Rock Island Developes *Single-Track Station-* Based on Coded Track

Arrangement of signals and controls make possible automatic signal protection on a very long mileage at a cost justified by increased safety protection on a line handling fast trains but a comparatively few such trains

Above—Train passing single-distant signal location. Right—Train at passing-track location, showing station-entering signal and station-leaving signal

On the Rocky Mountain Route of the Chicago, Rock Island & Pacific, between Chicago and Denver or Colorado Springs, there is 490 miles of single track between Omaha, Neb., and Limon, Colo., which is being equipped with an automatic block signaling system that includes several new and novel features, not only with reference to the operation and spacing of trains, but also in the use of a new and unique application of coded track circuits by means of which the signaling controls require no line wires in the station-to-station blocks. The territory involved is shown in the accompanying map, Fig. 1.

Between Omaha and Limon the Rock Island traverses rolling prairie country. Except for breaks in grade near rivers, the line rises gradually westward, the elevation above sea level being 1,035 ft. at Omaha and 5,359 ft. at Limon. From Limon, Rock Island trains operate over the Union Pacific for 90 miles to Denver. The Rock Island main line extends 79 miles from Limon to Colorado Springs. During recent years the track has been improved to permit higher train speeds. Lightweight high-speed passenger trains, the Rocky Mountain Rockets, are operated each way daily on fast through schedules. In addition to a second through passenger train in each direction daily, using standard equipment, there is also a local passenger train each way daily between Belleville, Kan., and Goodland, Colo., 234 miles, as well as a local passenger train daily except Sunday between Jansen, Neb., and Fairbury, 6 miles.

Freight Service

The fast through freight service scheduled daily includes two trains in each direction between Omaha and Limon in addition to local mixed trains on certain subdivisions. Extra trains are operated as required. Thus, on some sections, as for example between Fairbury and Goodland, the schedules include six passenger trains and from four to six freight trains totaling ten to twelve trains. On other

a Unique System of
to-Station Automatic Block
Circuits Without Line Wires

subdivisions the total may be eight to ten trains daily. Heretofore there was no automatic block signal protection on this territory except in a few isolated locations for protection on curves and over switches, and, therefore, the primary need was for an automatic block system to include complete track circuits for protection against collisions as well as to check for broken rails and the position of switches in the entire territory. On account of the extended mileage, 490 miles, between Omaha and Limon, the character of the line, and the comparatively light volume of traffic, only a limited expenditure could be authorized for the desired signal protection. In this instance necessity was the mother of invention. The Rock Island signal engineer and his staff planned a continuous track circuit controlled system with blocks extending from station to station.

No Intermediate Blocks

East of Fairbury no intermediate automatic blocks as such are provided to permit trains to follow one another in a station-to-station block. West of Fairbury, however, the signal system has been further developed and extended to provide additional signals in the center of certain station-to-station blocks in excess of eight miles in order to permit trains to follow each other. This feature is accomplished without the use of line wires, and the signal layout is similar to that at a passing track location, but minus the passing track.

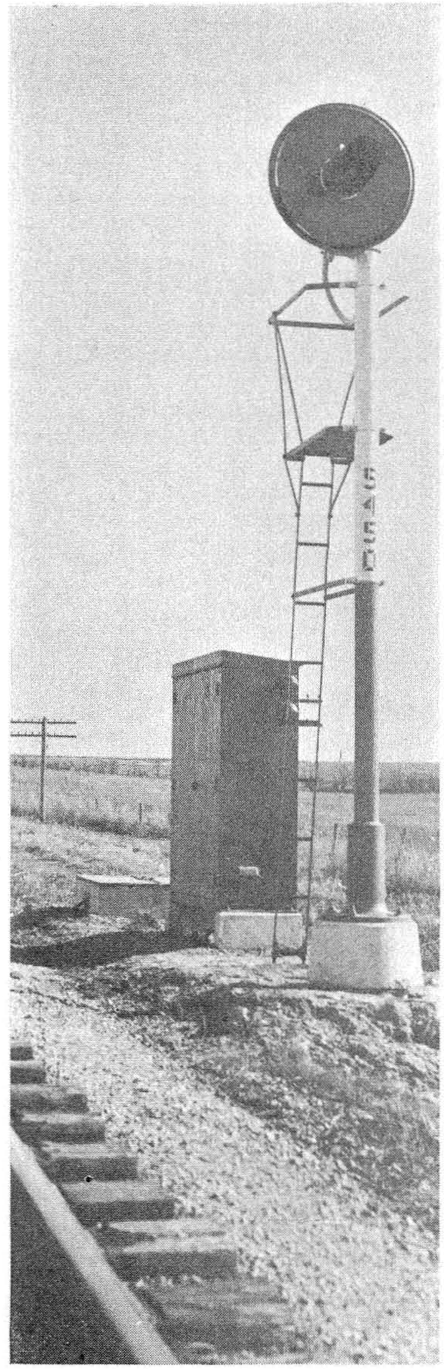
Furthermore, the Rock Island signal staff devised a new and novel scheme of using coded track circuits to control single-track automatic block signaling without line control circuits in the station-to-station blocks. As compared with conventional signaling the use of station-to-station blocks reduced the number of signals required, and the new circuit scheme eliminated line wires and pole line work so that the cost of the installation is considered to be in proper relationship with the volume of traffic and funds available for signaling on this line.

Protection and Track Capacity of the New Signaling

This new signaling on the Rock Island provides the same safety protection as any other automatic signaling, including protection from collisions, broken rails and misplaced switches. The installation includes separate automatic blocks through the limits of the stations, the same as in conventional signaling. For example at station A in Fig. 2, signal 9 is the westward station-entering signal, and signal 10 is the eastward station-entering signal. In order to give an engineman advance information concerning the aspect displayed by a station-entering signal, there is a distant signal located at full braking distance plus medium-speed braking distance from each station-entering signal. For example in Fig. 2, signals 7 and 12 are the distant signals for station-entering signals 9 and 10, respectively, and signals 6 and 1 are the distance signals for station-enterting signals 4 and 3, respectively. An important point is that signals such as 1, 6, 7 and 12 are merely distant signals and they are not located or controlled as intermediate automatic signals.

Station-to-Station Block Is Something Different

In this Rock Island project the station-leaving signals and their controls are different from conventional practice in that the block is from siding to siding, so that following trains are usually spaced the full station-to-station distance rather than being spaced by intermediate automatic signals, with the exception of certain instances west of Fairbury, mentioned heretofore, where intermediates have been installed in station-to-station blocks longer than eight miles to allow for following train movements. Referring to Fig. 2, which illustrates a station-to-station block in the Rock Island project, when an eastbound train departs from station A, the eastward station-leaving signal 8 at this siding will continue to display the Stop aspect to hold a following eastward train until the leading train has passed beyond station B or has entered the siding at that station.



Single-distant signal location showing instrument case and battery box

On this territory of the Rock Island, following trains of the same class and speed are not ordinarily operated very close together, and, therefore, the spacing from station to station does not cause train delays on this score. Where a freight train is on a siding waiting for a passenger train of the same direction to pass, the freight will have to wait at station A, for example, until the passenger train goes beyond station B. On account of the few instances of this nature due to the comparatively small total number of trains, and because the high speed of passenger trains reduces the time to pass beyond the next station, the delays due to the station-to-station blocks are few and of short duration. These delays are recognized as necessary in the system based on the station-to-station block, which in turn was accepted in order to reduce the costs to be in conformity with funds which could be justified and authorized. Based on observations since long sections of the signaling system have been placed in service, the trains leave stations on green aspects, thus accelerating to maximum authorized speed promptly, whereas in a different system in which a train would depart on a yellow aspect, the train would be required to proceed at reduced speed until arriving at a signal displaying a more favorable aspect. Therefore, the experience of the Rock Island is that train delays have proven nil because of the use of green aspects.

With an eastbound train passing from station A to station B, signal 12 remains at Stop until the train has passed signal 8, after which signal 10 displays Approach, and signal 12 clears to allow a second train to follow. Signal 8 will not clear until the first train is by signal 4 and signal 6 is displaying Approach.

Aspects Displayed

In Fig. 2, station-leaving signals such as signal 8 at station A and signal 5 at station B are absolute signals to which Rule 292 applies. Such signals are normal-clear signals. In view of the fact that these are station-to-station signals, they display only two aspects, red for Stop and green for Proceed. No yellow aspect is provided on this signal because it is not controlled or located to display an Approach aspect for any signal ahead.

Station-entering signals such as signals 10 and 9 at station A are normal-danger permissive signals to which Rule 291 applies. Such signals are capable of displaying three aspects, green, yellow and red. The green aspect indicates that the block on the main track between this signal 9 and signal 11 is unoccupied and also that signal 11 is displaying a green aspect. The yellow on station-entering signal 9 is an Approach aspect to indicate that signal 11 is displaying the red aspect.

The distant signal, such as signal 7, is a normal-danger permissive signal to which Rule 291 applies. It is capable of displaying three aspects. Red indicates Stop and then Proceed. The yellow and green aspects are track circuit controlled up to signal 9, and in addition the yellow is an Approach aspect indicating that signal 9 is displaying red. Also signal 7 displays green to indicate that signal 9 is displaying yellow or green, and that the track is unoccupied between signal 7 and signal 11.

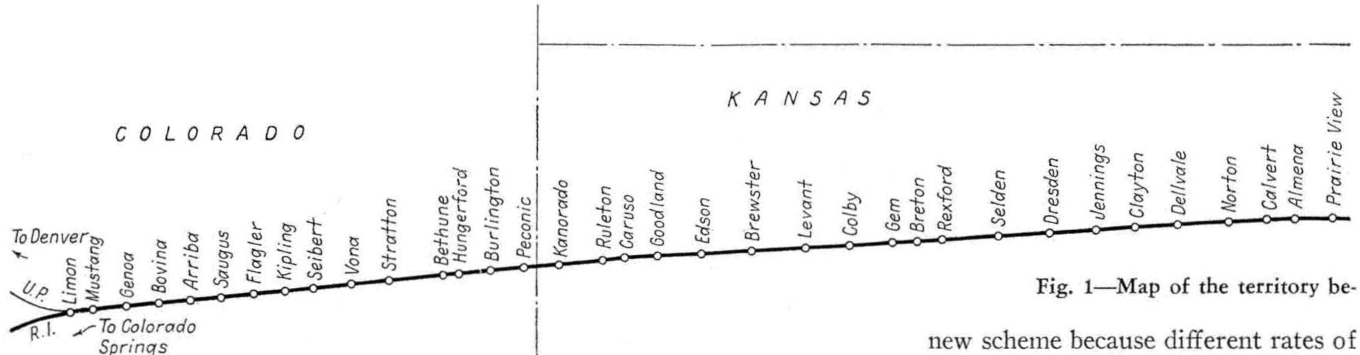


Fig. 1—Map of the territory be-

Impulses Feed Both Directions, Are Co-ordinated to Prevent Interference, but Are Not Interdependent

In a station-to-station block, as for example between signal 8 at the station A and signal 5 at station B, the signals are controlled by a new and unique adaptation of track circuits, without the use of line circuits. The commonly accepted term coded track circuits does not exactly apply to this new scheme because different rates of code, such as 75 or 180 per minute, are not used to control signals to display different aspects. In order to explain the Rock Island scheme, the term impulse may well be used. The absolute station-leaving signals, such as signal 5 and signal 8, are capable of displaying only two aspects. When no track circuit energy impulses are being received at such a signal, it displays Stop, but when impulses are being received, the signal displays green.

As shown in the typical diagram, Fig. 4, the track circuits on this Rock Island signaling are the double-end type, i.e., there is both a relay and a battery at both ends of every track circuit. With the system dormant, the relay is connected. But if the track circuit is to be fed from a given end, the contacts are operated to connect the battery rather than the relay. Thus the track circuits can be fed and operated in either one direction or the other. Looking at it another way, they can be fed first one way and then the

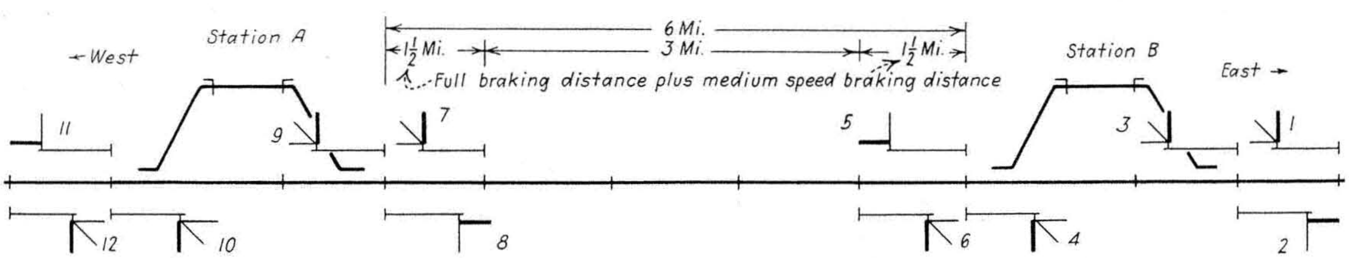
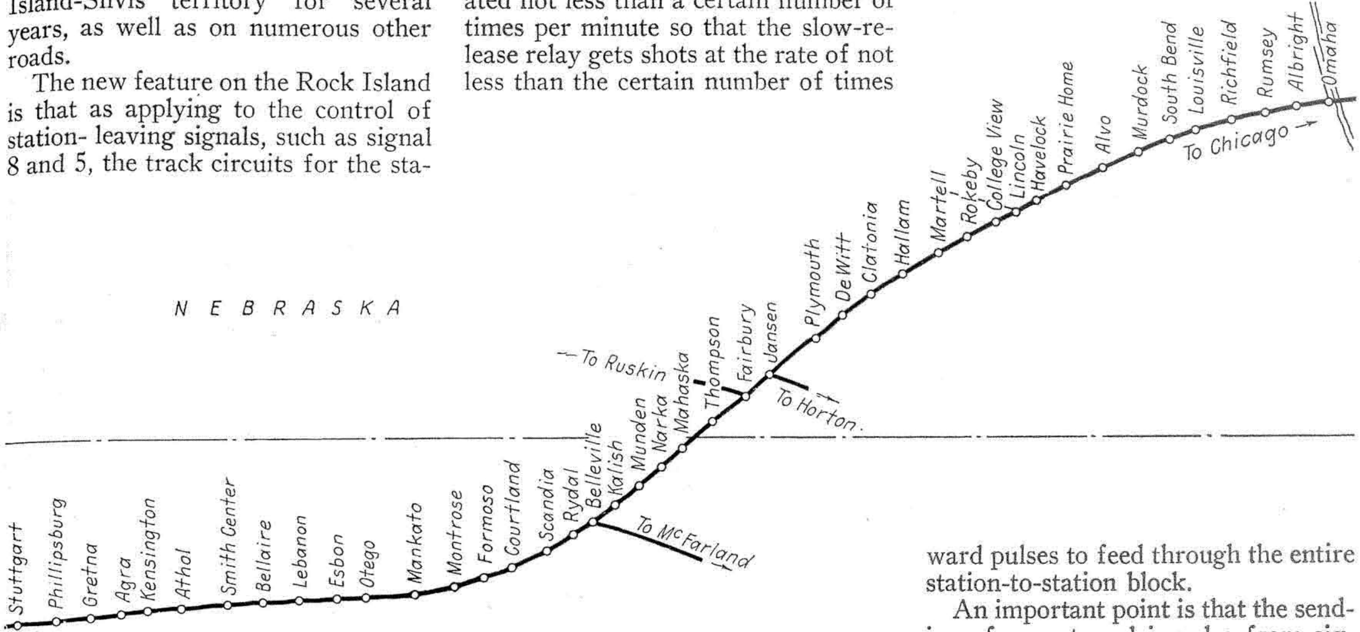


Fig. 2—Typical station-to-station track and signal layout with no intermediate signals as such

Where intermediate signals for each direction are provided in station-to-station blocks in excess of eight miles, each signal is provided with a distant signal, similar to the arrangement at passing track locations, forming in reality, two station-to-station blocks without a passing track at one. This arrangement is shown in Fig. 3, with the additional signals 7, 8, 9 and 10, signals 7 and 10 being distant signals to signals 9 and 8, respectively.

other through a station-to-station block as a whole. There is nothing new about this either-direction double-end track circuit, the principle having been used in the Rock Island's Blue Island-Silvis territory for several years, as well as on numerous other roads.

The new feature on the Rock Island is that as applying to the control of station- leaving signals, such as signal 8 and 5, the track circuits for the sta-



tween Omaha, Neb., and Limon, Colo.

tion-to-station block are normally in operation in *both* directions to hold *both* such signals at the green aspect, thus in effect duplicating the function of two-line control circuits in a conventional single-track automatic block circuit scheme.

Starting the explanation as of a certain instant, say that an impulse of d.c. energy about 0.4 seconds duration is fed eastward from signal 8 on track circuit *a,* shown in Fig. 5, and is relayed through track circuit b, c, d and e. On receipt of this impulse the track relay at the east end of track circuit e is picked up and then released. While this relay is up a surge of energy is fed to the coil of a slow-release relay, and as long as the track relay is operated not less than a certain number of times per minute so that the slow-release relay gets shots at the rate of not less than the certain number of times per minute, the slow-release relay stays up, thus effecting controls to display the green aspect in signal 5.

In this scheme an eastward impulse goes through the track circuits of the entire station-to-station block which in some instances is as long as 8 miles including as many as 5 track circuits averaging 9,000 ft. long. Each time a pulse of energy ceases in a track circuit, some appreciable time is required to allow the relay to release and for the so-called "charge" to dissipate from the track circuit so that the feed of the pulse in the opposite direction will carry through. Thus the "off" period between eastward pulses must be of sufficient duration to allow time for these operations through all the track circuits going east, and in addition the same duration for the westward pulses to feed through the entire station-to-station block.

An important point is that the sending of a westward impulse from signal 5 does not depend on the receipt of an eastward impulse at that location. The eastward pulse must simply get there when it should, otherwise it will be opposing a westward impulse which would cause unsatisfactory operation. Detailed explanations of the means for controlling the timing to prevent interference will be given in another article in a forthcoming issue of *Railway Signaling.* The point here is that each impulse is of about 0.4 seconds duration, and depending on lengths of track circuit and overall station-to-station blocks and ballast conditions, the lengths of the "off" periods range from 2 seconds up to 3

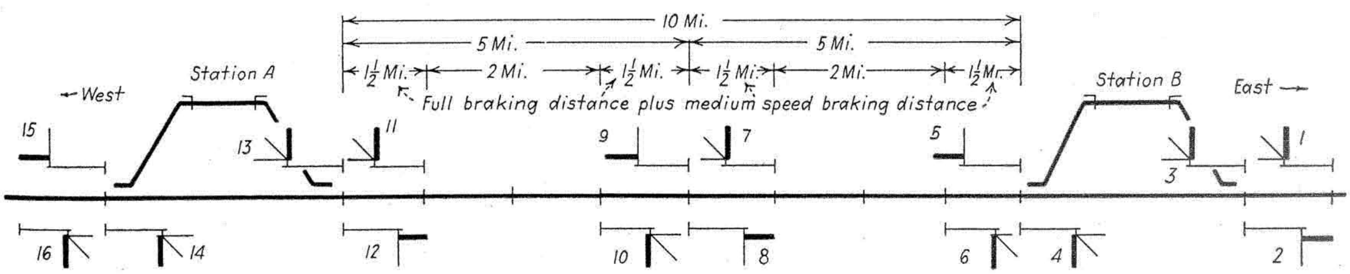


Fig. 3—Track and signal layout for station-to-station bl ocks in excess of eight miles, showing additional signals

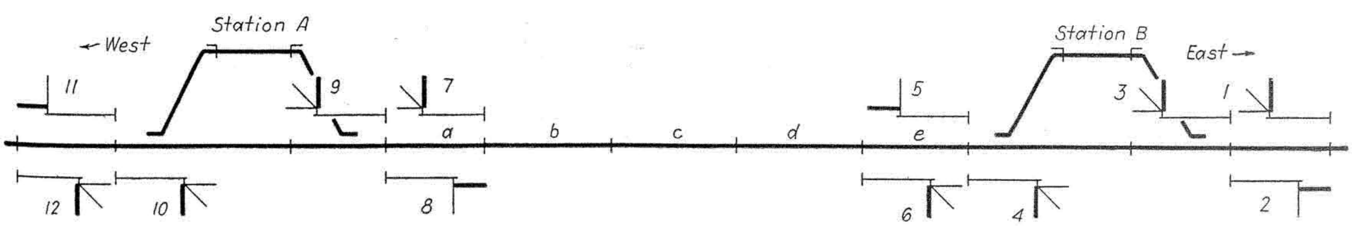


Fig. 5—Station-to-station block with station-to-station track circuit designated

seconds. The 0.4 seconds on and 2 seconds off totals about 25 impulses per minute.

To Control Signal to Stop

The track circuit scheme on this Rock Island project holds a relay normally energized at signal 8 to cause that signal to display the green aspect, and a normally-energized relay at signal 5 causes that signal to display green. Thus these are practically equivalent to the normally-energized line relays in a conventional single-track automatic block system. Thus in the Rock Island scheme the basic controls are normally energized for both directions. While the controls of the signals are affected to display certain aspects, the signals are not lighted until the approach of trains.

When an eastbound train enters the control limits of signal 8, the impulses feeding eastward from signal 8 to signal 5 are stopped and that signal displays the red aspect but the westward impulses feeding from signal 5 to signal 8 continue so that signal 8 displays the green aspect. Thus as applying to the control of station-leaving signals such as signals 8 and 5, the receipt of track circuit impulses establishes controls for the green aspect, but when no impulses are received the controls are set for the red aspect. As these station-leaving signals can display only red or green, this completes the discussion of the control of such signals.

Normally the circuits are in operation to establish controls for the signals to display the green aspect. If station-entering signal 9, however, is being held at the red aspect then the controls are changed so that distant signal 7 would display the yellow aspect but nevertheless the impulses must feed on eastward to control signal 5 for the green aspect. Briefly this result is accomplished by changing the polarity of the impulses being fed eastward in track circuit a from signal 9 to signal 7; this, however, does not change the polarity or character of the impulses which are fed on east from signal 7 to signal 5, nor does the change affect the impulses which are being fed westward from signal 5 to signal 8.

Station Overlaps for Opposing Moves

This installation, except west of Fairbury in certain instances, includes no intermediate signals as such to stop opposing trains if they simultaneously pass opposing station-leaving signals, such as signal 5 at station B and signal 8 at station A. Therefore, the control of signal 5 for opposing moves extends all the way through the station-to-station block and the station block at station A to signal 10 at the west end, as shown in Fig. 6. Similarly, the control of signal 8 extends through the station - to - station block and through the station limits at station B as far as the insulated joint on the main track opposite the fouling point on the east end of the siding. With these overlaps, when a train passes signal 10 at station A it controls signal 5 at station B to red. When a westbound train passes the insulated joint on the main track opposite the fouling point at the east end of station B, it controls signal 8 at station A to red. With these overlaps there is no possibility of two opposing trains getting proceed aspects to enter the same station-to-station block.

In addition to the foregoing overlaps for opposing train movements, shown in Fig. 6, the controls for the station-entering signal 3 and distant signal 1 extend to signal 10. Similarity, the controls for the station-entering signal 10 and the distant signal 12 extend to the insulated joint opposite the fouling point at the east end of station B. Thus, as an example, when an eastbound train passes signal 10 at station A and knocks signal 5 at station B down to red, as described

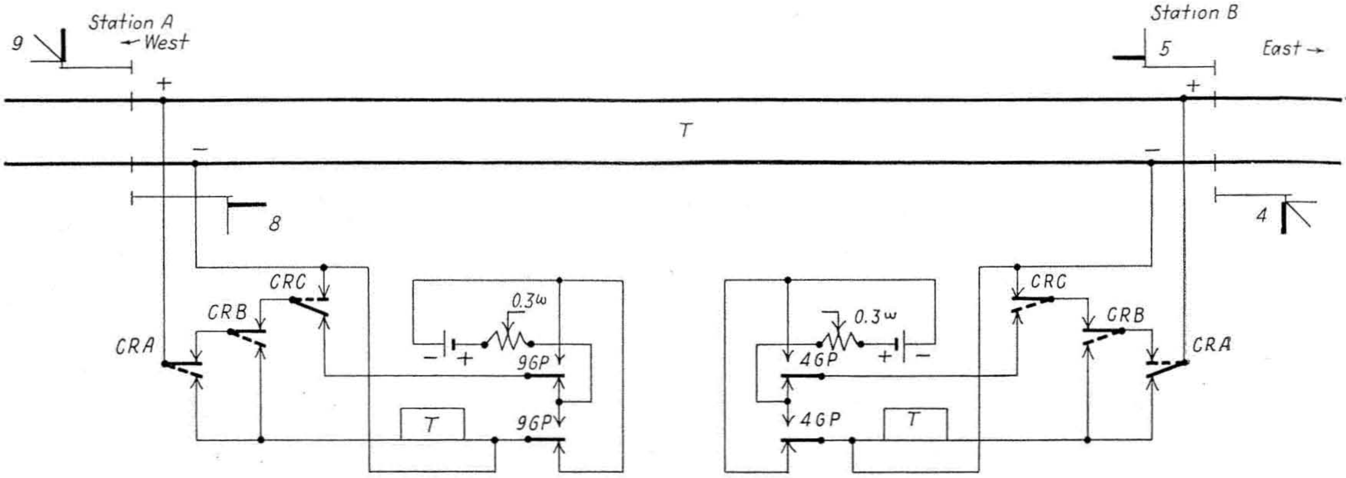


Fig. 4—Typical double-end type track circuit arrangement

A typical double-distant signal location between stations before, controls are also affected to knock down signals 1 and 3 to the yellow aspect.

Station Overlaps for Following Moves

For following train movements in station-to-station blocks in this installation without any intermediate signals, the overlaps differ from those for opposing moves, being cut down to reduce train delays which would be incurred if the same overlaps were used that are employed for opposing moves. Referring to Fig. 7, it will be noted that for following moves, the controls for signals 1, 3 and 5 extend to signal 8, while the controls for signals 12, 10 and 8 extend to signal 5. Thus if a second train is following a westbound train, signal 3 will clear to yellow after the first train has passed signal 5 and a 35-sec. time element has elapsed to provide braking-distance protection in the station block, and signal 1 will clear to green. If the first train has already passed signal 9, signals 1, 3 and 5 will all display green.

Control of Signal Overlaps

The control of signal overlaps for opposing and following moves, shown in Fig. 6 and 7, is accomplished automatically by train movements in connection with a special arrangement of long and short track circuits, switch circuit controller connections and relays at the passing track locations. Functioning of this arrangement depends upon the direction in which the train is moving on the main line and whether or not the train is taking siding.

Short Track Circuits

Referring to Fig. 6 and 7, it will be noted that at the east end of the passing tracks there is a short track circuit through the switch, but that there is no similar circuit at the west end of the passing track circuit, the long track circuit of the station block extending through the switch. A long and short track circuit in this arrangement are employed for several reasons, the most important being that a relay is required at the east end to pick the inbound stick relay. The short circuit, furthermore, is not part of the actual overlap, thus allowing trains to enter the siding without fouling the overlap, and thus resulting in unnecessary train delays.

The switch circuit controller on the east end switch of the passing track shunts the short track circuit, while the switch circuit controller on the west end switch of the passing track does not, the latter controlling a track repeater, not always acting as such, by a line control circuit. This arrangement, providing a relay at each end of the passing track, was found to be the most economical and effective arrangement, and furthermore, additional line wires are saved.

When the system was first designed, a short track circuit was also used at the west end of the passing track, but this required additional line wires for the necessary overlap controls. Furthermore, there was a chance of the inbound stick relay at the east end, which controls the overlaps, not picking up, such as in the case of a light locomotive passing over the short track circuit at the east end. This was because the controls had to pass from the east end to the west end and back, and in the long lapse of time in doing so the light engine passed off the short track circuit before the control returned.

It should be understood that when the switch at the west end is thrown it does not knock down the station-departure signal at the next station to the east, as the switch circuit controller, as mentioned before, does not put a shunt on the track circuit of the station block, but controls a track re-

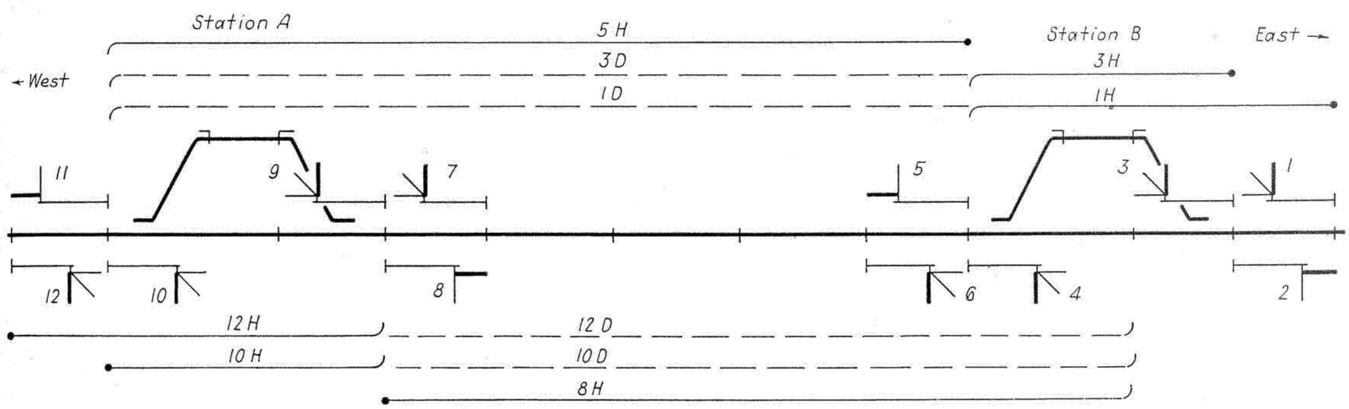


Fig. 6—Diagram of station overlaps for opposing train movements

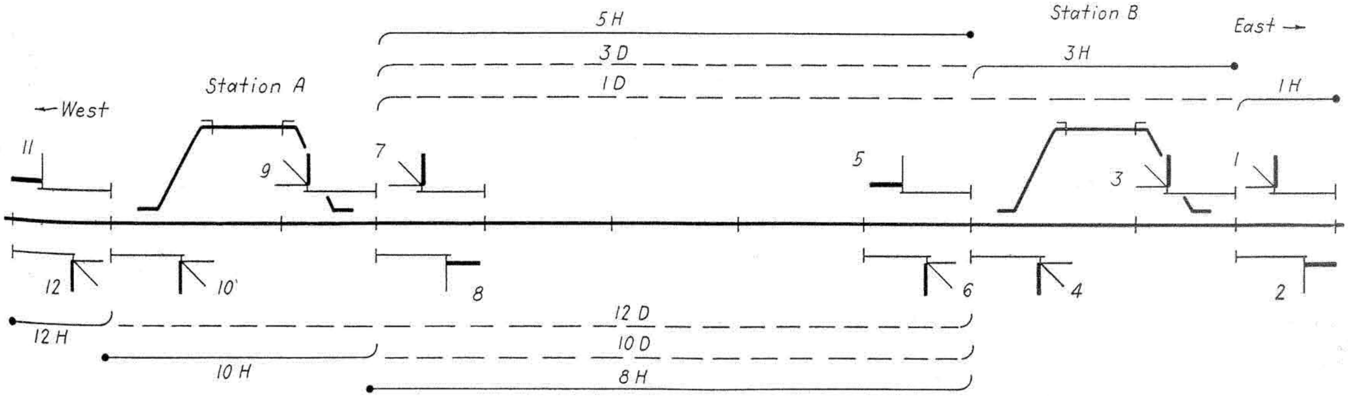


Fig. 7—Diagram of station overlaps for following train movements

peater relay, not necessarily acting as such, which controls the signals in the vicinity of that passing track only.

Overlap Signs

Signal overlaps are indicated by overlap signs mounted on the signals, as shown in Fig. 8. A train holding the main track at a meeting point is required to not pass beyond the overlap sign or open a switch within the overlaps until the opposing train has arrived and the siding switch has been set for entrance to the siding. The train taking siding must open the switch before passing the overlap sign. In certain instances overlap signs are moved forward in order to allow a train to advance further than usual, such as in the case of the location of a water plug, or for some other operating reasons.

Special Intermediate Signals

As mentioned before, west of Fairbury the signal system has been extended to provide an additional set of absolute signals and a set of distant signals in the center of station-to-station blocks in excess of 8 miles in length, as shown in Fig. 3, in order to allow trains to follow each other. Furthermore, the feature is accomplished by the use of coded track circuits without line wires, and the layout is similar as that at a passing track location, but, without the passing track. The controls are normally dead and the signal locations act as track repeating locations except when a train is approaching and sets up the controls for lighting the signals. After the train has passed, the system is again dead and only acts as a track repeater location. The signal arrangement consists of two two-position normal-clear absolute signals, similar to those at the head-block locations, to which Rule 292 applies, and two three-position normal-danger distant signals similar to the distant signals for the passing stations, to which Rule 291 applies.

No overlap controls are used between stations with this arrangement, as they are unnecessary. Referring to Fig. 3, with an eastbound train approaching from the left signal 15 will be red, and signal 14 will be clear providing no trains are approaching from the opposite direction. When the eastbound train gets between signals 14 and 12, signals 13 and 14 display red, signal 15 clears, and signal 12 displays green if there are no opposing trains or trains in the same direction less than two signal blocks ahead. When the train passes signal 12 that signal, as well as signals 11, 9, 7 and 5 display red, and signal 3 at station B displays yellow. If there is a following train, signal 12 will not clear until the first train is by signal 8, and likewise signal 8 will not clear for the second train until the first train is by signal 4. When the first train is by signal 4, signal 3 is knocked down to red and signal 1 knocked down to yellow, signal 2 displaying clear if there are no opposing trains or trains in the same direction less than two signal blocks ahead.

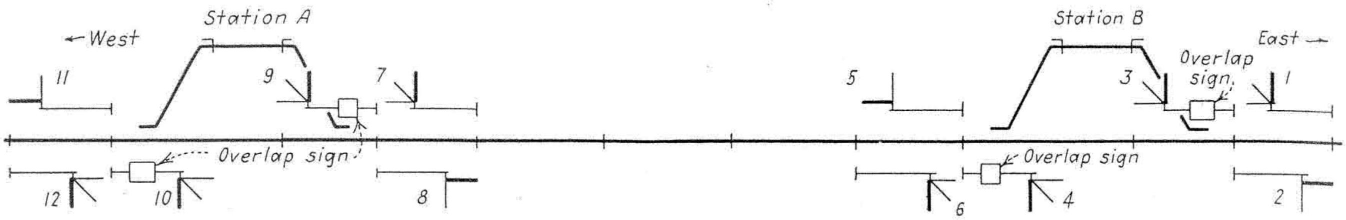
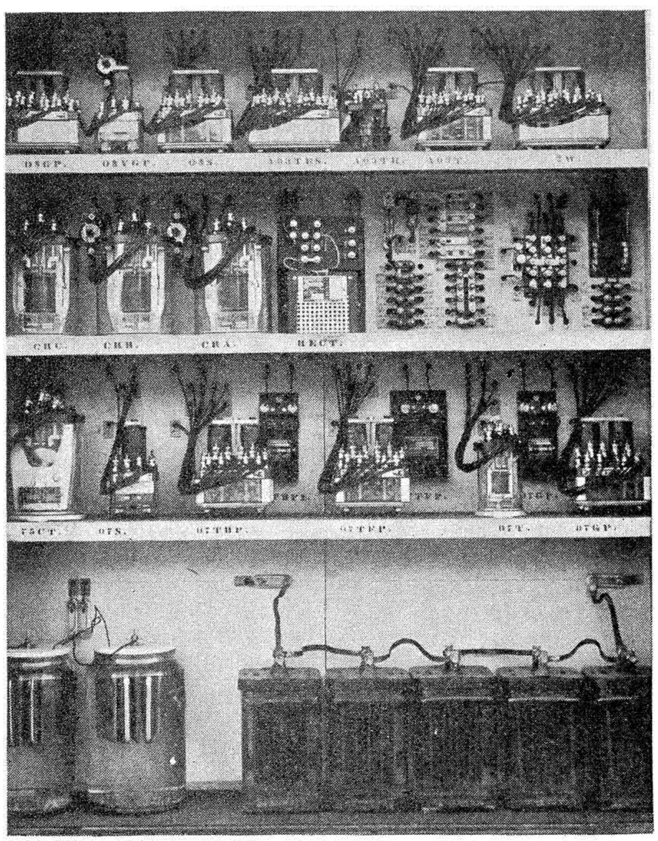


Fig. 8—Diagram of station-to-station block, showing use of overlap signs

In the event an eastbound train passed signal 12 and a westbound train passed signal 5 simultaneously, they would both be protected by signals 7, 8, 9 and 10 from a head-on collision.

Such locations will be in service when the project is completed between Plymouth and Jansen, Norton and Dellvale, Dresden and Selden, Selden and Rexford, Levant and Brewster, Brewster and Edson, and between Bethune and Stratton.


Interior of instrument case at a station-leaving signal and station-entering signal location

Previous Operation and Signal Protection

Train movements in the territory were formerly governed by timetable, manual block system and train orders. Block signals at isolated locations protecting switches, curves and stations were formerly located at Albright, Lincoln, Fairbury, Belleville, Courtland, Almena and Norton. The majority of this protection was A.P.B. controlled and was incorporated in the new installation and continued in service as such as a matter of simplicity.

Previously all main-line hand-throw switches were provided with oil-burning switch lamps. However, in the new installation lamps on all such switches within 500 ft. of the signals governing train movements over the switches have been removed from service, being considered unnecessary. Elsewhere lamps have been continued in service as before.

Interlockings

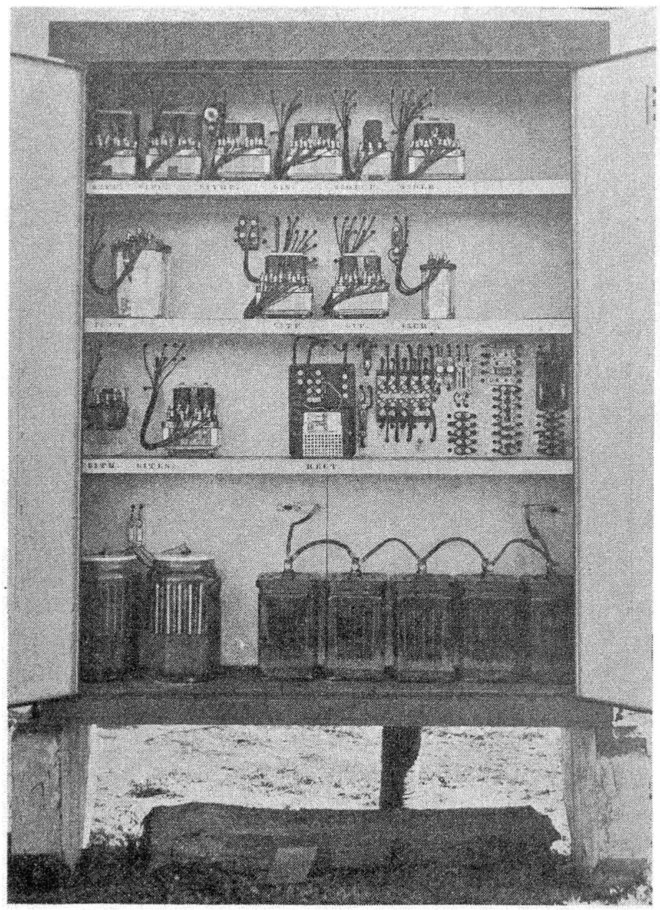
At the east end of Albright the Rock Island crosses a single-track line of the Union Pacific, this crossing being protected by a gate, operated by trainmen, normally set against the U.P. The gate is equipped with circuit controllers and a key box is used for setting signals against the Rock Island when the crossing is in use by the U.P. Extending west from Albright, the Rock Island crosses a single-track line of the Missouri Pacific at Louisville, at which point a semi-automatic interlocking is in service. Signals are controlled from the depot at Louisville. At South Bend there is a crossing with a single-track line of the Chicago, Burlington & Quincy, this crossing being protected by an automatic interlocking.

At Lincoln there are two crossings, one with the Omaha, Lincoln & Beatrice and the other with the Missouri Pacific. Train movements on both roads at the M.P. crossing are governed by Stop boards, but eventually an automatic interlocking will be in service. The O.L.&B. crosses the Rock Island by means of hand-throw crossovers. At the same location there is an interchange track leading from the Rock Island main line to the Chicago & North Western. The switch on the O.L.&B. end of the crossover and the Rock Island main-line switch to the C.&N.W. transfer are electrically locked. Before these switches may be operated, automatic signals must be placed at Stop. Instructions for operating these locks and switches are posted at each switch.

The Rock Island crosses a single-track line of the Union Pacific at Fairbury, movement over which by both roads is governed by Stop boards. Between Thompson and Mohaska there is a crossing with a single-track line of the Burlington, which is protected by an automatic interlocking. Another automatic interlocking is in service at Scandia, where there is a crossing with a single-track line of M.P. At Scandia westward train movements from the Rock Island siding and house track are governed by color-light dwarf signals. Switches must be properly lined for such movements before a proceed indication of signals can be given. Extending west to Courtland, a single-track line of the Atchison, Topeka & Santa Fe crosses the Rock Island. No interlocking is in service at this crossing, the same being protected by a gate, operated by trainman, normally set against the Santa Fe.

Signals

The signals on the new installation are the Union Type-H2 plug-in searchlight, designed for operation on 8 to 10 volts, d.c. All permissive signals have 8-volt, 5-watt, single-filament lamps, while absolute signals have 8-volt, 5-watt + 3½-watt, double-filament lamps. All signals are equipped with hot-spot lenses, and in some instances on curves, are equipped with 10-deg. right or left-hand deflecting prisms.



Interior of instument case at a distant-signal location

Signal masts are 12 ft. 8 in. overall. The searchlight units are mounted on the left-hand side of the masts, which is the track side, and 9 ft. above the center line of the rail. Two-"arm" signals are on 17-ft. 10-in. masts, the units being mounted on 10-ft. centers. The signals are mounted on Massey and Permacrete single section precast cyclindrical concrete foundations, bolt centers on the foundations being 11¾ in. square. The signals are ordinarily located 9 feet from the gage side of the nearest rail. In certain instances, such as in cuts, and where there are ditches, the signals are located 18 ft. from the gage side of the nearest rail so as to not interfere with Jordan ditchers doing maintenance of way work.

The signals are painted red from the first ladder brace down, including the ladder, and the upper portion of the signals are painted aluminum, with the exception of the face of the searchlight background which is painted black. On the permissive signals the number, to the nearest tenth of a mile, is painted in black about midways on the mast and on the portion which is painted aluminum. It has been found on the Rock Island that by painting the numbers on the masts there is only about 60 ft. difference in visibility compared with the use of enameled number plates. Absolute signals are not numbered thereby distinguishing them from permissive signals. Overlap signs are painted black with white letters.

Instrument Cases

At each station-departure and station-leaving signal location a 4-ft. 11-in. welded sheet-metal instrument case is provided for sheltering the relays, transformers, rectifiers, track and control batteries and other associated equipment. For cut sections, a 2-ft. 7½-in. case is provided for the same purpose. On the shelves in the cases corrigated-rubber matting is used to

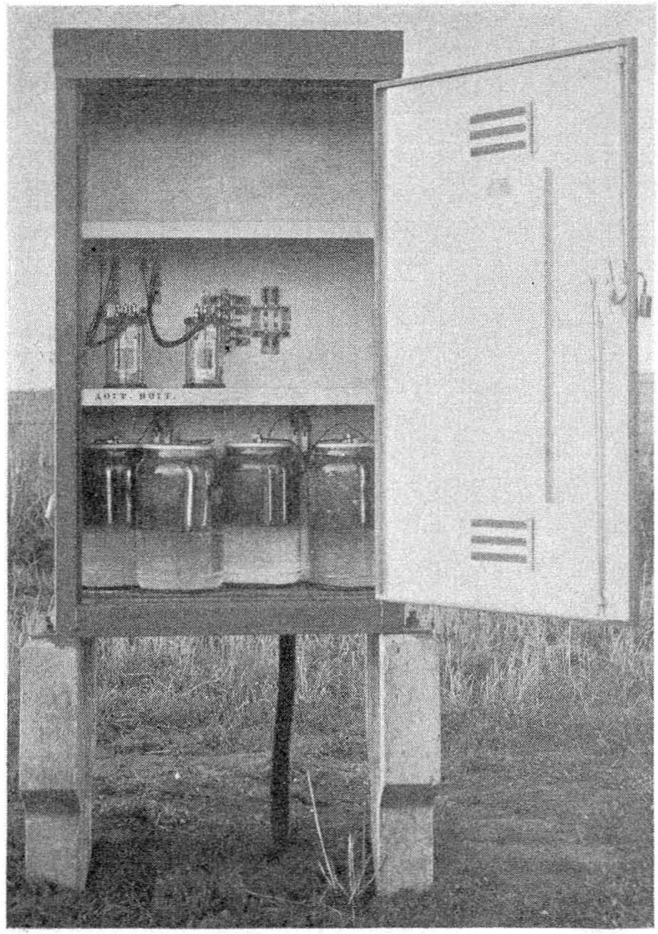
All instrument cases are prewired, ready for installation in the field, in the Rock Island signal shops at Chicago. Upper left—The interior of the cases are painted before wiring is started. Upper right—Signal shop foreman (left) gives instructions concerning case wiring. Note reels overhead for case wire. Lower right—Signalmen complete wiring of case. Center left—Before the cases are shipped to the field each relay is strapped in place. Lower left—General view of instrument cases being wired in the Rock Island signal shops at Chicago before being shipped to the field for installation prevent the apparatus from sliding due to any vibration that may be caused by passing trains.

All cases are mounted on a Permacrete single-slab precast concrete foundation at each end. These slabs are 4 ft. and 5 ft. long, their use depending upon the grade and condition of the soil.

All the instrument cases on this installation are prewired, ready for installation in the field, in the Rock Island signal shops at Chicago. Regular assembly-line procedure is used in this work, the first step being the painting of the insides of the cases with aluminum paint. Rubber matting is inserted and the relays are put in place and the cases completely wired ready for service, except for the connection of cables in the field.

Before the cases are shipped to the field each relay is strapped in place with iron binding wire and pieces of cardboard to prevent any shifting or damage in shipment. Using this procedure, considerable time is saved on the installation and difficulties incurred during bad weather are eliminated.

A unique device in wiring the cases was designed and built by the signal shop foreman to expedite wiring. The device consists of several collapsible reels mounted on a track over and in front of where the wiring of cases is taking place. The flexible case wire is wound on these reels, and they can be moved along in front of any case as required, thus keeping the wire and ordinary reels off the ground out of the way, and at the same time eliminating possible damage to the wire.



Interior view of instrument case at track circuit cut-section location, showing relays and primary battery

Special Derrick

On this project a special hand-operated derrick, furnished by Fairmount Railway Motors, Inc., and mounted on a trailer for towing by a gang-type rail motor car, was used to great advantage. The derrick facilitated and eased labor considerably in the transportation and erection of signal masts, installation and placement of instrument cases, as well as in doing many other odd jobs. The trailer car is equipped with braces to be placed around the rail head at each corner of the car in front of the reels. The capacity of the derrick with the braces is 3,000 lb., while the capacity without them is 1,500 lb.

Relays

The track relays are the Type P-4, two point, rated at 0.3 ohms, 0.1 volt, and drawing 320 mills. Single-point track relays are also used, being rated at 0.3 ohms, 0.1 volt, and drawing 215 mills. Single-point track relays are required in operating 11,000-ft. track circuits of the type used in this system, and the relay coil is by-passed when energy is being applied to the track. Track feeds, therefore, in the rear of each distant signal are provided with the by-pass feature. The CD code following relays have a resistance of 225 ohms with a charge of .06 amp. and a release of .006 amp. The minimum d.p.u. is .013.

The DM code transmitters are 75 coders for operation on 8 to 12 volts d.c. The timing units operate on the same voltage. Track front repeater TFP relays are the Style DN-22A, rated at 2,000 ohms, while the TBP track back repeater relays are the Style DN-11, rated at 1,000 ohms. Other d.c. neutral relays are the DNL-4 type, rated at 78 ohms, and are used for control of the lighting of signals.

Power Supply

At each station-entering and station-departure signal location a set of five cells of Gould NPRE, 80-a.h. lead-acid storage battery is provided for signal lighting and controls. This battery is located in the sheet-metal instrument case at the signal location. This battery is on a floating charge of 10 volts d.c. at 2.7 amps. from either a Model DH-25 or 26 Fansteel I.T.&T. selenium rectifier, rated at 100 to 110 volts, 60 cycles, a.c.

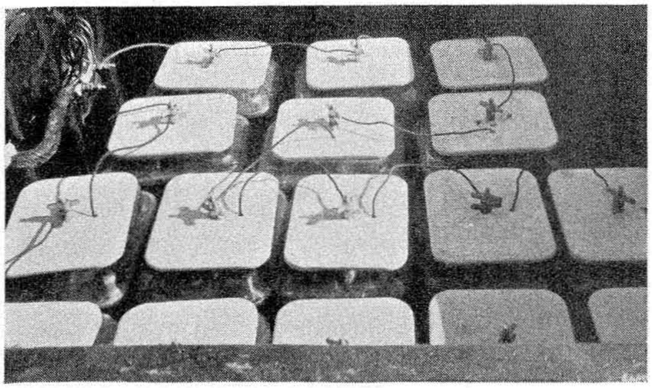
At each distant signal location 15 cells of Edison or Waterbury 1,000-a.h. primary battery are provided for signal lighting and controls. This battery is not located in the instrument case, but in a separate Massey or Permacrete precast concrete battery box at the location. These boxes are 16-cell capacity and are 34 in. by 34 in. by approximately 4 ft. Each coded track circuit is fed by two cells of Edison or Waterbury 1,000-a.h. primary battery in series and with a 0.3-ohm variable track-limiting resistance in series in the circuit. Primary track cells, in practically all instances, are located in the instrument case at the signal location.

Power at 110 volts, 60 cycles, a.c. is received at all stations where station-entering and station-departure signals are located. This power is cut through a watt-hour meter and is supplied by various public-utility concerns.

Underground Cable

The underground cable on this installation is General, Okonite, Anaconda and Kerite parkway. Track circuit connections are single conductor No. 9. Between instrument cases and signals 4 and 6-conductor No. 14 is used. Between pole boxes

General construction views in the field. Upper left—Special derrick in use, showing signal mast being hoisted in place. Upper right—Another view, showing special derrick in use. The mast has been placed and is being bolted down. Center left—Signalman setting up instrument case for service. Center right—Signalman installing pole-line terminal box. Lower left—Signalmen installing bootleg risers and drilling rail for bonds. Lower right—Searchlight signal being placed in service and instrument cases 10-conductor No. 14 is in use. In the latter, the cable is run in a 5-ft. length of 2-in. iron pipe at the base of the pole as fire protection. Parkway cable is used for connections between switch circuit controllers and the line and instrument cases.



Left — Primary battery at distant signal between stations

Cases are wired with No. 16 flexible insulated wire for the 10-volt circuits, while No. 10 flexible is used on the track circuits. All wiring in cases is marked by grey fiber tags, painted with black letters, and nailed on the backboards.

Line Wire

Where line circuits are in service, as between the ends of passing tracks, No. 9 double braid w.p. Copperweld line wire is used. Such circuits are located on a botton 10-pin crossarm added to the existing Western Union telegraph and telephone line. Signal line control units are tied to Hemingray No. 42 clear glass insulators, while power circuits are tied to brown glazed porcelain insulators. All insulators are on steel pins.

Terminal Boxes

At locations where there are line circuit dead-ends and line taps, a Western Railroad Supply Company cast-iron terminal box with two rows of six terminals each is mounted on the pole. Power and signal line taps into the box are made up of No. 14 solid copper bridle wire with a 5/64-in. wall. The bridle wires are pigtailed and soldered to the line and guided to the box by bridle rings on the underside of the crossarm. Brown glazed porcelain cleves-type insulators are used for dead-ends.

Lightning Protection

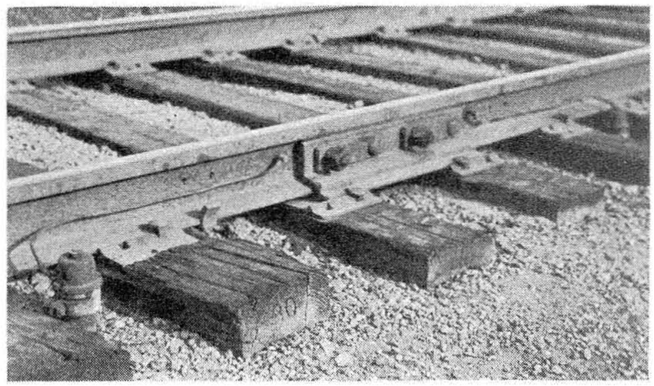
Western Railroad Supply Company No. 345 line arresters are used at all line-break locations, these arresters being located in the instrument cases. Track circuits and signal mechanism circuits are protected by Type TC-275 arresters.

Track

Type RE and RA continuous insulated rail joints, manufactured by the Rail Joint Company, are used throughout. Rail joints are bonded with Ohio Brass Company rail-head type bonds. For track circuit connections, bootleg risers with 3/8-in. 64-strand plug-type bonds with 3/8-in. plugs are used. The underground parkway cable is slack-looped in the riser terminated on the bond clamp at the top and packed in No-Ox-Id grease.

Switch Circuit Controllers

Each main-line switch is protected by a Union Type U-5 switch circuit controller with four normal and four reverse contacts. These controllers are the two-position type, with an ordinary connecting rod to the foot of the nearest switch point. A bevelled hole is on the switch-point foot, and a ball and socket joint is on the circuit controller end of the connecting rod. A Western Railroad Supply Company iron terminal box atop a foot pedestal is used at all circuit controller locations. Connections between the box and circuit controller are accomplished in flexible Greenfield conduit.



Right — Bootleg connections to track circuits. Below — A dispatcher telephone in use by maintainer

Communications

Dispatcher's telephones are located at both ends of sidings in territory where automatic block signals are in service.

This installation was placed in service under the direction of C. R. Swenson, signal engineer, and under the supervision of Fred V. Laverty, engineer-inspector in the office of signal engineer (now signal supervisor of the Western division). The major items of signaling material were furnished by the Union Switch & Signal Company.

(A detailed article explaining the timing and operation of the coded track circuits, as well as other control circuits in this system will appear in a forthcoming issue of *Railway Signaling*.—Editor.)