Technical Meeting of the Institution
held at
The Institution of Electrical Engineers
Thursday, October 28th, 1948

The President (Mr. A. MOSS) in the chair.

After the minutes of the previous meeting were read and approved, the **President**, introducing Mr. Ture Hård, the Chief Signal Engineer of the Swedish State Railways, stated that Mr. Hård had come a long way to address the Institution, and it was well known that he held an important position in the signalling profession and was a pioneer of modern development in Sweden and neighbouring countries.

He was sure that the Institution was very greatly indebted to Mr. Hård for being present that evening, and he invited him to read the paper, entitled " Modified Relay Interlocking in Sweden."

Mr. Hård prefaced the reading of his paper by saying that he was pleased to come to London and lay before an audience of experts a question of some importance to signalling in the future.

Modified Relay Interlocking in Sweden

By TURE HÅRD

Diagrams—Inset Sheets Nos. 14-16

Introduction.

In Sweden opinions differ considerably on what might be appropriate in a relay interlocking scheme. The possibility of varying circuits and apparatus is almost unlimited compared with conditions prevailing as long as signalling of stations and junctions had to be anchored to some well known and systematically built up interlocking frame. The following paper will deal with a detailed description of an actual installation so as to bring about critical remarks and comparisons with other solutions. By using British Standard Signalling Symbols in the circuit diagrams I have endeavoured to facilitate for the Members of the Institution the reading of my paper which I dare hope will contain some items of interest to those who have troubled themselves to realize in some way or other the fundamental thoughts implied in the term " relay interlocking."

General Considerations.

Railways in Sweden are operating the trains according to fixed time tables giving the time of departure and the track to be used at every station. When a train is delayed, the sequence of the trains can be altered only by train orders issued by the train dispatcher. For that purpose delays are reported from the stations to the dispatcher's office by means of dispatching telephones. For extra trains the times and tracks at the stations are given by train orders. The block system is absolute and based on telephone messages between stations except on a few stretches where automatic block signals are employed.

At stations where a train is required to meet or pass another train a station master (train clearer) is responsible for the setting of routes, the operation of signals and the delivery of train orders. If the station is not too large, or the traffic too dense, the train clearer has to do his work without the aid of signalmen or telephone operators. For that purpose the stations are equipped with means to operate points and signals from the station building. Where only a few points have to be operated when a train meets or passes another train, a mechanical frame located in the open on the station platform is generally used. With a great number of points only power operation has proved effective in giving the necessary facilities. In that case, the station master's office is often considered to be the proper place for the frame, and, in order to avoid costly extension of the office room, the size of the frame must be kept down.

The installation described in this paper is situated on a double line equipped with automatic block signals. The trains use the left-hand track normally but the direction of traffic can be reversed to allow trains to run both ways on the same track when required. Interlocked routes for arriving and departing trains, therefore, are required between each line track and the following tracks in the station, a plan of which is shown in fig. 1 :—

(1) Main tracks I and II are used by passenger trains and, as a rule, by non stop trains ;

(2) Track X is used by passenger trains ending at the station ;

(3) Track III is used by goods trains, preferably those stopping at the station to take or leave cars or to be passed by fast trains ;

(4) Loop track XI is used for removing locomotives of trains arrived in track X.

The other tracks are all side tracks for storing of cars.

All of the points except those leading into side tracks can be operated both from the interlocking frame to enable the station master to reset the routes for the trains, and from the ground to enable shunters to operate the points. In Sweden such dual control of points is generally used in connection with both mechanical and electric interlocking. Only at busy junctions or terminals where the keeping of signalmen constantly on duty is justified by the traffic the dual control has been omitted.

Cabin Equipment.

One lever being required for each cross over or pair of points, 8 point levers of standard design are needed to operate the 15 points. By controlling the signals with three position circuit breakers (non-locked signal levers), placed in a horizontal row at the top of the frame the length of the frame could be limited to 1.05 meter, including 4 spare places for point levers. The levers are numbered from left to right, odd figures being used for signal levers and even figures for point levers.

Points and signals are designated in fig. 1 with the same figures as the corresponding levers. Index " L" or " R" after the number of a signal denotes that the signal will clear by turning the lever to the left or the right respectively.

Time levers for local point operation and emergency release of routes are designated with the numbers of the corresponding points or signals and placed in a row under the point levers.

All tracks except side tracks are equipped with continuous track circuits. The track relays are located in a relay room under the frame. The track circuits are arranged according to fig. 3.

Mounted above the frame there is an illuminated track diagram showing track occupancy, positions of points, aspects of signals, the locking and releasing of routes, etc.

Point Locking.

Such points that are always operated from the ground have no levers on the frame but are fitted with electric locks, applied directly to the points, and contacts controlling the point indication relays in the cabin. The lock and indication circuits of points Nos. 52*a* and *b* are shown in fig. 4.

A point lever locking circuit is shown in fig. 5. When the lever is operated from full normal to full reverse position the lock magnet (NB)L functions as route and track lock (RD)L as indication lock. On restoring the lever the same magnets are used in reversed order.

Each point lever has two visual indicators, LK and WK (fig. 2), showing when the lever is free to operate from an end or an indication position respectively. The magnet LK also functions as an auxiliary track lock effective also if the lever is put back from an indicating position.

The lock magnets L are normally de-energized, the latch contact P being made by the preliminary movement before the lever engages the locking pin of the magnet L. When the lever is being operated in the opposite direction the same P contact remains open allowing the lock magnet to drop and its functioning to be checked mechanically before any full normal or reverse lever contact can be made.

As will be seen from fig. 5 the point lever is locked by front contacts of TR track relays and WLR point locking relays. When required the locking is selected by point lever contacts, e.g. 15LWLR does not affect No. 16 point lever if No. 22 point lever is reversed. The track locking can be annulled by a back contact of a WR point control relay shunting the TR contact.

Close to the fuse there is a proving relay CR which is energized when current is flowing from the fuse to the indicator LK. A CR front contact behind the lock magnets L prevents the magnet from being energized by current not entering the circuit through the proving relay winding.

Point Indication and Control.

The indication circuit of the points of a cross over is shown in fig. 6. In parallel with the three position two phase point indication relay WKR there is at the local lever at the points a lamp indicator enabling the operator of the local lever to see when the point operation is completed.

From the point motor control circuit shown in fig. 7 will be seen that the WR relay, when released, disconnects the current from the cabin point lever and connects it to the local point lever situated on the ground near the points. After the WR is released local operation can be made possible by putting the cabin point lever in one of its indicating positions.

The purpose of the point checking relay WCR is to detect, independent of the point indication, any non-correspondence between a lever and its points that may arise e.g. by a technical mistake while substituting some part of the WKR circuit while the points are disconnected from the cabin point lever. Should the lever be put to full normal or full reverse position without the points occupying their proper positions, the WCR will immediately pick up causing a bell to ring, a red lamp on the track diagram to be lighted and all of the signals to take their stop positions.

The control circuit of 14.16 WR relay common to point levers Nos. 14 and 16 is shown in fig. 8. The current to the relay winding is cut off by reversing the clockwork time lever 14.16 at the interlocking frame. The current supply can be restored by setting the point levers in the end positions corresponding to the actual positions of the points, and replacing the time lever to normal. After a predetermined time during which the signals are all showing stop, the WR will pick up. A stick circuit holds the armature attracted when the pick up circuit is opened momentarily on operating the points from the cabin.

Signal System.

Two kinds of fixed signals are employed, i.e. colour light signals for high speed train movements, requiring long sighting distance, and position light dwarf signals for low speed train movements, subsidiary movements, and shunting.

The first signal encountered by a train arriving on a left-hand (normal) line track is a distant signal showing a single flashing green light, when the entrance signal is " on," a single flashing white light when the entrance signal is cleared for the main route, and a steady yellow light below flashing green light when the entrance signal is cleared for a diverging route.

After the distant signal follows at full braking distance an entrance signal showing :—

Single steady red light for stop ;

Steady green over flashing green for the main route if the colour light starter " on ";

Steady green over flashing white for the main route if the colour light starter " off " ;

Two steady green lights for the diverging route to track III ;

Three steady green lights for the diverging route to the main track of the opposite direction.

On the ground under the entrance signal there is also a position light dwarf signal (calling on signal) by which trains are allowed to enter the station when a colour light aspect cannot be shown because of vehicles on the track. On such occasions the calling on signal display 45° aspect (proceed with caution after communicating with the station master). When the colour light signal is " off," the " calling on " dwarf is always showing vertical aspect. This aspect (proceed) is used alone when a train enters track X, red light then being retained on the colour light signal on account of special attention being required on entering short tail track.

Trains arriving from a right hand line track are signalled into the station with position light signals of a larger size, mounted 1.5 meter above the ground, the same vertical aspect (proceed) is shown for any possible route if the track is free, and the 45° aspect (proceed with caution, etc.) when a route is set but the track occupied.

Inner dwarf position light signals for incoming movements are located immediately before the outermost points with the purpose of directing subsidiary movements and shunting, but these dwarfs have to be cleared also for train movements.

Position light dwarf signals for outgoing movements are placed not only at either end of the station tracks I, II and III, to indicate the limits of the routes for arriving trains, but also inside the outermost points to allow a long train to pull past the inner dwarf in order to avoid the blocking up of points and routes by the rear of the train on account of insufficient length of the station track.

On outgoing dwarfs the vertical aspect (proceed) is shown, when the departure route is clear and the corresponding automatic block signal, viz. colour light signals Nos. 1 or 2 for left-hand running and dwarf signals Nos. 11 or 12 for right-hand running, in " off " position.

When " caution " is shown on a dwarf signal for outgoing movements the track may be occupied or the automatic block signal in " stop " position.

On dwarf signals governing outgoing movements a third light is displayed under the caution or clear aspects in order to indicate to which one of the two line tracks the route is leading. The third light is shown right under the central light (No. 1, fig. 9) of the dwarf for the left-hand line track and to the left under the central light for the right-hand line track.

In addition, the main outgoing routes are protected by colour light starting signals, the positions of which are repeated by the green and white flashing lights of the entrance signals.

To display a clear aspect with either a colour light or a position light signal, after setting the route, the points and point levers must be locked in their proper end positions, all the track circuits free, the opposing and conflicting signals in stop positions, and finally, the automatic route locking established.

When caution aspect is displayed equivalent conditions are prevailing except that this aspect is not controlled by track relays nor by automatic route locking relays.

To allow dwarf signals to be passed while shunting is performed without the assistance of a signalman in the cabin, two white lights on a line leaning 45° upwards to the right are displayed. This aspect means that the points are set for a movement to the signal in advance but disconnected from the cabin levers to allow the points to be operated on the ground by the shunters.

At either end of each one of the receiving tracks I, II and III, there is a special signal (stop lantern) displaying red light outwards, while a train is entering the track in the other end of the station. The purpose of the signal is to forbid shunting against an arriving train.

Signal Aspects Control Circuits.

According to fig. 9 three types of relays, viz. HR, DR and HHR, are needed to control a four aspect dwarf signal. Each dwarf signal has its own HR and HHR relays whereas the same DR may be utilized for two or more signals governing converging routes. The route indicating lights Nos. 5 and 6 are controlled by point lever contacts. The clear, caution, shunt, and stop aspects are repeated on the illuminated diagram in the cabin by miniature lamps fed from current transformers, the primaries of which are coupled in series with the signal lamps Nos. 2, 3, and 4.

In fig. 10 the wiring of a large size position light entrance signal for trains arriving from the right-hand line track is to be seen.

In fig 11 the wiring diagram of a colour light entrance signal will be seen. The HDR relays, controlling the steady green lights Nos. 1, 3 and 5, can be energized only one at a time. The lights Nos. 4 and 5, the latter only when flashing, repeat the colour light starting signal, the control circuit of which is shown in fig. 19.

From the diagrams fig. 11 and 12 will be seen that the control circuits of the green lights are electrically separated from all the other circuits by a special separating transformer, and, in addition, that the red signal light disappears by an ECR front contact shunting the secondary of a leakage transformer from which the red lamp transformer is fed.

Another item of interest may be that the display of a single steady green light instead of two lights, or one or two green lights instead of three, i.e. an aspect less restrictive than the wanted one is prevented by balancing impedances inserted in the feed leads to the signal light transformers (fig. 11).

The lamp behind a red lens is duplicated with a back lamp which is placed out of focus and equipped with a series resistance in order to limit the rise of voltage in case of the focussed lamp being broken.

The wiring of a searchlight distant signal repeating a colour light entrance signal is shown in fig. 13. The flashing part of the distant signal is an acetylene gas flame fed from an exchangeable gas container mounted on the signal pole. The gas pressure is used to operate the green and white roundels. The yellow indication, repeating the slow speed route aspects, is procured by a separate electric light signal of medium range.

Relay Interlocking Circuits.

As to the locking, distinction is made between subsidiary movements governed by caution aspects, and train movements governed by full clear aspects. Subsidiary movements including shunting are subject to a general speed limit to 30 km. per hour whereas the speed of train movements through the station is limited only by curves and other track conditions.

When a train enters the station on a full clear signal conflicting movements must be prevented not only with the limits of the route but also beyond the stop signal at the leaving end of the route, taking into account the possibility of the train's not being able to stop at the signal. When vehicles or trains are moved into the station on a caution aspect, no locking of points or routes beyond the dwarf at the leaving end of the route is required, except for opposing routes leading directly into the same track. The method of locking may be understood by the following examples.

HH Relays.

Considering at first the HH relay controlling the dwarf signal aspect allowing shunting while the points are free to be operated on the ground by the shunters, it will be seen from fig. 14 that the HH of 17 R, 21R*a*, and 15L, after the points have been set for movements between the signals 17R and 15L, will become energized on reversing the time levers 20N and 18.22N, provided the WLR route lock relays of 15L, 21R, and 17R, as well as the routes repeating relay II*s* ULPR are energized, i.e. when no route governed by any of the Signals 15L, 21R or 17R nor any incoming route from the south to track II is established. Reversing points No. 20 by means of the local lever will cause 21R*b*HHR to show the shunt permit aspect instead of 17R and 21R*a*. As long as any of the points in the route are in transit all signals protecting the points are showing stop.

When operating a time lever in order to remove the point control from the local lever to the frame, all of the signals protecting the points will take the stop position immediately, but the points cannot be operated from the cabin before the elapse of a predetermined time.

HR and UKR Relays.

From fig. 15 and 16 will be seen that an HR relay governing the caution aspect of a dwarf signal is controlled by a front contact of the corresponding UKR route indicating relay in series with back contacts of the HH shunt aspect and WIR point locking relays.

The control circuit of an UKR contains next to the relay winding a signal lever contact, enabling the signalman to replace the signal to stop at any moment. The indicator EK L or R lights up when the control circuit is closed right up to the signal lever contact.

In addition, the UKR control circuit contains the following contacts :—

(1) Full normal and reverse point lever contacts in series with contacts of the corresponding WKR point indicating relays ;

(2) Front contacts of WKR relays controlled by hand operated points (fig. 4) ;

(3) Front contacts of WLR point locking relays for opposing or

otherwise conflicting routes, except those already eliminated by different positions of points ;

(4) Front contacts of ULPR route lock repeater relays for inbound opposing routes ;

(5) Back contacts of ALS approach lock stick relays ;

(6) Normally closed contacts of clockwork time levers for emergency route release.

The contacts are selected for the various routes by means of N, R, NC, and RC point lever contacts, the two latter types to be used when the contacts must be selected by means of point levers not belonging to the route.

WLR Relays.

The energization of an UKR route indicating relay causes the corresponding WLR point locking relay (fig. 17) to assume the locking position. After being released the WLR will remain de-energized preventing the points of the route from being operated, until the signal lever is restored to normal, the UKR and HR are released, a time delay contact connected with the lever is closed, and, in addition, the ULR route lock relay is disengaged. Right above each signal lever there is a lamp EK which lights up when the ULR is released. When the signal lever is reversed for a subsidiary movement no locking by an ULR is established. In that case, the lamp EK will be lighted continuously as long as the signal lever is reversed.

ULR Relays.

The locking of the routes for arriving and departing trains is accomplished by means of two relays, ULR and UYR, having mutually interlocked armatures (fig. 18). The armature of ULR, after picking up, is mechanically held up until the armature of UYR picks up and *vice versa*. The ULR locks the route ahead of the train. The UYR releases the route behind the train.

As will be seen from fig. 18 the inbound route lock relay 21LULR will pick up on moving the signal lever in the direction indicated by the index L of the signal number, provided the HR of the inner dwarf 1FL is energized and, in addition, no conflicting route is established beyond the dwarf signal at the leaving end of the station track. When the control circuit is complete right up to the signal lever contact a lamp indicator is lighted to the left of the signal lever indicating the direction in which the lever has to be turned.

The picking up of the ULR will cause the route release relay 21L UYR to drop and close the current to the aspect control relays HR and HDR through TR and DR front and ALS back contacts.

The route lock relay of the outgoing routes is arranged to pick up after the HR of both of the inner and outer dwarfs have picked up, provided also the block signal repeating relay 12GPR is energized, i.e. the first automatic block section clear.

ULPR Relays.

An ULPR (fig. 19) is designated by the number I, II or III of the station track followed by the letter " N " (north) or " S " (south). For example, when the ULR picks up for an inbound route from the north to track II the relay II NULPR will drop and prevent the clearing of signals for conflicting or opposing routes in the leaving end of the station.

DR Relays.

Automatic control by track circuits is procured by means of DR clear aspect control relays, the control circuits of which are exemplified in fig. 20. For instance, 17LDR controlling the vertical aspect of dwarf signal 17L picks up when the route indicating relay 17LUKR and the route lock relay 21LULR both are energized, and the track circuits are clear right up to the leaving end of the station track. The de-energization of the route lock repeating relay ULPR is checked by means of a back contact.

The 17RDR picks up when 17RUKR and 18*b*TR are energized and dwarf signal 21R*a* has assumed full clear aspect. This occurs on energizing 21RUKR, provided the track circuits ahead are clear, the automatic block signal is " off " and the corresponding ULR relay in locking position. A current rectifier prevents 17RDR from being energized before 21R*a*HR has picked up.

UYR Relays.

From the route lock and release circuits in fig. 18 may be noticed that the route disengaging relay UYR will pick up on replacing the signal lever to normal, provided the approach lock stick relay ALS is energized and the signal aspect control relays are all de-energized. A lamp indicator EK located right above the signal lever indicates when the disengaging circuit is closed.

When two or more consecutive routes are established the routes are released and the signal levers have to be restored to normal in the same order as they are passed by the train (see fig. 17).

ALS Relay.

A common approach lock stick relay is used for all routes to and from each line track. From fig. 21 may be seen that the ALS will pick up for a passing train if the corresponding ULR is in locking position. After picking up, the ALS relay will remain energized until the UYR disengages the armature of the ULR.

For trains leaving the station the ALS picks up when the train has occupied the last track section and cleared all track sections behind that section.

For arriving trains the ALS picks up when the train has occupied the station track, and its last vehicle has come inside the outer dwarf for outgoing movements.

The necessary number of track relay contacts is reduced to a minimum by selecting the control circuit through point lever contacts and using the network of wires both ways.

To prevent signals from clearing automatically after a train has passed, ALS contacts are inserted in the aspect control circuits, thereby enforcing the restoring of the signal lever after each train.

Automatic operation of signals for the main tracks can be allowed for the normal direction of traffic by opening a key operated switch on the interlocking frame, thereby preventing the ALS from picking up by trains on the main tracks. The station then functions as an automatic block section, no operation of levers being required until the key switch is replaced.

A route for which the signals have been cleared can be cancelled before any train has passed by means of a clockwork time lever. After starting the clockwork the ALS will pick up after a predetermined time during which the signals protecting the route are displaying stop. The restoring of the clockwork to normal is checked by the UKR circuit.

Manipulation.

When a train passes the station, say, from the north down track over station track II to the south down track, the course of events is the following.

After cancelling any permission to shunt on the north down line and setting the point levers Nos. 18, 20 and 22 in their full normal positions, the left lamp indicator at No. 17 signal lever lights up provided no conflicting route is cleared in this end of the station nor any opposing route in the other end of the station. On turning No. 17 signal lever to the left the point levers become locked and a caution aspect (45° position) appears at dwarf signal 17L.

The left indicator at lever 21 lights up unless some conflicting route be established in the south end of the station. On reversing No. 21 lever to the left a red lamp at track II on the illuminated diagram lights up, thereby indicating that the automatic route locking is established. A red light also appears in the stop lantern at the south end of track II.

Provided all track circuits are clear right up to signal 9L*b* the caution aspect of 17L dwarf will change to vertical aspect and a steady green light over flashing green appear at the entrance signal 21L.

The outgoing route from track II to the south down track is prepared by setting point levers Nos. 4, 6 and 8 in their full normal positions and turning Nos. 5 and 9 signal levers to the left causing caution aspects to appear at 9L*b* and 5L signals. As soon as the block signal No. 1 clears, a red lamp lights up at the south down track on the illuminated diagram indicating that the automatic locking of the outgoing route has taken place. Provided the track circuits are clear the caution aspects of 9L*b* and 5L will change into clear and the colour light departure signal 9L assume the " off " position. At the entrance signal 21L the flashing green light changes into flashing white light, indicating that the route is clear all through the station.

The lamp indicator EK at No. 21 signal lever lights up when the last vehicle of the train has come inside signal 21R*a*, After No. 21 lever has been restored, the lamp EK at No. 17 lever lights up and the red indicator at track II on the diagram goes out. In a similar way the indicator lamp EK at No. 9 signal lever lights up and the red indicator at the south down track on the diagram goes out when the outgoing route locking is released. The lamp at No. 5 signal lever lights up after No. 9 signal lever has been restored. The automatic route locking will not be disturbed by a signal lever being restored to normal *before* the lamp indicator at the lever is lighted.

If several trains are to follow each other on the main routes through the station, automatic functioning of the signals may be switched in by opening the key switch in order to prevent the route locking from being released by the passing trains. If the key switch is restored to normal before the last train has passed the station, the signals, after that train has passed, will assume stop position and remain " on " until the signal lever has been restored and operated anew. If the route, after a period of automatic working, must be cancelled without having restored the key switch before the passage of the last train an emergency time lever must be used to release the route locking.

Conclusion.

The modification intimated by the title of this paper lies in the use of point levers of standard design for controlling the point motors. A full relay system should require special point controllers operated electrically by aid of non-locked point levers just as the signals. The selection of the circuits then should be accomplished by contacts of point indicating relays or repeaters of such relays, or some other device substituting them. Retaining the point lever as a means for locking and controlling point motors and selecting the interlocking, therefore simplifies the circuits and, consequently, increases the security and facilitates the maintenance.

In a large installation the following measures may be taken in order to simplify the various circuits.

Instead of using one WLR for each signal lever, each WLR may be arranged to refer to a certain track section in a group of tracks and to be affected by every signal leading to that section.

The number of point indication and point lever contacts required for the control of the UKR relays may be reduced by combining the circuits for in and outbound movements in a network and using signal lever contacts to select the direction of current in the same way as UKR contacts are used for the DR control circuits in fig. 20. In the same way, contacts can be saved by combining the control circuits of the HR relays for opposing routes and controlling the direction of current in the network by UKR contacts.

For a large layout with congested traffic of train and shunt movements, sectional release route locking may be adequate in order to obtain earlier release of the points. As the point levers are representing the smallest consecutive sections in which a route can be divided, the retaining of point levers as items of the route locking will not unfavourably affect the flexibility of the signal installation. Individual control of points contributes to avoid confusion during fall of snow.

DISCUSSION

The **President**, in opening the discussion, said that he was sure that everyone had been very interested to hear the paper and would wish to congratulate the author. There was a great deal in what the author had said, which might be compared with the practice in this country.

On page 125, it was mentioned that the trains normally used the left-hand track ; but that working could be reversed to allow them to run both ways upon the same track. In other words, they used reverse road working. This method was not used very much in this country over any great distance and although there were cases through the limits of a station where it was used, it involved complicated circuiting, owing to the precautions which had to be taken to hold an opposing signal until the train had cleared the intervening section.

An interesting feature referred to on page 127, paragraph 5, was the proving relay CR, which was apparently used to detect the presence of an extraneous current in the point lock circuit. It seemed very ingenious and he could not recall having seen a similar device in use here.

On page 128, paragraph 4, it was mentioned that the distant signal displayed a flashing white light when the entrance signal was " off," and a flashing green light when the entrance signal was " on." With this arrangement, it would appear that the breakage of a green lens would cause a less restrictive aspect to be displayed. To those in this country, accustomed to the three colours of red, yellow and green, and the various combinations, the aspects described by the author might seem a little complicated.

An interesting feature was the use of a common network of wiring in the circuit work. This was used in this country in some cases where a ground frame was controlled electrically on one wire ; an application very simple in comparison with the author's description of what was performed in Sweden with a common network.

Another point of interest described by the author was the use of telephone type multi-core cable for working the controls at a local station about a mile away. This practice did not find favour here where a cable of a more substantial nature was generally used for signalling work.

Mr. R. Dell said that to prepare and deliver a technical paper in a foreign language was a really outstanding feat and he wished to congratulate the author for the excellent manner he had performed it. He was in agreement with the author's remarks that relay interlocking should not be used unless there were advantages to be gained from it and it was an important point that complicated equipment should not be installed merely for the sake of doing so. One of the principal advantages claimed for relay interlocking in this country was the use of route control but from the paper it appeared that route control was not used in Sweden. He enquired if it had been found of no advantage to adopt its use.

He was interested to note that in some respects development in Sweden appeared to have been similar to the experience of London Transport, where a number of relay interlockings had been installed. The circuiting had been found complicated and a large number of relays required. As a result, they had of late changed to a simpler system using levers where possible in preference to relays in the power operated relay systems. It seemed that in Sweden, they had aimed at the same kind of simplification.

He also expressed interest in the diagram showing the red light control circuit in which a leak transformer was used to supply current to the red light and the lamp was short-circuited to extinguish the light. He thought the principle was the right one from the safety point of view but that some difficulty might be found in adjusting the voltage of the red lamp, and also through the voltage on the second lamp rising when the first lamp burned out. The arrangement was similar in essentials to the flux neutralizer type of signal installed in the early days in tube tunnels. This had the same valuable feature that the red light circuit was not broken when the light was extinguished. The difficulty of adjusting the voltage of the circuit and keeping a bright light without burning out the lamps, was against the circuit and it had not been used in any installation on London Transport in the last twenty years.

Mr. J. F. H. Tyler mentioned that last year he had had the good fortune to visit Stockholm for five or six days and for part of the time had been the guest of the author.

After seeing a great deal of the signalling in other continental countries, he had found a similarity in the practice and installation of signalling generally in Sweden and that which we had in this country. The flashing light had been a surprise to him and it seemed a little difficult to appreciate that a distant signal showing a flashing white light should mean " clear."

As to what would happen in the event of the lamp glass being broken, he thought that it would be most unlikely that the whole of the lens would be destroyed and nothing left to show the intended indication.

He found wrong road working a very interesting feature and understood that this was used over many miles of line and was, in a sense, related to the traction system. The latter was 16,000 volts a.c., and the sub-stations were great distances apart ; he understood in some cases, 50 or 60 miles. Men working in that length on overhead lines would naturally cause great interruptions to the train service and he believed that it was while considering this problem that the idea of wrong road working had come about.

He had noticed an interesting feature on a C.T.C. installation where the loud speakers at stations along the line could be switched to the control panel so that the operator could advise passengers of delays of which he was aware but of which the station staff were not.

Mr. Tyler made reference to the gas-lit distant signals which, he understood, were similar to the A.G.A. buoy used at sea. He asked how long the containers, or cylinders, lasted before charging.

Regarding the individual control of points, which was no doubt very useful during snow and ice ; he enquired if salt, flame-guns, electric heaters, oil pipes, or other means were employed in Sweden to prevent the freezing of points.

He expressed surprise that, although there was a great deal of colour-light signalling in Sweden, there were no overlaps and he enquired why it was not considered necessary to provide them. In the Swedish signalling system there was a distant signal which repeated the aspect of the entrance signal only, and a distant signal under the entrance signal for the starting signal ahead. Fundamentally, that was three-aspect signalling, for which, in this country, we had overlaps.

He regretted that the author had insufficient time to describe the many interesting installations in Sweden of automatic power operated level crossing barriers.

Mr. F. Horler said that he had listened with considerable interest to the author's description of the relay circuits and had only one question to ask. He gathered from the description that the method of point operation would not permit the use of an automatic route setting system. In this country, the relay interlocking tendency was towards the introduction of the route setting system and he would like to know if the Swedish authorities were content with the present limitations.

Mr. H. M. Proud stated that although he did not pretend to have thoroughly examined every detail of the circuits shown in the diagrams, he thought the paper would prove to be of exceeding value in future, particularly to young circuit engineers. Perhaps in helping them in the study of relay interlocking circuits, and certainly in leading them to study what had been done in another country and to appreciate why it had been carried out in that particular way. In addition to those present at the meeting, the paper would be studied by a large number of members in various parts of the world, and he felt sure it would receive the attention it deserved.

He noticed that the track circuits were of the constant current type and wondered if any difficulty had been experienced on the electrified lines due to a drop in potential along the track, causing a by-pass current through the track transformer. If there were a drop in its power potential from one end of the track to the other, there would be a shunt path which could pick up that potential and pass it through the track circuit transformers. There might be some safeguard against this, which he had not appreciated.

Mr. Proud asked the author if every shunting signal or every position light shunting signal was considered to be a "stop" signal, when it showed the horizontal aspect.

Referring to the telephone type cable mentioned by the author, he thought the circuit referred to could be termed a secondary circuit, not affecting any interlocking or control circuits, and in his opinion, no additional safeguard with that type of cable would be necessary if used for this purpose.

Mr. W. H. Challis expressed particular interest in the economy of apparatus described by the author, such as, the use of one approach lock relay for a group of signals and one stick relay for disengaging one group of signals.

He was also interested in the time release switch, of which there appeared to be one for each signal lever. He mentioned that London Transport have been giving careful consideration to the question of time release devices and he asked if there was a relay imposing a time interval in the interlocking described in the paper and, if so, how and when did it operate.

Mr. C. F. D. Venning said he wished to refer to a point that had already been raised in the discussion ; the possibility of route working. The author had placed particular emphasis on individual working and he assumed that was because of a large amount of shunting and the local control of points. For a straight-through movement, as illustrated, it might be possible for as many as eight or nine lever or thumbswitch movements to be made, with individual working. He enquired if the author would have considered route working for a more complicated station.

With regard to dwarf signals, which preceded main running signals ; although the shunt signal had no red light, he presumed that the driver of a train was expected to observe those intervening signals.

Referring to one of the photographs of an illuminated diagram, Mr. Venning asked if all the track indications were normally illuminated by white lights, this differing from the more usual practice in this country of having two red lights illuminated when the corresponding track circuit is occupied. He also enquired if the majority of points in Sweden had local controls.

The **Author,** in reply, first dealt with questions concerning the principle of route control versus individual control. In his opinion, route control may be adequate for complicated junctions with many interesting transit train movements but less suited for ordinary stations with passing loops and sidings for local traffic. When signals had to be provided for reverse traffic and auxiliary shunt movements, route control required a greater number of operating units than individual control. The choice between many route levers may put just as much strain on the signalman's mind as the manipulation of a few point levers. The same remark could, he thought, be made concerning an NX system where separate N- and X-knobs are provided for every one of the consecutive parts of a route. The existence of hand thrown points in an otherwise automatic route may also be confusing.

So far, route control had not been used in Sweden. As mentioned in the paper, route control might be more exposed to troubles due to snow and frost, another disadvantage might be that safety is more dependent upon the track locking, which might fail momentarily on account of light rolling equipment and rusty rails. Route control has not been called upon in Sweden on account of limitations experienced with individual control. The system, however, is known and considered as a fascinating technical innovation.

Referring to Mr. Venning's remarks, it may be mentioned that the number of signal lever movements needed at the frame described could be reduced by half by clearing dwarfs and running signals with the same lever. By letting dwarf levers precede running levers the circuits are simplified and the risk of points being thrown in front of trains reduced. The additional lever movements required are considered as less important.

In reply to the question of reversible working raised by the President, the track circuit control of block signals is absolute from station to station for opposing movements in both directions. Following movements are rendered possible in block distance by an A.P.B. stick relay at the beginning of each block section. The direction of traffic on a line track between two stations is controlled by a time switch located at the station where trains in the normal direction enter the track. If the switch is changed when the line is still occupied by a train, opposing signals are held at "stop," until the whole line is clear. The circuits are not very complicated. For block signalling at a double track line, four pairs of wires are available in a common telephone cable laid along the line in connection with the installation of electric traction.

The author agreed that Mr. Tyler's remark on the use of wrong direction block signals as a means to facilitate revisions of the overhead contact line was quite correct, but pointed out that the need to install such signals came from a fatal accident in a tunnel.

The possibility of getting a false clear indication due to broken green lens or a green roundel, was recognised. The author felt, however, that the risk was much greater with the mechanical disc signals extensively used as distant signals before light signals were introduced. The chance of a coloured inner lens being broken may be very remote, but the green and red roundels of searchlight distant signals received constant attention. The white flashing light is well liked by drivers on account of its good visibility, and there is at the moment no thought of abandoning it.

Telephone type cables are used for line wires in block signal territory and for distant control of relays at outlying points and detached stations. They are also used for selection of relays along a railway line by means of chains of electric impulses (CTC-control).

Common networks are often used in interlockings in order to save relay and lever contacts. Such networks are always confined to the cabin and, consequently, are separated from wires in outdoor cables in which contacts between insulated wires are more likely to occur.

Experience with non-interrupted red lamp circuits is good. The lamp transformer secondary has several taps for regulating the voltage. The stand-by lamp has, in addition, a series regulating resistance that prevents the lamp voltage rising above the rated value if the main lamp burns out. Breaking of the stand-by lamp will cause a slight rise of voltage at the main lamp, but the stand-by lamp is not likely to be the first one to burn out.

The freezing of points is largely prevented by installing draining-wells close to the points and by using roller bearings to support the point tongues, so as to make lubrication unnecessary underneath the tongues.

Flame guns are used in yards to keep snow away during severe storms. Electric heating apparatus is used in a few cases, experimentally, at outlying points. They are not sufficient to keep the snow away during heavy storms or low temperature but they help to keep things going until a man can reach the place. Points are usually kept clean by spades, scrapers and brushes.

The absence of overlaps in track circuit control in Sweden is a fact difficult to explain without knowing the reason for using overlaps in England, even though the stop signal is advertised to the driver by a distant signal at braking distance. No doubt the use of overlaps would to some extent reduce the present capacity of stations, but experience does not indicate that overlaps are necessary from the safety point of view.

Gas cylinders used at distant signals last three weeks with one charge of 1500 litre gas.

False pick-up of a track relay due to a foreign current is safeguarded against by the use of a track frequency not met with among the harmonics of the traction return current. In addition, certain measures are taken to prevent the traction potential drop from reaching the local windings of the track relays. Vane relays are used only in stations where track circuits are comparatively short. On the line, only direct current track circuits with series impedances to protect the relay are used so far: the maximum length of track per relay being 1000 metres.

After getting a full clear running signal the driver is expected to observe the indications of following dwarf signals and to stop the train as soon as possible if a "stop" aspect is unexpectedly encountered. Dwarfs have no red light but a red light is shown from a main signal at the end of a route that may be passed with high speed.

The time release equipment applied to signal levers is a mechanical circuit breaker consisting of a plunger which is pressed down on turning the lever and returns slowly after the lever has been put back to normal. The detaining is accomplished on the principle used for the dial of a telephone apparatus. Detaining of the plunger by air or oil has also been tried but with less success.

The track indicators on the illuminated diagram are normally out. At big stations with signalmen constantly on duty normally dark track indicators are used with the object of making the track occupancy more apparent.

About 90 per cent of all points operated from cabins are simultaneously equipped with local control.

The **President** said that he would be lacking if he did not ask for a very hearty vote of thanks to the author for his very excellent paper.

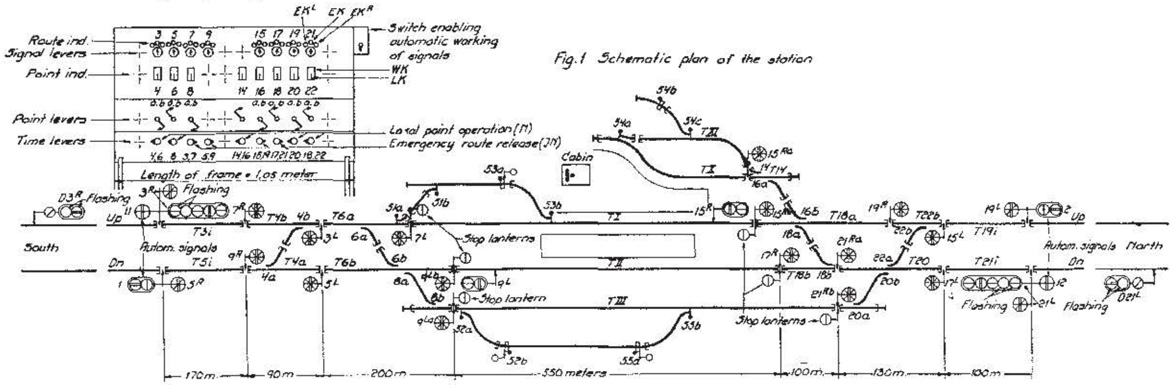
Mr. Proud had put it very admirably when he said that a much larger number of people would give the paper the attention it deserved, when it was seen by the members on being published in the Annual Journal. There was much food for thought and there was no doubt that the author had put in a remarkable amount of work in preparing his paper. He was particularly impressed that the author had transcribed the circuit work into the symbols and methods used in England, and he was sure that this was very much appreciated by the members.

The meeting terminated with the showing of two interesting Swedish films.

Modified Relay Interlocking in Sweden *(Hård)*

Fig. 2 Operating frame

Fig. 1 Schematic plan of the station



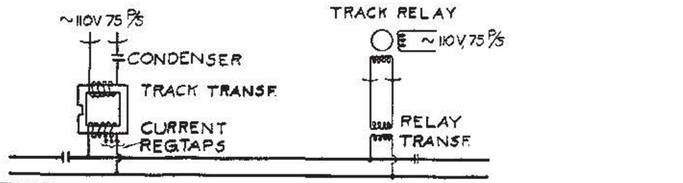


FIG 3. CONSTANT CURRENT TRACK CIRCUIT

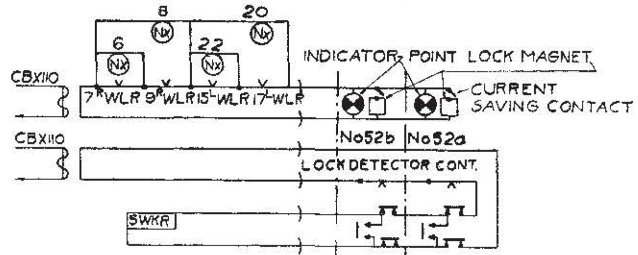


FIG 4. LOCK AND INDICATION CIRCUITS OF HAND OPERATED POINTS

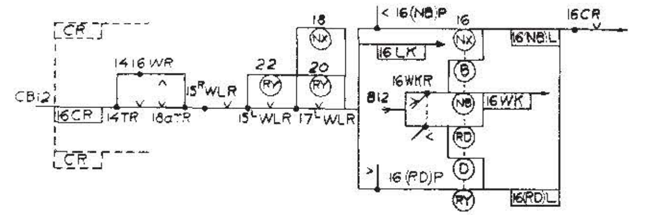


FIG 5. POINT LEVER LOCK CIRCUIT

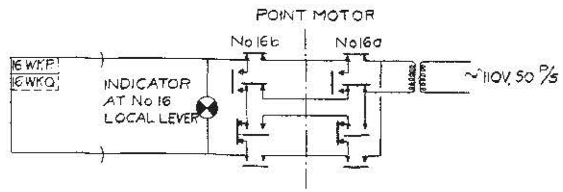


FIG 6 POINT INDICATION CIRCUIT OF MOTOR OPERATED POINTS

Proceedings 1948
Inset Sheet No. 15

Modified Relay Interlocking in Sweden (Hård)

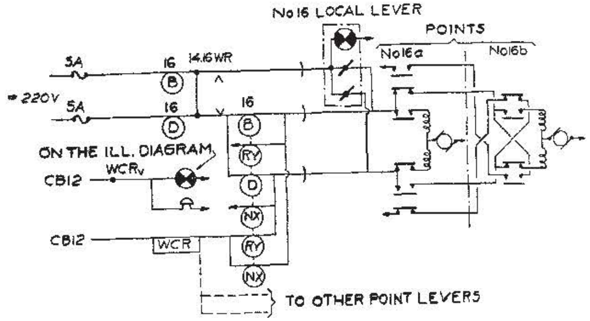


FIG 7. POINT MOTOR CONTROL CIRCUIT

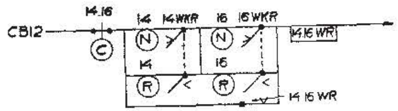


FIG 8. POINT CONTROL RELAY (WR)

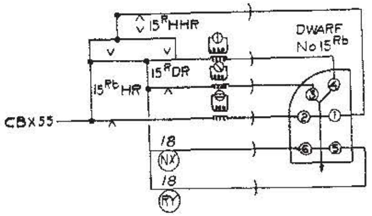


FIG 9. DWARF SIGNAL ASPECT CONTROL

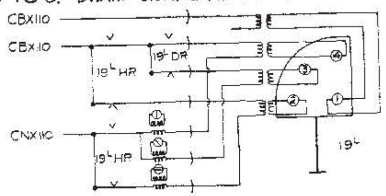


FIG 10. POSITION LIGHT ENTRANCE SIGNAL

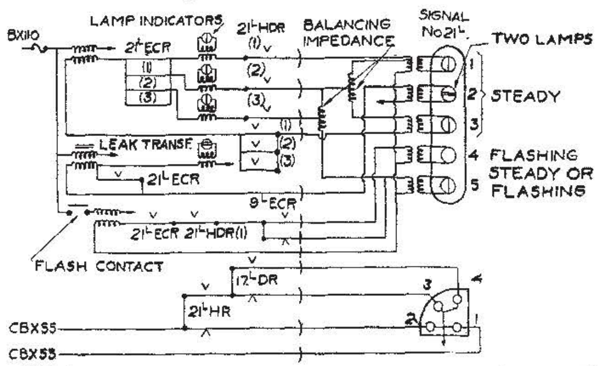


FIG 11. COLOUR LIGHT ENTRANCE SIGNAL WITH CALLING ON DWARF

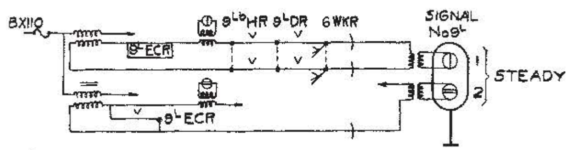


FIG 12. COLOUR LIGHT STARTING SIGNAL

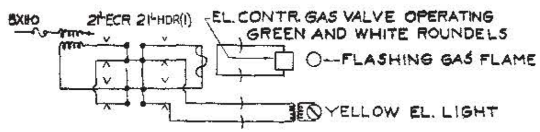


FIG 13. 3-POS SEARCH LIGHT DISTANT SIGNAL

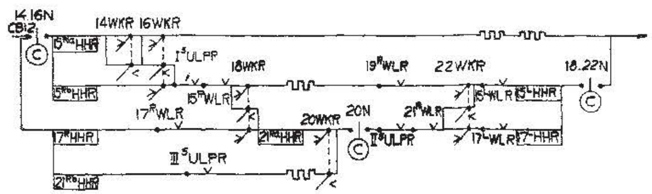


FIG 14. SHUNT ASPECT CONTROL RELAYS (HHR)

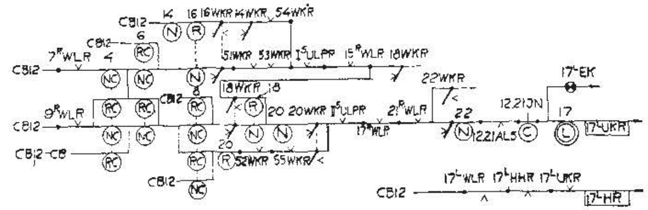


FIG 15. INBOUND ROUTE INDICATING (UKR) AND CAUTION ASPECT (HR) RELAYS

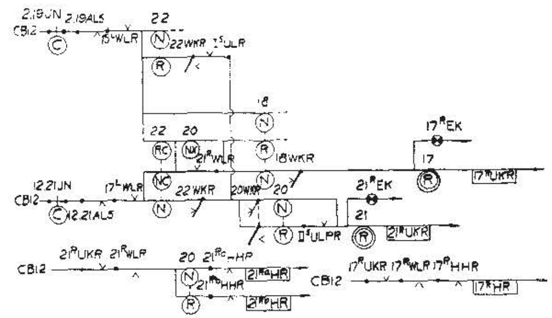


FIG 16. OUTBOUND ROUTE INDICATING (UKR) AND CAUTION ASPECT (HR) RELAYS

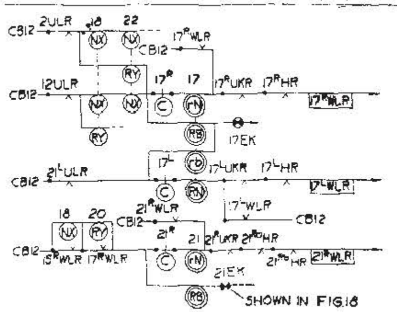


FIG 17. POINT LOCKING RELAYS (WLR)

Modified Relay Interlocking in Sweden *(Hård)*

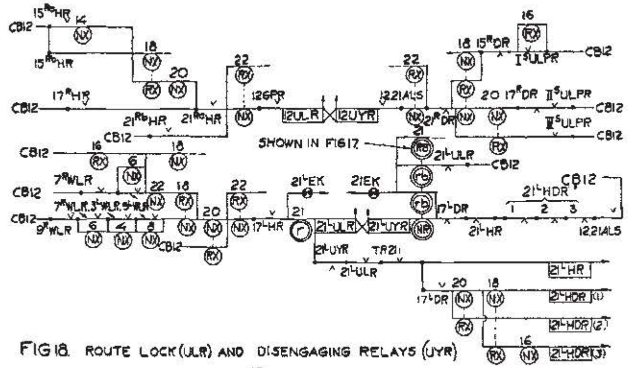


FIG 18. ROUTE LOCK (ULR) AND DISENGAGING RELAYS (UYR)

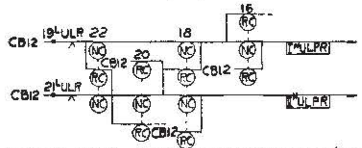


FIG 19. ROUTE LOCK REPEATER RELAY (ULPR)

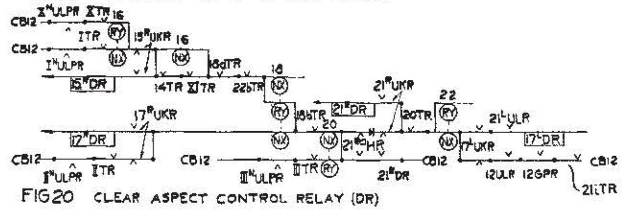


FIG 20 CLEAR ASPECT CONTROL RELAY (DR)

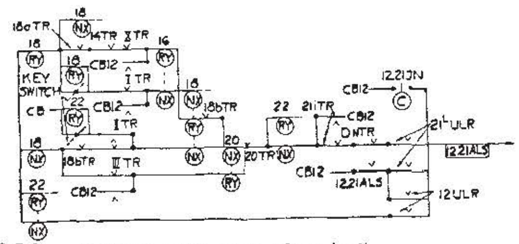


FIG 21. APPROACH LOCK STICK RELAY (ALS)