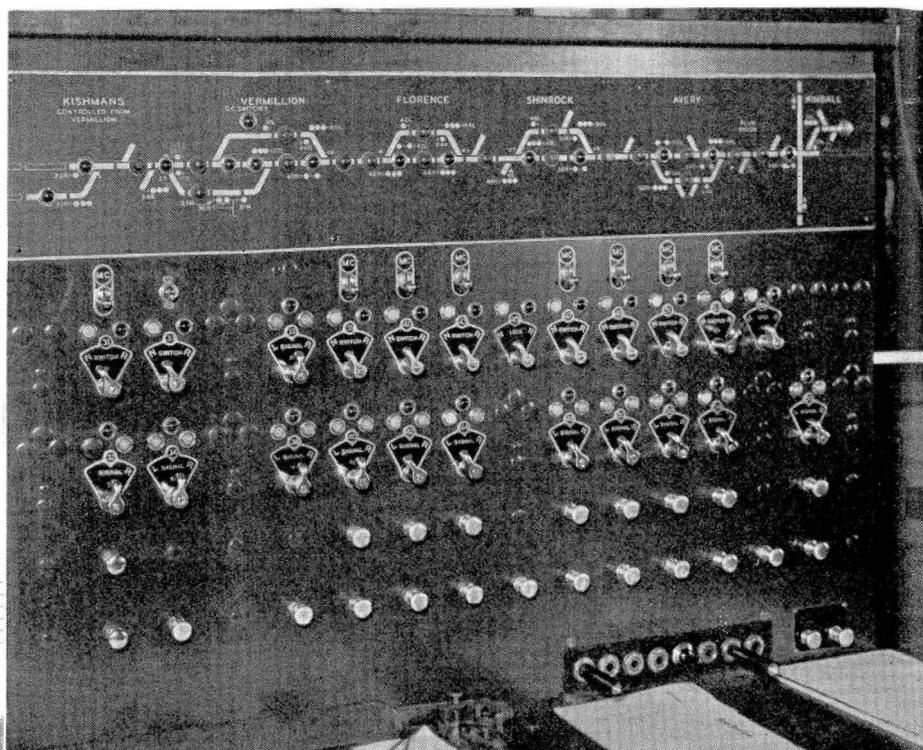
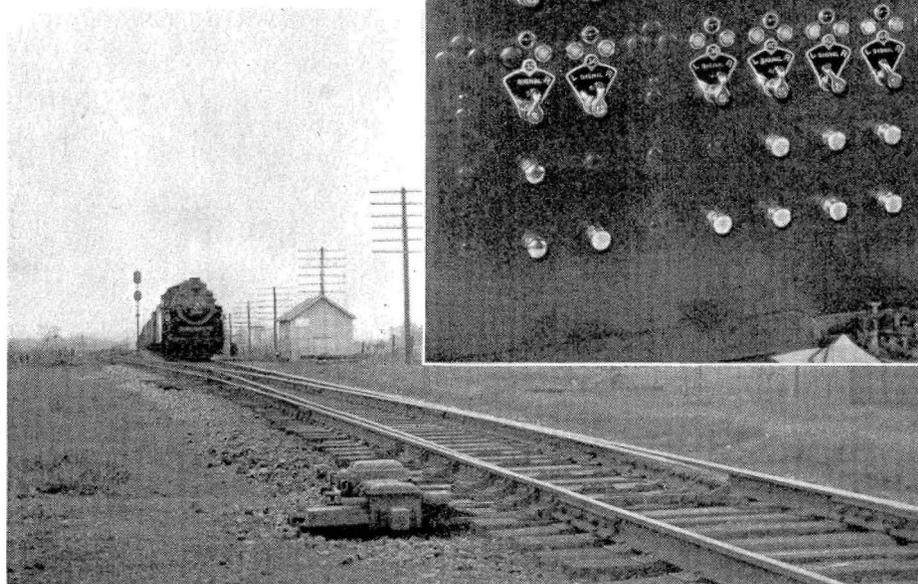


New York, Chicago & St. Louis Installs

Right—Panel of the C.T.C. control machine at "GC" tower
Below—An eastbound train approaching a power switch



Complete arrangements of signal aspects help to save train time—Special circuits save line wire—Directional track occupancy indications on control panel for all main and passing tracks

THE New York, Chicago & St. Louis has a program of centralized traffic control installations on various sections of single track. The portion of this railroad which handles the heaviest traffic, i.e., between Buffalo, N.Y. and Arcadia, Ohio, is made up of sections of double track with intervening sections of single track. For example, double track extends from Buffalo 49 miles to BM Tower, Brocton, N.Y.; 38 miles Thornton Jct. to Madison, Ohio; 47 miles from Euclid, Ohio, through Cleveland, to Kishmans; and from Kimball 45 miles through Bellevue to Arcadia, Ohio. In order to increase the capacity of intervening sections of single track, a program was started two years ago to install C.T.C., the single track section of 15 miles between Westfield, N.Y. and North East, Pa.; 20 miles be-

tween Hadley and So. Whitley, Indiana; and the 21.6 miles between Kishmans, Ohio, and Kimball, Ohio, having been completed in 1942. With reference to train operations and construction features, this last mentioned project is typical of the others previously completed as well as those contemplated, and therefore the following discussion is confined to the Kishmans-Kimball installation.

Color-light A.P.B. signaling has been in service since 1927 on the single track between Kishmans and Kimball. The switch at the end of double track at Kishmans was equipped several years ago with a spring and buffer mechanism, and later also with a mechanical facing-point lock. The switch at the end of double track at Kimball has for many years been included in a mechanical interlocking at

the crossing with the Baltimore & Ohio. The two switches at the lap at "GC" are included in a mechanical interlocking which has been in service for many years, and since 1930, the switch at the west end of the eastward siding has been equipped with an electric switch machine and semi-automatic signals, controlled remotely from "GC". Although no power machine was in service at the east end of the westward siding, the signals were controlled remotely from "GC" to direct trains to enter or depart at this hand-throw switch.

A mechanical interlocking had been in service at Shinrock to operate the switch and signals at the east end of

Centralized Traffic Control on Busy

Sections of Single Track

the passing track. Since 1930, the switch at the west end has been equipped with a power machine which, together with the signals, was controlled remotely from Shinrock tower.

As a part of the installation of the centralized traffic control, a new power switch machine was installed at the east end of the passing track at Shinrock, thus replacing the mechanical interlocking. The previously existing remotely controlled power switch and signals at the west end of Shinrock were included in the new C.T.C. control. Also power switches were installed at both ends of the passing tracks at Florence and Avery.

At "GC", the mechanical interlocking, including the two switches at the lap, was left in service, because the new C.T.C. control machine is also located in this office. The power switch and signals at the west end of "GC", which were formerly remotely controlled, are now operated from the C.T.C. machine, as also are a new power switch and the previously existing signals at the east end of "GC".

Also as a part of the C.T.C. project, the previous signals at the switches were rearranged as required with additional aspects, and dwarfs were installed for leave-siding signals. Also the intermediate signals were relocated to provide proper braking distance, all being located at double locations except for the set between Kishmans and the east end of "GC", this pair being staggered 1400 ft. in order to provide a better approach view, because of curves. In general the intermediate automatic block spacing is a minimum of 10,000 ft.

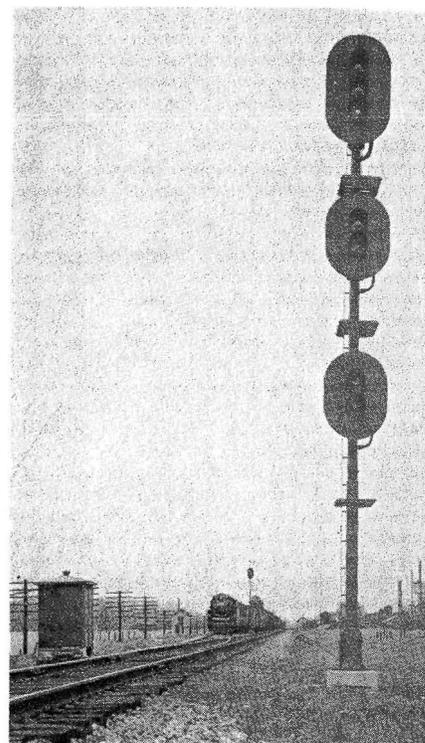
An important point, with respect to the train time saved, is that only five of the power switches now in the C.T.C. were formerly operated by hand-throw stands, these including the two at Florence, the two at Avery and the one at the east end of "GC". To a major extent, therefore, the saving in train time has been the result of authorizing train movements

by signals, the indications of which supersede time tables and train orders.

Traffic and Savings in Train Time

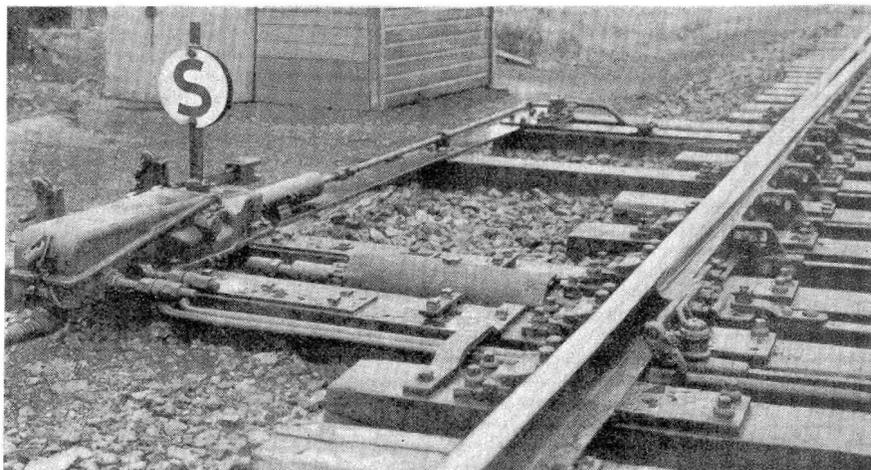
Between Kishmans and Kimball, the railroad traverses rolling prairie, with no long steep grades or curvature sharp enough to require reductions from normal train speeds. The turnouts at the ends of double track and at the ends of the passing tracks are No. 18 with 30 ft. points, except that the turnout at the east end of "GC" is a No. 11, which will be replaced as soon as practicable.

Prior to 1940, the average number of trains, operated daily in this territory, ranged from 20 to 25. During the first six months of 1942, the traffic increased to a maximum of about 54 trains daily, including 8 passenger trains, 30 symbol freight trains and about 10 Third Class freight trains. Since the centralized traffic control was placed in service in September 1942, the maximum has been 62 trains daily, including 8 passengers, 32 symbol, and 12 Third Class trains.



Typical station-entering signal

a.m., and between 3:30 p.m. and 8 p.m. Under the previous train order operation, numerous delays were incurred, especially by the Third Class trains, simply because there was no



Spring switch with mechanical facing-point lock

A large percentage of the total trains each day are operated over the Kishmans-Kimball section in two peak periods, between 5 a.m. and 11

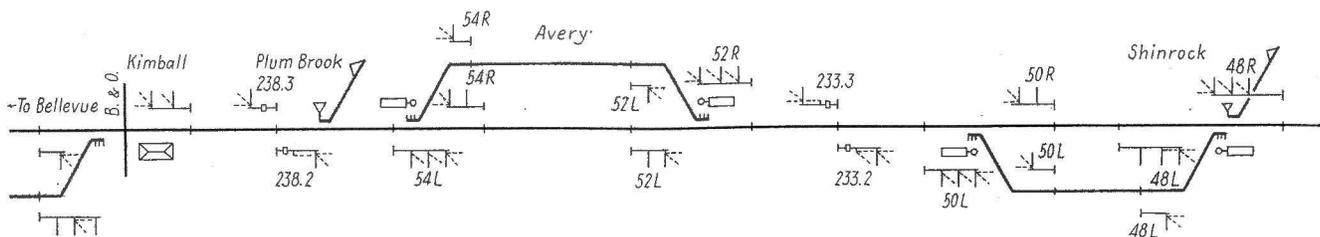
means for changing orders quickly enough to take advantage of the track which might be available. On the other hand, with the C.T.C. in service,

the operator in charge of the control machine is informed by his illuminated diagram of the location, direction, and progress being made by each train whether on the main line or any passing track. Furthermore, in view of the fact that no train stops are required to operate hand-throw switches, a train can be advanced from out of one siding and into another, about 12 to 15 minutes more quickly than if hand-throw stands were involved. When the operator sees that time and vacant tracks are available, he advances trains, considering time of arrival at the siding rather than the direction, in deciding which train is to pass through the siding. The overall average is that the eastbound symbol freight trains are saving 4 min-

over-yellow-over red, Medium Speed, as applying in an interlocking according to A.A.R. 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. With the exception of the westward siding at "GC", the sidings are longer than the average length of freight trains, so that trains can be brought to a stop from a speed of 35 m.p.h., before reaching the leaving end of the siding.

at the top, a green unit in the center and a red unit at the bottom. A single red is the Stop aspect, Rule 292. A single green light is the slow-clear aspect, indicating proceed, slow speed within interlocking limits, Rule 287 Fig. C. This green aspect 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.

A yellow-over-red is the Slow-Approach aspect, indicating proceed, preparing to stop at next signal, Rule 288. This aspect is displayed when the signal is lever controlled, with the first automatic block unoccupied but with the second block occupied by a



Track and signal diagram of the centralized traffic

utes, the westbound symbol trains 5 minutes, the eastbound Third Class trains 24.4 minutes, and the westbound Third Class trains 23 minutes. Although only five of the switches now power-operated were previously hand-operated, a total of 17 train stops are eliminated on the average daily.

Signaling of Passing Tracks

As a part of the C.T.C. project, each passing track is track circuited. If a passing track is unoccupied, when

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 instruc-

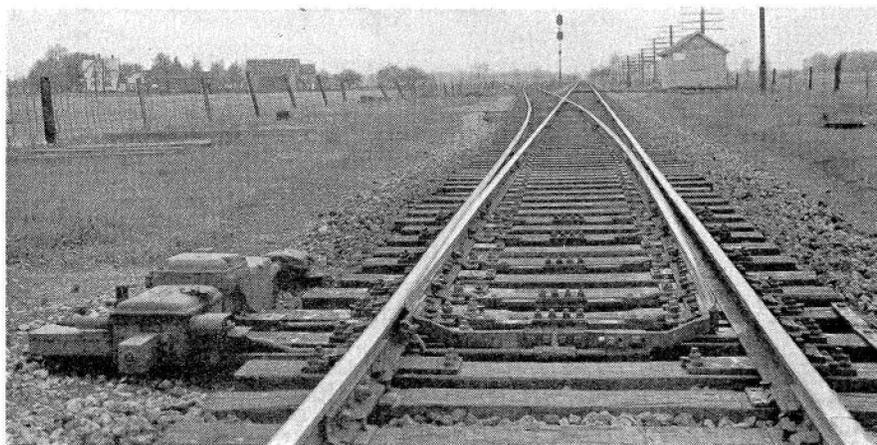
train of the same direction.

The single yellow is the Restricting aspect, Rule 290, indicating proceed at restricted speed, prepared to stop short of train or obstruction. This aspect is displayed when the signal is lever controlled and the automatic block ahead is occupied by a train of the same direction. The objective of this practice is to allow a train which is waiting on a siding for a train of the same direction to pass, to get underway while the leading train is receding in the first automatic block rather than waiting until the leading train clears the first automatic block.

The special arrangement of color units, to place the green between the yellow and the red, permits the display of the yellow-over-red aspect, with these lamps far enough apart to display a distinctive aspect which is sufficiently clear for the short range.

The Advance-Approach Aspect

The length of the automatic block between the signals at the two ends of some of the passing tracks is less than that adopted as minimum train stopping distance. When a train has accepted and passed a station-leaving main line signal, such as 37L at "GC", that signal displays the red-over-red Stop aspect, the next signal in approach No. 40L, displays the Approach aspect, and the second signal in approach, No. 225.0 displays the Advance Approach aspect, yellow-over-



Dual-control electric switch machine

the entering switch is reversed and the home signal cleared for an approaching train to enter, the aspect is red-

tions would be required. The leave-siding dwarfs are color-light type signals, with a yellow unit

yellow which indicates stop at second signal, Rule 282A.

Thus signal 225.0 can display any one of five aspects. With the lamps in the lower "arm" extinguished, the lamps in the upper "arm" can display a green for Clear, a yellow for Approach, or a red for Stop and then Proceed. With lamps in both arms lighted, a yellow-over-green aspect is the Approach Medium, and the yellow-over-yellow is the Advance Approach.

On a signal such as 225.1, there is no occasion to display the yellow-over-yellow Advance-Approach, because the block between the signals at the two ends of Florence is more than train stopping distance. Signal 225.1, however, can display the yellow-over-green Approach-Medium aspect, therefore the lower "arm" is a normally extinguished single lamp unit which can be lighted green.

Call-On for Station Entering Signal

If the main track in station limits is occupied and the operator wants to close in a second train of the same direction, the station-entering signal can be lever controlled to display a Call-on aspect, red-over-red-over-yellow, Restricting, Rule 290, indicating proceed at restricted speed prepared to stop short of train or obstruction.

Signaling at Spring Switch

At the spring switch at Kishmans, circuit controllers check the normally closed position of the switch point and the normal position of the lock plunger to determine that it is through the lock rod but that the overthrow is not too far so that it would not be withdrawn automatically during a trailing move over the turnout. Circuits through these controllers prevent the display of a Proceed aspect on any of the three signals if the switch is not normal or if the lock plunger is not in the proper position.

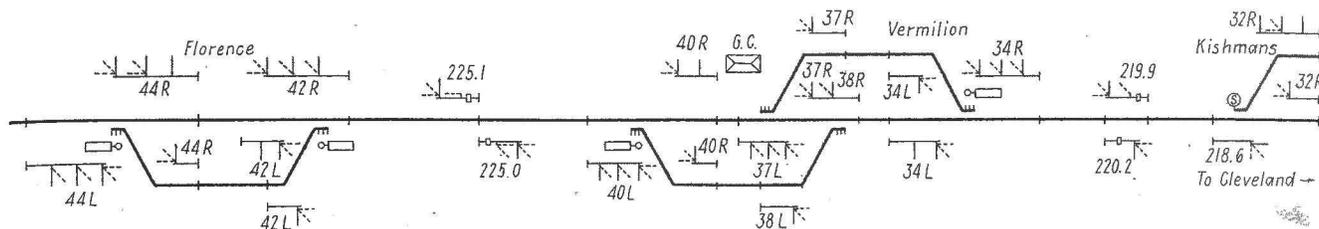
A dwarf type color-light switch lamp with aspects displayed in both directions is located on the south side of the facing point of the spring switch. When the switch is in the normal position and the locking plunger is in the proper position, this switch lamp displays the green aspect in both directions. If the switch is not normal or if the lock plunger is not in the proper position, the green light is extinguished and the red light is illuminated.

The purpose of using the switch lamp in addition to the signals is to give enginemen information to know whether improper position of the switch or lock is the factor which is causing a signal to display a Stop aspect. For example, if an eastbound train encounters a Stop-and-then-Proceed aspect on signal 218.6, and a green aspect is being displayed on the switch lamp, he knows that there is no occasion for him to inspect the

light is being displayed by the switch lamp, the engineman or a member of the train crew inspects the switch. Thus when the switch or lock are not properly positioned, the switch lamp serves to call attention to this fact, thereby localizing the factor which may be holding the signals at their most restrictive aspect, and in many cases saving a second stop for the trainmen to examine the spring switch.

The C.T.C. Control Machine

The C.T.C. control machine for the Kishmans-Kimball territory is located in the office at "GC", adjacent to the mechanical interlocking machine which operates the two switches



control territory between Kishmans and Kimball

switch, and that the signal is displaying a restrictive aspect because the block is occupied by a preceding train, or that a rail is broken, etc. Therefore, he is authorized to proceed at restricted speed, after having stopped at the signal. On the other hand, if the switch lamp is displaying a red light

at the lap. The levers for controlling the interlocking signals at the lap were retained in the mechanical interlocking machine, and these levers must be reversed preliminary to the clearing of such signals, but the final clearing control is effected by levers in the C.T.C. machine, in order to establish

Hand-throw switch stand with an electric lock at Shinrock



the engineman or a trainman inspects the switch. If it is being held open by some obstruction, this is removed so that the switch can return to its normal position and be locked automatically.

If a westbound train is stopped by a Stop aspect on either of the westward signals at Kishmans, and a red

lockout circuits to prevent signals being set at Stop by coding an opposing signal.

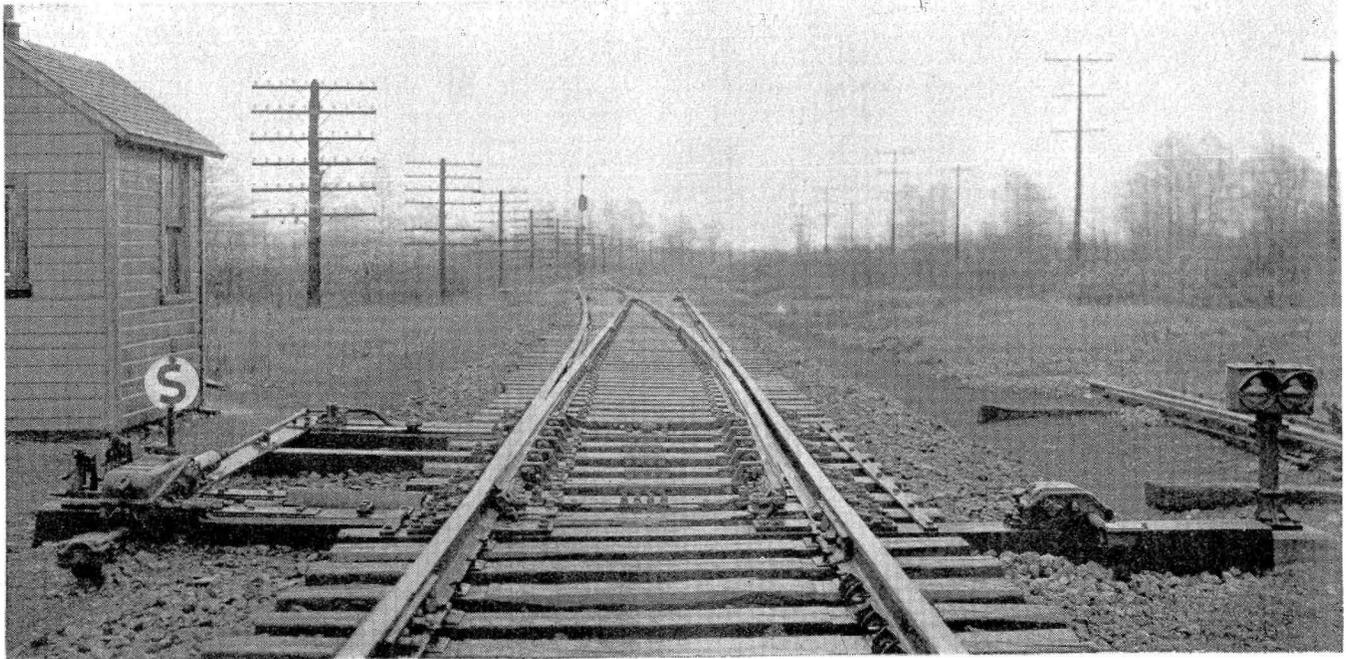
The transmission of controls from the office to the field stations, as well as the return of indications is accomplished by the U.S. & S. Co. time code system using two line wires. The control machine has 9 levers for

switches, 12 levers for signals and 2 levers for control of electric locks on hand-throw main line switches. One hand throw switch is located within semi-automatic signal limits at the east end of Shinrock, and the other is at an outlying point known as Plum

tion between the intermediate signals and the next switch. The control for each of these lamps is initiated through contacts of a relay in series with the signal HDR automatic line wire circuit, so that no extra line wires are required to provide the two

cupancy of the station-to-station block as a whole.

Time locking, effected automatically by time element relays, comes into effect if a semi-automatic signal is cleared and then taken-away before being accepted by a train. All semi-



Lamp target at right of spring switch layout

Brook which is located between Avery and Kimball.

The release of each of these locks is by lever control through the line coding system to the field station nearest to the switch and from there on a line wire circuit to the switch. Each switch lock is indicated in the C.T.C. machine as "locked" or "unlocked."

Directional Track-Occupancy Lamps

A new and interesting feature of the C.T.C. machine is that the track-occupancy lamps indicate the direction in which a train has entered the block. These lamps are normally extinguished, being lighted red by eastward train movements, or lighted white by westward train movements. This special control feature is effected by stick relays in the C.T.C. machine storage racks. The directional track-occupancy indication does not apply to the OS switch detector sections, but this practice does apply to all other main track sections as well as to passing tracks.

The main track between two stations is indicated by two track-occupancy lamps, one corresponding to the section between a switch and the intermediate signal location, and the other lamp corresponding to the sec-

tion between the intermediate signals and the next switch. The control for each of these lamps is initiated through contacts of a relay in series with the signal HDR automatic line wire circuit, so that no extra line wires are required to provide the two

automatic signals are "stick", i.e., they will not clear automatically for a second train until the operator sends out another code to clear the signal.

A Two-Wire Circuit for Automatic Controls

The automatic block previously in service included neutral d-c. track circuits using 2-ohm relays on the longer circuits and 4-ohm relays on short circuits. These d-c. conventional track circuits were retained in service as a part of the new C.T.C. system. Each of the longer track circuits is fed by five cells of 500-a.h. primary battery in multiple. Each of the new switch detector OS track circuits is equipped with a quick release 4-ohm relay and is fed by three cells of high-voltage 500-a.h. primary cells.

In the previous normal-clear automatic signaling, a two-wire line circuit was provided for the control of eastward signals, and a similar two-wire line circuit was provided for westward signals, these line wires being No. 10 hard-drawn copper with weatherproof covering.

With centralized traffic control, the signals need to be cleared for only one direction at any one time, and therefore the N.Y.C. & St. L. adopted the use of one two-wire line circuit for

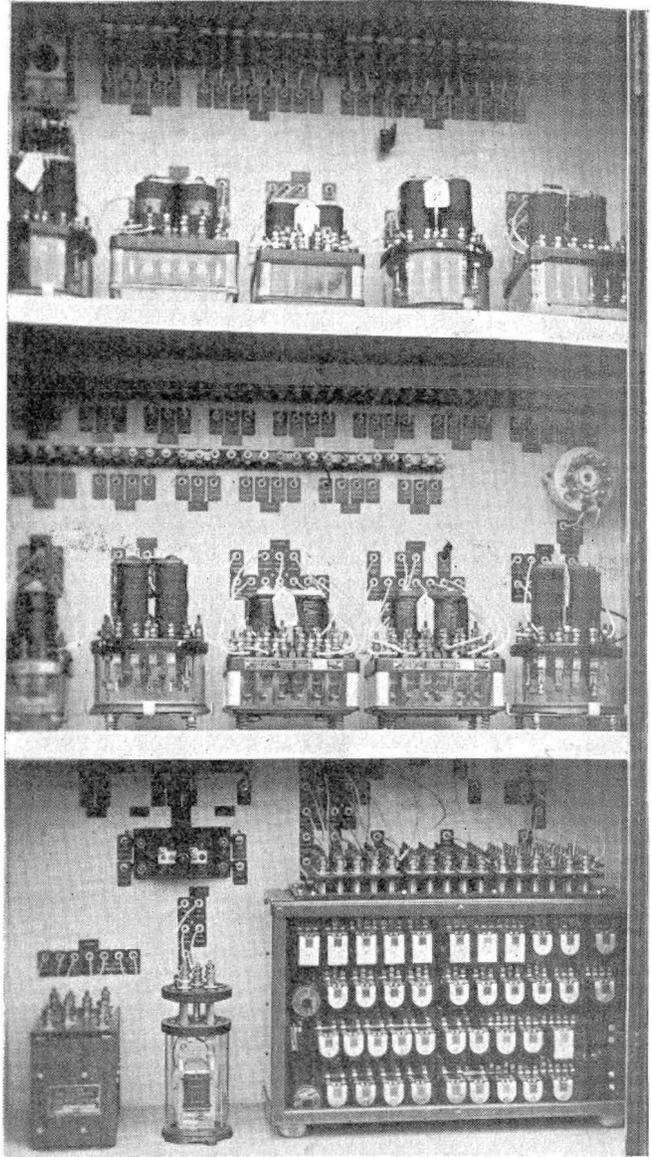


Voice-operated calling device

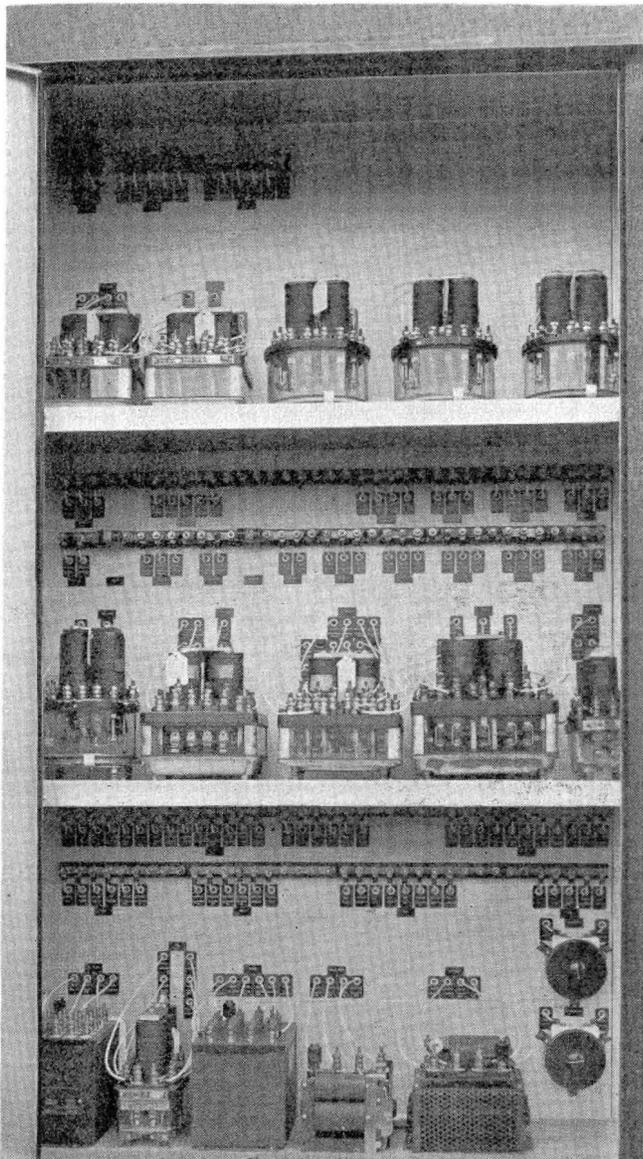
passes the intermediate signal location, thus affording information concerning the progress of a train, rather than limiting the information to oc-

the automatic controls of signals for either one direction or the other. This is a polar line circuit so that signals can be controlled to display two Proceed aspects, Approach and Clear, by means of this circuit. The details of the design and operation of such a two-wire line circuit were explained on page 426 of *Railway Signaling* for August, 1942. All of the intermediate signals with the exception of 220.2 and 238.3 are capable of displaying three Proceed aspects, including Clear, Approach and either Advance Approach or Approach Medium. The control of the third Proceed aspect requires an extra two-wire line cir-

Right half of the instrument case at the end of double track at Kishmans



Left half of the instrument case at Kishmans showing the relays and rectifiers



cuit. Therefore for nearly all of the territory there are four line wires for signal control circuits and two for the C.T.C. code line.

Telephone Communication on Code Line

A telephone circuit for communication between the field stations and the

operator in charge of the C.T.C. machine, is superimposed on the two line wires used for the code line. When a maintainer or a train man at a field location wants to communicate with the operator, he simply starts talking into the transmitter. The voice frequency on the line circuit actuates a voice-operated calling device in the control machine which causes

a buzzer to sound and a red lamp on the panel to be lighted. Thus the operator is informed to plug in his desk telephone set to connect with the code line circuit.

When the operator wants to call a maintainer at a certain field station a special code is sent which causes a lamp to be lighted on the track side of the instrument house at the field station.

Switch Machines and Signals

The electric switch machines are the low-voltage d-c., with dual control. With 20 volts d-c. at the motor, a switch is operated in 16 seconds or less.

The signals are the Style R2 color-light type using single-filament, 10-volt, 18-watt lamps. In order to prevent lamp failures due to lightning, an electrolytic type arrestor is connected across the lamp feed circuit for each signal. On the intermediate signals, the lamps are normally extinguished,

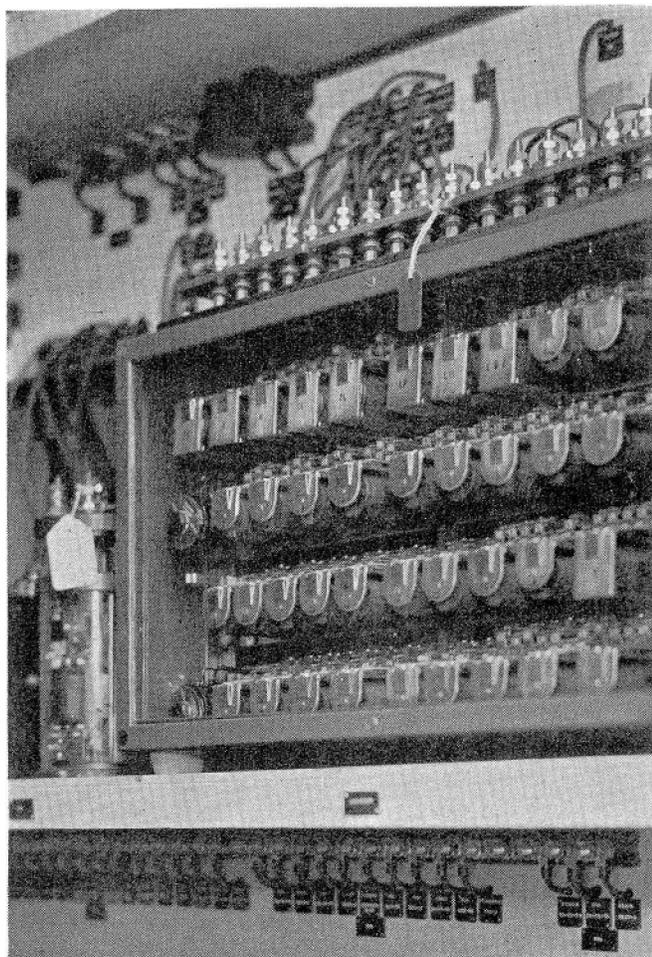
being lighted by approach control circuits. The lamps in the semi-automatic signals are normally lighted. "Light-out" protection is provided on signals which would display a less re-

16, 19 strand with rubber and synthetic insulation having no tape or braid. Wire connections to relays and terminals are made with wedge-on connectors. After the wiring was

were energized; local battery connected in each house and miniature signals were set up to complete the equivalent of actual field connections. Then by operation of the C.T.C. machine, a complete detailed operating check was made by every control and operating feature and as each control was set up a complete breakdown of each circuit was made. The connections between the houses were then removed, the instruments were blocked in place and the houses were loaded with derricks and transported by work train to their final field locations. The incoming line and underground cables were connected, and the apparatus and circuits in the houses were ready for service. For the most part, the underground cables have protective coverings which include no metal.

By wiring the houses at construction headquarters, the work was expedited because the wiremen did not lose time going to and from work, as would have been the case if the houses had been wired in the field. The practice of pre-testing the coding equipment and circuits as a whole, saved a lot of time as compared with making actual operating tests as the system was placed in service.

On account of the numerous train movements especially during the morning and late afternoon on this single track line, up to 62 daily, it



Line code equipment in the sheet metal house at Shinrock

strictive indication than the conditions required in case of lamp filament failures.

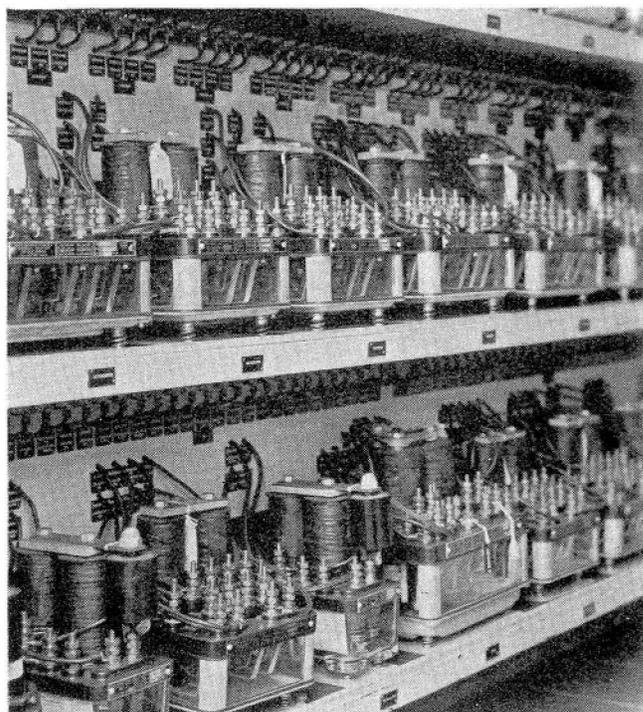
Power Supply

The previous automatic signaling included a 440-volt a-c. power distribution circuit on two No. 6 line wires. At each intermediate signal there is a set of 4 cells of 120 a.h. lead type storage battery. At a power switch location there is a set of 13 cells of the same type battery, the entire set being used to operate the switch machine, and 8 of the cells are used to feed the line coding equipment. The track circuits are fed from sets of primary battery as previously explained.

Pre-Installation Tests

The instruments at each power switch are located in a sheet metal house. Three of these houses were wired at the factory and the remaining four were wired by railroad forces at field headquarters in Vermillion, O. The wire used in these houses is No.

Typical mounting of relays in sheet-metal house at a power switch



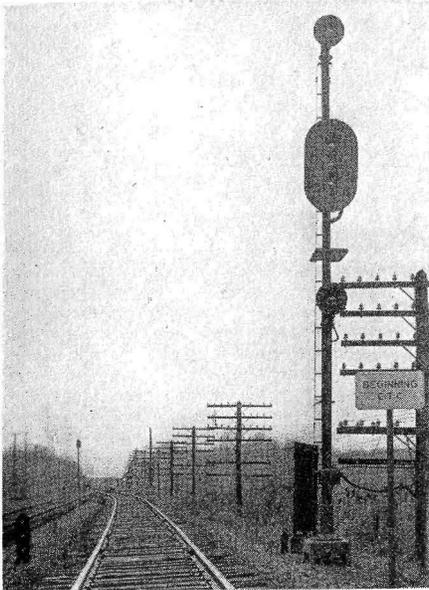
complete, the seven houses were set up in a row, and were connected by a dummy code line to the control machine and office equipment which was set up temporarily in a nearby building, with dummy signal control wires between houses. Track relays

was practically out of the question to haul materials to the locations on track motor cars and trailers. Two trucks were rented at a rate of \$30.00 per month plus 7 cents per mile, for each truck, covering maintenance, gasoline and other operating expenses with the

exception of a driver. These trucks were used to transport men and materials between headquarters at Vermillion and the various field locations. The use of these vehicles made possible a saving in time equivalent in money to all rentals and operating expenses plus a minimum of \$50.00 weekly per truck.

Rail Connections

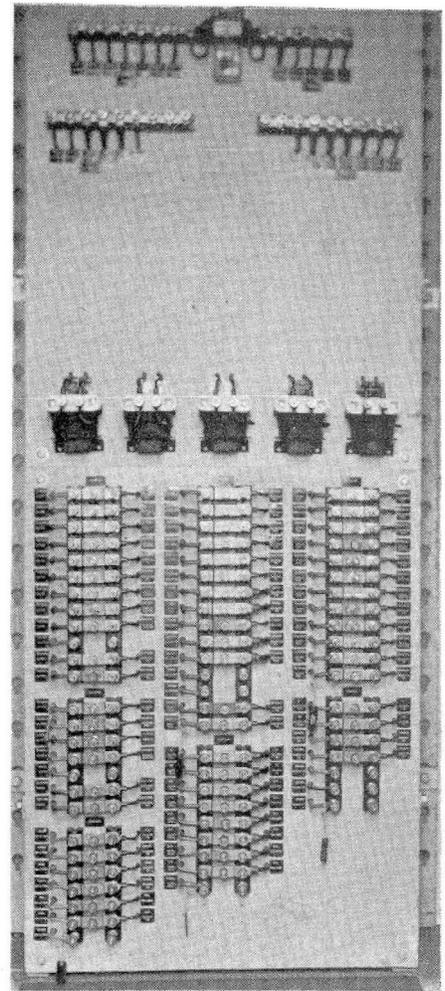
The track circuit connections from the instrument houses to the bootleg



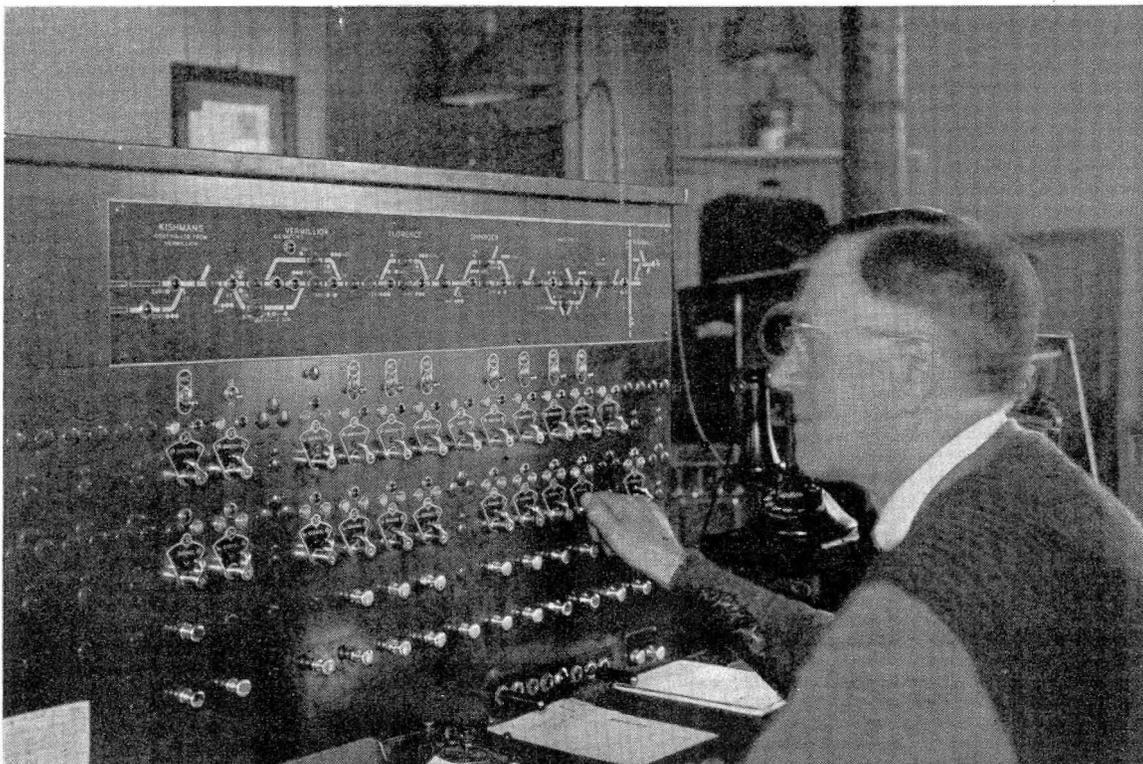
Signals at Kishmans

outlets are in No. 9 stranded underground 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 $1\frac{3}{4}$ 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 due to the track pumping.

This centralized traffic control project was planned and constructed by the signal forces of the N.Y.C. & St. L., under the direction of S. G. Raber, Superintendent of Telegraph and Signals, the major items of equipment being furnished by the Union Switch & Signal Company.



Board in sheet-metal house



Close view of centralized traffic control machine at "GC"