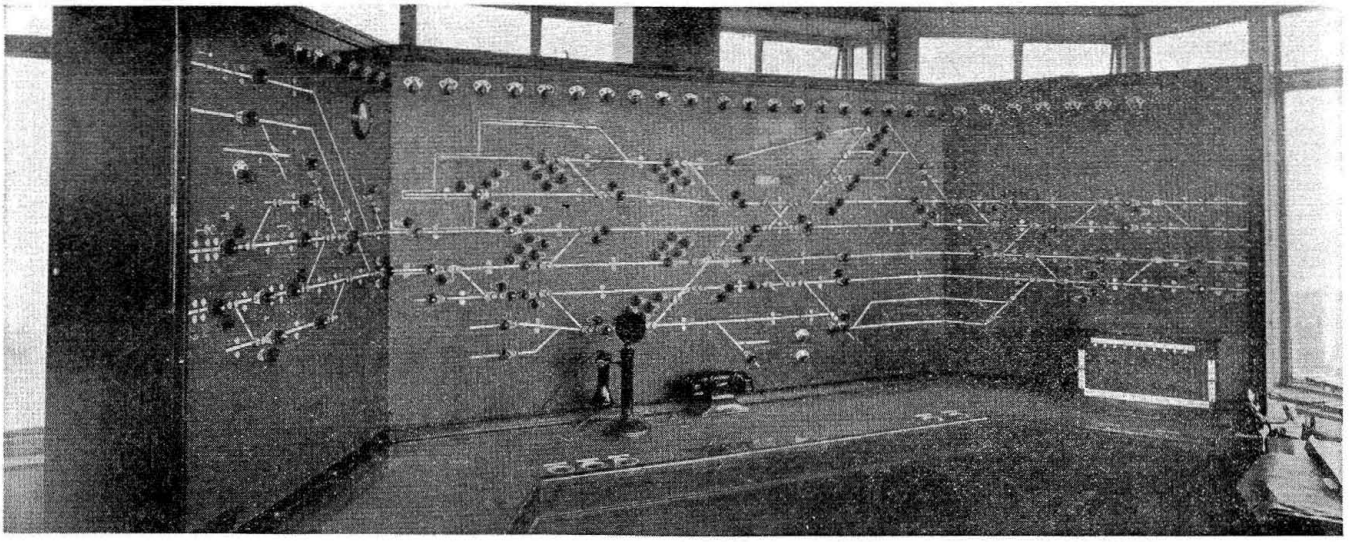
Re-Signaling the London North Eastern of England



The use of route levers is a feature of the all-relay interlocking machine at Thirsk

All-relay interlocking controlled by route levers . . . . . New series-phased track circuit applied

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THE new signaling on the London North Eastern (England) is truly a pioneer installation, and marks further progress in signaling development. It includes the first all-electric route-relay interlocking and series-phased track circuits in this or any other country. It is also the first occasion where position-white-light shunt signals have been used in this country. Other notable features are the use of searchlight signals and the approach-lighting of automatic signals. Because of the addition of tracks, involving 100 track miles, it was necessary to make extensive alterations to the right-of-way, and completely re-signal the stations and other interlockings. The original up-and-down lines between Alne and Thirsk were equipped with automatic signals of the Hall Signal Company's manufacture (installed in 1903), and the management decided to re-signal the entire section, employing color-light signals and a.-c. track-circuits.

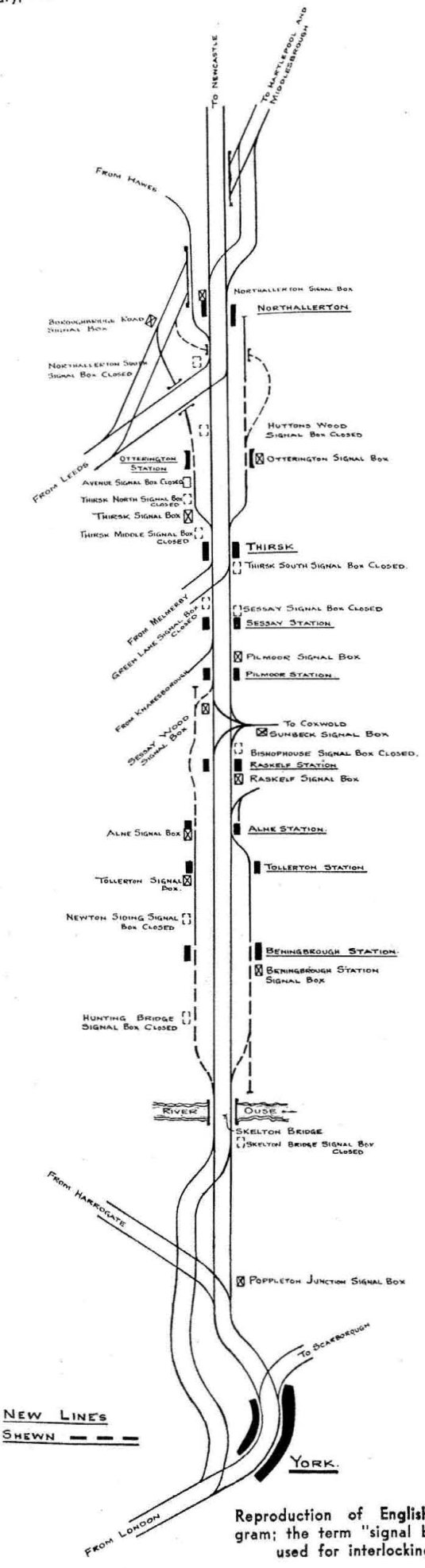
New Interlockings

In consequence of the widening, new interlocking towers were built at Beningbrough, Alne, Sessay Wood and Otterington, while the existing towers have been retained at Poppleton Junction, Tollerton, Raskelf, Pilmoor and Northallerton High Junction. At Thirsk, five existing interlockings were combined into one new plant. The Thirsk installation is believed to be the first where a combined switch-and-diagram panel, embodying the *route* system, has been employed in place of the conventional frame embodying miniature levers. It is also interesting to note that the area covered by the new interlocking extends over 4.5 miles, which is the largest in point of area so far as Great Britain is concerned. Interlockings have been abolished at Skelton Bridge, Hunting Bridge, Overton Crossing Gate Box, Newton Siding, Bishophouse, Sessay Station, Thirsk Green Lane, Thirsk South, Thirsk Middle, Thirsk North, Thirsk Avenue, Hutton's Wood and Northallerton South.

The Thirsk tower is divided into three sections. On the ground floor are two rooms, one being used as a workshop and store for the maintenance staff and also to accommodate the batteries for the operation of switches, while the other accommodates the relays used for control purposes. The combined diagram-and-switch panel is installed on the upper floor, this room being glazed all around and fitted with vita glass.

Relay Interlockings

With the exception of Poppleton Junction and Northallerton High Junction, where the existing mechanical locking frames have been retained, all the signal boxes have been equipped with relay interlockings. The arrangement at Thirsk is discussed in detail later. At the remaining plants, new mechanical lever frames of the L. N. E. R. (N. E. Area) standard pattern have been installed, the levers being employed only for the operation of switches which are within the prescribed distance for mechanical operation from the tower, and for shunt signals which are manually controlled. The operation of the color-light signals and power-operated switches and shunt signals, leading over power-operated switches,



Reproduction of English diagram; the term "signal box" is used for interlocking

is effected by means of small thumb-switches incorporated on the illuminated track diagram, the latter being placed immediately over the lever frame in the position usually occupied by the block instrument and bells. On the diagram the following indications are given:

Track circuits: No light when clear; two white lights when occupied. Color-light signals and shunt signals: One red light in the center of the switch for the normal or "On" indication; one green light adjacent to the switch for the "Off" position (yellow, double-yellow or green). Switch Indications: The actual direction of switches is given by means of a lamp behind a blue glass upon which is a black line, two separate lamps and glasses being used for each switch; that is, one lamp for normal and one lamp for reverse.

The interlocking between levers and switches is accomplished electrically, no mechanical locking of any kind being provided. Functions controlled by switches are operated through interlocking relays, and those controlled by mechanical levers are operated through a combined lever-lock and circuit-controller on each lever.

The adoption of the relay interlocking system, apart from centralized traffic control systems, is unique in this country. It should be stated that the thumb switches are not locked in any way, but are free to be turned at any time, the affected functions being inoperative unless all the controls and interlocking are such as to permit their operation. The first relay interlocking (at Sessay Wood) was placed in service in March, and the satisfactory performance of this and others has fully justified the confidence placed in this system.

At Poppleton Junction and Northallerton High Junction, color-light signals and power-operated switches are controlled in the usual manner through circuit controllers on the respective levers of the mechanical locking frame, and in these cases ordinary mechanical interlocking has been provided. A remarkable result achieved by modern signaling is that, despite the amalgamations carried out at Northallerton, and despite the additional tracks controlled from this interlocking, it has been possible to effect a reduction in the size of the lever frame, from 105 to 95 levers, of which 14 are spares.

Some of the trailing switches, over which shunting operations are not carried out (that is, switches which are used entirely in the trailing direction) have been made spring switches and are not connected to the tower in any way, but these are electrically detected and controlled by the mechanism of any switches which conflict with them. At Skelton Bridge, in the up direction and Sessay Wood, in the down direction, facing sand drags have been provided, owing to the reduced overlap available, and the special controls on the respective signals will be readily understood.

Color Light Signals

The color-light signals are of the British Power Railway Signal Company's searchlight type, equipped with 6-volt 6-watt lamps. Where a fourth aspect is required, it is given by the addition of a single-yellow aspect mounted directly over the main signal. This additional aspect comprises a containing case fitted with a yellow lens but not provided with a reflector, so that there is no possibility of a phantom indication. To compensate for the lack of a reflector, this aspect is given by a 12-watt lamp, which gives a beam intensity approaching that of the searchlight type.

The signals display three or four aspects, as required, the indications being as follow:—

Three-aspect signal: Red—Stop; Yellow—Caution, be prepared to stop at next signal; Green—Proceed.

Four-aspect signal: The above, with the addition of: Double-yellow—Proceed, prepared to pass next signal at restricted speed.

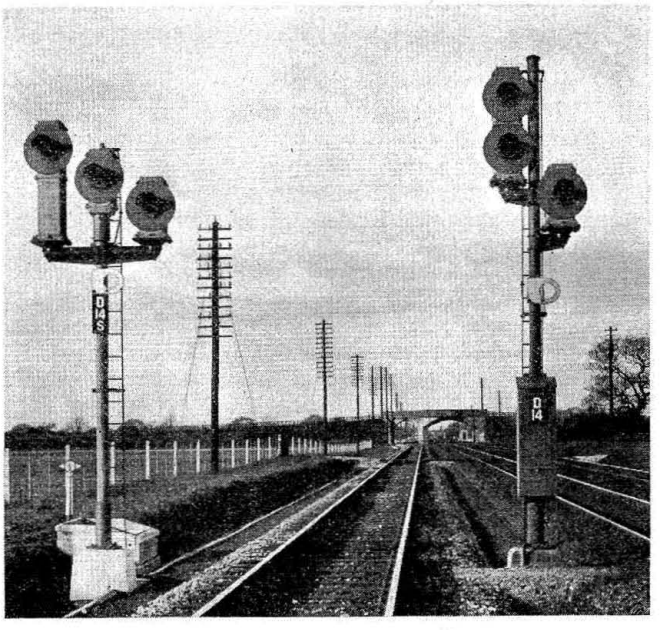
An interesting feature of the signaling is in the application of the fourth aspect, that is, the double-yellow. This is employed as follows: (a) To give enginemen the necessary warning that the signal ahead, showing a single yellow, is not located at braking distance from the second signal ahead showing red. (b) To give the necessary warning, at the signal in the rear of a junction signal, that a speed restriction is necessary over the junction.

The use of the double-yellow aspect under (b) has had an important effect in speeding up traffic, while giving the necessary warning to enginemen. On some sections this warning has been given by retaining the junction signal at red until the outer signal has been passed; thus an engineman was given no indication as to whether he had a clear run through the junction, and the adoption of the double-yellow at these locations has solved the difficulty in a satisfactory manner.

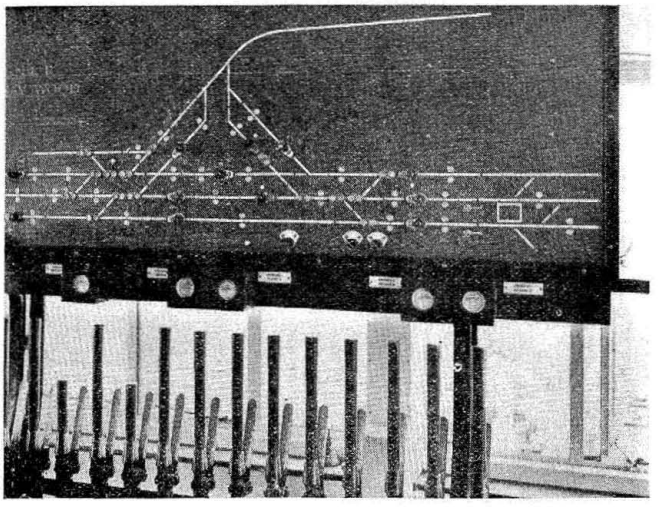
To avoid multiplicity of lights where slow speeds are prevalent, route indicators of the multi-lamp type are employed. They consist of a series of lamps fitted behind a yellow-tinted cover glass, which has been found to prevent the effects of glare and sunlight.

Approach Lighting of Color-Light Signals

Where approach-lighting is employed, the signal lamps are normally extinguished, and are lighted only on the entrance of a train into the approach section. Immediately after the rear of the train has passed the signal, the indication is extinguished and remains so until the entrance of the next train into the approach section. The North Eastern Area was the pioneer in the matter of approach-lighting so far as England is concerned, the first installation being made in 1928, between Eryholme and Black Banks. The advantages of and necessity for approach-lighting in locations where no power supply is available, are self-evident, but the query may be raised: why adopt approach-lighting where a cheap and reliable power supply exists? There are two reasons why approach lighting is desirable under such circumstances. One is that much longer lamp life is obtainable, even taking into account the fact that the lamps can be burned at greater brilliancy than is obtained with a continuous-lighting system. This results in a much better maintenance, as failures due to burn-outs are considerably minimized. The second reason is that, with approach lighting, the only signals illuminated are those required by the trains themselves. On a long, straight stretch of track, if an engineman sees only the signal immediately ahead illuminated, it certainly makes for simplicity and has a certain psychological effect on the engineman, as the signal he requires comes into view only at the moment it is required. At interlockings, however, continuous lighting of signals has been adopted, as interlocked signals are in a different category than automatic signals. It is essential in the case of interlocked signals that the signalman should have a constant indication as to the aspects displayed by the signals under his control.



Searchlight signals are used . . . View shows "down" signals at Bishophouse near Sessay Wood



At Sessay Wood the control board, including the track diagram and route lever control of signals, is mounted above the mechanical levers for the switches

The shunt signals are of the position-white-light type, and their use is also an innovation so far as this country is concerned. Two horizontal white lights are shown for the normal or stop indication, and two white lights inclined at 45 deg. to the horizontal for the "off" or proceed indication. With white lights used for shunting signals, the use of red, yellow and green lights is confined to running signals. Therefore, enginemen of through trains can concentrate entirely on the aspects given by the running signals, without being confused by a multitude of similar colors in the shunt signals which may or may not be applicable. The position-white-light shunt signal solves the difficulty heretofore experienced with shunt signals in color-light territory, renders the engineman's task much less burdensome, and paves the way for the adoption of ground-type color-light signals at complicated interlockings. The lenses are specially etched to produce a light as near as possible to lunar white. The lamps employed are the 110-volt, 25-watt, pearl type, gas-filled, and are arranged so that they can be switched out when not required. At night time, it has been found advisable to reduce the voltage to about 45 in order that the indication shall not be too brilliant. Although the position-white-light shunt signal has recently been adopted in the United States, South Africa and certain European countries, the installation under notice is the first in this country.

Auxiliary Lights and Identification Plates

In the case of purely automatic signals, a red auxiliary light and an enameled "A" sign are provided. The latter

comprises a white letter "A" on a circular black background. Both the main and auxiliary lamps are approach-lighted, but the auxiliary light functions only when the main lamp has failed. No auxiliary lights are provided at junction signals, for, if one lamp should fail, the remaining lamp or lamps will serve to locate the signal. In the case of permanently-controlled single signals, an auxiliary light is provided, which functions only on the failure of the main lamp. In the case of single semi-automatic signals not continuously controlled, two auxiliary lamps are provided. One of the auxiliary lights is arranged to display an illuminated white "A" when the signal is at Stop, irrespective of the main signal lamp when the signal is being operated automatically; the other auxiliary lamp functions when the main signal lamp fails. Experiments are being made with double-filament lamps, and, if these experiments are successful, it is hoped to dispense with all of the red auxiliary lights.

The scheme of numbering the signals is as follows: The prefex "U" or "D" is employed, according to whether the signal is located on the "up" or "down" line, and the number of the signal corresponding to the mileage of the signal from York, thus U21 implies the signal is in the twenty-first mile from York on the "up" line. Where signals are located on slow lines, the same numbering aspect is adopted, with the addition of the suffix "S" for the slow line.

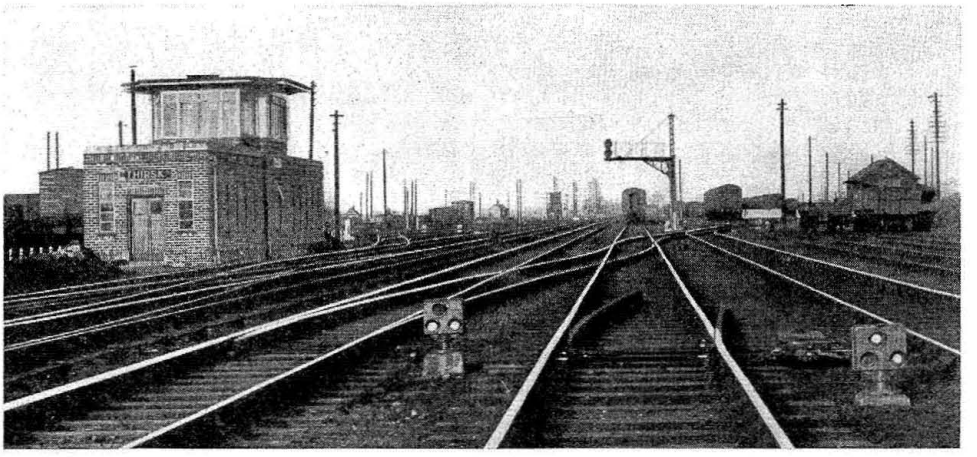
Power Supply

Power is obtained at Tollerton and at Thirsk, at 11,000 volts, 50 cycles, single-phase, and is transformed down to 660 volts at each signal location. The supplies are not in any way interconnected, the Thirsk supply feeding in the southern direction as far as signal D16B and that from Tollerton northward. An emergency power plant is provided at Tollerton and Thirsk and consists of an Aster gasoline engine directly coupled to a G. E. C. alternator, with an exciter and voltage regulator on the same shaft. Each set is capable of delivering the full load normally taken from the main supply, at that point. The engine is arranged to start up automatically within six seconds, in the event of the main supply failing, and will continue to run, even though the power be restored, until stopped by hand. This arrangement compels the lineman on duty at the time to visit the engine after it has been running and to give it any attention required.

The 660-volt cable is of the usual type for twin conductors, that is, it is lead-covered, paper-insulated, armored and taped throughout. Multi-core cable of similar construction contains the control and indication circuits. These cables are buried about 18 in. underground, alongside the line, throughout. This main cable is tapped at each interlocking and at each signal location, and is transformed down to 110 volts for operating the relays, signal mechanisms, etc. In addition, at each tower a metal rectifier is provided, giving 25 volts and 12½ volts, direct current, for the operation of the electric locks, interlocking relays, etc.

Track Circuits

Here again, a radical departure has been made from existing practice. In all previous installations, either in this country or elsewhere, the fundamental principle of the track circuit has been that a train occupying the track



View of Thirsk interlocking, showing, in the foreground, the position-white-light shunting signals

circuit shall divert sufficient current from the track relay to cause it to be de-energized. In this installation, two new types of track circuit have been installed one of which is considered to be a marked advance. In one type the arrangement of the apparatus conforms to the generally accepted practice. In the other, the relay is placed in series with the track feed at the feed end of the

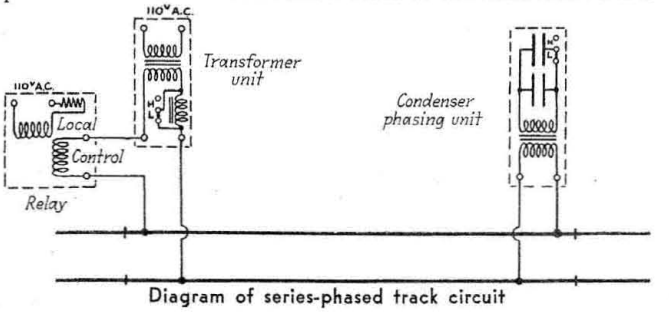


Diagram of series-phased track circuit

track, and a small transformer is connected at the remote end of the track, the primary of this transformer being connected to the track and the secondary to a small condenser. In the first type, not only is advantage taken of the train diverting sufficient current to shunt the relay, but also of the phenomenon of phase displacement, so that the imposition of the shunt across the track results in an alteration in the phasing of the currents traversing the track and local windings of the relay. The relays employed are of the quadrature type, but instead of the phasing being set at 90 deg., the angle is considerably less than this, so that the imposition of the train shunt still further decreases this angle, resulting, in some cases, in a reverse torque being obtained and in the relay vane being pulled down electrically, thus improving the train shunt. (Where a track relay is not located at the end of the track circuit, but is located some distance away,

instead of providing a line relay, as has been usual, a step-up transformer is fitted, at the end of the track, giving about 35 to 40 volts across the secondary, thus permitting the relay to be near the function which it controls.) In the second type of track circuit, the relay track winding receives more current when the track is shunted than when the track is clear, which is opposed to all previous conceptions of track circuit operation. Reliance is placed entirely on the phase shift produced by the imposed train shunt. Thus, as far as is known, this is the first application of this arrangement in this or any other country. The employment of the phase shifting properties of the circuit has resulted in a more efficient circuit, and in a considerable economy in installation costs, and represents a decided advance in the science of the subject.

The overlap track circuit ahead of each signal is 400 yds. in length, and the use of a step-up transformer for the "berth" track enables the relay to be located at the rear signal without the use of special heavy line wires. The berth track circuit is fed in the usual manner through the overlap track ahead, and, by this combination, the testing and tracing of faults at the signal itself is rendered very simple. All overlap-track-circuit relays are wired as stick relays, in order to prove that the signal mechanism has gone to red on each occasion that a train has occupied the overlap track circuit.

Route Relay Interlocking at Thirsk

The panel of the control machine at Thirsk is built in three sections, the side panels making an angle of 135 deg. with the center panel; the length is 12 ft. overall. If an ordinary power frame had been employed, this would have meant a frame of 170 miniature levers, occupying at least three times the size of the present panel, and, what is very important, an increase in operating staff.

The adoption of the relay interlocking is quite a radical departure, as far as England is concerned, but when one considers the developments in signaling during the last few years the introduction of the relay interlocking appears to be quite a natural development. As far as power signaling is concerned, progress in recent years has been concerned with the elimination of the mechanical interlocking, and, this having been accomplished, there appears to be no reason for the retention of the miniature lever. Tradition, however, dies hard, but it is anticipated that experience gained by the Thirsk installation will fully confirm the accuracy of the above statement. If the sphere of control at interlockings is to be extended appreciably—and no doubt this is the tendency of modern signaling development—then the power frame with the miniature levers as we know it today will have to make room for something much more flexible and convenient from an operating point of view.

It should be emphasized that, apart from the combined panel-and-diagram replacing the conventional miniature power frame, the interlocking and circuit arrangements are similar to those at the usual power interlockings and quite different from what is known as centralized traffic control. The route principle has been adopted at Thirsk; that is to say, instead of separate "switches" (levers) being provided for each individual function, switches are provided for each route, and the operation of a "switch" actuates the whole of the functions required to set up that particular route including the appropriate signal.

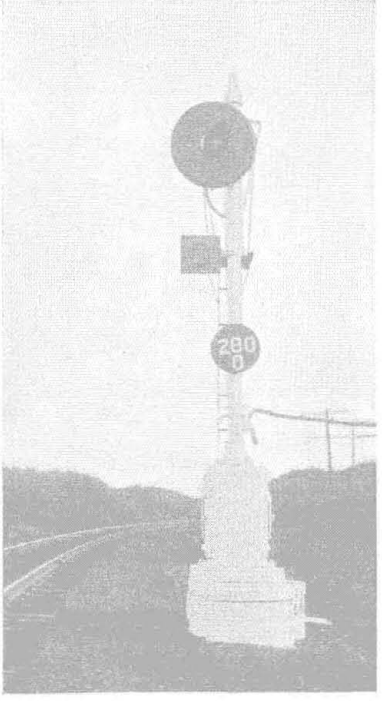
In one case, which shows the flexibility and labor-saving accomplished by the system, it may be mentioned that one "switch" operates seven sets of "points" and one signal, the total time being six seconds. This means that, for this particular function, the towerman has only one movement to make, instead of eight. Another advantage of the route system is the simplification rendered possible in the interlocking circuits. In fact, it may be said with every confidence that the introduction of the relay interlockings, with route signaling where necessary, has considerably enlarged the field whereby modern signaling can be employed to effect further economies from an operating point of view.

Along the top of the panel are provided emergency switches (levers) which enable switch points to be worked individually, either in case of failure or whenever it is necessary to make abnormal traffic movements which are not signaled. The electric controls of signals and switches are in accordance with standard practice of the North Eastern Area, direct-track locking being employed in the switch circuits; in addition, all of the signals are approach locked.

The power for the operation of this interlocking is obtained by means of oil-filled step-down 16-kv.a. transformers, in duplicate, located in the under portion of the tower; these transformers step down the voltage from 660 volts to 110 volts. The necessary power for the operation of the switches is obtained from a battery of nickel-cadmium cells, trickle charged from metal rectifiers, the rectifiers being fed from the 660-volt a-c. supply. Rectifiers in duplicate are also provided for converting the 110 volts a-c. to 25 volts d-c. for operation of the lock relays, etc. A separate transformer is provided for supplying power for the indications on the panel, this being connected to the 110-volt a-c. supply and arranged to provide 4 volts across the lamps.

In accordance with standard practice, emergency torpedo machines are fitted at each interlocking throughout the widened zone, those at Thirsk being operated electrically by means of small switches on the panel.

The contractors for these installations were the British Power Railway Signal Company, and, allied as sub-contractors, were the Siemens & General Electric Co. and Messrs. Siemens Bros., Woolwich. The railway company's interests were cared for by my chief, Mr. Miller, my colleagues and myself.



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