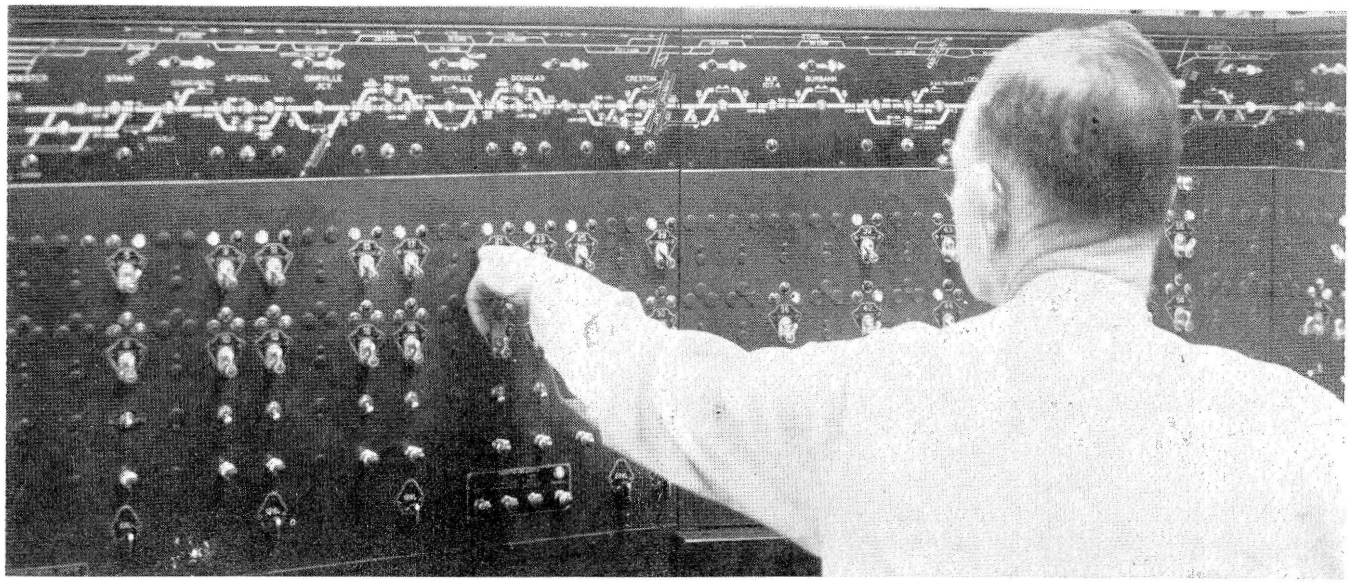


The control machine is located in the dispatcher's office at Brewster, Ohio

C. T. C. Installed on 128 Miles of N. K. P.

Project, increasing safety of and expediting heavy coal, ore and merchandise traffic on the W. & L. E. district, is extension of 53 mi. territory placed in service during 1946

REPLACING time-table and train-order operation, and as a means of increasing the safety of train movements and expediting the departure of trains out of yards, over the road and into their terminals, centralized traffic control has been installed on 128 mi. of single track of the Toledo division of the Wheeling & Lake Erie district of the New York, Chicago & St. Louis. The installation, which extends from Brewster, Ohio, in the Southeastern part of the state, northwest to Homestead, on the outskirts of Toledo, as shown in the accompanying map of the territory, Fig. 1, is a continuation of C.T.C. operation inaugurated in 1946 on 53 mi. of single track between Brewster and Adena. Train operation by signal indication is thus in effect on 181 mi. The control machine for the new territory is located adjacent to that for the Brewster-Adena section in the dispatcher's office at division headquarters in Brewster.

Between Brewster and Bellevue, 83 mi. west, the railroad follows generally rolling country with ascending grades and curvature ranging up to maximums of 1.3 per cent and 10 deg. 30 min., respectfully. From Bellevue to Homestead, the line traverses fairly flat and open terrain, with short ascending grades not exceeding 1.25 per cent and curves 6 deg. 45 min. In this territory between Brewster and Homestead, the W.&L.E. district crosses several other railroads at grade, including the Erie at Creston; the Akron, Canton & Youngstown, Spencer; Big Four at Wellington; New York Cen-

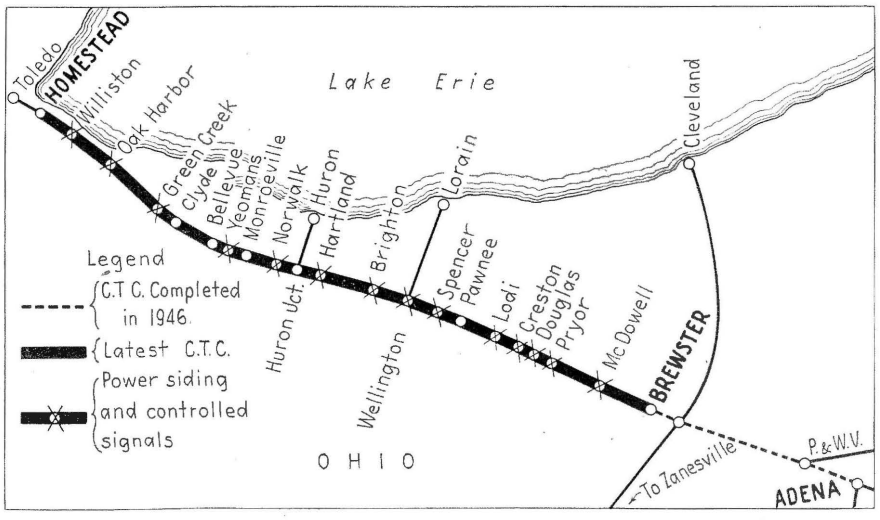


Fig. 1—Map of C.T.C. territory between Adena, Brewster and Homestead

tral and the Baltimore & Ohio, Monroeville; the Nickel Plate district of the N.Y.C. & St.L. and the Pennsylvania at Bellevue; and the Big Four again at Clyde. In addition, the subsidiary, Lorain & West Virginia railway, to Lorain, Ohio, on Lake Erie, leaves the main line near Wellington, and the Huron branch to Huron, also on Lake Erie, diverges at Huron Junction, about 2 mi. east of Norwalk.

No regularly-scheduled passenger trains are operated in the new territory—freight service only. Westbound traffic to Homestead consists primarily of coal from the southern Ohio mines, plus general merchandise, for delivery to other roads in Toledo; eastbound traffic out of Toledo consists primarily of general merchandise, in addition to empty hoppers being returned to the mines. Fast, through freight service in each direction daily between Toledo and Baltimore, Md., provided by the W. &L.E. district, in collaboration with the Pittsburgh & West Virginia, and the Western Maryland, is included in this traffic.

Traffic Density Varies

East of Bellevue, traffic is heavier, the main line being fed by additional trains to and from the Huron and Lorain branches. Traffic to these branches consists primarily of coal northbound to the Great Lakes and iron ore southbound for delivery to steel and other industries in the Canton (Ohio), Wheeling (W.Va.) and Pittsburgh (Pa.) and surrounding areas. The density of this traffic, of course, depends upon the season of open navigation on the Great Lakes. Accordingly, and under normal conditions, the number of trains daily in each direction between Brewster and Wellington averages around 44; between Wellington and Norwalk 42; and between Norwalk and Homestead about 16. The greatest density of traffic is thus concentrated between Wellington and Brewster, and must be kept moving to prevent congestion all along the line—one of the principal factors involved in the decision to install C.T.C.

Table of C.T.C. Power-Operated Passing Tracks Between Brewster, Ohio, and Toledo, Showing Car (50 ft.) Capacities

Location	Capacity-Cars
McDowell	120
Pryor	139
Douglas	142
Creston	127
Lodi	107
Spencer	79
Wellington	96
Brighton	140
Hartland	125
Norwalk	93
Yeomans	133
Green Creek	134
Oak Harbor	67
Williston	87

One Helper District

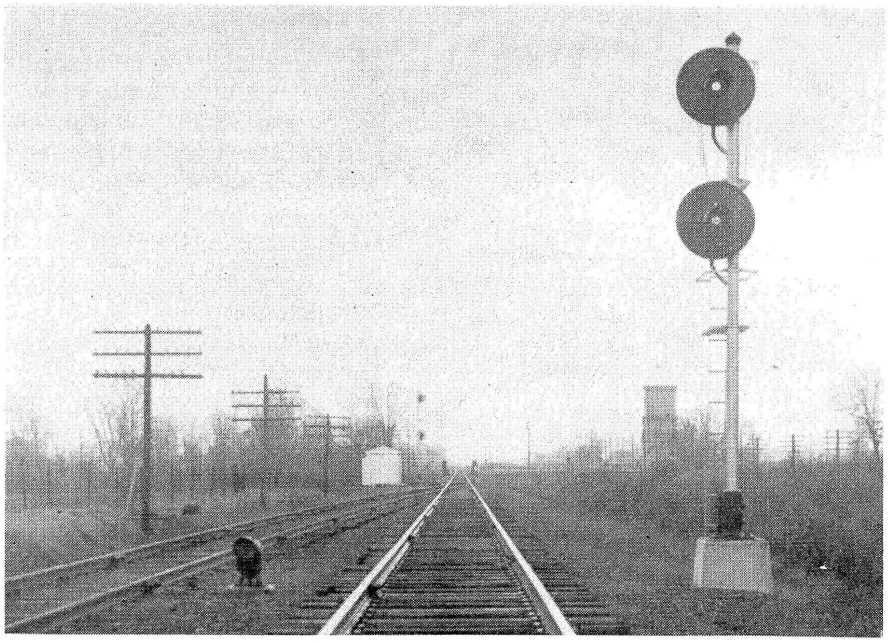
The majority of through freight trains are handled by Berkshire type steam locomotives. Eastbound out of Norwalk to Hartland, about 10 mi., there is a maximum ascending grade of 1.3 per cent. Berkshires will take trains up to 2,120 tons on this grade, helpers on the head end being used on trains in excess of that tonnage. This is the only helper district in the new C.T.C. territory.

C.T.C. Replaces Train Orders

Train movements between Brewster and Homestead were formerly governed by time table and train orders, passing tracks being located about every 4.5 mi. Under C.T.C. operation, however, trains are now directed to take and leave sidings by signal indication at 14 power-operated passing tracks spaced an average of about 7 mi. A total of 16 passing tracks were discontinued as such, but retained as storage tracks, and electric locks installed on the hand-throw switches. At four such locations, take-siding signals are in service to direct trains into the sidings. These passing tracks are not regularly used as such, but can be if necessary under extremely heavy traffic conditions.

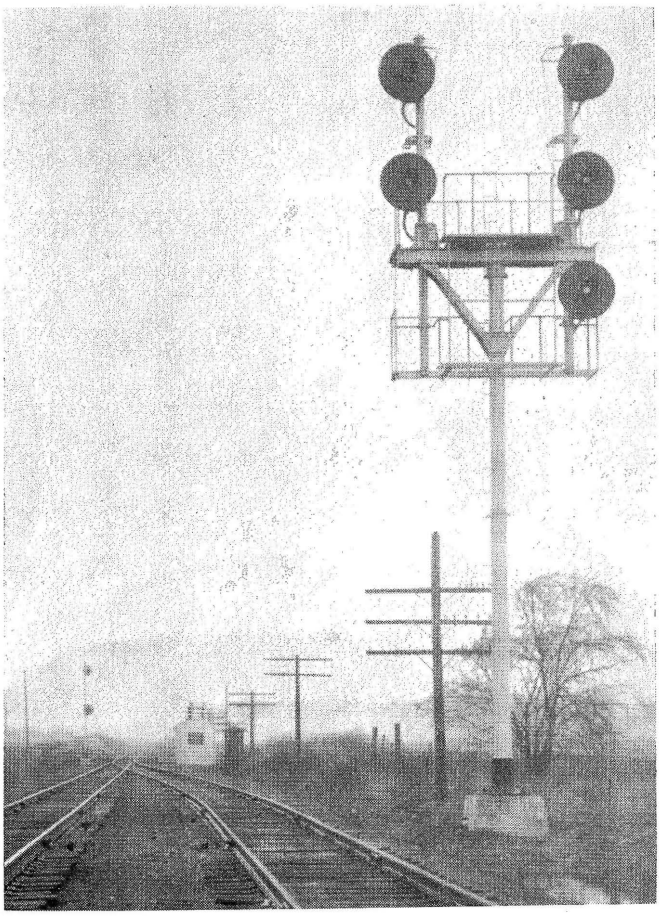
Trains were formerly operated on wait orders, often resulting in delays, especially if one was on a siding and something happened to the other it was to meet. This difficulty has now been overcome, and the dispatcher can keep his eye on the progress of all trains by watching the track model in front of him, thus enabling him to advance these trains and arrange meets on closer schedules than was heretofore possible under train-order operation. For example, a through freight train was proceeding west from Wellington to Huron Junction recently, when it was stopped at the former point because of a Big Four train on the crossing. An eastbound local train had been put in a siding between Wellington and Huron Junction to let the through train pass. Due to the through train being held at Wellington, it was possible to advance the local further than expected, which resulted in a 25-min. time saving to that train. Under train order operation, this probably would have been impossible, since there would not have been time to issue the necessary orders to change the meeting point of the trains involved.

The C.T.C. is saving train time



High and dwarf searchlight signals at the end of a power-operated passing track—main line at right and siding at left

and delay to switch crews in getting in and out of Brewster, Norwalk, Bellevue, Homestead and other yard limit areas, and a considerable amount of time is being saved in trains getting though sidings. In the case of the latter, whereas such movements formerly required about 20 min., they now take about 8—a saving of 12 min. For example, between Bellevue and Brewster, 83 mi., the C.T.C. is resulting in about a 15-min. saving on No. 90, a fast freight train between Toledo and the east. This time saving is being effected particularly at such points as Monroeville and Spencer. Train 85, is saving approximately 25 min. Other trains between Hartland and Brewster, about 64 mi., are saving about 20 min. in each direction.



Station - leaving signals on bracket mast at end of power siding — main line at the left and siding at right

Power Sidings and Signals

The power siding turnouts on this project are No. 18's with 30-ft. points with roller bearings, good for train speeds up to 30 m.p.h. for diverging and converging movements. The new power switch machines are the Style M 22A low-voltage d.c. dual-control type. Adjustable rail braces and 1-in. by 8-in. insulated gage plates are used on the first tie ahead of the points and the first two ties under the points. The ties under the layouts are protected against fire from snow melters between them during winter months by pieces of sheet metal which extend down the sides.

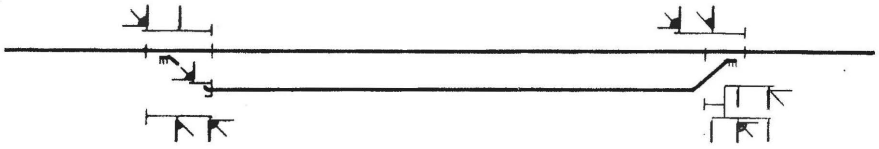


Fig. 2—Layout of tracks and signals at typical power siding

Each main-line hand-throw switch in C.T.C. territory is equipped with an electric switch lock, the control of which is by C.T.C. code from the control machine at Brewster. The majority of these locks are the Style SL6-A on high pedestals.

The new signals are the Style H-2 searchlight, a new feature of which includes the use of larger "hot-spot" lenses to improve close-up visibility of aspects. Deflecting prisms of 10, 20 and 30 deg. are used where required due to curves. As shown in Fig. 2, a typical power-siding layout, the station-entering signals are two-unit signals on three-unit height masts, with the center unit omitted, and display Standard Code aspects, Rules 281, 285, 290 and 292, for Clear, Approach, Restricting and Stop, respectively. The top unit of these signals governs train movements on the main track, and the bottom unit, train movements to the non-track-circuited sidings. Provision for the middle unit was made in the event the sidings are track circuited in the future, in which case the controlled signals would be capable of displaying the aspect under Rule 286, Medium Approach, when the passing siding is clear of trains, in addition to the foregoing aspects.

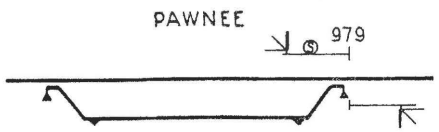


Fig. 3—Take-siding signal at Pawnee

The leave-station signals at the ends of power-operated sidings include a two-unit, three-aspect high signal to the right of the main line and a three-aspect dwarf signal for the siding, located between the siding and main track. These signals display the Standard Code aspects, Rules 281 (287, Slow Clear, on dwarf), 285 (288, Slow Approach, on dwarf) and 292. Where it was impossible to locate the high station-leaving signal immediately to the right of the main track, both the main-track and siding signals were mounted on bracket posts to the right of the siding, the main-track signal being a two-unit signal capable of displaying the same standard aspects as the other station-leaving signals, and the siding signal a three-unit signal capable of displaying the aspects under Rules 283, 286 and 292. These bracket post signals are well constructed with extra catwalks, railings, and railing supports, to insure the utmost in safety for men working on them, especially during icy, rainy and windy weather.

Take-Siding Signals

At some sidings with hand-throw switches and electric switch locks, such as at Pawnee, as shown in Fig. 3, "Take-Siding" signals controlled by the dispatcher are in service. These signals include a normaly-dark lamp unit below and staggered to the right of the regular signal units. If the dispatcher wants a train to take siding at such a location he con-

trols the regular signal units to display red, releases the switch lock, and controls the bottom unit on the signal to display a white letter "S" on a black background, Rule 292A, which is authority to throw the switch and to enter the siding at restricted speed.

An interesting feature of these signals is that the "S" indication holds until the last car of the train has passed the signal. This arrangement enables the conductor and rear brakeman in the caboose of a train to observe and know what signal aspect the engineer accepted, and that the movement was authorized and directed by signal indication by the dispatcher. This feature is accomplished by taking the control of the "S" unit through the first track circuit in approach of the signal and the OS track circuit. The unit is thus extinguished with the first track circuit in approach up and the OS down after a train has accepted the signal.

In and Out of C.T.C.

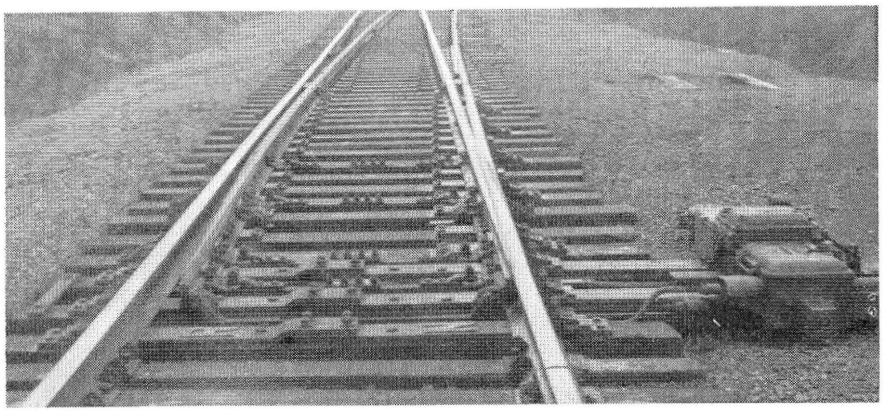
In leaving C.T.C. territory, such as at the ends of the projects and through Bellevue, the last signals are controlled signals, capable of displaying two aspects, Rules 290 and 292, the former of which authorizes a train movement at restricted speed. In the case of the west end of Bellevue, which is the end of a yard, there is a special yard-indicator signal. If, after accepting the last westward C.T.C. signal west of this indicator, a train finds the indicator dark, it continues on the main line in approach of the home signal at the crossing with the Nickel Plate and Pennsylvania. On the other hand, if the train is to take the eastward or westward yard lead into the yard, the dispatcher controls the indicator to display a white letter "E" or "W", respectively, on a black background.

At three points, the controlled home signals are located on heavy curves and grades, so that enginemen have no advance view of the signal. Grades are such that trains should lay back on tangent and more favorable grades until the home signal is cleared, but the home signals cannot be seen from such a point. In order to provide information that the home signal is displaying home proceed aspect, a special repeater signal is installed around the curve approaching the home signal. This repeater signal is normally dark, but when the home signal is displaying home proceed aspect, a white letter "R" on a black background is lighted to authorize train to proceed up to the next home signal.

Intermediate Signals

The majority of automatic intermediate signals between sidings are arranged as double locations, the signals in each direction being spaced at varying distances up to 10,000 ft., the spacing being determined by the braking distance involved in dividing the distance between sidings into approximately-equal-length blocks.

In addition to aspects under Rules 281, 285 and 291, on these signals, a fourth aspect, Rule 282, Approach Medium, is introduced on approach signals in approach of controlled signals good for medium speed on diverging-route movements. Where braking distances between signals are insufficient in some instances, such as between the ends of power sidings, the distant control of the station-leaving signal is overlapped to the station-entering signal in approach thereof, or otherwise as may be required to provide the proper braking distance.

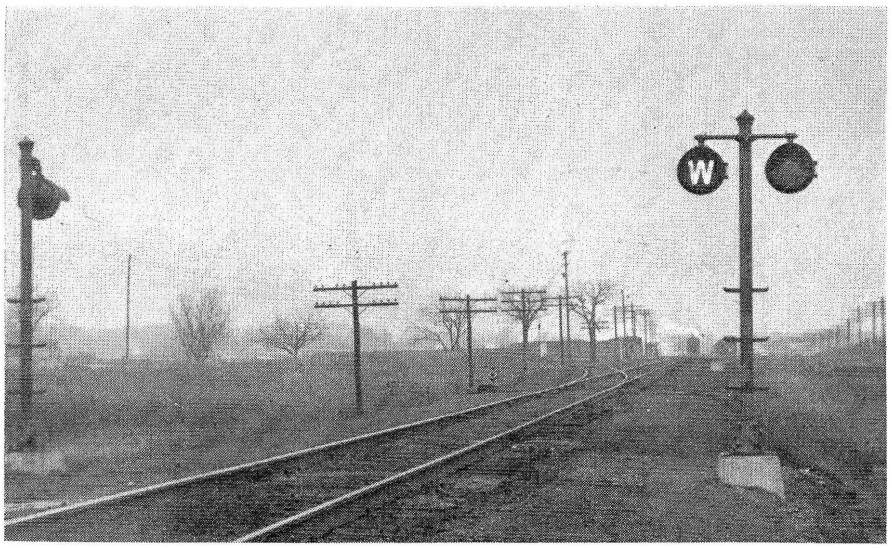


Typical power-operated turnout and switch machine

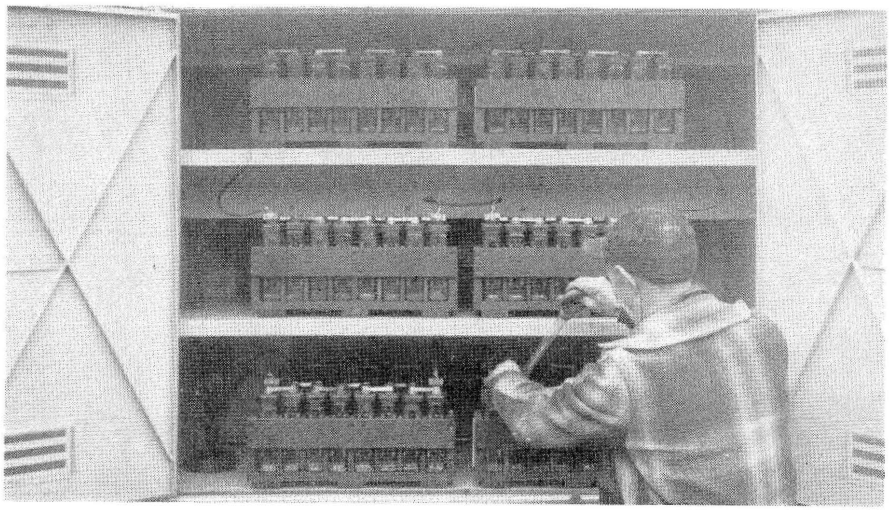
Tonnage Signals

Intermediate signals governing train movements on certain ascending grades are equipped with a 15-in. square yellow grade marker with a black letter "G", which authorizes trains having 75 per cent or more of their rated tonnage to pass the signal at restricted speed without making a stop when the signal is displaying Stop-and-Proceed.

The intermediate signals in each direction between sidings are controlled by a conventional two-wire polarized line circuit. Track circuits are the standard d.c. type, averaging 6,000 ft. in length, and employ DN-22BH two-point 0.5-ohm biased-neutral relays. Four-point



Yard-indicator signal with "W" unit lighted at the west end of Bellevue. Special repeater signal at left



Signal maintainer R. A. Webster checking storage battery in case at Wellington

DN-11 neutral relays are used on OS sections and on the short track circuits over highway crossings. Intermediate signals are approach lighted through DN-22A, 40-ohm series line approach relays, and controlled signals are continuously lighted.

Joint Control at Norwalk

At Norwalk, there is a yard and, at Huron Junction, 2.2 mi. east the Huron branch to Huron, Ohio, on Lake Erie, joins the main line, as shown in Fig. 4. A considerable amount of switching takes place in this area and, consequently, the signals, switches and electric locks therein are controlled from a separate small panel-type machine in the yard office at Norwalk. This machine is coordinated with the C.T.C. machine at Brewster.

At Creston, the W.&L.E. district crosses a double-track line of the Erie and, at Wellington, a double-track line of the Big Four. Interlockings were previously in service at these points and, as part of the project, were altered accordingly to coordinate their manipulation with that of the C.T.C. system. Home signals at these plants must be lined up by the C.T.C. dispatcher before they can can be cleared by the towerman and vice versa. An interlocking is also in service at the crossing with the Nickel Plate district and the Pennsylvania in Bellevue, although the particular location is out of C.T.C.

The W.&L.E. crosses the Akron, Canton & Youngstown at Spencer; the New York Central and the B.&O. at Monroeville; and the Big Four at Clyde. The Spencer and Monroeville crossings are single-track crossings, and the Clyde crossing is a double-track crossing, target signals having been in service at each location. As part of the project, new signals were installed at these locations, automatic interlocking being in effect at Monroeville and Clyde. At the A.C.&Y. crossing in Spencer, the signals are controlled from the C.T.C. machine, with supplementary control in the A.C.&Y. depot at that point.

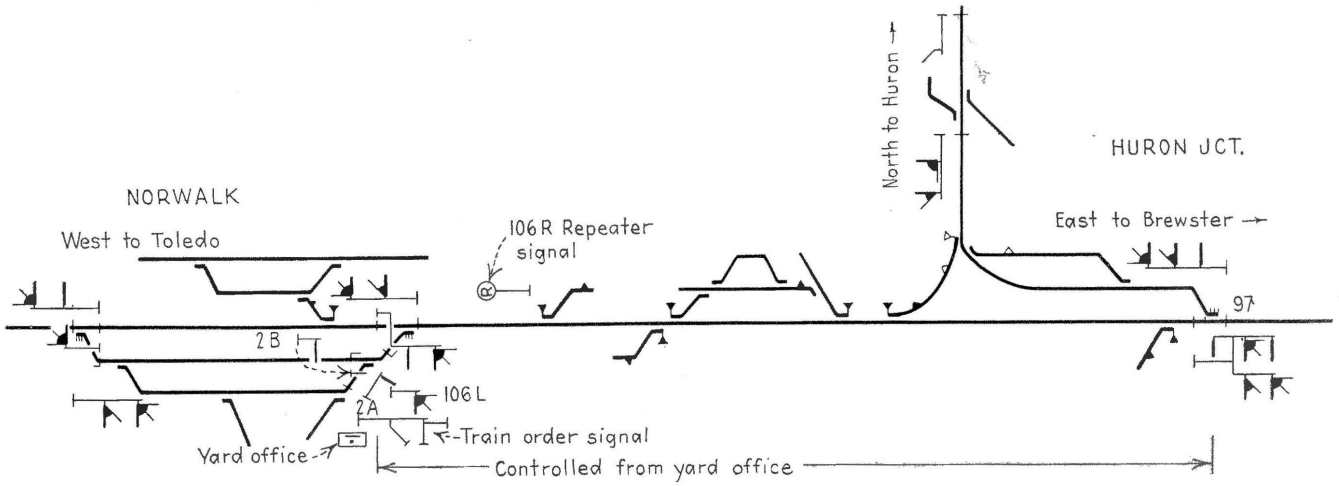


Fig. 4—Layout of tracks and signals betweeen Norwalk and Huron Junction

Flashing Red Aspect

At the west end of the yard at Norwalk, there are two switching signals No. 2A and 2B, shown in Fig. 4. A considerable amount of switching takes place in this area as mentioned previously and, to prevent such movements from blocking the lead to the yard and causing congestion, these signals are normally controlled to red for Stop from the yard office. To authorize switching between these signals and the leaving-siding dwarf signal No. 106L, the signals are controlled to flashing red, which indicates Stop, Then Proceed at Restricted Speed to Make Switching Moves. The flashing is controlled by a Style FN-16 flashing relay.

The Huron and Lorain branches are operated under train orders. Consequently, there is a train order signal at Norwalk, controlled from the yard office, which is used in connection with the issuance of orders to westbound trains destined for the Huron branch. This is a four-aspect signal with a two unit head and a normally-dark yellow marker below and staggered to the right. The signal normally displays (1) red for Stop, (2) red over flashing yellow for Stop—There are Orders for Train, (3) green over flashing yellow for Proceed Preparing to Receive Orders for Train and (4)

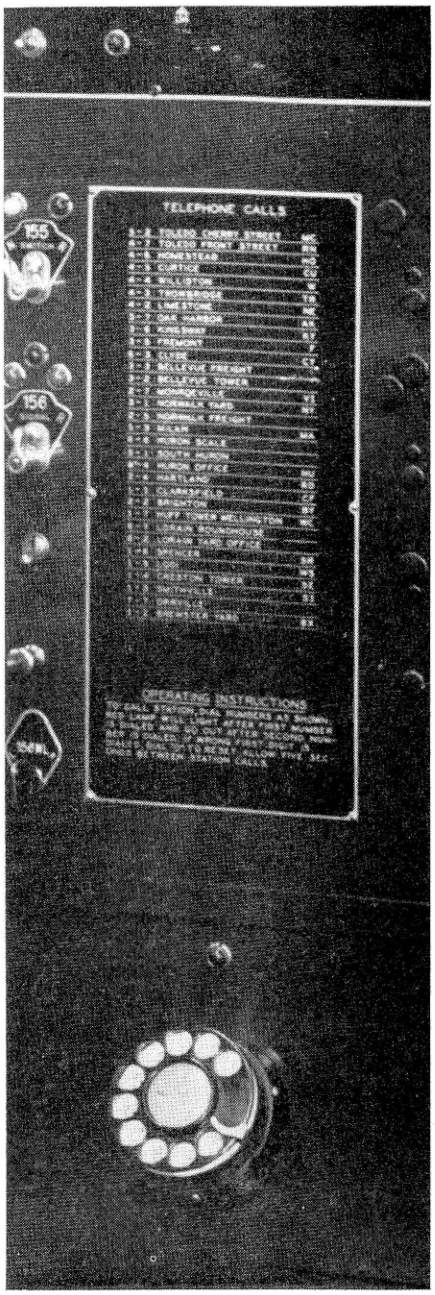
green for Proceed—No Orders for Train. At Wellington, the westward home signal for the Big Four crossing has a normally-dark yellow marker below and staggered to the right of the regular signal units, which is used similarly to the train order signal at Norwalk in connection with the issuance of train orders to westbound trains to the Lorain branch. Flashing of the yellow markers is also controlled by means of a Style FN-16 flashing relay.

Control Machine Features

The C.T.C. control machine at Brewster is a 5-ft. center unit with a 2½ ft. wing at each end, and includes a conventional illuminated track diagram and arrangement of signal, switch lock and other control levers and buttons. In addition, there are two 40-pen graphic train recorders, 29 pens of which are in service on one, and 10 on the other— a total of 39 working pens.

A new feature of the machine, compared with earlier machines, is the use of plug-coupling units for wiring connections between sections of the machine. Soldered connections on terminal blocks were used previously. This new plug-coupling arrangement facilitates installation, maintenance, inspection and any wiring changes which may be necessary from time to time.

Green and yellow indication lamps are used above the Normal and Reverse positions of switch levers, respectively. Red lamps are used above the Normal position of signal levers and green lamps above the Left and Right positions. The red lamps are extinguished when the corresponding signals are cleared, or when time locking is in effect. Similar lamps are located above the levers controlling take-siding signals, a black letter "S" on one of the lamps showing when the indicator in the field has been cleared. The lever controlling the yard indicator at the west end of Bellevue has indication lamps marked similarly, the letters "E", "W" and "M" being used. Track-occupancy lamps on the track diagram are opal, and combined OS and power-off indication lamps are red, all of which are normally extinguished. The sidings in this project are not track-circuited and, therefore, the occupancy lamps for the sidings are controlled manually by toggle-type levers below the signal levers. Traffic direction between sidings is indicated on the tack diagram by white arrows and lamps, a blue lamp being lighted when traffic is established in one direction and an opal lamp in the opposite direction.



Phone dial and table of calls on machine

On the right hand wing of the control machine is a standard telephone dial, which was modified and slowed up for use on the dispatcher's selector telephone circuit. Directly above the dial are a red indication lamp and a table of two-digit telephone numbers on the circuit. To call a station, the dispatcher dials the numbers shown to the left of the name of the station on the table. The red lamp above the dial lights after the first digit is dialed, and goes out after the second digit is dialed, indicating that the call has been initiated. If the wrong first digit is dialed, the call is cancelled by dialing "O", which resets the circuit for another call. Five seconds is allowed between station calls with this dialing arrangement. The control machine also includes a voice-actuated detector on the code-line circuit, which causes a buzzer to sound when someone in the field starts to talk to the dispatcher over this circuit.

The code line for the project is split into two sections—Brewster to Wellington, 49 mi., and Wellington to Homestead, 41 mi., carrier being superimposed on the first section between Brewster and Wellington for transmission of control and indication codes between the machine and the second section between Wellington and Homestead. Frequencies of 12 kc. and 17 kc. are used on this carrier for controls and indications, respectively.

The control office equipment, excluding the machine, is located in a room in the basement of the office building in Brewster, wiring between this room and the machine being all in conduit. Storage battery in this room is mounted on wood racks, the rectifiers on the wall and relays, code-line and other equipment in glass-panelled steel cabinets.

Sectional Power Circuits

The power circuits are sectional, that is, they are run only where power is required. Power is obtained through watt-hour meters at 13 locations between Brewster and Bellevue, and at seven locations between Bellevue and Homestead. At each bungalow and highway crossing protection location there is a 500-watt crossarm type transformer and at each cut section and intermediate signal location a 100-watt unit. Power circuits are cut through 10-amp. fused cut-outs in all bungalows and cases. A 3-kw. gasoline-engine driven generator set is on hand at each maintainer's headquarters to provide emergency power in the event of commercial power failures.

The storage battery at the control office in Brewster consists of 58 cells of MPE-3 type, rated at 9.2 ah., for the code line, and 16 cells of NPE-415 type, rated at 280 ah., for operation of the machine. There are 13 cells of 60-ah. storage at each power switch location. This battery is split into eight and five cells, for operation of the switch machines and for feeding the code line. At Wellington, where there is code-line carrier and repeater equipment, there are 95 cells of storage battery, rated at 9.2 ah., for the code line. Signal line control circuits are fed by a separate set of five cells of 120-ah. storage

battery, which is also used for standby lighting of signals. Each track circuit is fed by one cell of MP-307 60-ah. storage battery.

Pole Line Rebuilt

A communications pole line was in service along the right of way in the territory, and was used for running the new code line, signal control and power circuits. This line was completely rebuilt, one arm of Western Union wires being removed from the line at the time, due to cessation of contract between the railroad and telegraph company. New poles were installed and respaced 60 to the mile where heavy ice loading had been experienced in the past—primarily between Bellevue and Homestead. Forty poles per mile were used elsewhere.

The code line is on two No. 8 Copperweld weatherproof line wires, tied to Hemingray No. 42 clear glass insulators and transposed in standard patterns according to other signal and communication circuits on the line. This circuit is dropped into every signal instrument case for test purposes, and to assure maintainers a prompt means of contacting the dispatcher at all times.

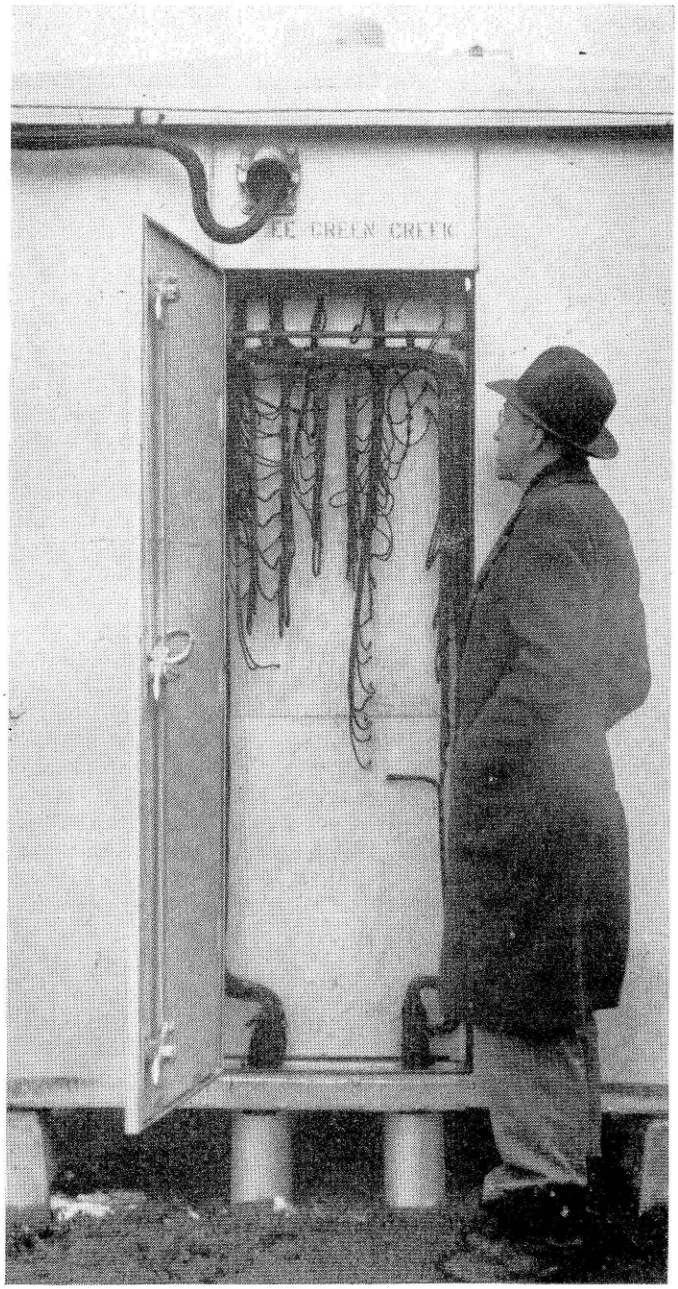
The signal line circiuts are on No. 10 weatherproof Copperweld wire, and the power circuits are carried on two No. 8 weatherproof copper wires tied to brown glazed porcelain insulators to distinguish these circuits from other signal and communication lines. Twisted pair No. 14 solid copper wire with 5/64-in. wp. insulation is used for code-line drops and telephone circuits between the pole line and bungalows and instrument cases, in order to minimize interference. Other circuits are in individual conductors of the same type wire. Line drops as a whole are suspended from Copperweld messenger strand by insulated scrap-wire ties and painted with insulating paint as protection against the elements.

Circuits between bungalows, instrument cases, switch machines and the track are in underground cable varying from 1 to 15 conductors.

Lightning Protection

The railroad extends through some fairly heavy lightning areas and, consequently, all circuits are well protected. The power circuits are protected by pellet-type lightning arrestors and cutouts. Signal line control and track circuits are protected by rare-gas arresters and, in addition, each track relay has a shunt-type rare-gas arrester across it. The code line is protected by series and shunt-type lightning arresters. Individual grounds are employed, except where a low enough ground could not be obtained, and in heavy lightning areas, where network grounds were used.

The rails are bonded with 42-in. Copperweld stranded web-type bonds with ⅜-in. plugs. As a means of protecting the bottoms of signal-mast bases and instrument houses and cases against corrosion, due to the accumulation of moisture, cinders, etc., the tops of all foundations are covered with heavy tar paper before this equipment is placed on them and bolted in place.



Signal supervisor J. M. Sigler looking over wiring in back of bungalow at end of a power siding

Maintenance and Installation

There are six maintenance territories between Brewster and Homestead, averaging about 21 mi., each, which are maintained under the supervision of J. M. Sigler, signal supervisor, at Brewster. Each maintainer has a 12 ft. by 20 ft. sheet metal house for his headquarters and for storing his motor car, tools and supplies. Motor cars are used by all maintainers in C.T.C. territory.

This project, which now falls under the general jurisdiction of S. G. Raber, signal engineer of the Nickel Plate system, was installed under the direction of E. A. Hamilton, formerly signal and electrical engineer of the Wheeling & Lake Erie, and now superintendent of electrical equipment of the Nickel Plate system. The construction labor, except for pole-line work, was furnished under contract. The pole-line work was handled by the regular line-construction forces of the railroad.