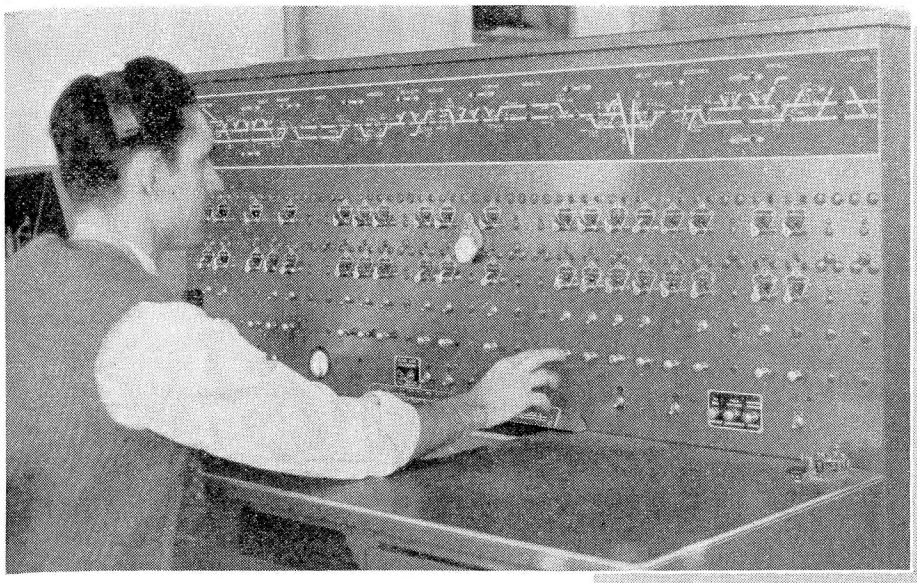
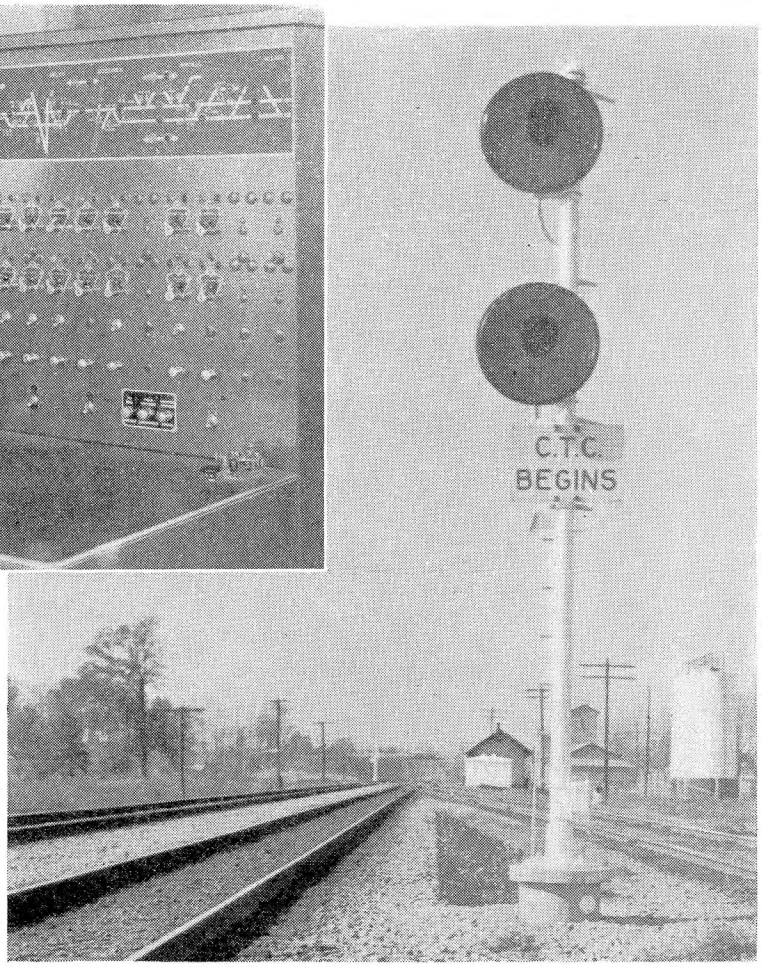




The C.T.C. machine is located in a dispatcher's office at Illmo Right—First southward C.T.C. signal at south end of yard

St. Louis-Southwestern

Installs Centralized Traffic Control

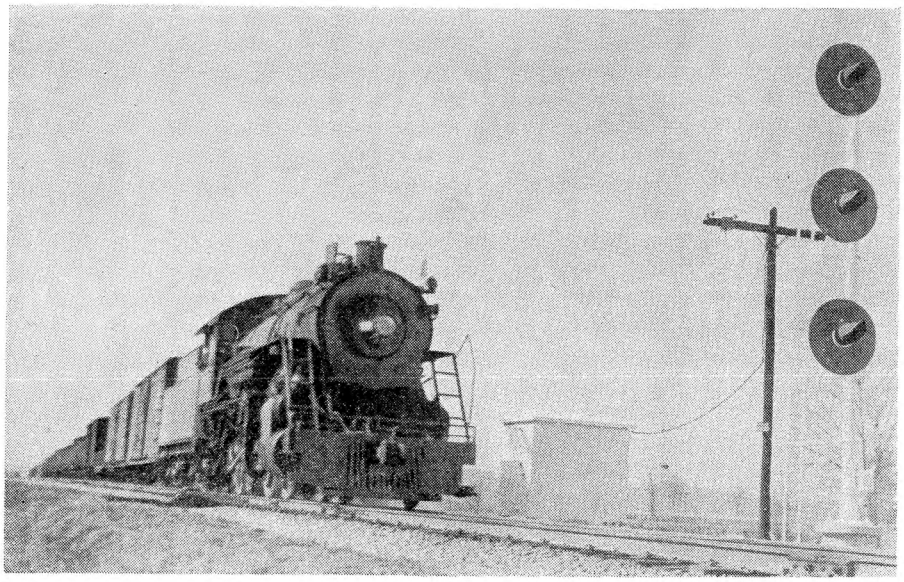
Project on 32 miles of single track and 15 miles of double track, is an aid in handling up to 65 high speed trains daily

As a means for expediting train movements and increasing track capacity on a line that is handling up to 65 trains daily, the St. Louis-Southwestern has installed centralized traffic control on 32 miles of single track and 15 miles of double track main line between Illmo, Mo., and Dexter Junction. Starting at Illmo, the north end, two main tracks extend 5.6 miles to Rockview, and starting at Dexter Junction, the south end, two main tracks extend 7.5 miles to Paront. Between Rockview and Paront there is 32 miles of single track with five passing tracks. The centralized traffic control includes semi-automatic signals for authorizing train movements by signal indication not only on the single track, but in either direction on both tracks of the sections of two-track.

This 47 miles of railroad between Illmo and Dexter Junction is an important part of through routes on the Missouri Pacific, as well as on the St. Louis-Southwestern. Between East St. Louis, Ill., and Thebes, 135 miles, the St. Louis-Southwestern and the Missouri Pacific operate jointly over tracks of the Missouri Pacific. The bridge across the Mississippi river at Thebes, and the tracks between Thebes and Illmo, 3 miles, are owned jointly by the St. Louis-Southwestern, and the Missouri Pacific. Between Illmo and Dexter Junction, the Missouri Pacific and the St. Louis-Southwestern operate jointly over the tracks of the St. Louis-Southwestern. To the south of Dexter Junction, the St. Louis-Southwestern extends through Paragould, Ark., and Texarkana, Ark., to Dallas, Ft. Worth, Tyler, Waco and other principal cities in Texas.

From the south end of the C.T.C. territory at Dexter Junction, the Missouri Pacific has a single-track line extending 25 miles westward to Poplar Bluff, Mo., where a connection is made with the north-and-south direct main line of this road between St. Louis, Mo., and Texarkana, Ark., via Little Rock, Ark. Between St. Louis and Poplar Bluff, the direct line passes over heavy grades and, therefore, the bulk of the through freight in both directions on the Texarkana line is routed out of and into the St. Louis area via East St. Louis, Thebes, Illmo, Dexter Junction and Poplar Bluff.

Missouri Pacific freight trains be-



The sidings are equipped with track circuits and the station-entering signals have the three arms

tween East St. Louis and points in Louisiana are routed via Thebes, Illmo and Dexter Junction, but instead of being diverted at Dexter Junction, these trains also use the St. Louis-Southwestern tracks on 63 miles between Dexter Junction and Paragould, beyond which point the Missouri Pacific has its own lines. Thus at the north end of the territory, the southbound trains are received either from the St. Louis-Southwestern yard at Ancell, or from Thebes via the bridge; while at Dexter Junction the northbound trains are received either from the line from Paragould or from Poplar Bluff.

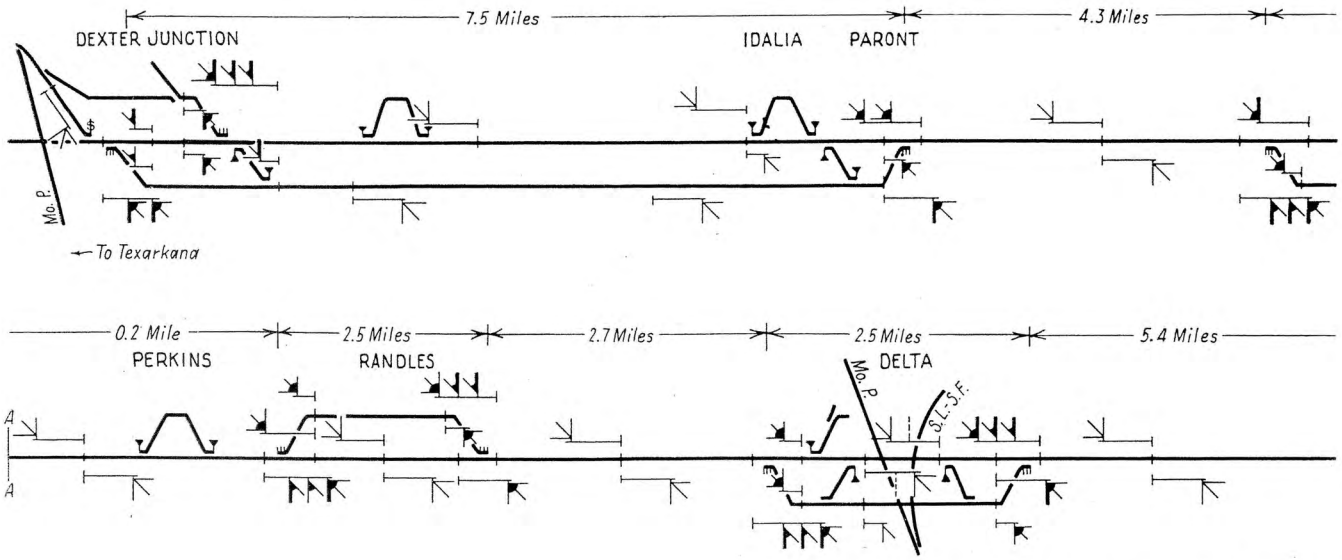
Between Illmo and Dexter Junction the line is located in comparatively flat territory in the valley of the Mississippi river, the maximum ruling grade being only 0.3 per cent. None of the curves are more than 4 deg., and, therefore, do not limit the maximum permissible speed of trains. The track is constructed with 112-lb. rail, treated ties and rock ballast.

Up to 65 Trains Daily

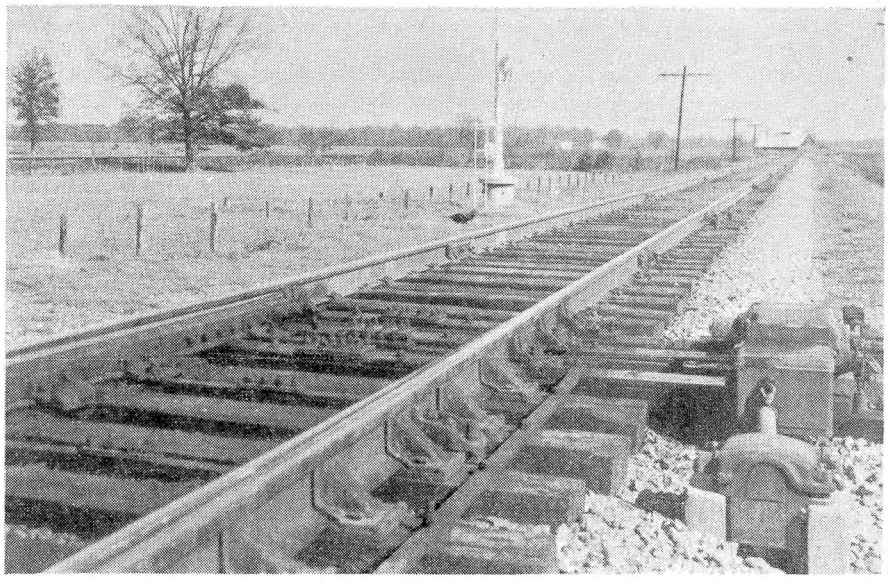
The St. Louis-Southwestern operates one through passenger train known as the "Morning Star" each way daily over this territory, the remainder of the traffic, totaling up to 65 movements daily, being freight trains. A local freight train is operated each way daily except Sunday. The St. Louis-Southwestern operates three scheduled through freight trains in each direction daily, and the Missouri Pacific schedules four through freight trains each way daily. Extra trains are required to handle the present traffic, so that on the average about 27 trains are operated each way daily, while in some instances 60 or as many as 65 trains are handled in a 24-hour period.

Prior to the installation of centralized traffic control, the train movements were authorized by timetable and train orders. In addition to automatic block signaling throughout, facilities were in service for operating certain switches. Power switch machines, controlled from the office at Illmo, were in service at the crossover and yard-lead switch at Ancell. The end of double track switch at Rockview was, and still is, included in an interlocking at a crossing with the St. Louis-San Francisco. An operator at Dexter Junction handled the hand-throw switch at the junction between the Missouri Pacific and the St. Louis-Southwestern. Spring switches were in service at the north end of double track at Paront, and at the south end of double track at Dexter Junction. Lap sidings were in service at Randles and Avert. Operators at these laps lined the hand-throw switches for trains to enter the passing tracks, and the trains could head out through spring switches at the far ends.

As the number of trains increased due to the war time traffic in 1942, the delays due to the timetable and train order operation became so serious in this Illmo-Dexter Junction territory that something had to be done quickly. A decision was made,



Track and signal diagram of the C.T.C.



The power switch machines are of the low-voltage d-c. type with dual-control

therefore, to install centralized traffic control.

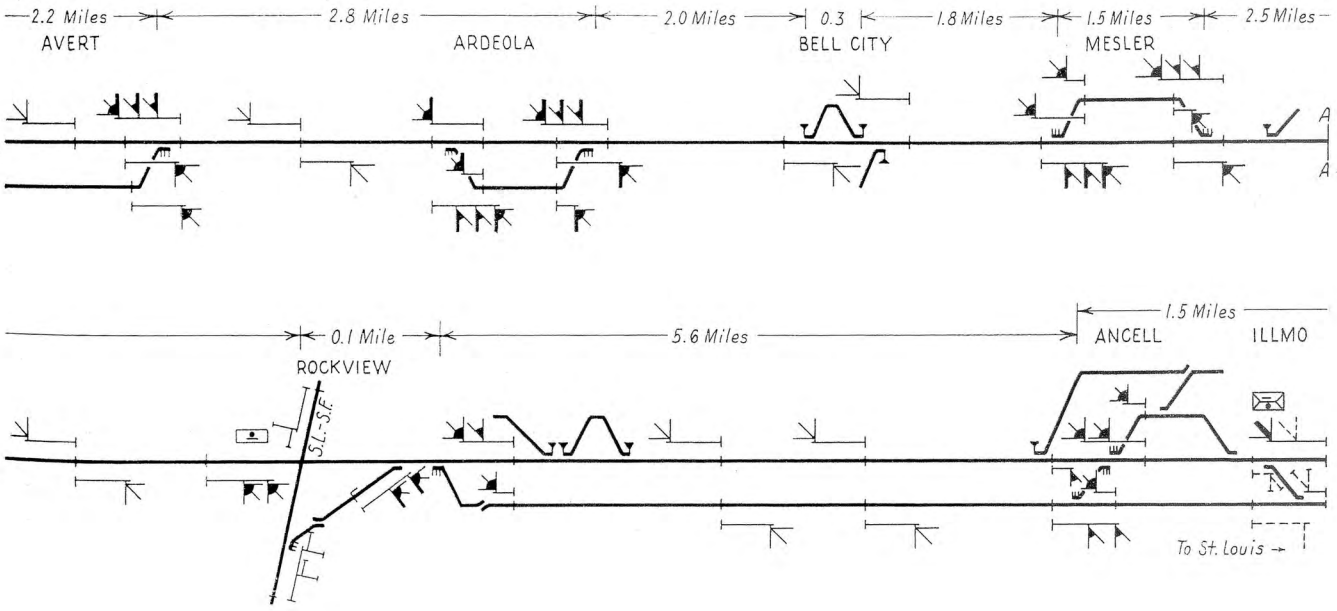
When making studies to determine the possible benefits of centralized traffic control, the trains for several days were redispatched on time-distance charts. These charts showed that in a very few instances only were the lap siding layouts used effectively to hold two trains while a third train passed. For this reason, and in consideration of the fact that additional switch machines, signals, etc., as well as new No. 16 turnouts would have been required, the lap sidings as such were eliminated, the tracks being thrown to connect the sidings through as one long siding at both Randles and Avert. New No. 16 turnouts were installed at these passing tracks as well as at the single sidings at Delta, Mesler, and Ardeola.

The power switch machines at the yard lead switch and crossover at Ancell were retained in service. New power switch machines were installed at the end of double track at Paront, and at Dexter Junction, as well as at both switches at the passing tracks at Delta, Randles, Mesler, Ardeola, Avert and Dexter Junction. The only spring switch retained in service is at the junction switch at Dexter Junction. As a part of the C.T.C. system, electric locks were installed at 21 hand-throw main line switches. The previous automatic signaling included electric locks on the gates at the crossings between the St. Louis-Southwestern with branch lines of the St. Louis-San Francisco and the Missouri Pacific at Delta.

Changes in Signaling

When installing automatic block signaling in this territory in 1941, the station-leaving main-line signals were located opposite the fouling point as required in C.T.C., so that no changes were required in these signals. Two additional searchlight units were added to the station-entering signals to form three-"arm" signals. Three-aspect color-light dwarfs were installed as leave-siding signals.

As a part of the C.T.C. project, track circuits were installed on the passing tracks not only to control track-occupancy indications on the panel of the control machine, but also to control the signals for directing trains to enter sidings. The turnouts are No. 16, good for train speeds up to 20 m.p.h. when making diverging moves. If a switch is reversed for an approaching train to enter a siding which is not occupied, the entering signal can be cleared to display an aspect of red-over-yellow-over-red. If the siding is occupied by a train of the same direction, the entering signal can be cleared to display an aspect of red-over-red-over-yellow, to authorize an approaching train to enter the siding at restricted speed prepared to stop short of train or obstruction. A signal cannot be cleared to direct a train to enter a siding in a direc-



tion opposite to that of a train which is occupying that siding that is being discussed here.

Features of the C.T.C. Control Machine

The C.T.C. control machine is located in the dispatcher's office at Illmo. The illuminated track diagram on this machine includes lamps which indicate train occupancy of all sections of main line, as well as the passing tracks. One such lamp indicates occupancy of each station-to-station block as a whole, one lamp indicates for each OS switch detector section, one lamp indicates for each section of main track opposite a passing track, and one lamp indicates for each passing track. These lamps are normally extinguished but are lighted red if the corresponding section of track is occupied.

Above the track diagram, and corresponding with each station-to-station block, there is a double-ended arrow with two lamps. When the C.T.C. control is established for traffic direction northward, an amber lamp near the right end of the corresponding arrow is lighted, but when the traffic direction is established southward, the northward lamp is extinguished and a second lamp near the left end of the arrow is lighted. The direction of traffic is established before the C.T.C. line code is sent out to clear the semi-automatic signal governing train movements into the station-to-station block.

The switch levers in the top row and the signal levers in the bottom row are equipped with the conventional arrangement of indication lamps. Toggle switches in the third row are for controlling maintainers' call lamps at corresponding stations in the field. Toggle switches, in a row below the code starting push buttons, are for the control of electric locks on hand-throw switches.

C.T.C. Code Line

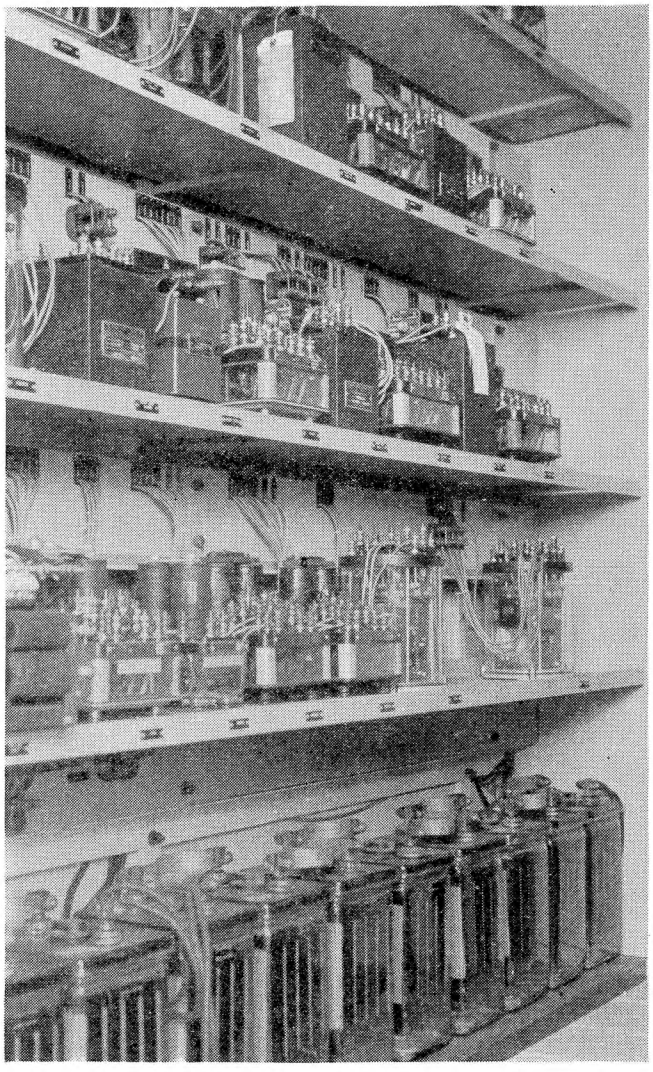
The outgoing controls and incoming indications of the C.T.C. system are handled by the Union Switch & Signal Company time code system using two line wires between the office at Illmo and the south end of the territory. A telephone circuit is superimposed on the C.T.C. code line circuit. At each power switch location, a telephone is located in a compartment on the rear of the entrance door to the sheet-metal instrument house, the telephone being accessible by opening a small door in the entrance door as shown in one of the illustrations. This arrangement obviates the use of separate booths for telephones. At each electric switch lock which is remote from other telephones, there is a telephone in a box on top of the electric lock as shown in one of the views.

When a person speaks into the telephone transmitter at any of the field stations, this operates a voice-frequency relay in the C.T.C. control machine which causes a red lamp to be lighted on the panel, thus calling the dispatcher's attention.

Field Station Disconnect

This control machine is equipped with a field station disconnect button and control scheme the purpose for which is to disconnect from the code line any particular field station which may not be operating in the normal manner.

In the event of an irregular line operation, which is suspected as being due to a faulty field station, the man in charge of the C.T.C. machine depresses the field station's "Disconnect" button and holds it for a period of approximately 15 seconds. This disconnects all the field stations from the line. The procedure then is to release the button, and code out a control code to each field station in order, one at a time, and return them to normal condition. This procedure is continued until the station is found which fails to send in an indication code or which causes the original trouble to appear on the line. The panel of the faulty station is then marked in a convenient manner and again the button is depressed for 15 seconds which disconnects all the field stations. Then all the field stations, except the one which has a fault, are returned to normal, operating in the manner described above.



Battery, relays and code apparatus in a typical housing

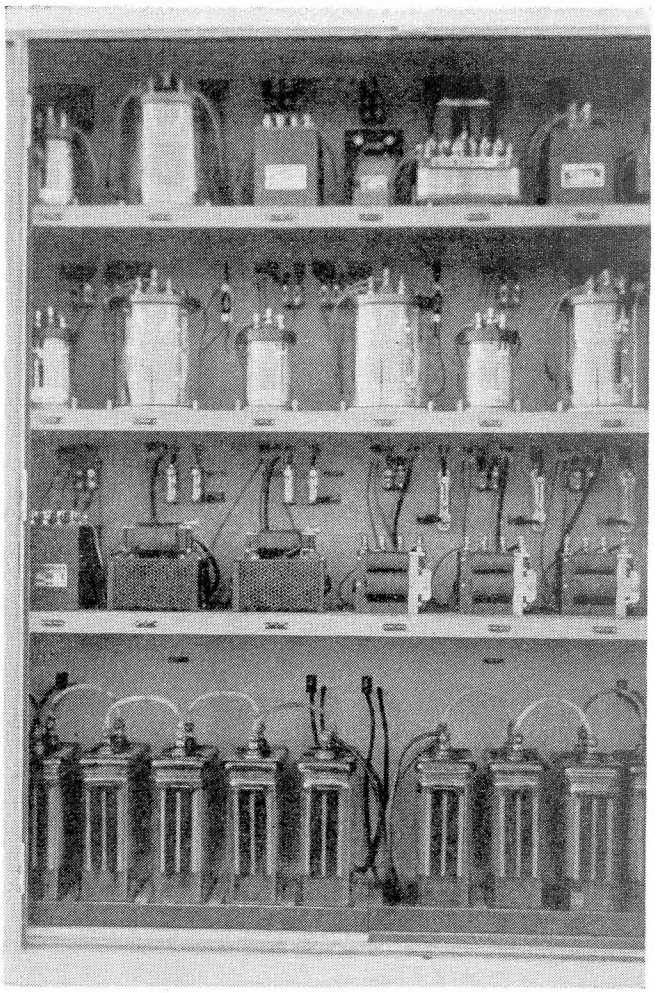
Control of the Electric Locks

The electric locks on the hand-throw main-line switches are controlled by toggle levers which are mounted in a row below the code starting buttons on the C.T.C. control machine. The locks on switches which are located in the same automatic block are all controlled by one toggle lever. The controls for the

electric locks are handled over the line coding system the same as for controls of switches and semi-automatic signals. When a release control for an electric lock is to be sent out, the man in charge of the machine throws the corresponding toggle lever to the "up" position and the code-starting button just above is pressed. This causes a release code to be sent out to the field station nearest to the corresponding electric lock, and then the release is sent from the field station over line wires to the lock.

If a train on the main line is to enter a switch, an unlock can be given any time after the train has entered the block from either end and the track-occupancy block light is lighted, and the semi-automatic signals governing movements into the block from each end are displaying the Stop aspect. After the unlock code has gone out to the corresponding field location, the electric lock on the respective switch will be unlocked after the expiration of the "track occupied" time, which starts when the track circuit involved is occupied by the train. The sending of a switch unlock code automatically sets up traffic direction.

If a train on a spur track is to use a switch to come out on to the main track, the conductor telephones the man in charge of the C.T.C. machine. In order for a release to be given, the block must be unoccupied, as is shown by the track-occupancy lamp, and the semi-automatic signals governing trains into the block from both ends must be indicating Stop.



Case at an intermediate automatic signal showing the coded track relays on second shelf from top of case

Changes in Circuits

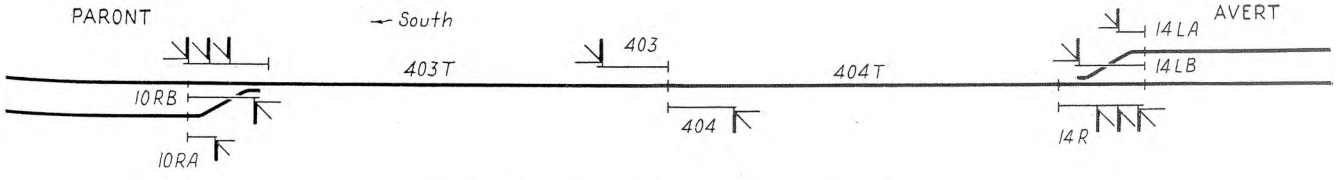
The original automatic block signaling installed in 1941, included coded track circuits which extended from signal to signal so that no cut sections were required. On the single track, the A.P.B. line circuits included two two-wire polarized line circuits, one for each direction. The change to C.T.C. included the use of one two-wire polarized local signal line circuit for the control of signals in one direction or the other between two sidings, depending on the direction of traffic established by the C.T.C. control. These circuits are practically the same as those explained on page 420-429 of *Railway Signaling* for August, 1942, the major differences being the control of the station-to-station block-occupancy indication lamp on the C.T.C. machine, and the traffic-direction selection arrangement, both in the machine and at the field locations.

Station-to-Station Block-Occupancy Indication

On the sections of single track between sidings, coded track circuits are used for detecting the presence of trains. These track circuits are fed 180 code constantly. For example in the section between Avert and Paront, 180-code is fed southward from Avert on track circuit 404 T to the code-following track relay at intermediate signal 404, and 180-code is fed northward from Paront on track circuit 403 T to a track relay at intermediate signal 403.

The two-wire line wire circuit, previously mentioned, is broken through front contacts of both track relays, and this line wire circuit remains established for the last direction used, say for example that the last train departed southward past Paront, thus leaving the circuits established for southward moves. Under this circumstance, the line relay at Avert is energized with the polar contacts to the left because both automatic blocks in the station-to-station block are unoccupied and intermediate signal 403 is displaying "yellow" or "green." A relay at Avert controlled through a left polar and front neutral of this line relay is repeated in the office, and is known as 14 LBK.

On the other hand, if the two-wire



Layout of track circuits between Paront and Avert

either-direction circuit is set up northward, then, if the station-to station block is unoccupied, a line relay at Paront is energized with its polar to the left, and a repeater relay 10RBK in the office is energized. As long as both 14LBK and 10RBK are de-energized, the track-occupancy lamps representing the main line between Paront and Avert is lighted, but when either 14BK or 10BK is energized the lamp is extinguished to show that the block is unoccupied.

Advantage of This Control

The advantage of thus using contacts in the line relays to repeat track occupancy is that the track relays can be located at the intermediate signals where they can be used also in the pick up control of direction-stick relays. A second advantage is that the direction of line up in the field is repeated in the office, a fact which permits certain simplifications of the interconnections of circuits in the machine to insure that once traffic direction is established and a signal cleared, movement of no other lever will "knock down the signal."

Also in the C.T.C. control machine the circuits are interconnected so that if signal 14L or 10R has been cleared and a train has entered the station-to-station block, the direction of traffic cannot be changed until the train has passed out of the station-to-station block.

Referring to the accompanying diagram on this page, the relays 257S and 258S are the final station selection relays in the code equipment which pick up on the eighth step of the station selection part of the code. Relays 9-10D and 13-14D are also in the code equipment and are known as the delivery relays. They pick up immediately following the station selection or "S" relays mentioned above.

When lever 10 is placed to the right with lever 14 either in the normal or to the right, relay 10-14LPR will receive energy through one of the windings and the relay will be positioned opposite that shown by the circuit. Relay 10-14LPR is a "KP" relay and remains in its last energized position. This relay cannot be positioned unless all track circuits between 10R and 14L are unoccupied. Relays 10RBK and 14LBK are the "block" relays and are energized one from each end depending upon the direction of traffic. 10RFK and 14LFK are the "traffic" relays and one or the other is energized depending upon the direction of traffic. When the direction of traffic is being changed between these locations, both traffic relays are de-energized during the transmission of the control code and both block relays are also de-energized. The back contacts of the 10RFK and the 14LFK in the 10-14LPR circuit prevent a "lockout" of this relay. When the control code has been completed and an indication returned from the field, the proper "S" relay and its corresponding "D" relay, in this case it would be 258S and 9-10D, will be energized picking up 10RBKR through the front contact of the 9-10D which, in turn, would pick up the 10RFK relay through the polar contact of 10-14LPR in its reversed position and the front contact of 10RBK. On the 16th or final step of the indication code, the 9-10D would drop out but the 10RBK would "stick" through the front contact of the 10RFK, its own front contact, and a back contact of the 9-10D.

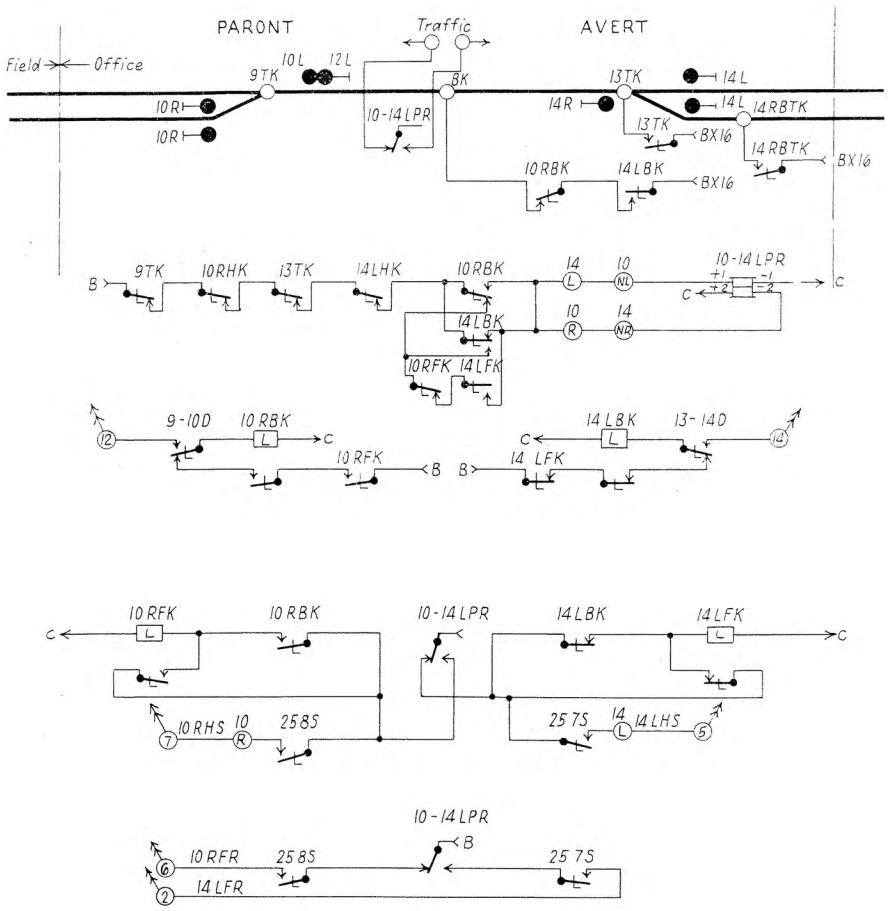
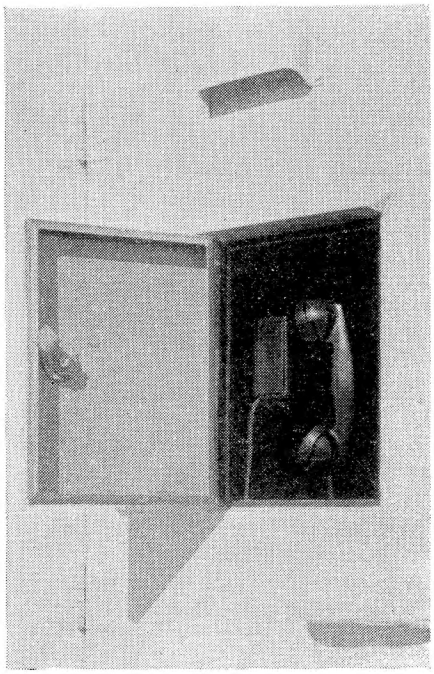


Diagram of typical circuit in the C.T.C. machine



Small door, in the door to an instrument house, opens to the telephone box

Lever Control Relay

It will be noted that the 10-14LPR is positioned by the manipulation of the signal levers. With lever 10 to the right and the transmission of a control code, the picking up of 258S

would connect post 7 on the code unit to battery and would send out a 10R signal control. After all relays in the field had been positioned in response to the control code, the indication would be returned from the field to set up conditions on the machine as outlined above. It will be noted that under these conditions, with signal 10R cleared, it would not be possible to clear signal 14L because the LPR relay could not be returned to its normal position until after the 10RHK relay closed its back contact. This back contact would not close until after the signal returns to stop and the indication registered by the centralized traffic control machine.

Track Circuits in Station Limits

Each of the switch detector OS track circuits is of the conventional constantly energized d-c. type, using a neutral d-c. relay rated at 4 ohms. Polar reverse coded track circuits are used on the sections of single track main line opposite passing tracks. This form of track circuit provides the control of the signals for both directions to display three aspects without using line wires. On each passing track there is a normally-energized coded track circuit with reverse code so that track-occupancy is detected, and also the entering signal at either end can be controlled without a local line circuit.

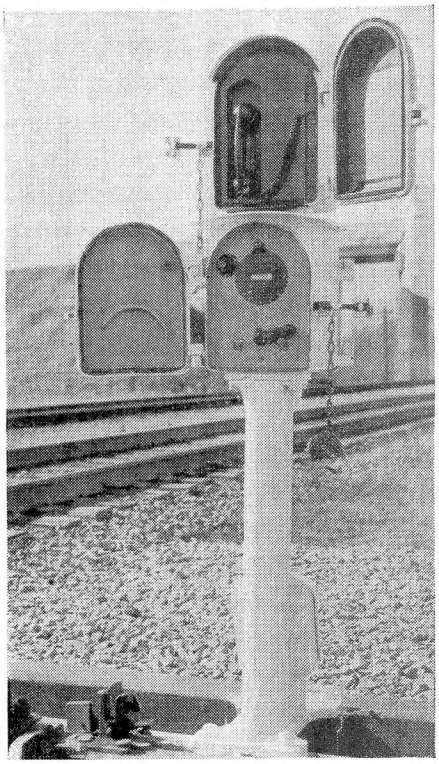
Track Circuit Control on Double Track

On the sections of two tracks between Ancell and Rock View, as well as between Paront and Dexter Junction, the automatic signaling is arranged for train movements in either direction on both tracks. This form of control is provided by coded track circuits which feed in either direction, i.e., toward an oncoming train, the direction being established when traffic direction is set up, thus no local line control circuits are required. Typical circuits of this type were explained on page 86 of the February, 1943, issue of *Railway Signaling*.

Power Supply

The 550-volt a-c. power distribution is on two steel-core stranded aluminum conductors equivalent to No. 6 copper. This 550-volt circuit is fed at Rockview, Bell City and Idalia. Air-cooled line transformers rated at 250 volt-amperes are used at the power switch locations, and at 150 watts at the intermediate locations. The signal control, as well as the C.T.C. line code wires are No. 10 Copperweld with weatherproof covering.

At each power switch there is a set of 13 cells of 80-a.h. Exide storage batteries for operation of the switch and the line code apparatus. Each coded track circuit is fed by one cell of the same type storage battery. Each of the OS d-c. neutral track circuits is fed by one cell of Edison 500-a.h. primary battery with a rectifier connected to carry most all of the normal load.



Electric lock on hand-throw main-line switch and telephone in the upper case at Ancell

Fireproof Control Office

At Illmo, the two-story station and office building, 93 ft. long and 24 ft. wide, was of frame construction throughout. For many years the dispatcher's office has been in the upper floor at the north end over the waiting room on the ground floor. When planning the centralized traffic control, a problem was to protect the control machine and office equipment from fire hazard.

A brick wall, 17 in. thick, was built from the ground up, to cut the building in two at a point 26 ft. from the north end, thus isolating this portion of the strucure. The edges of this brick wall extend 12 in. out beyond the frame walls, as well as 36 in. above the original roof line.

All portions of the frame building north of the fire wall were covered with fireproof material, using asbestos shingles on the roof and outer walls, as well as sheet asbestos on the walls and ceilings inside the building. The floors were covered with fireproof asbestos tile. All wiring in the part of the building was placed in metal conduit.

Benefits of the C.T.C.

Previously when train movements were authorized by timetable and train orders, trains were delayed in numerous instances waiting for train orders to enter this territory, simply because the dispatcher did not have advance information of sufficient accuracy concerning the arrival of trains so that he could plan the meets and passes, and get the orders issued ahead of time. Likewise in numerous instances, trains were delayed on passing tracks because the dispatcher had no means, in numerous instances, of knowing the location of trains, or of changing orders to take advantage of changing conditions. With the C.T.C., the illuminated track diagram shows the locations of all trains on the main track as well as on the passing sidings. By watching the progress being made by each train, the dispatcher can advance trains to make close meets, and in numerous instances meets are made without either train being stopped.

Train Time Saved

A study made soon after the C.T.C. was placed in service showed that the average time of southbound trains was reduced 37 minutes, and northbound trains 35 minutes. Further increases in these time savings are being made gradually as the dispatchers and engine crews become more familiar with the use of the C.T.C. facilities. In numerous instances freight trains which make one or more meets are now running through this 47 miles in 1 hour 15 minutes to 1 hour 35 minutes, this including one water stop at Delta or Avert.

This centralized traffic control project was installed by St. Louis-Southwestern forces under the jurisdiction of W. S. Hanley, chief engineer, and under the supervision of B. J. Alford, signal supervisor. The plans and major items of equipment were furnished by the Union Switch & Signal Company.