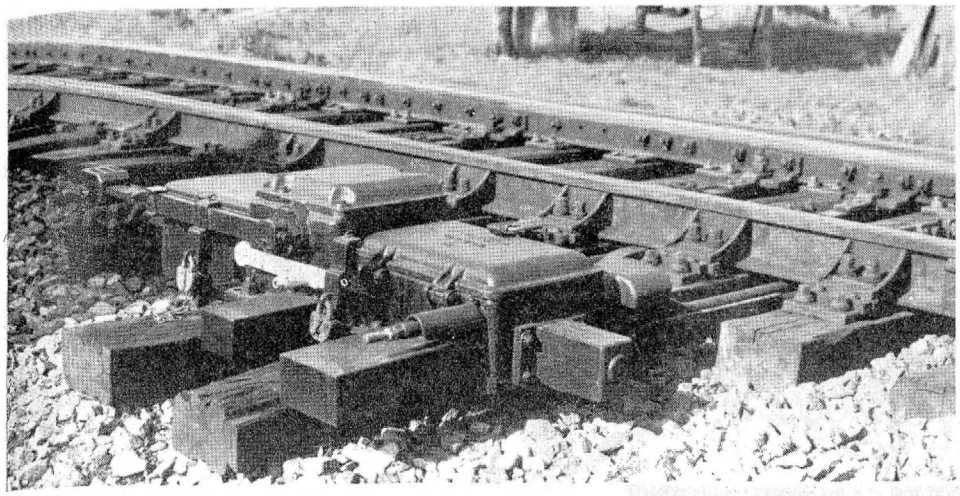
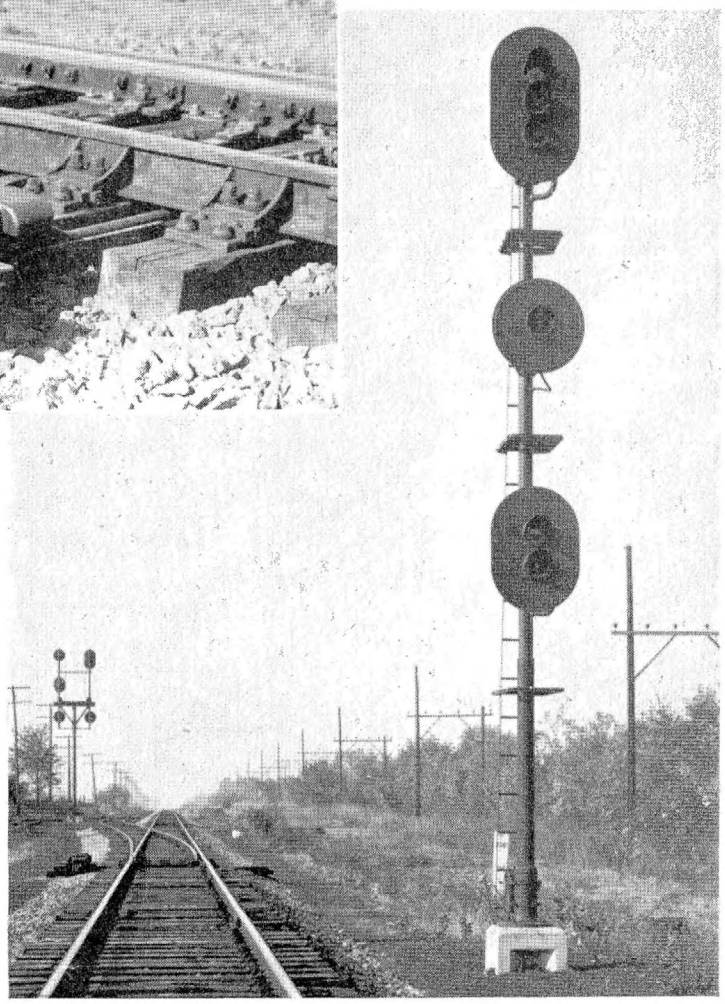




Above—The new power switches are operated by dual-control machines
Right—Signals display aspects for trains to utilize track facilities

Train Operation By Signal Indication

Used Extensively on the Nickel Plate

Extensive program of installing centralized traffic control on sections of single track, on routes between Buffalo and both Chicago and St. Louis

THE New York, Chicago & St. Louis, more popularly known as the Nickel Plate, is now well along on an extensive program of installing centralized traffic control on single track sections on its through routes. Westward from Buffalo, N.Y., through Cleveland, Ohio, to Arcadia, 285 mi., the Nickel Plate has four long sections of double track with three intervening sections of single track totaling 106 mi. which were equipped with centralized traffic control prior to 1948. Automatic block signaling for right-hand running is in service on the double track, except between Buffalo, N.Y., and Plate (Dunkirk), where manual block rules are in effect. Westward from Arcadia the Nickel Plate has two principal lines, one leading to Chicago, 237 mi., and the other to St. Louis, 434 mi.

The Chicago line has been protected by automatic signals for many years, with intermittent inductive train control in service between Ft. Wayne, Ind., and 71st Streets, Chicago. The single-track sections are Arcadia to New Haven, Ind., 78.8 mi., on which the C.T.C. construction is nearing completion; and Hadley, Ind., to Van Loon, 120.4 mi., of which 33.5 mi. Hadley to Claypool, Ind., are now in service. Claypool to Van Loon has not been authorized.

On the 434 mi. between Arcadia and East St. Louis, where no automatic block was previously in service, the 188 mi. from Arcadia to Frankfort, Ind., are being equipped with centralized traffic control. The first section, 63 mi., between Arcadia and St. Marys, Ohio, has been completed, and the remainder, 60.8 mi. between Frankfort and Muncie, and the 64.1 between St. Marys and Muncie is authorized and will be completed during 1949. The completion of this project will provide operation by C.T.C. or double track westward

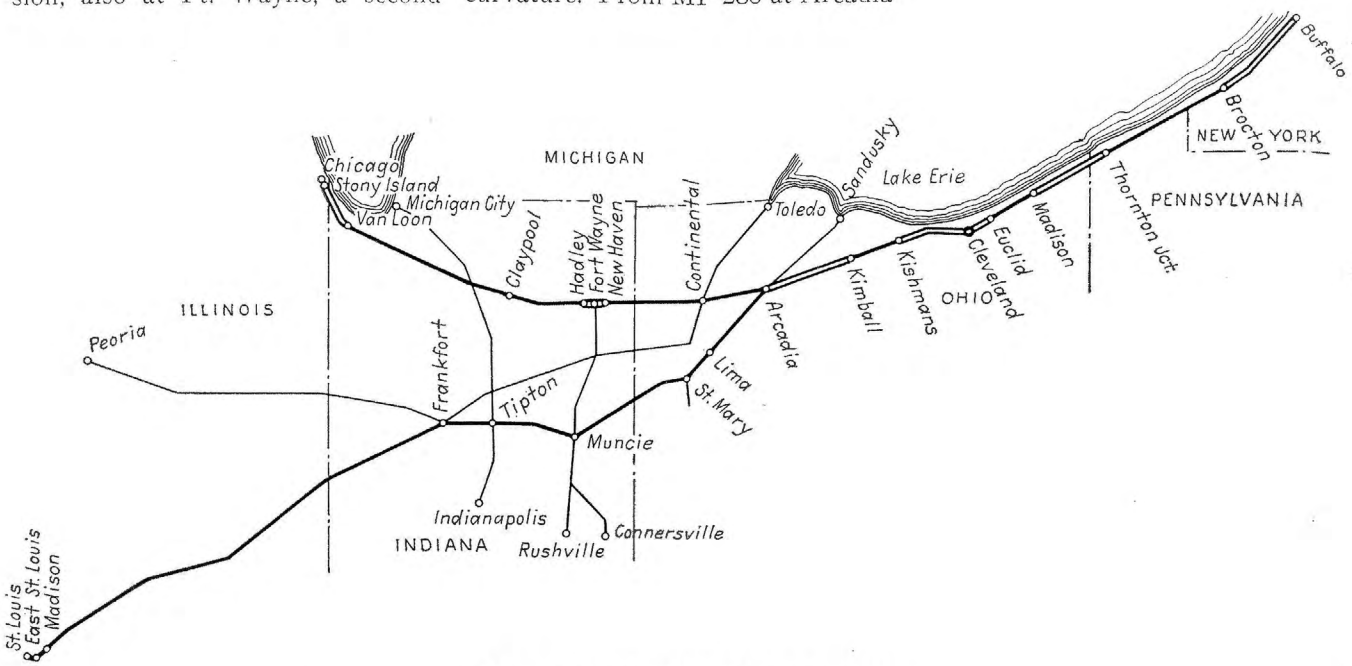
from Buffalo to Claypool, and Frankfort. The further construction of some form of automatic signaling westward from Frankfort to St. Louis, 248 mi., is being studied.

The C.T.C. control machines west of Bellevue, Ohio, are in the respective division dispatcher's offices. One machine, in the office of the dispatcher for the Ft. Wayne division at Ft. Wayne controls the Arcadia to New Haven section, and in the office of the dispatcher of the Chicago division, also at Ft. Wayne, a second machine controls the Hadley-Claypool section, and is designed to control on west to Van Loon, a total of 120.4 mi. The machine in the dispatcher's office at Lima, Ohio, which controls the 63 mi. of C.T.C. now in service between Arcadia and St. Marys, is designed to control a total of 188 mi. between Arcadia and Frankfort.

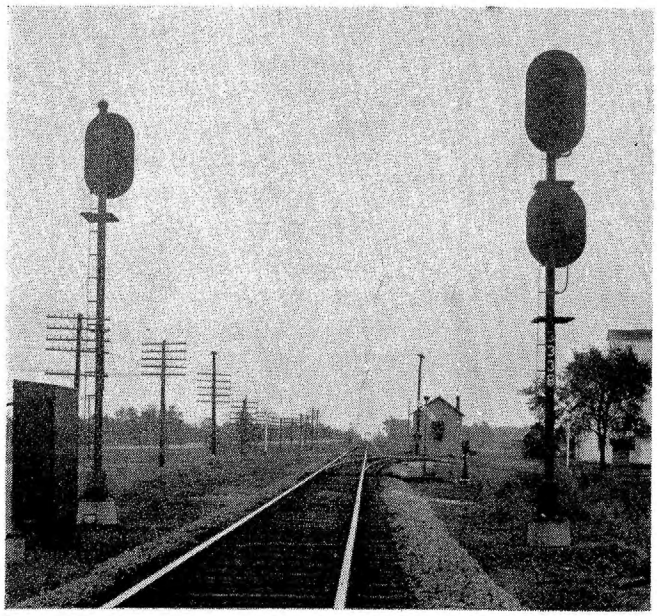
Low Grades and Easy Curves

Generally speaking, the grades are light on the Nickel Plate lines west of Arcadia. Especially between Arcadia and Ft. Wayne and between Arcadia and Lima, the country is prairie, with only slight rolling grades, and comparatively slight curvature. From MP 286 at Arcadia to MP 361 a few miles east of Ft. Wayne, there are 75 mi., of tangent track, except for slight curves of 0-deg. 4-min. or less. Likewise, on the St. Louis route, the line is tangent from MP 58 at Findlay to MP 86 at Lima, except for a 0-deg. 15-min. curve at MP 74. On account of the relatively light grades and curvature, the trains handle heavy tonnage at good speeds.

In addition to operating two passenger trains each way daily on its lines from Arcadia to Chicago and to St. Louis, the Nickel Plate has six scheduled through freight trains each way, with extra sections as required. For example, on the line between Lima and Frankfort, the normal daily traffic includes four passenger trains and from 12 to 18 freight trains, totaling 16 to 22 trains daily. Approximately the same number of trains are operated daily on the line between Arcadia and Chicago.



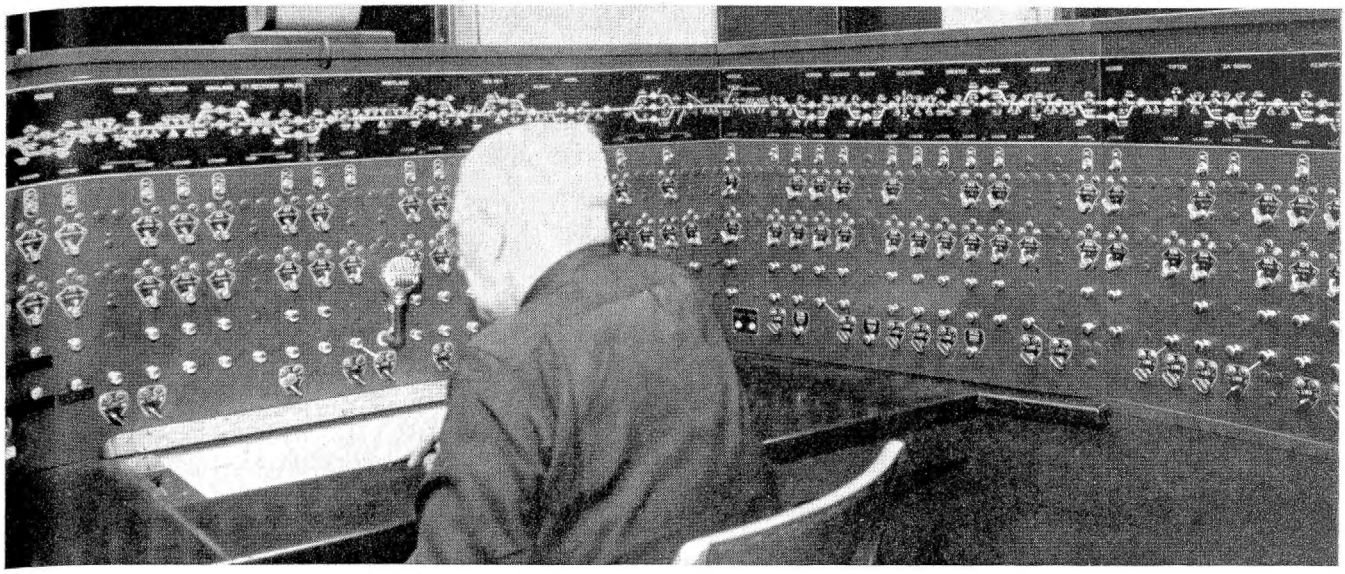
Map of principal lines of Nickel Plate



An approach signal with second arm to display Approach-Medium aspect—282

Fewer Sidings

Previously when train movements were authorized by timetable and train orders, the freight trains lost too much time when waiting on sidings for meets. Also time was lost when trains reduced speed and stopped to permit trainmen to operate the hand-throw switches. Now, with centralized traffic control, the train movements are authorized by signal indication, and these signals, as well as the power switches, are controlled by the dispatchers. By means of the indication lamps on the track diagram of the control machine, each dispatcher can watch the progress being made by each train and he can control the signals and switches to direct trains to make meets on very close time.

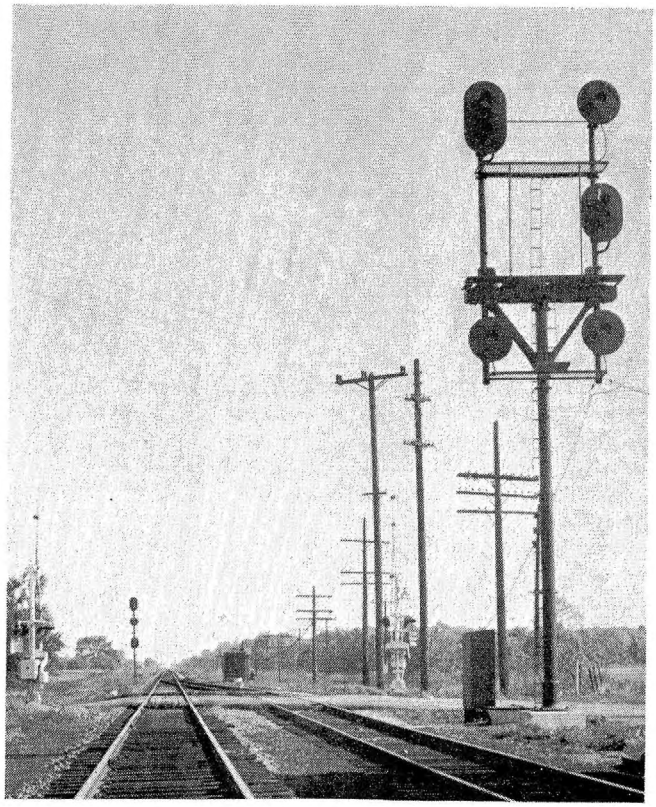


The C.T.C. control machine in the dispatcher's office at Lima, Ohio

The experience which the Nickel Plate has had with earlier installations indicated that traffic can be handled efficiently under C.T.C. with fewer sidings than were required under operation by train order and timetable. Whereas 36 sidings had previously been used between Arcadia and Frankfort, the new project included power switches and C.T.C. controlled signals at only 23 of these sidings which are shown by names on the map. In general, these sidings are located about 6 mi. to about 9 mi. apart. At 13 other locations, the previous sidings were either removed or were left in place with the hand-throw switch stands in service for use as house tracks or switching spurs to serve local industries. In general the sidings to be power equipped as part of the C.T.C. have been lengthened to a minimum of 7,500 ft. where physical conditions permitted.

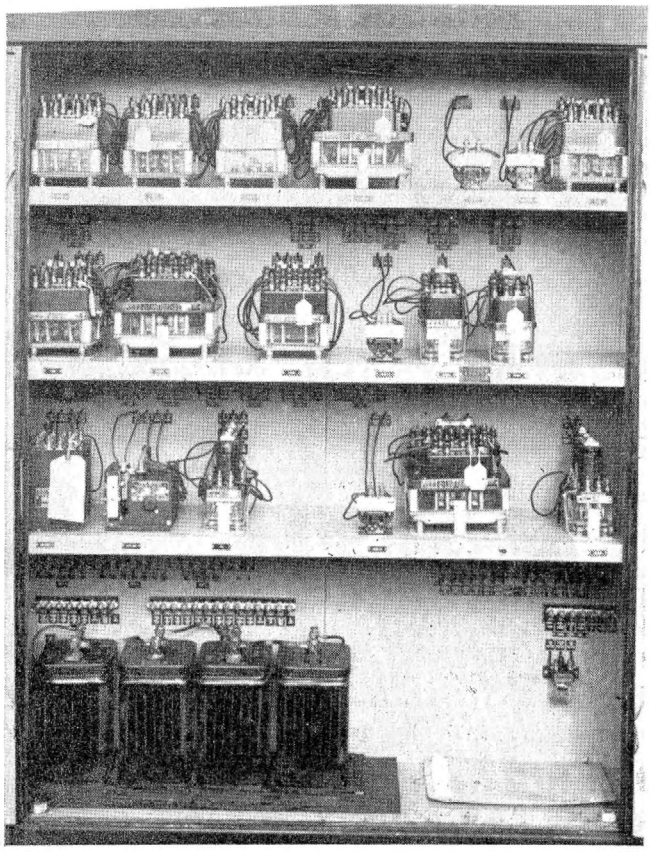
Signal Aspects Save Train Time

The signals now in service on these C.T.C. territories provide a complete range of aspects to direct trains to utilize the track facilities most effectively. With certain exceptions the turnouts at the ends of double track and at the ends of the sidings used by through trains, are No. 18, with 30-ft. points, which are good for diverging train movements at medium speed. Furthermore, the sidings have been brought up to a standard of construction and maintenance so that trains can operate on the sidings at medium speed. On these sidings, the project included the installation of track circuits which are used to control the aspects of signals to direct trains to enter, and also these track circuits control track-occupancy lamps on the C.T.C. control machines to show when trains occupy corresponding sidings. Each station-entering signal has the equivalent of three operative "arms." The top one is a standard three-unit head. The second is a single lamp unit that is normally dark but which can be lighted yellow. The third "arm" is a two-unit head, which displays either red or yellow.



No dwarfs are used, the main-line signal and the leave-siding signal are on a bracket mast at right of siding

If a passing track is unoccupied, when the entering switch is reversed and the station-entering signal cleared for an approaching train to enter, the aspect is red over-yellow-over-red — Medium-Approach, Standard Code Rule 286. In this instance, the approach signal displays the yellow-over-green, Approach-Medium aspect, Rule 282. Thus the engineman of an approaching train has information which permits him to bring his train up to and through the No. 18 turnout at the speed for which these turnouts are designed, rather than pulling into a passing track at restricted speed, prepared to stop short of train or obstruction. The sidings are longer than the average length of freight trains, so that trains can be brought to a stop from



Interior of case showing batteries and relays which have plug couplers

medium speed before reaching the leaving end of the siding. Thus the No. 18 turnouts, together with the signaling arrangement, save considerable time for trains when entering passing tracks.

If a passing track is occupied and a second train of the same direction is to enter, the aspect is red-over-red-over-yellow, Restricting, Rule 290. No signal can be displayed for a train to enter a passing track if a train of an opposing direction is already occupying that passing track, or if a signal for an opposing movement is displayed. If such a move must be made in case of emergency, special instructions would be required.

Out in a Hurry Too

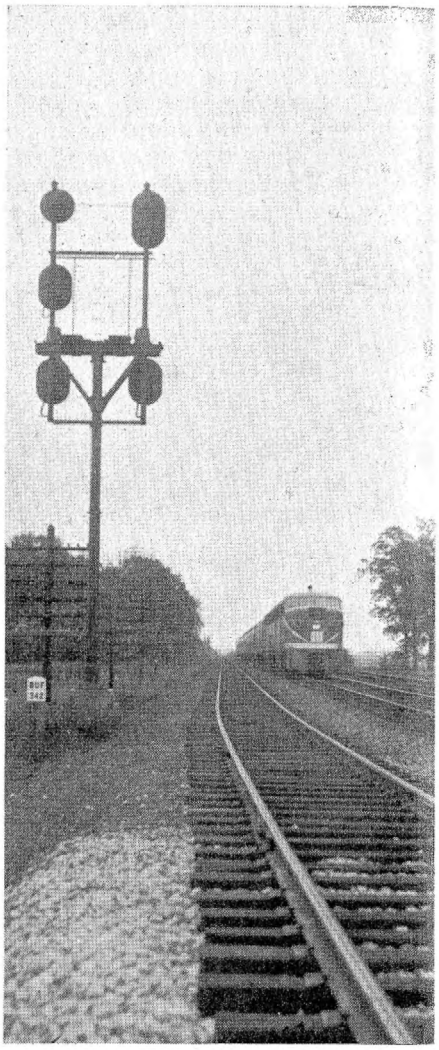
In consideration of the fact that trains are to operate on sidings and pull out of sidings at medium speeds, it is important that the leave-siding signals display aspects which can be seen plainly by enginemen at a considerable distance in all kinds of weather. In winter, snow frequently obstructs dwarf signals. For these reasons the Nickel Plate has adopted the practice of using high signals rather than dwarfs for leave-siding signals, and these high signals display aspects that are helpful in expediting trains when leaving sidings. In each instance, the leave-siding signal is on a bracket mast with the main-track station-leaving signal. For example, as shown in one of the pictures, the mast is to the right of the siding so that the main-track signal is on the left and the leave-siding signal is at the right. The leave-siding signal has the equivalent of three "arms", the top one and the bottom one being represented by red marker units, and the middle arm is a two-lamp head which is normally dark but can display either green or yellow. The Medium-Clear aspect, Rule 283, red-over-green-over-red, indicates Proceed; medium speed within interlocking limits, and is displayed when the signal is lever controlled and two or more automatic blocks ahead are unoccupied. Therefore, after an engineman knows that the rear of his train has passed through the turnout, the speed can be accelerated to maximum authorized speed.

The Medium-Approach aspect, Rule 286, red-over-yellow-over-red, indicates Proceed at medium speed preparing to stop at next signal. This aspect is displayed when the signal is lever controlled with the first automatic block unoccupied but with the second block occupied by a train of the same direction.

The Restricting aspect, Rule 290, red in the top arm, yellow in the bottom arm, indicates proceed at restricted speed prepared to stop short of train or obstruction. This aspect is displayed when a leave-siding signal is lever controlled and the automatic block ahead is occupied by a train of the same direction, but is only used at points where required to allow a train, which is waiting on a siding for a train of the same directions to pass, to get under way while the leading train is receding in the first automatic block, in order to facilitate local switching or station work.

Flashing-Red Aspect

In the yard areas through Lima there are numerous switching moves which require the switch engines to make movements on the main track. When a road train is to be moved through the yard territory, standard code aspects are displayed on the various home signals, for the desired train movements. For such movements the tracks must be clear of trains and switches properly lined. At other times the dispatcher in charge of C.T.C. control machine can display "Flashing Red" or "Switching" aspect on certain home signals to permit engines to make the necessary movements past these signals to shift cars, or to change engines and cabooses on standing road



Signals authorize train movements

trains which are being serviced at the terminal. Road trains are not authorized to accept this aspect either to enter or depart from the yard territory. To clear the main track through the yard for a road train movement, the "Switching" aspects are changed to Red-Stop; a siren is sounded, notifying all yard moves to clear the main track and yard leads; and, after a time delay, if main tracks have been cleared and switches positioned, the proper aspects for road train movements can be displayed. In this way through train movements are protected but yard moves are not delayed unnecessarily.

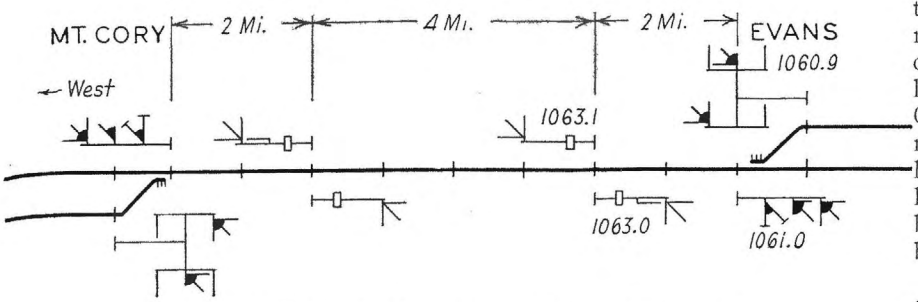


Fig. 2—Plan showing spacing of intermediate signals

Spacing of Intermediates

In each siding-to-siding block, ranging from 7 mi. to 9 mi. in length, there are two double locations of intermediate signals, which are spaced for short blocks at the ends, as compared with a much longer "middle" block. For example, as shown in Fig. 2, the overall distance between sidings at Evans and Mt. Cory is about 8 mi. The two end blocks are each approximately 2 mi. long, thus leaving the middle block 4 mi. long. One advantage of this spacing is that a short block, such as between signal 1061.0 and its approach signal 1063.0, allows maximum time for an eastbound freight train, for example, to get in the siding at Evans, without stopping a following passenger train. Looking at it another way, the short block from signal 1060.9 out to the first intermediate, 1063.1, permits a westbound passenger train to clear this block more quickly, and thus allow a westbound freight on the siding to depart and follow on a "clear board" that much sooner.

At each field station, the local circuits include time locking effected automatically by time-element relays. A special feature is the use of route-check circuits which, upon receipt of a signal control code at the field station, check that the route is complete and safe for the desired train movement, after which the opposing signals are locked out and time locking is made effective, before clearing the desired signal.

For use on these C.T.C. projects, the Nickel Plate developed a new arrangement for an OS track circuit which requires a train to pass out of the second of two successive track circuits to effect a release of the locking. Therefore, momentary shunting of one track circuit will not release the time locking. As shown in the Fig. 3, the two track circuits are independent except for the portion of the track including the frog which is common to both, and, therefore, both track circuits are released if the frog is removed. This two-track-circuit release arrangement requires the two track relays to be released in the proper sequence for the train movement involved, and then both must be re-energized before the time locking is nullified.

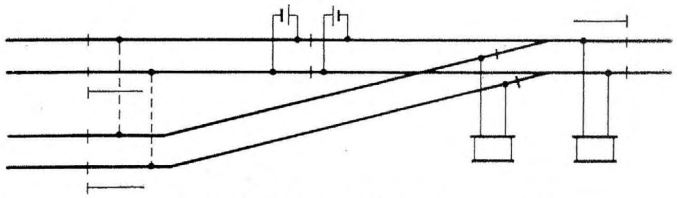


Fig. 3—Two track circuits in OS section

Track Circuits

Each power-operated, signaled siding is equipped with complete track circuits and where highway crossing protection does not make cut sections necessary a coded track circuit using reverse code with a track relay on each end, is used. By this means, the signals directing trains to enter from both ends can be controlled by the one track circuit without the use of line-wire circuits. With home signals displaying "stop", 180 code is sent out from the battery end and returned on the reverse code. When a signal is displayed to enter the siding at the battery end of the circuit, the code is changed to 75 and the opposing signal is locked out. If the signal at the relay end is desired, 180 code must be received, and clearing of this signal cuts off the reverse code, thus locking out the opposing entrance signal into the siding. This coded track circuit also indicates track-occupancy on the control machine.

Conventional d.c. neutral track circuits with 2-ohm relays are used on ordinary track circuits on the main track ranging from about 2000 ft. up to 6000 ft. in length, and four-ohm relays are used on the shorter track circuits. Four-ohm quick-release relays are used on "OS" track circuits. On all new work where there were no track circuits in service previously for crossing protection or interlockings, the new track circuits were bonded with 6½-in. thermite welded bonds.

In the station-to-station blocks, the track relays are at the signals and the feed ends are at cut sections. Such track circuits are each fed by a set of five cells of 1000-a.h. primary battery. The shorter track circuits are each fed by a set of three cells of the same type. Each track circuit is carefully adjusted to secure a low normal discharge and thus lengthen the life of the battery.

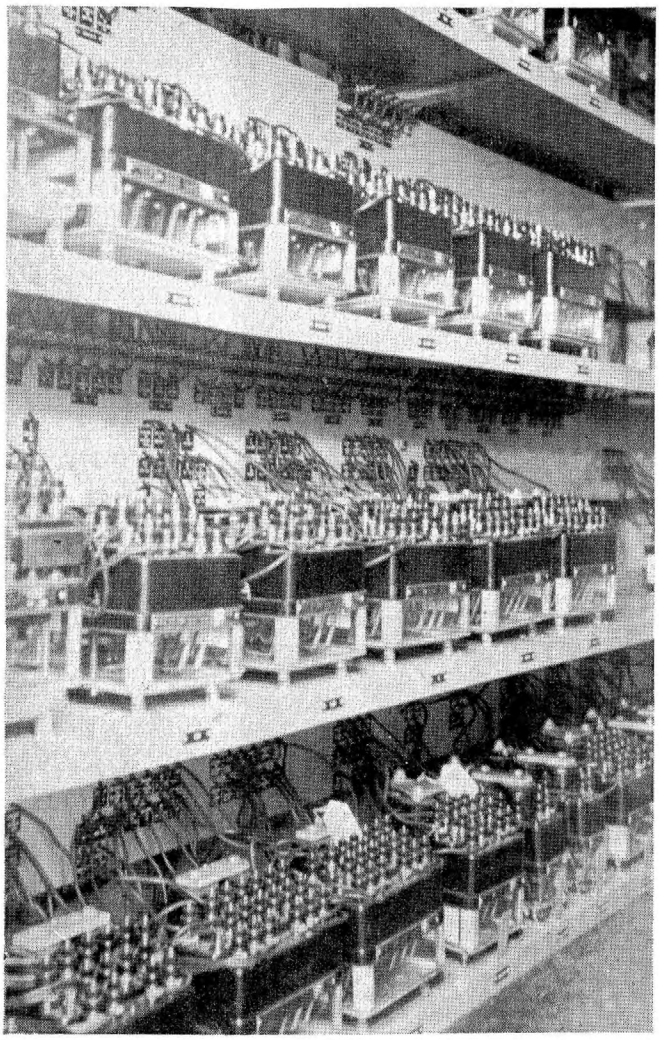
On this project, in each siding-to-siding block, there is a two-wire line circuit for the control of eastward signals and a second two-wire line circuit for the control of westward signals. These line circuits are normally energized and, in general, the controls are similar to those in conventional automatic block. These line-wire circuits are used also to check occupancy of the station-to-station block to control track-occupancy lamps on the C.T.C. track diagram, and also these same line-wire circuits enter into the automatic portion of the controls of electric locks on hand-throw switches in station-to-station blocks in conformity with A.A.R. Signal Section requisites, Part 211.

At each intermediate signal, the line circuit is fed by a battery of four cells of lead storage of 120-a.h. capacity, charged from a 440-volt power line. At each power switch location, there is a 26-volt set of nickel-iron storage battery, for switch machine operation. The 16-volt portion is used for local C.T.C. coding equipment, and 10-volt por-

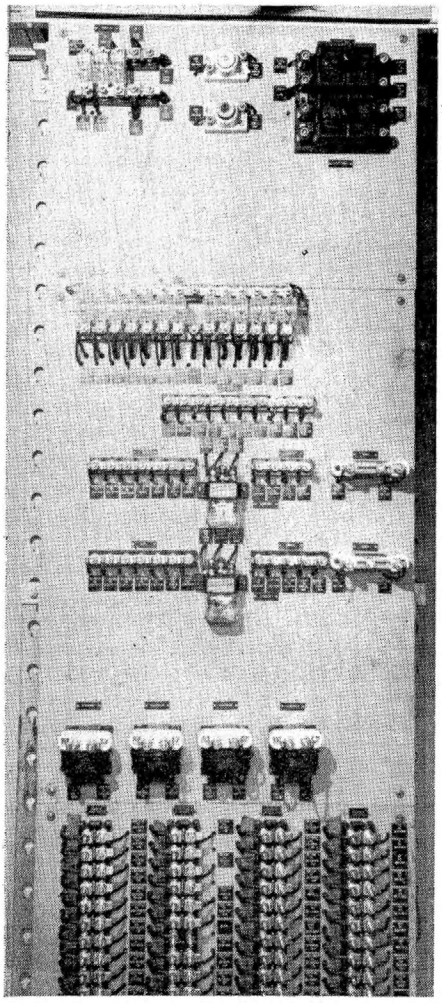
tion for local relay operation. Also there are two 10-volt batteries of nickel-iron storage to feed line circuits in each direction and operate signal lamps in case of power failure.

Pole-Line Work

On the St. Louis line, for example, where there previously was no signaling, the former pole line used for communications circuits was rebuilt as required, and new crossarms were added for the signaling wires. The four new wires for local line controls are No. 10 copper. The C.T.C. code line circuit is on two No. 8 copperweld wires. The 440-volt a.c. power distribution circuit is on two No. 6 copper wires. All these wires have double-braid weatherproof covering. The power feed locations are about 12 mi. apart to feed 6 mi. in each direction. Line-break switches are located at feed points and at the ends of feed sections, so that if one feed station fails for any considerable period of time, the 440-volt feed can be cut through from each adjacent section. The 440-120 volt line transformers are rated at 250 V.A. at the intermediate signals and at 500 V.A. at the power switch locations.



The interior of a typical instrument house showing the plug-couplers on all these relays



Terminal board in relay house

Welded sheet-metal buildings are located at the power switches to house the relays, line coding equipment, batteries, etc. The relays in these houses, as well as at the intermediate signals are the conventional shelf types, all of which are equipped with plug couplers, by means of which a relay can be replaced quickly and with no chance of connecting the wires incorrectly. The wires from a house to each switch machine are in a 15-conductor No. 9 buried cable, and a 12-conductor No. 9 cable goes to each signal. Underground cables are made up of conductors with 5/64-in. wall insulation, with four protective coatings of jute and two of armour, but with no lead sheath. The line-drop cables are No. 14 wire with 5/64-in. insulation; tape and braid.

Rail Connections

The track circuit connections from the instrument houses to the bootleg outlets are in No. 9 stranded buried cable. At each location the bootlegs are all on the same side of the track as the instrument housing. The connections from the top of each bootleg to a rail terminal are bare stranded bronze including 139 No. 28 conductors. The connections to the far rail are run along the side of the ties, being 2 in. below the top of the tie where passing under the rail and only 1 in. elsewhere. The stranded connection is held in place against the side of the tie by single cable strap each held by one 1¼-in. drive screw, the strand being wrapped with tape where it goes through each strap. This practice of locating all the bootleg outlets on the side of the track nearest the instrument house or battery, obviates digging up the ballast under the track to permit the installation of cable. In addition to minimizing the digging, an advantage is that the ballast is not disturbed under the ties, which is important because the ballast cannot easily be tamped back to its previous condition for some time, and in the meanwhile the insulated rail joints may be damaged.

This centralized traffic control project was constructed under the direction of S. G. Raber, signal engineer.