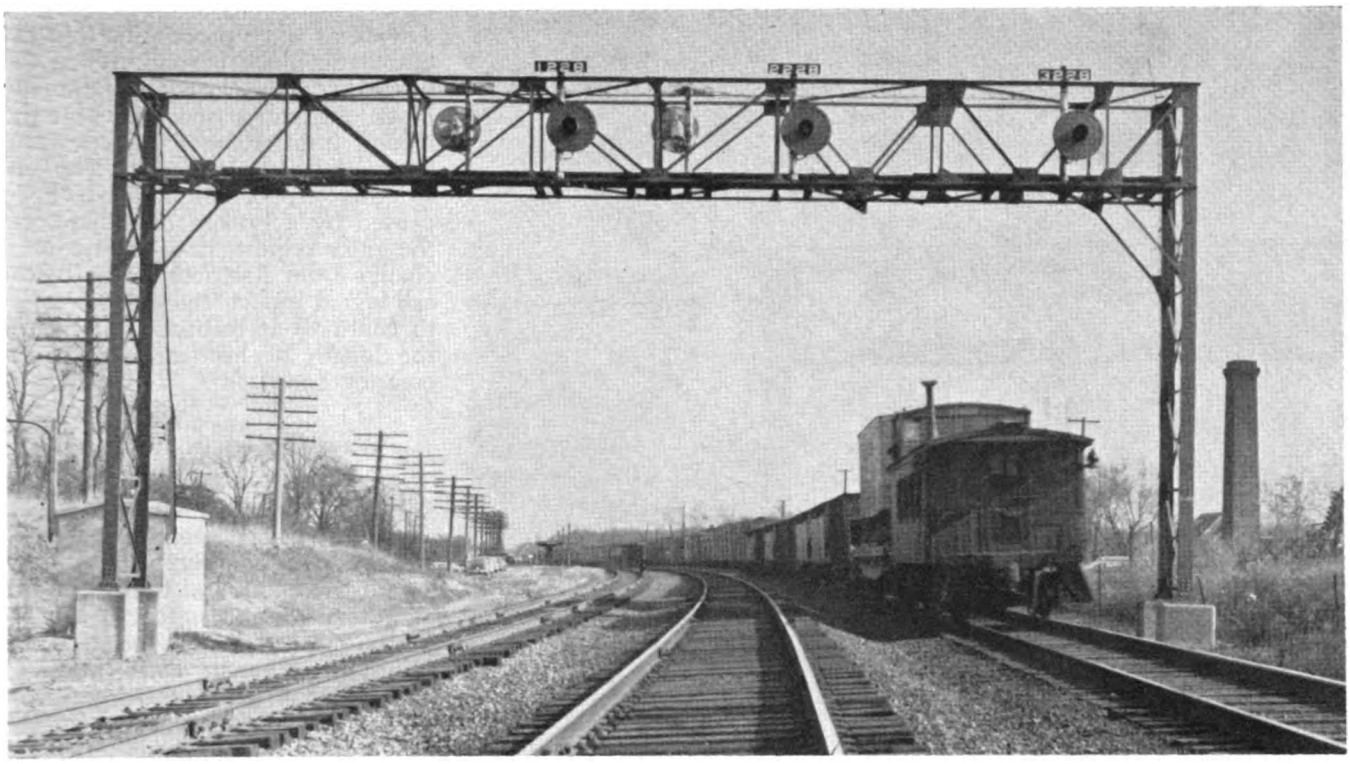


New Wayside and Cab Signaling

Four-aspect system, with one or more tracks signaled both directions, increases track capacity and saves train time. Installation includes unique use of d.c. code on local signal line circuit, and a.c. code on rails to feed cab signal

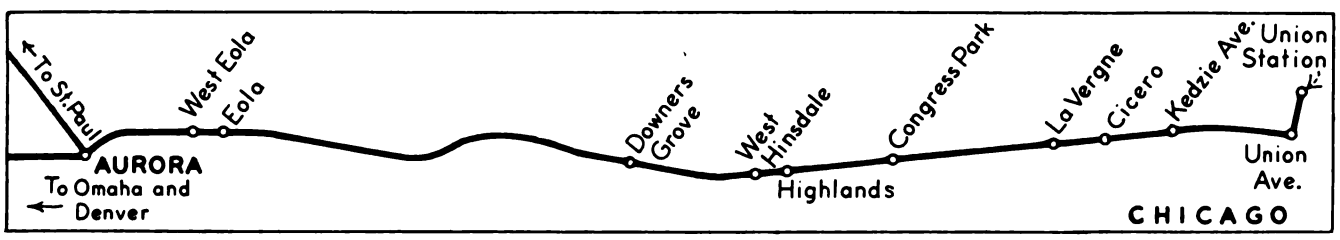
FOUR-ASPECT, CONTINUOUSLY CONTROLLED, cab signaling and wayside signaling, which involves the installation on locomotives, as well as extensive changes in automatic block and interlocking signaling, is being installed on the Burlington. The reconstruction of the wayside signaling on three-track terminal territory, between Chicago and Aurora, was completed in 1954. Also in 1954, cab signaling equipment was installed on 130 diesel locomotive "A" units, which are included in a pool that supplies locomotives for all through passenger trains from Chicago to Denver and St. Paul, as well as for suburban passenger trains operated in the Chicago-Aurora territory.

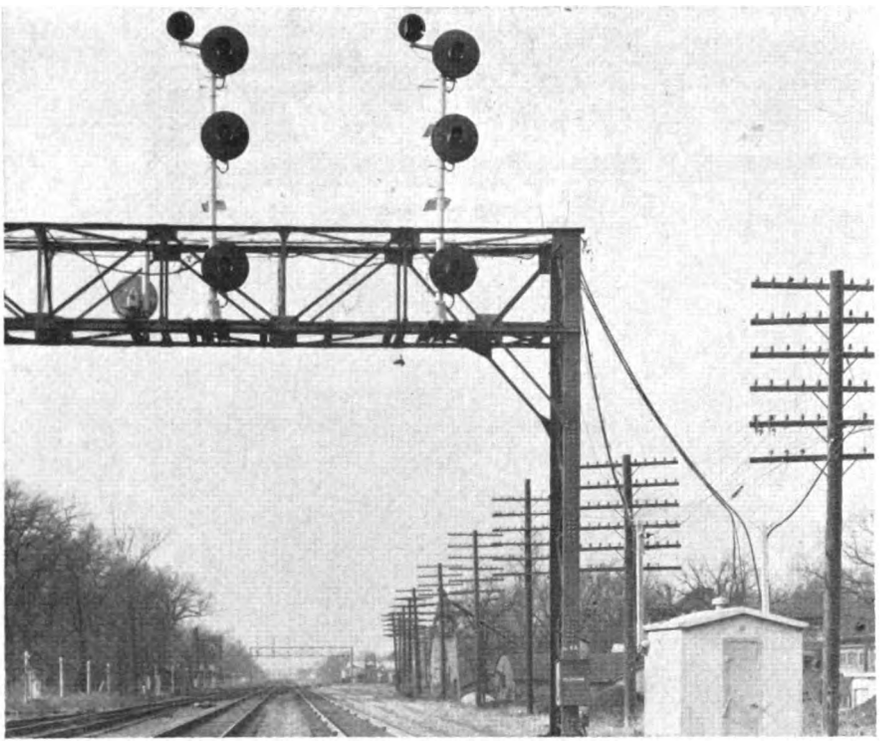
Four Aspect System

In this system, the cab signals display four aspects; green for Clear; yellow-over-green for Approach-Medium; yellow for Approach; and red-over-yellow for Restricting. With certain exceptions, a cab signal aspect is the equivalent of the aspect displayed by the last wayside signal which the locomotive passed.

When the cab signal changes to a more restrictive aspect, such as from green to yellow-over-green, a whistle in the cab starts to blow as a warning to the engineman. This whistle continues to blow until the engineman acknowledges the change in aspect by operating his acknowledging controller. Likewise, four aspects are displayed by the wayside automatic signals, which are the single-unit searchlight type. In such signals, green is for Clear; flashing-yellow is Approach-Medium; Yellow is Approach; and red is for Stop, or Stop-and-Proceed.

When a diverging route is over a short crossover, which is not good for 30 m.p.h., the aspect on the home





Lunar unit is above and to left of "top arm" of interlocking home signal

signal is red-over-yellow, Restricting, and the approach signal displays the yellow aspect, Approach; and the next signal displays the flashing-yellow aspect, Approach-Medium.

Additional Aspects

When a route through an interlocking is lined up for a train to make a diverging move over a turnout or crossover, good for 30 m.p.h. or more, the interlocking home signal displays the Diverging-Clear aspect, red-over-green, and the automatic signal, in approach, displays the Approach-Medium aspect, flashing yellow. In this instance, the cab signal displays the corresponding Medium-Speed aspect, not only throughout the automatic block approaching the home signal, but also while the locomotive is passing through the interlocking limits.

A list, in the time-table, gives the maximum speed for each diverging route in the interlockings which are used for routing trains to and from tracks that are signaled for train movements in both directions. For example, "Downers Grove track No. 1 to No. 2, good for 50 m.p.h. by passenger trains handled by diesel locomotives, operated with electro pneumatic straight air brakes; 40 m.p.h. for other passenger trains; and 35 m.p.h. for freight trains." Thus, the Diverging-Clear aspect indicates that the diverging route lined up is good for 30 m.p.h. or more, and the engineer knows how much more, according to the type of his train and the route in the particular interlocking, as listed in the time table, for example, 50 m.p.h., as explained above. Thus the signaling, and timetable, aid the enginemen in bringing their trains up to and through the crossovers at the speeds for which they are designed. This saves much time.

Red With Lunar

The aspect of the home signal is governed, not only by the lineup of the route through interlocking limits, but also by track occupancy of the automatic block extending from the leaving end of the interlocking to the next automatic signal. If the route through interlocking limits is lined up, but the home signal is held at the red aspect because a preceding train has not as yet left the automatic block, a lunar light mounted 22½ in. to the left of the top aspect will be lighted. This aspect, lunar over all red, indicates stop short of home signal, and then proceed through the interlocking, and enter automatic block beyond, at restricted speed, prepared to stop short of train or obstruction. Thus the lunar, in combination with the red, converts the absolute Stop aspect to a Stop-and-Proceed aspect. The benefit of the special lunar unit is to avoid delay to trains under the circumstances discussed. In such instances, the cab signal aspect is red-over-yellow, restricting, while the locomotive is in interlocking limits, as well as when proceeding into the automatic block beyond. When the preceding train clears the automatic block, the cab signal aspect in the second train changes at once from Restricting to Approach. The restricting aspect might have been caused by a broken rail; therefore, the rules require that in case of a change from Restricting to a better cab signal aspect, the engineman is to continue at restricted speed for the length of his train before increasing speed.

Wayside Signals Relocated

A major part of the overall cab signaling project is to re-locate the wayside signals on the basis of block lengths required, and to provide the additional controls so that all aspects can be displayed where needed, and to install equipment and controls to feed the a.c. code to the rails for control of the cab signaling on the locomotives. In 1954, all this wayside signaling reconstruction was completed on the most complicated section, which is the multiple track terminal division between Chicago and Aurora.

Previously, the intermediate automatic signals were spaced for blocks about 3,000 ft. long. As part of the project, all these signals were relocated to space the signals about 4,000 ft. apart on the section between Chicago and Downers Grove, and about 6,100 ft. apart on the section between Downers Grove and Aurora.

The Burlington connects with the tracks of the Chicago Union Station east of Union avenue interlocking, which is at MP 0.86. Aurora is at MP 37.76. Three main tracks extend throughout this 36.9 mi., which may be likened to the main trunk of the Burlington System tree. The daily schedule includes 36 through passenger trains, 66 suburban passenger trains, 20 freight trains eastbound, and 22 westbound. This totals 144 scheduled trains daily, in addition to which there are numerous transfer moves, and switching. The peak of the traffic is inbound in the morning, and outbound in the evening.

The through passenger trains make no stops between Chicago and Aurora. Local suburban passenger trains stop at all the 26 stations. However, the express suburban trains stop at only certain stations. These trains must be on the outside right-hand track when making station stops. This necessitates extra crossover moves at interlockings.

Some of the inbound through trains are scheduled during the morning peak period of inbound

suburban trains. Therefore, through trains must be run around suburban trains. In the evening, the high-ball Chicago-Kansas City through freight, scheduled to leave the Clyde yard at 6 p.m. goes west through the evening peak of suburban trains. In order to secure track capacity to handle these peaks, either one way or the other, and in order to make run-around moves, certain sections of one or more tracks are signaled for train movements both ways, the same as single track.

The track on the north is track No. 1; the center one is track No. 2; and the one on the south is track No. 3. The center track is signaled both directions throughout the entire 36.9 mi. Between Union avenue interlocking and La Vergne, a distance of 7.22 mi., track one is signaled for westward movements; track two in both directions, track three in both directions between Union Avenue and Cicero, from Cicero to La Vergne for eastward movements only. Between Cicero and Kedzie Avenue, there is a fourth main track, which is signaled in both directions. La Vergne is at the west end of the principal freight yard. The north track and the center track are signaled both ways between La Vergne and Congress Park, 3.19 mi. This gives added track capacity, needed because freights stop to set out and pick up cars at Congress Park, which is an interchange with the Indiana Harbor Belt. Also, transfer moves are made between Congress Park and the Burlington yard, east of La Vergne.

All three tracks are signaled both directions 1.5 between Highlands and West Hinsdale, which includes two interlockings where diverging moves are made between tracks. The north track and the center track are signaled both ways for 12 mi. between Downers Grove and Eola. All three tracks are signaled both ways for 4 mi. between Eola and Aurora. This is an aid in making run-around moves when freight trains stop to set out and pick up cars at Eola, which is an interchange point with the Elgin, Joliet & Eastern. Thus, of the 114.50 mi. of track on the 37.88 mi. of road, about 72.28 track mi. are signaled for both directions, and 42.22 mi. for one direction only.

Diverging Moves at Eleven Interlockings

Interlockings that include crossovers to route trains between tracks, according to directions of running, are located at Union Avenue, Kedzie Avenue, Cicero, La Vergne, Congress Park, Highlands, West Hinsdale, Downers Grove, Eola, West Eola and Aurora. All but two of these plants have been in service for years, but new controls were required as part of the new project. The interlockings at Highlands and West Hinsdale were installed in 1953.

Cab signal unit is centrally mounted, visible to enginemen and firemen

The track circuits are the conventional d.c. type, using 1-ohm relays. This territory includes track circuit controlled flashing-light signals and gates at numerous grade crossings, and, therefore, track circuits are various lengths. Where no crossing protection is involved, the track circuits extend full block length, that is, up to 6,100 ft. With some exceptions, each track circuit is fed by one cell of 60 a.h. lead storage battery.

Either-Direction Coded Local Signal Line Circuit

A unique feature of this project is the Burlington designed, either direction, two-wire d.c. coded local signal line circuits, which include controls that superimpose (on the conventional d.c. track circuits) the 60-cycle a.c. coded energy to feed the cab signals.

An important result obtained in this circuit arrangement is that, at a double intermediate signal location, the circuits for both directions are served by one signal repeater relay, one traffic locking relay, one line coding relay that controls the feed of a.c. code on the rails either east or west, and one decoding combination, including one home relay, one distant relay and one flashing-yellow control relay.

(NOTE—Signals are numbered on a mile basis, signal 127.3 being located 27.3 mi. from Chicago on track No. 1. As the discussion and diagrams are confined to track No. 1, the numbers here used omit the "1" to expedite reading.)

As explained previously, the center track, as well as various sections of the other two tracks, are signaled for train movements either westward or eastward, the same as on sections of single track centralized traffic control. The direction of traffic between any two interlockings, on a given track, is established by cooperative action of levermen at the interlockings at the ends of such a section. The north track, No. 1, is signaled for both directions between Downers Grove and Eola. When the signals on this track are to be cleared for a westbound train, the leverman at Eola operates a traffic-direction lever which causes coded d.c. impulses to go east on the two-wire local line circuit for track No. 1. This circuit has double break through front contacts of track relays in the automatic block to the first intermediate automatic signal 27.3. The rate of code fed to the line circuit determines the aspect to be displayed by that signal. Code at 180 pulses per minute controls the green aspect; 120 the flashing-yellow; and 75 the yellow. Code at any other

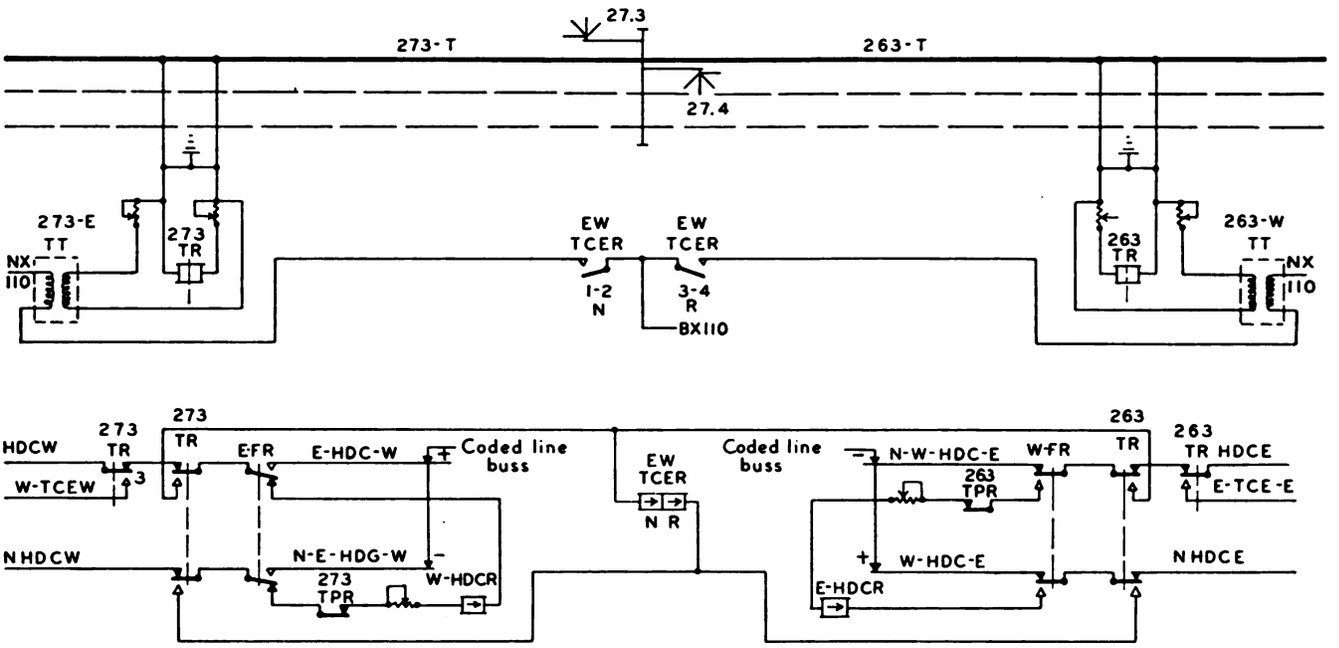


Fig. 2 Diagram of some of the circuits at signal 27.3

rate, steady energy, or no energy, causes the red aspect to be displayed.

Thus, if the westward home signal on track No. 1 at Eola had been cleared to a high green, the code going out to signal 27.3 would be 180 pulses a minute. At signal 27.3, this code operates a code following relay which controls circuits through decoding equipment to pick up relays that control the signal to display the green aspect.

120 or 180 pulses a minute, depending on the aspect to be displayed by the next westward signal 26.3, and the cab signal track code to be fed to track circuits in that automatic block. Thus, in the instance being discussed, 180 code is received at each intermediate signal and then repeated on east to the next eastward signal, all the way from Eola interlocking to Downers Grove interlocking. This 180 code, in combination with local control by the leverman at Downers Grove will clear the westward home signal on track 1 at that interlocking.

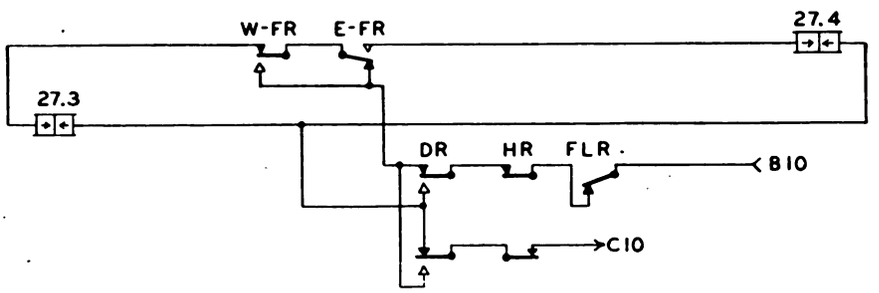


Fig. 3 Diagram of circuits to control operating coils of signal 27.3

A two-wire circuit, starting at signal 27.3, is selected through signal repeater relay, and signal control relay, to send code eastward at 75,

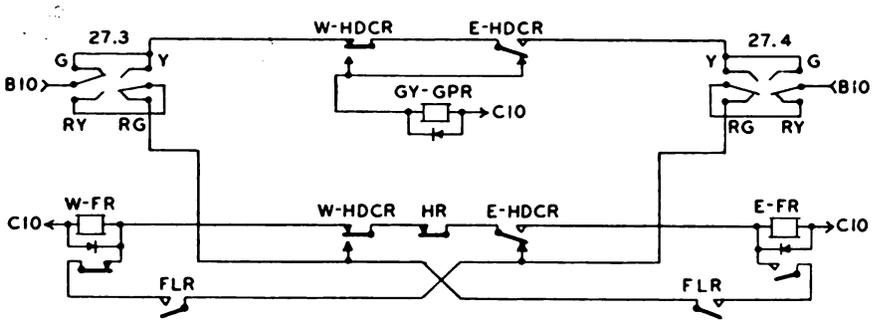


Fig. 4 Signal repeater indication and traffic-direction circuits

Some of the circuits at signal 27.3 are shown in Fig. 2. The two-wire coded local line circuit, coming in from the west, is on wires HDCW and NHDCW, at the left of the diagram. This circuit goes through front contacts of track relay 273TR, and back contacts of east traffic-direction relay E-FR, to coil of code-following relay W-HDCR. Contacts, in this relay, control circuits through decoding units to energize relay 1HR and 1DR; these circuits are similar to conventional practice. As shown in Fig. 3, contacts in HR, DR, the traffic direction relays W-FR and E-FR, and traffic lock relay FLR are used to control the operating coils of the searchlight signal 27.3.

Traffic-Direction Circuit

The signal repeater indication circuits and traffic-direction circuits are interconnected, as shown in Fig. 4. When the relay 1-W-HDCR starts to follow line code that is coming in from the left, as previously discussed, then in Fig. 4, traffic direction circuits, the westward traffic-direction relay 1-WF-R is picked

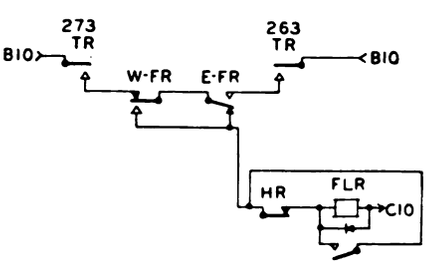


Fig. 5 Traffic locking circuits

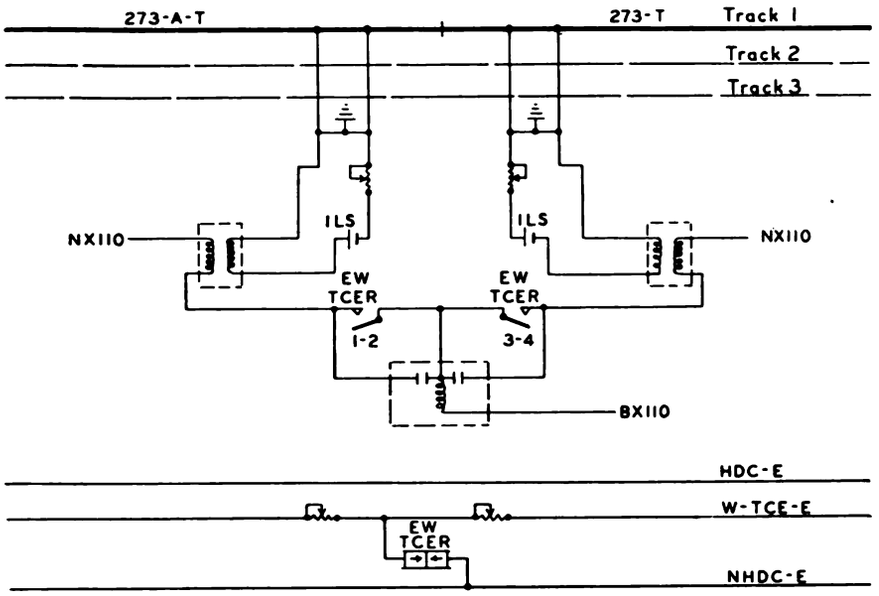


Fig. 6 Diagram of some of the circuits at a typical cut section

up, and remains up as long as it receives impulses in the range 75 to 180 per minute. When the locomotive of the westward train passes signal 27.3 to enter track circuit 273-T, track relay 273 TR drops, and as shown in traffic locking circuits, Fig. 5, a circuit, through back contact of track relay 273TR, picks up traffic locking relay FLR, which sticks up as long as the track circuit is occupied. In Fig. 4, traffic circuits and a front contact of FLR hold W-FR energized through its stick contact and signal 27.4 at red. Thus the traffic direction is held. Therefore, the direction of traffic cannot be changed until the entire section of track between Downers Grove and Eola is unoccupied, and all signals are at the red aspect. As shown in Fig. 3, signal control circuits, W-FR must be up, and 1E-FR down, to clear signal 27.3. In Fig. 4, when searchlight signal 27.3 clears, the repeater relay GY-GPR is picked up. By means of the selections shown in these circuits, one GY-GPR relay serves for both signals, 27.3 and 27.4. Contacts of the GY-GPR relay are used in circuits which determine the code rate that is fed eastward on the line circuit toward the next westward signal.

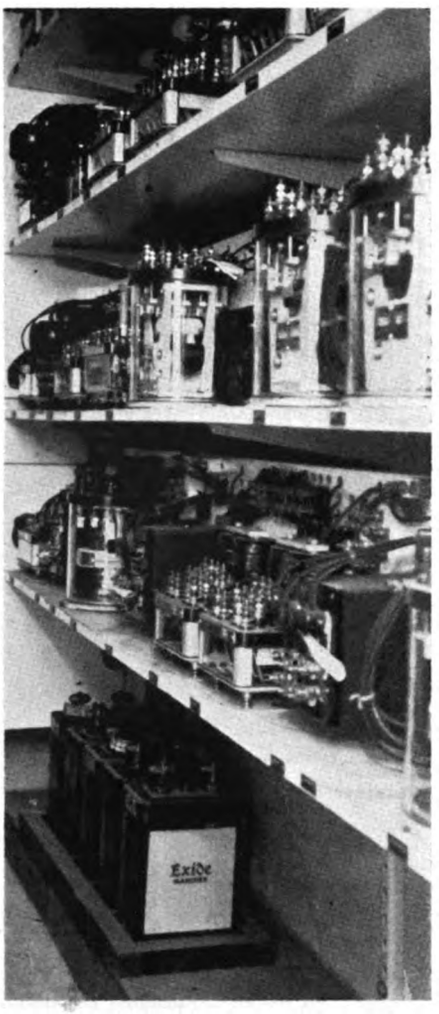
Cab Signal Rail Feed

As mentioned previously, the cab signal is controlled by 60-cycle a.c. coded energy, which feeds in the rail from the leaving end of a track circuit toward an on-coming locomotive. The feeding of this a.c. energy, on any track circuit, does not start until the front wheels of the locomotive shunt that track circuit, and thus drops the conventional d.c. track relay. This all happens so quickly (in less than one second) that there is no "flip" of the cab signal aspect. In Fig. 2, when an approaching westbound locomotive enters the east end of track circuit 263-T, (at right of diagram) the track relay 263TR drops. When 263TR is down, coded line busses, N-W-HDC-E and W-HDC-E feed coded d.c. impulses through front contacts of W-FR, and back contacts of 263TR to operate relay EWTCER to follow code. This is a biased neutral code following relay with two armatures, one of which operates contacts 1 and 2, and the other of which operates contacts 3 and 4. When the polarity of the d.c. impulses is in one direction, the contacts 1 and 2, operate, and the others stay down. Or, when the polarity is in the reverse direction, the contacts 3 and 4 operate, but contacts 1 and 2 stay down.

Because of the polarity control in code transmitter relay EWTCER, as explained above, this relay serves to feed code either east or west on track No. 1, depending on direction of traffic.

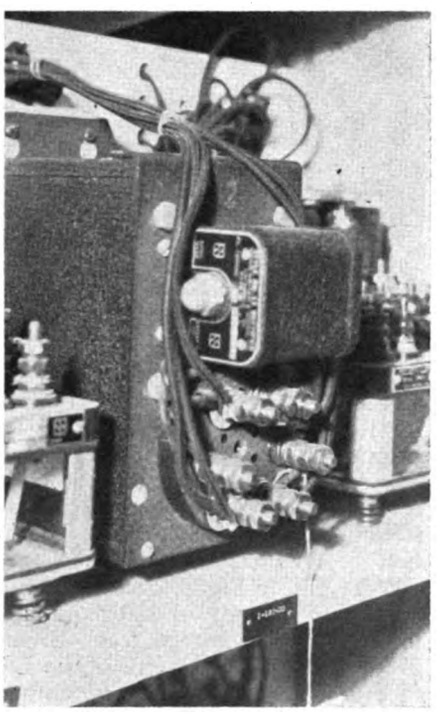
In the instance being discussed, the polarity is to operate contacts 3 and 4. In Fig. 2, 110-volts a.c. feeds through front contacts 3 and 4 of EWTCER, through the primary of the track transformer and to NX110. From the primary, impulses of a.c. at 4.5 volts feed to the rails eastward on track circuit 263-T toward the westward locomotive.

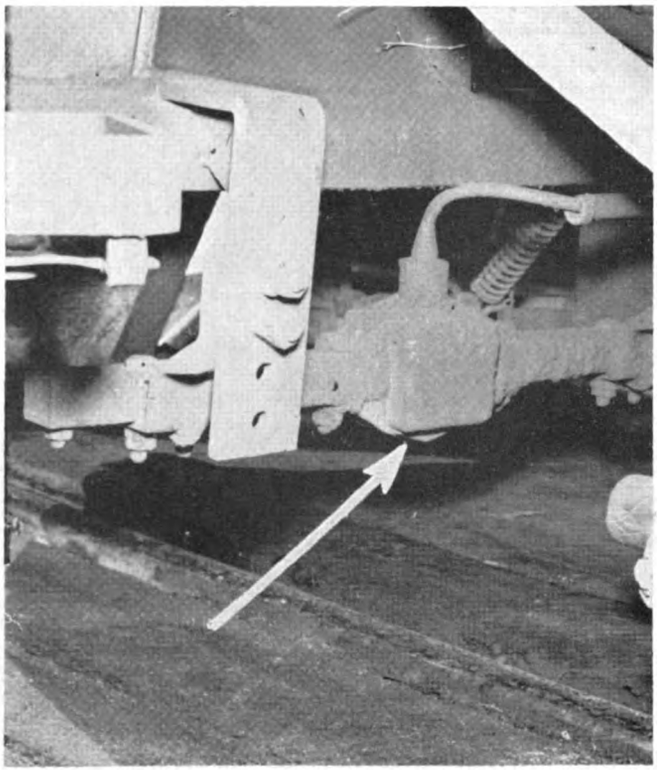
When the front wheels of the westbound locomotive pass signal 27.3 and shunt track circuit 273-T, the track relay 273TR is dropped. As shown at the left of Fig. 2, the back contact 3 of this relay connects incoming line wire HDCW to line wire W-TEC-W, going out to the left. These wires enter Fig. 6



Inside a bungalow at a signal location

Below: A 180-code decoding unit





Receiver is mounted under locomotive ahead of leading truck

Cab signal equipment is rack-mounted in nose of locomotive

Code transmitter for 180 code

at the right to operate code following relay EWTCER, with a polarity to operate contacts 3 and 4, to follow code. In this instance, the code is 180, if signal 27.3 is being controlled to the green aspect. Operation of contacts 3 and 4 of relay EW-TCER, in Fig. 6, causes a.c. impulses, at the rate of 180 a minute, to be fed eastward on track circuit 273-T, as explained before. The LS, in Fig. 6, is one cell of lead storage battery, which feeds the steady d.c. energy to track circuit 273-T to energize track relay 273TR at signal 27.3.

The automatic controls for some of the crossing protection include short track circuits, 110 ft. long, across the width of a street. The coded a.c. cab signal energy is fed to such a short circuit when the locomotive enters the track circuit in approach to the short one. This eliminates the possibility of a "flip" of the cab signal aspect.

Cab signal receiver coils are mounted, one above each rail, at the front of a locomotive, about 7 in. in front of the place where the front wheel contacts the rail. The a.c. in the rails, at the leaving end of the circuit, is adjusted for axle current of 1.2 amp., which is enough so that, at normal train speeds, one receiver coil will hold the circuit to prevent a flip of the cab signal when passing from one track circuit to another, even though the rail joints are staggered one-half a rail length.

Suburban passenger trains, when stopping at some of the stations, may stop with an insulated joint between the receiver coil and the first locomotive wheel on that rail. If this happens, the cab signal may drop to Restricting, because coded a.c. has not yet been applied to the circuit over which the receiver extends (but not the wheels). To prevent this, a wire plugged into the rail extends along the rail, but insulated from it, past the insulated rail joint for about 20 ft. This prevents a Restricting cab signal under the condition discussed.

On the crossovers between main tracks where diverging moves are made at 30 m.p.h. or more, a new arrangement of series fouling circuits was installed. If a bond, a wire, or the rail breaks, the circuit is open, and the relay is released. Also in this arrangement, the cab signal rail energy is effective to control the cab signal continuously while a locomotive is passing through the crossover.

Crossing Gates

As part of this project, new flashing-light signals and automatic electric gates were installed at several crossings, including Brookfield and at Riverside. Through passenger trains, suburban passenger trains and freight trains operate at different speeds, and some suburban trains make stops at stations within the track circuit controls. Therefore, to minimize delay to street vehicles, the Burlington installed time-speed controls and station stop cutouts in the circuits for these crossing gates and signals.

This cab signaling, wayside signaling and crossing protection project was planned and installed by Burlington forces under the direction of A. L. Essman, chief signal engineer. The major items of signaling equipment were furnished by the Union Switch & Signal, Division of Westinghouse Air Brake Company.