Typical head-block double signal location at the end of passing siding, note overlap sign on signal at right

# Automatic Block Without Line Wires On the Kansas City Southern

**Slow codes, back and forth on the track circuits throughout a station-to-station block, control the signals for both directions**

THE automatic block signaling installed on 117 mi. of single track between Kansas City, Mo., and Oskaloosa Mo., on the Kansas City Southern, has two interesting features:—(1) The blocks are from siding to siding and; (2) the controls are by coded track cricuits without the use of line wires in station-to-station blocks. The signals for both directions are controlled by so-called slow codes, in which an impulse originating at a station-leaving signal is repeated through the track circuits to the next siding, and then a similar impulse is originated to be repeated in the opposite direction back through the track circuits, thus controlling the signals for both directions in the normal clear condition.

North from Pittsburgh, Kan., to Oskaloosa, 15.5 mi., automatic block has been in service for several years. Therefore, with the new project between Oskaloosa and Kansas City, automatic block is now in service on the entire engine district of 129 mi. between Kansas City and Pittsburg. On this district, the Kansas City Southern operates six scheduled passenger trains, including the "Southern Belle", a high class streamlined luxury train between Kansas City and New Orleans. Three manifest freight trains are scheduled each direction daily, and extra trains are operated as required. Therefore, the number of trains ranges from 12 to 16 daily.

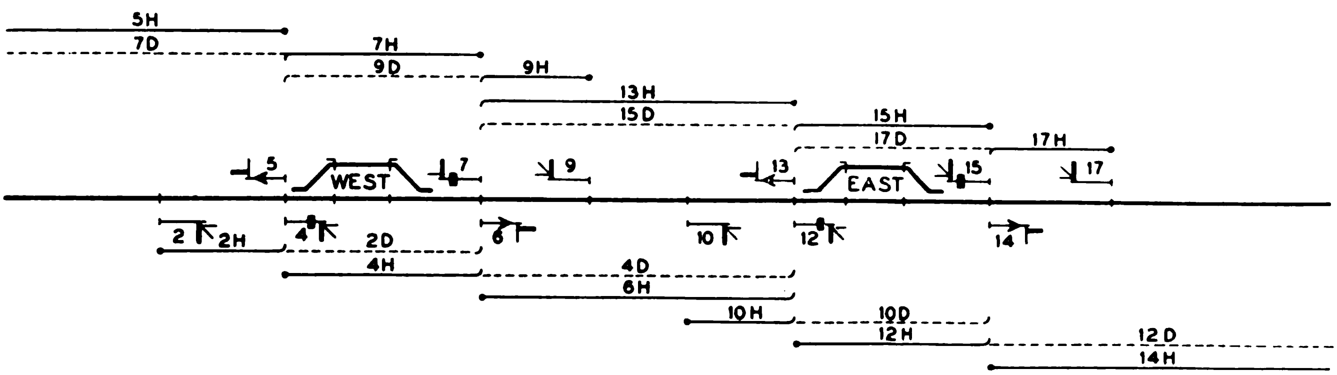
On this district between Kansas City and Pittsburg, the railroad traverses undulating upland prairie, with numerous short rolling grades but no long heavy grades. The passenger trains are hauled by Diesel locomotives. The freight trains are operated by steam locomotives, the Class E4 handling about 3,800 gross ton either way. In rougher country, between Pittsburg, Kan., and Texarkana, Ark., the Kansas City Southern uses Diesel freight locomotives which handle about the same tonnage as the steam locomotives do between Pittsburg and Kansas City.

Ordinarily a train of 3,800 gross tons is made up of about 100 cars or less. On the 117 mi. between Kansas City and Oskaloosa, there are 10 sidings which have been lengthened to hold trains of 100 to 125 cars. Five other sidings will hold 72, 87, 91 and 93 cars. This makes a total of 15 sidings which are regularly used for meeting and passing trains. Shorter sidings, used primarily as house tracks, are in service on the opposite side of the main track within the overall limits of some of the longer sidings mentioned above. The new automatic block system includes head-block signals at the two ends of each of the 15 sidings. In each instance, one automatic block extends from siding to siding with no provision for a second train to follow. For example, referring to Fig. 1, when a westbound train accepts and passes the westward station-leaving signal 13 at station East, that signal is held at Stop until the rear of the train passes the location of signals 6 and 7 at the east end of siding West. The overlap for signal 13 is longer for an opposing move. For example, when an eastbound train passes insulated rail joints on the main track opposite the fouling point on the turnout at the west end of the siding at station West, then signal 13 is controlled to Stop. This arrangement permits an eastbound train that is to take siding at West, to stop, throw the switch and enter the siding without placing signal 13 at Stop and without the use of circuits, depending on switch position to accomplish this result.

In normal procedure when making a meet, the train to take siding arrives first. If the train which is to hold the main track arrives first, it is stopped short of the station-entering signal. This is a permissive signal, but a sign on the mast reading "Overlap" designates that a train holding orders for a meet is to stop short of that signal, and wait for the opposing train to arrive and enter the siding. For example, if a westbound passenger train has a meet at East with a freight train that has not arrived, the passenger train is stopped short of signal 15. For opposing trains, the yellow, as well as green control, of this signal, overlaps to the insulated joints opposite the fouling at the west end of the siding at West. Therefore, if the eastbound freight has passed the west end of West, signal 15 at the east end of East is at Stop, and the crew on the passenger train are thereby so informed. On the other hand, if signal 15 is green when the westbound passenger train arrives, and stays green for some little time thereafter, the conductor can use the telephone at the switch to call the dispatcher to inquire whether some emergency has occurred.

Thus the automatic blocks are from station-to-station, and because of this fact no intermediate automatic block signals, as such, are used. Signals such as 9 and 10, or 2 and 17, were installed as distant signals to provide approach aspects for their respective station-entering signals. For example, one phase of the control of distant signal 2 causes it to display the yellow aspect for an approaching train if signal 4 is red. Another part of the controls for signal 2 causes it to be set for the yellow aspect when the head end of a westbound train passes the insulated rail joints on the main track opposite the fouling on the turnout at the east end of the siding at East. On the other hand, for a following eastbound train, signal 2 will display yellow when the rear end of an eastbound train ahead passes signal 4, and green when the train ahead passes signal 6.

In each station-to-station block the track circuits are the coded type. Ordinarily, the two distant signals,

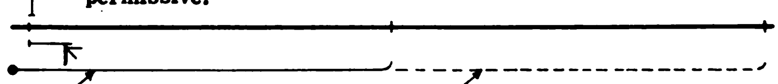



**SYMBOLS**

**Station-entering signal with overlap sign, normally stop, approach cleared.**

**Station-leaving signal with absolute sign, normally proceed.**

**Station-approach signal, normally stop, approach cleared, permissive.**



**This line shows the extent of the track circuit control for the approach indication.**

**This line shows the extent of the track circuit control for the proceed indication.**

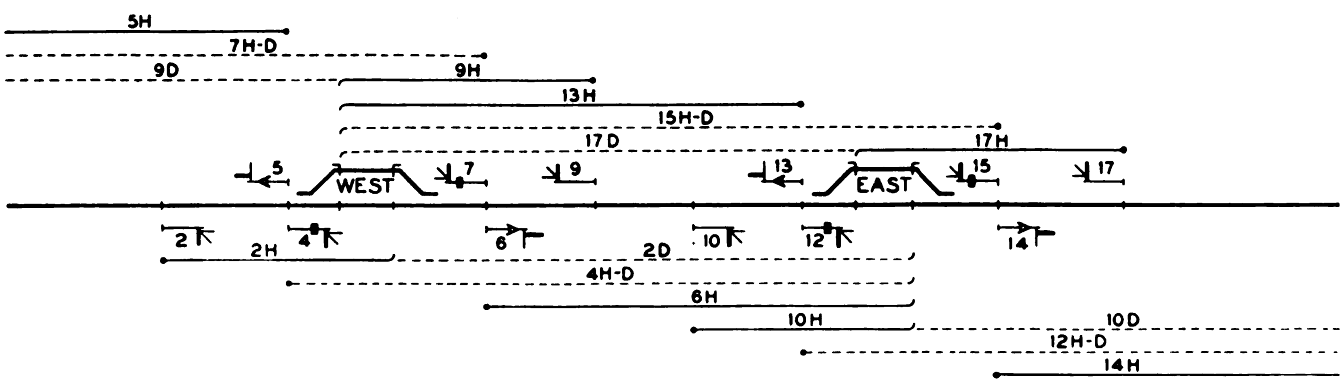



**Fig. 1—Top—Station overlaps for following train movements in typical layout of single-track station-to-station automatic block. Bottom—station overlaps for opposing train movements**

such as 9 and 10, are about 9,000 ft. from their respective station-entering signals. This 9,000 ft., in each instance, is one coded track circuit,

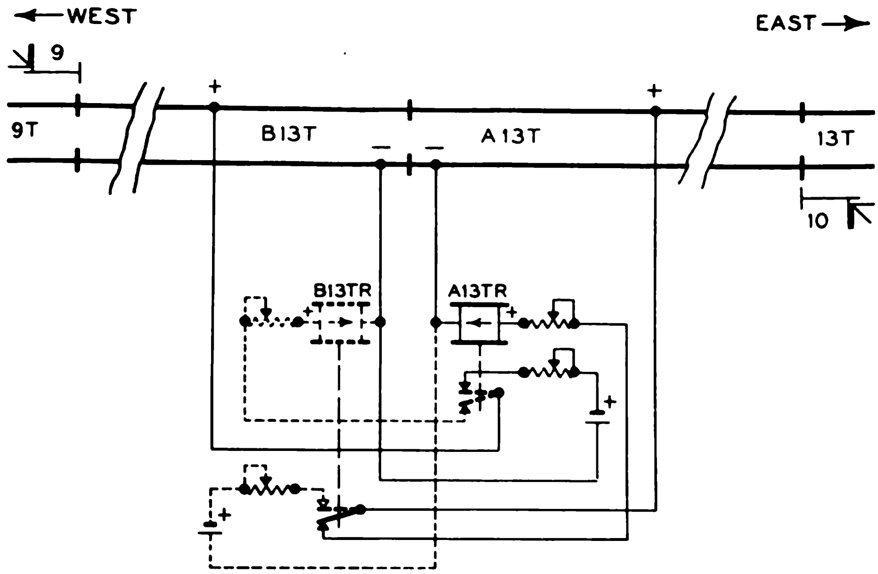


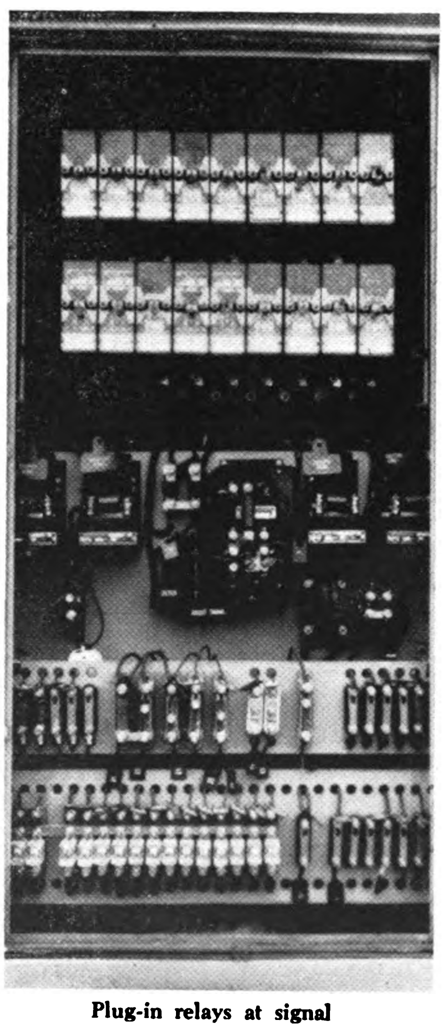

Fig. 2—Typical track circuit arrangement at a cut section

except where highway crossing controls are involved. Where the distance from one siding to the next is roughly 7 mi., subtracting 18,000 ft. leaves about 19,000 ft. or more which is cut into either two or three track circuits between the two distant signals.

The rail is 127 lb. with good ties and crushed rock ballast, clear of the rail. Several manufacturers furnished bonds for this project but the bonds are all of the rail head pin type. The ballast resistance never falls below 2.5 ohms per 1,000 ft. of track. The track relays are rated at 0.16 ohm, with a steady energy pick up of 500 m.a. The track battery feed at approximately 1.7 volts, 3 amp. (to occupied track) is in impulses each with a duration of about 0.40 sec.

At each end of every track circuit there is a relay as well as a battery for that track circuit. Circuits at a typical cut section are shown in Fig. 2. An incoming westward pulse of energy in track circuit A13T energizes track relay A13TR for the duration of this impulse, then it is released. While A13TR is up, track battery feeds through a front contact to send an impulse of energy west on track circuit B13T. In a corresponding procedure when an eastbound impulse of energy comes from the left on track circuit B13T, relay B13TR is picked up which feeds an impulse from the battery to be fed eastward, to the right, on track circuit A13T.

Referring to Fig. 1, under normal conditions, and starting explanation when an impulse is being fed east from station-leaving signal 6, this impulse is repeated through the distant signal locations and cut sections to arrive at station-leaving signal 13 to pick up relay 13 WTR (Fig. 3) which picks up slow-release repeater



Plug-in relays at signal

relays. Then, during the slow release of one of these relays, an impulse of energy, about 0.40 sec. long, is fed west.

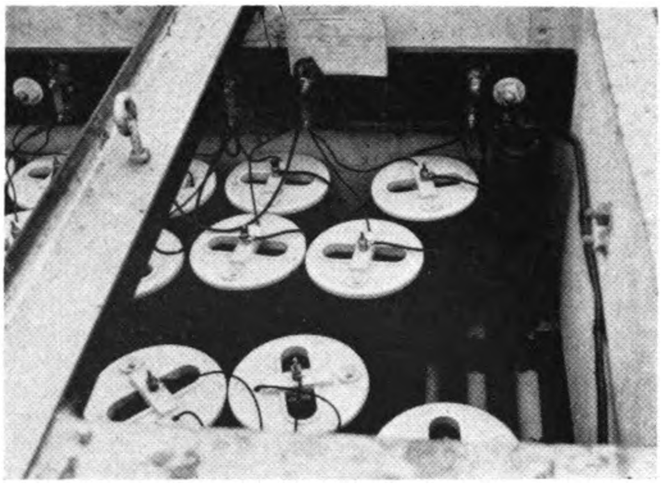
When such an eastward impulse arrives at station-leaving signal 13, (see Fig. 3) track relay 13 WTR is picked up, and a circuit through front contact 2 picks up slow-release relay 13TPBR. At the end of the incoming impulse, relay 13TWR releases, and its back contact 2 closes a circuit which picks up slow-release relay 13CPR. Then, for the duration of the slow release time of TPBR and CPR, about 0.40 sec., an impulse of energy is sent west on track circuit 13T. This impulse is repeated through the track circuits in the station-to-station block to station-leaving signal 6, where a sequence of relay operations occur, which are correspondingly the same as those explained above, and then an impulse goes back eastward to signal 13 thereby completing a cycle of operations.

Referring to Fig. 3, as long as track relay 13WTR gets an impulse to pick it up and drop it at least 20 times per minute, the front and back repeater relays 13WFPR and 13WFBPR remain up because their slow-release periods are long enough to bridge over the time between impulses. With relay 13WFBPR up, signal 13 is controlled to display the green aspect. In a corresponding manner, and referring to Fig. 2. as long as westbound impulses are being received at signal 6, that signal is controlled to display the green aspect.

### Code Cut Off

Referring Fig. 1 and 2, when eastbound train accepts and passes station-leaving signal 6 at West, track circuit 9T is shunted which releases the track relay and controls signal 6 to the Stop aspect. An eastbound train will cut off the eastward code to signal 13 as soon as the eastbound train passes the insulated joints at the fouling point at the west end of West. Thus the eastward code ceases before 9T is shunted. Non-receipt of incoming eastward codes at signal 13 at East, leaves track relay 13WTR down, and, at the end of their slow release periods, relays 13WFPR and 13WFBPR are released which opens the circuit to control signal 13 to display the Stop aspect. Both of the station-leaving signals 13 and 6 continue to display the Stop aspect until the train clears the station-to-station block.

In addition to the control of the station-to-station signals such as 13



**Eveready air-cell type primary batteries at intermediate signals where no a.c. power is available**

and 6, the coded track circuits serve also to control the distant signals such as signal 10. For example, referring to the explanation above, the entrance of an eastbound train into the station-to-station block caused the sending of eastward impulses to cease, and the next discussion is to show how westward impulses can now be sent westward on the track to distant signal 10 to control it. Signals 12 and 10 are normally in the red position and are normally dark, being cleared and lighted by approach control.

When the eastbound train passed signal 6 at station West, as previously related, this cut off the eastward code, and nonreceipt of this eastward code at signal 13 at East causes relay 13WFPR to drop and stay down. This drops 13CCR before the expiration of the slow release of 13TPBR, and, as a result, a circuit is closed to pick up 13TPCR which, with 13TPBR still up, closes a circuit to pick up 13CPR. As 13TPCR picks up, it opens the circuit for 13TPBR which drops at the end of its slow release to again close the circuit for 13TPCR which when up energizes 13TPBR. Thus, these two relays, as a consequence of the timing of their slow release features, will operate to energize and release each other automatically and entirely independent of the receipt of incoming eastward impulses. And each time 13TPBR picks up, it closes the circuit for 13CPR which, as previously explained, causes an impulse to be sent westward on track circuit 13T to distant signal 10. If station-entering signal 12 is at Stop, its yellow-green repeater relay, 12YGPR, controls the polarity of the outgoing track impulses to control distant signal 10 to the yellow aspect. Or if signal 12 is at yellow or green, the polarity of outgoing track impulses is changed to control signal 10 to the green aspect. Polarity of code at signal 10 is detected by two polarized code responsive track relays in series, one follows code on energy of one polarity and the other relay follows code on the other polarity.

### As Train Recedes

As the eastbound train, mentioned before, passes signal 6 at station West, and goes on eastward, the nonreceipt of incoming westward impulses causes outgoing eastward impulses to be fed toward the rear of the receding train, the production of these codes being accom-

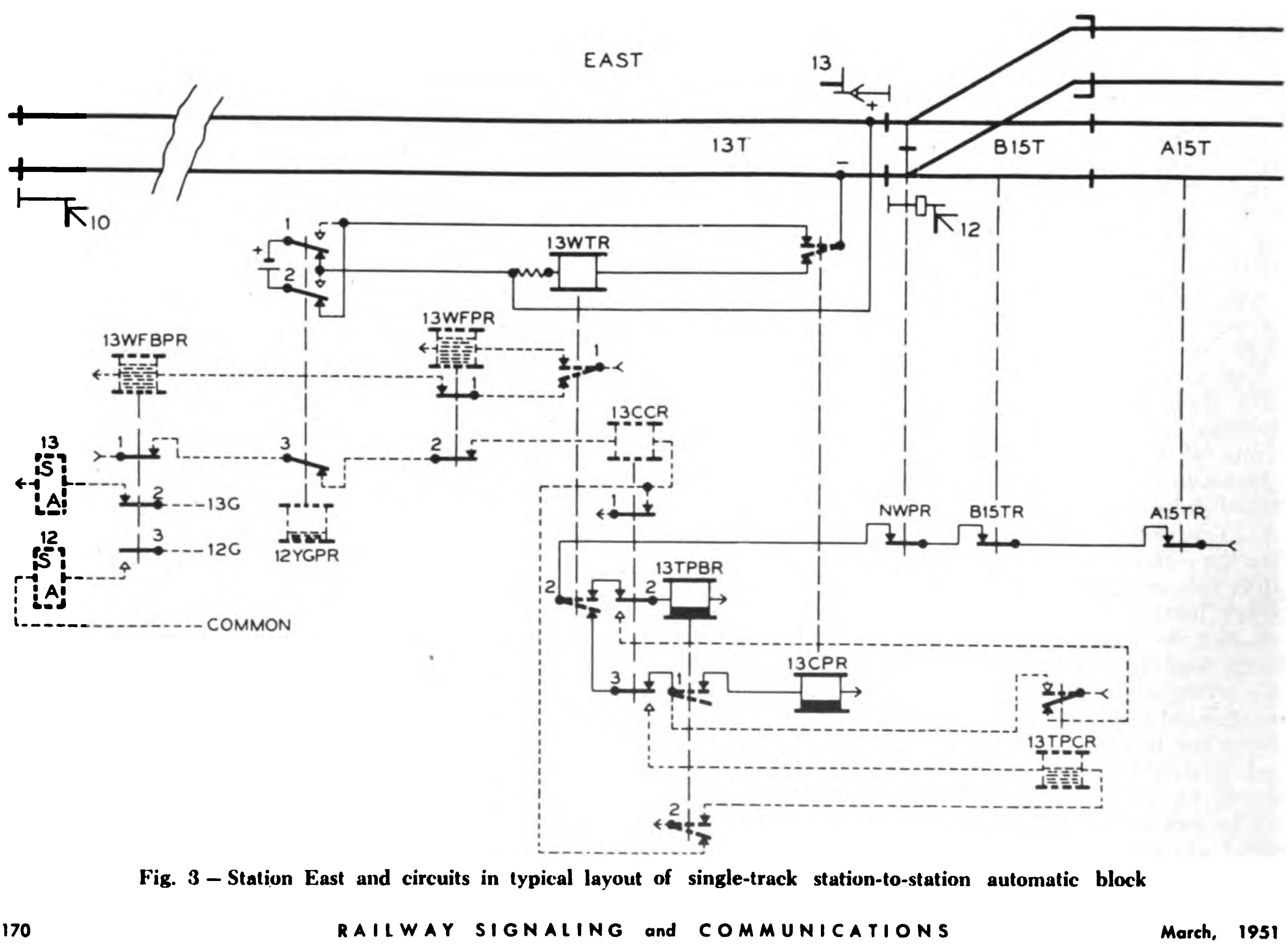
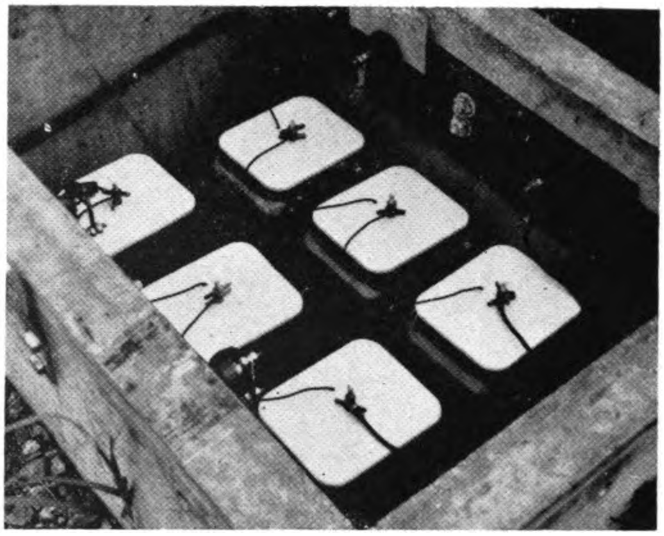



**Fig. 3 — Station East and circuits in typical layout of single-track station-to-station automatic block**

plished in correspondingly the same method as the description above which applied at signal 13.

Thus, with a train in a station-to-station block, the equipment at each of the two station-leaving signals, 6 and 13, causes impulses to be sent in opposite directions toward the train. When the rear of the train clears the station-to-station block, the opposing impulses feed through each other because the timing is slightly different. When the impulses for one direction operate the track relay such as 13WTR at signal 13, then the relays 13WFPR and 13WFBPR are picked up and 13CCR is energized and held up, which releases 13TPCR, and thereby stops the chain action to operate 13CPR to send out impulses—this function then being returned to control from 13WTR, which is dependent on the receipt of incoming eastward impulses from the other end of the station-to-station block. The three track circuits within the limits of each siding layout are the conventional d.c. neutral type, and the control of the station-entering signals within siding limits is accomplished by conventional line control circuits using No. 10 weatherproof Copperweld line wires. For the length of each siding there are seven such wires: three for controls, two for repeaters and two for 110 volt a.c.



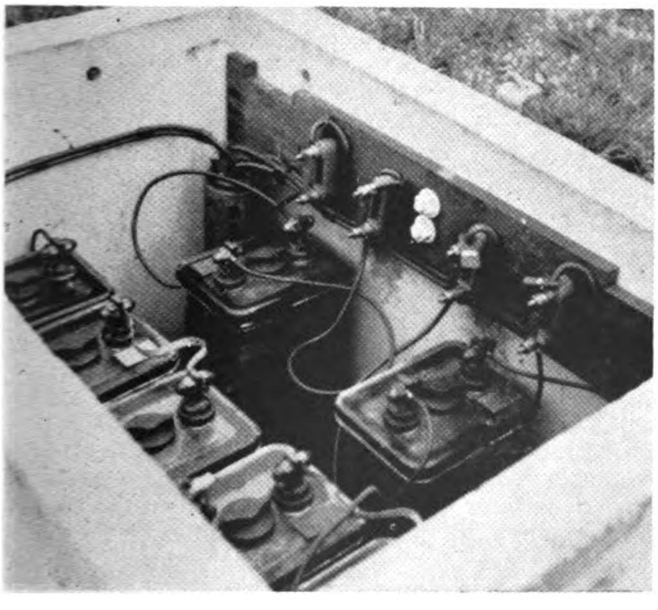
**Edison primary battery is used to feed track circuits where no a.c. power is available**

### Searchlight Signals

The signals on this project are the SA searchlight type. The station-leaving signals are Absolute Stop signals and are so designated by a second "arm" which consists of a reflector type unit 7¾ in. in diameter with red reflector buttons, and a standard-size circular background as shown in the pictures. The signals are on 5 in. by 15 ft. 5 in. masts on pre-cast foundations, and every signal is at the immediate right hand of the track governed. (The center line of the top arm is 14 ft. above top of rail.) An interesting feature of this project is that all the relays are the Type B plug-in. Raco Clearview lightning arresters are used on track circuits, as well as on line circuits at siding.

Each head-block location includes two signals directly opposite, and these signals are about 500 ft. from the siding switch. This distance was adopted rather than 25 to 30 ft., not only to permit short switching moves, but also to reduce the chances for two opposing trains to depart from stations simultaneously with clear signals.

Because of the wide spread distribution of commercial a.c. power in this territory, augmented in recent years by the Rural Electrification Authority of the Federal government, a.c. power was available to feed all the head-block locations and a great many of the distant signal locations. Where a.c. is thus available, it is fed through rectifiers to charge storage batteries. At each such signal, there are 5 cells of 87 ah. Exide battery for operation of relays and as stand-by for the signal lamps, and each track circuit is fed by one such cell. At distant signal locations where no a.c. is available, the signal mechanism, lamp and relays are fed from a set of 10 cells of primary battery, which are either Edison caustic soda cells, or Eveready air-cells, made by the National Carbon Company. Also, where no a.c. is available, the track batteries each consist of three multiple-connected primary cells. Most of these are Eveready and the remainder are Edison.



**Exide storage battery at the signals and for track circuits where a.c. power is available**

### Cables and Wires

The connections from the rails to the cases are No. 9 single-conductor buried cable. This cable and other insulated wires installed on this project were furnished by the Kerite Company. In this project, conventional d.c. neutral track circuits are used for the control of highway crossing signals, and the coded track circuit impulses are taken around these conventional track circuits by using No. 8 insulated Copperweld line wires for distances up to 6,000 ft. These line circuits are, of course, controlled through contacts of the conventional track circuits.

This project was planned and constructed by railroad forces under the direction of C. F. Grundy, signal engineer, the major items of equipment and typical circuit schemes being furnished by the General Railway Signal Company.