Longest Continuous Double-Track C.T.C Is on North Western

Trains expedited and delays reduced on 75-mi. with both tracks signaled for both directions and with crossover layouts, spaced approximatlely 6 mi. to faciliate run-around moves, thus keeping all trains moving at normal speed rather than some waiting on sidings

ON 75 mi. of heavy-traffic two-track territory between West Chicago, Ill., and Nelson, the Chicago North Western has installed centralized traffic control. Short sections of this territory have more than two tracks; also, this project includes 11 mi. of a separate single-track cut-off. Thus, a total of 86 road miles and 169 track miles of main track are included in the project.

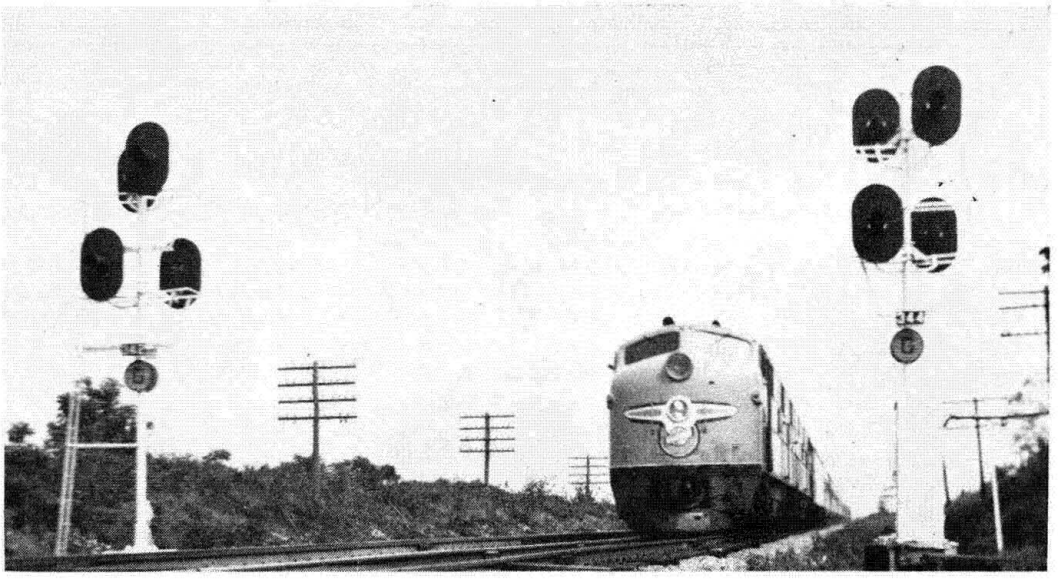
On the 75 mi., both main tracks are signaled for train movements in both directions, just the same as two single-tracks side by side. New high-speed crossover layouts are located an average of 6.4 mi. apart, and these crossovers, as well as siding switches, are operated by electric switch machines. These machines, and the governing signals at these locations for authorizing train movements, are all controlled by the dispatcher at Chicago. Indication lamps on the dispatcher's control machine show the locations of and progress being made by all trains. In the morning, when the preponderance of traffic is eastward toward Chicago, faster trains can be crossed over to the other track to run around slower ones, or slower trains can be crossed over to allow the faster ones to pass. In either instance, all trains are kept moving at normal speed, rather than delaying the slower trains on sidings. Similarly, in the evening, when the preponderance of traffic is westward, sections of both tracks are used by westward trains.

Character of Line

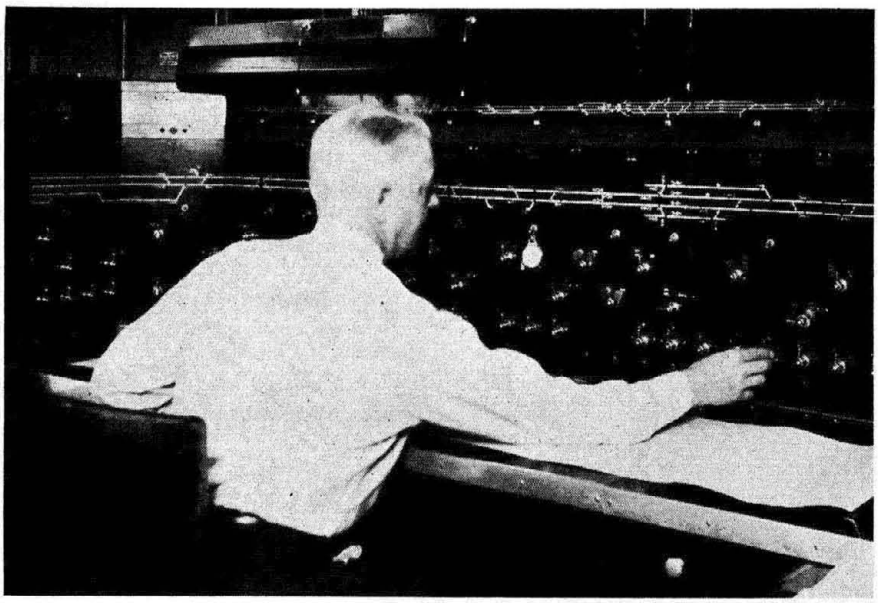
From the North Western passenger terminal in Chicago, there are three or more main tracks westward for 30 mi. to West Chicago, which is the beginning of the new C.T.C. territory. From West Chicago, there are two main tracks for 458 mi. westward to Omaha, Neb., where connections are made with North Western lines through Nebraska and Dakota and with the Union Pacific on through routes between Chicago and Denver, Salt Lake City, Portland, Seattle, San Francisco and Los Angeles.

Between West Chicago and Nelson, the railroad traverses prairie country with long rolling grades, except in the vicinity of river crossings where grades range from about 0.3 to 0.7 per cent for short distances. The curvature is light, most of the curves being 1 deg. or less, and the only speed restrictions due to curvature are on two curves at Dixon. On one of these curves of approximately 2-deg., the speed of passenger trains is restricted to 70 m.p.h., and freight trains to 50 m.p.h. On the 3-deg. curve, the limit is 50 m.p.h. for passenger trains and 45 m.p.h. for freights. The rail is 112 lb. throughout, and the track is well constructed and maintained for high train speeds.

Some of the reasons why the 75-mi. section between West Chicago and Nelson was equipped with C.T.C. first, are: (1) this section handles heavier traffic than any of the other two-track territories, and (2) this section is nearest to Chicago where C.T.C. would be most useful



This picture shows the typical intermediate approach signals for both directions, both tracks, with westward train running on left track, and its signal on mast at its left



Dispatcher at control machine in Chicago

in relieving congestion, both inbound in the morning and outbound in the evening. At Nelson, the west end of the new C.T.C. project, there is a junction with a C.&N.W. line diverging to the south to Peoria, Ill. and East St. Louis, Ill. Although no passenger trains are operated over this line, there is a heavy freight traffic which adds to the volume on the section east between Nelson and Proviso yard which is 16 mi. east of West Chicago.

Train Movements Bunched

The daily traffic between Nelson and West Chicago includes 22 passenger trains, and approximately 16 through freight trains, as well as a local freight train each way daily except Sunday. Also, 14 suburban passenger trains are operated daily between West Chicago and Geneva, 5.5 mi. The difficulties of train operation are increased due to trains being bunched. For example, eight of the 12 eastbound through passenger trains, in addition to five Geneva suburban trains, arrive at Chicago between 6:30 a.m. and 11:30 a.m. Eight of the 10 westbound through passenger trains, and three of the Geneva suburban trains depart from Chicago between 5:05 p.m. and 8:10 p.m.

Previously, when train movements were authorized by timetable and train order, and the siding switches were hand-thrown, difficulties were caused by dispatching westbound freight trains from Proviso yard during or just prior to the evening parade of westbound passenger trains. The results were that the freight trains lost a lot of time on sidings or were held in the yard during the period between 5:00 p.m. to 8:30 p.m. or later. Similarly in the morning, there was not much chance to move eastbound freight trains during the parade of eastbound passenger trains. As a result, the freight trains lost a lot of time waiting on sidings. The solution was to install the C.T.C., so that both tracks could be used either westward or eastward to handle the preponderance of traffic.

Train Time Saved

One important benefit of the C.T.C. is the ability to start trains out of the yard westward, or out of Nelson and Nachusa eastward, when they are ready, without waiting, as was previously the case, for passenger trains to go. By means of the illuminated track diagram on his control machine, the dispatcher can see the locations of and progress being made by all trains. Accordingly, he can control train movements on a minute-to-minute basis to make close meets and passes, with a result that all trains are kept moving at normal speeds a much greater percentage of time. In contrast, with the previous operation under time-table and train orders, a freight train might take siding to clear for a passenger train, which might be running late but the dispatcher had no practical means of getting train orders to the freight to advance it further ahead of the passenger.

By Signal Indication

With the C.T.C., including power switch machines and signals controlled by the dispatcher to authorize movements, the engine and train crews have no concern about other trains, but rather, the engineer moves his train in accordance with signal aspects displayed at the time and place where he is to take action in each instance. Also an added advantage in this Chicago & North Western project is that both tracks are signaled for both directions so that, nine times out of ten, meets, as well as passes, are made by keeping both trains moving on main tracks, rather than incurring even a short delay for one of the trains to use a siding.

As a typical example of operation, an eastward freight train, No. 254, stopped on track No. 2 at Malta, to set out stock cars. In order to avoid a delay for a following eastward freight train, No. 256, it was crossed over to track No. 1 at Creston to run around No. 254 and then return to track No. 2 at Cortland. This move was completed just in time to clear the westward signal on track No. 1 at Cortland for a westward freight approaching on that track. The run-around move for No. 256 saved 30

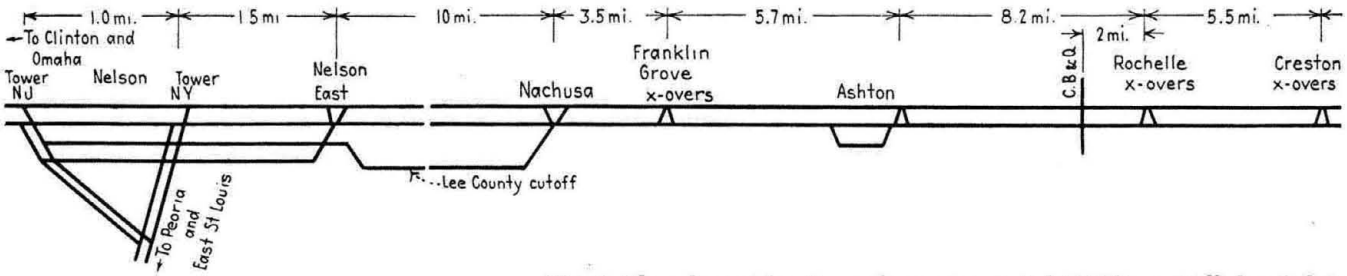
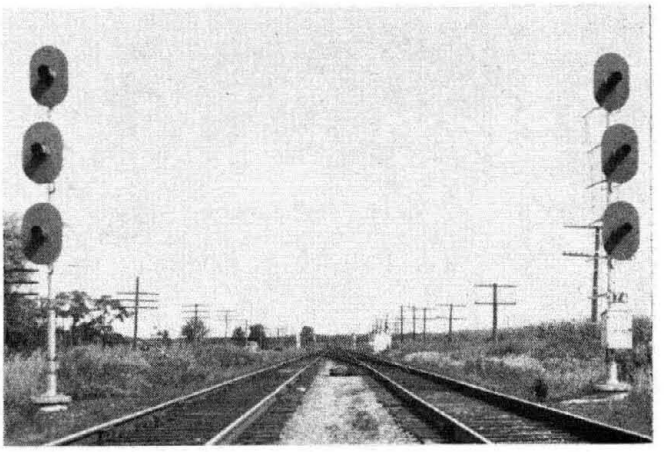


Fig. 1—Plan showng locations of power-operated C.T.C. controlled switches,

to 45 min. for this train, and permitted it to go to Proviso yard ahead of a passenger train.

A westward merchandise freight train No. 381 for the line to East St. Louis is due out of Proviso yard at 10:00 a.m. Westward freight, No. 251, for the west coast, usually in three sections, is due out of Proviso yard at 11:00 a.m. Westward passenger train No. 1 is due out of Chicago at 12:01 p.m. noon. Previously with time tables and train orders, difficulties were encountered in getting the freight trains, No. 381 and No. 251 out of the yard and over a section of line and into sidings to clear for No. 1. With the C.T.C., as for example on February 28, the freights departed from the yard when they were ready, and were kept moving. The passenger train No. 1 was about 30 min. late. Freight No. 381 made such good time that it went all the way to Nelson, and off on the line to East St. Louis before No. 1 passed Nelson. Also "on the board", during this period, were two eastward freights and an eastward passenger train, none of which were stopped, and the eastward freight went right on into Proviso yard ahead of the following passenger, whereas under the previous time-table and train-order operation, it would have taken siding at some place, such as Rochelle, and lost at least 45 min. to 1 hr.



The eastward home signals at Geneva crossovers. Signal at left governs on the track to the left hand

Trains Moved In Fleets

The present signaling for both directions on both tracks permits the movement of trains in fleets using both tracks in one direction or the other. An important advantage is that several following freight trains can be kept moving westward on track No. 1, for example, while a similar parade of passenger trains can be routed westward on the other track. For instance, a fleet of westward passenger trains are scheduled out of Chicago in the evening at 7:15, 7:30, 8:00, 8:10 and 9:00 p.m. No through passenger trains are scheduled eastward to arrive in Chicago during this period.

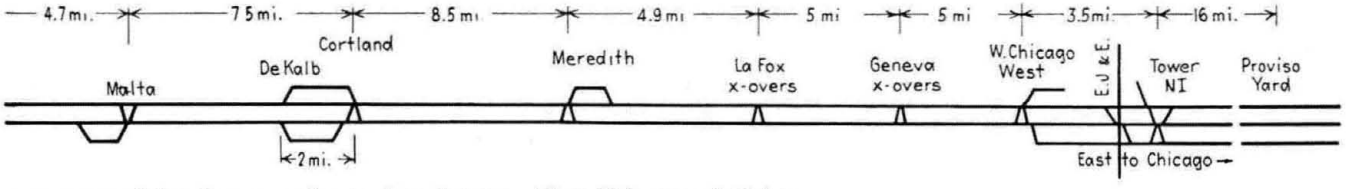
Another important advantage of the signaling for both directions on both tracks is that if a freight train is stopped on account of a hot box, other following trains can be routed around, with very little or no delay. Whereas, with the previous single-direction operation on each track, with time table and train orders, if a train stopped on account of a hot box, the following trains were seriously delayed because crossovers were not available at the proper locations to cross trains over readily, train orders could not be issued quickly enough to authorize reverse running, and wayside as well as cab signaling was not arranged for reverse running. Therefore, reverse operation was used only in case of serious circumstances.

Previously, with time-table and train order operation, there was no ready means of determining the progress of a freight train if it took siding for some period unknown to the dispatcher. Now, from his illuminated track diagram, the dispatcher knows at a glance the average speed a train is making and can quickly see whether an engineman is moving promptly when a signal is displayed to proceed. Previously, eastward freight trains lost time when waiting on the Lee County cut-off at Nachusa, thus giving the train crews time to buy eggs at a country store. Now, trains seldom stop at Nachusa, and, as a result, the storekeeper has complained that he has lost a market for about 90 doz. each week.

As mentioned previously, the project includes new crossover layouts at various locations which are spaced an average of 6.4 mi. apart. Each of these universal layouts includes two crossovers—one faced each way—so that trains in either direction can be crossed over from either main track to the other. These crossovers were installed new with No. 20 turnouts, so that diverging moves can be made safely at speeds up to 40 m.p.h., thus minimizing the time lost for a train when crossing over.

The east end of the C.T.C. is at NI interlocking M.P. 29.5, at West Chicago. Between NI and West Chicago West, about 2.5 mi., a previous siding was converted to a main track, and all three tracks were signaled for train movements in both directions, so that now West Chicago West is the west end of the three-track territory. The new layout at West Chicago West includes power switches for: (1) the end of the third track, (2) for the yard lead to the north, and (3) for the two No. 20 crossovers between the two main tracks.

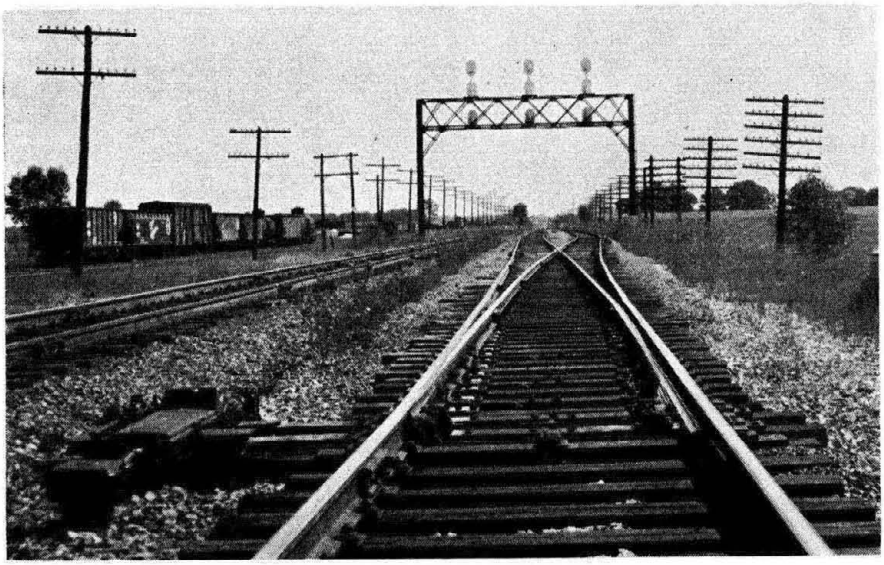
The extreme west end of C.T.C. operation is at a remotely-control-



crossovers and junction on entire territory between West Chicago and Nelson

led interlocking, NJ, at mile post 105. This interlocking includes turnouts and crossovers for wye connections and for connecting two main tracks to four main tracks. The NJ layout is remotely controlled from an interlocking, NY, at Nelson. In the 1 mi. between NJ and NY, three tracks are signaled both directions and one track eastward only.

The NY interlocking at Nelson includes crossovers and turnouts connecting four tracks to the wye



Power switch at equilateral turnout at West Chicago West

leading to the line to Peoria. The four tracks between Nelson and Nelson East are signaled both directions. No interlocking was previously in service at Nelson East. The improvements at this location included the installation of three No. 20 crossovers and a No. 20 turnout. The power switch machines at these switches, together with the signals, constitute the most westerly layout under the direct control of the dispatcher.

A single-track, low-grade cut-off extends 10.6 mi. eastward between Nelson East and Nachusa, at M.P. 93. A previously existing mechanical interlocking at Nachusa included one No. 14 crossover and a No. 14 junction turnout. The improvement program included the installation of a new No. 20 junction turnout and two new No. 20 crossovers. The old interlocking was removed, the five new switch machines and all new high signals for train movements in both directions on all tracks now constitutes one of the C.T.C. layouts controlled by the dispatcher.

Thus, as explained above, the locations of new universal crossover layouts at West Chicago West, at Nelson East, and at Nachusa were determined because of junctions, etc., at those locations. When locating the remaining nine new universal crossover layouts, consideration was given to several factors: (1) Other circumstances being equal, to space the layouts as nearly as practicable, on an equal time-distance basis; (2) to place a new crossover layout at one end or the other of an existing siding, if such a sidng was one that was to be equipped with power switches; (3) to find locations away from towns so that if trains were stopped and held for a few minutes, they would block a minimum number of grade crossings with streets or highways; and (4) to give preference to locations at the bottom of short grades from one or both directions so that, if a train is required to stop and wait just short of such a location, the grade would be favorable for the train to start.

Local conditions were such that new universal crossover layouts were located at one end or the other of existing sidings to be equipped for C.T.C. at Meredith West, Cortland, Malta East and Ashton East. Additional new universal crossovers were located out in the country at Geneva, La Fox, Creston, Rochelle and Franklin Grove. The siding switches and crossovers are all power operated, and these switch machines and signals are controlled by the dispatcher. As a part of the project, an electric lock was installed on each of the hand-throw switch stands at main-track switches leading to house tracks and industrial spurs, a total of 83 such locks being installed.

This project includes two crossings with other railroads—with the E. J. & E. at West Chicago, and with the Burlington, at Rochelle. Each of these crossings is protected by a manually-controlled interlocking. North Western signals at these plants are cleared under the direction of the North Western dispatcher and, then, only in the direction established by the C.T.C. system.

Signal Changes

This double-track line of the North Western has been equipped for many years with a complete system of automatic train control including speed control and cab signaling, the wayside controls being for one direction only on each track. With this system, there were no wayside signals except home and apporach signals at interlockings. The new system includes high home signals and approach signals for train movements in both directions on both tracks, these signals being installed not only at the NI interlocking at West Chicago and NY and NJ at Nelson, but also at the 15 crossovers, end-of-siding and junction layouts in the C.T.C. system controlled by the dispatcher. Also, the project included changes and additions as required on the wayside to control the train control and cab signaling on the locomotives for operation in both directions on both tracks in accordance with the direction established by the C.T.C. system.

The wayside signals are the searchlight type. Where three or four tracks are involved, such as at West Chicago West, DeKalb and Nelson, signal bridges were installed on which the signals were mounted. However, as applying to two tracks, the signals are on masts at the side of the tracks, as shown in typical pictures herewith. In each instance, the signal is immediately adjacent to the track which it governs. When a train is running on the right-hand track, its signal is at the right of the track when a train is running on the left-hand track, its signal is to the left of that track.

In each layout, the home signals in approach to the facing-point switch of the nearest crossover is located 50 ft. from such facing points so that this 50 ft. will allow for two car trucks, to hold track circuit shunts until the last car is clear of the switch when moving out of the plant. Each home signal has three "arms," each consisting of a searchlight signal head, which are mounted in a vertical row. Standard A.A.R. aspects are used. A green in the top "arm" is for a high-speed straight through route. Red-over-yellow-over-red or red-over-green-over-red is for a diverging move. Red-over-red-over-yellow is for a slow-speed move, and can be used as a call-on aspect independent of track-circuit control outside interlocking limits, to permit one train to follow another into the block. In this respect, this aspect corresponds with the most restrictive aspect of the cab signaling.

Each approach signal has two "arms," each consisting of a search-

light signal head. The top head is to the right of the mast, and the lower one to the left, this staggered effect being used to designate it as a permissive signal, in contrast with an absolute home signal. Each of these permissive intermediate signals has a marker which authorizes a train to pass such a signal, when displaying its most restrictive aspect, at not exceeding train control maximum low speed, in accordance with the most restrictive aspect of the cab signal.

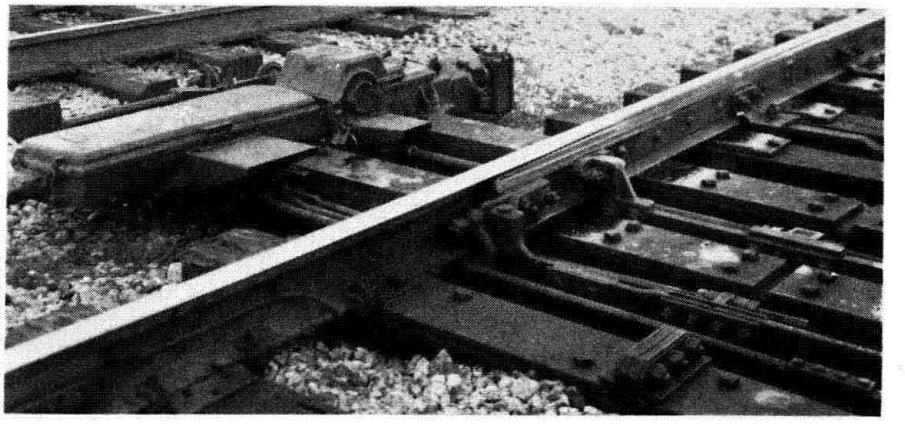
When a No. 20 crossover is reversed for a diverging move, and the home signal governing the move is cleared, the corresponding approach signal displays a yellow-over-green aspect, which gives an engineman advance information that he is to bring his train up to and through the crossover at the speed for which it is designed. Thus, the use of the yellow-over-green aspect on the approach signals saves train time as compared with approach signals which display a single yellow under such circumstances, because the single yellow would require that the speed be reduced at once and then proceed prepared to stop at the home signal.

The same home signals that govern trains at the crossover layouts also authorize train movements by signal indications which take the place of time-table and train order authority as used previously in this territory. These signals, which are cleared by control from the dispatcher, change automatically to the Stop aspect as a train passes, and they will not again clear unless the dispatcher sends out another control, i.e., the signals are stick controlled. If a home signal has been cleared and is then "taken away" without having been accepted by a train, then time locking comes into effect automatically, to prevent operation of a switch or the clearing of an opposing signal until an adequate time interval has elapsed. Time is figured on the A.A.R. Signal Section recommended basic, taking into consideration required automatic train control stopping distance.

Pre-Condition Control

If a pre-condition control is sent out, calling for operation of a switch that is prevented from operating because electric locking is in effect, the pre-condition control will not take effect for approximately 5 sec. before the electric locking is released. This time delay prevents operation of a switch if the shunt of a track circuit is lost momentarily.

As previously stated, in order to save train time by permitting diverging moves at speeds up to 40 m.p.h., new crossovers with No. 20 turnouts, were installed throughout this project. Where the two main tracks are at 13-ft. centers, these crossovers are approximately 370 ft. long. The adjacent ends of the crossovers are 19 ft. 6 in. apart. At the west end of three-track at West Chicago West, track No. 1 and track No. 2 from the east join track No. 2 to the west by means of an equilateral turnout with a No. 20 frog. The authorized train speed over this equilateral turnout is 50 m.p.h.



The switch layouts are well constructed

The No. 20 turnouts include 30-ft. reinforced points, using undercut stock rail. Ramapo-Ajax vertical-pin Type-MF front rods and Type-M No. 1 rods are used on these switches. A ¾-in. insulated gage plate is located on the No. 0 tie. Stiles adjustable rail braces are used on this tie, as well as on the two machine ties. In order to minimize friction and binding, each set of switch points is equipped with a roller bearing made by the General Railway Signal Company. This roller bearing and mounting plate serves as one of the tie rods.

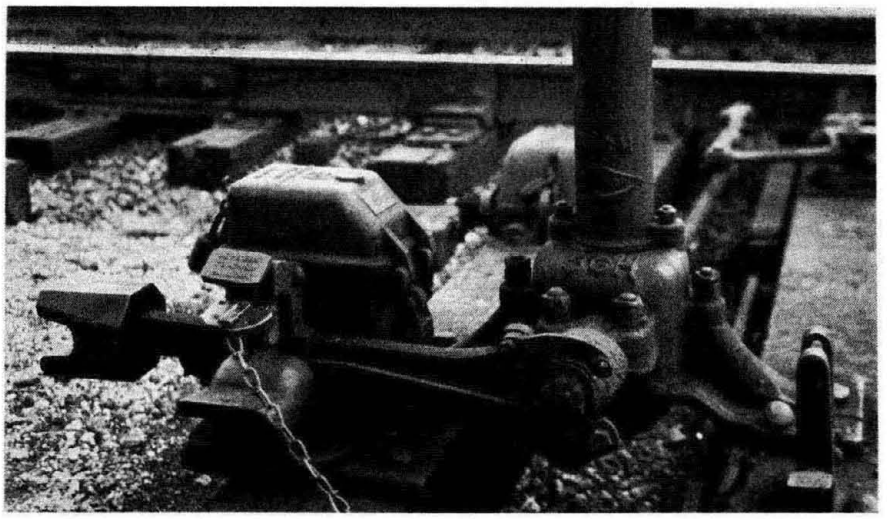
Direct current switch machines, Model 5D are used throughout this project. These machines are of the dual-control type which have a lever for manual operation during switching moves or during emergencies. With 24 volts at the motor, these machines will operate a switch in about 5 to 7 sec.

Track Circuits

The track circuits on this project are the conventional d.c. neutral type with 4-ohm relays. Although there are no wayside signals except home signals and approach signals, nevertheless, the wayside controls are cut into so-called blocks, and the local controls for these blocks are on two-wire line circuits which break through contacts of the track relays in a conventional manner. The so-called blocks begin and end at cut sections which are the places at which changes, if any, are made in the control of the train control and cab signaling. These locations coincide with approach signals where such signals enter into consideration. For the control of train control and cab signaling on the locomotives, 60-cycle a.c. energy is fed to the rails in the direction toward an on-coming locomotive. The feed of this a.c. is governed by the line control "block" circuits discussed above. Normally, when two or more "blocks" ahead are unoccupied, the a.c. energy in the rails controls the cab signal to display the proceed aspect—green, indicating proceed at not exceeding authorized time table speed. The maximum for streamliners is 93 m.p.h.; for steam passenger trains, 73 or 83 m.p.h., depending on class of locomotives; and freight trains 50 to 63 m.p.h., depending on locomotives. When no a.c. feeds in the track toward a locomotive, the cab signal displays the restrictive aspect which is red-over-yellow, this indicating proceed at not exceeding maximum low speed, which is 30 m.p.h. for streamliners; or 23 m.p.h. for freight trains or passenger trains hauled by steam locomotives.

Reversal of Train Movements at Geneva

Each morning, certain suburban passenger trains leave the yard at West Chicago to back westward on a main track to the Geneva passenger station where they take on passengers and start their run eastward to Chicago. As shown in Fig. 2, Geneva passenger station is 8,450



Hand - thrown main - track switches are equipped with electric locks as a part of the C. T. C. installation

ft. east of the home signals for GX crossovers, and there are no C.T.C. dispatcher - controlled signals at Geneva to authorize a train at that station to reverse its direction and proceed eastward. Furthermore, the block is too short to install such signals.

After considerable study, an arrangement was devised to accomplish the result desired. On the operator's desk at Geneva, there is a small panel with an indicating lamp and push button for track No. 1, and a lamp and push button for track No. 2. Also on the dispatcher's C.T.C. control panel, there is a special push button for each track at Geneva.

When a train, which has approached Geneva from the east is ready to reverse its direction and return eastward, the whole train must be standing on a track circuit west of the Third street crossing. The conductor informs the operator that his train is ready to move, the operator telephones the dispatcher for permission to make the move. If granted, the dispatcher pushes his button and the operator pushes his button for the track on which the train is standing. These actions start changes in control circuits to prevent the clearing of C.T.C. controlled signals to enter the WX-GX over-all block, and to reverse the directional controls on the track occupied by the train, so that train-control cab signal energy feeds westward from WX to the train at Geneva and, in so doing, checks that the track is unoccupied in that section. This change in controls is indicated by the lighting of the indicaton lamp on the operator's panel above the button for the track being used. Then the operator issues a train order to authorize the train to move from Geneva to WX, at which point the C.T.C. dispatcher controlled signals authorize its further progress.

Thus, this procedure provides for reversal of train movements at Geneva in the middle of an overall C.T.C. block extending from WX to GX.

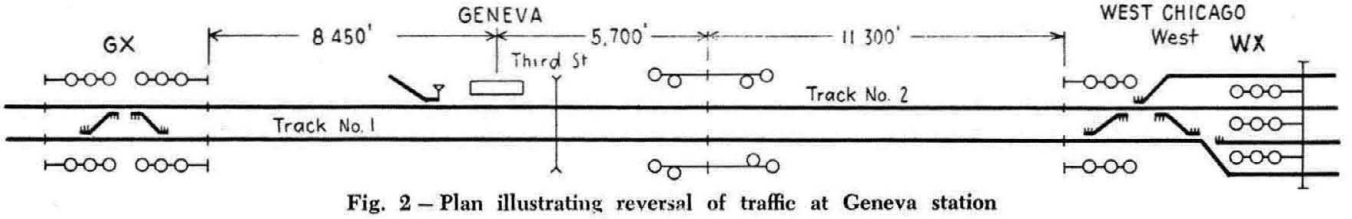


Fig. 2 — Plan illustrating reversal of traffic at Geneva station

In DeKalb there are hand-throw turnouts and crossovers which are used several hours daily by a switch crew when serving industries, freight houses, coal yards, etc. In order to permit this crew to continue their work as long as practicable prior to approach of through trains and still not delay the through trains, special signals known as hold-out signals and controlled by the dispatcher were installed west of the hand-throw switches, as shown in Fig. 3. When the switch crew is authorized to use the main tracks between bridges A and B, the signals on these bridges are held at Stop by the dispatcher. This accomplishes two results, it limits the area in which the switch engine can go, and in the meantime, an approaching eastward train, for example, can be directed to move at normal speed from Malta toward DeKalb. Being advised of the approach of a through train, the switch crew clears the main track, as is indicated on the dispatcher's machine, and he clears the holdout signal for the through train to pass on through DeKalb without stopping. If the special hold-out signals had not been provided, the switch engine would have been required to clear the main tracks at DeKalb before a train could be authorized to pro-

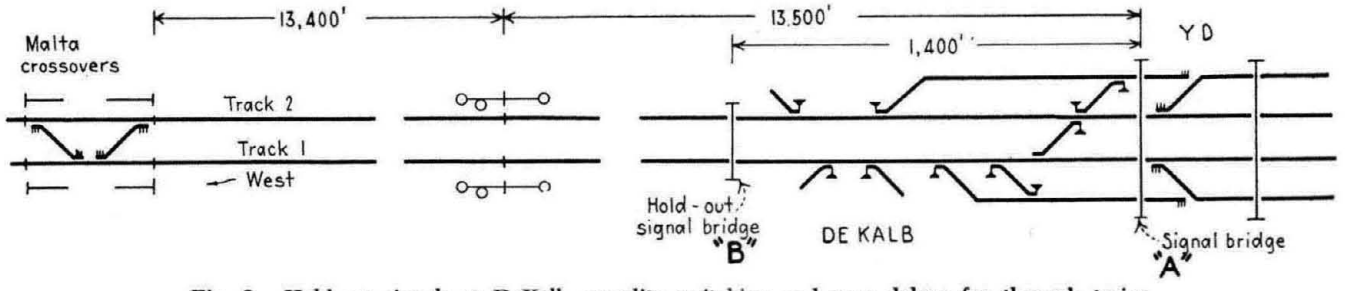


Fig. 3 — Hold-out signals at DeKalb expedite switching and save delays for through trains

ceed at normal speed from Malta East toward DeKalb. Under such conditions, the switch crew would have been tied up so much of the time that they could not get their work done, and service to shippers would have been hampered seriously.

Control of Electric Locks

The electric locks on hand-throw switches within home signals limits are lever controlled by the dispatcher. The electric locks on outlying hand-throw switches are automatically locked when the lever-controlled main-track signal is cleared to govern a train movement over the switch, and the locking is retained by track occupancy.

When a switch is to enter a spur, release of the electric lock is effected by occupancy of a short track circuit immediately in advance of the switch. When the front truck of the locomotive or leading car is within 75 ft. of the switch, this, in combination with other controls, releases the electric lock.

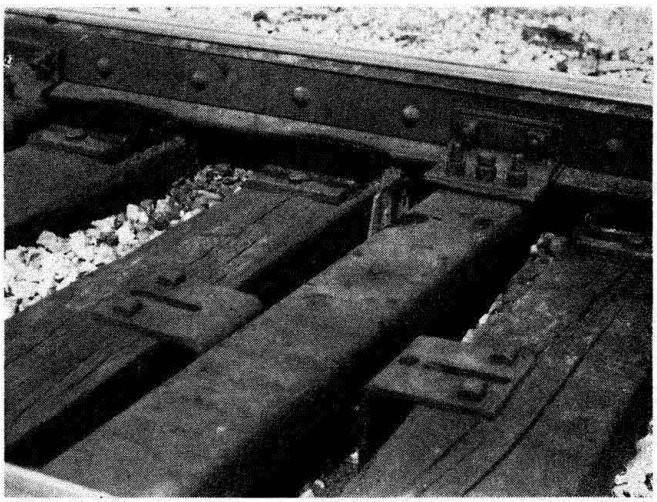
When a switch train on a spur is ready to depart, the conductor telephones the dispatcher for permission. After receiving permission the conductor or a trainman removes the padlock, and contacts are closed by the latch contact. If the main-track signals governing train moves toward the switch are at Stop and if no trains are occupying the intervening main track, the electric lock will be released.

Carrier on C.T.C. Code Line

The C.T.C. territory is cut into two separate areas—West Chicago to DeKalb, 26 mi.; and DeKalb to Nelson 45 mi. Each section includes eight field stations. The outgoing controls and incoming indications for the section between West Chicago and DeKalb are handled by conventional d.c. codes on a two-wire line circuit. These two wires, in this section, also handle carrier codes for outgoing controls and incoming indications for the DeKalb-Nelson section. For the DeKalb-Nelson territory coded carrier at 13.7 kc. goes out from the C.T.C office to DeKalb, where it is converted to conventional d.c. codes to be transmitted to the field stations between DeKalb and Nelson. From these field stations, conventional d.c. indication codes go east to DeKalb where they are converted to 17.3 kc. for transmission to the Chicago C.T.C. office. The conventional d.c. codes and the carrier codes are handled simultaneously over the same wires without interference with each other. This use of carrier permits controls to go out or indications to come in from different sections simultaneously, thus practically eliminating delay in transmission of codes.

In the 10 mi. from the dispatcher's office in Chicago out to River Forest, the C.T.C. code line circuit is on two wires in cable, most all of which is underground. These wires are No. 19 for 30,300 ft. and No. 14 for the remaining 23,200 ft. From River Forest to Nelson, 95 mi., this C.T.C. code circuit is on a pair of No. 8 weatherproof Copperweld open line wires. At the end of the cable at River Forest, there is a carrier repeater station, which commonly could be referred to as a booster station for the coded carrier to compensate for the loss in the 10 mi. of cable.

The carrier at the dispatcher's office, at the repeater station, and at DeKalb is in duplicate. If any of this equipment fails in service, the standby unit can be cut into service under control of the dispatcher. The carrier equipment was furnished by the General Railway Signal Company.



Each power switch is equipped with a roller bearing the roller being under the plate which serves also as a switch rod

Pole Line Construction

A previously existing signal department pole line was extensively reconstructed as a part of the C.T.C. project. Throughout most of the territory this pole line has two 10-pin arms. For carrier use, the two No. 8 C.T.C. line wires in the section between River Forest and DeKalb are transposed for 30 kc., and between DeKalb and Nelson for 3 kc. About 500 Hubbard point-type transposition brackets were used on this project.

The various two-wire local line circuits are No. 10 weatherproof Copperweld wires, an average of about eight such wires being in service. These signal block wires are used also to transmit a.c. energy to carry track-occupancy indication controls from blocks to the field stations where they are sent by C.T.C. code to the control office. The 440-volt a.c. power distribution circuit is on two No. 6 bare copper line wires. This line is fed locally in sections an average of 6 mi. long. The feeds are through automatic power boards. If the normal feed on a section fails, it is cut over automatically to be fed from the adjacent section.

Telephone Service

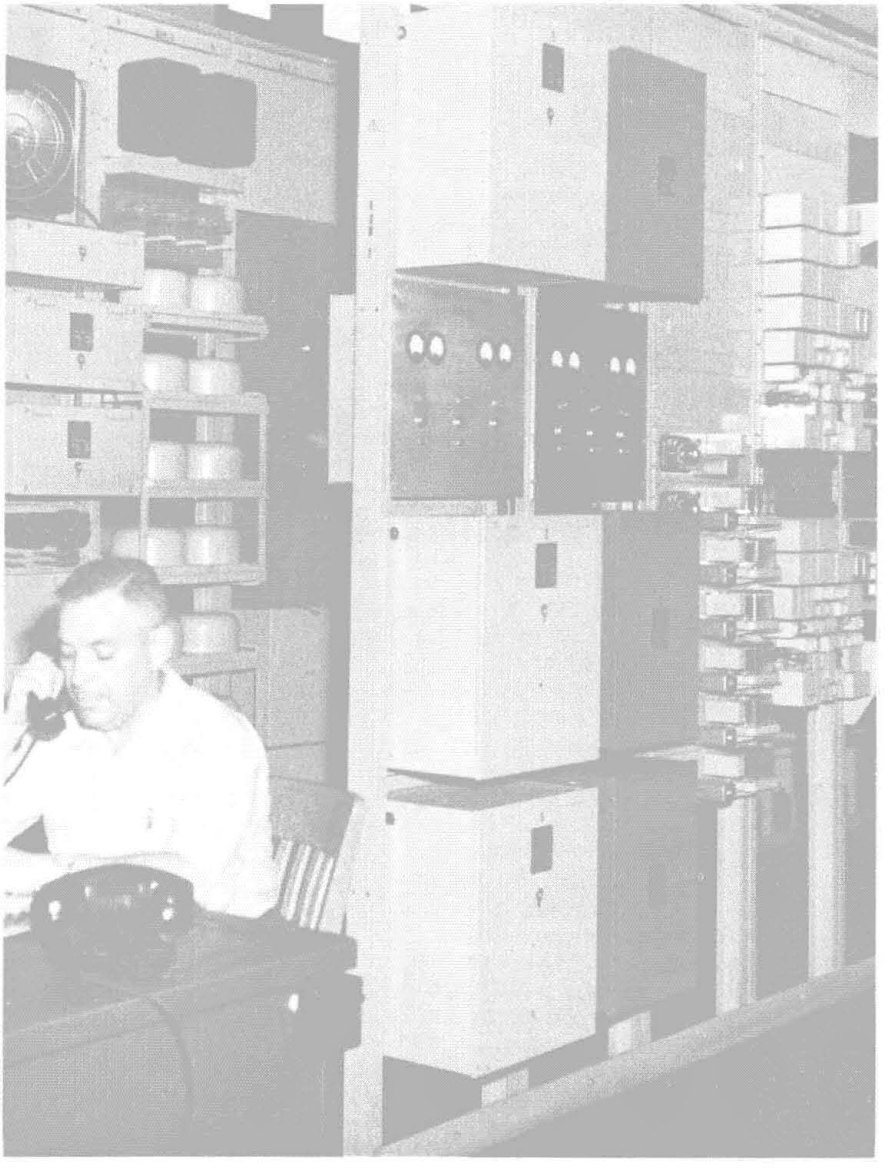
A pair of No. 9 bare copper wires is used for a telephone circuit, with phones at all home signals, motor-car set-offs and hand - throw switches, there being a total of approximately 220 phones on this circuit. At each instrument house, there is an employees' call light on the track side which is lighted when it is desired that any employee at that location call the dispatcher on the phone. The 220 telephones on this circuit are the hand-set type made by the Stromberg-Carlson Company.

Cables and Wiring

Dry-spot insulators are used at locations where connections are made from the C.T.C. code line wires to the line drops to the houses. These wires are No. 14, and twisted pair is used to minimize the capacity effect. Each wire of this twisted pair is connected to the two line wires (one in each direction) by means of a Kearney screw-clamp connector. The advantage is that the code line circuit can be opened to sectionalize the line, merely by opening the Kearney connector and pulling the two

(Continued on page 233)

answer-back equipment on which these Morse circuits terminate has been newly designed on a unit-panel basis for relay-rack mounting. This is a successful and much-improved departure from the older practice of mounting such equipment on repeater tables.



All d.c. power used in the office for energizing printers, selective-ringing equipment, telegraph circuits, etc. is furnished from rack-mounted rectifiers supplied by the Fansteel Metallurgical Corporation. Direct-current voltages of both polarities are made available in the usual ranges from 120-160 volts to 250-400 volts. Lower voltages for battery supply for local telegraph and telephone signal circuits are also available.

The installation of this new office in its entirety was under the general supervision of P. S. Hughel, superintendent communications, and G. L. Miller, assistant superintendent communications of the New York Central, in accordance with plans and specifications provided by H. N. Wasserman, telegraph and telephone engineer of the railroad. The actual installation work was performed under the direct supervision of C. E. Mulheran, installer foreman.

The jacks, jack-mountings, key-shelves, racks, etc., used in setting up the wire chief's switchboard and associated facilities were supplied by the Graybar Electric Company, as were all of the selective-ringing apparatus cases and impulse repeaters. The printer equipment was supplied by the Teletype Corporation, and the rack-mounted duplex equipment was furnished by the Electronic Communication Equipment Company.

C. & N.W. Signaling

(Continued from page 223)

wires out. The code line is protected by Raco Clearview type lightning arresters, and the other line circuits by Western Railroad Supply Co. No. 3 Premier arresters. The ground rods are ⅝-in. by 9-ft. Copperweld.

The underground cable from a typical instrument house to a switch machine includes a 3-conductor No. 6 and a 7-conductor No. 14. The cables to each signal include two No. 6 wires for the signal lamp feed, and other No. 14 cables as required in 4-conductor, 7-conductor or 12-conductor cables. The rail connections are single-conductor, No. 9 solid with no lead sheath or steel tape. The insulated wire and cable on this project was furnished by the Okonite Company.

At each power switch location, there is a set of 12 cells of 80-a.h. Exide DMG09 battery which feeds the switch motors. Two extra cells were added, dependent on number switches and distance from the battery. At each approach signal there is a set of 6 cells of 90-a.h. Exide battery to feed the line circuits and act as stand-by for signal lamps. With certain exceptions, the track circuits are each fed by one cell of 40-a.h. lead storage battery. Track circuits outside of interlocking limits are each fed by Edison primary battery. At the dispatcher's office, and also at the carrier housing in DeKalb, there is a set of 6 cells of 200-a.h. Exide battery which, when commercial a.c. power fails, feeds a converter to produce 110-volts 60-cycle a.c. to feed the carrier apparatus. The C.T.C. code line circuit is fed at Chicago by 55 cells of 9.2-a.h. Exide battery, and at DeKalb by 45 cells of the same type.

The railroad purchased eight Fairmont track motor cars, two International stake-body motor trucks, rated at 2½-3 ton, and a Ford station wagon, for transporting men and materials during construction. The centralized traffic control system is the General Railway Signal Company's Type K, Class M, and the principal items of signaling, including the control machine, were purchased from the General Railway Signal Company. The installation was made by railroad forces under the jurisdiction of S. E. Noble, assistant chief engineer communications and signals of the C.&N.W. System.