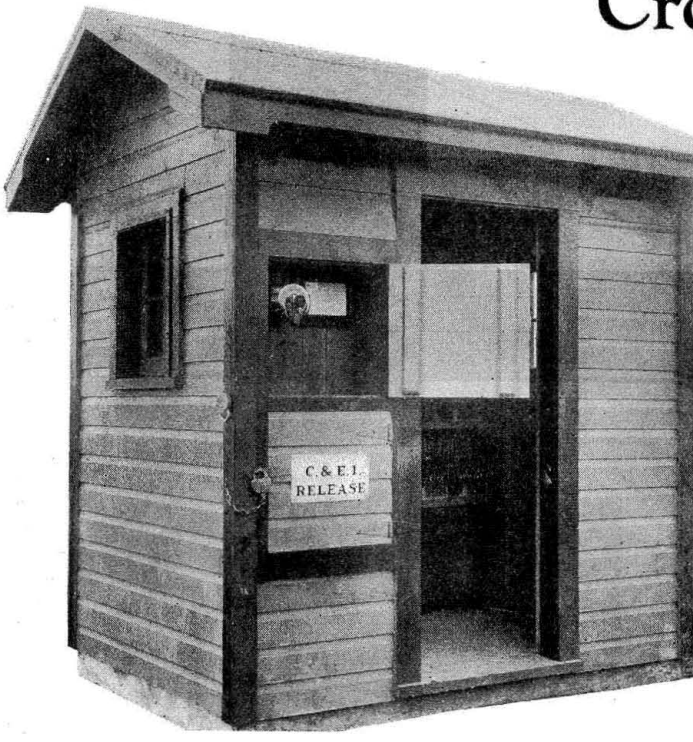
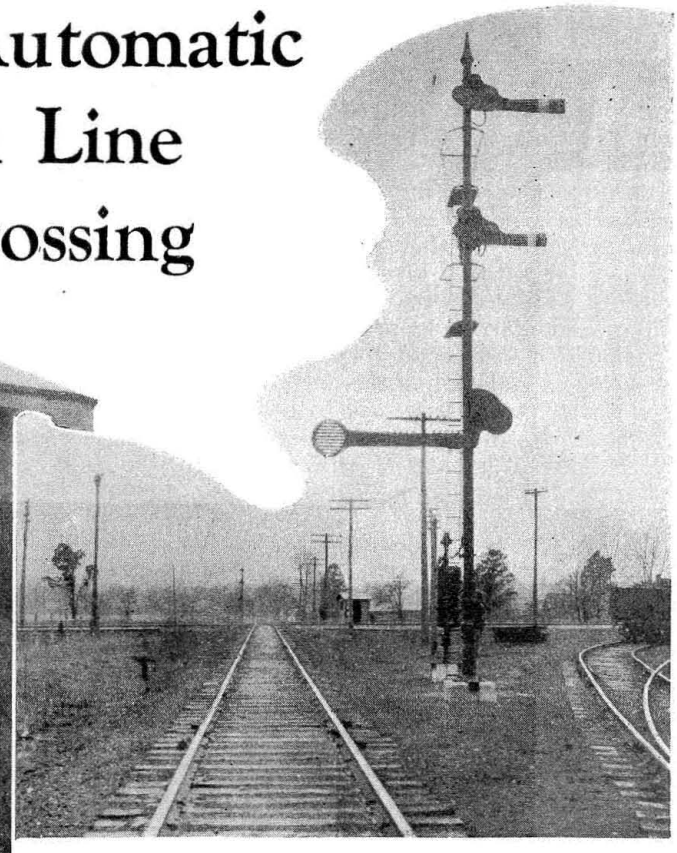
C. & E. I. Installs Automatic Interlocker at Main Line Crossing





Left—Relay shelter at crossing
Right—Westbound home signal and smashboard on Illinois Central

Smashboards required by Indiana Public Service Commission—Presence of two interchange tracks necessitated special control circuits

At the crossing of the single-track main line of the Chicago & Eastern Illinois with the branch line of the Illinois Central at Sullivan, Ind., 25 miles south of Terre Haute, the installation of an automatic interlocking plant with smashboards has eliminated the necessity of stopping approximately 50 trains a day. These new facilities cost $11,600, of which amount about $3,200 represents the investment required for the four smashboard mechanisms and associated control equipment. It is conservatively estimated that the elimination of approximately 18,000 train stops a year represent a saving of $12,000. The installation is thus expected to pay for itself in a year.

Train operation on both railroads has been noticeably benefitted since the automatic interlocker was installed. Immediately east of the crossing there is a 1¾ per cent adverse grade westbound on the branch line of the Illinois Central. There is an adverse grade northbound of about 0.8 per cent approaching the crossing on the C. & E. I. Because of the adverse grades the elimination of train stops at the crossing has speeded up train movements materially.

Semaphore Type Home Signals and Smashboards

Briefly, the protection consists of automatic semaphore home signals so controlled through track circuits and interlocked that a train approaching the crossing on one road causes the home signal for that movement to change from the "stop" to the "proceed" indication, provided that no train is approaching the crossing either from the opposite direction or on the crossing line. The train then moves over the crossing on the authority of the "proceed" indication of its home signal without making a stop. All this operation is automatic, no manual attendance is necessary. On each road, the home signal conforms to the standard two-arm interlocking signal. On the C. & E. I., the home signal top arm is a Union three-position upper-quadrant semaphore and, in addition to governing movements over the crossing, is connected into the regular automatic block signal system. The lower arm is fixed and is used only as a marker. This is the C. & E. I. standard signal arrangement for interlocking plants where there are no diverging routes.

Approach Lighting

The I. C. home signal is slightly different, owing to the fact that the top arm is fixed and the bottom arm is a Union two-position, upper-quadrant semaphore, operating from 0 to 45 deg. This is the I. C. standard slow-speed home signal for interlockers. The night indication of these home signals is obtained from electrically-lighted lamps, fitted with Lebby lenses and 13.5-volt, 5.6-watt bulbs. With the exception of the eastbound home signal on the Illinois Central, all of the lamps are lighted only while the approach section is occupied. On account of the short approach section for the eastbound home signal on the I. C. it was necessary to make it constantly lighted. The distant signals on the C. & E. I.

are the regular automatic block signals while on the Illinois Central two fixed signals are used.

Each home signal is equipped with a Union electric smashboard mechanism, the smashboard arm extending 12 ft. above the right-hand rail. When horizontal, the smashboard is close enough to the track so that an engine moving past the signal will strike and break the arm. When the smashboard is in the vertical or clear position, however, an engine can pass the signal without striking the board. The smashboards were required by the Indiana Public Service Commission so as to provide a means of identifying a train if it moved past a home signal in the "stop" position in violation of the prescribed rule. Normally the home signal arms are in the "stop" position on both roads and the smashboard arms are in the horizontal or "smash" position.

Normal Operation of Plant

The operation may be understood by following a train movement through the plant from the point where it enters an approach section. Assume a southbound C. & E. I. train is approaching the plant. Also assume there is no C. & E. I. train in the southbound home signal block and no train in the approach or home sections on the I. C. When the southbound train enters the approach section, both C. & E. I. smashboards automatically operate to the vertical or "clear" position and the southbound home signal *1* changes to proceed. The train may then proceed through the plant and over the crossing without making a stop. The southbound home signal goes to the stop position as the engine passes it, and when the rear of the train passes the northbound home signal both smashboards go to the horizontal or "smash" position. This automatically releases the plant for use of other trains, which may approach the plant on the C. & E. I. or I. C. (See page 208.)

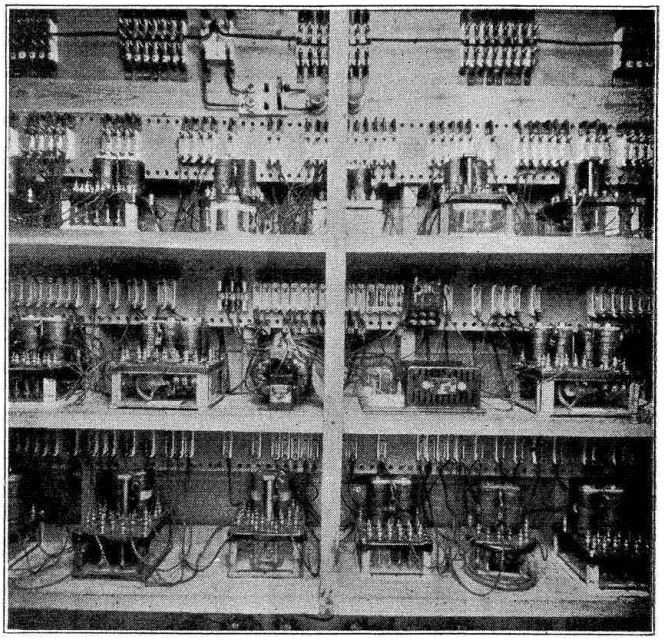
However, if after the rear of the train has passed the northbound home signal *2*, and the southbound home signal *1* and the smashboards have returned to normal position, the train is stopped in the approach section south of the plant and is then to be moved back through the plant, a trainman must unlock the push-button box at the home signal and operate the button. If the other three approach sections and the two home sections are still unoccupied, the operation of the push button will cause both C. & E. I. smashboards to go to the "clear" position and the northward home signal 2 to go to the "proceed" position. The train may then move back through the plant. It must be understood that while a home signal is in the "proceed" position, or a smashboard is in the "clear" position on one line, the home signals on the other line are automatically held in the "stop" position and their smashboards in the horizontal or "smash" position.

The operation of the other usual movements through the plant on both the C. & E. I. and I. C. is similar to the typical movement just described in which the C. & E. I. southbound train was used as an example.

How Switching Movements are Handled

Assume that a southbound C. & E. I. train enters the approach section intending to use the east or west interchange track. When the train enters the approach section, the smashboards on the C. & E. I. operate to the "clear" position, and this is followed by the movement of the southbound home signal 1 to the "proceed" position. Assume that the train stops short of the switch to move into the west interchange track. Reversal of the switch will set the southbound home signal at stop, and, after a time interval of about one minute, the two smashboards on the C. & E. I. will return to the "smash" position and will remain in this position as long as the train occupies the approach section, or one of the interchange track switches is reversed.

Operation of the plant for any approaching I. C. train will then be the same as if the C. & E. I. section were unoccupied and no switching movements were being made. This arrangement greatly facilitates the movement of traffic, because switching on the interchange tracks does not tie up the plant. When the train has finished switching, and the interchange switches are again set for main-track movement, the plant is restored automatically to normal when the train moves north out of the approach section. However, if the train after completion of switching operation moves south, it is necessary for the trainman to operate the push button at the southbound home signal to clear the two C. & E. I. smashboards and southbound home signal.



Control relays and power supply equipment in crossing shelter

Northbound Switching Moves

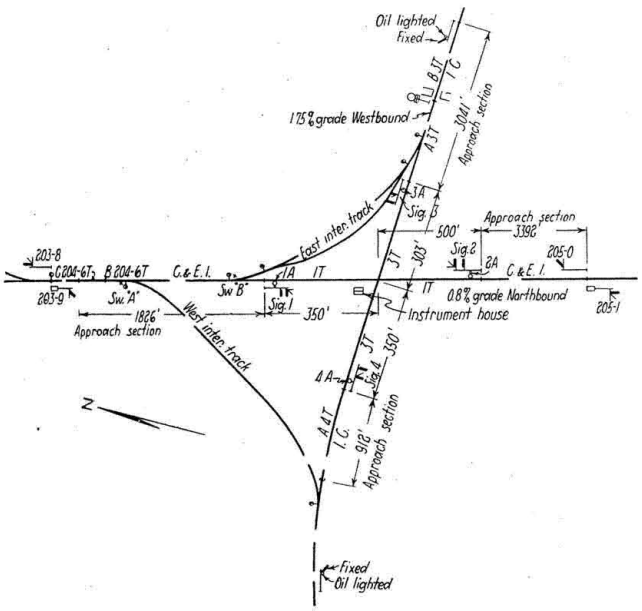
Assume that a northbound C. & E. I. train has the two smashboards in the "clear" position and the northbound home signal 2 at proceed, but stops just south of the northbound signal, and the engine cuts off, moving north with the head end. The balance of the train is left in the approach section south of the plant. After moving north through the plant, the head end of the train may pick up or set out any cars on the two interchange tracks, and, when this work is completed and the switches set normal, the C. & E. I. smashboards will again operate to the "clear" position, and the head end of the train may then move south and pick up the rest of the train. This assumes that no I. C. train has entered an approach section. When the rear end of the train is picked up, the smashboards return to horizontal position, and it is necessary that a trainman operate the push button at the northbound home signal 2, before

the C. & E. I. smashboards will again clear and the northbound home signal change to proceed.

During the interval that the engine and head end of the train are switching north of the crossing, and occupying both approach sections, with interchange switches normal, an I. C. train cannot use the plant except by operating the time release at the crossing. Operation of the release, after a time period of one minute, will put the C. & E. I. smashboards at stop and then clear the two smashboards on the I. C. and the desired signal, but, when the movement is completed, the two I. C. smashboards will return to the "stop" position and the two C. & E. I. smashboards will automatically go to the "clear" position, because the rear end of the C. & E. I. train is still occupying the approach section south of the northbound home signal.

Control of Backup Movements

If a train enters the approach section, thus setting the smashboards for that route in the "clear" position and the home signal at "proceed," and then enters the home section (the track section between home signals) and then stops and backs out without completing the movement through the plant, the signal and smashboards will return to their normal position. If the train is then to be moved through the plant, without first backing entirely out of the

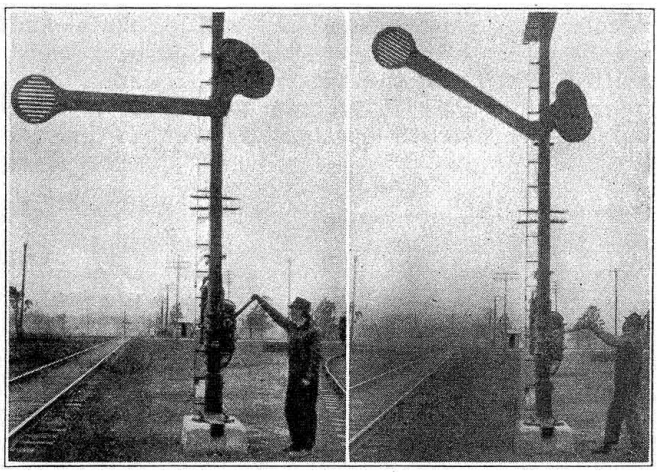


Track and signal plan of crossing at Sullivan, Ind.

approach section, it is necessary for a trainman to operate the push button at the home signal, in order to clear the smashboard and home signal. This movement is frequently made by I. C. westward freight trains, when setting cars into the east interchange track.

Assume that an eastward I. C. train desires to use the east interchange track. The engine leaves the rear of the train west of the approach section, then moves east through the plant. When the engine and cars have passed the westbound home signal 3, the I. C. smashboards and home signal return to their normal positions, because the rear end of the train is not in the approach section on the I. C. After completing work in the east interchange track, it will be necessary for a trainman to operate the push button at the westward home signal 3, in order to set the I. C. smashboards in the "clear" position and home signal 3 at proceed so that the engine may move west through the plant and couple on to the train. However, if in using the east interchange track, the engine and cars move far enough into that track to clear the approach section, the I. C. smashboards will automatically operate to the "clear" position and the westward home signal to the "proceed" position, when the engine and cars again move out on to the main track.

There are two clockwork time releases at the crossing, one for each road, and operation of one or the other of these releases will, in every case, accomplish the same result as operation of the push button for the particular switching operations described in the foregoing. They provide also for releasing the plant in case of approach track circuit trouble, or if a train is standing in an approach section.



Smashboard arm can be cleared in an emergency by a quarter turn of a crank kept under padlock when not in use

In case of a total electrical failure, it is possible to clear the smashboard by manipulation of a crank which fits to the smashboard mechanism. A quarter turn of the crank will clear the smashboard. The smashboard operating mechanism is in many respects similar to a signal mechanism, the only difference being in the provision made for cranking the smashboard to the clear position. A feature of the smashboard mechanism is the mechanical lock which prevents a trainman from pushing the arm clear while standing on an engine. The smashboard arm can only be cleared in an emergency by operating the crank.

An inexpensive wood relay shelter, about five feet wide by seven feet long, inside measurement, is located at the crossing to house most of the control relays and the operating battery. The two time releases are located in wall recesses in the front wall of the relay shelter and are accessible by opening wood doors. The wood relay shelter is believed to be better than the conventional type of wood or iron relay cases, because of the large number of relays and batteries to be housed and because of the greater convenience afforded the maintainer when checking the plant.

Circuit Control Features

For the automatic control of the signals and smashboards a total of 26 control relays are used. Of these, 18 are located in the relay shelter at the crossing. Four of the remaining relays are the home control

relays for the signals and these relays are located in the relay case at the signal in each instance. In addition a local control relay for each smashboard mechanism is located in the relay case at the signal.

In order to explain the circuit features of this installation several typical control circuits are given. It is believed that this simplifies the explanation considerably. The principal circuits involved for a southbound movement on the C. & E. I. approaching signal *1* are taken as typical. Thus Fig. 1 shows the control for home relay *1HR*. It will be seen that that part of the circuit to the left of relay *1HR* represents the automatic polarized control for the south end of the block governed by signal *1*. Continuing the circuit to the right, it is seen that the northbound approach repeater *2AR* must be energized and the northbound signal and smashboard repeater *2GP* must be reversed, which indicates that the smashboard is cleared. Furthermore the approach repeater *1AR* must be down and both home section repeaters *1TP* and *3TP* must be stick relay *1-2FS*. Reference to the pick-up part of the circuit, shown to the right of the relay, discloses that the smashboard stick relay cannot pick up until the rear end of the southbound C. & E. I. train has cleared the home section on that road. Relay *1-2SR*, which is the directional signal control relay for the C. & E. I., will, of course, pick up immediately when the southbound train passes signal *1*, but the home section repeater *1TP* is de-energized until the rear end clears the home section. A track circuit failure on the C. & E. I. would de-energize the smashboard stick relay *1-2FS* just in the same manner as an approaching train. Since this relay must be energized before any signals or smashboards may be cleared on the I. C., an emergency pick-up circuit is provided in parallel with the normal pick-up circuit through a back contact of the I. C. time release located at the crossing.

The local control relay for smashboard mechanism *1A* is a polarized relay (*1A-HR*) and this relay is controlled in parallel with relay *2A-HR*, which in turn controls

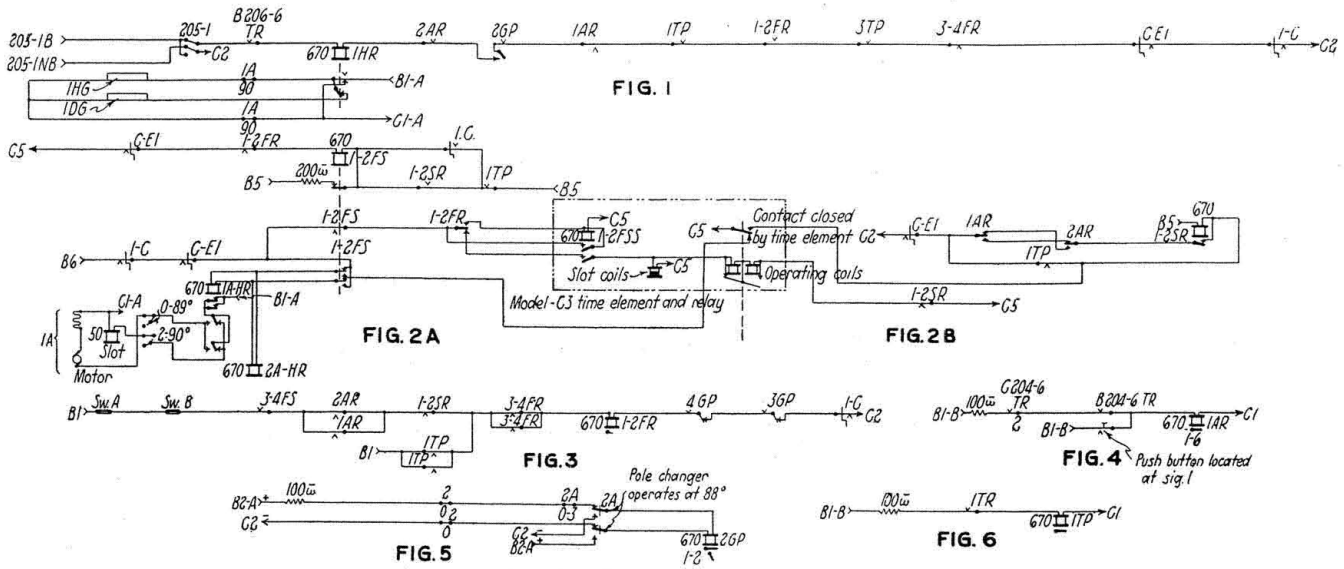


Fig. 1—Typical signal control circuit including local wiring (Signal *1*)
Fig. 2A—Smashboard mechanism control circuit including local motor wiring (Smashboard *1A*)
Fig. 2B—Typical circuit for directional stick relay control (*1-2SR*) with time-element pick up feature for emergency operation
Fig. 3—Circuit for C. & E. I. route control relay *1-2FR*
Fig. 4—Typical circuit for approach repeater (*1AR*)
Fig. 5—Control circuit for signal and smashboard repeater *2GP*
Fig. 6—Typical home section repeater (*1TP*)

up. Then if the route control relay for the C. & E. I., namely relay *1-2FR* is picked up and that for the crossing road *3-4FR* is down and the two screw releases at the crossing in their normal position, relay *1HR* will pick up and signal *1* will clear. Breaking of the control for relay *1HR* through a front contact of *1-2FR* and a back contact of *3-4FR*, furnishes a double check upon the interlocking feature of these two route control relays.

Smashboard Control

Normally-energized stick relays are used for the primary smashboard control. Let us take relay *1-2FS*, which controls the smashboards on the C. & E. I., as typical for purposes of circuit explanation. This relay, when once picked up after the passage of a train through the plant, is caused to stick up through its own front contact in series with a back contact of the C. & E. I. route control relay *1-2FR* and a normal contact on the C. & E. I. time release. When a train enters the southbound approach section, however, the relay *1-2FR* picks up and in doing so drops the smashboard smashboard mechanism *2A*. It will be seen that the polarized control of these two smashboard relays is carried out by means of the pole-changing contact arrangement of relay *1-2FS*, the control of which has already been described. When in the normal position, as shown, and smashboard clear, the slot coil is energized, allowing the arm to go to the normal position by gravity. However, if relay *1-2FS* is de-energized, the local control relay *1A-HR* will reverse its polar contacts, and this will close the motor circuit to clear the smashboard arm. The operating current of the motor is cut off and the arm is held clear by the slot mechanism as long as the slot coils are de-energized. The smashboards are returned to normal by relay *1-2FS*, picking up, when the rear end of the train clears the home section. It should be noted that the control for relay *1A-HR* is carried through a normal back contact of a time-element relay. The function of this time-element relay will be described later. It will be seen, however, that the momentary opening of this contact, or the time-element mechanism sticking (making the reverse contact), will de-energize relay *1A-HR*. With *1A-HR* and *2A-HR*

de-energized, the smashboards will remain in the position to which they may have operated, and if not in full clear position they can be cranked to that position by hand.

Directional Control Relay

Figure 2B shows the normal and emergency control of the directional signal contral relay *1-2SR*. The normal operation of this relay will first be described. One side of the relay is connected direct to the battery and the normal pick-up circuit is completed through a back contact of home section repeater *1TP* to common. By carrying the normal control wire through a back contact of the C. & E. I. time release, it is possible to drop this stick relay to clear a signal for a back-up movement in the same way as by pushing a button at the signal as already described in the article. When once picked up, relay *1-2SR* remains up until the rear end of the train clears the extreme limits of the approach section south of signal *2*. An auxiliary pick-up circuit is effected through a reverse contact on the time-element relay.

Time-Element Relay

The following description illustrates the safety features of the time-element relay: With a southbound movement on the C. & E. I., a train entering the approach section drops relay *1-AR* which picks up relay 1-*2FR*. The picking up of relay *1-2FR* de-energizes relay *1-2FS*, which allows the smashboards to clear as already described. With *1-2FR* relay up and *1-2FS* relay down, relay *1-2FSS* will be energized and will hold up through its own point as long as relay *1-2FS* is down. The operating control circuit for the time element is not complete until relay *1-2FR* drops, which it will not do unless the train backs off the approach section, allowing relay *1-AR* to pick up, or because of a failure of relay *1-AR* to remain up while the train is approaching the signal. If relay *1-AR* picks up and allows *1-2FR* to drop, this will immediately set the home signal at stop, and the time-element relay will start operating. After a period of one minute the time-element contact will be made, which picks up relay *1-2SR*. The picking up of relay *1-2SR* picks up relay *1-2FS*, which puts the smashboards normal. It will be noted that, if the approaching train under the above conditions does not stop at the home signal and enters the home section, relay *1-2FR* will pick up immediately and stop the operation of the time-element relay, thus holding the smashboards in the clear position. If relay *1-2FR* does not pick up for any reason, when the train enters the home section, the time-element relay will stop operating due to energy being cut off when *1-2SR* relay is picked up, but relay *1-2FS* will not pick up due to the home section being occupied.

A further advantage of the time-element feature is to delay the return of the smashboards to normal when interchange switches *A* and *B* are reversed. If, after a short southbound train had just passed switch *A*, a switchman or sectionman should reverse this switch, the home signal would immediately go to stop, but the smashboard would not go to normal, until after the operation of the time-element relay, which allows the train either to stop or to get into the home section. As just explained, with the home section occupied, the smashboards cannot go to the normal position.

Route-Control Relay

Two route-control relays are used, one for each road. The circuit control for the C. & E. I. route control-relay *1-2FR* is shown in Fig. 3. It should be noted that this circuit checks the position of the I. C. smashboard control relay *3-4FS* in the energized position. A further and more positive check, however, upon the position of the signals and smashboards on the Illinois Central is secured by the signal and smashboard repeaters *4GP* and *3GP*, both of which must be normal. It will be seen that either approach repeater *2AR* or *1AR* will pick up the route-control relay. When a southbound train passes signal *1*, the route-control relay is held up through a back point of the home section repeater 1*TP*. The C. & E. I. train thus holds the route until the rear end clears signal *2*. By breaking the *1-2FR* control through a back point of relay *1-2SR*, the desired directional control of the home signals is secured. A southbound train in the approach section south of signal *2* will, of course, drop the approach repeater *2AR* but under these conditions the directional-control relay *1-2SR* is held up and maintains the route-control relay *1-2FR* in a de-energized position.

The control circuit for approach repeater *1AR* is shown as typical in Fig. 4. Attention is directed to the push-button control of this approach repeater. It will be remembered that operation of the push button is necessary to clear a signal for a back-up movement. Pressing the button has the same effect as a momentary picking up of the track relay. Release of the button then drops the approach repeater just as an approaching train would drop it due to the de-energized track circuit. The momentary picking up of the approach repeater has the same effect as though the train had proceeded away from the crossing and out of the approach section. It should be remembered that this will drop the directional-control relay *1-2SR* and thus restore the plant to normal ready for another train.

The signal and smashboard repeater circuit for relay *2GP* is shown as typical in Fig. 5. This repeater checks the position of the signal arm at *O*, the position of the smashboard arm both in the "smash" position and in the "clear" position. There are two home section repeaters, namely *1TP* and *3TP*, of which the former is shown as typical in Fig. 6.

Equipment Used

A 6-cell storage battery, Exide Type-KXHS7, is housed in the relay shelter and is used for all circuit controls. In addition, this battery also supplies the power for the operation of the signals, smashboards and electric lamps. This 6-cell battery is under continuous floating charge by means of a Union electronic rectifier Type-RX21. This rectifier is rated at one ampere, 8 to 12 volts. While approach lighting is used (with one exception) for the electric lamps in the semaphore signals, these lamps are burned on alternating current, except when there is a power failure. A Union Type ANL-30 power-off relay then connects the light circuit to the storage battery. The two time-element relays are Model-C3, made by the Southern Signal Company. Their operating coils are of 670-ohms resistance.

Mount Shasta on the Southern Pacific