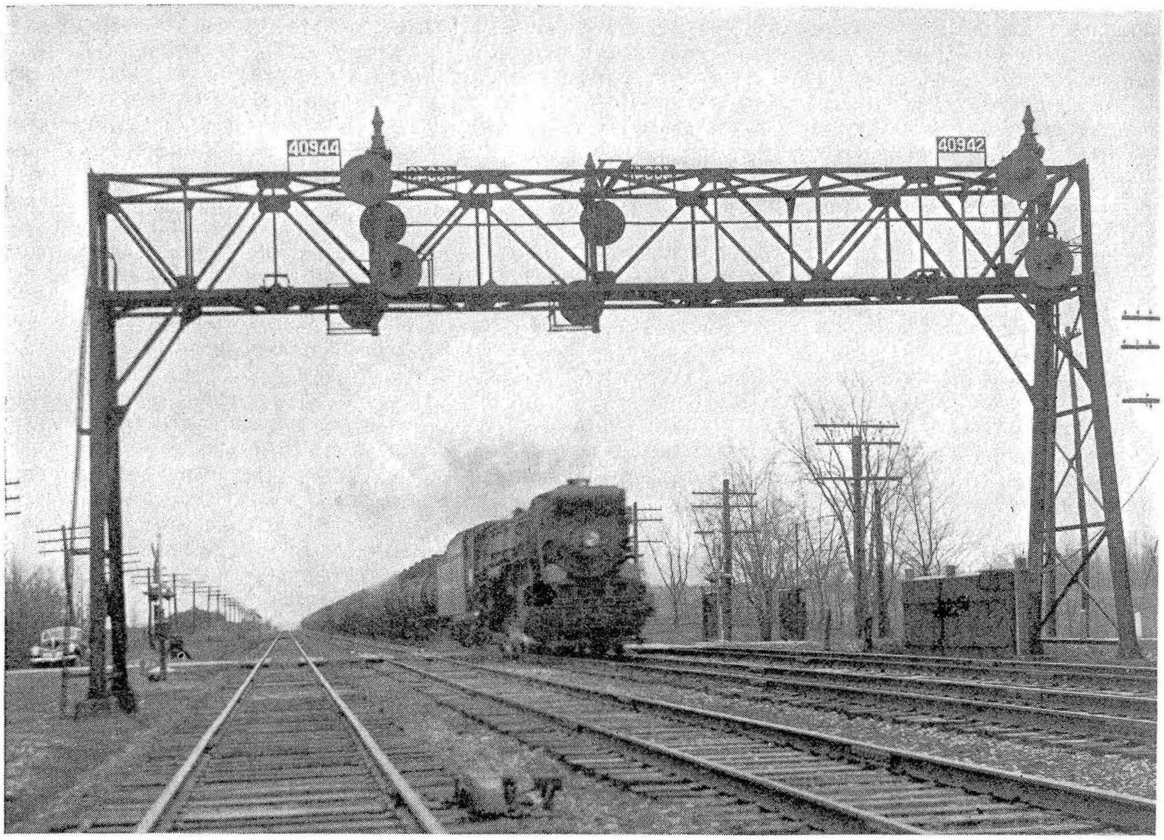


Modernization of Automatic Signaling On the New York Central

Multiple-aspect searchlight signals replace semaphores, and new coded track circuits eliminate line control wires on 12 miles of four-track main line

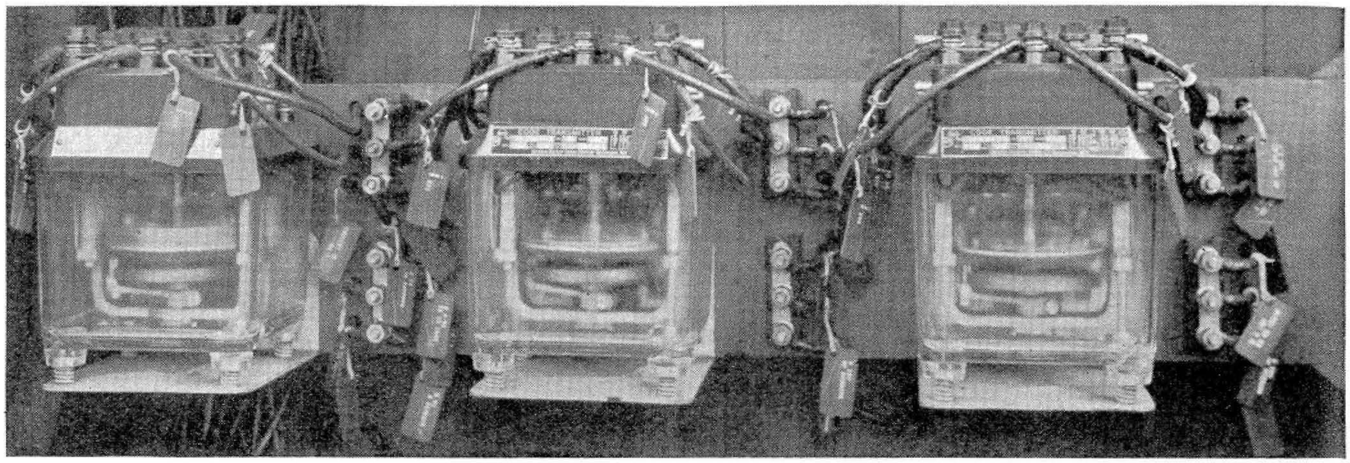
On 12-miles of four-track main line, totaling about 48 track miles, between an interlocking at Batavia, N.Y., and an interlocking at Corfu, N.Y., the New York Central has replaced the former automatic block signaling; the signal bridges, the bonding, and some of the underground cable connections being practically the only items which were retained as a part of the new project. The primary reason for the modernization program was to renew this signal installation, and, in doing so, to meet the requirements for present day train operations by providing more and better aspects, and while making these changes, to include modern systems of coded track circuit controls, thereby eliminating line wire control circuits, and also to install a system of a-c. power distribution with rectifier feeds for the d-c. apparatus and a-c. feeds for the signal lamps.

Fifty-seven scheduled passenger trains, and approximately 70 freight trains are operated through this section daily. From a point near Corfu to another point just west of Batavia, the grade ascends eastward at approximately 0.5 per cent, so that helper locomotives are required on some eastbound freight trains between Corfu and Batavia, and these locomotives return light to Corfu. The rail is 127 lb., with good ties and rock ballast. The curvature is light, so that no speed restrictions are required on this account. The maximum permissible speed for passenger trains is 80 m.p.h. and for freight trains, 50 m.p.h.

Reasons for Changing Signaling

The automatic block signaling previously in service in this territory included Style-L Hall top-post, three-position, upper-quadrant semaphores, which were installed in 1921. Each of the four tracks is signaled for train movements in one direction only. The signals are on four track bridges which are spaced for block lengths approximately 5,000 ft. long, the block lengths being the same for the passenger and the freight tracks.

As the weight and speeds of trains increased during recent years, it became necessary to provide increased signal approach distance. As a temporary measure, the circuits were changed so that the Approach aspect was displayed on two signals in approach to a signal displaying the most restrictive aspect. Although this practice provided safety, the policy was established to change the signals to provide four or more aspects as soon as practicable on all such territories. On this particular division, the Batavia-Corfu section was chosen to be changed because of the unfavorable weather conditions which caused numerous failures due to broken line wires, and frost on the commutators and contacts in the semaphores.



One set of three code transmitters serves for all four tracks

Aspects of New Automatic Signals

When making the changes, the signal bridges were not moved; therefore the block length remains the same as previously, i.e., approximately 5,000 ft. The old semaphore signals displayed three aspects, but the new light signals regularly display four aspects, and certain signals in approach to interlocking home signals can display a fifth or a sixth aspect. Each of the new signals consists of two Type-SA searchlight units each of which can operate to display red, yellow or green. The upper searchlight unit is mounted to the left of the mast, and the lower unit to the right, thus creating a stagger effect as a distinction for an automatic signal as compared with an interlocking home signal on which the lamps are all on a vertical line. The vertical distance between the lamp centers on an automatic signal is 60 in.

A previous practice still used on certain roads is for the Clear aspect to consist of green-over-red. However green-over-green is used as a Proceed aspect on the New York Central in order to assist the engineman in picking up the indication when the view may be partially obstructed. The Approach aspect is yellow-over-red, indicating proceed preparing to stop at next signal. The Advance-Approach aspect is yellow-over-yellow, indicating proceed preparing to stop at second signal. The Stop and Then Proceed aspect is red-over-red. Thus each automatic signal can display any one of four aspects. Furthermore, when an interlocking home signal displays a Medium-Clear aspect for a route over a long cross-over, the first signal in approach displays the Approach-Medium aspect yellow-over-green, indicating proceed approaching next signal at medium speed. Also the second signal in approach to the home signal displays the Advance-Approach-Medium aspect, green-over-yellow, indicating proceed approaching second signal at medium speed. Thus a total of six signal aspects are included in the new arrangement of automatic intermediate signals.

Intermittent inductive automatic train stop, with a wayside inductor located 90 ft. in approach to each signal, is included in this signaling system. When a signal displays any aspect other than Clear, green-over-green, the inductor is effective in applying the brakes on a train, unless the engineman operates an acknowledger. When the Clear aspect is displayed, a contact in a V relay shorts the coil of the inductor so that no acknowledgment is required.

New Controls All By Coded Track Circuits

The controls in the new signaling are all accomplished by coded track circuits, no line wires being required. Codes at the rate of 75 per minute are used to control the yellow-over-red aspect, 120 per minute for the yellow-over-yellow aspect, 180 per minute for the green-over-green aspect, positive d-c. energy being used in each instance. The control for the yellow-over-green aspect is at the rate of 75 per minute but the energy is negative, and likewise negative energy at the rate of 120 per minute is used for the control of the green-over-yellow aspect.

For the control of signals, the code is fed at the exit end of each track circuit, the code-following track relay, decoding apparatus and signal control relay being located at the entering end of the track circuit. Except for blocks in which highway crossing signals are located, the coded track circuits extend the length of the automatic block, which average about 5,000 ft. long. The longest coded track circuit is 5,500 ft., and the shortest is 300 ft., a total of 52 coded track circuits being included on the 48 track miles of this project. The previous signaling included d-c. neutral track circuits with two-wire line control circuits. Thus the new coded track circuits eliminated the cut section in each block as well as the line wires.

In the approach to interlockings, the approach annunciators and approach locking are controlled by inverse code which feeds from the entrance end of the track circuit to the exit end, the impulses of this inverse code being timed between the impulses of the normal direction code. This arrangement of inverse code is used also for the approach control of highway crossing signals, and follow-up code is used to cut out the operation of crossing signals after the rear of a train passes a crossing. Three crossings in this territory are equipped with crossing signals with all the automatic controls accomplished by coded track circuits without line wires.

Where inverse code is in service for other purposes, it is used also to control the approach lighting of signal lamps; otherwise approach control is accomplished by a relay connected in multiple across the feed to the track circuit. Counting the six signal controls, the inverse codes, and the follow-up crossing signal cut-outs, as many as eight different forms of repeater relay CTPR is operated 75 times each minute if the block ahead is occupied; 120 times if the first block is unoccupied but the second block is occupied; and 180 times if two or more blocks are unoccupied. When the front contact of relay CTPR is closed, positive d-c. energy from the rectifier is fed to the top rail, and negative is fed to the bottom rail. When the back contact of CTPR is closed, the connections to former and decoding units so that if the code is 75, signal 40941 will display the Approach aspect, yellow-over-red; if the code is 120, the aspect is Advance Approach, yellow-over-yellow; and if 180, the aspect is Clear, green-over-green. If a train is occupying the immediate block, the track circuit is shunted, and, therefore, relay 1TR remains in the de-energized position which results in the display of the red-over-red aspect. The de-

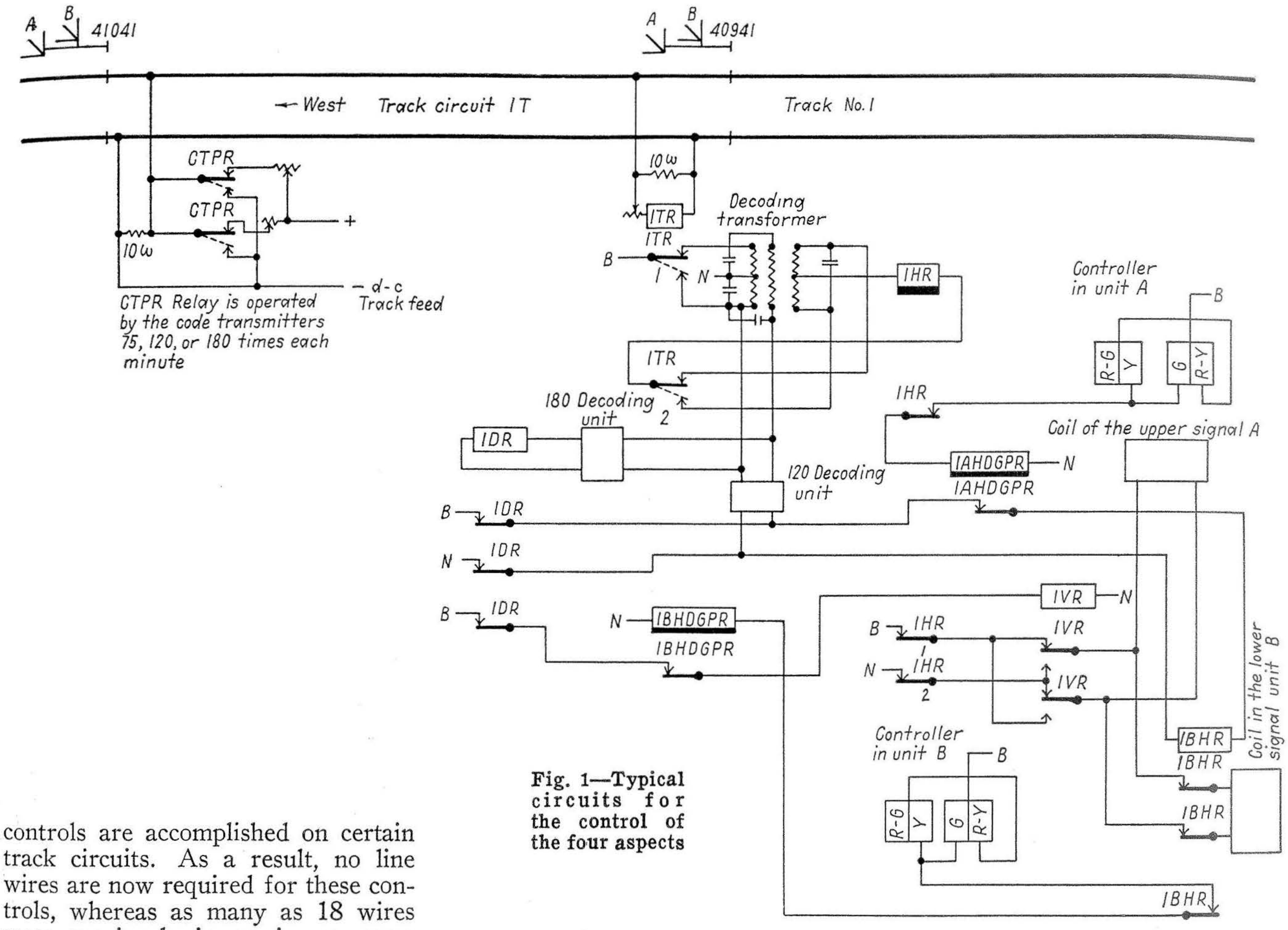


Fig. 1—Typical circuits for the control of the four aspects

controls are accomplished on certain track circuits. As a result, no line wires are now required for these controls, whereas as many as 18 wires were previously in service on some sections with the semaphore signaling which displayed only three aspects. The only signal line wires in this territory now are two No. 4 wires which are used as an a-c. power distribution circuit, as will be discussed later. In brief here, the coded track circuits, the operating coils of the searchlight signals, and control relays are of the d-c. type, fed from rectifiers, and the signal lamps are fed a-c. from transformers.

Basic Coded Track Circuit

A typical coded track circuit for the control of four aspects on signal 40941 on Track 1 is shown in Fig. 1. This diagram includes only the basic signal control features, thus excluding, for the time being, other considerations. At the feed end at the left of the diagram, the code transmitter the rails are shunted, thus bleeding any storage effect from the rails. As a further item contributing to this objective, a 10-ohm resistor, acting as a bleeder, is connected across the connections to the rails.

At the relay end of the track circuit at the right in Fig. 1, the connections from the rail extend to the coil of the code-following track relay 1TR, also a 10-ohm bleeder resistor is connected across the connections from the rails. Each impulse of incoming track code causes the code-following track relay 1TR to be energized. Likewise when each impulse ceases, relay 1TR is released. Therefore, relay 1TR is operated to follow the code.

Contacts of relay 1TR control local circuits through a decoding transformer and decoding units so that ... tails of how these various decoding operations are accomplished will now be discussed.

Local d-c. positive energy feeds to the heel of contact 1 of relay 1TR. When the front point is closed, this energy feeds through the upper portion of the primary of the decoding transformer and out to negative at the middle connection. When the back point closes, energy feeds through the lower half of the primary coil and out at the middle connection to negative. This transformer action induces current in the secondary of the transformer, and contact 2 of relay 1TR changes the connections to cause the feed through the coil of relay 1HR to be always in the same direction. Relay 1HR is slow release so that it will not release in the time between impulses from the transformer if the incoming code is not less than 75 per minute.

If the incoming code is 75, only the 1HR relay is energized. Front contacts 1 and 2 of relay 1HR complete a circuit to the coil of the upper searchlight unit to cause it to operate to the yellow position, but the lower searchlight unit remains in the red position.

If the incoming track circuit code is operating the contacts of relay 1TR at the rate of 120 per minute, relay 1HR is energized, and also, by a circuit from the secondary of the transformer through the 120 decoding unit, relay 1BHR is energized. Contacts of 1HR complete the circuit to operate the upper signal unit to the yellow position as previously explained, and front contacts of relay 1BHR close a circuit to cause the lower signal unit to operate to the yellow position, thus establishing the controls for the display of the yellow-over-yellow aspect. Note that a front contact of relay 1AHDGPR is included in the control of relay 1BHR. The relay 1AHDGPR is not energized until the upper signal unit is operated to the yellow position. Thus, unless the 120 code is effective in operating the upper unit to yellow, the lower unit cannot be operated to the yellow position, thereby preventing the display of a red-over-yellow aspect improperly.

When the incoming code is operating relay 1TR at the rate of 180 per minute, relay 1HR is energized, the feed through the 120 decoding unit is not effective, but the feed through the 180 decoding unit is effective to energize relay 1DR. Contacts of 1DR complete another circuit to energize 1BHR. Also a contact of 1DR closes a circuit to energize relay 1VR provided 1BHDGPR is also up, which places a shunt across the coil of the train stop inductor so that the train can pass without the engineman operating the acknowledger. Also with 1VR energized, contacts of this relay change the polarity of the feed to the coils of both the upper and lower signal units so that they are operated to the green position, thereby establishing the control for the green-over-green aspect. This completes the discussion of the control of the four ordinary aspects.

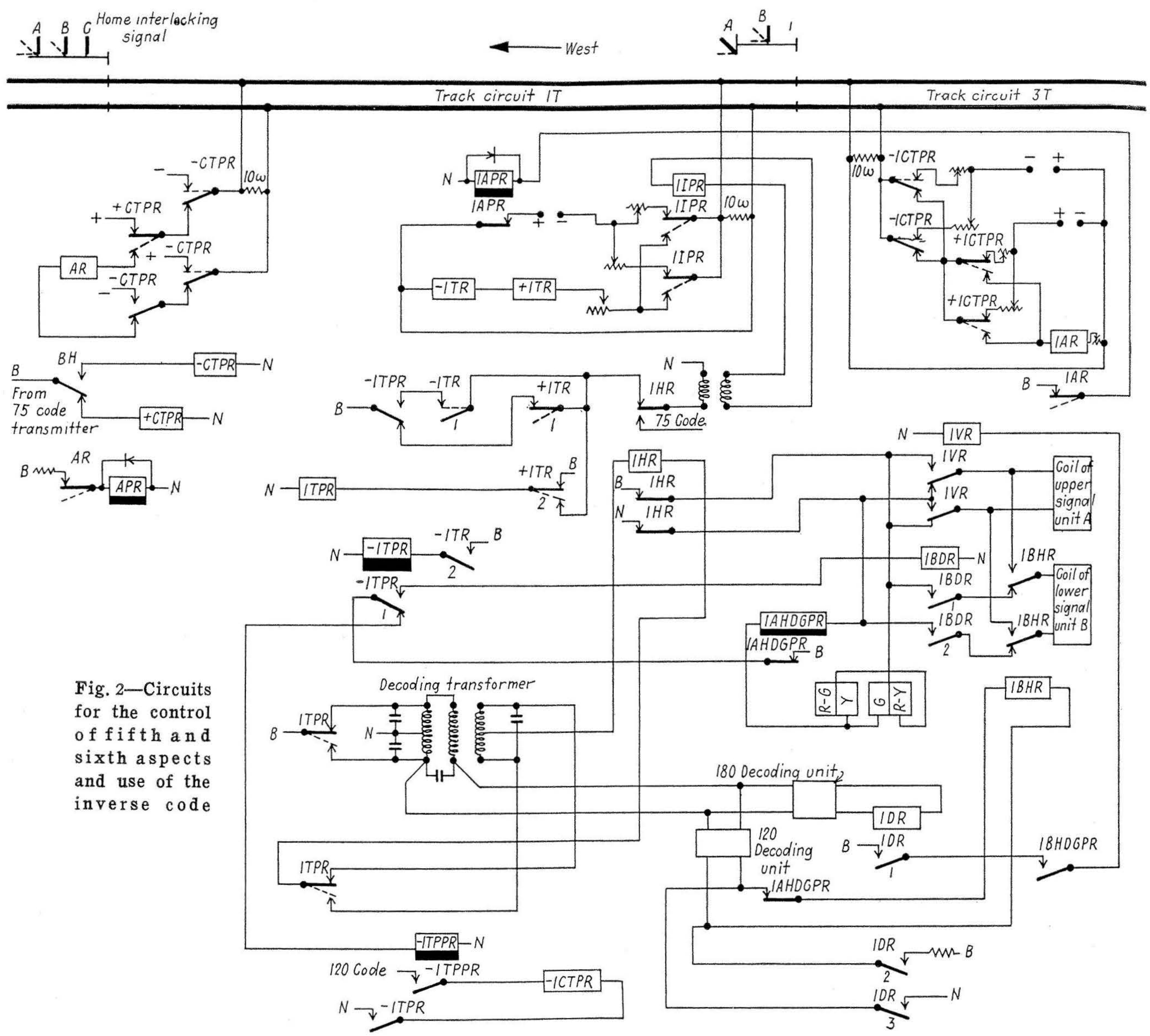
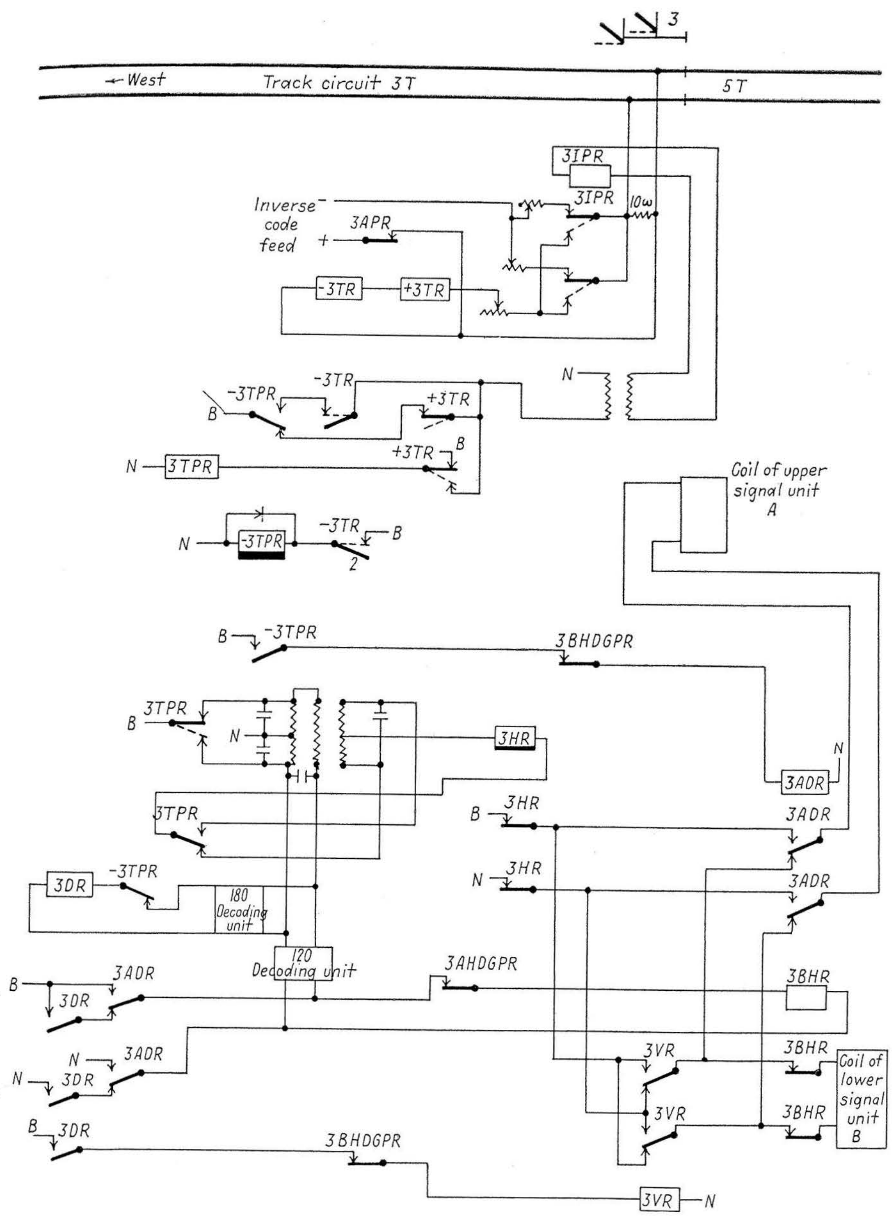


Fig. 2—Circuits for the control of fifth and sixth aspects and use of the inverse code

The Use of Negative Code

Positive d-c. energy fed to the upper rail as shown in the diagram, is used to feed the code to the track circuits for the three proceed aspects as explained above. On the other hand, negative energy fed to the upper rail at the code rate of 75 per minute is used to control a signal to display the Approach-Medium aspect, yellow-over-green, and negative energy at 120 per minute controls the Advance-Approach-Medium aspect, green-over-yellow.

For other purposes, the actual circuits include various contacts, but for the purpose of discussing the use of negative code, reference is made to a simplified diagram shown in Fig. 2. In any track circuit that is to handle either positive or negative code, means must be provided at the feed end to select for either the positive or the negative feed to the top rail, and likewise, at the relay end, means must be provided to select not only between the 75, the 120 and the 180 codes but also to determine whether the incoming code is positive or negative as coming from the top rail.



Referring to Fig. 2, when the westward interlocking home signal displays the Stop aspect, the relay shown as BH is released, and impulses from the 75 code transmitter feed through the back contact of BH to cause relay +CTPR to operate the follow code. This is the normal condition which causes the Approach aspect to be set up on signal 1 which is the first signal in approach to the home signal. On the other hand, when the interlocking lever control causes the Medium-Clear aspect to be displayed on the home signal, relay BH is energized to open its back contact, thus stopping the operation of +CTPR, but closing its front contact to start operation of —CTPR, which causes 75 code to be sent eastward with negative to the top rail.

At the relay end of the track circuit at signal 1 there are two track relays in series. These relays are polar biased by permanent magnets so that +1TR will be energized only when positive energy is coming in on the top rail, whereas —1TR will be energized only when negative energy is coming in on the top rail. The result is that when negative 75 code is being received, relay +1TR remains deenergized but —1TR operates to follow code.

Operation of either +1TR or —1TR causes operation of relay 1TPR at the same code rate, and as a result, 1HR is energized, with either polarity, and the upper searchlight unit displays the yellow aspect. Negative incoming code controls the bottom searchlight unit from the red to the green position, provided that the upper unit is yellow, thus giving the Approach-Medium aspect.

Front contact 2 of —1TR completes the circuit to energize relay —1TPR which is slow release so that it remains up while —1TR is coding. With the front contact of AHDGPR closed, due to the fact that the upper signal unit is at yellow, and with front contact 1 of —1TPR closed the circuit is complete to energize relay 1BDR.

In the circuits for the control of the coils of the searchlight units, the front contacts of HR and 1BDR are closed, but the back contacts of 1BHR and 1VR are closed; therefore the circuits are complete to hold the upper searchlight unit at yellow and to operate the lower unit to the green position, thus completing the Approach-Medium aspect, yellow-over-green.

Control of the Advance-Approach-Medium

Through selections established when the yellow-over-green aspect is displayed on signal 1, the 120 code with negative to the top rail is fed eastward. At the next signal in approach, 3, this incoming negative 120 code causes —3TR relay rather than +3TR relay to be operated to follow code. Relay 3TPR continues to operate and 3HR remains up. Due to the fact that 3TPR is operating to follow 120 code, the decoding transformer secondary feeds through the 120 decoding unit to energize relay 3BHR. With 3HR up, 3VR down, and 3BHR up, the circuits are complete to operate the lower signal unit to the yellow position, which causes signal repeater relay BHDGPR to be energized. When the front point of contact 2 of —3TR closes, relay —3TPR is energized and it remains up as long as it receives code pulses.

In the circuits for relay 3ADR, the front contacts of —3TPR and 3BHDGPR are now closed so that relay 3ADR is energized. In the circuits for the coils of the searchlight units the front contacts of 3HR, 3BHR and 3ADR are now closed, and the back contacts of 3VR are closed, thus operating the upper unit to the green position and completing the Advance-Approach-Medium aspect green-over-yellow.

Operation of Inverse Code

The discussions up to this point have applied only with reference to the code fed from the exit end of a track circuit to the entrance end, in other words in the direction opposite to that of train movement. In the automatic blocks in approach to interlockings, the control of approach annunciators and approach locking is accomplished by inverse code, which, during the off periods of the normal direction code, feeds in the direction from the entrance end to the exit end of each track circuit.

The diagram Fig. 2 shows in part the circuits at signals 1 and 3, which are the first and second signals on the westward passenger track No. 1 in approach to a westward home interlocking signal. Regardless of whether the 75, the 120 or the 180 code is being sent eastward in any given track circuit, the inverse code is operative.

Referring to signal location 3, the incoming code from the rail feeds through a back contact of 3IPR to operate either +3TR or —3TR depending on the polarity of the code as previously discussed. Operation of either +3TR or —3TR feeds the primary of the impulse transformer, and the induced current in the secondary energizes relay 3IPR when the front contact of either +3TR or —3TR opens. Thus 3IPR is energized after the flow of an incoming pulse of track circuit code. With the contacts of 3IPR up, the circuit from the rails to the relays +3TR and —3TR is opened, and a circuit is closed from local d-c. supply to the rails so that, for the duration of the energization of 3IPR, energy feeds westward.

At signal 1 at the west end of the track circuit 3T, the incoming westward inverse code feeds through back points of —CTPR and +CTPR, therefore the incoming energy picks up relay 1AR. A front contact of 1AR closes the circuit to the coil of 1APR, and due to its slow release it stays up while 1AR is operated. A front contact of 1APR closes a circuit in the inverse feed westward from signal 1 on track circuit 1T. At the interlocking home signal, this inverse code feeds through the back contacts of the code transmitter repeater relays to energize an AR relay. A front contact of AR closes a circuit to energize relay APR which is slow release so that it will stay up while AR is operated. As long as this APR relay is energized, the train approach annunciator is not operated, and the approach locking is not in effect.

The inverse code is provided in three blocks in approach to each home signal, and may be in four blocks if desirable for the annunciator and approach locking to be in effect for four approach automatic blocks. When a train enters the first of such blocks, the entrance end of the track circuit is shunted which stops the feed of inverse code. This causes relay 1AR at signal 1 to cease following code, and relay 1APR is released which in turn cuts off the feed of the inverse code westward in track circuit 1T, and as a result the AR relay and its repeater APR at the home signal are released, thereby causing the train annunciator to operate, and also to set the approach locking in effect if a proceed aspect on the home signal is taken away.

Where the inverse code is used in the blocks in the approach to interlockings, the release of an AR relay and its slow-release repeater, also serves to control the feed to the signal lamps, thus accomplishing the approach lighting control.

Control of Highway Crossing Signals

Where automatically controlled protection such as flashing-light signals are in service at a highway crossing in an automatic block, the control of these signals is accomplished by the track circuits, as shown in Fig. 4. At the crossing, a pair of insulated joints is provided in each track, thus forming two track circuits for the block as a whole. Regardless of whether the 75, the 120 or the 180 code is being fed westward from signal 40652, the relay B2TR at the crossing follows code. Front contact 1 of B2TR controls the circuit to cause relay B2TPR to follow code. In the feed to track circuit A40752T, when the front contacts of B2TPR are closed, an impulse is fed westward on the track circuit. Thus the incoming code from track circuit B40752T is repeated through track circuit A40752T, this being the normal direction code for the control of the automatic block signals.

At signal 40752, this incoming code operates code-following track relay A2TR. When contact 1 of A2TR closes its front point, relay 2FPR is energized, and it stays up as long as it receives code impulses. When the back point of contact 1 of relay A2TR closes, and with 2FPR up, then relay 2FBPR is energized and remains up as long as it receives code impulses. Also with front point contact 1 of A2TR closed and with 2FBPR energized, a circuit is complete to energize relay 2HR which remains up as long as it receives code impulses. Thus the combination of the front and back repeaters afford a means for de-

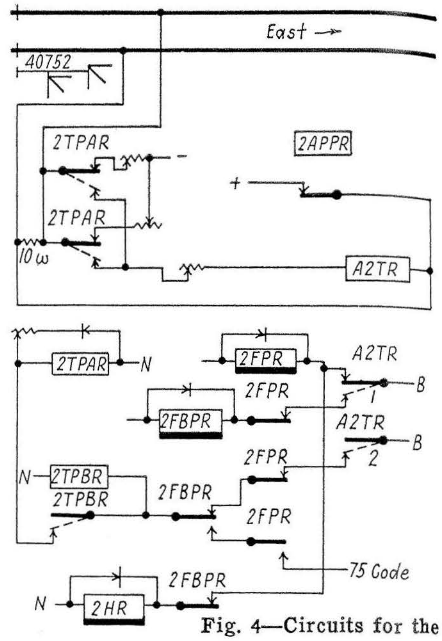


Fig. 4—Circuits for the

tecting code without the use of a decoding transformer as explained in the discussion of Fig. 1.

Also when the back point of contact 2 of A2TR is closed, with 2FPR up, relay 2TPBR is energized, but during the time taken for the contact of 2TPBR to leave its back point, relay 2TPAR is energized and then its circuit is opened when 2TPBR picks up. Thus 2TPAR has its front contacts closed for a shorter period than ordinarily for a code transmitting repeater relay. The front contacts of this relay 2TPAR send inverse code eastward on track circuit A40752T.

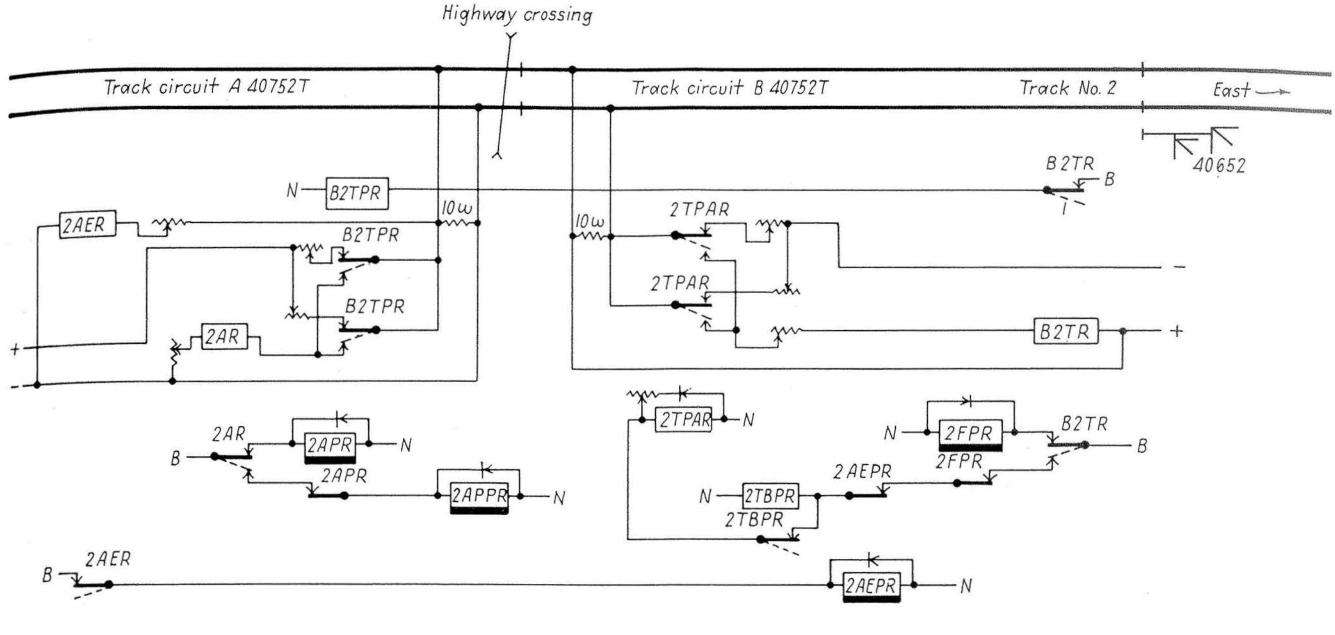
At the east end of track circuit A40752T, at the crossing, the inverse code operates code-following track relay 2AR. When the front point of 2AR first closes, relay 2APR is energized and stays up as long as it receives code impulses. When the back point of the contact of 2AR closes and with 2APR up, relay 2APPR, which controls the crossing signal, is energized and it stays up as long as it receives code impulses.

When an eastbound train is occupying the block in approach to signal 40752, the relay 2APPR at signal 40752 is released, which opens the feed for the inverse code going eastward on track circuit A40752T, and thus controls the highway crossing signal.

Likewise when the train passes signal 40752 and occupies track circuit A40752T, the shunt on the rails stops the operation of code-following track relay A2TR, which stops the operation of 2TPAR, so that the feed of inverse code eastward on track circuit A40752T is stopped. At the highway crossing, the absence of incoming inverse code due to the train shunt, causes relay 2AR to remain de-energized, and thus maintains control of the crossing signal through a back contact of 2APPR.

Returning now to signal 40752, with relays 2FPR, 2FBPR and 2TPBR all released, a circuit through back contacts of these relays is closed to the 75 code transmitter to operate relay 2TPAR. Through the front contacts of 2TPAR coded energy, at the rate of 75 per minute, is sent eastward in track circuit A40752T behind the eastbound train. When the rear of the train passes the insulated rail joints at the crossing, the incoming code from the west feeds through back contacts of B2TPR, to operate relay 2AR. Operation of 2AR energizes relays 2APR and 2APPR, which opens the back contact of 2APPR, thus causing the operation of the crossing signals to cease.

When the rear of the train passes signal 40652, then 75 code is fed westward from signal 40652 in track circuit B40752T. At the crossing this code operates relay B2TR, which as previously discussed, operates B2TPR. Contacts of B2TPR cause 75 code to be fed westward on track circuit A40752T opposing the eastward code being fed in at the west end. The impulses of the westward code are slightly longer than those of the eastward code, so that the westward code takes control to operate relay A2TR which energizes relays 2FPR, 2FBPR and to operate relays 2TPBR and 2TPAR in step with the incoming westward code, thus reestablishing the inverse code eastward.



highway crossing protection with no line circuits

Approach Lighting

As previously discussed, the incoming codes on the track circuit cause the spectacles in the searchlight signal units to be positioned, but the lamps are not lighted until a train enters the block in approach to the signal. One method of approach lighting control is by means of a relay connected across the connections to the rail at the exit end of a block. Referring now to the approach lighting of signal 410 at the left of Fig. 3, relay AER is connected as shown. When the 75, the 120, or the 180 code is being sent eastward from this location, the AER relay is energized by each impulse. A front contact of AER completes the circuit for the coil of relay AEPR, which is slow release and remains energized when AER is coding.

When a westbound train passes signal 409, thus shunting the track circuit, relay AER is shunted, causing it to be released. This opens the circuit for relay AEPR, which is released, thus closing its back contact to close the circuit which feeds the lamps in signal No. 410, which, of course, is the signal which a train is approaching when occupying the track circuit shown. The controls are arranged for a train approaching on either of the two westward tracks to cause the lamps to be lighted in the signals for both tracks, so that an

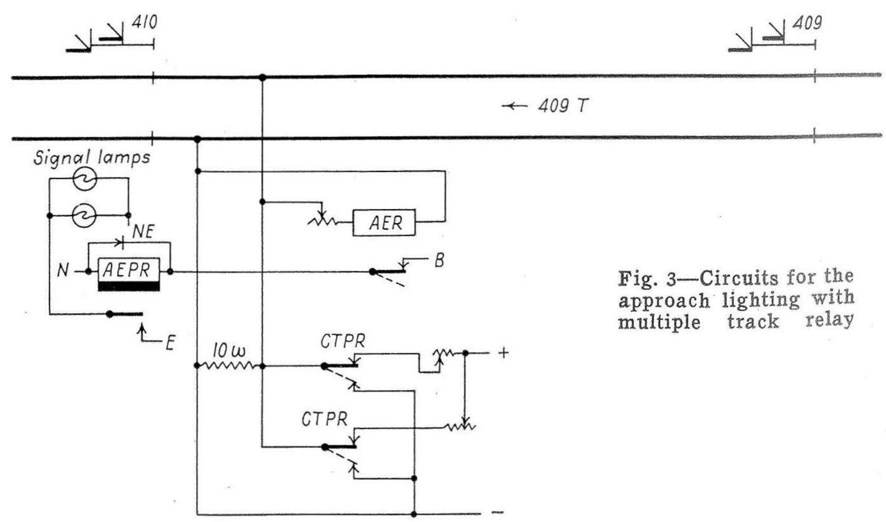


Fig. 3

Fig. 3—Circuits for the approach lighting with multiple track relay

engineman can pick out the proper signal for the track on which he is running.

Protection at Hand-Throw Switch

Between the interlockings at the two ends of this coded-track circuit project, there is only one hand-throw main line switch, and it is on the eastward freight track. In approach to the facing point, there is an insulated joint in each rail. Connections from the rail ends extend through contacts in a switch circuit controller. When the switch is normal, the track circuit is connected around the insulated joints. When the normally-closed point is more than ¼ in. from its normal position, the contacts in the controller open the track circuit and also shunt the rails in the direction toward the relay end.

Ballast Resistance Varies

In this territory, the ballast is crushed rock about 18 in. to 24 in. deep, and the ballast is well drained. No zinc treated ties are in service. Only three highway crossings are included in the territory. From first consideration, it might seem that these conditions would result in a minimum ballast leakage, thus contributing to ideal track circuit conditions, but such is not the case at all times. Following a period of dry weather, the ballast resistance may be as high as 6 ohms per thousand feet or perhaps more. When the ballast is frozen, the resistance may be much higher.

A peculiar circumstance on this section is that the stokers on the locomotives crush some of the coal to a fine powder or dust, a portion of which is blown out the stack without having been burned, and is deposited on the rails, ties and ballast, as a coating. When moistened by a heavy dew or light shower, followed by warm sunshine, the ballast resistance may be reduced to as low as 0.5 ohms per thousand feet. The rail is 127-lb. to the yard and the rail joints are bonded with Raco rail-head bonds which are applied mechanically by expansion in 9/32-in. holes in the rails. By using a micro-ohmer, practically all of the bonded joints have been tested to show that the resistance of each joint was either too low to give a reading, or did not exceed more than 300 to 400 micro-ohms. The rail resistance ranges from .015 to .022 ohms per thousand feet of track.

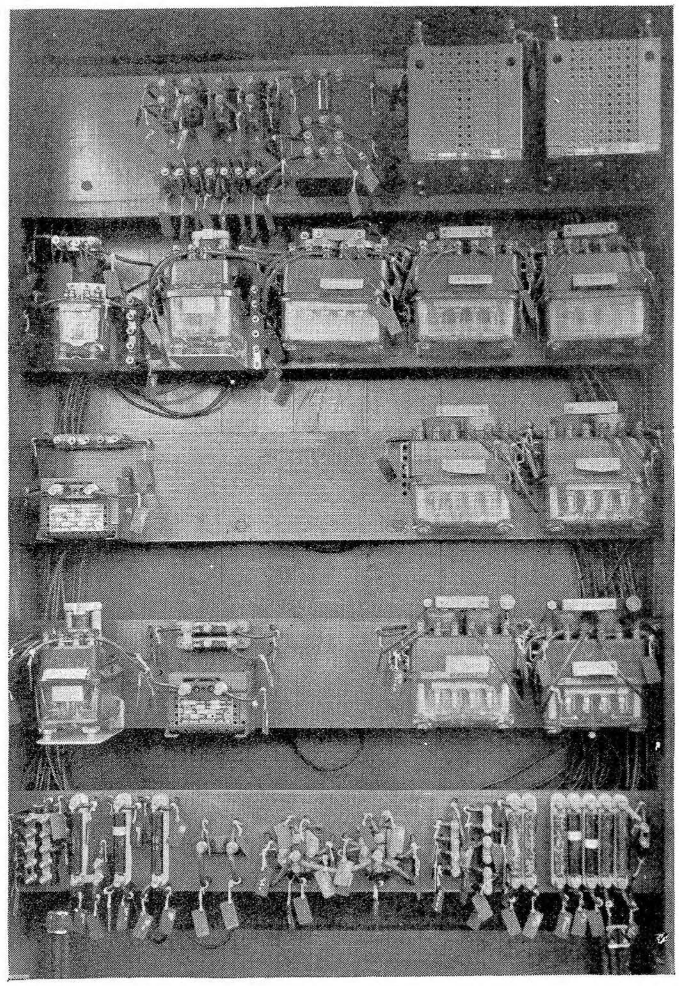
If the special condition of low ballast resistance, down to 0.5 per thousand feet, develops, and if the rail resistance is up to .04 ohms per thousand feet, the factors involved are closely approaching the limits at which the code-following track relays will operate successfully. However, the project has been in service for more than a year without any such failures.

A peculiar fact with reference to the stoker dust, shower, sunshine combination, is that the passage of a train breaks up the crust of dust so that the ballast readings may jump from as low as 0.5 ohms per thousand feet before the train arrives to as high as 3.5 ohms after the train passes. The operating characteristics of the relays, and the voltage of the track circuit feeds must, therefore, be planned to operate successfully over a rather wide range of conditions.

Track Feeds to Relays

The coils of a code-following track relay, plus lead wires, have a resistance of 0.4 ohms, and the relay will operate properly on a voltage as low as 0.3 volts, but ordinarily this voltage may range from 0.4 to 0.8 volts or more.

The feed to each track circuit comes from a full-wave rectifier at about 4 volts, and after passing through the limiting resistors may be about 0.8 to 1 volt. For example, one set of readings on a 5,000-ft. track circuit were: 0.89 volts on the rails at the feed end, and 0.67 volts at the relay; the ballast resistance being 4 ohms per thousand feet and the rail resistance 0.02 ohms per thousand feet. Another set of readings were: 0.6 volts at the feed end and 0.45 volts at the relay, with 0.5 ohms per thousand feet ballast resistance. The flow of current to a track feed is, of course, interrupted by the code transmitter repeater relays, so that in order to get a reading, the code must be stopped. Such a reading indicated about 1.9 amp. at 0.6 volts. When a train is shunting a track circuit, the limiting resistors prevent the average current from exceeding about 2 amp. The wires from an instrument case to the rail connection is No. 10 solid copper in underground cable, and the resistance of two such wires, even to the farthest track, do not exceed 0.3 ohms.



The relays are equipped with plug couplers

Power Supply Arrangement

In the previous semaphore signaling, there was a set of 10 cells of

150-a.h. Edison storage battery at each signal bridge which fed the line circuits and operated the signal motors. Oil lamps were used. Each automatic block was cut into two track circuits, each such circuit being fed from one cell of Edison storage battery. The batteries at the signals and for each track circuit were in duplicate, one set or the other being connected through voltage limiting resistors to a 110-volt d-c. charging line, by operating a double-throw switch from one position to the other. These switches were thrown twice each week.

In the new arrangement, with the 550-volt a-c. power distribution circuit, the signal lamps are fed from transformers, and all d-c. circuits, such as track circuits, relays and code transmitters are fed from rectifiers. Thus no batteries are required at any of the locations between Batavia and Corfu.

Automatic Protection

The 550-volt a-c. power distribution line circuit is normally open at the center point. Commercial sources of power feed from Batavia to the center, and from Corfu to the center. If the normal source fails, a second commercial source is cut in automatically. If both commercial sources fail, a 1.5-KVA General Electric inverted dynamotor, fed from the 110-volt main storage battery at the interlocking, will be started within 1½ cycles, and will be switched to take the line load within four cycles, which is so quickly done that no relay is released or signal affected.

The automatic switching equipment and meters, mounted on a slate panel as shown in one of the illustrations, was furnished by the General Electric Company. If the commercial sources are to be out of service for some time, the maintainer can push a button which starts a Kohler gasolene engine driven generator rated at 5 KVA output, which can be connected to carry the line load indefinitely, thus permitting the dynamotor, supplied from battery, to be shut down.

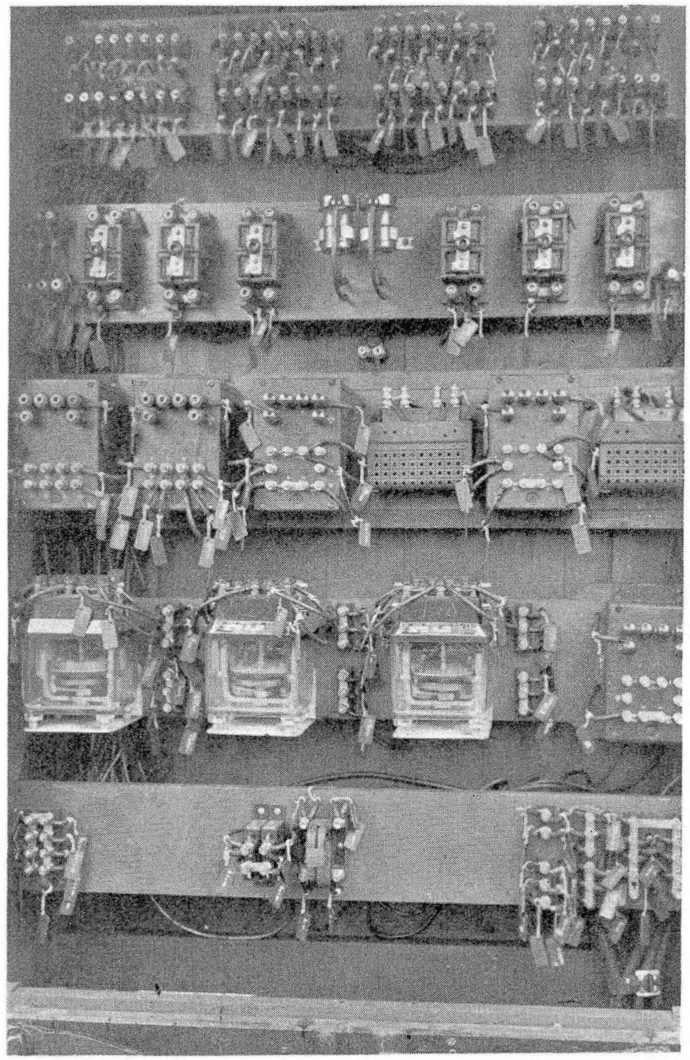
Automatic Warning

When the commercial sources of a-c. power fail, a normally lighted green lamp on the leverman's desk is extinguished, so that the maintainer can be notified at once. If the a-c. power distribution wires are broken at any point on the line, the switch at the center point automatically closes thereby feeding up to the break. Then in the block where the line is broken, the plug-fuses can be pulled at each end to cut this part of the line dead, while repairs are made, but the signaling would all be in service in the meantime.

Field Construction Details

In view of the fact that the two No. 4 line wires for the 550-volt a-c. power distribution were already in place on the pole line, the new construction work was confined solely to the signal bridge locations. At each signal bridge location, the 550-volt a-c. line from each direction extends through two No. 6 insulated wires in a cable drop to the instrument case, thus four wires are required in each cable. In the case, these wires are connected to two General Electric Company type 9LA10A204 lightning arresters. All terminals, to which the 550-volt circuit is connected are equipped with insulated nuts so that the circuits and apparatus are dead-front insofar as touching a 550-volt circuit is concerned.

At each signal bridge location, one transformer feeds the lamps on the eastward signals and a second transformer feeds the lamps on the westward signals. The lamps are single filament rated at 12-16 volts 15 watts, and are normally fed at about 10.5 volts. After approximately 2,000 burning hours of service, the lamps are replaced. Experience indicates that the lamps will give a useful life of at least 2,000 burning hours, providing they do not fail during the first day or two. The practice of burning the lamps on a test rack, prior to installation, was tried, but the results did not prove to be worthwhile.



Power equipment and code transmitters

One transformer feeds low-voltage rectifiers for feeding the coded track circuits, and another transformer feeds the rectifiers with 10-volt output for operating the code transmitters and the local control relays.

The relays and the code transmitters are all equipped with quick-detachable plug couplers, so that a defective instrument can be replaced quickly and without chances for a

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be considered to perform the function intended in a reliable manner, and data have been assembled to show just how coded track circuits will operate under varying conditions. Therefore, on the whole, the next problem is to determine the application of coded track circuits, as compared with conventional track circuits, in the various systems of signaling.

On account of the fact that coded track circuits can be up to two miles in length, several roads have installed such circuits to advantage on multiple track lines on which each track is signaled for train movements in one direction only, the track circuits feed normal from the exit to the entrance end at all times, and all the advantages of controlling signals to different aspects are accomplished without the use of line wires. Likewise on single track, such as on the Milwaukee, the Pennsylvania, and the Louisville & Nashville, coded track circuits, always feeding at a certain rate and always feeding in one direction, are used to detect the presence or absence of trains, the control of signals to two proceed aspects being accomplished by line circuits. In such applications, the advantage of using coded track circuits is to permit the use of only one track circuit for each automatic block.

In centralized traffic control, the line code controls from the office to the field stations afford a means for initiating controls of track circuits to feed throughout the station-to-station block in the direction opposite that of the next train movement. With this arrangement, codes at various rates such as 75, 120, and 180, can be used to control signals to three or more Proceed aspects, thereby eliminating line control circuits. So far as we know, no road has installed single-track absolute permissive block signaling including coded track circuits. However, with all the possibilities of normal direction code, inverse code, and follow up code, undoubtedly the control of A.P.B. signaling can be accomplished exclusively by coded track circuits, and perhaps this will be done before many years.

Thus, except for territories where the track circuits must be cut into short lengths on account of local conditions, the use of coded track circuits offers advantages which should lead to their extensive adoption and use within the next few years.

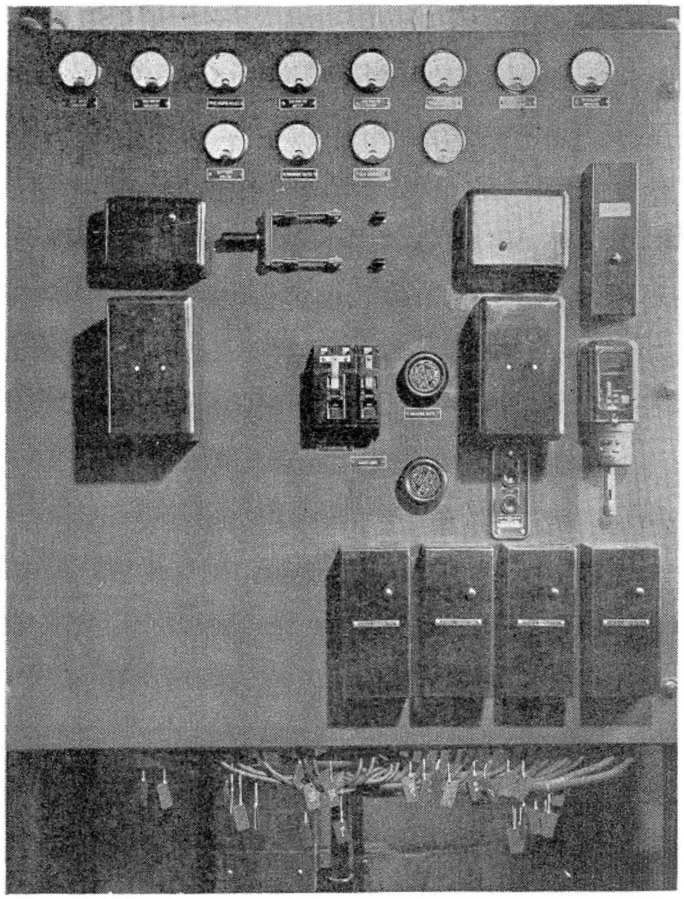
Signaling on N.Y.C.

(Continued from page 255)

mistake when making connections. The incoming wires from the signals are connected to terminals on the top board, and the incoming wires from the rails are connected to terminals or block arresters on the bottom board. The relays are equipped with wall-type spring hangers, and the code transmitters are on spring bracket mountings.

The 550-volt arresters, fused plug case, and then the cables are held together by Raco straps to a stranded Copperweld messenger which goes up the signal bridge and across to the various signals. These cables are covered with Collins cable-coat, which protects the cable coverings from moisture and remains plastic so that it does not crack if the cables swing in the wind or are pushed.

The signaling reconstruction program discussed herein was planned and carried to completion by the signal forces of the New York Central,



Automatic power panel at Corfu

cut-outs, code transmitters and part of the transformers are in one case, and a separate compartment of a case is used for the relays in connection with each of the four tracks, each compartment being 44 in. wide, 70 in. high and 16 in. deep. A door for each compartment is hinged at the top, and, when swung up, is supported by an iron rod; thus the door serves as protection from rain or snow. The cases and doors are made of 1½ in. pine, tongue and groove, and are painted two or more coats of black paint. The cases are supported at the ends on concrete posts.

A cable of aerial type construction with braided covering extends from the case to each searchlight signal unit. Each cable comes out through a separate hole in the rear of the

Lines East, under the direction of R. B. Elsworth, signal engineer; the new signals, coded track equipment, transformers, rectifiers, etc., being furnished by the General Railway Signal Company.