New Signal Control Line Circuits

in Centralized Traffic Control Territory

on the Burlington*

By W. F. ZANE
Signal Engineer
Chicago, Burlington & Quincy

Two-wire either-direction line circuits, controlling the signals in both directions in C.T.C. station-to-station blocks, have battery connected at both ends when dormant

THE Chicago, Burlington & Quincy has installed centralized traffic control on a 131-mile subdivision between Hastings, Neb., and McCook, this being a portion of the through route between Chicago and Denver. Color-light automatic block signals, previously in service on this territory, were retained in service as intermediate signals, but new searchlight type signals were installed at C.T.C. controlled locations. The automatic block signaling previously in service included d.c. neutral track circuits, and these were continued in service. The additional OS track circuits are the same type.

Two-Wire Either-Direction Line Circuits With Biased-Neutral Relays

The A.P.B. signal line control circuits were converted to new two-wire either-direction line circuits, which in a station-to-station block, are used to control the eastward signals for an eastbound train movement, or the westward signals for a westbound train movement. An important new feature of the circuits as used on the Burlington is that when in the dormant condition, battery is connected to the line circuits at both ends. Therefore, when eastward signals, for example, are to be cleared, one code control is sent out from the office and that goes to the field station at the signal to be cleared which, in the example being discussed, is at the east end of the station-to-station block. Another new feature of the Burlington circuits is that at the intermediate double signal locations the line circuits extend through back contacts of the HR and SR stick relays for the opposing direction.

Neutral and Biased-Neutral Line Relays

At the intermediate automatic block color-light signals, the selection to display the yellow or the green aspect is accomplished by the use of a neutral and a biased-neutral line relay rather than by the conventional past practice of using a polar line relay. The two relays are connected as shown in the accompanying diagram.

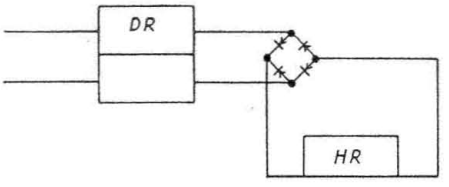
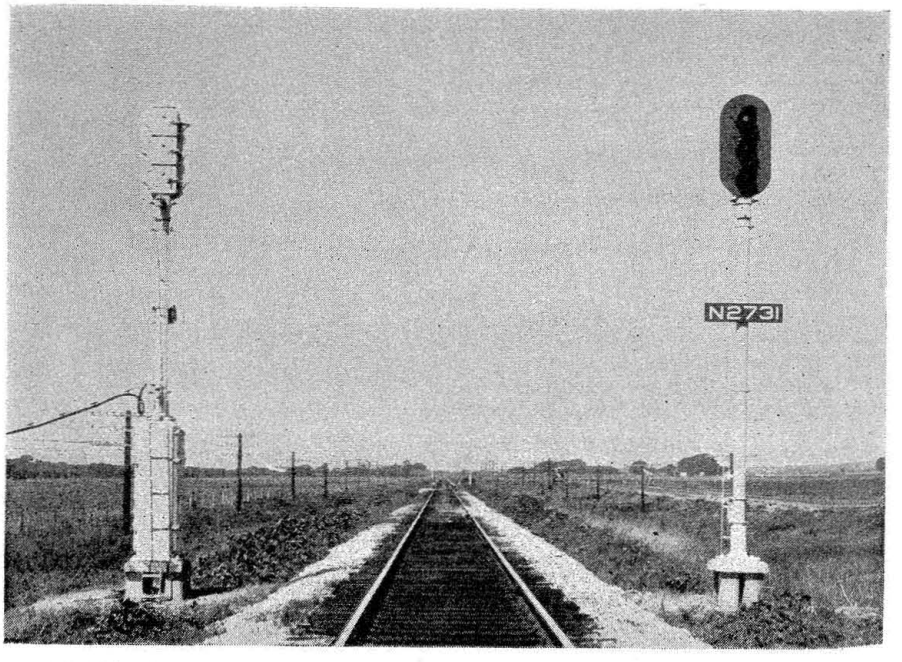


Fig. 1—Connection of relays

Fig. 1. The neutral relay is the HR relay which is so connected to the full-wave rectifier that the current flows in the same direction through the coil of the relay for either polarity of the line wire circuit.

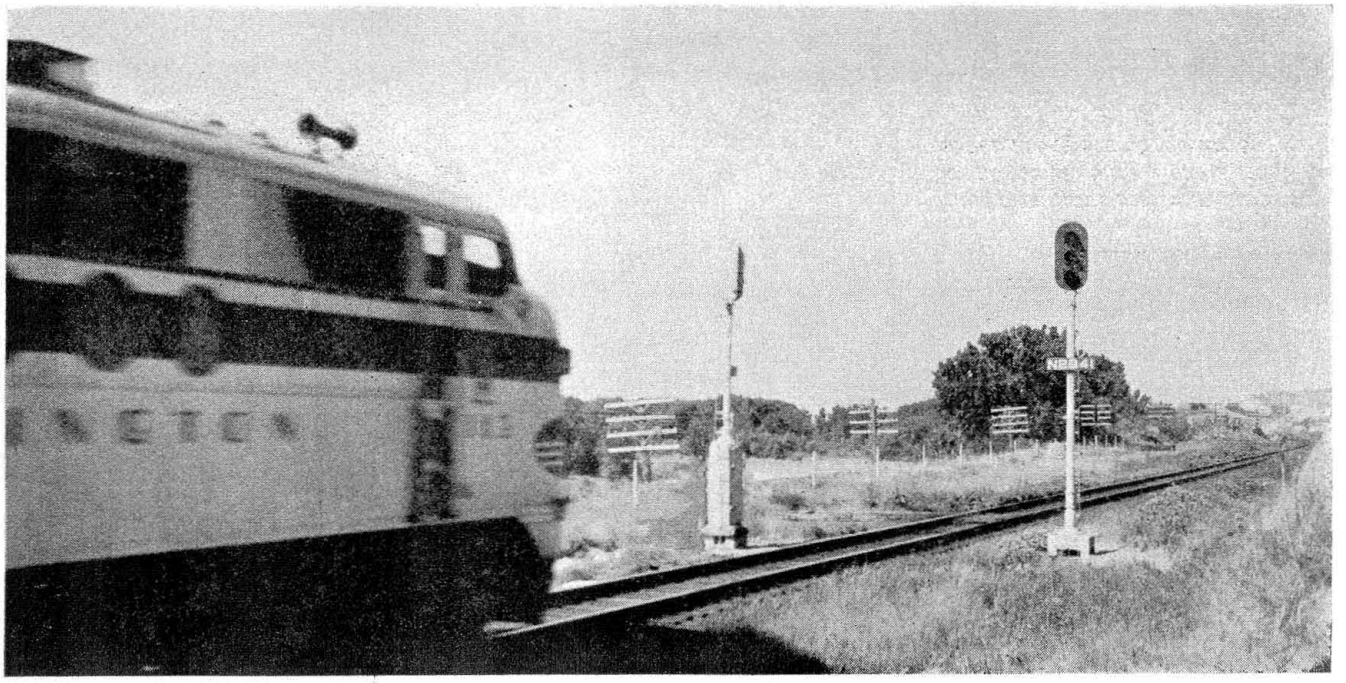
Two-Coil Relay

The biased-neutral relay DR has two coils connected, as shown in Fig. 1, and this relay has a permanent magnet so arranged that if the electro-magnetic force in the coils is of the polarity to aid that of the permanent magnet the relay will not pick up, but if the polarity of the line



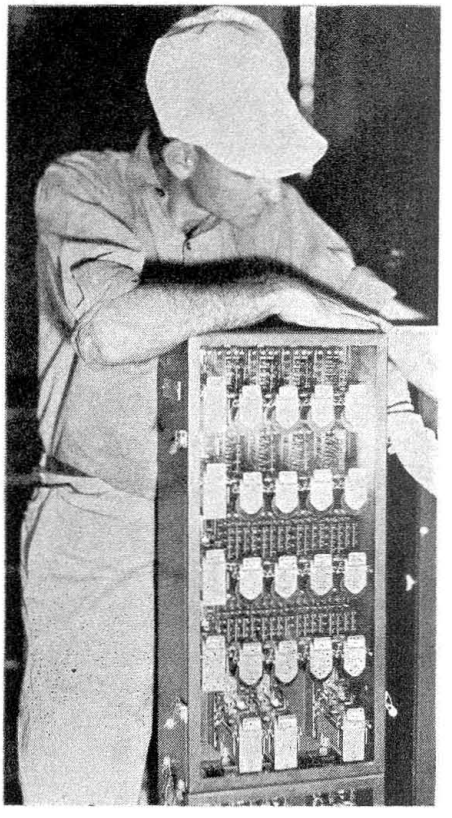
Typical double-intermediate automatic location between Indianola, Neb., and Bartley

*This article is the second of two to appear on the installation of C.T.C. on 131 miles of the C.B. & Q. between Hastings, Neb., and McCook. The first article appeared on page 528 of the August issue of *Railway Signaling*, and should be read first in order to obtain a full understanding of the entire installation, operation thereof, and the circuits explained in this article.



Westbound freight at double-intermediate location N2841-S2842 in the Narrows along the Republic river east of McCook, Neb.

Left—Interior of concrete instrument house at Oxford, Neb., showing part of the equipment. Right—Maintainer E. B. Bright working at rear of C.T.C. machine at McCook



circuit is reversed, so that the electromagnetic force opposes that of the permanent magnet, the relay will pick up. With only the HR relay picked up, the yellow aspect is displayed, but when the polarity of the line circuit is reversed, the DR relay is picked up also to cause the green aspect to be displayed. An advantage is that more contacts are available in the biased-neutral relay than can be furnished as polar contacts in a polar relay.

Details of Circuits

The accompanying diagrams, Fig. 2, show a typical station-to-station block with two double-intermediate automatic signal locations. In this arrangement the circuits are so designed that traffic direction between the two passing tracks is always set

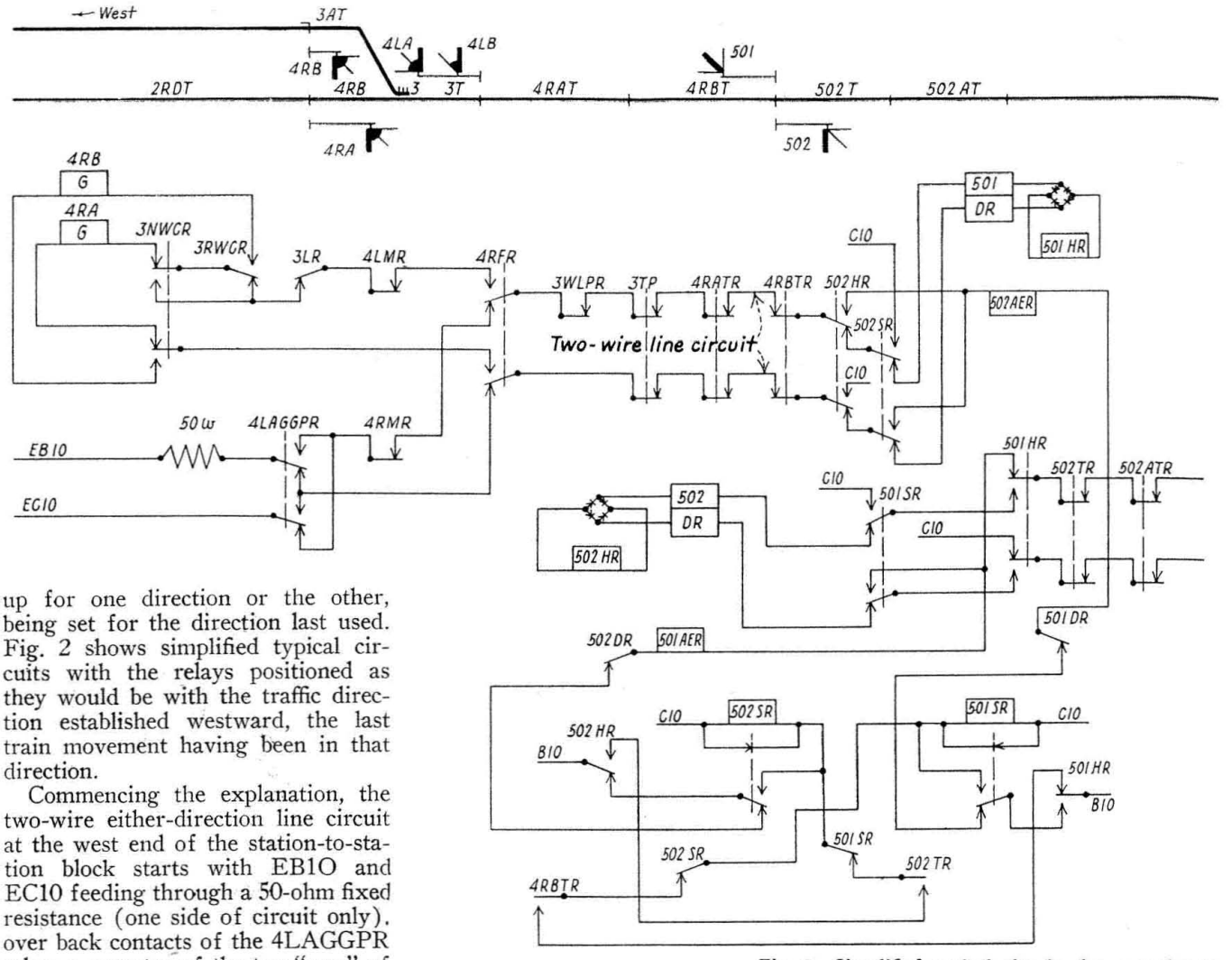


Fig. 2—Simplified typical circuits for a station-to-

up for one direction or the other, being set for the direction last used. Fig. 2 shows simplified typical circuits with the relays positioned as they would be with the traffic direction established westward, the last train movement having been in that direction.

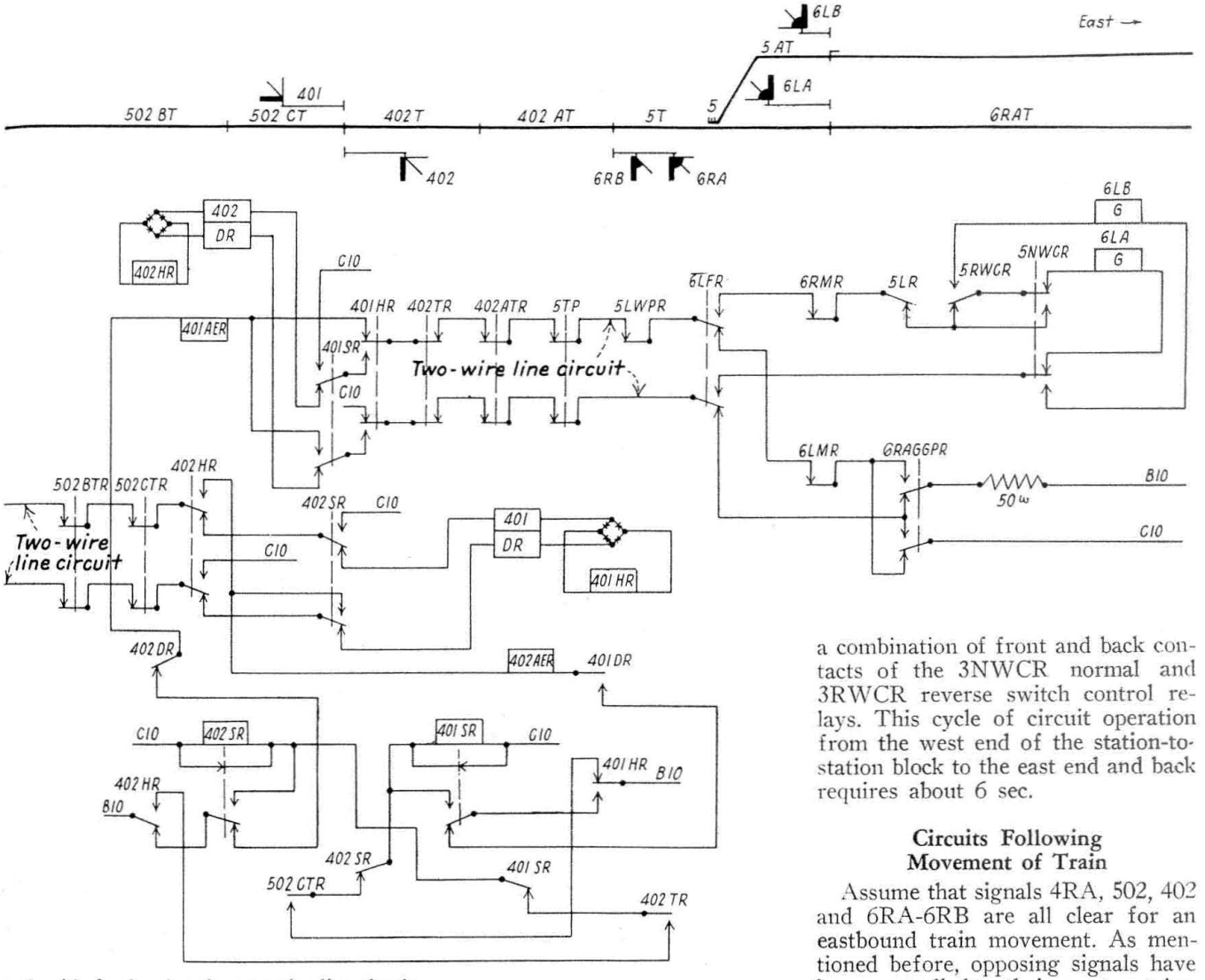
Commencing the explanation, the two-wire either-direction line circuit at the west end of the station-to-station block starts with EB1O and EC10 feeding through a 50-ohm fixed resistance (one side of circuit only), over back contacts of the 4LAGGPR relay, a repeater of the top "arm" of signal 4LA-4LB cleared to green, over a front contact of the 4RMR relay (one side of circuit only), a red repeater of signal 4R, over back contacts of the 4RFR eastward traffic relay, over a front contact of the 3WLPR switch lock repeater relay (one side of circuit only), over front contacts of the 3TP track repeater and 4RATR track relays, and thence to line eastward. This circuit continues eastward to the first double-intermediate signal location 501-502, where it breaks over front contacts of the 4RBTR track relay, back contacts of the 502HR home and 502SR stick relays, through the two coils of the neutral-biased distant relay 501DR, the principles of which were described heretofore, and thence through a full-wave rectifier to the 501HR home relay.

From signal location 501-502, a similar two-wire either-direction line circuit extends to the next double-intermediate signal location 401-402, and then another extends from the latter location to the east end of the station-to-station block. The description thus far has treated these circuits in their normal state, all C.T.C. controlled signals being at stop, and the direction of traffic being established westward due to the last train movement having been in that direction. Consequently both eastward intermediate automatic signals are knocked down to their most restrictive aspect, and westward signals are cleared to the most permissive aspects.

When code for clearing eastward station-departure signal 4RA or 4RB is received at the field station at the west end of the station-to-station block, the eastward traffic relay is picked up over a front contact of the eastward signal control code application relay RGZ in the field coding unit. Neither the RGZ nor 4RFR relay controls are shown in the accompanying circuits.

With the 4RFR relay up, positive battery EB10 and negative battery EC10, which had ben feeding eastward over the line circuit, as described heretofore, is opened. This makes no difference in the position of the 501DR relay at signal location 501-502, as it was already down. However, the line energy having been opened, does result in the de-energization of the 501HR relay, causing the westward automatic signal 501 to assume its most restrictive aspect. With the 501HR relay down at signal location 501-502, positive battery B10 and negative battery C10, feeding eastward over the next two-wire line circuit, is also opened, which results in the de-energization of both the 401DR and 401HR relays at the next intermediate signal location 401-402. At this location, with both the 401DR and 401HR relays de-energized, signal 401 is, likewise, controlled to its most restrictive aspect. The 401DR and 401HR relays down, positive battery B10 and negative battery C10 feeding over the next two-wire line circuit eastward from signal location 401-402 to the east end of the station-to-station block, is similarly opened. However, the line circuit extends eastward to positive battery B10 and negative battery C10 at the east end of the station-to-station block.

With the line circuits in this con-



station block, showing the two-wire line circuit

dition, the positive battery B10 and negative battery C10, just mentioned, feeds westward over the line circuit to signal location 401-402 to control the 402HR and 402DR relays. Since the 401HR relay is down, this is accomplished by the circuit extending over back contacts of the 401HR and 401SR relays. Relay 402HR is a neutral relay and relay 402DR is a biased-neutral relay, as described before.

If signal 6RA-6RB is at Stop or Restricting, the 6RAGGPR relay will remain down, and, therefore, only the 402HR relay will pick up for controlling signal 402 to Approach. On the other hand, if signal 6RA-6RB is cleared to a more favorable aspect than Stop or Restricting, the 6RAGGPR relay is energized. This action pole changes the line circuit westward, causing the 402DR biased-neutral relay to pick up, as described before, and in addition, to control signal 402 to the Clear aspect.

The 402HR relay energized results in positive battery B10 feeding over a back contact of the 401HR relay, de-energized as described before, over back contacts of the 401SR and 401DR relays, de-energized as explained heretofore, through the coils of the 402AER approach-lighting relay, over a front contact of the 402HR relay and thence to line and westward over a front contact of the 502CTR relay.

Negative battery C10 for this circuit is picked up over another front contact of the 402HR relay. Thus, the line circuit is energized westward to signal location 501-502. The operation of the circuits at this location is identical to that at location 401-402, and which cascades the energized line westward to the west end of the station-to-station block.

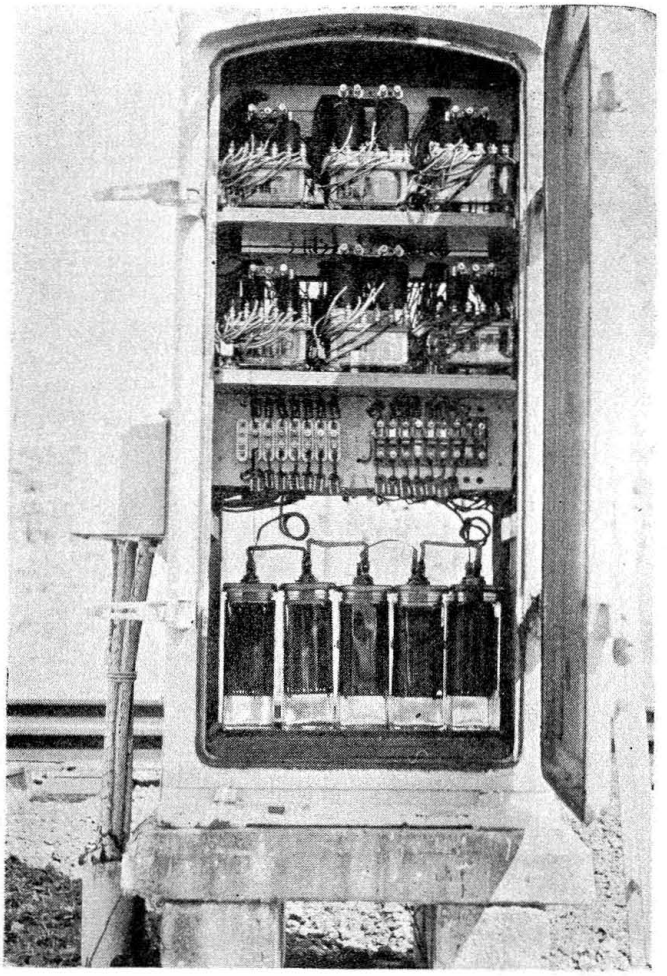
As described before, the 4RFR relay is up, and as a result the energy on the line from intermediate location 501-502 is fed over front contacts of that relay ot the searchlight operating mechanism of signal 4RA or 4RB, breaking on one side only over a front and back contact of the 4LMR and 3LR relays, respectively. Clearing of either signal is selected over a combination of front and back contacts of the 3NWCR normal and 3RWCR reverse switch control relays. This cycle of circuit operation from the west end of the station-to-station block to the east end and back requires about 6 sec.

Circuits Following Movement of Train

Assume that signals 4RA, 502, 402 and 6RA-6RB are all clear for an eastbound train movement. As mentioned before, opposing signals have been controlled to their most restrictive aspects. When the eastbound train passes station departure signal 4RA and enters track section 3T, the 3TP track repeater relay drops and opens the line circuit, which causes signal 4RA to display Stop. The line circuit is again opened when the train enters track section 4RAT and drops the 4RAT relay, through which the line circuit passes over front contacts. At signal location 501-502, when the train enters track section 4RBT, the 4RBTR track relay drops, again again opening the line circuit. When the train passes signal 502, the 502TR relay drops, which opens the line circuit from the east, causing relay 502HR to drop and cause signal 502 to display Stop. Also when the 502TR relay drops a circuit is completed, momentarily before the 502HR relay has a chance to drop, to pick up the 502SR stick relay to hold traffic direction eastward. This circuit starts momentarily with positive battery B10 over a front contact of the 502HR relay, back contacts of the 502TR and 501SR relays, through the coils of the 502SR relay, and thence to negative battery C10. When the

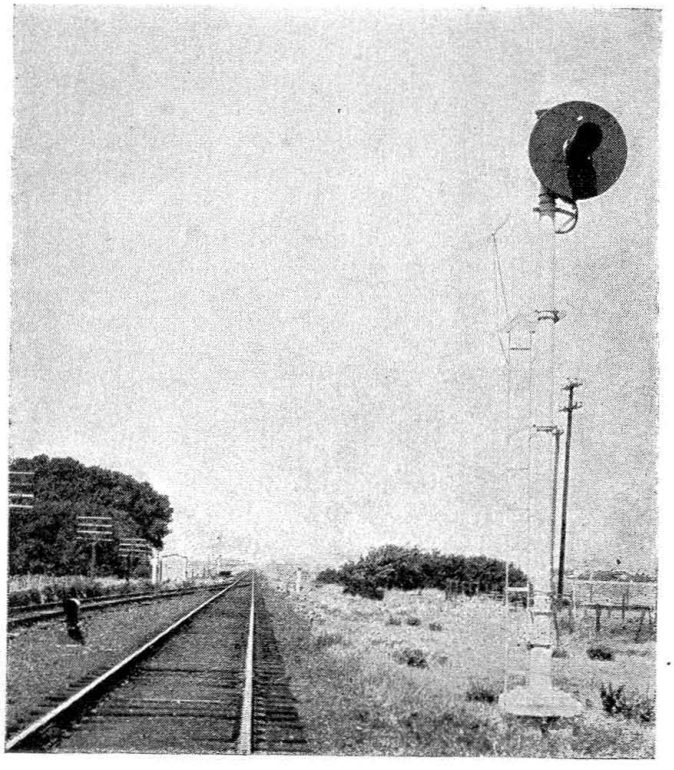
502HR relay drops, positive battery B10 feeds over a back contact of that relay and a front stick contact of the 502SR relay to hold that relay up. With the 502SR relay up energy is prepared to be fed westward on the line circuit over front contacts of the 502SR relay, and furthermore the 501DR and 502HR relay circuits are open to retain signal 501 at Stop. When the train clears track section 4RBT, energy again flows westward to permit clearing of signal 4RA or 4RB for another eastbound movement if desired. On the other hand, if the 4RFR relay has been released with the restoration of C.T.C. machine levers to normal, energy also feeds eastward from that location to signal location 501-502, thus placing energy on the line at both ends as mentioned heretofore.

When the train clears the track section between signal locations 501-502 and 401-402 the 502HR relay, but not the 502DR relay, again picks up, controlling signal 502 to Approach. The 502SR relay circuit also is opened when the 502HR relay again picks up, the second pick-up circuit for 502SR relay already being reopened when the 502TR relay again picked up. Signal 501 is retained at Stop, because energy is fed west over the line with the 502HR relay up instead of the 502SR, and relays 501DR and 501HR are still down.



Interior of a typical base-of-mast instrument case at double intermediate automatic signal location

The circuit operation at signal location 401-402 is similar to that at location 501-502. When the train clears signal 6RA-6RB the 402HR relay again picks up and pole changes the line circuit west, causing the biased-neutral relay 502DR to function and clear signal 502 to green. When the eastbound train has cleared the track section between signal location 401-402 and 6RA-6RB, controls are effected to clear signal 402 to yellow. Signal 401 is retained at Stop by controls similar to signal 501.



Typical high and dwarf station-leaving signals at the west end of Arapahoe, Neb.

Traffic direction is maintained until the eastbound train is by signal 6LA or 6LB, after which it can be changed if desired. In lining up for a westbound train movement the function of the two-wire either-direction line circuit is similar to that for an eastbound train movement.

The two wires in the line controls for signals are used also in the controls for the electric locks on hand-throw switches. The circuit schemes for the automatic controls of these locks were explained on page 439 of the July, 1945 issue of *Railway Signaling*, a new feature of the 1946 installation being a check to be sure that the door of the lock case is closed. If a train crew departs without closing the door of the case for the electric lock, the track occupancy lamp for the short track circuit will continue to be lighted. In such an instance the dispatcher must call someone to go to the switch and close the door.

This C.T.C. installation was engineered and installed by the Burlington signal forces. The major items of signaling equipment were furnished by the General Railway Signal Co.