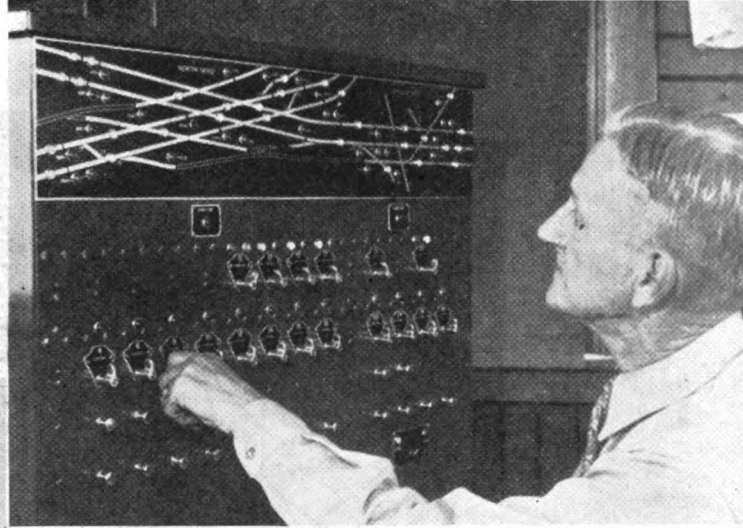
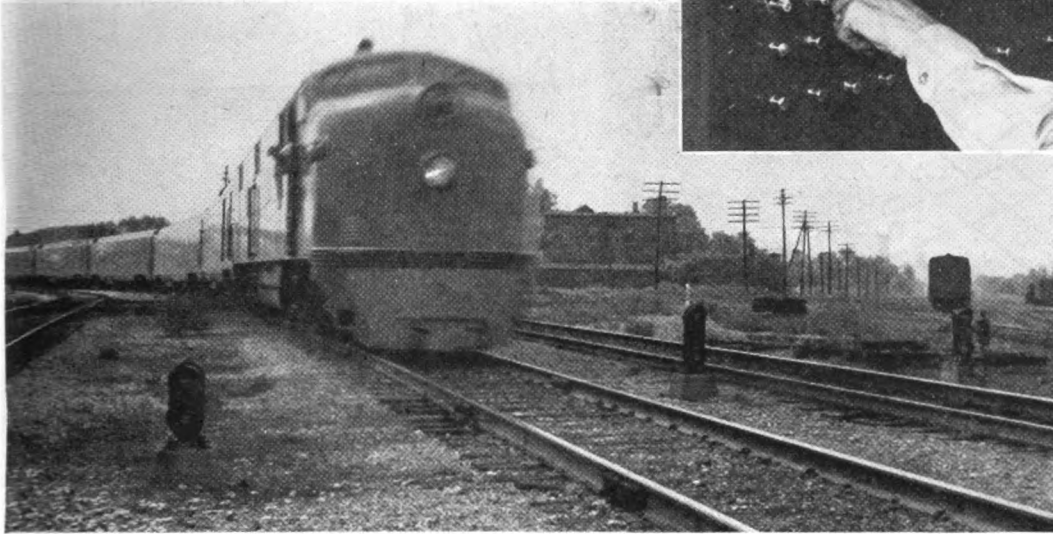


New plant replaces outmoded protective facilities at complicated crossing layout involving three railroads



Left — North-bound C. & E.I. train "The Whippoorwill," leaving Danville station. Above—The control machine

# All-Relay Plant on the *C. & E. I. at Danville, Ill.*

ELIMINATION of 55,000 train stops annually, relief from serious congestion and delays, and increased flexibility and safety of train movements—these are the results of a new all-relay interlocking installed by the Chicago & Eastern Illinois, at a complicated crossing involving three railroads, in Danville, Ill., 123 mi. south of Chicago. At this point the main line of the C. & E.I. between Chicago and Evansville, Ind., crosses the main line of the Wabash between St. Louis and Detroit, as well as the main line of the Peoria & Eastern (New York Central) between Peoria and Indianapolis. The P. & E. and a branch line of the C. & E.I., known as the Westville district, also cross the Wabash nearby, thus forming a triangular arrangement of trackage between the three crossing locations, which are approximately  $\frac{1}{4}$  mi. apart. The layout is shown in Fig. 1.

The location where the main line of

the C. & E.I. crosses the Wabash is known as North yard, the crossing between the C. & E.I. main line and the P. & E. as Cory, and the location where the P. & E. and C. & E.I. Westville district cross the Wabash, as Danville Jct. The C. & E.I. main line and the Wabash are double track, while the P. & E. and C. & E.I. Westville district are single-track lines. Furthermore, the North yard crossing is on a 4-deg. curve on the C. & E.I. and a 2-deg. curve on the Wabash. The other main-line crossings are tangent.

### A Complicated Layout

In addition to the foregoing main tracks, the layout as a whole is further complicated by numerous yard, interchange and other secondary tracks. For example, the Westville district of the C. & E.I. leaves the main line just north of the Wabash crossing at North

yard and parallels the Wabash on the north side to Danville Jct. where it crosses the Wabash. At the junction, a lead also continues to parallel the Wabash for about one mile to the C. & E.I. freighthouse.

At North yard, a secondary crossing is involved in a connection which crosses the C. & E.I. main line from North yard to the Westville district and the Wabash interchange. A considerable amount of switching is done over this crossing. Another secondary crossing involves the Westville district and the Wabash-P. & E. interchange at Danville Jct. Both of these crossings had to be protected in the new layout, as shown in Fig. 1.

The C. & E.I. passenger station is located between Cory and North yard, this being the only station involved in the layout. In addition to the two main tracks between Cory and North yard the C. & E.I. has a station track, as well as a yard track which extends

over the Wabash crossing to the west end of North yard.

The traffic on the C. & E.I. main line consists of 9 passenger and 5 freight trains in each direction daily.

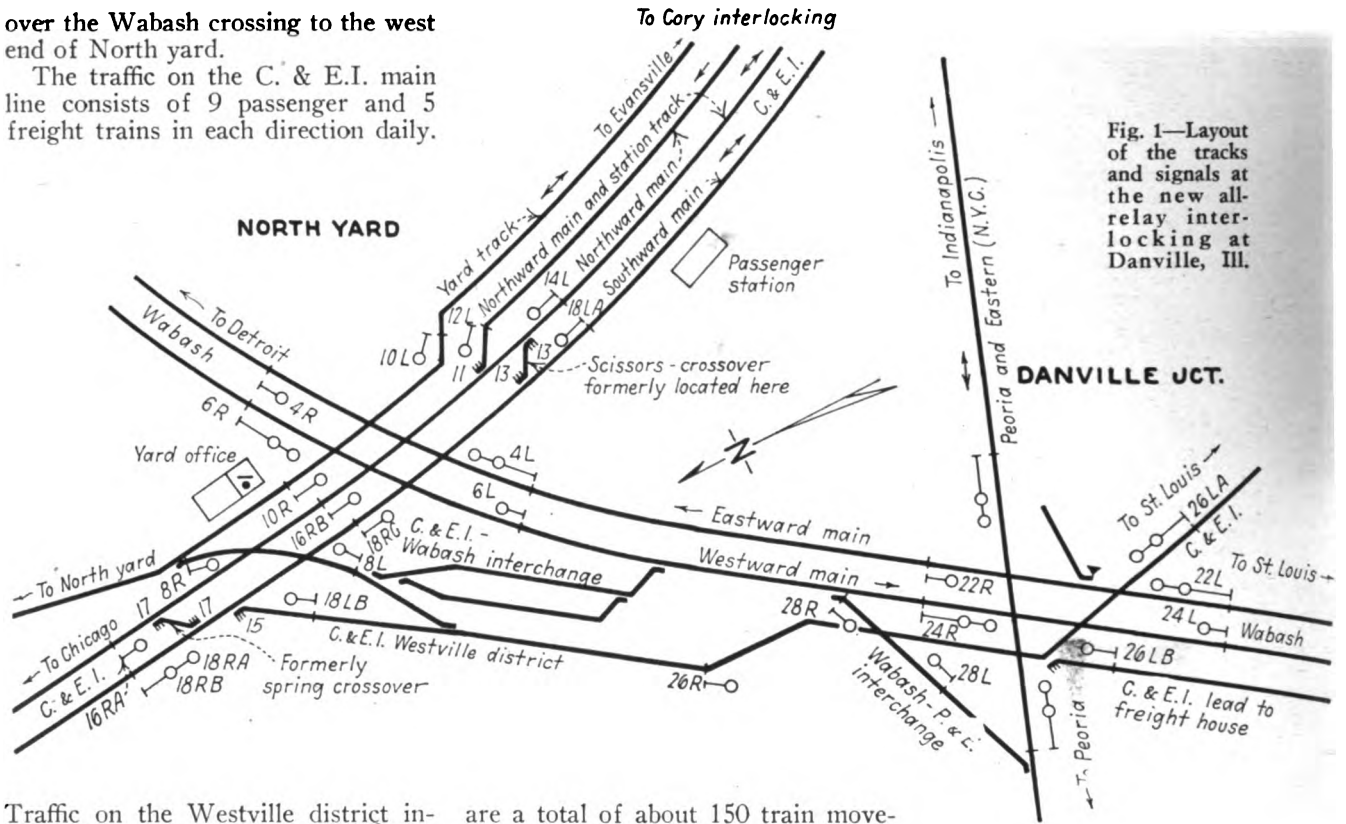


Fig. 1—Layout of the tracks and signals at the new all-relay interlocking at Danville, Ill.

Traffic on the Westville district includes 1 passenger and 3 freight trains in each direction daily. There are approximately 25 C. & E.I. switching moves through the plant every 24 hr. The speed limit for all trains on the C. & E.I. between Cory and North yard is 20 m.p.h., while the speed limit on the Wabash and P. & E. is 15 and 20 m.p.h., respectively.

Traffic on the P. & E. through Cory and Danville Jct. includes 2 passenger and 6 freight trains in each direction, plus numerous switching movements. The traffic on the Wabash consists of from 12 to 15 trains in each direction daily, of which 2 in each direction are passenger trains. The Wabash has about 20 switching moves. Thus there

are a total of about 150 train movements daily on the three roads through the plant.

**Former Protection**

Prior to the installation of the new plant, all trains were required to stop at North yard and Danville Jct. A semaphore crossing signal was in service at North yard, and a tilting crossbar signal was in service at the crossing at Danville Jct. Train movements at Cory were controlled from an electro-mechanical plant at the crossing. This plant was continued in service.

Before the new plant was installed, a scissors-crossover arrangement was in service between C. & E.I. tracks

1 and 2 just south of North yard. These crossovers, as well as others were hand operated, over which train movements were governed by semi-automatic signals. As part of the project, the old trailing-point crossover was removed. Crossover 17 was moved 50 ft. north between the C. & E.I. main tracks to get it off the curve. This crossover was formerly equipped with spring mechanisms which were replaced with power machines as part of the project.

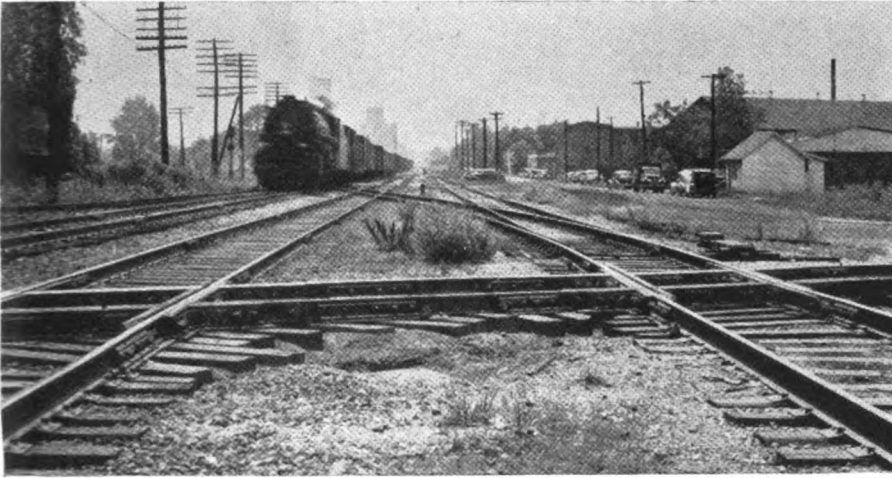
Numerous minor track changes were made on secondary tracks to provide proper distances for signal locations and to eliminate the necessity of installing signals not actually justified. To increase the flexibility of operation through the C. & E.I. station, the two main tracks and station track were equipped with signals to permit operation in either direction by signal indication.

**Grades a Problem**

Eastward there is a 0.6 per cent ascending grade on the Wabash through Danville Jct. and North yard. Likewise, there is a 0.55 per cent ascending grade northward on the C. & E.I. through Cory and North yard. An ascending grade eastward on the P. & E. extends through Cory and Danville Jct. These grades presented a serious operating difficulty, particularly on the Wabash, in getting trains started after they had stopped. Heavy eastbound tonnage freight trains often



Crossover 17 on the C. & E.I. at North yard. Signal 18RA-B is in the background



Layout at Danville Jct., showing C.&E.I. at right, Wabash, left, and P.&E. in foreground

stalled when stopping, and required pushers to get them started again. This resulted in a considerable loss of time, and the blocking and congestion of trains on the P. & E. and C. & E.I. This in turn often tied up highway traffic in the vicinity since there are several highway grade crossings.

Due to the eastward ascending grade on the Wabash, heavy tonnage freight trains will now hold back at the distant signal until a green aspect is displayed so a run can be made for the crossings, thus eliminating stalling due to a stop. When possible, the towerman tries to give trains a run for the crossings.

### Operating Savings

Estimates on the Wabash indicate that 10 min. are saved by the elimination of eastbound passenger train stops, and  $\frac{1}{2}$  ton of coal is saved. Freight trains in the same direction save a total of 20 min. and 2 tons of coal. Westward, passenger trains save 8 min. and  $\frac{1}{2}$  ton of coal, while freights save 10 min. and 1 ton of coal. Similar figures on the C. & E.I. indicate 3 min. for passenger stops and 10 min. for freight trains.

### Power Switches and Signals

The new power switch machines are the Style M-2, designed for operation on 24 volts d.c. The high signals on the C. & E.I. are the P-5 vertical color-light type, and the dwarfs are the N-2 vertical color-light type, equipped with 10-volt, 18 + 3.5-watt double-filament lamps. The high and dwarf signals on the Wabash are the H-2 searchlight type, while those on the P. & E. are the triangular color-light type.

There are only two high home signals on the C. & E.I., namely, southward signal 18R on the main line and

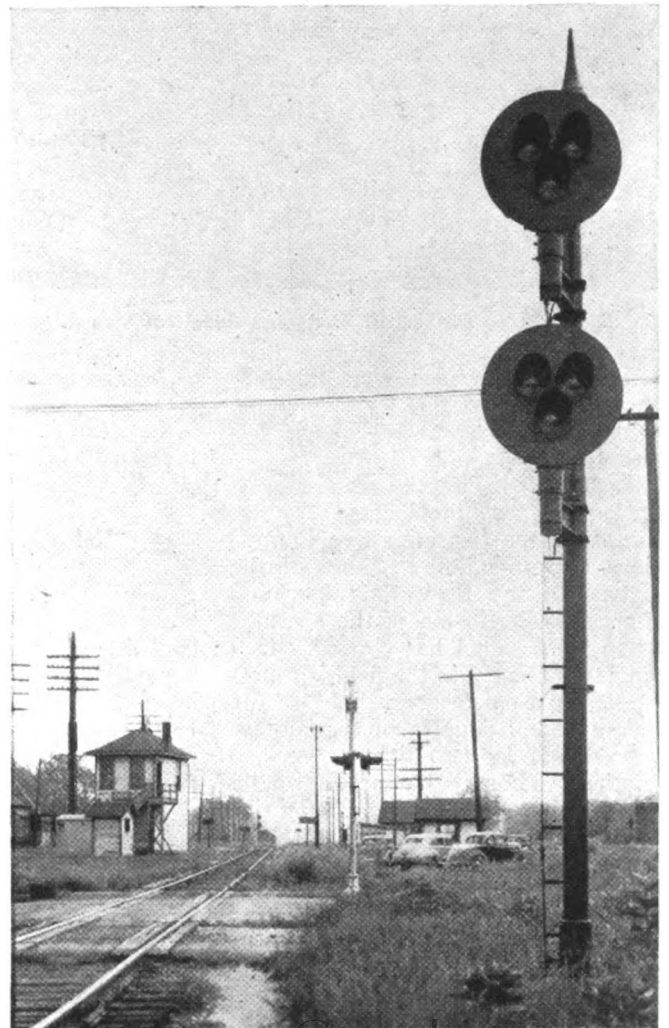
northward signal 26LA coming off the Westville district. The remainder of the C. & E.I. home signals are dwarfs because clearances prohibited installation of high signals without bridges or cantilevers. This was considered unnecessary because this plant is all slow-speed territory on the C. & E.I., a 20-mi. speed limit being in effect.

All the signals at North yard and at Danville Jct. are controlled from

North yard, except the P. & E. signals at the latter location. These are controlled by one miniature lever at Cory. This arrangement is used to provide better coordination of train movements and lessen the chances of the plants tying up each other.

### Machine in Yard Office

The interlocking machine is located in the west end of the North yard office near the C. & E.I.-Wabash crossing, and is the Style C miniature-lever type, the same as used on C.T.C. installations. At the top of the machine is a diagram of the track and signal layout at North yard and at Danville Jct., including opal track-occupancy lights. These lights are normally extinguished, and are illuminated when a train is on the respective sections. Directly below the diagram is a row of two-position switch levers. Five such levers control three single switches and two crossovers. One lock lever, in the same row, controls an electric lock on a facing-point switch leading from the Wabash eastward main track to an industry track at Danville Jct. Above each of the normal and reverse positions of these levers, except the



The signals on the P. & E., which are the color-light type, are controlled from Cory, shown in the background

lock lever, is a green and amber light, respectively. These repeat the positions of the switches and crossovers in the field.

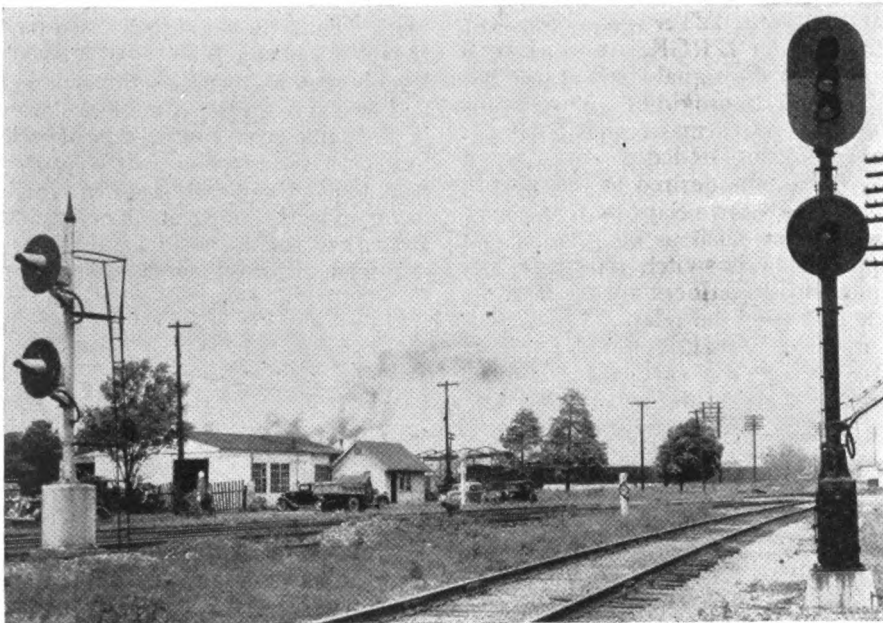
### One Light Only Above Signal Levers

Directly beneath the switch levers is a row of 12 three-position signal levers for control of 30 signals. The normal position of these levers is in the center, which controls the signals to Stop. The levers are moved to the left or right to clear the signals. An unusual feature is that each signal lever has only one indication lamp. This lamp is red and is located above the lever. When a signal lever is thrown, the push-button below the lever has been operated, and the cor-

trically interlocked to prevent signals from clearing in the event that a lever is inadvertently moved, an additional reminder to the operator of what route and signals he is lining up is provided by the fact that in all cases he must operate the push-button under the lever concerned. Otherwise, the signal will not clear. Pushing the button picks up the H relay for the corresponding signal and drops the stick relay which holds the route, and also checks that opposing home signals have not been cleared and are displaying Stop.

Two buttons are provided under the levers which control the Wabash home signals 6R, 4L, 24R and 22L. These are two-arm signals, the second arm being for the display of a call-on

above the key at North yard, and indicates that Danville Jct. is released to Cory and that the P. & E. signals can be cleared from Cory, and that the Wabash and C. & E.I. home signals cannot be cleared from North yard. Cory retains the release regardless if the operator at North yard returns the key to the left. Before North yard can regain control of the Wabash and C. & E.I. home signals, Cory must restore his lever, releasing Danville Jct., and the North yard key must be in the lefthand position with a white light displayed above it. Similarly, North yard retains control of Danville Jct. once Cory has released it to him, regardless of the position of the lever at Cory after release has been given. Thus, the levers at both plants must be in correspondence with each other, and at the same time circuit protection is provided to prevent inadvertent release in the event that one of the towermen should move the lever by mistake.



Signal 22L on the Wabash (left) and signal 26LA on the C.&E.I. at Danville Jct.

responding relay picked up, the indication lamp above that lever is lighted until the corresponding signal has cleared.

Instead of having the signal repeater lamps above the levers, they are located on the diagram above, in positions corresponding to those of the signals in the field, thus lessening chances of confusion of the operator as to what signal has cleared. Each single-arm signal in the field is represented by a single green light on the diagram, and double-arm signals are represented by two lights over one another. These lights are normally dark, and are lighted only when a signal has been cleared. The machine is also equipped with two red power-off lamps, one for North yard and one for Danville Jct.

Directly below each single-arm signal lever is a push-button, and below each double-arm signal lever are two buttons. While the circuits are elec-

trically interlocked to prevent signals from clearing in the event that a lever is inadvertently moved, an additional reminder to the operator of what route and signals he is lining up is provided by the fact that in all cases he must operate the push-button under the lever concerned. Otherwise, the signal will not clear. Pushing the button picks up the H relay for the corresponding signal and drops the stick relay which holds the route, and also checks that opposing home signals have not been cleared and are displaying Stop.

### Release Between Plants

While the Wabash and C. & E.I. home signals at Danville Jct. are controlled from North yard, the P. & E. home signals are controlled from Cory interlocking. However, before the P.&E. home signals can be cleared from Cory there must be a release from North yard.

On the lower right-hand side of the machine at North yard there is a two-position key, with a white and red light above it. If the operator at North yard wants to release Danville Jct. to Cory, he moves the key to the right-hand position, and the towerman at Cory moves a similar lever. This results in the display of a red light

### Relays for Indication Circuits

The control circuits for this plant are based on a standard network arrangement at North yard. Clockwork time release circuits are in effect, timing of 4 min. applying to all routes.

On this installation, small 180-ohm and 500-ohm relays are used on all the indication circuits, including track, switch power-off, signal, etc., these relays being furnished by the Automatic Electric Company. The contacts of the 180-ohm relays are of two types, namely preliminary and standard, and correspondingly, there are two pick-ups. The preliminary contacts pick up when 15 m.a. is fed to the relay, the standard contacts remaining down. When 35 to 45 m.a. is fed to the relay both the standard and preliminary contacts pick up. Selection of whether the preliminary or standard contacts are to pick up is determined by the cut-in or cut-out of a 750-ohm resistance in the controls of the relays. With the 750-ohm resistance cut in, the primary contacts pick up (15 m.a.), and without the 750-ohm resistance the standard contacts also pick up (35 to 45 m.a.).

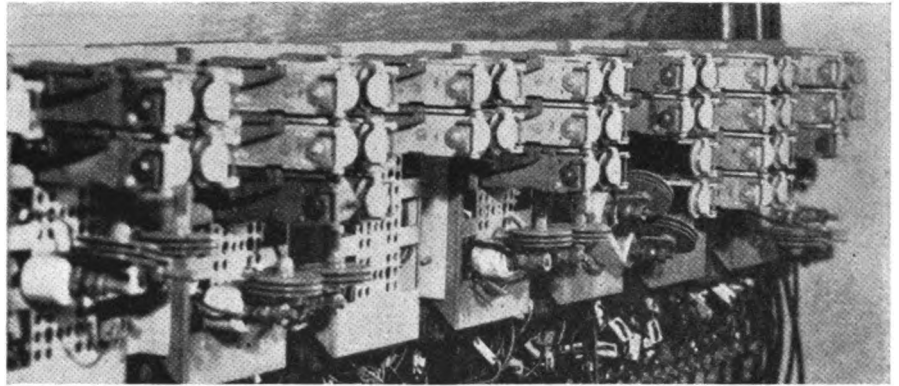
There are 50 of these relays in the instrument house at North yard, mounted on a special rack. Due to their small size, they take up but a few feet of space. Each relay is protected from dust and other foreign matter by a metal cover. The relays are equipped with individual plug coupling arrangements, and it is impossible to interchange them, thus obviating chances of getting a relay in the wrong place.

An example of how the indication circuits work is shown in Fig. 2. This



circuit is for the repeater indication of high signal 22L and dwarf signal 22R on the Wabash eastward main track at Danville Jct., as well as the track-occupancy indication for the track section over the P. & E. crossing and between these signals.

Normally G-NL 12 power is incomplete over front contacts of the 22LGP and 22RGP relays, which repeat signals 22L and 22R in the Stop position. Consequently the 180-ohm 22S relay, with preliminary and stand-aid contacts, is down. Thus, A-BX 10 power which feeds over a front standard contact of this relay to the track occupancy lamp 22TK is open and the lamp is dark. Another relay, the 22TS, is fed over a front preliminary contact of the 22S relay from A-BL12 to AN12, and with the 22S down, the 22TS is also down. This relay selects between the signal-normal and signal-cleared indications on the machine. With the 22TS relay down the cleared indication lamp for signals 22L and 22R are extinguished. The signal-normal indication above the lever is also out, and would not be lighted unless the 22AES or 22BES stick relay is picked up by pushing one of the push-buttons under the signal lever. Normally, with the 22TS relay down and the 22BES relay up, A-BX10 would be fed over a back contact of the 22AES relay, front contact of the 22BES relay, back contact of the 22TS relay and through the lever light to A-CX10 battery. If the 22AES relay, on the other hand, is picked up then this circuit extends over a front contact of



Small 180 and 500-ohm indication relays in North yard instrument house

gram that the bottom arm of signal 22L has cleared.

If the 22AES is up, then this circuit is taken over another front contact of the 22TS relay to lamp 22LAGK or 22RGK, over an L or R contact of the signal lever, respectively, and thus providing an indication that the top arm of signal 22L or dwarf signal 24R has cleared.

Where it is desired to control two of the 180-ohm relays on one indication circuit, such as on some of the approach and switch indication circuits, small rectifiers are mounted on the rack near the relays. These rectifiers serve to make the relays responsive to certain polarities only, which are controlled from the field, thus saving additional line circuits.

These circuit arrangements were developed by G. P. Neal, C. & E.I. superintendent of signals and telegraph, and his signal staff. The cir-

cuits are located near by this battery is sheltered in it. Otherwise, the battery is located in Massey or Permacrete concrete battery boxes. The track circuits are the d.c. neutral type each of which is fed by Edison, Waterbury or Ever-ready 500-a.h. primary battery.

The relays, transformers, storage battery and other equipment at North yard are sheltered in a Permacrete 6-ft. by 12-ft. precast concrete house. A 6-ft. by 10-ft. house is provided for the same purpose at Danville Jct.

Part of the interlocking circuits are on open pole line, while part are in underground cable. Circuits on the pole line are on No. 10 line wire. Line drops are made of No. 14 rubber covered copper wire. All line taps and splices are made with National Telephone Supply Company Nicopress sleeves. The underground cable is the parkway type with jute only, furnished by the Okonite Company and the Kerite Company. Track connections and motor leads are No. 9, while No. 12 and No. 14 conductors are used on control and lighting cir-

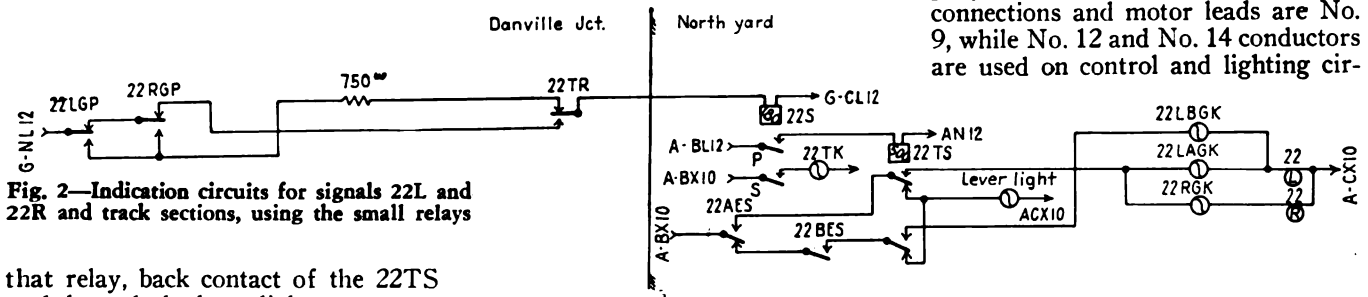


Fig. 2—Indication circuits for signals 22L and 22R and track sections, using the small relays

that relay, back contact of the 22TS and through the lever light.

Assume that the operator clears home signal 22L or 22R. This causes either relay 22LGP or 22RGP, respectively, to drop, feeding G-NL 12 over a back contact of either, through a 750-ohm resistance and relay 22S to G-CL 12 battery, thus picking up the 22S relay. With the 22S relay up, the 22TS relay is picked up. If the call-on arm of signal 22L is cleared, positive battery A-BX 10 extends over a back contact of the 22AES relay, front contact of 22BES relay, front contact of the 22TS relay, through the 22LBGK lamp, and over an L contact of the signal lever to A-CX10, thus giving an indication on the track and signal dia-

grams have been in service for several months now, and have been working very satisfactorily.

### The Power Supply

Two sets of storage battery are provided at North yard for control circuits and the machine. One consists of six cells of Gould 120-a.h. lead-acid battery and the second set consists of six cells of Exide KXHS-7 80-a.h. battery. At each group of power switches or crossovers there is a set of 12 cells of 120-a.h. lead-acid storage battery for operation of the switch machines. If an instrument house is

suits. Instrument cases and houses are wired with 19-strand No. 16 flexible insulated wire. Electric Service Supplies Company crystal-valve lightning arresters are used on all line control and track circuits. The rail through this plant is 112 lb., bonded with Cadweld rail-head bonds. Insulated joints are the Rail Joint Company's four-bolt continuous type.

This plant was installed by the regular C. & E.I. signal forces under the jurisdiction of G. P. Neal, superintendent of signals and telegraph. The major items of signaling and interlocking equipment were furnished by the Union Switch & Signal Company.