Eastbound "Detroit Limited" passing signals 3520 and 3521 between Bement and Ivesdale

Wabash Installs Automatics

THE Wabash has installed automatic block signaling, about half of which is controlled by continuously-coded track circuits, on 17.4 miles of double track between Bement, Ill., and Tolono, on the Ninth district of the Decatur division, thus marking the completion of automatic block signaling on the entire main line between St. Louis, Mo., and Detroit, Mich., via Decatur, Ill., of which the newly signaled territory is a part. The line is double track from Decatur, 37.6 miles eastward to Tolono and single track from Tolono, 34.1 miles eastward to Tilton, from which point the main alternates between single and double track eastward to Detroit via Fort Wayne, Ind. The installation of signaling, which has just been completed, adjoins that section of absolute-permissive block signaling, controlled by polarized-line circuits, between Tolono and Tilton, which was completed last year, and described in the April, 1941, issue of *Railway Signaling*. The new signaling was installed to increase the safety of train operation, reduce delays of train movements to a minimum, and to close the last unsignaled gap in the main line between St. Louis and Detroit.

Between Bement and Tolono, 17.4 miles, train order offices are located at Bement, Ivesdale, Sadorus and Tolono. One interlocking is in service at the east end of this territory, at Tolono, to control the necessary signals, interchange track switches, crossovers and end-of-double-track layout in the vicinity of a crossing with a double-track main line of the Illinois Central. A junction is located at Bement, the west end of the installation, 20.2 miles east of Decatur. From this point a main line extends north to Chicago. The switches and crossovers at Bement are operated by hand-throw stands, which are handled by an operator. Train movements over these switches and crossovers have been governed by signal indications for several years.

Character of Line and Traffic

The line between Bement and Tolono traverses a reasonably rolling country. However, the track is practically level and tangent except for a slight grade and curve approaching Tolono from the west. The rail in service in this territory is 110-pound and 112-pound stock, and the ballast is gravel. The speed limit for passenger trains on tangent track is 80 m.p.h. and 50 m.p.h. for freight trains.

The traffic over this territory includes two passenger and two red ball freight trains westbound daily, and one local freight train westbound Tuesdays, Thursdays and Saturdays. The eastbound traffic includes two passenger and four red ball freight trains daily, and one local freight train Mondays, Wednesdays and Fridays.

Searchlight Signals

At the Tolono interlocking, searchlight signals were already in service. The only change made at this interlocking was to provide the control for an approach aspect on the westward two-"arm" home signal, the top "arm" of which governs train movements to the westward main track, and the bottom "arm" of which governs movements against the current of traffic to the eastward main track, or serves as a call-on signal. The distant signal 3395 was already in place and was not changed. The only changes that were made at the layout at Bement was to add the control for an approach aspect on the eastward two-arm semaphore home signal, the top arm of which governs train movements to the Detroit line, and the bottom arm of which governs train movements to the Chicago line.

The new signals are of the Union Switch & Signal Company's H-5 type with detachable mechanisms. Each searchlight operating unit is equipped with 250-ohm operating coils, designed for operation on 10 volts, d-c. The signal lamps are of the double-filament type, rated at 10 volts, 5 + 3.5 watts. The signals are mounted on 5-in. masts, the center line of the searchlight unit lens being placed at 14 ft., 9 in. above the level of the rails. This arrangement places the signal lens in direct line with an engineman in a locomotive cab. The signals are painted with white paint, except the front side of the signal backgrounds, ladders, platforms and the pinnacles, which are painted with dull black signal paint. Conforming with the standard practice of the Wabash, portable sectional concrete foundations, manufactured by the Railroad Concrete Products Company, are used for mounting the signals. The anchor bolts are on 11-11/16-in. centers. The anchor bolt slots in the signal mast bases are filled with plastic signal cement to prevent cinders, dirt, water and snow from accumulating, which would otherwise cause corrosion of the anchor bolts. This cement never hardens. Each signal has one operative head, mounted on the field side of the mast, which displays one of three colored aspects: red, yellow or green, for Stop-and-Proceed, Approach and Clear, respectively. The automatic signals are distinguished from interlocking signals by the presence of an enameled black and white number plate on the mast. The signals are numbered to the nearest tenth of a mile.

Arrangement and Control of Signals

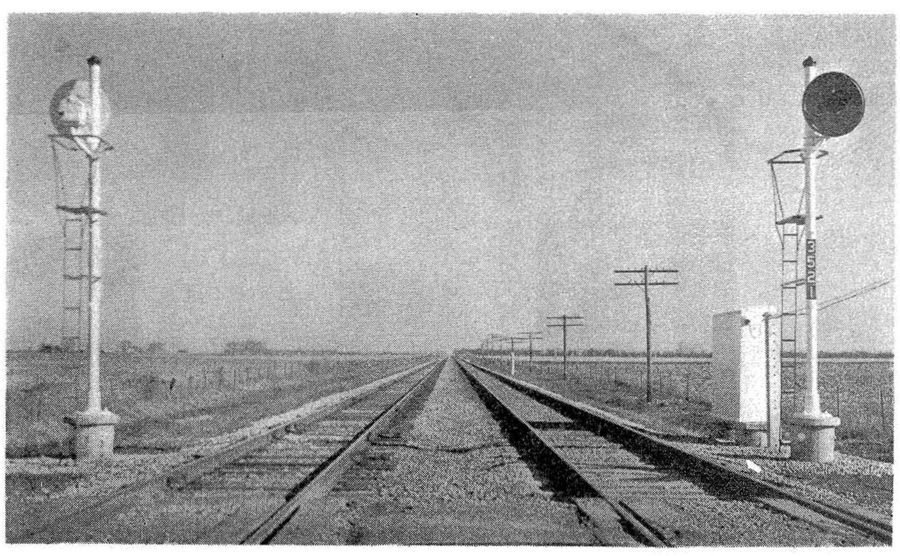
When designing the new signaling between Bement and Tolono, all signal locations were planned as double locations. Between these two points there are eight such locations. The spacing of all signals is approximately two miles. All signals are controlled by continuously-coded track circuits, except in the cases where certain blocks are divided into short track circuits for the control of highway crossing signals, in which case conventional neutral d-c. track circuits are employed. The coded track circuits vary in length from 11,000 ft. to 9,500 ft., while the conventional neutral d-c. track circuits, used for the control of highway crossing signals, average 3,500 ft. There are a total of eight coded track circuits, four between Sadorus and Ivesdale, and four between Ivesdale and Bement. The track circuits between Bement and signal locations 3540-3539 are non-coded neutral, while those between signal locations 3540-3539 and 3500-3499 are coded. Neutral track circuits are used between signal locations 3500-3499 and 3480-3479, and coded track circuits are used between locations 3480-3479 and 3438-3439. Between the latter location and Tolono, neutral track circuits are used for the control of signals. A recent development in design of continuously-coded track circuits is employed in this installation for the approach lighting of all signals controlled by coded track circuits, that is, the reverse feed code to the rails at the entrance end of the block during the off periods or interruptions in the normal 75 or 180 coded current, from the exit end of the block. With the coded energy being fed at the exit end and operating a code following relay at the entrance end of the block, another coded current is applied to the rails at the entrance end of the block during the off-periods of the normal code current, this reverse code operating a relay at the exit end for the control of approach lighting, thus requiring no line wires. All the automatic signals are approach lighted, regardless of how they are controlled.

Major portion of installation on 17.4 miles of double track controlled by coded track circuits with reverse code for approach lighting

Control Circuits

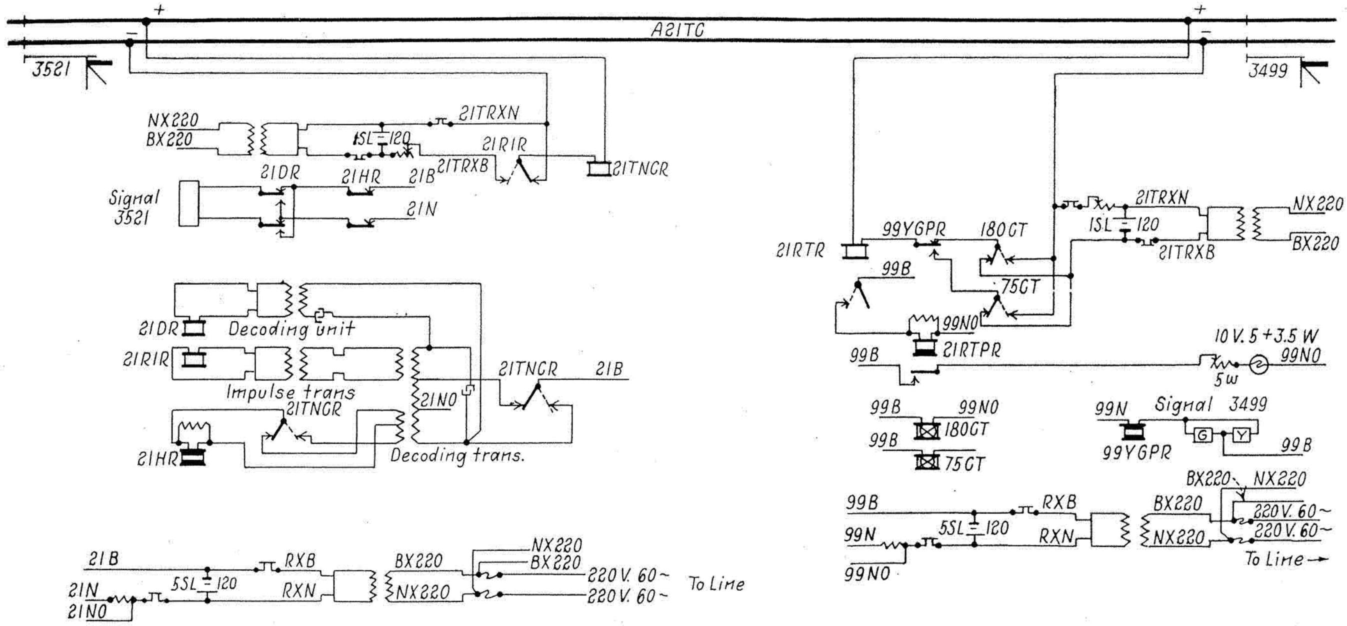
The accompanying simplified circuit diagram represents one block in which a continuously-coded track circuit is used for the control of signals, as well as for the approach lighting of signals, no line wires whatsoever being used in the controls. Under normal conditions and with no trains approaching, positive battery 21TRXB flows over a left contact of the 180 code transmitter at signal 3499, over a front contact of the 99YGPR, to check that signal 3499 is displaying the yellow or the green aspect, through the operating coils of the reverse-code track relay 21RTR, to the positive rail and to signal 3521 through the coils of the normal-code track relay 21TNCR, over a right contact of the reverse-impulse relay 21RIR, to the negative rail, back to signal 3499, and to negative battery 21TRXN, thus positioning the contacts of the 21RTR, 21TNCR and 21RIR relays in the right, left and right positions, respectively. When the 180 code transmitter at signal 3499 shifts to the right, the 21TNCR relay is released to the right-hand position. This cycle of operation occurs 180 times per minute or three times per second as long as the 99YGPR relay is energized. A similar cycle of operation follows 75 times per minute or once every 4/5 second when the 99YGPR relay is released, due to signal 3499 being at Stop-and-Proceed, and a code of 75 being sent into the rails over a back contact of the 99YGPR relay at signal 3499.

The reverse-impulse relay 21RIR, at signal 3521, is a polar-biased Style CD code-following relay, and there-



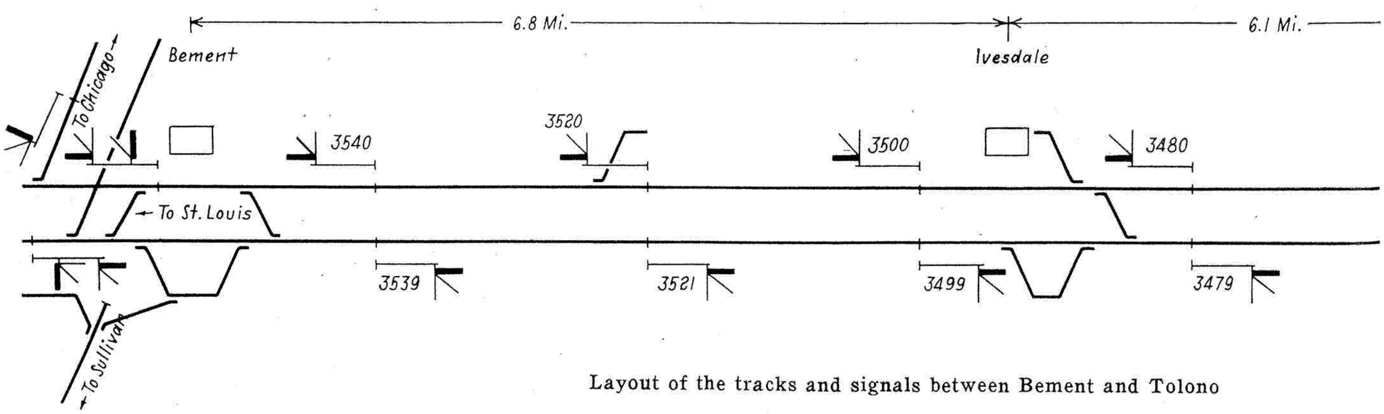
Typical double signal location between Bement and Tolono fore, will become energized only with energy of the proper polarity. When the track relay 21TNCR is energized, that is, with its contacts to the left, the voltage induced in the secondary winding of the decoding transformer, period is a little less than the off period of the shortest code. At the start of each on period of the normal track circuit code, relay 21RIR is deenergized and its right contact is closed. The negative rail of the track circuit. The negative terminal of the reverse-code battery 21TRXN is connected to the negative rail.

As mentioned previously, during the on period of the normal code, the track battery at signal 3499 is con-



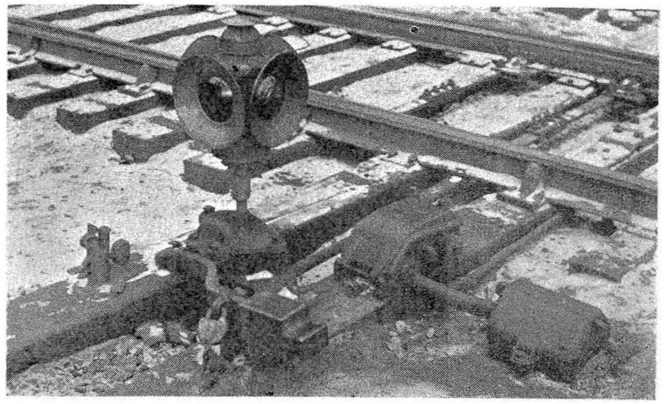
Typical coded-track circuit control circuits for one block

and the energy induced in the secondary winding of the impulse transformer, is such as to cause relay 21RIR to be energized to the right. track circuit is therefore connected over a right contact of the 21RIR relay to the negative terminal of the track relay, the positive ter- nected in series with the winding of the approach relay 21RTR to the positive rail of the track circuit, and the negative terminal of the track battery



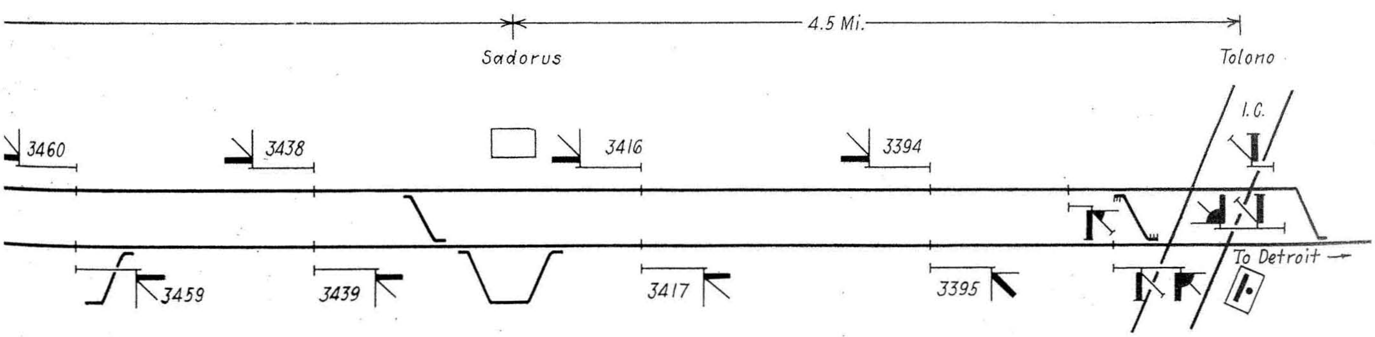
Layout of the tracks and signals between Bement and Tolono

When the track relay 21TNCR is deenergized, and its contacts to the right, the voltage induced in the secondary windings of the decoding and impulse transformers is of such polarity as to energize relay 21RIR, to cause it to be energized to the left, closing its left contacts. The windings of the decoding transformer and impulse transformer are so proportioned, as regards relay 21RIR, that the left contacts of relay 21RIR will remain closed for only a short period, which minal of the track relay being connected to the positive rail. The on period of the normal code will therefore energize the relay 21TNCR. When relay 21TNCR is deenergized at the end of the on period of the normal code, relay 21RIR becomes energized, as described heretofore. The positive terminal of the reverse-code battery 21TRXB is then connected to the left point of the 21RIR relay contact, thence from the heel of the contact to the positive rail of the is connected directly to the negative rail of the track circuit. Relay 21RTR is a Style P-4 relay. This relay is magnetically toggled so that it remains in its last energized position. During the on period of the code, the current from the track battery causes the contacts of the 21RTR relay to close to their right-hand position, as shown. When the normal track battery energy is cut off by the code transmitters shifting to the right, producing the off period of the code, energy from



Switch circuit controller cable pedestal connection at hand switch

the reverse-code battery flows from the positive rail in the opposite direction through the winding of the 21-RTR relay, through the right contacts of the code transmitter and thence to the negative rail. This reverse-code energy causes the contacts of the 21RTR to assume their left-hand position as shown dotted in the circuit diagram. Therefore, when the track circuit is unoccupied, normally coded track circuit energy feeds from the exit end of the track circuit to the entrance end of the track circuit to operate the code following track relay 21TNCR, and, during each off period of the normal code, reverse-code energy is fed for a short period from the entrance end of the track circuit to the exit end of the track circuit to operate the approach relay 21RTR. The 21RTPR relay can be energized only when reverse code is being received at the exit end of the track circuit. The reverse-code circuit operates exactly the same whether the normal code frequency is 180 cycles or 75 cycles per minute. This relay is a slow release relay. If the block is occupied this relay is deenergized because the reverse code is not generated by the operation of the normal track relay 21TNCR. The 21RTR relay positions its contacts to the right with the normal code flowing into the rails. This closes the approach lighting circuit for signal 3499, causing positive battery 99B to flow over a back contact of the 21RTPR relay, through low-frequency alternating current is induced in the winding. The induced energy in the auto winding of this decoding transformer is connected directly to the 180 decoding unit. This 180 decoding unit includes a tuned circuit so that energy is passed through the decoding unit only when the frequency of the induced energy is 180 cycles per minute, which is three cycles per second. The 180 decoding unit includes a rectifier so that relay 21DR is supplied direct current energy. When the track relay is energized, battery flows over a left-hand contact of the track relay, through the upper half of the secondary winding of the transformer, to the mid tap of that winding, which is connected to the negative terminal 21NO of the battery. This causes a flux to build up in one direction in the core of the frequency alternating current induced in the secondary winding of the decoding transformer, to cause uni-directional current to flow in the winding of the 21HR relay. Relay 21HR can only be energized if the flux in the transformer is being constantly reversed. With the block occupied this is not the case, and relay 21HR is deenergized, causing the control circuit for the mechanism of signal 3521 to be opened, thus resulting in that signal mechanism assuming the most restrictive position. When the track circuit is receiving energy of 75 code frequency, relay 21DR is deenergized. This causes positive battery 21B to flow over a front contact of the 21HR relay, over a back contact of the 21DR relay, through the operating coils of signal 3521, over a front contact of the 21HR relay, and



a variable 5-ohm resistance, through the lamp and to negative battery 99NO.

Control of Signal Aspects

The aspects displayed by the signals, controlled by continuously-coded track circuits, is determined by the HR and DR relays. Referring to the accompanying circuit diagram again, relay 21HR receives energy from a decoding transformer, when the code-following track relay is responding to either 75 or 180 code. As the flux in this decoding transformer is reversed at the rate of frequency of operation of the code-following track relay, a decoding transformer. When the track relay is deenergized, positive battery 21B flows over a right-hand contact, through the lower half of the primary winding of the decoding transformer in the opposite direction to the common connection at the center of the winding. This current causes the flux in the core of the decoding transformer to be reversed. As the code-following track relay responds to coded track energy, the flux in the core of the decoding transformer is continuously being reversed at the frequency operation of the code transmitter. The second contact of the code-following relay is used to mechanically rectify the low- to negative battery 21N, thus causing the mechanism of signal 3521 to be poled to the yellow, i.e., Approach position. When the track circuit is receiving energy of 180 code frequency, relay 21DR is energized, causing signal 3521 to be poled to the green i.e., Clear position.

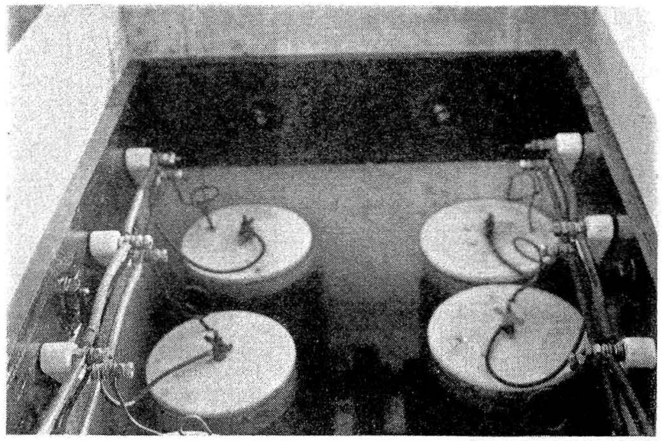
Instruments

The 180 and 75 code transmitters are the Style DM. The TNCR, normal-code-following relays, and the RTR, reverse-code track relays are the Style P-4, 2-point. The RIR, reverse-impulse relays are the Style

CD, 2-point. The HR, home signal relays are the Style DN-18C, 4-point, and the DR, distant relays are the Style DN-22C. The RTP, reverse-code track-repeater relays are the Style DN-22C, slow-release, with a resistor snub. The AER, approach-lighting relays used in the now-coded neutral track circuit territory are the Style DN-22, 60-ohms, with 2 front and 2 back contacts. The repeater relays used in neutral track circuit territory are the Style DN-18, 350 ohms, slow-pick-up, slow-release, with 4 front and 4 back contacts. In the same territory, the polarized line control relays are the Style DP-14, 250-ohms, with 4 front and 2 back neutral contacts and 2 normal and 2 reverse polar contacts. The neutral track relays are the Style DN-11, 4-ohms, with 4 front and 4 back contacts. All relays subject to vibration troubles are supported on the shelves by means of spring shock absorbers.

Instrument Cases

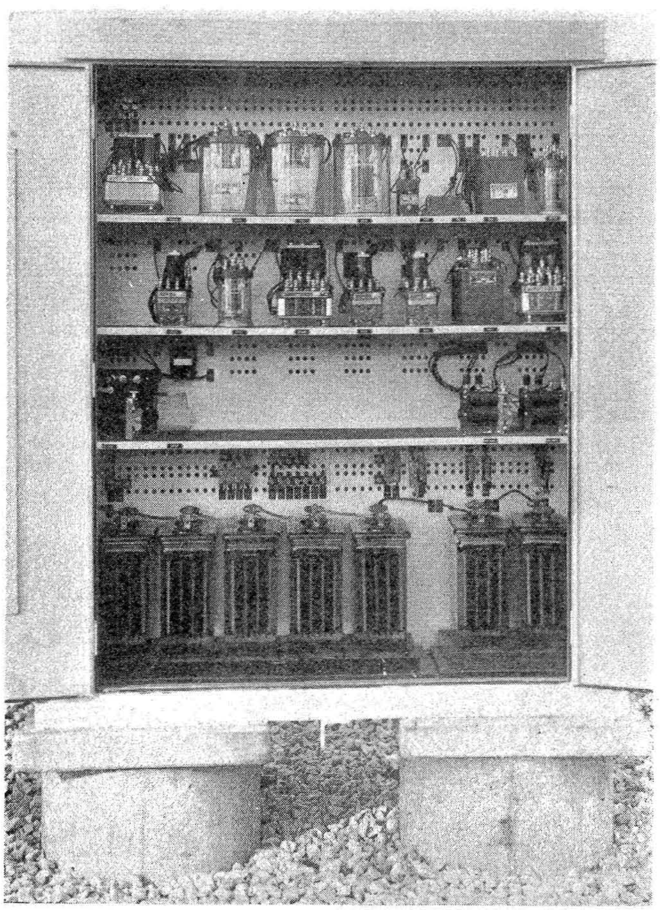
At each one of the double automatic signal locations there is a welded sheet-metal instrument case for sheltering the storage battery, rectifiers, transformers, relays, etc. In coded territory, a 6-ft., 9-in. case is used at each location. At locations in neutral track circuit territory, or coded locations adjacent to neutral d-c. track territory, a small case, 4 ft. 11 in., is used. The shelves are provided with strips of rubber rug anchor, 1/8 in. thick and 9 in. wide. This material, manufactured by the Ozark Rubber Company, comes in rolls 54 in. wide, which is cut down to the 9-in. strips. The cases are painted with white paint on the outside.



Typical primary cells for neutral track circuits

Mounting of Cases

These cases are mounted on two portable sectional concrete foundations, 27 in. by 48 in., manufactured by the Railroad Concrete Products Company. The anchor bolts of these foundations are on 22-in. by 25½-in. centers. As a means of supporting the instrument cases on the concrete foundations, each case is mounted on a frame or rack. The frame is made of 3/8-in. by 2-in. by 2-in. angle iron, and is assembled in the signal shop. A piece of this material extends along the front and back of the base, across each end, and beneath and across the center of the base of the case. This frame rests on the two foundations. Before the case is set in place on the foundations, the bottom and the portions of the case which rest on the frame are well covered with a coating of No-Ox-Id, Grade-A grease, which aids in the prevention of deterioration of the base metal. In addition to the No-Ox-Id grease, plastic signal cement is employed, to throughly seal any space or cracks between the base and the angle iron frame. This prevents any water from seeping between the base metal and the rack support angles. The instrument cases for this installation were wired in the Wabash signal shop at Decatur, Illinois.

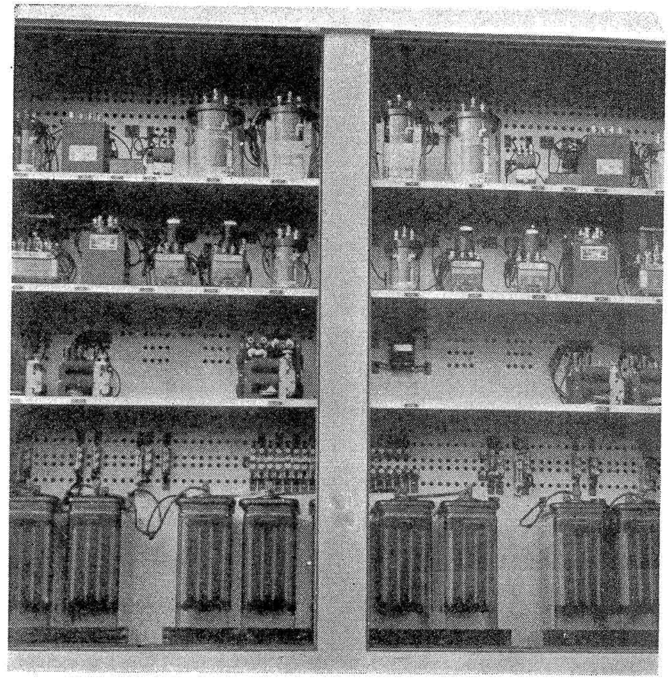


Small instrument case in coded territory adjoining non-coded track territory

Power Supply

At each one of the double signal locations, connections to a 220-volt, single-phase, 60-cycle, a-c. pole line power circuit extend in a line drop to the instrument case, where they are terminated in a Western Railroad Supply Company No. 2305-12 enclosed-fuse disconnect switch, provided with insulated sleeves and caps and two 250-volt, 3-amp. fuses. All other a-c. terminal posts on various apparatus are equipped with Raco No. 408 insulated terminal nuts. At the double signal locations, where coded equipment is in service, a set of five cells of Exide EM-7, 120-a.h. lead storage battery is in service for the operation and lighting of signals. This battery is on floating charge from an RT-42 line transformer-rectifier. The normal and reverse codes to the tracks are fed by one cell of Exide EM-7, 120-a.h. lead storage battery, on floating charge from an R 3T line transformer-rectifier.

At the double signal locations in the territories controlled entirely by neutral d-c. track circuits, the signal operating and lighting battery consists of five cells of DMGO-7SR, 60-a.h. storage battery, on floating charge from an RT-21 line transformer rectifier. Each of the neutral d-c. track circuits is fed by three cells of Columbia high-voltage, Type-572, primary battery, connected in multiple, with a Raco limiting resistance in series with the feed. At the various signal locations, the storage battery is sheltered in the instrument cases, but where primary battery for neutral d-c. track circuits is in service, concrete battery boxes with wood frost covers, manufactured by the Railroad Concrete Products Company, are provided for sheltering the primary battery.



Large instrument case in entirely coded territory

Switch Circuit Controllers

Each of the main line switches in this territory is provided with a U-5 switch circuit controller equipped with a return spring device so arranged that if the controller connecting rod becomes disconnected, the spring will operate the controller, thus resulting in signals displaying the most restrictive aspect. At each switch circuit controller, a switch circuit controller cable pedestal connection is used. The cable pedestal consists of a riser terminal box, provided with 12 terminal posts. Flexible conductors from the terminal box extend through a hose, clamped to the box and circuit controller, thus decreasing the possibility of individual cable conductors being broken if the underground cable entered the controller directly. This Western Railroad Supply Company assembly is known as the No. 1143.

Construction Details

As no line wires, other than the power distribution circuit, are required, few changes were required on the existing Western Union pole line, except in the neutral track circuit territory. Where any line control circuits are required, they are run on double-braid weatherproof, No. 10 A.W.G. Copperweld, 40 per cent conductivity wire. Two A.A.R. double-braid weatherproof No. 8, A.W.G., solid copper wires are used for the 220-volt, single-phase, 60-cycle a-c. power circuits. These two wires are tied to No. 42 Hemingray glass insulators on the track side of the existing bottom arm of the pole line. They are transposed every mile in order to reduce inductive interference with the communication circuits immediately surrounding. The 220-volt circuit is not continuous throughout the installation, but is secured at several convenient points within the territory. The circuit may extend in each direction from such a feed location only a few hundred feet, or several miles, ending at a signal location. From that point on to the end of the next feed, no 220-volt circuit is provided, thus saving considerable first cost and additional maintenance expenses. At each signal location this line is protected by Electric Service Supplies Company crystal-valve lightning arresters mounted on the cross-arm.

Cables and Wires

The runs from the instrument cases to the rail connections are in No. 9 A.W.G., single-conductor, 5/64-in. wall, underground cable having a non-metallic armor finish. The control circuits from the case to the signal on the opposite side of the track are in a five-conductor, 5/64-in. wall, No. 12 A.W.G. cable having a mummy finish with no metal therein. The lighting circuit is in a two-conductor, 5/64-in. wall, No. 9 A.W.G. cable, which also is run under the track and up in the mast of the opposite signal from the case. From the instrument cases to the line connections, open wires are suspended by 2-in., "V"-bottom, Blackburn Neverslip cable rings on a 5/16-in., 7-strand galvanized messenger cable, No. 14 A.W.G. and No. 12 A.W.G. wires being used for control and the 220-volt circuits, respectively. Of course, in coded territory there are only the two power wires in the line drop to the nearest pole. Line drops from the pole line at the signal locations, are supported at one end of the instrument case by means of a 12-ft. precast concrete post in the ground, thus placing no strain on the outer sheet metal of the case. These posts are 5 in. by 8 in. at the top and taper to 8 in. by 8 in. at the bottom. An eye bolt at the top of the post is used for securing the messenger of the line drop.

Instrument Case Wiring

The instrument case wiring is done with No. 14 A.W.G., flexible, 19-strand copper wire, with 3/64-in. wall, smooth wax finish, 0.2-in. outside diameter. Also, No. 14 A.W.G., flexible, 19-strand copper wire, with 7/64-in. wall, plain insulation, is used for storage battery leads. The battery circuits in the instrument cases is on No. 12 A.W.G., flexible, 37-strand, tinned copper wire, 3/64-in. wall with a 1/64-in. belt.

The ground rods are ½-in. by 8-ft. Copperweld, with ½-in. Copperweld clamps. Each ground is salted with 50 lb. of common rock salt. Each rail joint is bonded with a 5-in. Cadweld welded rail-head bond, Type TAB.

This installation was planned and installed by the signal department forces of the Wabash under the direction of G. A. Rodger, signal engineer. The major items of signaling equipment were supplied by the Union Switch & Signal Company.