical F.P. Layout

of 1892, that Charles Hodgson, of Saxby & Farmer Ltd., patented an arrangement for allowing points to be trailed. Reference to this will be made at a later stage in this paper.

From point locking came the associated function of point detection, and in mechanical working in this country the most generally accepted practice over many years has been the same, in principle, as that used for point locking. Proof that the switch is actually against the stock rail is obtained no more than indirectly, depending upon the correct positioning of the detector box, first in relation to the stock rail, and secondly to the plunger lock box, which itself positively determines the position of the switch blades. Again, the justification for the continued use of this extremely simple mechanism, seen in fig. 7, is to be found in the high standards of permanent way maintenance that could be relied upon in this country. One of the earliest uses of electricity as an aid to the protection of facing points was for detection. It is recorded that as early as the year 1889 the Northern Railway of France had electric detection on 1,755 pairs of points. It was not detection in the sense we understand it now, but rather a form of " non-correspondence " indicator. When the points were being pulled a bell rang in the cabin; if they did not close properly on completion of the stroke of the lever the bell went on ringing.

British practice in using a solid lock stretcher, and a plunger lock, was followed in all the Commonwealth countries, and in the Crown Colonies; the only exception was on the Central South African Railway, serving the Transvaal, where Dutch practice was retained. British practice was followed in the United States and on the various British-owned railways in South America, while in Europe it was also standard practice in France and Italy. In the two latter countries the only exceptions were in Alsace-Lorraine, where the railways were signalled in the German style, and in those parts of Italy that were part of the one-time Austro-Hungarian Empire. The simple plunger lock was standard in France until after the nationalisation of the railways, when some interesting developments, to be described later, took place. Despite established practice in this country, permanent way and signal engineers have not always seen eye to eye over the type of apparatus used for facing point protection. There are some

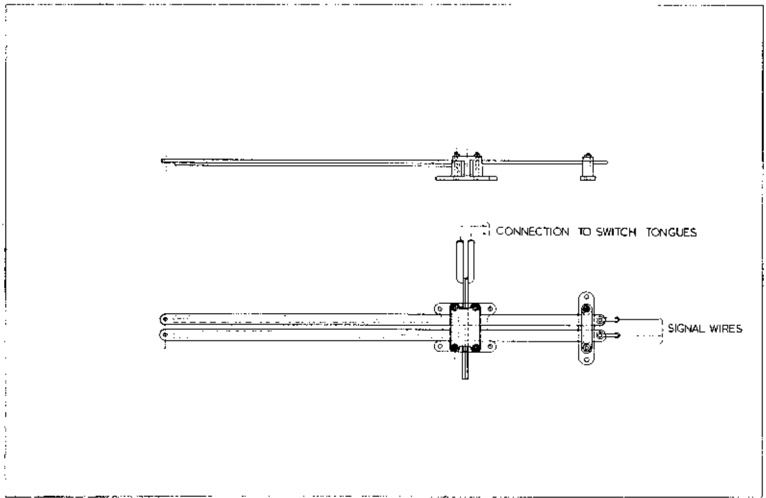


Fig. 7 Simple Slide Detector

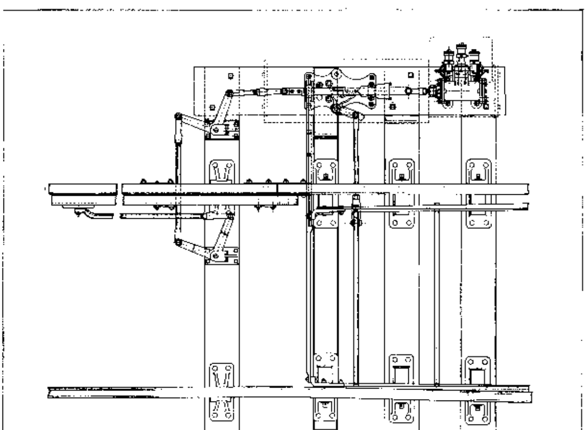


Fig. 8 Early E.P. Point mechanism 1899

who maintain that the "four-foot" is unquestionably the correct place for the facing point lock, while others would clear the four-foot of every form of signalling gear the better to facilitate packing of the sleepers in this most vital of places, and to facilitate adjustment and maintenance of the signalling gear itself.

Power Working in Britain

In a paper of this kind it is always a little difficult to decide as to how far one should preserve strict, or even reasonably strict chronological order, or how far to pursue one group of developments, and then retrace steps, in history, to pick up another group in process of evolution in other countries. The present author has chosen to take British practice in operation, locking, and detection of points through the earlier years of power signalling before turning to the mechanical signalling practice evolved in Germany and followed in many other European countries.

The earliest applications of power in Great Britain were made purely to do the jobs formerly done by mechanical rodding. In certain cases, for example, separate air cylinders were used for actuation of points and the facing point locks, though from the earliest days of electro-pneumatic working an adaptation of the McKenzie & Holland butterfly crank was available for economical working of electro-pneumatic points and was widely used. Fig. 8 is a reproduction of a beautiful original drawing of 1899, showing one of the earliest methods of driving points and locking bar from one cylinder. The introduction of track circuiting however, provided a much less cumbersome method of holding the road than by using facing point locking bars, though it was some little time before it became generally adopted, and in the large power installations at Bolton, Hull,

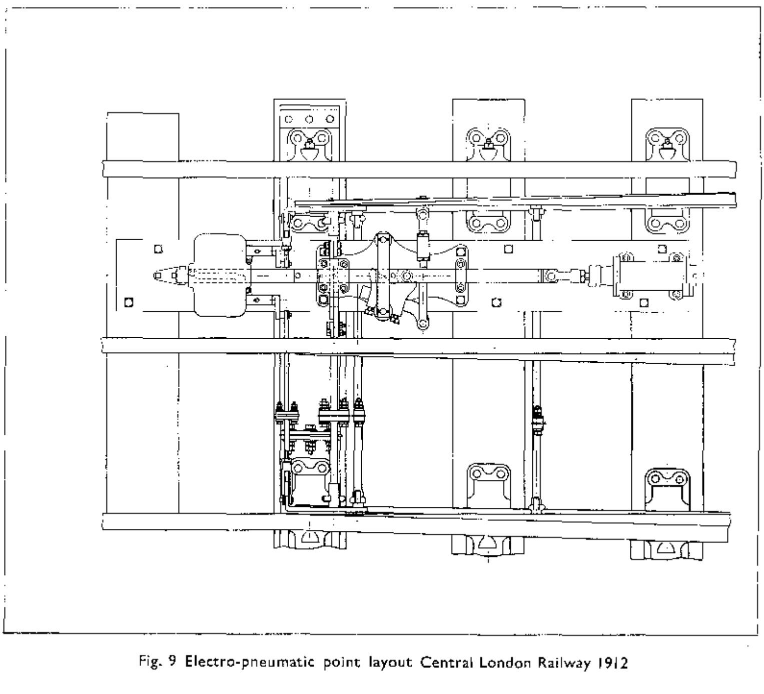


Fig. 9 Electro-pneumatic point layout Central London Railway 1912

Newcastle and Glasgow Central, all brought into service between 1900 and 1910, facing point locking bars were used. Perhaps because the pneumatic operation of points provided the nearest parallel to manual working—in the straight push or pull of the cylinder, in conformity with the push or pull from a mechanical locking frame—this method of power working provides some of the most graphic examples of the gradual development of point working practice from the standards of last century. The economic facing point movement readily lent itself to having a lock combined with it, and instead of having the plunger lock in the four-foot, it was eventually moved outside, providing one of the earliest examples of clearing the "four-foot" of all signalling gear. With it eventually came the detector also. The particular form of detector used had a mechanism which detected, through a combining device, the correct position of both points and bolt. The simple proving circuit originally used was not made up unless both points and bolt were in the correct positions. Not all the earliest uses of the combined facing point lock and detector mechanism with electro-pneumatic working were applied from the "six-foot." Then, as now, the requirements of the London Underground railways provided a constant challenge to the ingenuity and resource of signalling engineering designers, and the diagram, fig. 9, shows an arrangement of working used on the Central London Tube line, where the mechanism, including the operating cylinder, is mounted in the confined space between the centre current rail and one of the running rails.

Reverting to the use of mechanisms in the "six-foot" however, it must be recorded that such attempts to remove the signalling gear from the four-foot were far from being universally acclaimed, —quite the reverse. As recently as the 1920's, opinion in many parts of Great Britain was strongly in favour of using a 4-ft. lock; not merely so, but of standardising the R.E.C. type of facing point lock for all purposes, and adapting all electrical or power devices to work with it, even to the extent of reproducing the "in and out"

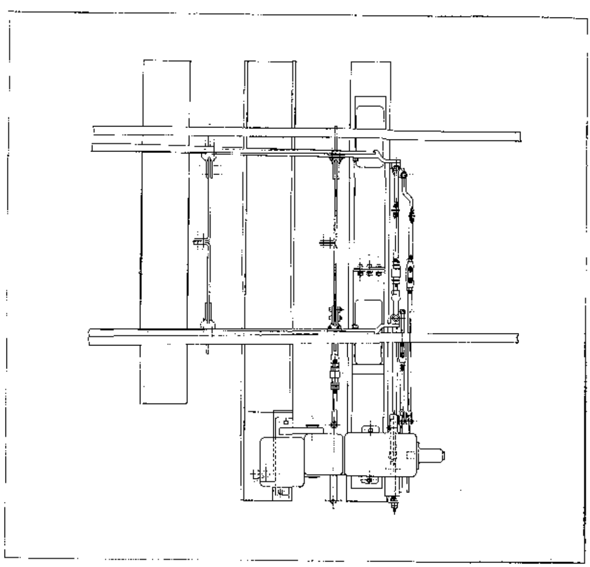


Fig. 10 Electric Operation L.M.S.R.—(L.N.W. type switches) 1928

motion of the lock plunger necessary with non-economical manual operation. The resulting layouts, while enabling the facing point lock to be standardised as between power and mechanical operation, did involve quite a number of different appliances. By contrast, on those railways that adopted a point and lock machine, with electric detection combined, the result was very much neater. The accompanying illustration, fig. 10, showing application of a combined electric point and lock machine to permanent way of the former London and North Western Railway, shortly after grouping, provides a good example.

The progress possible with power working, in combination with track circuiting, permitted of the operation of facing points at distances from the signalboxes far beyond the 350-yd. limit for rod worked points, and an interesting development of the early 1920's was the use of hand generators for providing power for working simple junctions from boxes a mile or so away. The pioneer case was at Charleville, on the former Great Southern and Western Railway of Ireland. There the junction box had been gutted during the political troubles of the time; but by use of the hand generator system it was found possible to work the entire interlocking from the adjacent station, and so avoid renewing the box at the actual junction. The accompanying slide, fig. 11, shows the actual junction, while the signalling arrangements are shown in fig. 12.

The Ground Track Lock

With the gradual spread of power signalling and the provision by power of safeguards that had previously been accomplished by purely mechanical means, the necessity for additional safeguards was becoming apparent. Originally the circuits were of the simplest; but as experience mounted it was deemed necessary to provide against every conceivable kind of failure; a broken wire, or faulty connection; stray currents, leaking valves, and so on.

In the provision of safety devices "proving" equipment, and suchlike, it is however a little difficult sometimes to know just where to stop. The case can be likened to that of securing a door with a slide bolt, padlocking the slide bolt, putting the padlock key in a locked container, and so on *ad infinitum*. But one additional safeguard towards the securing of facing points that has won wide acceptance is the provision of a ground track lock. Basically, the interlocking, which provides for the integrity of the setting of the road and the clearing of the appropriate signals, is between the levers in the cabin; but if through some mischance the outside equipment does not agree with the lever positions the effect of the locking is reduced to nothing at all. One of the most alarming cases of this kind occurred at Lichfield, in 1946; there, through a chain of exceptional circumstances a point lever in a mechanical frame had been forced into a position out of correspondence with the lie of the points, and a disastrous accident

Fig. 11 Charleville Junction

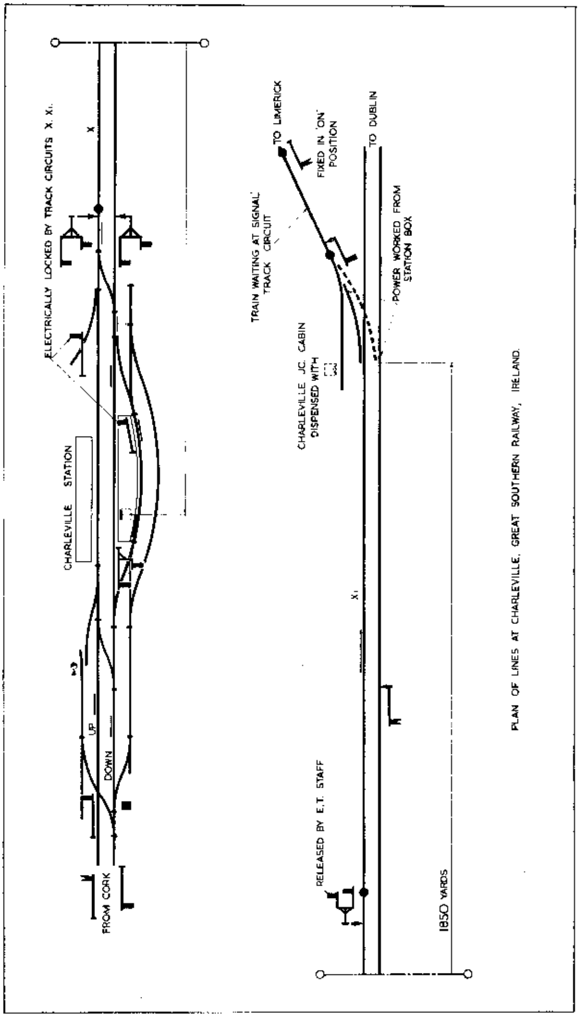


Fig. 12 Charleville Signalling Layout

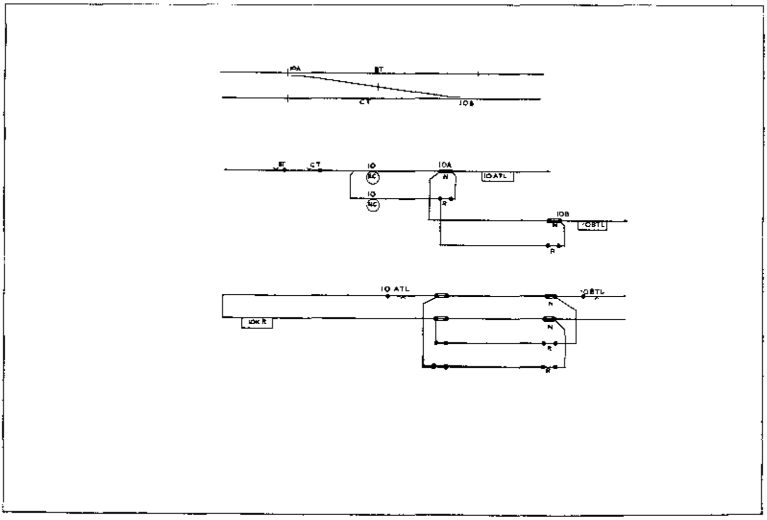


Fig. 13 Track lock and point indication circuit

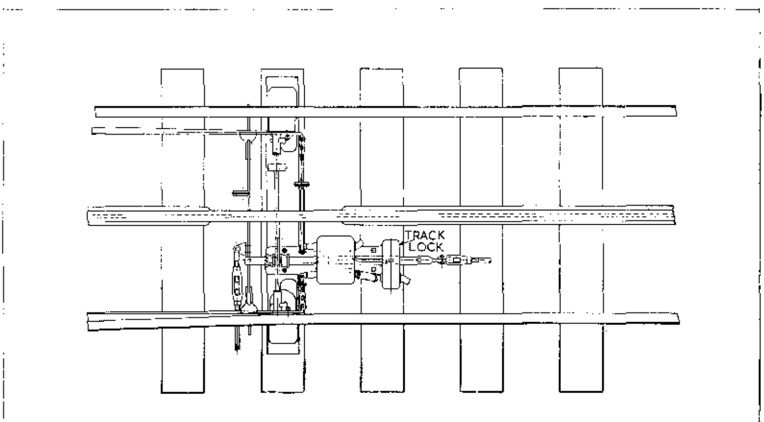


Fig. 14 Ground Track lock added to point and lock detector

followed. Even with power signalling, with electric detection and with every care taken in the control circuitry to guard against such a mischance at its source, cases have occurred of points being thrown out of correspondence with the lever. The ground track lock, independently controlled, provides a most valuable additional safeguard. The plunger acts as a positive mechanical lock against removal of the facing point locking bolt; electrical release of the magnet actuating the plunger is obtained through contacts on the point lever, through front contacts of the track relays concerned, and through additional, independent contacts on the point detector. The usual point indication circuit is taken through contacts in the track lock mechanism made only when the plunger is " in " (see fig. 13).

The more usual place for the track lock, as it is generally known, is on the facing point lock plunger, as shown in fig. 14. This illustrates an installation on an electrified road, with mechanically operated points; but the principle can be applied equally to " six-foot " layouts, or those cases where a combined electric facing point and lock machine is used. The locking plunger which operates longitudinally inside the machine is extended at one end, and the track lock mechanism is contained in an attachment bolted to the main machine casing. In the application of the track lock principle to all-electric working on the former L.M.S. railway, at St. Enoch station Glasgow, in the early 1930's, the track lock was put, not on to the locking plunger, but on to the operating bar of the point machine. It was felt desirable to apply the safeguard up to the very last moment before the movement of the switch blades, even after the lock had been withdrawn, but this method has not been used since.

Trailable Mechanisms

As long ago as the " nineties " of last century the frequency of " run-throughs " in yards and station approaches during shunting operations was leading signal engineers to give serious consideration to apparatus that would prevent the facing point locks and ground gear from getting smashed up, but which would at the same time give a clear indication that something had gone amiss, and would prevent the points from being operated again until certain examinations and procedures had been carried out. In 1892, Charles Hodgson, Managing Director of Saxby & Farmer Ltd., designed and patented the trailable facing point lock and operating gear shown in the accompanying diagram, fig. 15. By means of the three-

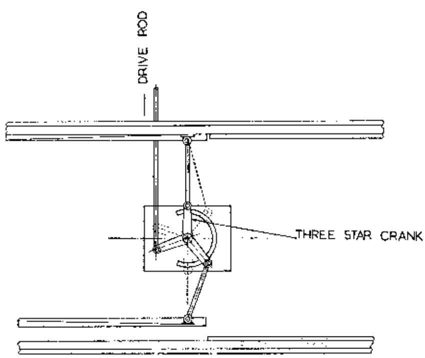


Fig. 15 Hodgson's Trailable facing point lock

pointed star crank the points were thrown against the stock rail, and locked when the arm of the crank was in line with the connection. If a run-through occurred the pressure of the wheel flange against the open switch would rotate the star crank through the appropriate connection, and draw the closed switch away from the stock rail. This device was not, however, complete in itself. During the process of trailing some motion was imparted to the operating rod from the cabin, and Hodgson's arrangements had a special attachment made on the point lever in the frame including a brass shear pin. The fracture of this pin, following a run-through, put the lever out of action until the pin was replaceed. But apparently the signalmen was allowed to do this job himself and contemporary descriptions state that a supply of brass shear pins was as much a part of the signalman's equipment as lamps, red and green flags, and detonators !

In Germany, from the "seventies," the first forms of trailable mechanism also included fracture pieces, just as Hodgson was to use many years later. But in 1881 the firm of Schnabel & Henning of Bruchsal, brought out what is believed to be the first trailable mechanism that did not involve the use of any breaking and replaceable pieces. As in Great Britain the design of apparatus for the protection of facing points was largely at the initiative of the manufacturers, and several variations of the Bruchsal toggle mechanism were used extensively in South Germany. One, due to Vögele, of Mannheim, was widely used on the Bavarian railways, and was to come into prominence at a much later period. The Jüdel toggle lock, now standard in Switzerland, is derived from the same principle. In this latter device, fig. 16, there is the same type of mechanism for providing the trailable feature, in that pressure on the open switch tongue causes a crank to rotate; but instead of the lock being provided by the rod to the closed switch tongue on dead centre of the star crank, as in the Hodgson device a, locking piece is drawn up behind a face on the central lock box, and any movement of the closed switch away from the stock rail on its own account would force the rod against this locking face. The crank mechanism is such that this pressure would tend to thrust the lock harder against the face.

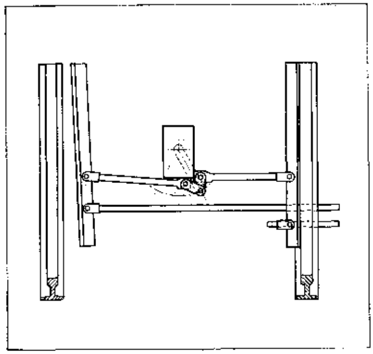


Fig. 16 Jüdel Trailable mechanism

Again, however, as in British practice, this device depends for its successful operation on first class permanent way maintenance, since the extent to which the switch is locked against the stock rail is entirely dependent upon the correct distance between the rail and the lock box.

German Practice

It is important however, not to associate the old firm of Jüdel exclusively with the toggle form of trailable facing point lock, for they also made the well-known *Hakenschloss*, or hook lock. This device had its origin in the general repair works of the Prussian State Railway, at Witten, Westphalia, but it was later improved by an engineer named Büssing, who was at Jüdels for some time. The hook lock was standard in Prussia and Saxony for very many years, and it is interesting to recall that that this German device was in many ways a development of the original British conception of facing point locking, in the clamping of each switch against its own stock rail. The principle of the hook-lock is shown in the accompanying diagram, fig. 17. There is a hook member attached to each switch, and the operating arms of these hooks are connected together by a solid, non-adjustable rod, which is in itself connected to the operating lever or mechanism. Each hook is pivotally mounted on the switch concerned, so that when force is applied to the operating rod to move the points from normal to

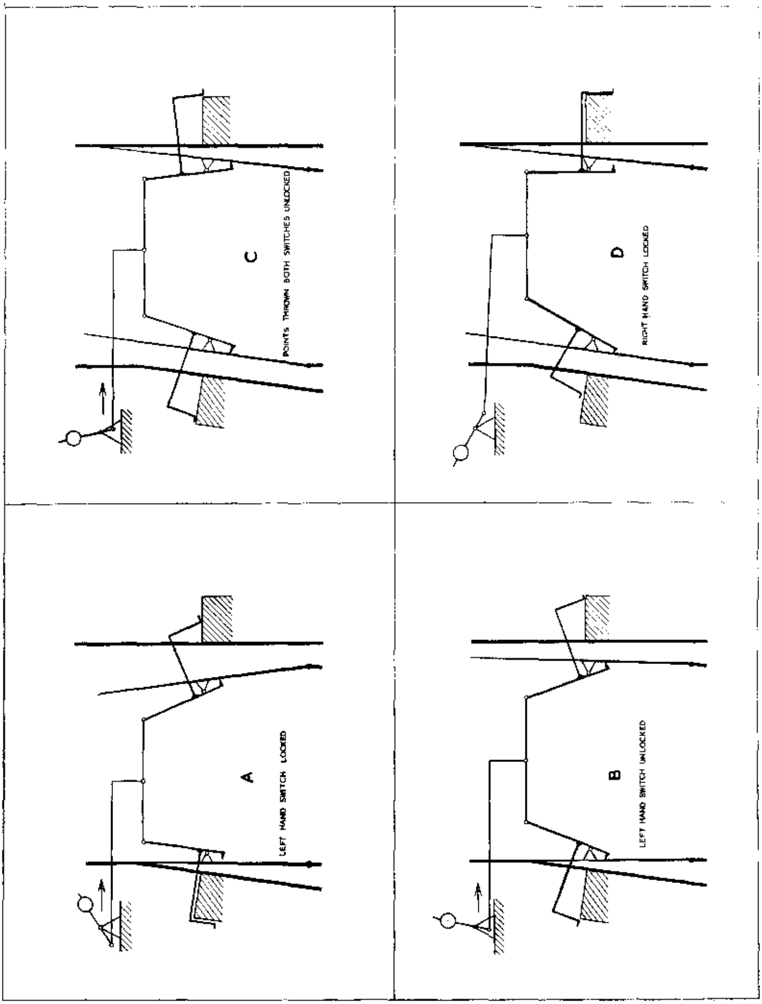


Fig. 17 Diagram of Hook Lock

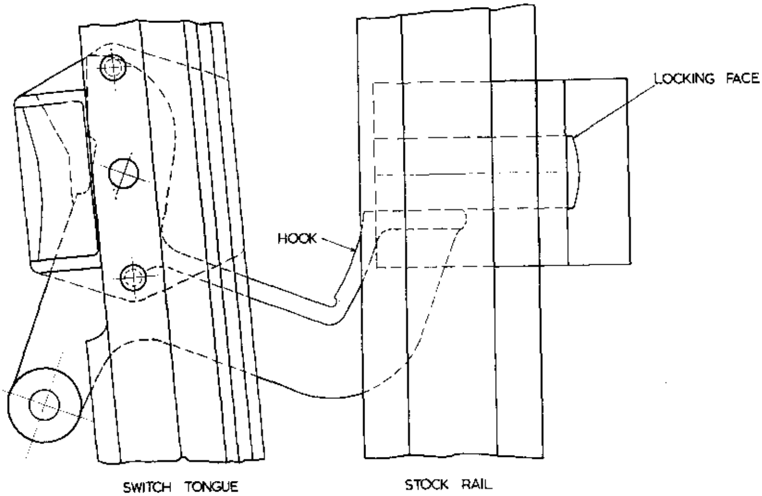


Fig. 18 Details of Hook Lock

reverse the hook is rotated out of contact with the lock face on the back of the switch until the further end engages a stop; then both points are moved until the further one comes into contact with its stock rail. Further movement of the operating arm of the hook causes the locking piece to engage behind the lock face on the back of the stock rail. Should a run-through occur, wheel pressure on the open switch would cause the lock on the closed side to be withdrawn, and the switches moved over without damage to the mechanism.

With the hook lock mechanism it will be appreciated that the effectiveness of the locking of the switch against the stock rail depends upon the accuracy of manufacture of the hook, of the switch tongue bracket on which the hook is pivoted, and of the locking piece fixed to the rail. The diagram, fig. 18, shows the schematic detail of the hook, and lock piece, so that the construction at the actual point of engagement can be seen. It is of interest to see an early British arrangement of 1904 for operating a non-trailable form of hook lock by an electro-pneumatic cylinder, fig. 19. and a further illustration, fig. 20, shows a trailable layout, using a British design of point machine working through a trailable crank. This latter takes care of the driving-back action imparted to the point operating rod during the trailing movement, and protects the mechanism from damage. The hook lock mechanism is extensively used with double-wire operation on the continent of Europe.

Before passing on to more modern developments some of the relative features of the Jüdel toggle lock and the hook lock may be noted. The Jüdel apparatus which is mounted in the four-foot and above the sleeper level is favoured in Switzerland as being less likely to be affected and clogged up by driving snow; and while it is dependent on first class permanent way maintenance it is not affected by creep of rails and switches. It is true that adjustments have to be made to a mechanism which is in the four-foot way, a feature which is not looked on with

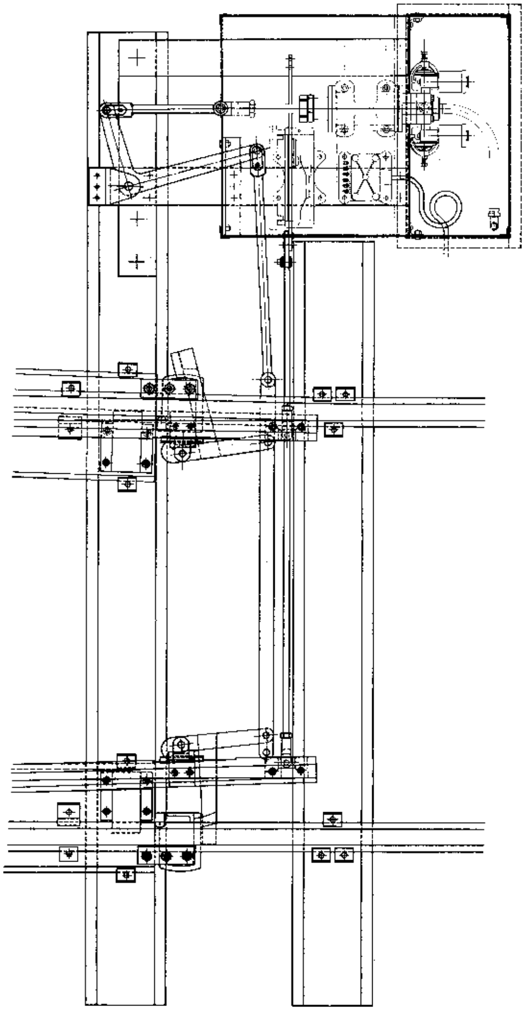


Fig. 19 E.P. operation of Hook Lock

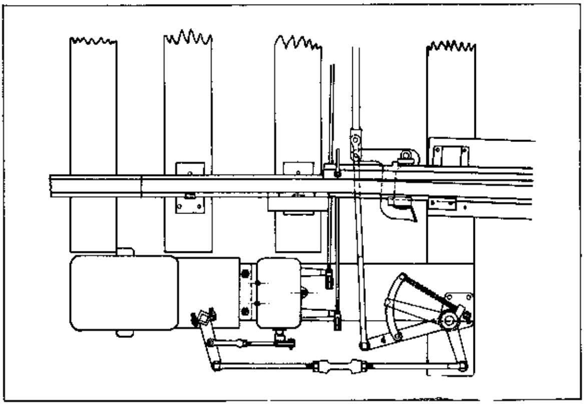


Fig. 20 Electric operation through trailable crank

favour in many countries today, and the fact that the mechanism is fairly high up makes it necessary to put a heavy protective cover on in order to eliminate as far as possible damage from parts that might be hanging from a passing train. On the other hand, the hook lock has all its gear well down and out of the way. As can be seen from the diagram, fig. 18, however, a true lock is only obtained when the curves on the hook and the locking piece have a common centre. The slightest creep upsets the adjustment, although the extent to which the hook lock was used on the continent rather suggests that the extent of the error could not have been very serious. Again it could be said that the hook lock depends on first-class permanent way maintenance, though in respect of the prevention of creep rather than maintenance of the rail gauge.

German Developments Since World War I

After the end of World War I, the railways of the various States of Germany were amalgamated to form the Deutsche Reichbahn, and with the great variety of equipment to be found in the country it was felt essential to standardise for the future. Among many items considered by the Buddenberg Committee was the debatable question of trailable facing point locks. In its deliberations this Committee went far towards proving once again the old saying, " There's nothing new under the sun." As far back as the year 1907 an obscure firm—Scheidt & Bachmann—had made its contribution towards the diversity of signal equipment available in Germany by designing yet another form of trailable facing point lock; but at that time the railways were not interested, and the idea was allowed to lapse without any patent being taken out. But in 1928, the Buddenberg Committee, having in view the disadvantages of both the toggle and hook locks then in use, set about the redesign of the Vögele lock, dispensing with the central casting and dividing it into two, with a separate attachment to each switch tongue. By this means one secured the advantages of the hook lock, in having each switch clamped to its own stock rail, but eliminated the troubles arising from creep of rails. This clamp, or claw lock as it is now well known, turned out to be very similar in both principle and detail to the Scheidt & Bachmann apparatus of 1907, and so it can be truly said that this long-forgotten and never-used invention became in effect the Reichbahn standard, from 1930 onwards—purely by accident, for the Buddenberg Committee were apparently unaware of the earlier design. The clamp lock has one solid transverse member, directly coupled to the operating mechanism, which passes through castings fixed to each of the stock rails. These castings also provide passage for one end of the clamp, or claw, that is fixed to each of the switch rails. The method of working is shown in the accompanying diagram, fig. 21.

(*a*) left-hand switch closed and locked.

(*b*) movement from left to right in progress, right-hand switch has moved a certain distance, left-hand switch about to be unlocked.

(*c*) both switches moving.

(*d*) right hand switch closed and locked

While both the hook lock and the claw lock type of facing point mechanism permit of a run-through in the trailing direction without damage to the mechanism, in such circumstances a complete reversal of the points, with locking in the reverse direction does not take place, and a set of points that have been so trailed is dangerous to normal traffic. A suitable alarm must be given to provide notice of the state of the point gear, and with the double-wire system of operation the lever in the cabin, which has been moved out of its normal position by the motion imparted to the point operating rod must not, in its changed position, be utilised for any release of the interlocking. In a double-wire locking frame the trailable levers are fitted with a trip gear which comes into action during trailing, and disconnects the lever from the locking normally associated with it. There are several types of detectors used with trailable point mechanisms that indicate, mechanically, when a run-through has taken place; in their design every care is taken to guard against false positions, in the event of any part being broken due to the forcing over of the points during the run-through.

Electric point machines used in connection with the claw lock differ in detail in different countries, though the principles are generally the same, as follows:

(1) Whatever trailable features may be included, the point machine and points must be positively locked for signalled movements in the facing direction.

(2) The trailable arrangements must include means for withdrawing the lock and reversing the mechanism without damage, but must at the same time give such notice to the signalman that a run-through has taken place as to draw his immediate attention, and prevent any further movements of the points concerned until he has followed some definitely laid down course of action.

There is also, of course, the clutch mechanism in the motor drive, to prevent overloading of the motor if an obstruction should be encountered before completion of stroke. This feature is not peculiar to trailable point machines.

The present standard electric trailable point machine of the German State Railways provides a good example in which to

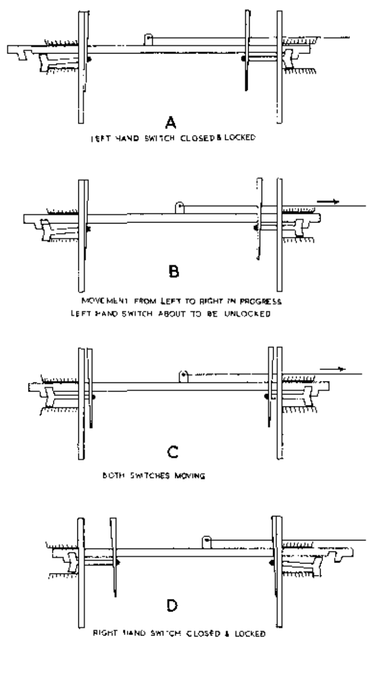


Fig. 21 Diagram of claw lock

study how basic principles required are actually worked out in practice. The motor drives through a worm to a multiple disc and clutch mechanism to a pinion, which is in constant and direct engagement with the point operating rod connected to the claw bar. There are four rings in this mechanism:

1. Driving
2. Worm and clutch
3. Cam
4. Holding.

The driving ring is connected directly to the operating pinion. The inner face of the worm provides the surface on which the ordinary clutch operates; the cam ring is used in certain circumstances to more the locking levers out of engagement, and so free the holding ring to revolve. The pictorial view, fig. 22, will, it is hoped, make the construction and interaction of the various parts clear.

In normal working the first motion of the worm causes the cam ring to revolve sufficiently to move the lock roller out of engagement, after which the whole assembly revolves together. In the case of a trailing movement, it is the driving ring that first commences to move. It compresses the trailable spring, since the end faces constraining this are composite

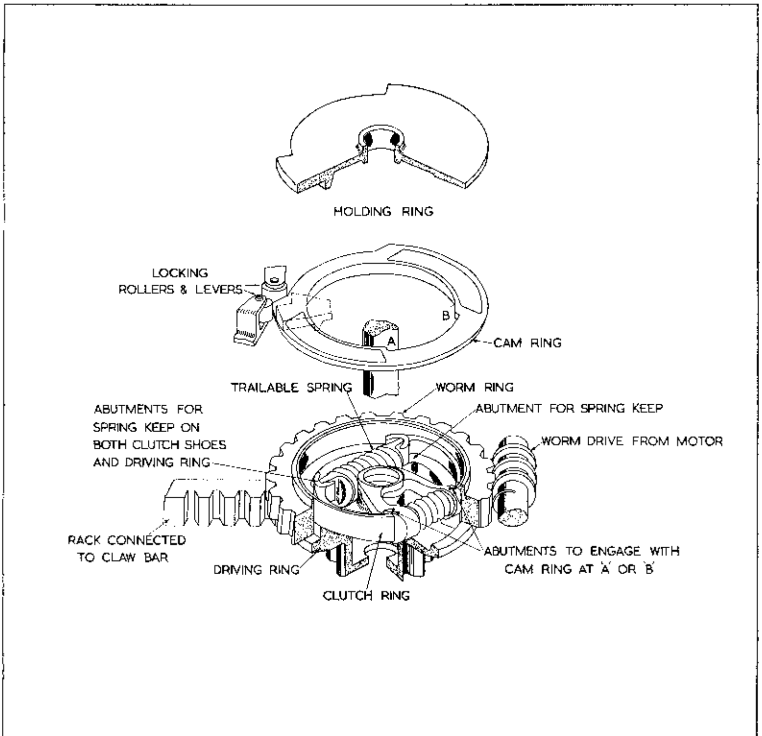


Fig. 22 Trailable Point Machine (pictorial)

ones, including abutments on both driving and the clutch shoes. Movement of the driving ring, however, imparts motion to the cam ring by pressure at the abutments A or B, according to direction of rotation, and the small amount of differential rotation permitted between the cam and holding ring permits the movement of the cam ring to move the locking roller out of engagement, and so allow the holding ring to revolve. The force necessary to compress the trailable spring permits the trailable feature to come into operation only when the thrust on the switch blade exceeds a definitely specified value. The breaking of the detection contacts, through the movement of the lifting ring, puts the detection out of correspondence with the lever in the cabin, and this causes an alarm bell to sound, and a fuse to blow. The signalman must move his lever into correspondence with the new position of the points before he attempts to renew the fuse; otherwise it would immediately blow again.

British Post-War Conditions

From this necessary brief reference to some of the more important practices on the Continent of Europe, a return must now be made to Great Britain. In the later stages of the second World War interest in forms of facing point lock in which the switches were locked against their own individual stock rail began to be revived in this country. This was partly due to troubles arising from arrears of maintenance in both permanent way and rolling stock, due to war conditions. From the permanent way point of view renewals of track and day-to-day maintenance work fell into arrears, resulting in a deterioration of standards generally and the likelihood of locking and detection becoming less accurate than had been customary before the war. This situation was aggravated by arrears of rolling stock maintenance, and the extending of the periods between general repairs of coaching stock, wagons, and locomotives beyond the normal peacetime intervals. As a result, tyres became more heavily worn than previously, and flanges worn thinner, and to a sharper profile. The risk of splitting open facing points became increased from both the rolling stock and the permanent way point of view. Finer limits of detection were called for on existing types of point detectors, demanding enhanced precision in manufacture; but at the same time attention came to be drawn to forms of facing point lock used on the Continent of Europe, among which were noticed the German hook lock and claw lock.

The S.N.C.F. Chair Lock

Following the end of the war, when the wholesale destruction of railway track and equipment in France and Holland enabled those responsible for rehabilitation to start once again with a clean sheet of paper, a new form of facing point lock was developed in France, and subsequently adopted very widely on the S.N.C.F. This type of mechanism differs fundamentally from British types in that each switch is individually locked to its own stock rail when in the closed position In this respect the S.N.F.C. type corresponds with established German standards though the method of accomplishment is quite different from the new standard claw lock. On the S.N.C.F. layout the drive rod is connected to two switch locking arms, each of which pivots on its own switch. These locking arms are in the form of right angle cranks, one arm of which is connected to the drive mechanism; the other arm includes locking faces which engage with corresponding faces in the lock box chair castings, to afford the necessary mechanical locking. A special feature of this particular layout is that the lockbox is cast integrally with the first slide chair for the points. In this respect the S.N.C.F. arrangement differs from the German hook lock, which engages with a special lock piece bolted to the rail. For this reason the S.N.C.F. arrangement has been referred to in this country as a "chair-lock." The accompanying illustration, fig. 23, shows the mechanism as originally developed in France, and as first brought to this country.

The L.T.E. Chair Lock

Chair locks of the French type were the subject of considerable interest when members of this Institution visited France in May, 1952, and examples were seen in service at Bobigny and Bry-sur-Marne. As a result of this investigation the London Transport Executive obtained a set of

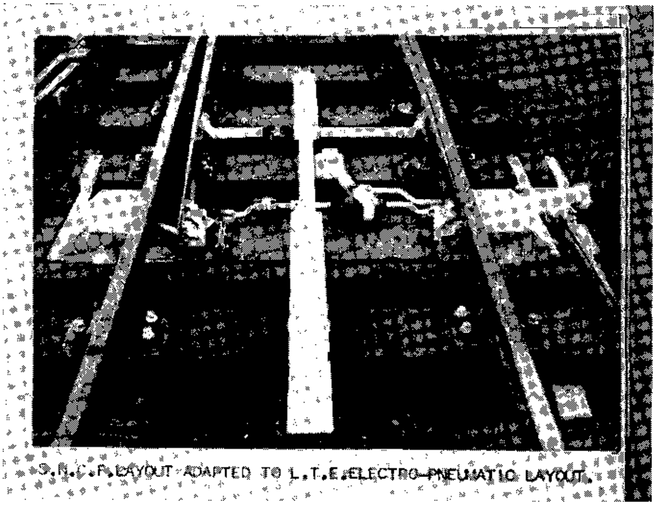


Fig 23 S.N.C.F. Layout Adapted to L.T.E. Electro-Pneumatic Layout

Fig. 24 L.T.E. Chair Lock Layout—Earls Court

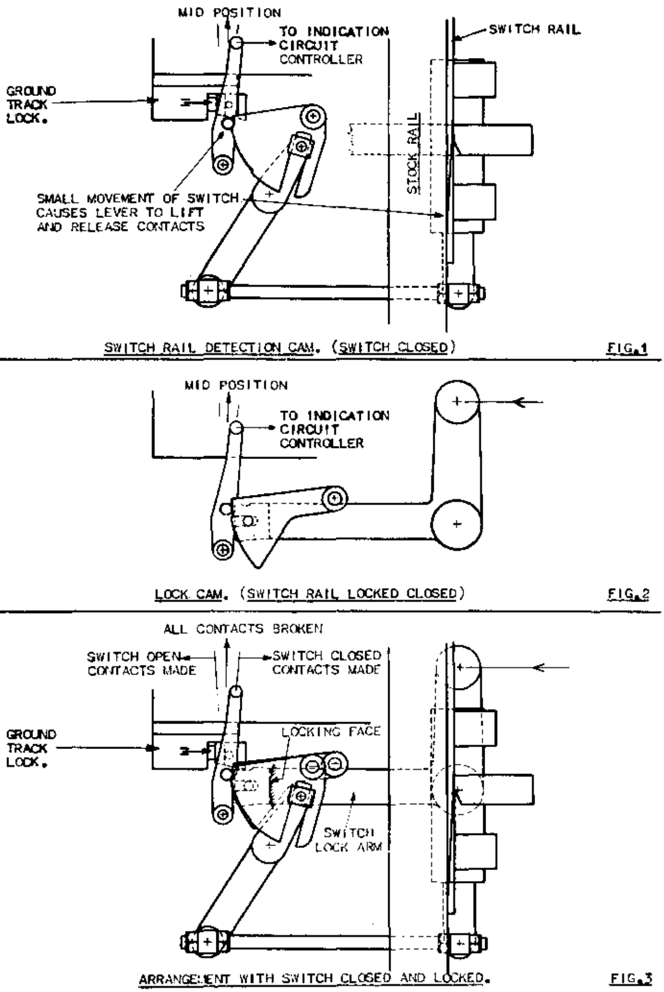


Fig. 25 Diagram of L.T.E. Chair Lock with Track Lock Mechanism

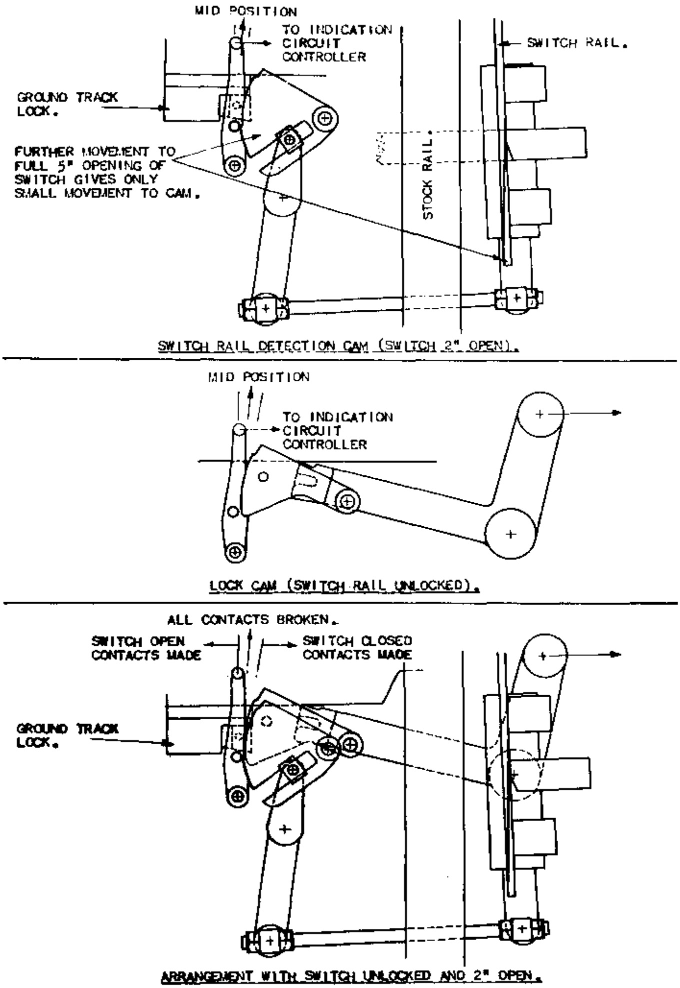


Fig. 26 Diagram of L.T.E. Chair Lock with Track Mechanism

apparatus and investigations were put in hand to see how it could be adapted for use on bull-head rails on London Transport lines. An English version of the chair lock layout was made up, including the addition of a ground track lock, now standard on all London Transport lines, and it was fitted to a pair of facing points at the east end of Earls Court Station on the District Line (see fig. 24). As was remarked in the discussion in this Institution recently concerning the London Transport programme machine, one might have thought, with the chair lock also, that it might have been tried out first on some quiet country branch. On the contrary, one could scarcely have found a location on London Transport lines where the innovation of the chair lock could have been subjected to heavier or more frequent operation. The results in this very intense service were entirely satisfactory. A number of layouts incorporating the chair lock have now been put into service on London Transport lines. These latter include the ground track lock and an improved method of electrical detection. The method of working of the track lock is shown in the accompanying diagrams, figs. 25 and 26. Regarding the track lock, it should be added that it is standard London Transport practice to have the track lock energised on an entirely separate circuit from the signalbox and subject to the same controls as applied to the lever controlling operation of the point mechanism itself. This provides a safeguard against any irregular movements under a passing train, or otherwise. The inclusion of this safety feature with the electro-pneumatic system makes it necessary for at least three separate and distinct circuit faults to occur simultaneously before any such irregular points movement can occur. An installation of this latest form of the chair lock at Watford, Metropolitan line, is shown in fig. 27.

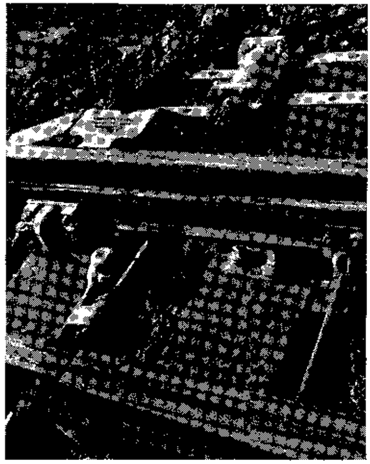


Fig. 27 Layout of L.T.E. Chair Lock, Watford, Metropolitan Line

Electric Trailable Mechanisms

On more than one occasion in papers presented to this Institution, reference has been made to the dilution in standards of operating staff on railways following the extremely severe conditions of the war and its immediate aftermath. Its effect upon signalbox equipment has been discussed, relating especially to staff discipline in carrying out regulations and routines; but the same dilution in standards has also been responsible for the increase in the number of run-throughs in shunting yards and station approaches where light engines and empty stock movements are concerned. The incidence of such run-throughs has revived interest in this country in point mechanisms that could be trailed without damage to the apparatus, and serious consideration has been given to the continental type of point layouts and trailable point machines that have been in service in Germany and elsewhere for many years. The fact that British manufacturers secured contracts to supply power signalling equipment for the rehabilitation of the Spanish Railways, including the supply of trailable point machines, could not fail to increase the interest in such equipment growing up in this country. The Spanish layout is shown herewith, fig. 28.

Conclusion

Historically, it now seems that on the railways of this country there are distinct signs that the wheel is tending to turn full circle, so far as the locking of facing points

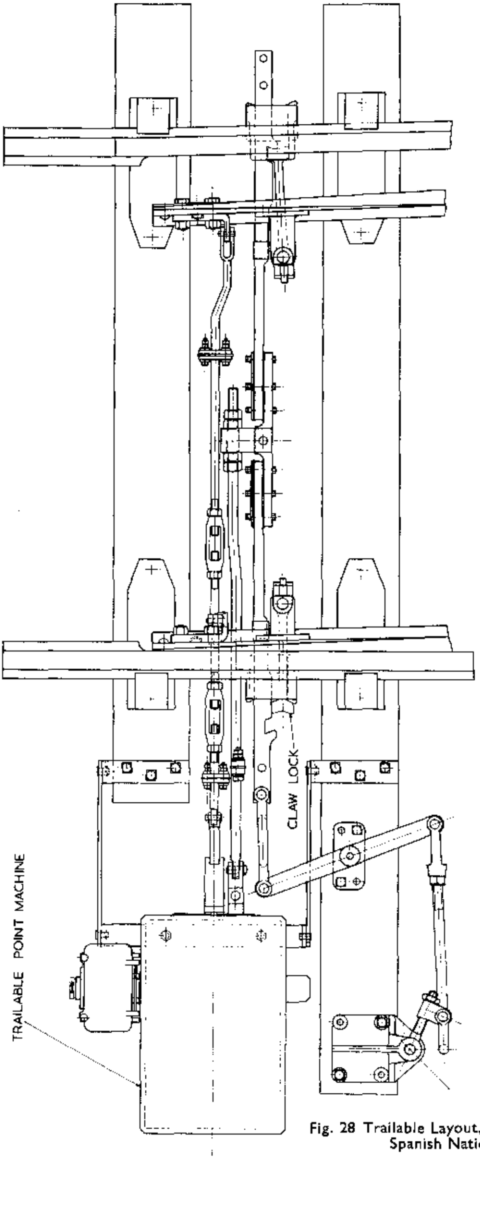


Fig. 28 Trailable Layout, Electrically Operated, Spanish National Railways

is concerned. Certainly the modern chair lock, as developed on London Transport can be put in the direct line of succession from the primitive idea of Stroudley, the rotary cam mechanism of McKenzie, Clunes & Holland, and Harrison's wedge lock. It remains to be seen how far this principle will be adopted in future work on the British main line railways. With a return to the first-class standards of permanent way maintenance traditional before World War II, which have already been achieved. and which will need to be further enhanced to carry the accelerated services promised under the British Railways Modernisation Plan, the need for something more than the simple plunger lock may temporarily have receded; but it is not without significance that on the railway system where the new chair lock was first adopted, and is now being installed as standard, the French National Railways, the services regularly operated are among the heaviest and fastest to be found anywhere in the world.

In conclusion, in acknowledging the help of many friends and colleagues I must thank particularly our President, Mr. J. F. H. Tyler, who has made a particular study of modern continental practice, Mr. R. Dell for information and diagrams concerning the London Transport chair lock, and Mr. A. F. Wigram, Signal Engineer North Eastern Region, British Railways for illustrations of the Harrison wedge lock still in service. In this Institution, also, it goes almost without saying that an author preparing a paper with a historical background naturally invokes the aid of Mr. T. S. Lascelles, and receives the most generous and comprehensive help. The present paper has certainly been no exception; I am most grateful to him. Lastly I must thank my colleagues in the Westinghouse Brake & Signal Company for their suggestions and help, particularly towards the preparation of the drawings from which many of the slides were made.

DISCUSSION

The **President** said that Mr. Nock's paper came at a very appropriate time. There had been, since the war, considerable interest in alternative methods of locking facing points. With the British method of facing points, with the present P. W. layouts, the position of the switch rail was detected relative to the centre of the 4-ft., as Mr. Nock had said. They were detected to a very fine limit, to $\frac{3}{32}$-in., but it was not made sure that the stock rail was still there · a rather grave weakness. Whereas, if the switch rail and the stock rail could be tied together, and the civil engineer be left to look after the gauge, then the tolerance could be 1-in., because the road would still be safe even if it was 1-in. to gauge.

In this country, in addition to the chair-lock on the L.T.E. some attempt had been made on the main lines, and Mr. Brentnall had kindly offered to open the discussion and tell them something of what had been done on the London Midland Region.

Mr. E. G. Brentnall said that Mr. Nock had taken them through the whole development of facing point protection from its earliest days, and it was strange, but very noticeable, that there was later a tendency to move away from the original methods, and now a tendency to go back to them.

The first illustrations showed the switch rail being held close to the stock rail, which, after all, was what should happen, and later, the straightforward plunger lock, in which Mr. Nock mentioned that reliance was placed on the maintenance of the permanent way. But there was some risk to lock the switch rail with respect to the centre of the four foot and not to the stock rail, which could move under certain circumstances. When people were dealing with rails 60-ft. in length, $\frac{1}{16}$-in. did not mean very much, but it meant a good deal to the present-day signal engineer.

The duty of the signal engineer was to place the switch rail up to the stock rail. If the road spread, that was not his direct responsibility.

Where the switch rail was not held to the stock rail, if any apparatus from the train caught the lock stretcher, then it was possible for the switch to be pulled away from the rail and cause trouble. That had happened on the London Midland Region, when brake gear trailing from a locomotive did hit the lock stretcher and pulled the closed switch away from the stock rail, resulting in a serious accident, eight vehicles being completely derailed and two locomotives being turned on their side. By some miracle, no one was killed, but a number were injured.

Efforts were made to find some means of locking the switch rail to the stock rail, and the London Midland Region tried to do it simply. Some trials were being carried out at that time, using standard mechanical facing point locks and double bolts, so that the closed switch was bolted to the stock rail in any case. The slide showed facing points so equipped. The arrangement was that the closed switch was bolted, and the open switch proved open at least $3\frac{1}{2}$-in. If it should move more than that, it did not matter. The illustration was an arrangement with mechanical detection, but the London Midland Region had some installations with electrical detection.

With regard to the advantages of ground track locks, there were some possibilities, but as had been obvious from the pictures shown, the arrangement was very involved. Mr. Brentnall was rather of the opinion that, with double cutting of circuits and with suitable proving, a very high standard of safety was obtained. The question of additional expense of ground track locks in general was doubtful. He believed that, on the main lines abroad, only Sweden used ground track locks; they had started to use them recently.

Trailable mechanism was used a good deal on the Continent, largely because there were no shunt signals. Again, it was a question whether the extra cost and expense on the mechanism was really worth while.

Mr. T. S. Lascelles said Mr. Nock has referred to the anxiety felt at one time by engineers such as T. E. Harrison, about the use of facing points: this anxiety was, I think, fully justified. In the four years 1872 to 1875, during which period Harrison made the remark Mr. Nock has quoted, no fewer than 112 accidents occurred in the United Kingdom at facing points calling for official inquiries: how great was the improvement eventually achieved is reflected in the fact that from 1892 to 1902 only 7 took place. The Board of Trade official requirements long said that facing points were to be provided as seldom as possible and also severely limited the distance from the lever at which they might be worked. In Harrison's time trains had to negotiate junctions at very reduced speeds, and if there had been many facing points journey times would have been seriously affected. The old installations at termini like Waterloo, Charing Cross and Cannon Street of which firms like Saxby & Stevens were so proud, had no facing point locks and no detectors, for a long time. The rod-worked signals on the tops of the signalboxes, then usual, of course could not detect the points. This led to those designs of f.p. mechanism which tried to make the operation of bolting accomplish the detecting but later when separate detectors appeared the bolting became simpler. No doubt the simpler and more straightforward all such mechanism is the better—provided certain essential safeguards are given—my feeling is, looking at all the different contrivances that have been made, that 100% protection against every conceivable contingency is not possible; in the last resort we must rely on well designed robust parts *and* first class inspection and maintenance, but of course we ought to try and cover every likely source of failure.

The trailable mechanism so much seen in Central Europe are not specifically f.p. mechanisms, for there *all* points are constructed alike, and additional bolting—by what are really detectors—is applied for running movements in the facing direction which temporarily suppresses the trailability. The likelihood of a run-through, however, after a running signal has been cleared is practically nil. In those countries, long after we had taken to signalling shunt movements, all shunting was carried out without any signals and there was no interlocking between point levers making runs-through much more likely—although trailing the points was strictly forbidden. This was the origin of Henning's and all the later equipment Mr. Nock has referred to. This is something to be clearly distinguished from simple spring return points at passing loops or spring toggle points, not connected to a signalbox, and it complicates the locking frames in a way unknown to us.

At large stations filled with power working I think we might find trailability offering some attractions as you cannot avoid a run-through now and then and if you have one at the peak hour it can cause a very serious hold-up. I was told by Mr. Hård, the Swedish signal engineer, who read papers here you remember a few years ago, that although they went over to signalling every shunt movement they retained trailability largely for that reason but of course they already had all their points and lock gear adapted to it, which we have not. We should have to turn to new designs.

As Mr. Nock says to study the details of all these devices is a long task—and I have been a witness to the very great thought and care he has devoted to his valuable paper—and they all have something to be said, for and against them. Quite recently I read that when the Germans were in Russia in the war they applied Henning's—or the Bruchsal—point mechanism, which is in the 4-ft. like the Jüdel—and not their latest standard because it was much less interfered with by the severe weather conditions obtaining.

Perhaps I might venture to point out that trailing through the double-wire points does not move the actual *lever* as expressed on p. 75—but moves the driving drum into discordance with it and this lifts the catch-handle so that the mechanical locking becomes fouled. Mr. Nock speaks of the apparatus on p. 72 as not being trailable but I think the hook mechanism there shown would be: I am not quite clear on that. I take it trailing would merely force the air back in the cylinder so that at least there would be no actual damage, of course the points would—if nothing else is provided—return to the original position—and truly "trailable" points in the German sense do not *do* that, I admit. We cannot give too much care and attention to the problem of making facing points as safe as humanly possible, for without that they must offer elements of grave risk and it is very valuable to have the question brought before us again by this paper, in continuation of the work done by the late Mr. Griffiths.

Mr. H. W. Hadaway entirely agreed with one of the points that had been made in the paper—the question of the accuracy and good maintenance of the permanent way. It was one of the problems facing the signal engineer in designing his point equipment. Generally, he was dealing with apparatus that had to function to small tolerances but with the permanent way engineer, the smallest dimension he was prepared to observe was something of a much larger order. There was quite a large gap between views which seemed to be difficult to bridge. Mr. Hadaway did feel that they could get to the state they wanted to achieve. For the necessary accuracy of operation, the permanent way engineer would have to work to much closer limits than at present. The permanent way point layout was not sufficiently stable and moved too easily and the signal engineer had great difficulty in observing his standards if, in the course of a few operations, the permanent way ironwork dimensions had changed.

In Mr. Hadaway's experience, much better operation of points was found in tube tunnels, where the ironwork and timbers were located more securely in a concrete bed, than was the case where the timbers were merely on the ballast.

Since Mr. Hadaway had been concerned with the installation of chairlock equipment, it might be useful to mention that, on London Transport, there were approximately 50 sets of chairlock points now in operation. In installing these points. London Transport had faced up to most situations the signal engineer experienced in the installation of equipment. Not only had chairlocks been put down on brand new layouts, but the problems of change-overs had been met—where, after the cessation of traffic one night, by the next morning (at most, a period of five or six hours) the whole layout had had to be changed from one type to another. The chairlock had shown up very well under those conditions.

In the paper, reference was made to the circuits for track locks being separate, but identical in form to the circuits for control of the points. That was not quite the case. The circuit for a tracklock was made to contain only the actual track circuits which were covering the layout of the points, and any additional circuits, such as a time control relay or signal proving which might appear in the point control, were excluded from the ground track lock circuit.

Reference was made in the paper to the installation of ground track locks by the L.M.S. Railway in the early 1930's. Mr. Hadaway was not sure whether that was intended to be the first installation of track locking which was known, but the L.T.E. did have track locks in 1927.

Reference was made to the ground track lock being an integral part of the chairlock layout itself. London Transport did not install ground track locks on all their chairlocks—only for facing moves.

There was a separate valve for operating the ground track lock, and London Transport did make a special feature of seeing that the ground track lock was installed in such a position that no one person could touch or reach the point valve at the same time as being able to handle the valve of the ground track lock.

Mr. D. G. Shipp referred to the matter which had been raised by Mr. Hadaway when he said he disliked relying on the work of the civil engineer if it could affect the proper working of the signalling equipment. It seemed to Mr. Shipp that the chairlock would be affected by spreading of the road unless a particular form of drive were used.

In fig. 18, imagine the switch tongue being closed to its stock rail and the lug to the left of the diagram attached to a drive rod. Now, if the stock rail should spread to the right, then the effect would be the same as if the drive rod had been pulled to the left, so the hook would be moved away from its fully locked position and the electrical detection would be broken. Although that was a right-side failure, it did mean that the proper working of the equipment was dependent on the track being held correctly to gauge.

This would not occur if the drive rod is able to follow up any such movement, and that could be obtained if the drive were obtained from a pneumatic cylinder.

On the L.T.E. such a pneumatic drive was used, but Mr. Shipp understood that this was arranged so that the piston came to the end of its stroke at the same time as the hook assumed its fully hooked position, so that there was no follow-up available to look after the track spreading to gauge.

He would be grateful if the author or Mr. Hadaway would comment on this question of drive in relation to spreading of the gauge.

Mr. N. F. Reed said that on the railways of Australia, they used pneumatic point layouts quite extensively, and electro-pneumatic ground tracklocks. As he understood it, with a standard layout, ground tracklocks were an electro-pneumatic device, but with chair locks, a pneumatic cylinder was used for the purpose.

In connection with the protection of electrically operated facing points, there had been no device for a ground track lock used. The same result was achieved by an isolating relay, as it was called, connected directly in the point motor circuit; and, in his opinion, it had almost the same effect.

Even though double cutting was in use, it could not cause the point motor to operate, because the lock circuit at the machine itself was open in those circumstances.

Mr. C. P. B. Hodgson said that, with regard to the question of the relationship between all the elements of facing point layouts, on the railway with which he was connected for many years, the gauge of the permanent way was maintained by a steel sole plate which ran on the slide chair sleeper from one side to the other, and included the fastening of the lock, detector, stock rails, and everything connected with the layout. So the gauge never spread and there was no trouble at all in keeping the correct relationship between the various elements.

Mr. P. A. Langley, with regard to the economical lock, considered that it should be used with extreme caution, particularly on running lines. Owing to the incidence of wear and tear there is a risk of the lever movement being completed and due to the loss of stroke the points may not be fitting. It is then necessary to rely on the detection to prevent a movement being signalled and with mechanical detection there is a risk of obtaining the signal lever by stretching the wire.

In certain circumstances a plunger type facing point lock can be employed in lieu of detection whereas, of course, an economical lock cannot.

In the case of power working, the facing point lock can be an integral part of the machine and, of course, electrical detection is always provided.

Trailable mechanisms are of necessity complicated and would, therefore, be expensive to install and maintain and would only be justified in large stations and power interlockings where delay due to run-throughs is serious.

With regard to chair locks, these have the following advantages:—

1. The rigid F.P. lock stretcher bar is abolished and the full benefit of the permanent way flexible stretcher bar is obtained, thus resulting in easier working of the points.
2. The points can be adjusted to widened gauge without resorting to packing.
3. If the track spreads under load, it will not be possible for a wheel flange to get between the switch and stock rail because the closed switch will be securely locked to the stock rail and

derailment will be prevented.

The author had said that the wheel is tending to turn a full circle so far as the locking of facing points is concerned. Mr. Langley ventured to suggest that they were now on a second revolution. Every additional item of equipment was a potential source of failure and it not only added to the initial cost of an installation but additional maintenance was also involved.

Mr. A. Cardani said that not being particularly mechanically minded, he had made rather heavy weather in following the mechanisms recorded in the paper.

Would, therefore, the author confirm his impression that, as regards all the trailable mechanisms described, if there was a rigid connection between the mechanism and the actuating lever, then a shear pin, or its equivalent, was essential.

Further, if in this country, we should uncouple the switch rails in order to achieve trailability, he felt that we should have to give consideration to stiffening the switch rail section towards the toe; otherwise there would be a possibility of the tongue to be opened remaining closed at some point towards the heel as a result of an obstruction such as clip left on inadvertently or a broken slide.

This hazard could, of course, be minimised by additional drive connections but at the cost of increased complications and expense. Perhaps the author would care to comment on this point.

Mr. D. J. W. Brough mentioned that, on the Southern Region, a turnout having " G " switches had recently been installed at Worting Junction. The length of the switch rails was nearly 60-ft., and because of their great length three drives and two facing point locks had been provided.

On p. 57 of the paper there was a reference to " 1876, fifty-one years after the opening of the first public railway in the world. . . . ." Surely, this could not be right, as the world's first public railway—the Surrey Iron Railway—was opened in 1803. Possibly, however, Mr. Nock was using the word " railway " in the modern sense, meaning a line which worked all its traffic by mechanical traction. In this case it would seem that the date implied should be 1830 (the year in which the Liverpool & Manchester Railway was opened), rather than 1825, which was, of course, the year of opening of the Stockton & Darlington Railway.

Mr. J. P. Coley could not agree that the track lock was always so superfluous as Mr. Brentnall and Mr. Reed had seemed to suggest. He had in mind in particular the chair lock.

Referring to fig. 18, on the left-hand side of the diagram there was an air cylinder connected to the hook itself, and when air was applied to that cylinder, it drove the hook round to its position behind the lock face. Normally, there would be a small clearance between the hook and the lock face, but in the event of loss of air on the cylinder, then the hook would make contact with the lock face. Mr. Coley had some grounds for feeling convinced that, under these conditions, vibration caused by a train going over the points could cause the hook to move back to or towards the unlocked position. The addition of the track lock prevented such a dangerous condition from arising.

Mr. H. W. Hadaway, referring to the point raised by Mr. Shipp regarding the point motor and its stroke, said that that question was one that had posed problems prior to the chair lock, and it really sprang from the time when it was decided to change from the old leather-packed piston to the cylinder using piston rings. The leather-packed piston was of such a character that it was able to seal the cylinder and prevent air leaking; but with the use of piston rings, to prevent air leaks and to seal the cylinder adequately, the motor had to complete its stroke. This meant an adjustment of the point layout, in order that the point motor itself might be adjusted to complete its stroke, rather than leaving a little in hand, should it be wanted at any time.

Personally, Mr. Hadaway would prefer to have the adjustment available to adjust the point movement; it was a pity that feature had been lost in changing the type of cylinder. That was his own personal view; he did not know that others would agree with him on that point. He hoped that, with constant changes in design, they might yet find an agent to use in point cylinders, which would retain the advantages of rings and leather-packed pistons combined, so that there would be a seal at each end of the point cylinder.

Regarding Mr. Coley's point, Mr. Hadaway had had some experience of installing these points and had yet to learn of any tendency for points to change due to vibration at any time. He thought that Mr. Coley had said that normally air was maintained on the points to ensure keeping them in position. It would be quite an unusual feature for the air to be missing from the points. He had no personal experience which would lead him to believe that it was possible for points to attempt to move, once they were locked, on the chair lock type of layout.

The **President** referred to the claw lock, fig. 21, about which very little had been said, that was to say, the standard German lock It was a trailable lock which meant that there could be no stretching trailable lock between the switches There was no need to fix the switch rails precisely in relation to one another. There was a real difficulty in anchoring down the stock rails, which often have to withstand side thrusts measured in tons. It seemed to him that anything that could be done to eliminate the fine limits in the setting of facing layouts was to be commended. In considering point layouts of the future, he would like to put forward a plea for the claw lock.

Mr. W. J. Sadler said that, on p. 57, reference was made to the absence of facing points on the Settle & Carlisle extension of the Midland Railway. At that time, there was a short limit in the distance from the points to the signalbox. If facing points were used for loops and facing sidings, it would have meant two signalboxes to control movements, and in that rugged and isolated country, it would not only have been very costly, but very difficult to staff signalboxes.

With regard to shunting trains on the wrong line, that was quite a normal procedure of traffic operation; but in 1904, he believed, there was a very serious disaster, at Norton Fitzwarren when a train was actually shunted on to the wrong line, forgotten by the signalman and a passenger train collided with it. This caused the development of mechanical reminder or sequential locking before the introduction of track circuiting.

It was rather unfortunate that the author did not go a bit farther, because the Midland Railway Company, so far as Mr. Sadler was aware, was the only railway which did not use the plunger facing point lock. The whole of the facing points on the Midland Railway were worked and detected by the Langley & Prince economic facing point lock, and Mackenzie & Holland were given a licence to manufacture it for sale to those who wished to use it. There are many of those facing points locks used today and, by and large, they worked efficiently and were reliable.

That was not the first economic facing point lock used on the Midland Railway. The Midland was so determined to obtain economic working, that prior to Langley & Prince's they used a rack and pinion device and so provided actuation and locking of points in either position by the same lever. That particular principle had a very interesting effect on the mechanical signalling policy of the Company. To perform the unlocking, actuation and relocking of points by one move entailed a travel of about 10-in. It would be realised that to obtain this long stroke at the facing point lock considerable power was required. For that reason, the Midland Railway adopted the stroke of 6½-in. on the rodding. That was possibly why the Midland type of lever frame was very high in mechanical efficiency the total travel of the lever handle being 4-ft. 3-in. Other Railway Companies, who used a low centre type of frame, had tried the Midland facing point lock but could not work it, because the mechanical efficiency of their lever frames was lower. That was the reason why the R.C.H. Committee, in 1921, proposed a standard design of lever frame on the Midland model. These particular features arose to a very large extent, because the Midland insisted on using the economic type of facing point lock to keep down the size of signalboxes.

It was only when the Midland took over the London, Tilbury and Southend Railway in 1913, that the Midland had to deal with independent type plunger locks.

The use of this Langley & Prince's economic type facing point lock meant that invariably the stroke of the switches was limited absolutely to 4¼-in. For that reason, it was very important to make sure that every endeavour was used to prevent spreading of the stock rails. At that time, on the Midland Railway, the sole plate was under the toe of the points. They had holding strips on the sole plate to retain the slide chairs and they also had trouble with creeping of the switches a result of which it was decided to anchor the switches to the stock rail. These sole plate strips and switch anchors were embodied in the

R.B.S. design of points. Of course, when this lock was adopted, the switches were hinged and only 18-ft. long and the lock bar 20-ft., but as time went on, they had 24-ft. spring switches and lock bars 45-ft. or 50-ft. long worked with the facing point locks. Now, the policy was, where possible to abolish economic facing point locks, but in many cases, they were still being made and put in.

An historical point in connection with the working of facing points was on the old Caledonian Section. They had not single plungers, locking both ways, but had two separate plungers and two separate levers in the signalbox. When the route was signalled for the main line, one lever was pulled and the second one was used to bolt the points reverse.

With the development of facing point lock practice and the allowance by the Ministry of Transport of greater distance from the signalbox it was found that the working of the equipment became very heavy indeed, particularly with long facing point lock bars. That raised the question of providing some other alternative method for holding facing points and led to the replacement of mechanical locking bars by mechanical depression bars, at the points, which, when depressed by a train, locked the mechanism and prevented unbolting under the train. If points were required to be trailable stretcher rods could not be used. Each switch must be entirely separate, but according to requirements laid down by the Ministry of Transport points must be tied together by at least two stretcher rods. The points could not be made trailable by using the device known as the Hakenschloss they had seen that evening, but it was interesting to note the chair lock as used by the S.N.C.F. which although the principle was similar to the Hakenschloss, did have points connected with stretcher rods, a leading feature which could influence the adoption of that type of lock in this country.

Mr. O. S. Nock in his reply said that in listening to the discussion he had become even more conscious of the great variety of apparatus that could be used for the protection of facing points. He had prepared a general survey himself, and in the discussion, many other ways of doing the same job had been instanced. Among the purely British methods, Mr. Brentnall had shown the double plunger lock devised on the London Midland Region, while Mr. Sadler had referred to the Langley and Prince lock extensively used on the Midland.

Practically all the problems connected with the protection of facing points, as a modern problem at any rate, can be traced to the inescapable fact that whatever preventatives are employed, the road is going to move. There might be means of holding the gauge, by use of soleplates or tiebars as mentioned by Mr. Hodgson, and Mr. Sadler had referred to the practice standard in this country for many years of adding buttplates to assist in taking the side thrusts. Despite all precautions however, one still experienced spread of the gauge, such are the side thrusts imparted by the passage of trains at speed.

Mr. Hadaway mentioned the question of the difficulty of keeping detection. Mr. Nock had seen detection lost after the passage of a single train, but one of the difficulties one often came across, particularly in large city stations, was the difficulty of getting proper drainage. The track floated about, crept, and made it most difficult to maintain detection. One had to design apparatus to try and eliminate that kind of trouble, and he thought that their President had very aptly summed up the requirements of signalling gear and point locking gear, in saying that we had got to have something that was not susceptible to those small changes.

The **President**, in moving a very cordial vote of thanks to Mr. Nock, said that the paper was a very fine contribution to the records of the Institution and, with the paper given in 1936 by Mr. Griffiths, formed very complete information on facing point detection.

This was carried with acclamation.