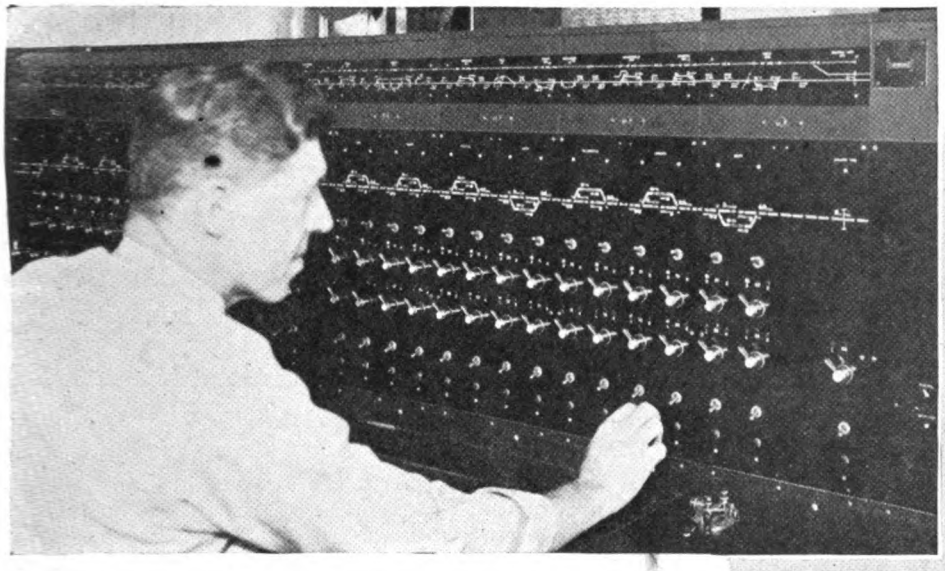
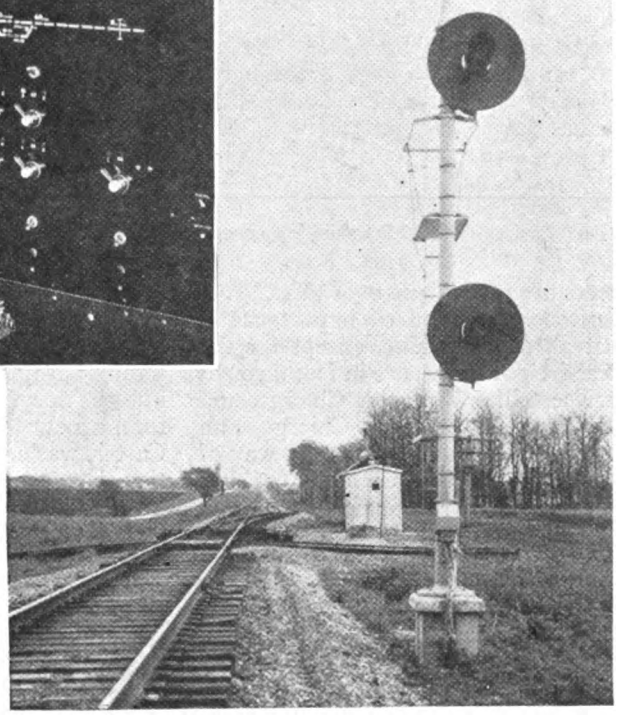




Above—The train dispatcher at Aurora operates the centralized traffic control machine for Aurora-Savanna line. Right—View of layout at west end of Chadwick which is typical with search-light signals, electric switch machine, concrete house for relays and batteries.

More C.T.C. on the Burlington

By W. F. Zane,
Chief Signal Engineer, Chicago Burlington & Quincy

Project on 59 mi. of busy high-speed single track, includes seven sidings spaced an average of 5.85 mi., switch to switch, thus increasing the number of the non-stop meets

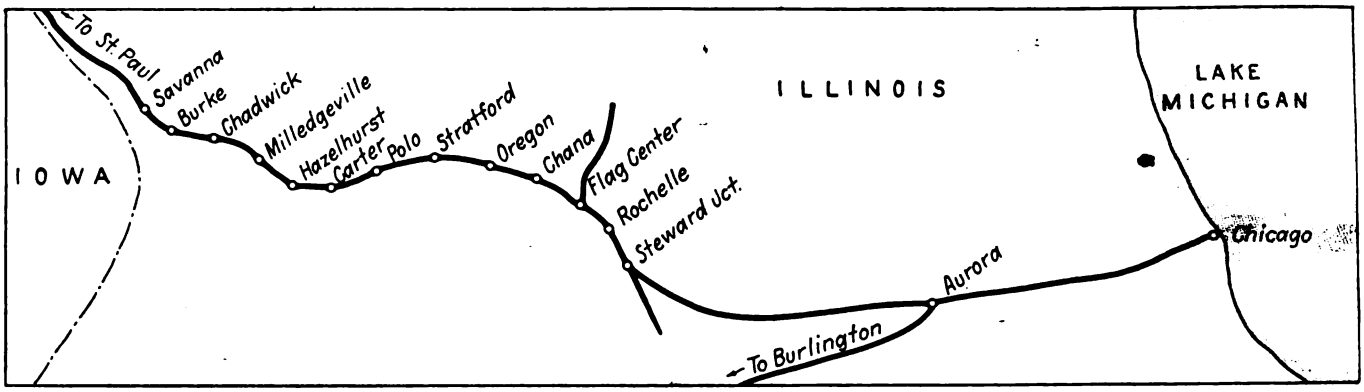
In line with a general policy of installing centralized traffic control on its heavy-traffic single-track lines, the Burlington has completed such a project on 59 mi. of single track between Flag Center, Ill., and Savanna. This project, with the 40 mi. of C.T.C. installed in 1943 between Aurora and Steward Junction, totals 99 mi., which completes all of the single track mileage on the 427-mi. line between Chicago and St. Paul.

The Burlington has three or more main tracks on the 37.7 mi. between Chicago and Aurora, and double track extends 282 mi. between Savanna and St. Paul. The 8.5 mi. of double track between Steward Junction and Flag Center, which is used also by trains of the Chicago, Milwaukee, St. Paul & Pacific, was equipped, in 1929, with centralized traffic control, using direct-wire controls from the machine at Rochelle, which is near the center of this section. Using line code equipment, with a two-wire line circuit, one control machine in the dispatcher's office at Aurora controls not only the 40 mi. of single-track C.T.C. between Aurora and Steward Junction, installed in 1942, but also the recently completed 59 mi. of single-track C.T.C. between Flag Center and Savanna. The operators in charge of the machine at Rochelle, which controls the 8.5 mi. of direct-wire C.T.C. between Steward Junction and Flag Center, works under the supervision of the dispatcher at Aurora. Thus the entire 107 mi. between Aurora and Savanna is now equipped with C.T.C.

Rolling Country

Between Flag Center and Savanna, the railroad traverses rolling country, with numerous short grades ranging up to about 0.8 per cent. Savanna is on the Mississippi river. Starting about three miles east of Savanna, a grade of about 0.8 per cent ascends eastward for about three miles. The curves are few, and most of them are 1 deg. or less, with some 2 deg. and only three 3 deg. The track consists of 130-lb. rail, and rock ballast. Therefore, insofar as grades, curves and track are concerned, this territory can handle heavy traffic at high speeds.

The traffic includes 12 passenger trains and an average of about 9 freight trains, operated daily, with extra trains as required. Thus, a total of about 21 to 24 train move-



Map showing general location of the new C.T.C. territory between Flag Center and Savanna

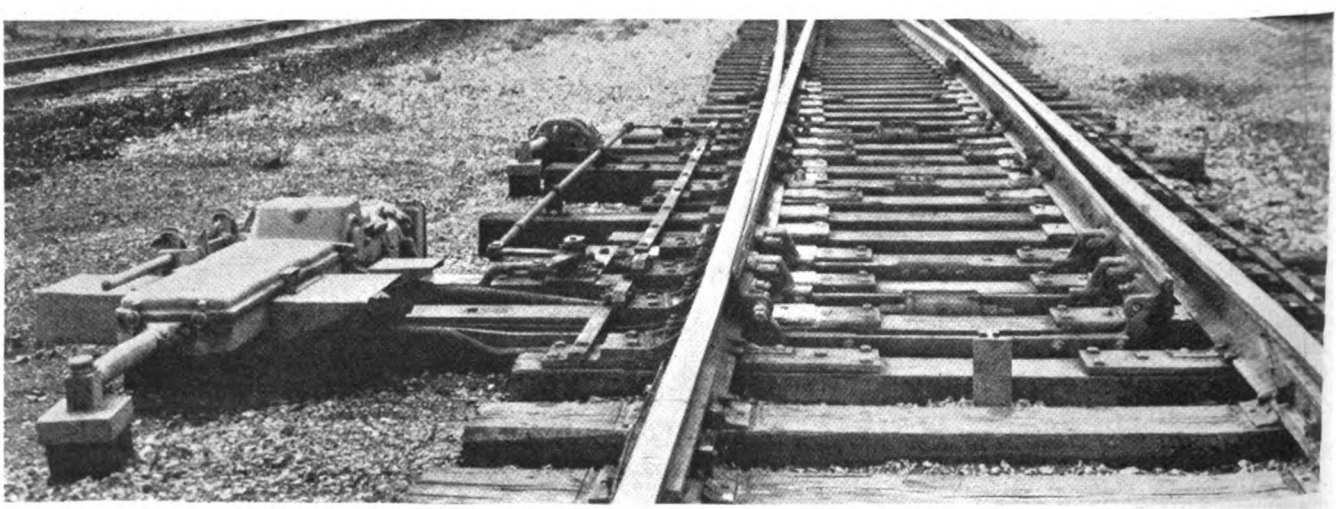
ments are made daily over this C.T.C. territory. A point of importance is that all of the trains, except for the local freight trains, are in fast through service, either between Chicago and St. Paul or between Chicago and cities on the Pacific Coast, by way of St. Paul. A further factor of importance, with reference to the need for C.T.C., is that the preponderance of traffic is eastbound into Chicago during the early morning, and westbound out of Chicago during the late afternoon and evening. Previously, train movements were authorized by timetable and train orders, with automatic block protection. The installation of C.T.C., including power operation of siding switches and the use of signals to authorize train movements, has increased track capacity and facilitated train movements, especially the through freight trains.

Layout of Sidings

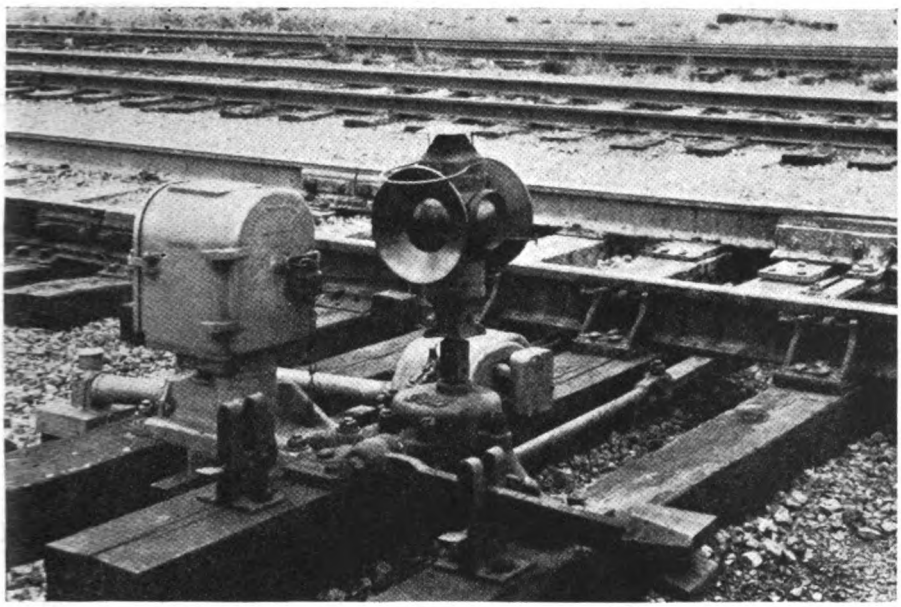
As a part of the improvement program, several changes and additions were made in the lengths and locations of sidings. This was done to improve the uniformity of train time between sidings as well as to take advantage of grades and other local conditions when trains are entering and leaving sidings. The previous sidings at Polo and Hazelhurst were not located properly to be incorporated into the new C.T.C. operation. Therefore, a new 140-car siding, known as Carter, was constructed at a new location between Polo and Hazelhurst. The sidings at these two towns were left in place for use as house tracks, with hand-throw switch stands, and without C.T.C. signals for authorizing train movements onto the main track. All other sidings were lengthened to 140-car capacities except two—one of these being 136-car capacity and the other 76-car capacity. Between Flag Center and Savanna the sidings are spaced as uniformly as practicable on a time-distance basis for trains. On the average, the distance between the west switch of one siding and the east switch of the next siding is 5.85 mi.

As a general rule, the freight trains operated over this territory are made up of about 80 cars, which, of course, is much less than the 140-car capacity of the sidings. One reason for the longer sidings is that trains can enter at the speeds for which the turnouts are designed, and, after the rear end is in the clear, there is plenty of track length left on which to stop. Another advantage is that long sidings are advantageous in making meets in which neither train stops. These non-stop meets save lots of train time, and experience on this project, as well as other installations in service on the Burlington, is that nearly 40 per cent of the meets can be made non-stop, where sidings are arranged as previously explained. As a part of the improvements at these seven sidings, the old turnouts were replaced with new No. 15 turnouts, including 30-ft. points, so that trains can enter or depart from the sidings at speeds ranging up to 25 m.p.h.

As part of the signaling project, electric locks were applied to 12 hand-throw main-track switches; two at Flag Center; four at Oregon; one at a spur west of Oregon; one at Polo; and two at Hazelhurst. The electric switch machines installed at the seven sidings are the G.R.S. Co. Model 5D, with dual control, so that they can be operated manually by trainmen when making switching moves. These machines are equipped with built-in controllers including normal and reverse contactors and over-load relays. The brakes are the outboard type. The motors are designed to operate on 24



Power switch showing pipe and cranks for second connection to mid-section of the long points



Electric lock applied to hand-throw switch

to 30 volts d.c. With 24 volts at the motor, the machine will operate a switch in about 7.5 sec.

New Light Signals

Previously this territory was protected by automatic block signaling including two-position lower-quadrant semaphore signals. When installing the C.T.C., these old semaphores were removed, new searchlight signals being installed at the controlled siding switches, and color-light signals for intermediates.

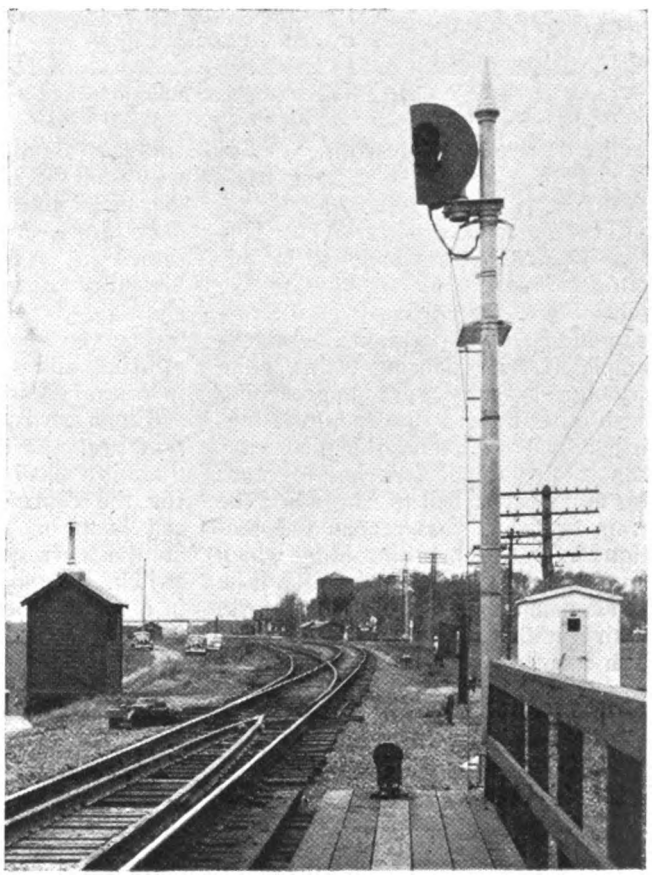
Following Burlington standards, the top signal unit on all high signals govern main-line straight-away train movements. Such a signal displays red for Stop, and either yellow or green for a Proceed aspect, depending on occupancy of the two blocks ahead. The second unit is 5 ft., centers below the top one. This second unit, when used, governs for diverging main-line routes other than to passing sidings. The third unit, 7 ft. 9-in. centers below the second unit, is for directing trains to enter sidings. For example, such a third unit displays yellow, under red in the top unit, as the Restricting aspect to direct a train to enter a siding. A dwarf signal is used to display the Clear Restricting aspect to direct trains to leave a siding and enter the main track. It displays yellow if the first block is unoccupied, or green if two or more blocks are unoccupied. The standard rules and indications applying to these signals are given in the accompanying chart.

The switch at the east end of the siding at Oregon is just beyond the end of the Rock River bridge. In order to locate the westbound station-entering signal so it could be seen by the engineman of a westbound train passing through the bridge, this signal had to be located so close to the track that part of the standard circular background, on the top unit, was cut off to conform with standard clearance requirement. As shown in the accompanying picture, this searchlight signal mechanism is mounted on a special angle-iron bracket to the left of the mast, this being done to place the signal lamp to the left as far as practicable, and, at the same time, place the mast and ladder to the right beyond clearance limits. On account of space restrictions, a dwarf signal, rather than a unit in the third position on the mast, is used at this location, to direct trains to enter the siding.

The C.T.C. Control Machine

The C.T.C. control machine in the dispatcher's office at Aurora has the Burlington's standard panel arrangement. A diagram across the top of the panel shows the track arrangement and car capacities of the sidings, as well as other information for the dispatcher. Above the symbol for each field station there is an opal lamp which is lighted during the time the corresponding field station is coding. This information aids the maintainer in checking that the stations are indicating properly. Below these opal lamps is the conventional illuminated track and signal diagram which includes lamps to repeat track occupancy of all sections of main track: (1) between stations; (2) the OS sections at switches; and (3) the main track through stations, thus providing continuous indication except for the sidings. In each of the symbols representing a siding, there is a hole in which a token can be placed by the dispatcher to remind him of the identification and location of a train using the siding.

Below the illuminated diagram is a row of small toggle switches, one



Signal at east end of Oregon has a special mounting so it can be seen by enginemen when coming through the bridge span

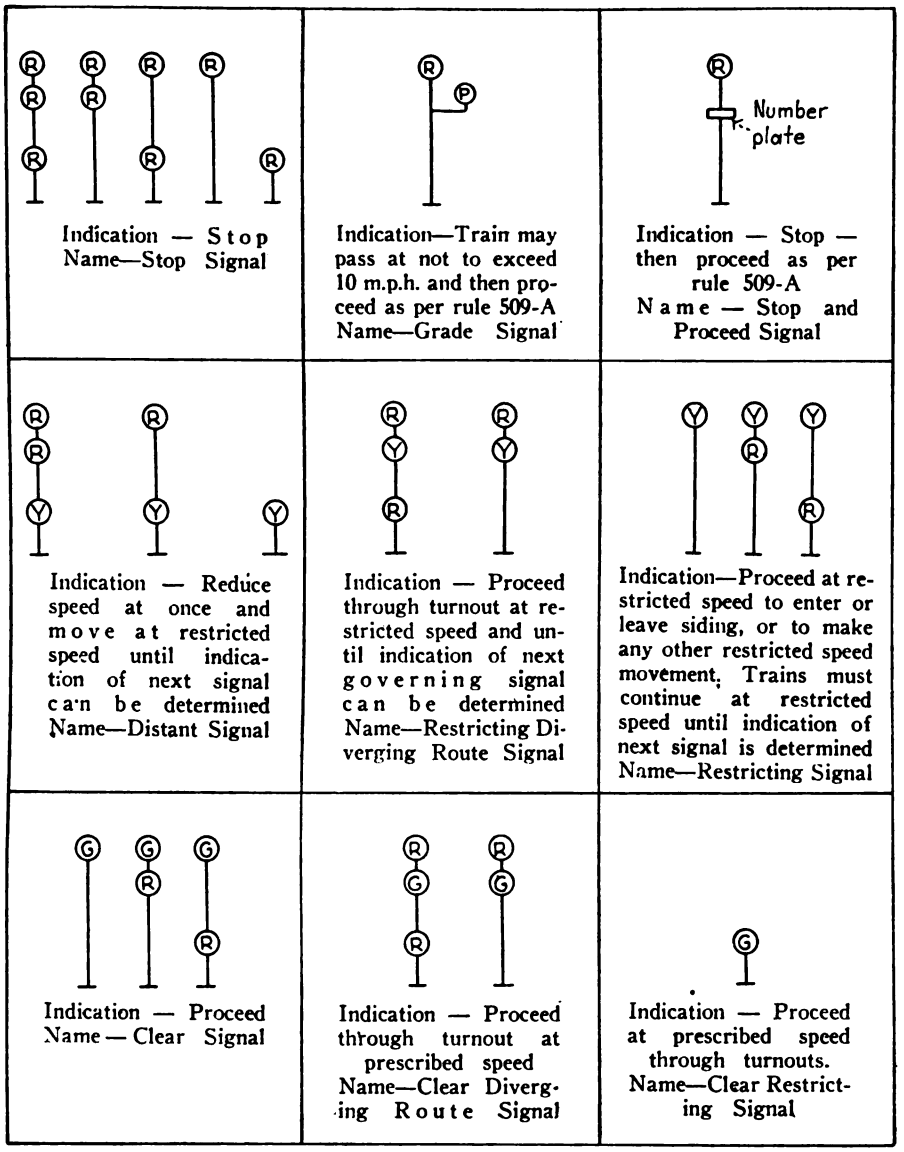


Chart of signal aspects, indications and names

under the symbol representing the OS section at each of the passing track switches.

These toggle switches are used by the dispatcher to cut in or cut out his annunciator bell as applying to the incoming OS indication from the corresponding field location. For example, if two opposing trains, quite widely separated, are approaching each other but it is too soon to establish a meeting point, the dispatcher can set his toggle switches to cause his annunciator bell to ring when the train or trains pass certain OS sections in approach to the siding which he plans to use for the meet. Thus he can devote his attention to other work, with confidence that the bell will call him in plenty of time to set up the signals for the meet as planned; or, if one of the trains does not make as good progress as expected, the meet can be arranged on close time at some other siding. Experience has proved that this Burlington practice of providing the individual toggle control for the annunciator, in connection with each OS section, is a help to the dispatcher in that he can arrange for close meets between trains, and at the same time, he does not have to devote his entire attention to the C.T.C. machine.

The levers for controlling the switches and signals, as well as the indication lamps above these levers, are in accordance with conventional practices. Below each signal lever there is a small toggle switch which is for the control of the maintainer's call lamp on the instrument house at the corresponding passing-track switch. The code-starting buttons are in a row at the bottom of the panel.

Time-Locking Lamps

If the dispatcher clears a signal and then takes it away by lever control, the switch at the field station cannot be operated or a signal cleared until the expiration of a predetermined time interval which is measured automatically by a KB time-element relay. In order that the dispatcher may know when this time has expired, a row of amber lamps is provided below the starting buttons on the dispatcher's control machine. Each lamp corresponds to a respective field station. Each of these lamps is lighted during the time that electric-time locking is in effect at the corresponding power switch location. In addition, the lamp would be lighted, and continue to stay lighted, if the a.c. power fails at that field station.

Graphic Train Chart

In the top of the desk portion of the control machine, there is a graphic train recorder with pens which indicate not only the passing of trains at certain field locations, but also record the clearing of signals. Corresponding to each passing-track switch location, there are two pens. One is operated when a signal at the corresponding location is cleared, and the second pen is operated when the OS section is occupied. Thus the record on the chart shows how long the signal was cleared before the train arrived. The lack of a continuous "signal clear" record, with an OS track-occupancy recorded, shows that the train has passed a red signal. A very short "signal-clear" record shows that the man in charge of the machine is not lining up the signal in time for the train to get a green instead of a yellow at the distant signal.

Local Automatic Controls

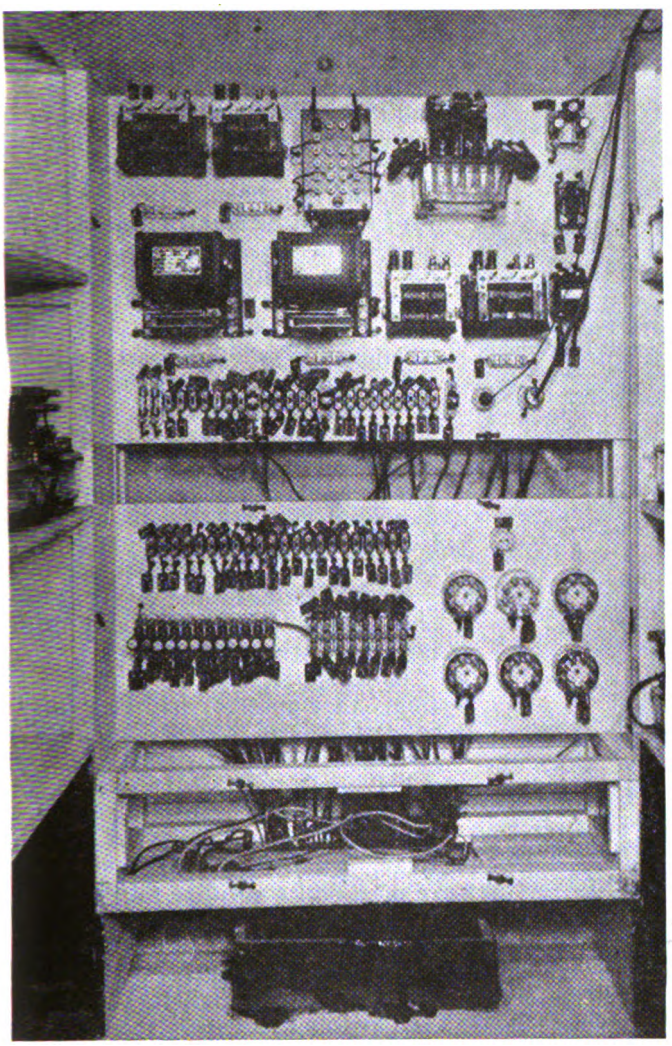
The previous automatic block signaling included d.c. neutral track circuits, and these were retained in service, although they were rearranged as required when the intermediate signals were relocated. The local signal line circuits are the either-direction type, in which two line wires, through a station-to-station block, serve to control either the eastward signals or the westward signals, depending on the direction established by C.T.C. control. An important feature of this two-wire either-direction circuit, as used on the Burlington, is that when in the dormant condition, battery is connected to the line at both ends. Therefore, code is required to be sent to only one field station to clear a signal. For example, if the eastward signals are to be cleared, one code control is sent from the office to the field station at the signal to be cleared, which in this case, is at the west end of the station-to-station block. Another feature of these circuits is that, at the intermediate double locations, the line circuits extend through back contacts of the HR and SR relays for

the opposing direction of operation.

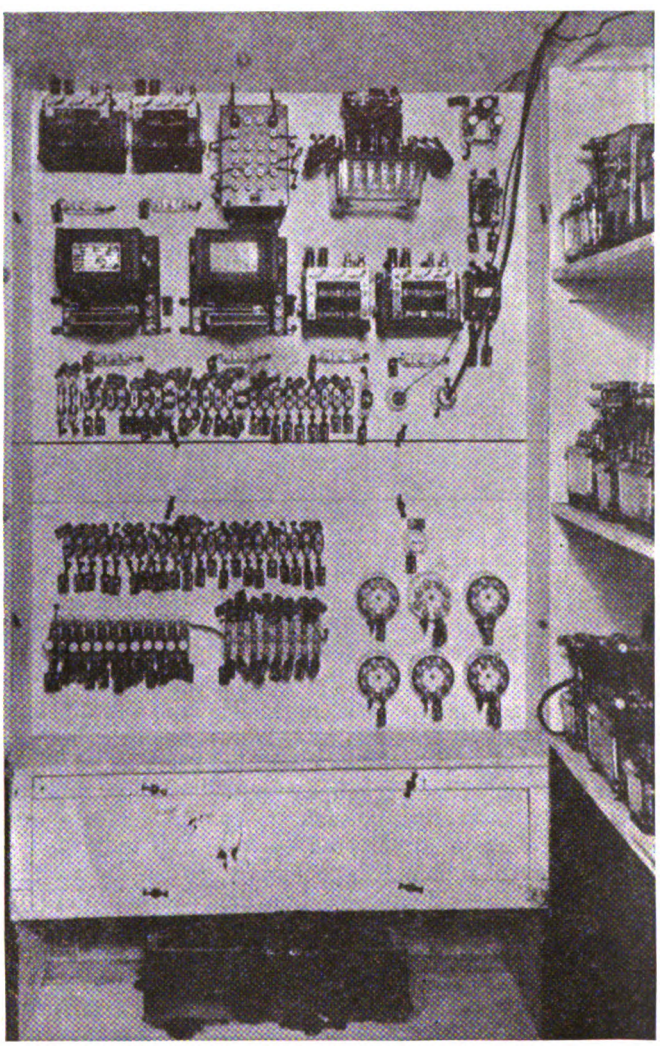
At the intermediate automatic signals, the selection to display the yellow or green aspect is accomplished by the use of a neutral and biased-neutral line relay rather than by the conventional past practice of using a polar line relay. The neutral relay is the HR relay which is so connected to the full-wave rectifier that the current flows in the same direction through the coils of the relay for either polarity of the line wire circuit. The biased-neutral relay DR has two coils and a permanent magnet, so arranged that if the electro-magnet force in the coils is of the polarity to aid that of the permanent magnet, the relay will not pick up. But if the polarity of the line circuit is reversed, so that the electro-magnetic forces oppose that of the permanent magnet, the relay will pick up. With only the HR relay picked up, the yellow aspect is displayed, the biased-neutral relay then can be furnished as polar contacts in a polar relay.

The controls for the electric switch locks on the hand-operated switches is carried on the two wires of the line control for the signals. The controls of these electric switch locks are as explained in my article on page 439 of the July, 1945 issue of *Railway Signaling,* excepting a later feature has been incorporated which is a check to be sure the door of the case of the lock is closed. If the train crew leaves without closing the door of the case, the track-occupancy lamp for the short track circuit will continue to be lighted. When such a condition happens, the dispatcher must call some one to go to the switch and close the door, and this also gives him a check on the crew that failed to operate correctly.

The C.T.C. line coding equipment is the General Railway Signal Company's Type K Class M using two line wires from Flag Center to Savanna, which is an extension of the two wires previously installed between Aurora and Steward Junction. Thus the control of signals and the power switches as well as the return of indications from the field is accomplished by conventional d.c. code impulses on these two line wires. No carrier is used.



Panel in rear of instrument house with the boards removed for access to the wire space

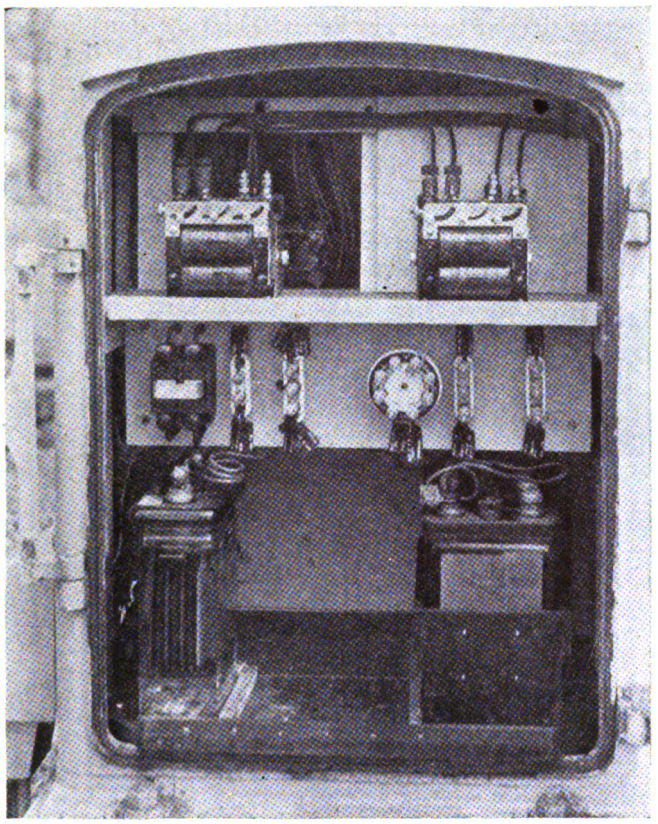


The same view of panel with board in place. Cables coming through floor are encased in box filled with sealing compound

Pole Line Wires

The line wires for the signaling system are on a crossarm on the same pole line with the telegraph and telephone wires. The two C.T.C. code wires are No. 6 AWG 40 per cent Copperweld with 3/64-in. Neoprene insulation. The tie wires which are 23 in. long, are No. 9 AWG, soft Copperweld with 2/64-in. Neoprene insulation. The line wires for the local signal line control circuits are the same wires that were used for this purpose in the previous automatic block signaling. The two wires for the 220-volt a.c. power distribution are No. 6 copper with tape and braid weatherproof covering. Commercial power at 220 volts a.c. is purchased at several towns, and is fed in both directions from each such town to include all signal, switch and track feed locations. At these locations the a.c. feeds through transformers and rectifiers to

charge storage batteries. Each track circuit is fed by one cell of 80-a.h. storage battery. At each power switch location there is a set of 12 cells storage battery which feeds the switch machine and the line code equipment.



Case containing a track battery and battery for an electric lock and circuits at hand-throw switch

At each intermediate signal location there is a set of 5 cells of battery. All this storage battery is the 9-plate chloride accumulator type, rated at 80 a.h.

The signal lamps are normally lighted through transformers from the a.c. supply. If the a.c. fails, the power-off relay cuts the lamps over to feed from battery but in such an instance, the lamps are lighted on approach control rather than constantly.

At each power switch location the relays, code equipment and storage batteries are in a 6-ft. by 9-ft. concrete house. From the factory these houses are shipped to our signal shop at Aurora where the shelves, wiring and apparatus is installed complete. Then the houses are shipped out to their respective final locations and set in place by a power crane in a work train. Then the outside wires or cables were brought into the houses and connected.

Placed in Service in Sections

As the power switches and signaling at the ends of a siding were completed, this layout under control by the dispatcher was placed in service as a remote control interlocking. With the timetable and train orders being continued for authorizing train movements, the dispatcher used the corresponding levers to control the switch and the signals at a given end of siding just as at any ordinary remotely-controlled interlocking. This practice was continued until reaching a station at which operators were on duty 24 hr., so that train orders could be issued for the territory beyond to the west. Then the section from there back to Flag Center was bulletined in service as centralized traffic control, the only difference being that the train movements were then authorized by the indications of the signals rather than by timetable and train orders. Thus the C.T.C. between Flag Center and Savanna was bulletined in service in three sections. One advantage of this procedure is that the dispatchers and the enginemen had an opportunity to become acquainted with the new signaling gradually. Another advantage is that the signal forces can check and place in final service each of the siding switch layouts as a single unit, rather than being required to change over a great many such units at a predetermined time.

This C.T.C. was engineered and constructed by the signal department forces of the Burlington, the major items of equipment, such as power switch machines, and control machine, being furnished by the General Railway Signal Company.

False Clear Signal

(*Continued from page* 488)

roneously thought that this condition was the result of their having made incorrect connections to the coil terminals of this relay, and they transposed the coil wire connections. After this change was made, the polar contacts were in normal position, and the control-panel indicated that the positions of the crossover switches were in correspondence with the position of the control lever, and the signalmen thought the north crossover switch also was in normal position. After completing further tests, the signalmen proceeded to the yard office at Champaign to test the interlocking machine. Before leaving the vicinity of the crossover, they did not examine the north crossover switch to determine whether this switch was in the position corresponding with the position of the control lever of the interlocking machine, and they did not look at the signal to determine if this signal was displaying a proper indication. The last test of the interlocking machine was conducted by the signalmen about five minutes prior to the time the accident occurred, and they observed no unusual condition.

In tests after the accident it was found that an error had been made in making the connections to the switch-control-lever repeating-relay. As a result of this condition, together with the transposing of the connections of the switch repeating-relay, the north crossover switch was in position for entry to the crossover when the lever in control of this switch was in normal position, and false proceed indications were displayed by the signals.

It is found that this accident was caused by a train entering a crossover at a high rate of speed, as a result of approach and home signals of an interlocking displaying false proceed indications.

By the Commission, Commissioner Patterson.