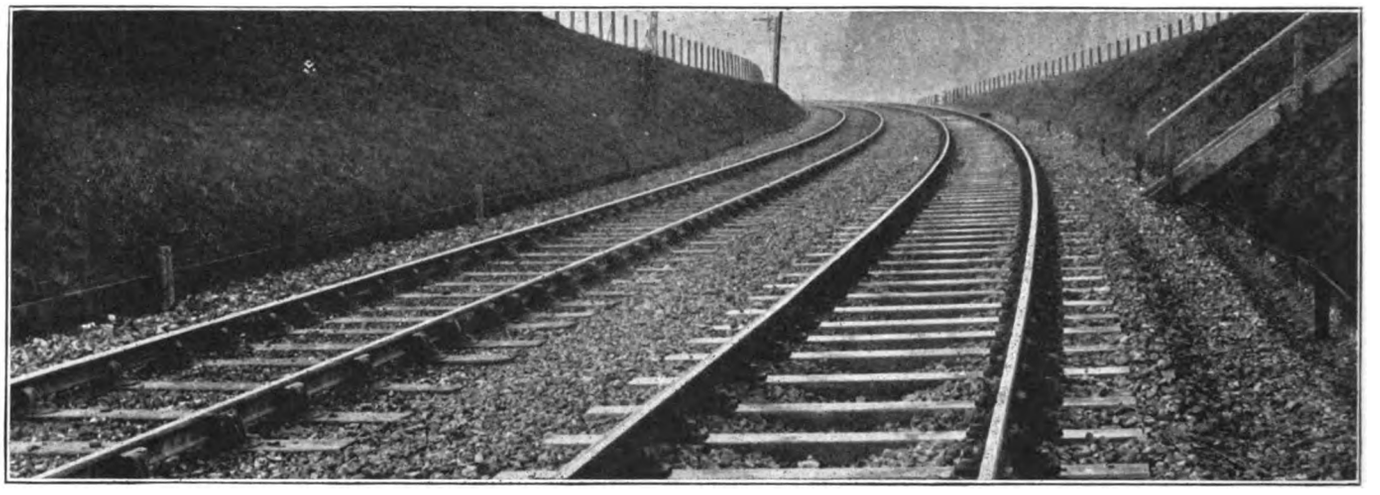


An English Roadbed

Block Signaling Practice on a British Railway

Use of Track Circuits, Signal Repeaters and Lamp Indications—Position of Arm Shown While Pyrometer Indicates if Lamp Is Lighted

By F. B. HOLT and A. B. WALLIS, Derby, England

THE use of track circuiting, signal repeaters, signal light indications, train waiting apparatus and tunnel alarms on the Midland Railway of England is described in this article, which is the second of three covering the block signaling practice on this road. The first article appeared in the May number of the *Railway Signal Engineer,* on page 159, and was descriptive of the ordinary and interlocking, single and multiple line block.

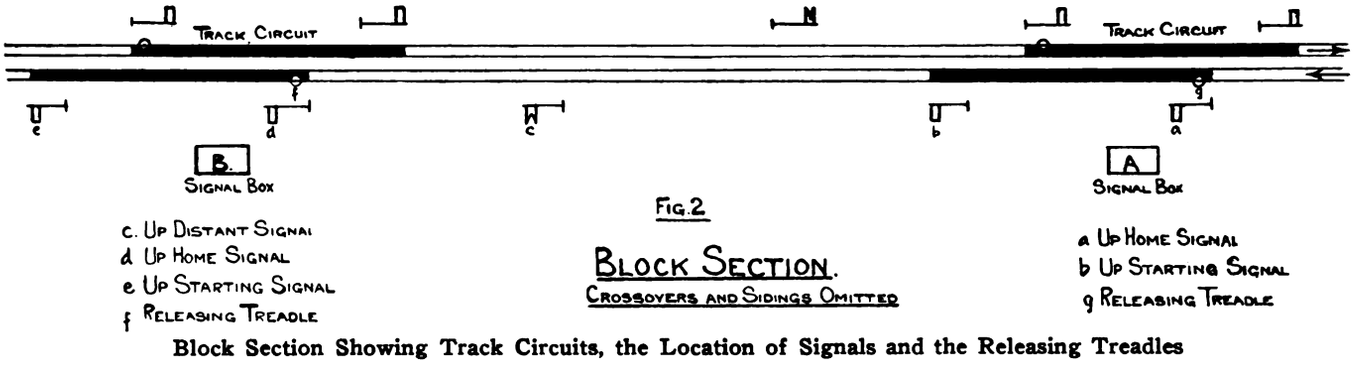
Track Circuiting

The primary object of the track circuiting installed on the Midland Railway is to protect engines or trains at a starting or advanced starting signal. The track circuit commences at the home signal and extends from this point to 10 yd. beyond the starting or the advanced starting signal where such is provided. A train passing the home signal enters the track circuit, thereby locking the home signal, and this lock is maintained until the whole of the train has passed the starting or the advanced starting signal. It will be seen that, by this combination of track circuiting and interlocking block, any train has always at least one locked signal in the rear. Before the block is released by means of the train passing over the treadle, the train has locked the home signal by means of the track circuit and before this signal is again free, the starting signal will be locked by means of the block. Figure 2 illustrates the arrangement of signals and circuits.

The starter track circuits are always arranged to lock the home signal in the rear, and in addition usually lock any other signal admitting a train towards the starting signal. In a few special cases the starter track circuit also locks the block instrument handle in the "Train on Line" position. This prevents the signalman moving the block handle to the normal position until after the whole of the train has cleared the track circuit.

In addition, the track circuit is used in some cases to control the ordinary block apparatus. The track circuit is installed for a length of 200 yards outside the home signal. Track circuit "Occupied" will move the block indicator needle to the "Train on Line" position irrespective of the position of the drop handle of the block instrument, and will maintain the needle in that position until the track is "Clear," and the block instrument movements have been carried out in proper sequence.

Track circuits are also installed at outer home signals. These signals are provided where necessary at a point 440 yd. outside the home signal. Such track circuits do not lock any signal, their only function being to indicate



Block Section Showing Track Circuits, the Location of Signals and the Releasing Treadles

to the signalman the presence of a train standing at the signal.

All the foregoing track circuits are very simple ones, but at junctions the problem is more complicated. A description of the track circuiting suggested for a junction will serve to show the latest arrangement of such

track circuits. It should be understood that track circuiting schemes in use extend from the simplest possible through all the stages to the scheme as illustrated. The four starting signals are not shown, but in each case the track circuit is taken 10 yd. beyond each starting signal.

The Midland track circuits generally follow American practice, but the details, such as bonding, insulated rail joints, etc., are adapted to suit the Midland permanent way. The whole of the track circuits on the Midland Railway are d. c. circuits.

Track Relays. Batteries and Line Relays

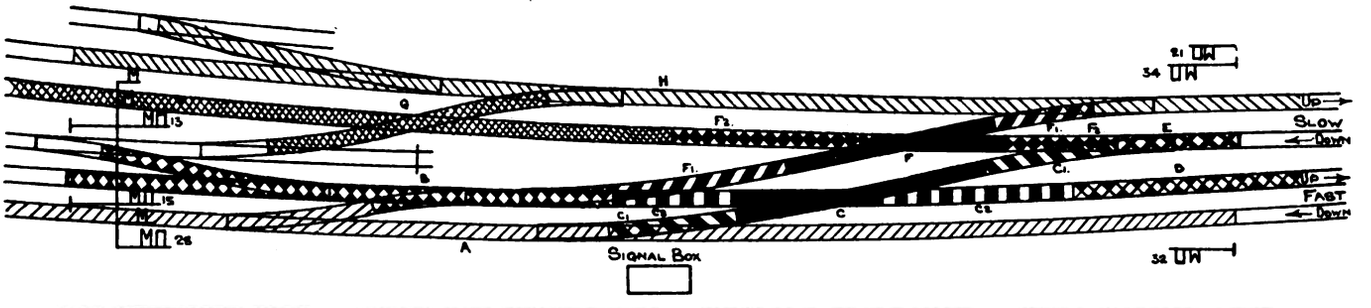
The standard resistance is 9 ohms, as this is found to be the best average value. At the present time there are 644 track circuits and 990 track relays are in use on them. About 400 of these are of American manufacture, the remainder being of British manufacture. All the relays give satisfactory service with a slight advantage in favor of the American relay. On these it is found that the adjustment values of the pick-up and the drop away point remain constant for a longer period than is the case with the British relay. The normal voltage across the relay is .5 volt, and the relay will drop when the voltage is reduced to .22-volt, and will pick up when the voltage is .36-volt. In connection with the track adjustments the object is to attain one ohm as the maximum shunt to drop the relay.

Line relays are only used in connection with track circuiting at junctions. At such places any one of the track circuits may form an item in several locking combinations. The line relays are fitted in the tower, one relay for each track circuit. Each relay is capable of operating six local circuits. The resistance of the line relay is 700 ohms, and the normal working current is 14 milliamperes. The adjustment is that the relay must pick up with a current of 10 milliamperes, and fall when it is reduced to 4 milliamperes. The type of battery used for the operation of track indicators, locks and line relays is the ordinary Leclanche Battery. Although not usually considered a constant battery, it is constant at the very low rate of output required for this purpose.

Track Indicators and Locks

All the track indicators are two position instruments giving the "Track Circuit Clear" indication when energized by current, while the "Track Occupied" position is obtained by gravity when the circuit is de-energized. The special feature of these indicators is that the indicating flag floats in the "Clear" position. This removes the possibility of the flag sticking to the stop pin and giving a false clear indication. The resistance of the indicator coils is 1,000 ohms, and the normal operating current is 6 milliamperes.

The track lock is similar to the starting signal lever



No	Name
13	Up Slow Home
15	Up Fast Home to Slow
21	Down Slow Home
28	Up Fast Home.
32	Down Fast Home
34	Down Slow Home to Fast

Track		Track	
A		E	
B		F	
C		F1.	
C1.		F2.	
C2		G	
D		H	

Lever	Locked By
13	F(Up). F1. H
15	B.C(Up).C2.F(Up).F(Dn) F. F2. H
21	C(Dn).C1. E.F(Up).F(Dn).F1. F2. G
28	B.C(Up).C(Dn).C1. C2. D.F(Up).F1.
32	A.C(Dn).C1.
34	A.C(Up).C(Dn).C1.C2. E.F(Dn). F2.

Track	Locks	Track	Locks
A	32·34	E	21·34
B	15·28	F(Up)	13·15·21·28
C(Up)	15·28·34	F(Dn)	15·21·34
C(Dn)	21·28·32·34	F1	13·15·21·28
C1	21·28·32·34	F2	15·21·34
C2	15·28·34	G	21
D	28	H	13·15.

Fig. 4.

Junction Track Circuiting.

Track Circuits as Used at a Junction Point on the Midland Railway

All track circuits over 500 yd. in length are sub-divided as may be necessary to ensure that the length of any one section does not exceed this distance. In some cases the relays are connected on the "Cut Section" method, but the general practice is to carry the line through each of the relays in series.

The soda cell is in general use on Midland track circuits. Two cells, each of 300-ampere hour capacity, are connected in parallel on each track circuit. The life of these cells varies from 3 months on a 500-yd. track circuit with crossover and siding connections, to 9 months on an outer home track circuit. Taking the average of all the Midland track circuits the output of the track battery is almost exactly one kilowatt hour per year. Gravity and storage cells have been used, but the soda cell is found to be the most economical. Storage cells are in use on some of the automatic signaling track circuits, but as these are charged in position direct from the signal mains, the problem is entirely different to their use on track circuits which are far from any electrical power supply, making it necessary to transport them.

lock used in connection with the interlocking block, and is connected to the signal lever in a like manner. The bolt is held out by current, and, as in the case of a simple track circuit, the lock is connected in series with the track indicator; the resistance of the coils is 1,000 ohms, and the operating current is 6 milliamperes. The adjustment of the lock is: the bolt must lift with a current of 4 milliamperes, and fall when the current is reduced to 1 milliampere. As the normal current is 6 milliamperes with track "Clear," and nil when the track is "Occupied," this adjustment gives a fair working margin.

Crossing Track Circuit and Release Keys

One special feature of Midland track circuiting is the crossing track. Referring to Fig. 4, it will be seen that trains in both directions pass over track circuit *C*. An Up fast train on this track circuit must lock signals 15, 28, 34, but a train crossing from the Down slow to the Down fast line must lock signals 21, 28, 32, 34, and these conditions must also obtain if a single car is brought to a stand on the diamond crossing, either on the Up fast line

or the Down slow to Down fast line. This can only be attained by a departure from pure track circuiting, that is, track circuiting which is operated by one pair of wheels. In this case, four wheels are necessary. All sections of track circuit *C* lock 28 and 34, which are common to both combinations, but a car passing on to the Up fast line will, when entering section 1, lock 15, 28, 34, and when astride the insulated joint between sections 1 and 2, bring in the auxiliary relay, which will maintain this locking when the car is entirely on section 2, and also, until it has moved clear of section 1, passing off the track either in the forward or the reverse direction. Similarly, a car passing from the Down slow to the Down fast line will lock 21, 28, 32, 34, and when in section 2 will maintain this locking, which holds until the vehicle has moved clear of section 3, and this movement may also be in either direction. The principle of the crossing track will be seen by following the connections in Fig. 5.

In this case the problem is to lock signal 32 when an engine is on the Down line portion of track *B* (*B* (*Dn*) in table), but not to lock this signal when an engine is on the Up line portion of this track (*B* (*Up*) in table).

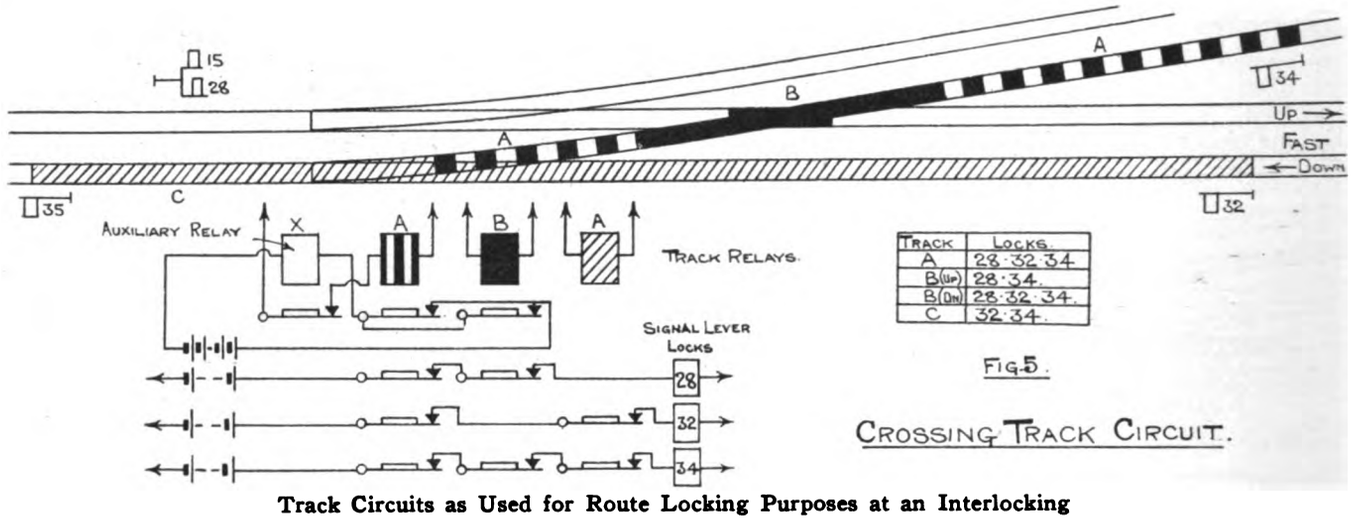
An engine on the Down line passing from signal 34 to signal 35 will, when on track *A*, lock signals 28, 32, 34, and when passing from track *A* to track *B* will, when both track relays are in the dropped position, break the circuit of the auxiliary relay *X*. This will maintain the locking 28, 32, 34, when the engine is entirely on track *B*. The circuit of the auxiliary relay *X* can only be restored by the engine passing clear of track *B* and also of track *A* in either direction. An engine passing signal 28 and proceeding on the Up fast line, will, when on track *B*, only drop relay *B*, thereby locking 28, 34, and leaving 32 free. It should be understood that in Fig. 5 only that portion of the track circuiting involved in the differential locking of signal 32 is shown.

Emergency release keys are provided, one for each track lock. In each case these are sealed, and it is necessary for the signalman to break the glass front before he can use the release. In the case of track locks, the only circumstance in which the release key may be legitimately used is during a track circuit failure. The conditions operating in connection with the interlocking block do not apply, and the general opinion of the engineering staff is, that the release keys in connection with track locks should be abolished.

Rule 55

Rule 55 of the General Rules and Regulations deals with the protection of trains detained at home, starting or advanced starting signals. In such a case either the brakeman, switchman or fireman must go to the tower to remind the signalman of the position of the train, and remain there until the signalman can give permission for the train to go forward. Details are given as to which particular person this duty devolves on in practically every conceivable case.

One very desirable result of the provision of interlocking block, track circuiting and train waiting apparatus is the abolition of Rule 55 in connection with trains detained at home, starting or advanced starting signals. As the work proceeds, the signals exempt from this rule are given in the weekly notice, to all concerned with the working of traffic, but as more than 1,200 signals are now exempt, the practice in addition to the notice is to provide a sign at each signal. The sign for signals exempt by interlocking block or track circuiting is of sheet iron, diamond shaped, and enameled white, fixed on the signal post immediately under the semaphore arm. In the case of signals exempt in connection with train waiting apparatus, a similar sign "D" shaped is fixed under the semaphore arm.



Track Circuits as Used for Route Locking Purposes at an Interlocking

Again referring to Fig. 2, it will be seen that a train proceeding or standing on a running line will always be protected by at least one locked signal in the rear. In addition, the signalman has an indication of the position of the train by the block needle indicator when the train is passing through the section or standing at the home signal, and by the track circuit indicator when the train is proceeding from the home signal to the starting signal, or when standing at the starting signal. These factors enable the rule to be abolished where interlocking block and track circuiting is in use.

Signal Repeaters

Repeaters are installed in connection with signals which are out of sight of the signalman. The repeater is fixed on the front edge of the instrument shelf, immediately above the signal lever which operates the signal. Three indications are given, signal "Off" (clear) or signal "On" (stop), both positive indications by current, and an intermediate position "Failed" by gravity and the absence of current.

A two-way switch is fixed on the signal post, and is directly operated by the semaphore arm. Midland signal arms are arranged to stand horizontal in the "On" position, and to fall to an angle of 45 deg. in the "Off" position. The "On" contact is arranged to break circuit when the arm falls 5 deg. from the horizontal. A battery of two Leclanche cells is fitted at the signal, one in

the "On" circuit and one in the "Off" circuit. The resistance of the coils is 200 ohms, and the normal working current is 6 milliamperes. Although the Leclanche cell is usually considered best suited for intermittent working, it is at this low output quite constant and quite free from polarization. The indicating needle is not provided with stop pins. The needle is weighted to fall to the central position, and a current of 6 milliamperes is just sufficient to hold the needle floating in the correct position. This arrangement removes the possibility of the needle hanging against the stop and giving a false indication. The wire connection between the signal lever and the signal expands and contracts in accordance with the changes of temperature, and close attention to the action of the signal repeater enables the signalman to correctly adjust this wire by means of the mechanical regulator which is provided in each signal wire at the signal tower.

Repeaters are also provided when a signal is controlled from one tower and operated from an adjacent one. In such a case the repeaters will indicate the position of the "Control" or weight bar.

Signal Light Indicators

Signal light indicators are also installed in connection with signals which are out of sight of the signalman. The indication is both visible and audible. This is effected by means of a pyrometer or expansion bar. This bar is provided with an electrical contact normally broken by the pressure of the steel wire which is in the brass expansion tube.

This expansion tube is fitted in the signal lamp immediately above the flame, and is so adjusted that when the light is burning properly, the heat from the flame is sufficient to expand the brass tube, and as the steel wire only expands roughly as 5 to 8, this difference is sufficient to slightly withdraw the steel wire from the contact lever, allow this to close the circuit, and indicate light "In." The indication is, therefore, directly controlled by the presence or absence of the heat of the flame, but as the heat and the light of the flame always maintain a fixed relationship, the indication is in practice as positive as an indication direct from the light alone, even if this were possible. As the indicator is held to the light "In" position by current, a switch is provided to enable the signalman to switch the current off during the hours of daylight when the signal lamp is not burning and no indication is necessary.

When several signals are fixed near to each other, as on a bracket pole or bridge, it is usual to connect the respective expansion bars on these signals in series and connect them to one indicator. If a signal light goes out, the circuit is broken at the expansion bar, and the indicator flag falls to the "Out" position by gravity. This closes a local buzzer circuit and thereby gives audible warning of the failure. When several light indicators are provided in one tower, the buzzer circuit is connected in parallel to each of the indicators. The resistance of the indicator coils is 200 ohms and the normal working current is 12 milliamperes.

Train Waiting Apparatus

This apparatus is provided at home signals on lines of lesser importance. A cast iron pillar is provided near the signal pole, and when a train is detained at the signal, the fireman presses the plunger operating a buzzer in the tower and also causes the indicator to show "Train Waiting." The indicator flag in this position closes the circuit to operate a small electric horn at the pillar. This indicates to the fireman that the apparatus in the tower has operated as required. In addition to the "Train Waiting" indication, one of the three following functions is also arranged to be carried out as required by local circumstances:

(1) The needle of the block instrument is electrically held in the "Train on Line" position until the home signal lever has been cleared and again restored to the normal position.

(2) The distant signal lever is locked in the normal position until the home signal lever has been cleared and again restored to the normal position.

(3) The "Train Waiting" indication is maintained until the home signal lever has been pulled off and again restored.

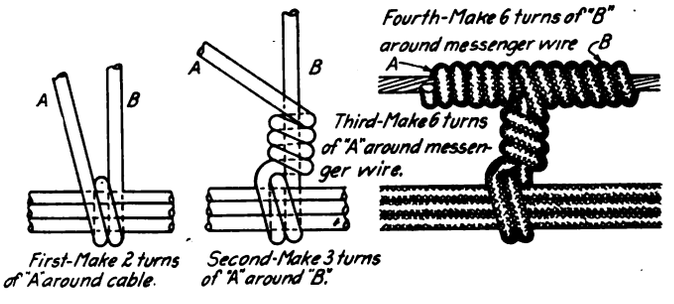
Tunnel Alarms

This apparatus is provided in connection with six tunnels on the Midland Railway. In each case the object is to enable the brakeman of a train to immediately give a continuing alarm in the tower at each end of the tunnel in the event of a train coming to a stand in it, or of the line being unsafe from any cause. The apparatus at each tower consists of a needle coil to indicate the current, and a relay normally held up by current, closing a local bell circuit when the line circuit is broken. The line is a continuous insulated conductor fixed on the wall of the tunnel on the Up side of the line and returning on the Down side.

By this arrangement the brakeman can, in case of necessity, cut the line at any point in the tunnel and thereby cause the alarm bell in each of the towers to ring continuously, and the indicator needle to fall to "Tunnel Blocked." After the alarm is given the signalmen must not allow any ordinary traffic to enter the tunnel on either Up or Down lines until after they have been informed in writing that the line is clear. The signalmen test these alarms twice daily, giving the ordinary test signal by means of a plunger contact which short circuits the lines and apparatus to a value below that sufficient to cause each relay to drop. The normal working current of these alarm circuits is 22 milliamperes. A soda battery is used, and this will give satisfactory service for about 18 months without attention other than a periodic inspection and voltage test.

A COPPER CABLE HANGER

AERIAL cables supported from messenger wires requires some means of hanging. The illustration shows a method adopted by the Illinois Central for accomplishing the purpose. The scheme used consist of applying a piece of insulated copper wire of the proper



Method of Attaching Cable Hangers

length to permit two turns being made around the cable, three turns around one end of the hanger and six turns of each end of the hanger around the messenger wire. This type of cable hanger provides for a use of the short lengths of wire that may be left over from construction or maintenance jobs, that otherwise would be scrapped.