Field Circuits For Simplified Semi-Automatic Signaling

By Homer W. Dunn

VARIOUS comments and inquiries have been received with reference to the editorial in the March issue of *Railway Signaling,* which included no specific statements concerning the local control circuits at the passing tracks, while the diagrams as well as the discussion did not include intermediate signaling. The thought at that time was that details of this nature would be determined by the arrangement of circuits and the number of line wires which are in service on existing installations of automatic block signaling. Some of the comments received, however, suggest that an explanation be given of at least one possible arrangement of automatic intermediate signals, as well as office-controlled field circuits for the control of the signals, and for inter-connections and lock-outs of opposing or conflicting semi-automatic signals in a group. The following discussion applies to a scheme of circuits which might possibly be practicable under certain conditions.

In view of the fact that the station-to-station semi-automatic signals such as 2R1 and 2R2 at station C as well as the corresponding opposing signals 2L1 and 2L2 at station B, all normally display the Stop aspect, and that only one of these signals can be cleared at any one time, the head-on protection, for trains between passing tracks, is complete. For this reason, the intermediate signals need not necessarily be staggered for the purpose of providing head-on protection. In the diagrams herewith, the intermediates are shown as two double locations, but the signals for one direction could be spaced independently of those for the other direction, thus providing efficient operation of following trains, as well as expediting operations where one of two trains is to enter or leave a passing track.

The following discussion applies to the arrangement of six semi-automatic signals at each passing track, but as explained in the first column on page 140 of the March issue, if station-departure signals are desired, only six of the signals would be semi-automatic, and, therefore, the proposed circuit arrangement would apply in so far as the number of office-controlled relays and basic inter-connections are concerned.

Office Control of Signals

As explained on page 137 of the March issue, the objective of the proposed signal arrangement is to minimize the equipment at each passing track, not so much as a means of economy in this respect strictly, but to arrive at a control arrangement for semi-automatic signals which can be justified economically on extended mileages of existing automatic block, where the hand-throw switch stands are to remain in service. The purpose of the semi-automatic signaling, of course, is to direct train movements by signal indications which take the place of time-tables and train orders.

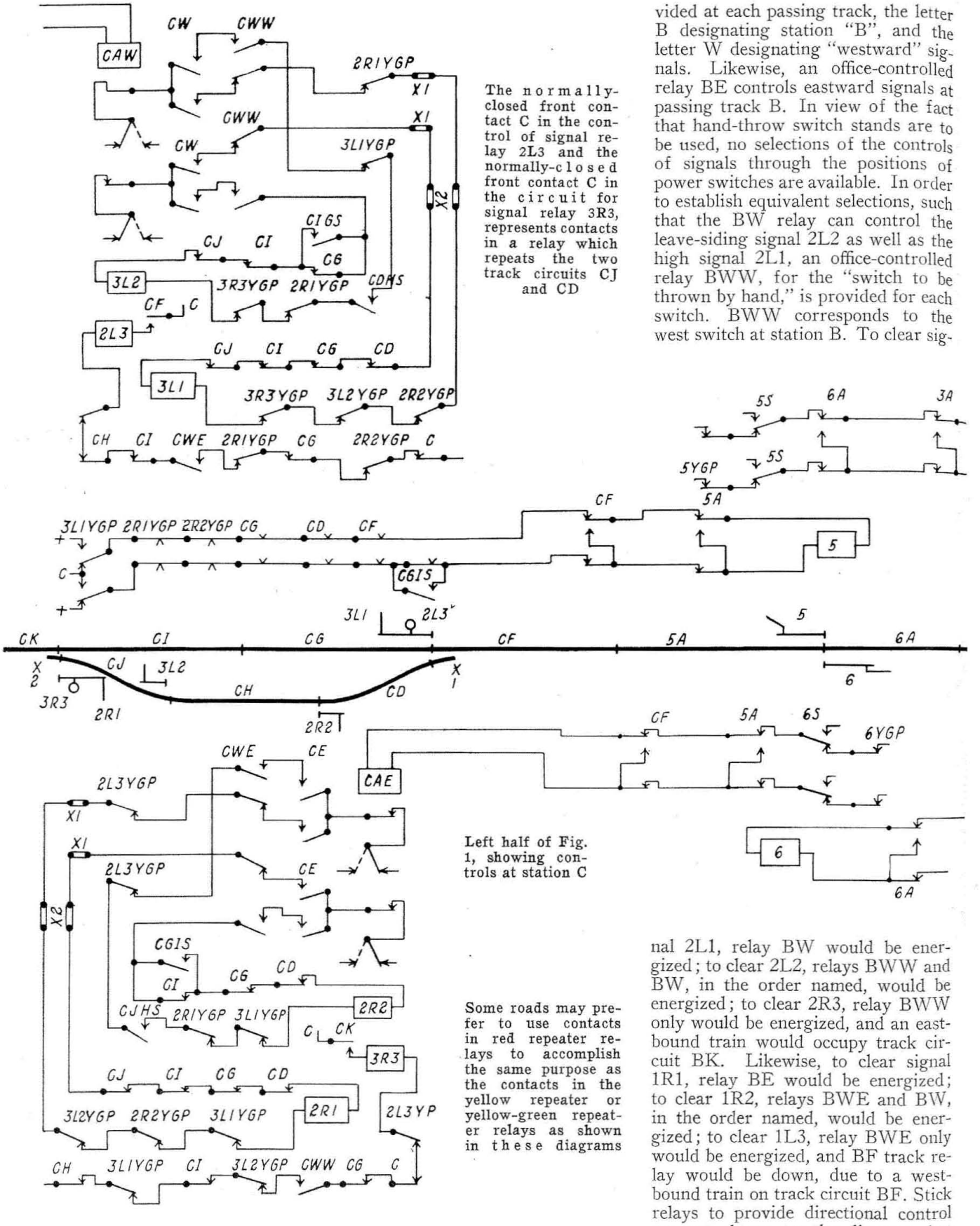
With only six semi-automatic signals at each passing track, one easy method would be to control each signal by an individual office-controlled relay. However, perhaps recognition of facts concerning the directions in which trains are headed, and the use of relays which give the equivalent of selections which would be established if power switches were used, can be the basis of controlling more than one signal by an office-controlled field relay.

Diagrams for several different circuit schemes have been developed. A conclusion to date, however, is that penurious reduction in the controls between the office and the field stations is not advisable. The use of normally clear semi-automatic signals, with an office control of a knock-down for the direction of signals not to be used by an approaching train, is one possibility. Normal-clear for one direction, with a knock-down for the other, likewise is possible. Normal-Stop signals, with approach clearing, likewise is intriguing, but may be too expensive, and may involve I. C. C. Rule 207. A point of importance is that the leverman should have control of each semi-automatic signal that is to be cleared. Furthermore, the closed-circuit principle should be followed, in that the placing of a signal to the Stop aspect should not depend on the *energization* of a relay, except that this principle can logically be used with reference to the lever office control of the "take-away" of the *one* signal in a set of opposing and conflicting signals. Nothing worse than a train delay would result, if an office-controlled field relay failed to pick up or be released by lever control because automatic controls are in effect in the field. An important consideration is that the scheme of control circuits should permit the control of power switches, if desired later, especially at locations where the grades are adverse.

Four Office-Controlled Relays

Based on these considerations, a diagram for one scheme is shown herewith. This scheme is not being advocated as something finished and perfect, but is presented to encourage study of the subject. Comments and suggestions concerning this or other schemes will be welcome. The scheme herein proposed is intended for application where the regular absolute permissive block system of circuits is now in service for existing normal-clear automatic signaling. For those roads which do not have such circuits, and do not care to install them, another scheme can be developed.

The arrangement of circuit diagrams shown herewith were prepared primarily to illustrate the basic schemes, and do not include all of the possible connections or perhaps all which may be needed. Contacts in track repeater relays would be used, for obvious reasons. The symbols for the relays for the control of the semi-automatic signals represent primary control of the semi-automatic signals, other local circuits will be required for actual control of the signal mechanisms or lamps. The controls for the take-siding signals as well as the leave-siding signals are for the preliminary aspects, and further local circuits can be designed as explained in the second column on page 138 of the March issue. Time locking is suggested in connection with the controls of all the semi-automatic signals, but no such



The normally-closed front contact C in the control of signal relay 2L3 and the normally-closed front contact C in the circuit for signal relay 3R3, represents contacts in a relay which repeats the two track circuits CJ and CD

Left half of Fig. 1, showing controls at station C

Some roads may prefer to use contacts in red repeater relays to accomplish the same purpose as the contacts in the yellow repeater or yellow-green repeater relays as shown in these diagrams

details are shown on the circuit diagrams.

Following trains, which are operated through on the main track, can follow one another at regular automatic block spacing as in ordinary signaling, providing, of course, that the leverman leaves the levers in the correct positions. Stick control of the semi-automatic signals can be used if desired, but this feature is not shown in the diagrams.

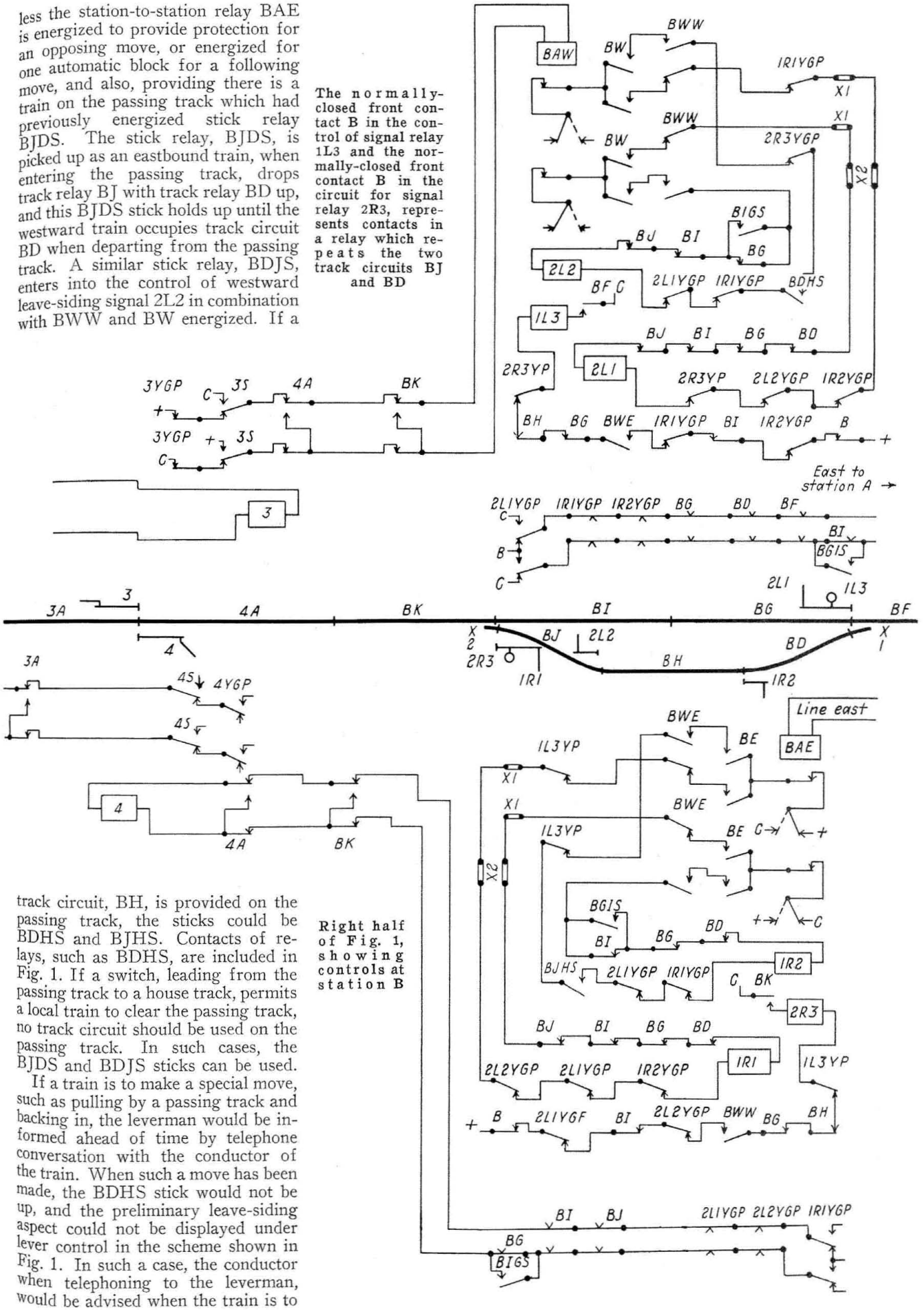
Referring now to Fig. 1, an office-controlled relay, such as BW, is provided at each passing track, the letter B designating station "B", and the letter W designating "westward" signals. Likewise, an office-controlled relay BE controls eastward signals at passing track B. In view of the fact that hand-throw switch stands are to be used, no selections of the controls of signals through the positions of power switches are available. In order to establish equivalent selections, such that the BW relay can control the leave-siding signal 2L2 as well as the high signal 2L1, an office-controlled relay BWW, for the "switch to be thrown by hand," is provided for each switch. BWW corresponds to the west switch at station B. To clear signal 2L1, relay BW would be energized; to clear 2L2, relays BWW and BW, in the order named, would be energized; to clear 2R3, relay BWW only would be energized, and an eastbound train would occupy track circuit BK. Likewise, to clear signal 1R1, relay BE would be energized; to clear 1R2, relays BWE and BW, in the order named, would be energized; to clear 1L3, relay BWE only would be energized, and BF track relay would be down, due to a westbound train on track circuit BF. Stick relays to provide directional control are not shown on the diagram, but could be provided if considered desirable.

Continuing discussion of Fig. 1, when eastward leave-siding signal 1R2 is to be cleared, office-controlled relays BWE and BE are energized. The relay, 1R2, is not energized un-

less the station-to-station relay BAE is energized to provide protection for an opposing move, or energized for one automatic block for a following move, and also, providing there is a train on the passing track which had previously energized stick relay BJDS. The stick relay, BJDS, is picked up as an eastbound train, when entering the passing track, drops track relay BJ with track relay BD up, and this BJDS stick holds up until the westward train occupies track circuit BD when departing from the passing track. A similar stick relay, BDJS, enters into the control of westward leave-siding signal 2L2 in combination with BWW and BW energized. If a track circuit, BH, is provided on the passing track, the sticks could be BDHS and BJHS. Contacts of relays, such as BDHS, are included in Fig. 1. If a switch, leading from the passing track to a house track, permits a local train to clear the passing track, no track circuit should be used on the passing track. In such cases, the BJDS and BDJS sticks can be used.

If a train is to make a special move, such as pulling by a passing track and backing in, the leverman would be informed ahead of time by telephone conversation with the conductor of the train. When such a move has been made, the BDHS stick would not be up, and the preliminary leave-siding aspect could not be displayed under lever control in the scheme shown in Fig. 1. In such a case, the conductor when telephoning to the leverman, would be advised when the train is to

The normally-closed front contact B in the control of signal relay 1L3 and the normally-closed front contact B in the circuit for signal relay 2R3, represents contacts in a relay which repeats the two track circuits BJ and BD



Right half of Fig. 1, showing controls at station B

depart, and then a trainman would throw the switch to the reverse position, at which time, the signal would display a proceed aspect without the inclusion of the BDHS stick feature being required. If the preliminary aspect is to be displayed on the westward take-siding signal 1L3, the office-controlled relay BWE is energized.

With a track circuit BH on the passing track, the westward take-siding signal preliminary aspect clears with BWE and BH up, and with BF down. Thus the selection between the leave-siding 1R2 and the take-siding 1L3 is accomplished automatically, and both signals are controlled by BWE relay energized.

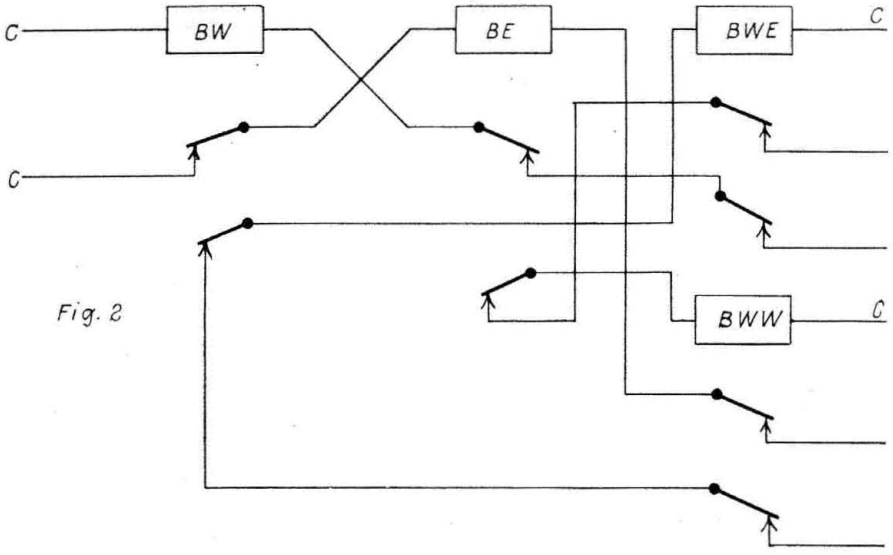


Fig. 2

Fig. 2—Diagram of circuit interlocking between the office-controlled relays for control of the six semi-automatic signals at a typical passing track. BW, when energized, opens the control circuits for BE and BWE down, (i.e.) they are locked down; BE locks BW and BWW; BWE locks BW and BWW; and BWW locks BE and BWE

If office-controlled relays BWW and BW are energized to clear westward leave-siding signal 2L2, and the leverman inadvertently operates the lever for take-siding signal 2R3, nothing would happen to knock down 2L2. In this instance, BWW is already up in the control for 2L2, but 2R3 does not clear, because BK is not released, and, furthermore, BH is down, because, presumably a train is occupying the passing track, otherwise there is no need to clear 2L2.

Checks and Lock-Outs of Opposing Station-to-Station Signals

The following example would apply when no train is occupying the over-all station-to-station block between westward signal 2L1 at station B and the eastward signal 2R1 at station C, and the present objective is to clear westward signal 2L1. When office-controlled relay BW at station B is energized, the coil of relay 2L1 is connected through contacts of BAW which is controlled by the two line wires extending westward. This line circuit extends through the ordinary arrangements used on normal-clear absolute permissive block automatic intermediate signaling, the only difference in this instance being that signal 5 normally displays the yellow aspect because signal 3L1, at station C, normally displays the Stop aspect. This line circuit is checked through front contacts of all track relays between signal 2L1 at station B and signal 2R1 at station C. These track circuits include turnouts BD, BJ and CD, but not CJ; the CJ not being included so that an eastward train can be pulling in at the west end of passing track C, while westward signal 2L1 at station B can be cleared for a westbound train to proceed toward station C. This is a typical example which would apply for corresponding moves. The switch circuit controllers do not shunt the track circuits, and the line circuits are not taken through contacts in these controllers. Normally-closed contacts in the switch circuit controllers are included in the controls of the relays for the high signals such as 2L1 and 1R1. In an actual installation, contacts in switch repeater relays would be used. The reasons for controlling 2L1 by the position of the switch at the east end of station B are explained on page 138 of the March issue.

The control of westward leave-siding signal 2L2 at station B includes a front contact in track relay BG, but this contact is connected in parallel with a normally-open front contact of BIGS stick relay which is held up while the rear end of an eastbound train occupies track circuit BG. The purpose of this stick relay contact is to allow westward signal 2L2 to be cleared for a westbound train to depart from the passing track as soon as the rear of an eastbound train clears track circuit BI. By using an additional track circuit, with insulated joints on the main line opposite the fouling clearance, further time could be saved when making such moves. For discussion of this matter, see the second column on page 139 of the March issue. The line circuits or local circuits check the Stop position of the opposing station-to-station opposing semi-automatic signals.

When signal 2L1 or 2L2 is energized, the corresponding YGP relay picks up, and the feed to the line to the west is opened, so that signals 2R1 and 2R2 at station B cannot be cleared, even if the leverman manipulated the levers for those signals. Corresponding circuits provide that if 1R1 or 1R2 at station C is cleared, manipulation of levers for 1L1 and 1L2 would not "knock down" a proceed aspect on 1R1 or 1R2. This feature should meet the requirements of I.C.C. Rule 412, with respect to station-to-station opposing signals.

Locking Between Office-Controlled Relays at Passing Tracks

Not only with reference to station-to-station opposing signals, but also with reference to the signals at a passing track, the circuit interlocking should be such that only one route can be established by clearing a signal of a set of opposing or conflicting signals, at any one time, regardless of lever manipulation, and regardless of whether the proper office-controlled field relay is energized when it should be, following corresponding operation of that lever with the intention of clearing a certain signal.

A control machine can be made with seven-position levers, as explained on page 142 of the March issue, but with a revised suggestion to place a lever below the portion of the track diagram representing each passing track, and to use each such lever to control the six signals at the corresponding passing track. This machine could include the time locking, as explained in the second column on page 143 of the March issue. The present forms of machines with individual levers, or with three-position levers, can be used, however, if desired, but the time locking would be in the field.

The diagram Fig. 2 shows typical circuit interlocking between the office-controlled relays, as, for example, at passing track B. These detail circuits are not included in the basic diagram Fig. 1, but should be incor-

porated in complete plans. Office-controlled relays BE and BW need not be energized simultaneously, therefore, either relay, when up, opens the feed to the coil of the other. Relays BW and BWE need not be up simultaneously, therefore, BW opens BWE, and BWE opens BW. Likewise, BE opens BWW, and BWW opens BE. Relay BE energized cannot be permitted to open BWE, otherwise these two relays could not be used in the energized position for the clearing of eastward leave-siding signal 1R2. Likewise, BW energized should not open BWW.

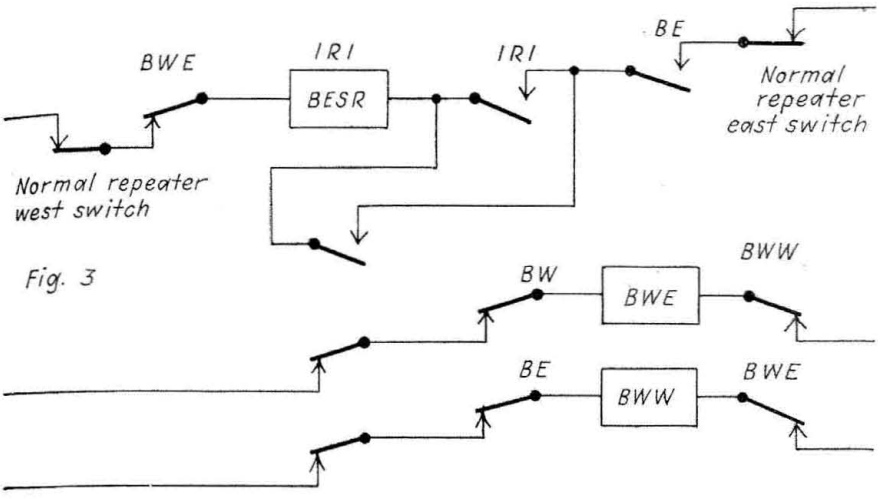


Fig. 3—Diagram of stick relay for locking the "switch" relays

Stick Locking of "Switch" Relays

This leads to a consideration of Fig. 1, that might indicate a violation of Rule 412, which, however, is prevented by auxiliary circuits not shown of Fig. 1. For example, eastward high signal 1R1 has been cleared by energizing BE. By inadvertent operation, the leverman might place the lever for the eastward leave-siding signal 1R2 in the clearing position, which from the appearance of circuits in Fig. 1 would indicate that BWE would be energized, thus opening the control of high signal 1R1, and thus might take away the proceed aspect of 1R1, by operation of a lever other than that for the control of 1R1. As shown in Fig. 3, with the two relays BE and 1R1 up, a circuit is closed to energize a stick relay BESR, which can stick up through front contacts of BE and a back of BWE. The pickup as well as the holding for the stick could include a contact closed when the switch involved is in the normal position. The control of the mechanism for signal 1R1 breaks through a front contact of BESR. When BESR is up, the circuit for relay BWE is opened, and, therefore, with 1R1 clear, inadvertent operation of an independent lever for 1R2 would not "knock down" a proceed aspect on 1R1. In view of the fact that BE and BWW are never energized, simultaneously, there seems to be no good reason why BESR stick relay, when energized, should not open the control for BWW as well as BWE. The relay BESR is typical, and a similar BWSR relay is provided, as well as corresponding relays at other passing tracks.

Control of Power Switch

The relays such as BESR and BWSR provide a means for "locking", the "switch to be thrown" relays, BWE and BWW, when the high signals 1R1 or 2L1 are cleared. If power switches are used, it would seem that these stick relays might be used to "lock" the switches in the normal position. This is assuming that either relay BE or BW, as preliminary controls for the respective high signals, would also be effective in operating both switches to the normal position, if they were not already so positioned.

Stick relays such as BWEBE1R2S could lock the switch at the east end, in the reversed position, the switch formerly having been operated by BWE up. The pickup of the stick would include a contact in the switch closed when reversed. The same idea might be applied for the operation of the switch and the clearing and locking for a westbound move into the passing track. If such control, operation and checking is practicable, possibly a power-operated switch can be installed without additions to the office-controlled field station arrangements.

Combined Control Check

In any of the proposed signal controls involving two office-controlled relays in the energized position, such as BWE and BE energized to clear eastward leave-siding signal 1R2, protection should be provided such that both relays must be energized in order to clear the signal intended, and, furthermore, no other signal should clear if either of the relays does not pick up.

When establishing the control for eastward leave-siding signal 1R2, office-controlled relays BWE and BE at passing track B are energized in the order named, which prevents the possibility of 1R1 being cleared by BE only, this feature being included in Fig. 1. If BWE picks up but BE does not, the westward take-siding signal 1L3 would display the preliminary aspect if a westward train occupies BF, and if no train is occupying the passing track BH. All train movements into a passing track are from a standing start, and at a low speed, under authority of a yellow aspect, and prepared to stop short of train or obstruction. This is standard practice, regardless of whether hand-throw or power switches are used. No hazard, therefore, seems to be involved. If the hazard is considered important, the use of a track circuit on the passing track would, under these circumstances, prevent the take-siding signal from being cleared. If a track circuit on the passing track is objectionable,

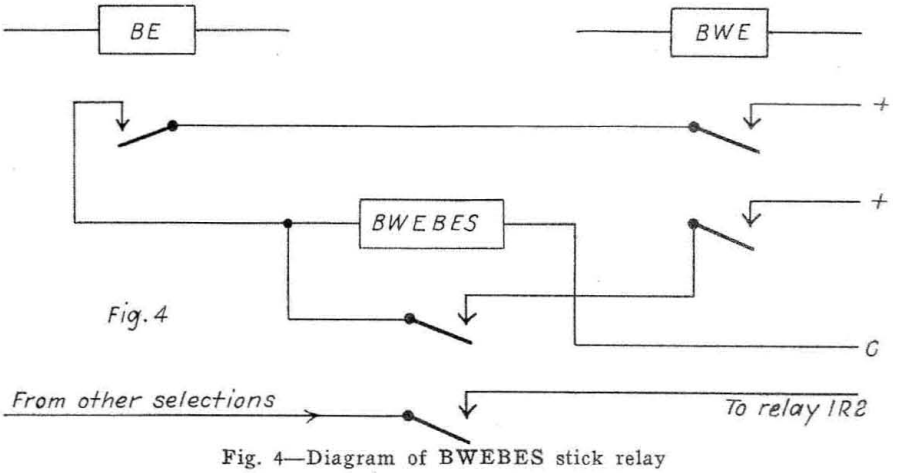
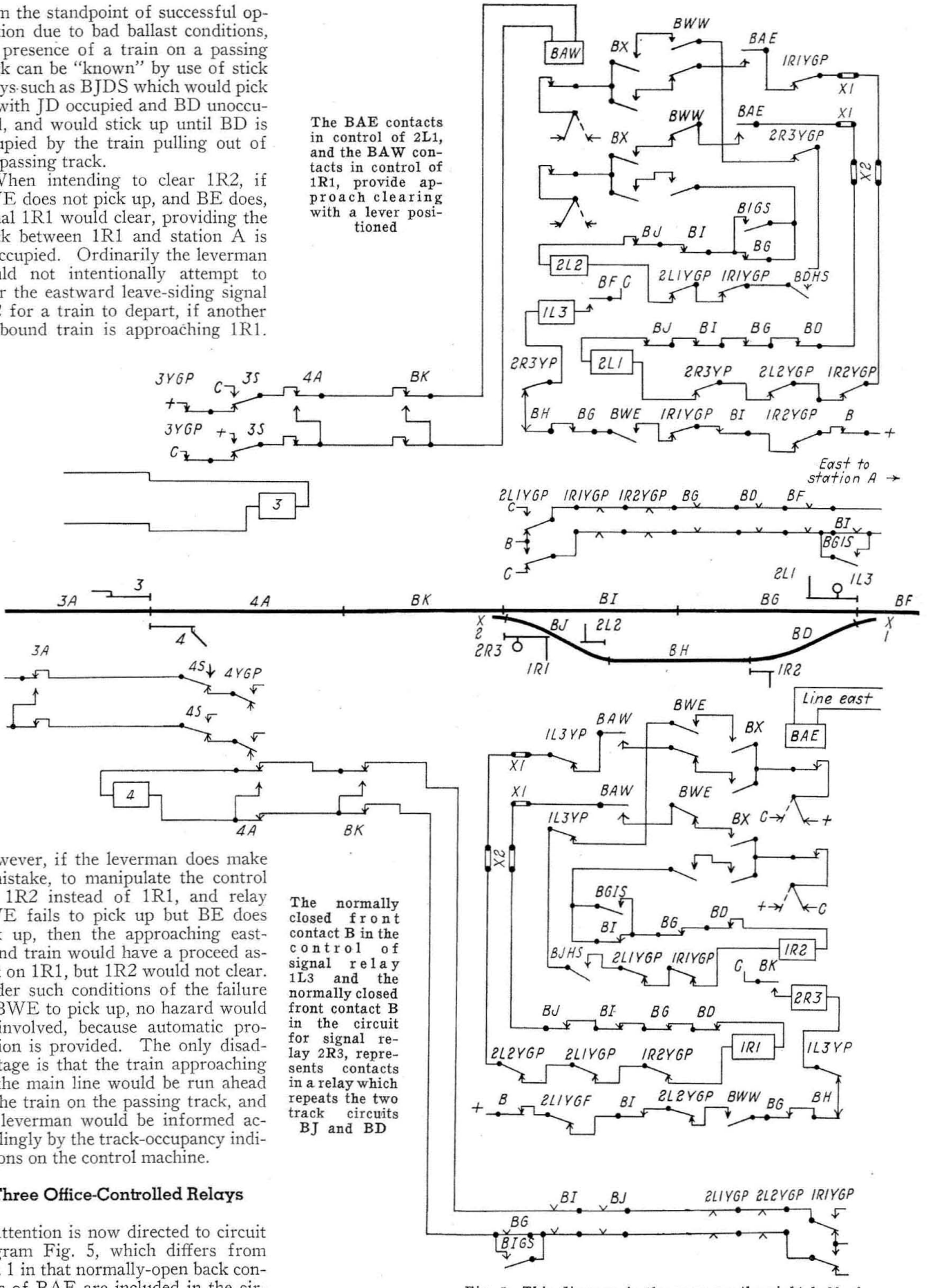


Fig. 4—Diagram of BWEBES stick relay

from the standpoint of successful operation due to bad ballast conditions, the presence of a train on a passing track can be "known" by use of stick relays such as BJDS which would pick up with JD occupied and BD unoccupied, and would stick up until BD is occupied by the train pulling out of the passing track.

When intending to clear 1R2, if BWE does not pick up, and BE does, signal 1R1 would clear, providing the block between 1R1 and station A is unoccupied. Ordinarily the leverman would not intentionally attempt to clear the eastward leave-siding signal 1R2 for a train to depart, if another eastbound train is approaching 1R1.

The BAE contacts in control of 2L1, and the BAW contacts in control of 1R1, provide approach clearing with a lever positioned



The normally closed front contact B in the control of signal relay 1L3 and the normally closed front contact B in the circuit for signal relay 2R3, represents contacts in a relay which repeats the two track circuits BJ and BD

However, if the leverman does make a mistake, to manipulate the control for 1R2 instead of 1R1, and relay BWE fails to pick up but BE does pick up, then the approaching eastbound train would have a proceed aspect on 1R1, but 1R2 would not clear. Under such conditions of the failure of BWE to pick up, no hazard would be involved, because automatic protection is provided. The only disadvantage is that the train approaching on the main line would be run ahead of the train on the passing track, and the leverman would be informed accordingly by the track-occupancy indications on the control machine.

Three Office-Controlled Relays

Attention is now directed to circuit diagram Fig. 5, which differs from Fig. 1 in that normally-open back contacts of BAE are included in the circuit controlling relay 2L1. Another feature which is different from Fig. 1 is that Fig. 5 includes only one re-

Fig. 5—This diagram is the same as the right half of Fig. 1, except that relay BX controls all the contacts which were controlled by relays BE and BW in Fig. 1.

lay, BX, which controls both the eastward high signal 1R1 and the westward high signal 2L1. Thus BX serves the purpose of the BE and the BW in Fig. 1. Say, for example, that signal 2L1 is to be cleared and no westward train has passed station A, or no eastward train has passed station C. When office relay BX is energized, no further action takes place until the approaching westbound train passes station A and causes relay BAE to be released. Then back contacts of that relay complete the circuit to energize relay 2L1. In other words, this is a station-to-station approach control which, of course, would already be in effect if the lever for 2L1 is not thrown to the clearing position until after the westbound train had entered the block between stations A and B.

An important point with reference to Fig. 5 is that two over-all station-to-station opposing signals cannot be cleared simultaneously, which also is true for Fig. 1. When a westbound train passes signal 1L1 at station A, signal 2L1 at station B is cleared, and at that time, when relay 2L1YGP picks up, the feed to the possible control of the eastward high signal 2R1 as well as the eastward leave-siding signal 2R2 at station C, are opened. The controls of the leave-siding and take-siding signals are the same for Fig. 5 as for Fig. 1.

Machine Indications

For use with either of the schemes, Fig. 1 or Fig. 5, a simplified form of track-occupancy indications can be used. Instead of using small lamps in the lines representing the track on the diagram, arrow indicators are suggested to show not only track occupancy but also the direction of train movements. One idea would be to have arrows pointing eastward below the line representing the track to indicate eastward moves, and arrows above the line to represent westward moves, this applying if the machine is on the north side and facing toward the track. Another idea would be to have the arrows form parts of the line representing the track. Normally the arrows would be non-illuminated. When a signal is cleared for a train movement, the corresponding arrows would be illuminated white, this control being through lever contacts. When a train occupies the route, the arrows would be lighted red.

The main line within station limits, such as track circuits BI and BG, as well as turnout track circuits BD and BJ, would be indicated on the track diagram as a unit, in other words, with any one or more of these track circuits occupied, the section as a whole would be indicated.

For example, the line relay BAW at station B is de-energized from the time that the head end of an eastbound train passes signal 2R1 at station C, until the rear passes signal 1R1 at station B. In the office, a relay, BAWP, can repeat the position of the contacts of relay BAW. Thus the control of the eastward arrows, to indicate track occupancy eastward, can be accomplished through contacts of the BAWP. Likewise, a repeater for relay CAE at station C provides a means for controlling the westward arrows.

While a westbound train is occupying track circuit BK, the office repeaters BAWP and CAEP would both be in effect, but the eastward arrows would not be lighted red because of interconnects through contacts to control eastward indications.

When the westbound arrows are lighted, a leverman should decide what signal is to be cleared at station C. As additional information, however, the equivalent of an approach annunciator can be provided. A stick relay in the office can be energized when both the CAEP and the BAWP relays are controlled by the CAE and BAW relays de-energized. Using these positions of these relays a stick relay is energized.

Then the stick is held up through CAEP. The BAWP operates when the rear of the westward train clears track circuit 4A. Therefore, the annunciator indication that a westward train is approaching station C can be controlled through the stick up and BAWP in its position which repeats BAW energized. Cut-outs to prevent the appearance of this approach indication for an eastward train are obvious, because, for example, BAW is dropped before CAE is released. For all practical purposes, this arrangement gives information of the progress being made by trains, and of approach to stations.

A conclusion is, that track-occupancy indications can be controlled by three relays in the office, BAWP, CAEP and BP, the latter to be operated when any one or more of the track circuits BD, BG, BI or BJ is occupied. The track-occupancy indications give information of the arrival and the departure of trains, at passing tracks, and also show direction for moves on *all* portions of the main line between passing tracks and, in addition, the approach of trains toward stations is provided.

Indications on the control machine to show when a signal has cleared are not absolutely necessary, but can be provided. For example, a relay, BQ at station B, could be operated when any one of the six signals is cleared. In the office, a circuit through contacts of BQP repeater relay could control a circuit through lever contacts to light a lamp in the symbol of the signal corresponding with that of the lever position. No two signals at a passing track can be cleared at any one time, and, therefore, the signal repeater indication on the machine is "actual."

OPEN FORUM

This column is published to encourage interchange of ideas on railway signaling subjects. Letters published will be signed with the author's name, unless the author objects. However, in order to encourage open discussion of controversial matters, letters may be signed with pen names at the request of the author. In such instances, the correspondent must supply the editor with his name and address as evidence of good faith. This information will not be disclosed, even on inquiry unless the correspondent consents.

Simplified Signaling

Cincinnati, Ohio
March 22, 1941

To the Editor:

I am glad to see your editorial on "A Simplified Signaling Arrangement" beginning on page 136 of the March issue.

It should have a good effect in bringing people, who have gone "crazy" about unnecessary features on centralized traffic control, back to their senses. The manufacturer is somewhat helpless in this regard because if he refuses to give the customer a lot of "stuff" he wants to pay for, but does not need, he is apt to lose business.

To cure this, the railroad people themselves must start thinking, and also analyzing what they need, rather than what they think they need. The difference is enormous in dollar value and, in many instances, is just enough to "sink" a proposed centralized traffic control installation, which many times could be made almost as cheaply as Absolute Permissive Block. As you have pointed out, the simplified arrangement of semi-automatic signals surely does overcome all of the shortcomings of Absolute Permissive Block, particularly in light of the Interstate Commerce Commission requirements.

I hope you will keep on "pounding" on this matter.

B. J. SCHWENDT,
Assistant Signal Engineer,
New York Central System.