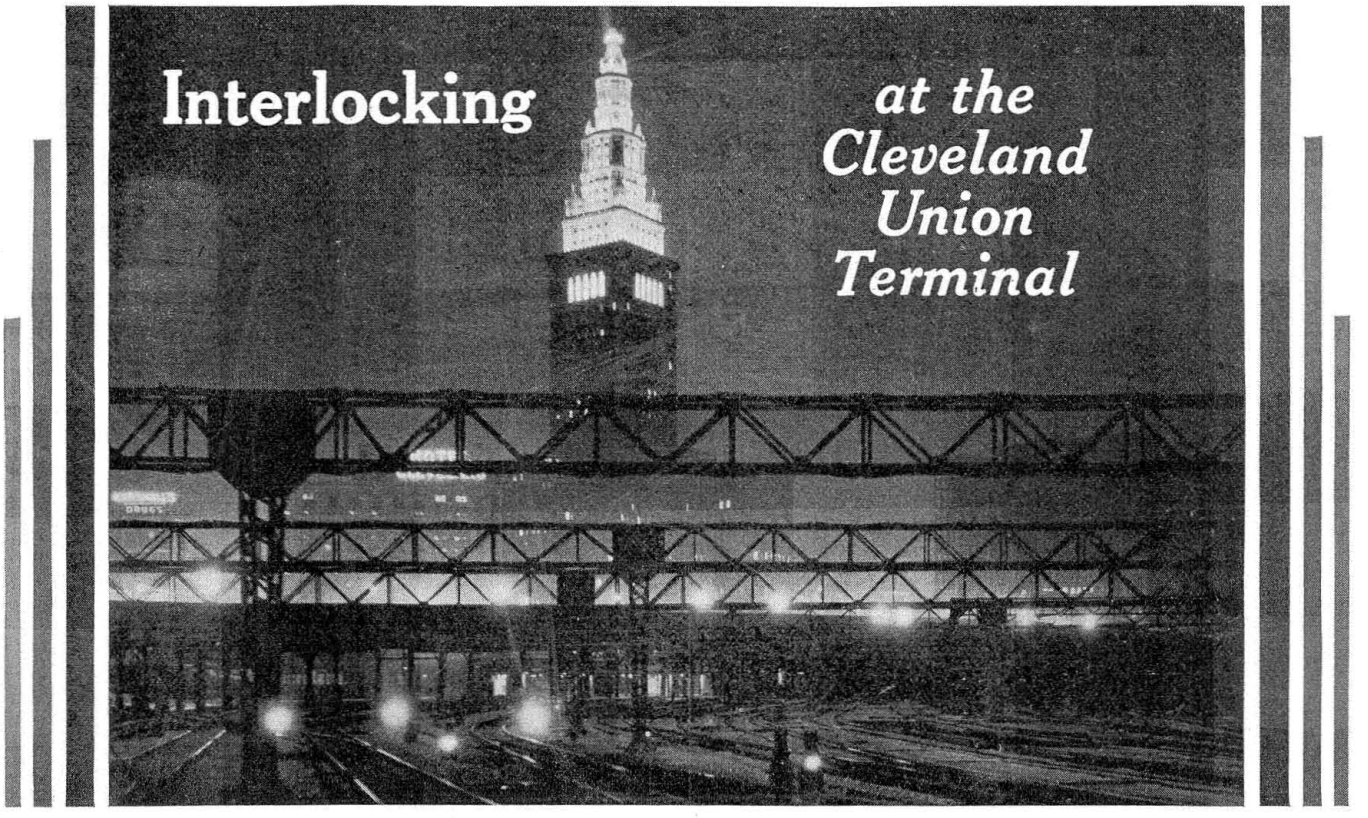
Railway Signaling



A night view of the west end of the station layout

One machine controls terminal and approaches including 3.8 miles—Operation expedited by elimination of indication locking—No lock rods on switches

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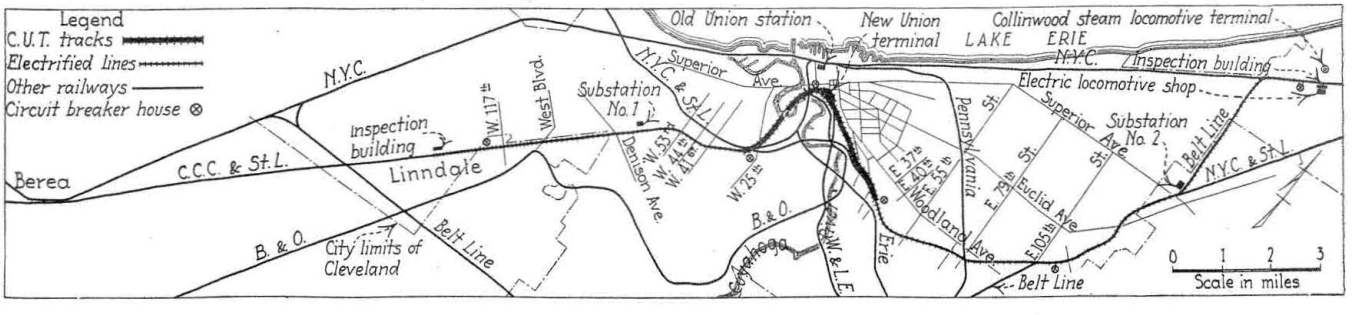
THE Cleveland Union Terminals Company, on June 29, placed in full operation the new passenger terminal at Cleveland, an important part of which is the interlocking facilities. The New York Central, the New York, Chicago & St. Louis, and the Cleveland, Cincinnati, Chicago & St. Louis are joint owners in the Cleveland Union Terminals Company and trains of these three roads, as well as those of the Wheeling & Lake Erie, now use the station. However, adequate space has been provided to handle also the passenger trains entering Cleveland on all the other roads in case they later decide to use this terminal.

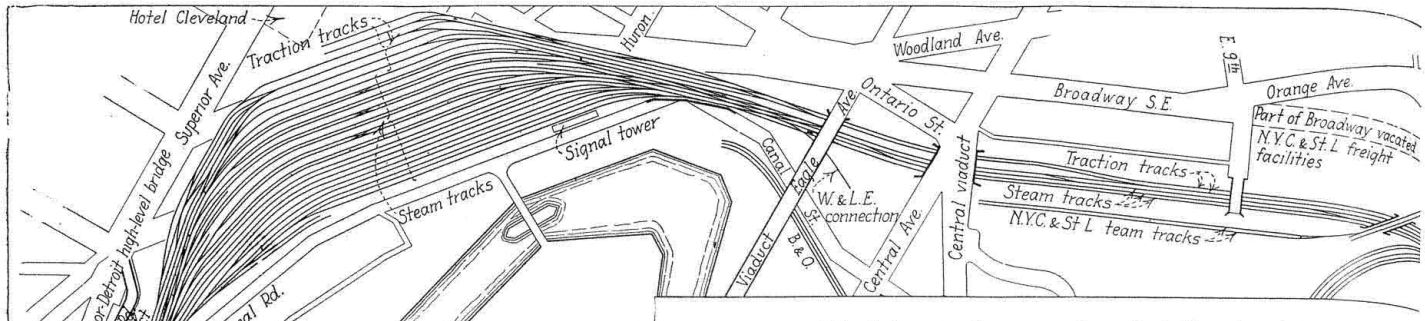
The terminal layout consists of 12 station tracks with platforms, and 10 yard tracks now used for the storage of coaches. The entire layout of the tracks controlled from the interlocking station, as shown in the accompanying map, is approximately 3.8 miles in length, the distant switches on the west being approximately 8,000 ft., and those on the east approximately 9,200 ft., from the signal station. There are 124 switches, double-slip switches, movable-point frogs and derails, 193 signals, and 2 check-lock levers comprising the layout. Of the signals 153 are four-position and 40 are three-position.

Signal Station

The signal station is a two-story and basement structure of fireproof, reinforced construction. Outside stairways of steel lattice construction are provided at



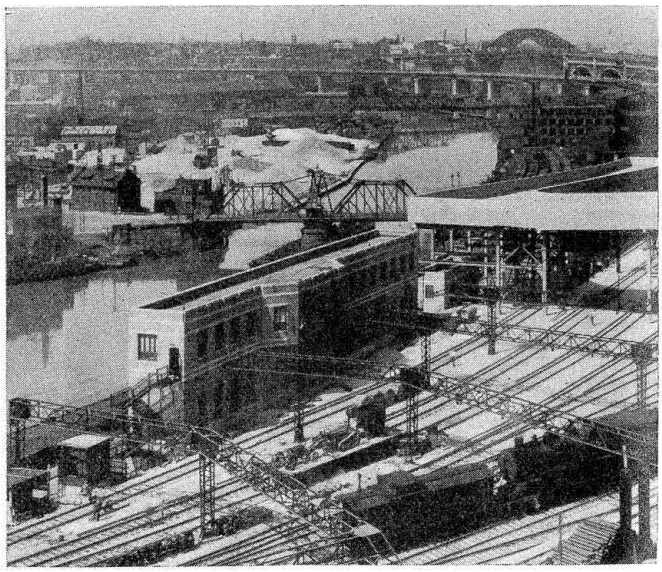
How the trains of the various roads reach the station



West terminal approach and station tracks

each end. The space in the building is apportioned as follows: Basement: Crew and locker room, toilet facilities for crew and locker room, transformer room, and battery room; first floor: Relay room, power room, and the telegraph and telephone room; second floor: Operating room for interlocking machine, and the maintainer's room.

The 576-lever-frame interlocking machine contemplates sufficient lever spaces to care for the final track layout, which is to include 24 tracks. When this has been completed there will be but 59 spare lever spaces. The machine, which is about 95 ft. long, is arranged in six sections to increase the flexibility of operation. Six ammeters are provided, one for each section. There are three track diagrams, one at the center embracing the entire layout and one at each end, covering the east and

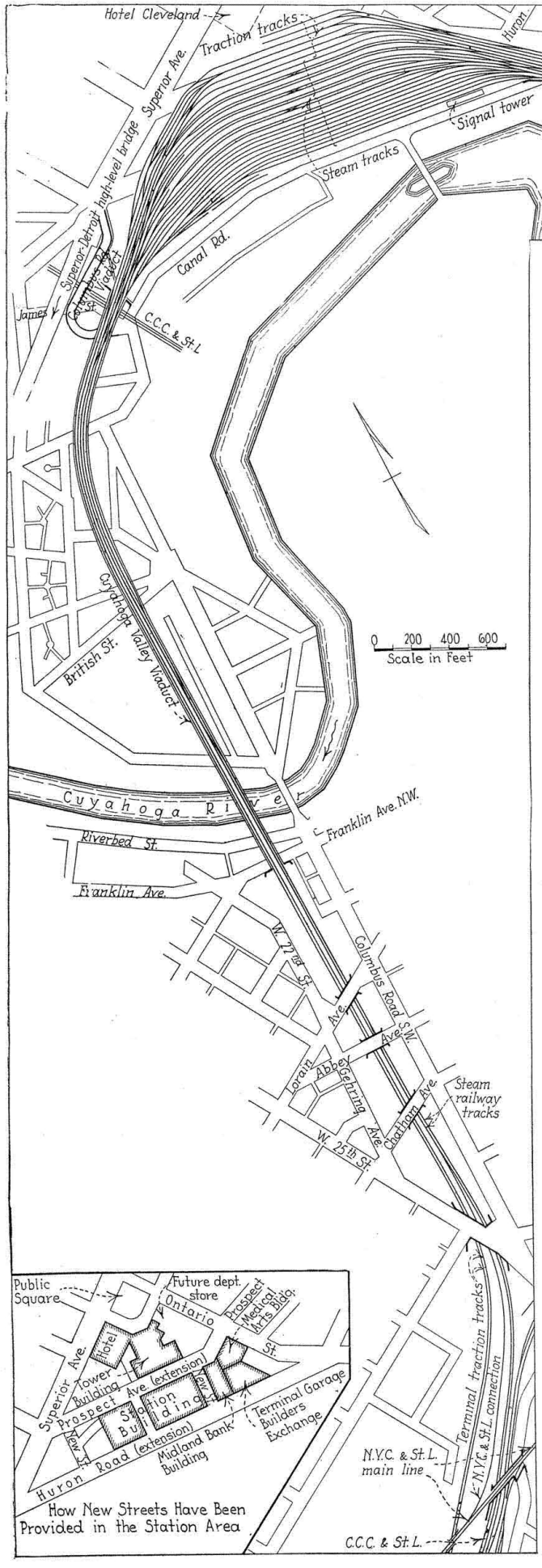


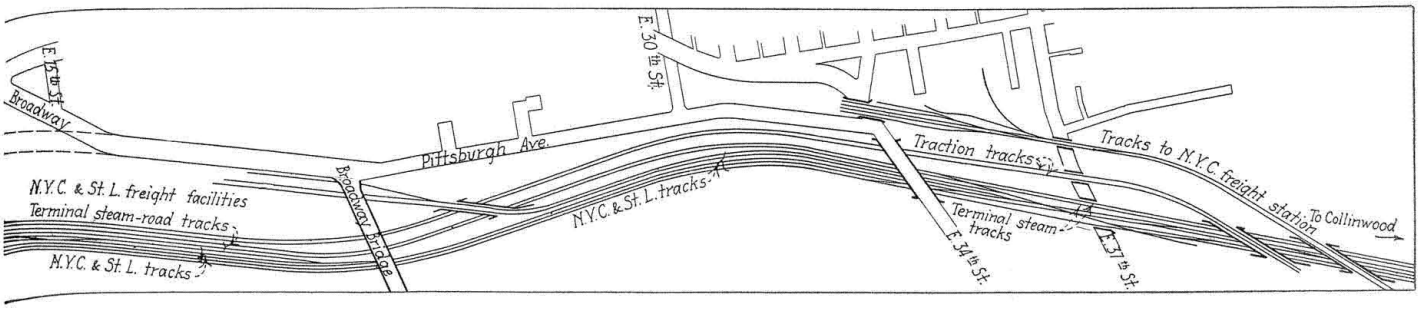
The signal station, during construction period

west approaches respectively, including the corresponding half of the station layout. The levers are of the latest type with the preliminary latch-locking feature which eliminates any strain on the mechaical locking structure when operating the lever.

The circuit controllers operated by the levers of the interlocking machine are of special design, being made up in lengths to provide three pairs of contacts for each unit and it is possible to use 36 circuits through a controller for a given lever. The contact members consist of one piece of rigid metal against which a finger of the relay type is moved by a roller operated from a shaft by the lever. The contact roller is capable of adjustment to provide all of the contact combinations that are provided for the symbols of the A. R. A. Signal Section.

Three sets of lever lights are provided for each switch





East terminal approach

lever. The transit light, a small white button-like light, located just back of the lever handles, is illuminated when the lever is reversed and the switch is moving between its extreme positions. The next lamp is a red unit which is larger than the transit light above it and which is illuminated to indicate to the leverman which of the cross-protection relays have operated due to improper connection to the switch-operating circuit. Both the switch and the signal levers have a lower light, in the lamp case, with blue etched figures on ground glass to show the lever number, and, when lighted, to afford information as to whether the lever is electrically locked, as in the case of a switch lever; or whether the signal is clear, as in the case of a signal lever.

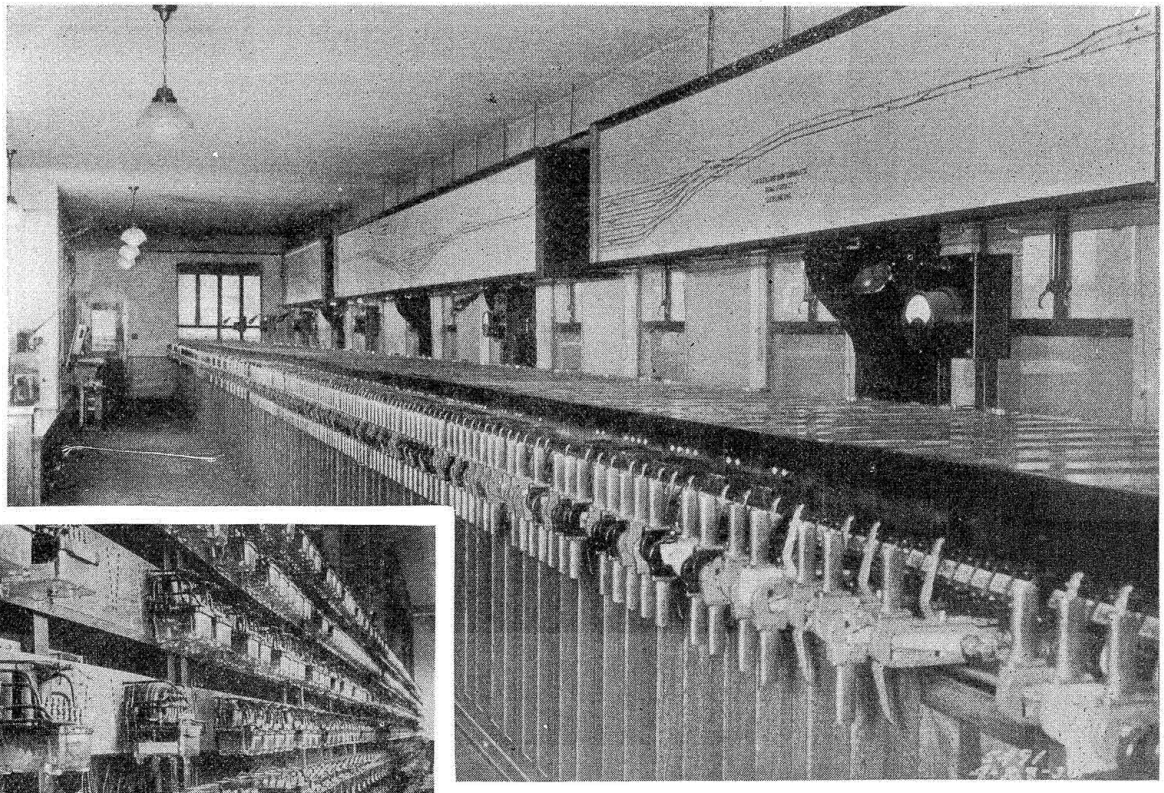
The machine is sectionalized, it being divided into six parts so arranged that should trouble be encountered in excess of that provided by individual cross-protection, the entire section can be cut out without disturbing the operation of the other sections. With this arangement it was possible, by bus-bar cutting, to include in each section only such switches as were desirable.

The machine was furnished without mechanical indication parts or magnets, dynamic-current-operating indication selectors being used instead. These innovations facilitate the operating of the machine.

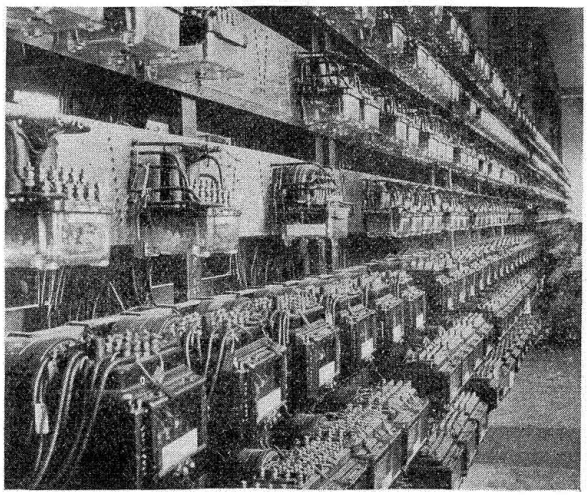
Signals

The signals for the approaches are of the standard A. R. A. Signal Section type as used in speed signaling; the top arms being operative where used in connection with No. 16 or No. 18 turnouts and the bottom arms used as "call-on"; and in addition, the signaling provides for "call-on" to be used only in proceeding from approach signaling sections into the section controlled entirely by four-position dwarf signals.

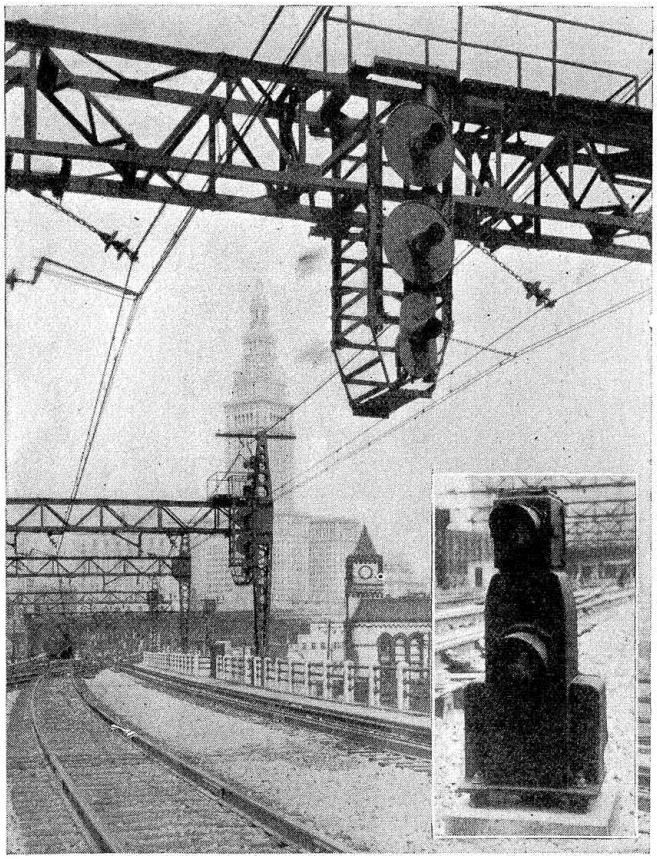
The high signals on the tracks approaching the station proper are mounted on the overhead bridges used for the support of the catenary. The signals themselves are suspended from a channel iron located at the top of the signal cage which is made of channel iron with lattice bracing. This cage provides a ladder and is so constructed as to prevent anyone from falling while engaged in the maintenance of the signal. The bottom of the



The interlocking machine has a 576-lever frame



There are 1,758 relays in the tower



A typical installation of signals on a catenary bridge. In the insert—A four-position dwarf signal

cage is shaped so as not to encroach on the clearance for equipment.

The four-indication dwarf signal was used within the station layout because a considerable portion of the station tracks and their approaches are or will be under cover; also considerable curvature exists within the switching limits, and in order that the engineman and the trainmen might have a knowledge of the track conditions it was felt that the four-indication dwarf signal, displaying indications as outlined, would provide train and engine crews with information as to the handling of the trains, bearing in mind that if the less-restrictive indications were displayed, the movement could be made at increased speed safely.

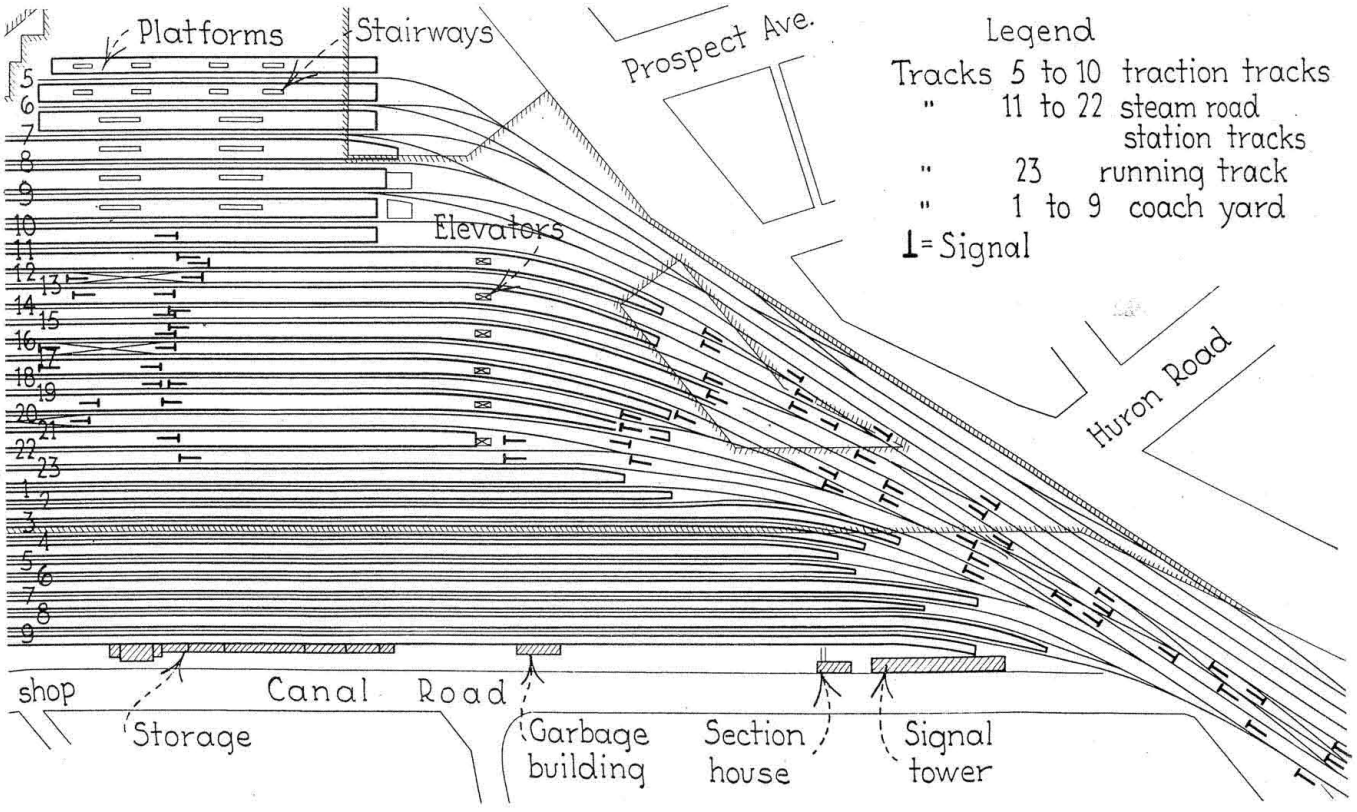
The four-position signals display the following indications:

Position	Indication
Red	Stop
Red over yellow	Proceed at slow speed prepared to stop —track occupied
Yellow	Proceed at slow speed prepared to stop —track unocupied, next signal stop
Green	Proceed at slow speed—track unoccupied, next signal clear

The accompanying illustration shows two views of a four-position dwarf signal. The space in the bottom of the mechanism case was provided for the track transformer and terminals for track connection, two-conductor parkway cable being used between the signal and the distribution point and single-conductor cable being used between the signal and the rail. Transformers located above the Type SA mechanism are used for signal lighting and for the filament control of the signal unit located at the top of the signal.

No Lock Rods on Switches

A feature of the Cleveland plant is that no lock rods are used on the interlocked switches. The switch machine, as used on this plant, includes a dog in the slide-bar mechanism, which locks the cam that operates the throw bar of the switch. In addition, the Type-SS control system for the interlocked signals includes circuits through independent point detectors, thus insuring that



Track and signal plan of east half of station layout only. Since the plant covers 3.8 miles of road it was impracticable to reproduce the track and signal plan of the entire layout. The portion shown above illustrates typical signaling.

the signals will not be cleared unless the switches are in the proper position.

Signal department tie plates and rail braces are used on the first four ties of single-switch layouts and on the first nine ties at each end of double-slip layouts, and for four ties in each side of the knuckle rails at the movable frog points. These plates are recessed for the base of 127-lb. Dudley section rail, which was used on all main tracks. This same type of plate and brace was also used for inside bracing of the rail on the first tie in advance of the switch point. The plates were furnished complete with butt straps attached and holes punched ready for application, by the Cleveland Frog & Crossing Company, which furnished all the switch and frog material.

Track Circuits

Single-rail track circuits are used within the interlocking limits or at such points at which the total cross-sectional area of the propulsion return rails was sufficient to provide satisfactory return. Where this was not possible double-rail track sections with impedance bonds were used. In connection with the single-rail track sections, it will be noted that there is a step-down transformer at the energy end, and at the relay end balancing impedance with a step-up transformer is used, thereby enabling all relays to be placed in the signal station. This arangement provided selectivity without considerable additional use of repeater relays. In addition, considerable protection is afforded if a contact wire should drop down on the rails, as this arrangement would prevent serious damage to the relay equipment in the signal station by reason of the balanced impedance and step-up transformer.

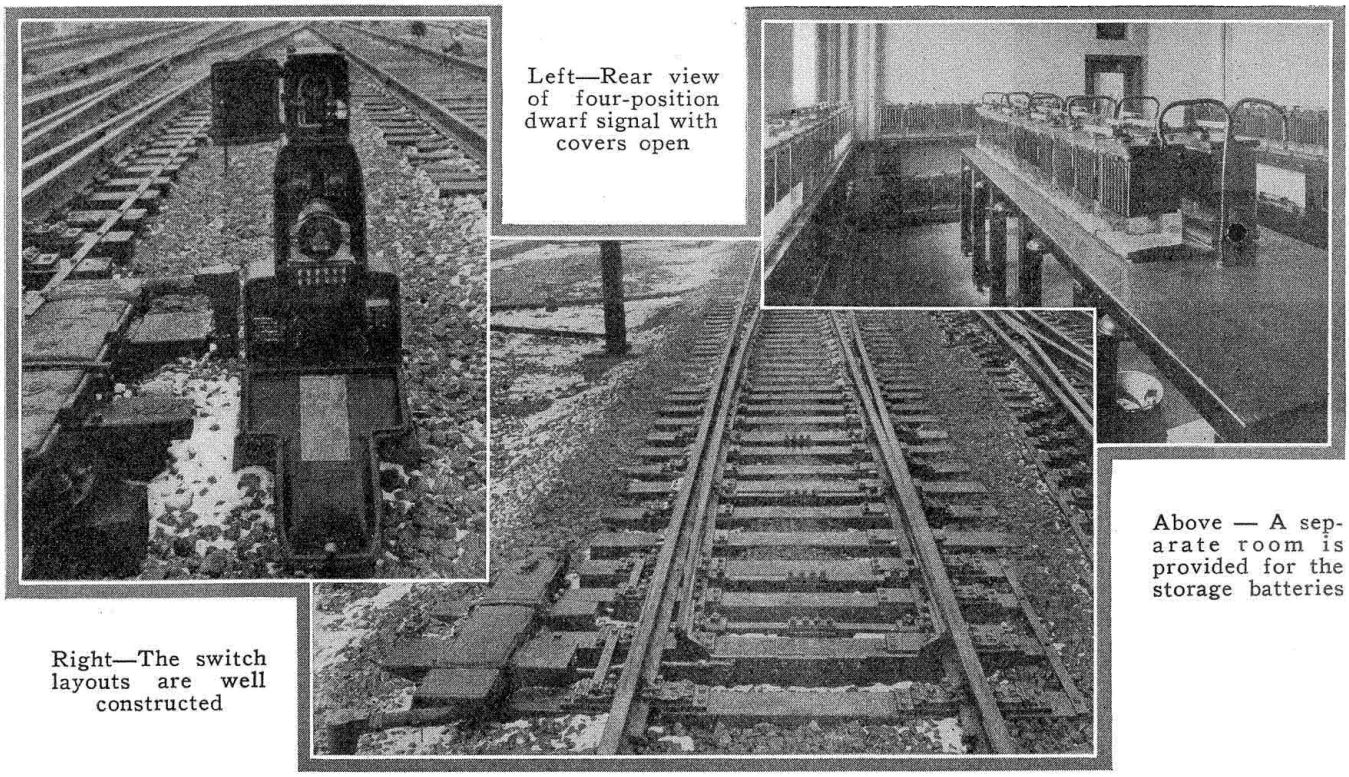
The relays are all housed in the tower. The tracks are made of 1¼ in. by 8 in. cypress plank fastened to a 3-in. channel support. Wall-type relays are used, and where the design of the relay requires one of shelf type special individual brackets are provided so that the general appearance is one of wall-type construction.

The terminals for all incoming lead and parkway cables are located on the back of the relay rack. There are 1,758 relays located on the two racks and these are divided as follows: 853 d-c. Type-K neutral 500-ohm; 150 a-c. track; 133 a-c. 3-position WP or switch repeating; 622 a-c. HP, DP, HR, and DR relays.

Route Locking Circuit

Figure 1 represents a typical arrangement of the route locking as taken from a portion of the layout. Units 281 and 388, as shown in the figure, are actual local conditions encountered. A normally-closed stick relay is provided for a given direction. Separate lock relays simplify the electric lock circuits. This plan shows the typical arrangement of the 10-sec. time contactors, which is operated at the time the lever is placed in its normal position, thus insuring that the timing does not operate until the lever has been restored to its full-normal position.

Another feature in connection with the track sections of the master chart, the track section of the chart for the benefit of the leverman, and that installed for the maintainer, is that if any of the tracks are occupied at a given time the information is repeated on each of these charts ,thus making it possible for all to be informed of the condition.



Left—Rear view of four-position dwarf signal with covers open

Above — A separate room is provided for the storage batteries

Right—The switch layouts are well constructed

In connection with the track relays shown in the figure: Two lights, one red and one green, are provided in the front of the track relay, the green light showing that the track relay is energized and the red light showing that it is de-energized, as the case may be. This is helpful in acquainting the maintainer of the position of the track relay. The lever lights shown as 339 and 342 are switch-lever lights and are lighted as soon as the signal lever is reversed. This indicates to the leverman that all of the switch levers thus lighted are electrically locked.

Switch Control Circuit

Figure 2 shows the control circuits for the switch machines, which are 220-volt, Model 5A. One side of the circuit for the SS or WP relay is superimposed on the

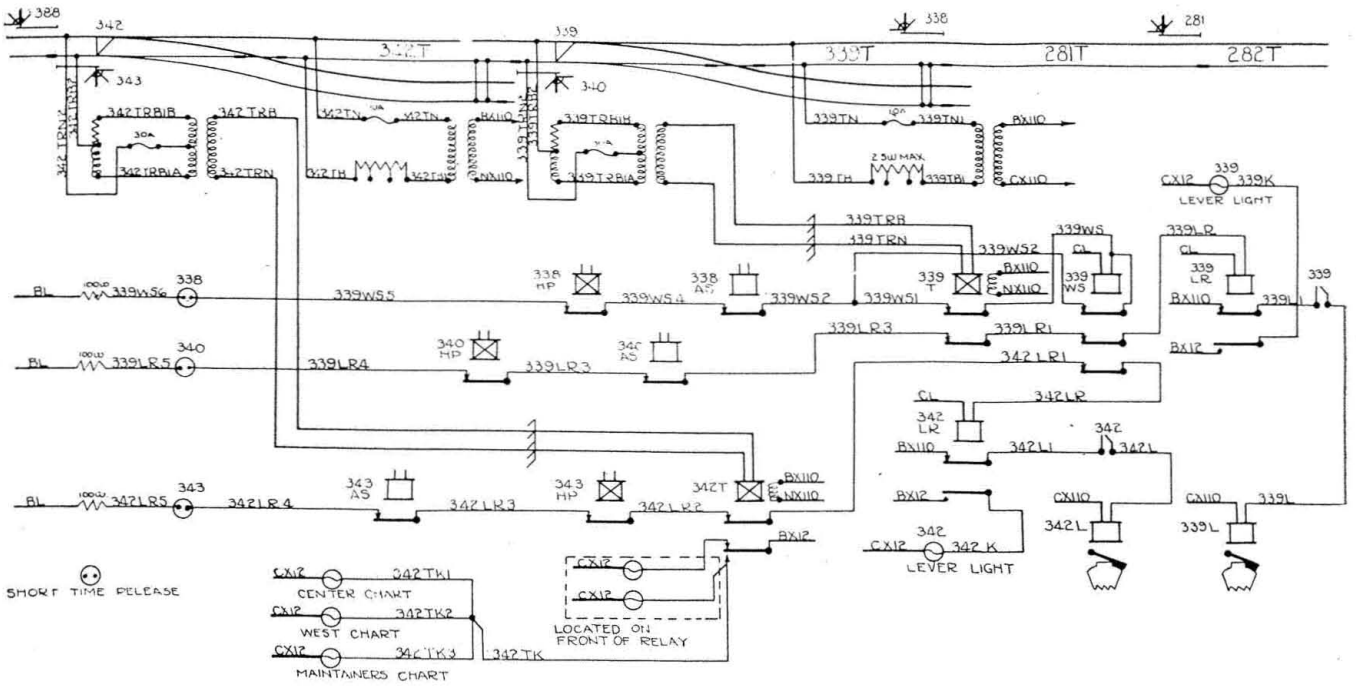


Fig. 1—Special electric circuits

common return wire which makes it possible to use a-c. relays for the three-position switch repeating relays and reduce the number of conductors to four instead of five which would be required if d-c. switch-repeating relays were used.

The two parts of the switch machine, that is, the pole-changer contacts and the contacts operated by the point detector are checked to determine the position of both mechanical portions of the switch, that is, the portion which is directly connected to the switch through the throw rod and that portion which is connected to the switch through the point detector rod. This seems desirable in order that no condition could obtain in which the point detector and the throw rod did not operate in unison.

The WP relay provides that a lever light on the lamp case is lighted when the relay is in the de-energized, or center position. This light has been designated as a transit light, it being lighted only while the switch repeating relay is de-energized, which is effected only through the movement of the switch point. Where a six-way switch-repeating relay is used, 110 volts are to be applied to the control and the local; whereas when the ten-way is used, 130 volts are to be applied at the local and control elements.

A feature of the Model-5A switch machine as used in the terminal interlocking is the junction box located at the entrance to the switch machine. In this box are located the resistance units and transformer for the switch-repeating relay, together with a service or discon-

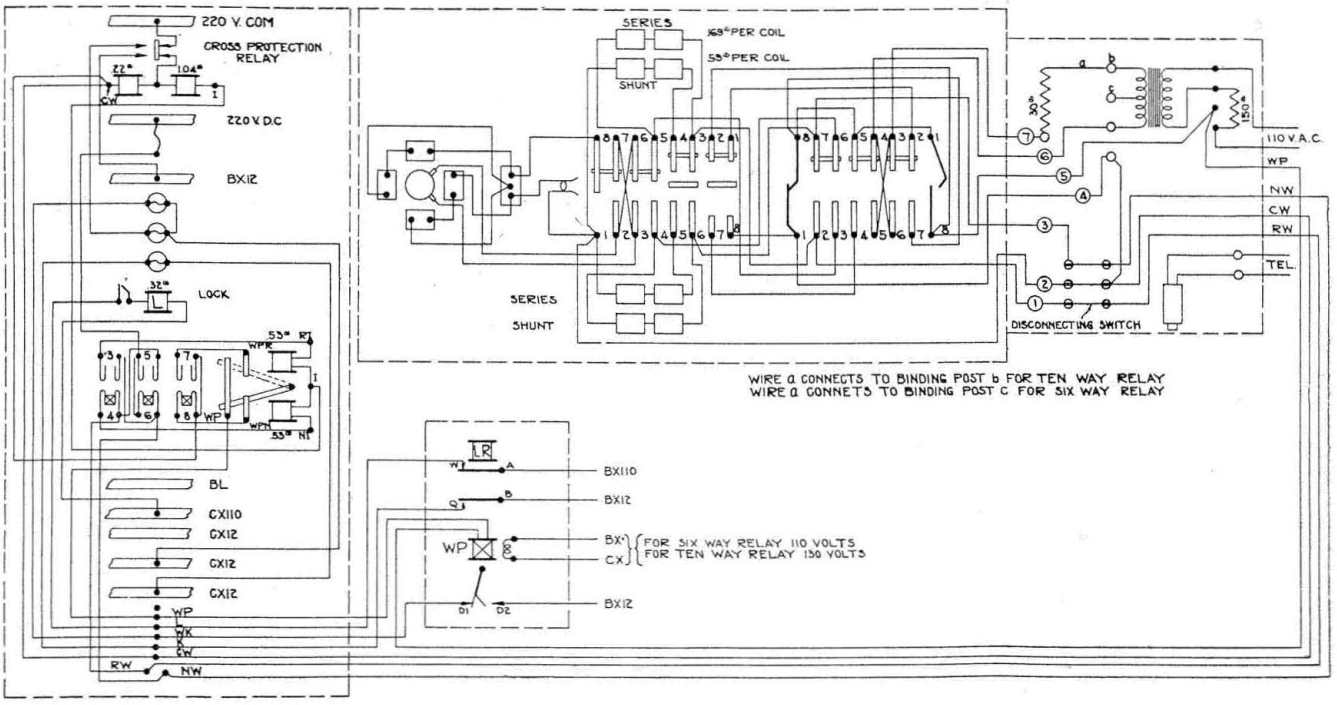


Fig. 2—Circuits for control of 220-volt switch machine from Model-5B interlocking machine using cross protection and WP relays, four-wire circuit and no indication magnets

necting switch so that, when desired, the 220-volt operating circuit can be entirely disconnected from the switch machine to permit the maintainer to make all electrical adjustments in entire safety. As an innovation, we have provided a telephone jack in this box, in which the maintainer may plug a portable telephone, thus making it possible for him to communicate directly with the leverman without the necessity of crossing tracks to some distant telephone. This has been found to be desirable, especially when adjusting or oiling the switch or switch machine.

Referring to the circuit for the control of the switch machine, it will be noted that there are no indication parts or magnets at the lever. The indication selector as formerly used has been utilized and placed in the circuit in such a manner as to accept the dynamic indication as it is generated at the end of the operating stroke of the motor. This indication selector is used as a means of selecting the proper polarities for the WP relay, thus insuring a positive operation of the WP relay after the switch machine has completed its operating stroke, and providing the usual snubbing action on the free-running motor. The LR, or lock relay controls the electric locking of the lever and also provides a circuit for lights in the lever lamp case when the relay is de-energized.

Electric Locking

The electric locks used are operated by 110-volts a-c., but are of the normal 10-volt d-c. design. This lock was adopted so that standard electric lock equipment could be used, and as this is a forced-drop lock, if found necessary it could be operated manually by applying 10 volts d-c. which might be available, without the necessity of manually operating it by so-called "picking."

The cross-protection relay is of the double-coil type, non-polarized, which has the advantage of having its coils checked at each operation and one which, when once adjusted, will maintain its reversal value indefinitely.

Signal Control Circuits

Figure 3 shows the signal control circuits for the four-position dwarf signal. It was necessary to provide for entire automatic operation of the signal indications to be displayed; that is, with the red-over-yellow indication it was necessary to separate the control in such a manner as to control the signal for the red-over-yellow indication through the switches only. This required that a WPP relay be arranged for. With the switches in position corresponding with the levers in the interlocking machine, the WPP relay is energized. If the track circuits in advance of the signal are unoccupied or not de-energized, the HR relay becomes effective and the yellow indication only is displayed. With the four-indication dwarf signal, it was necessary in connection with the green indication to provide for an approach-stick relay to make approach locking effective in the event of the signal approaching it being clear and therefore subject to restoration to its most restictive indication. Particular attention is called to the circuit in the figure for signal 338 displaying the green indication for signal 388.

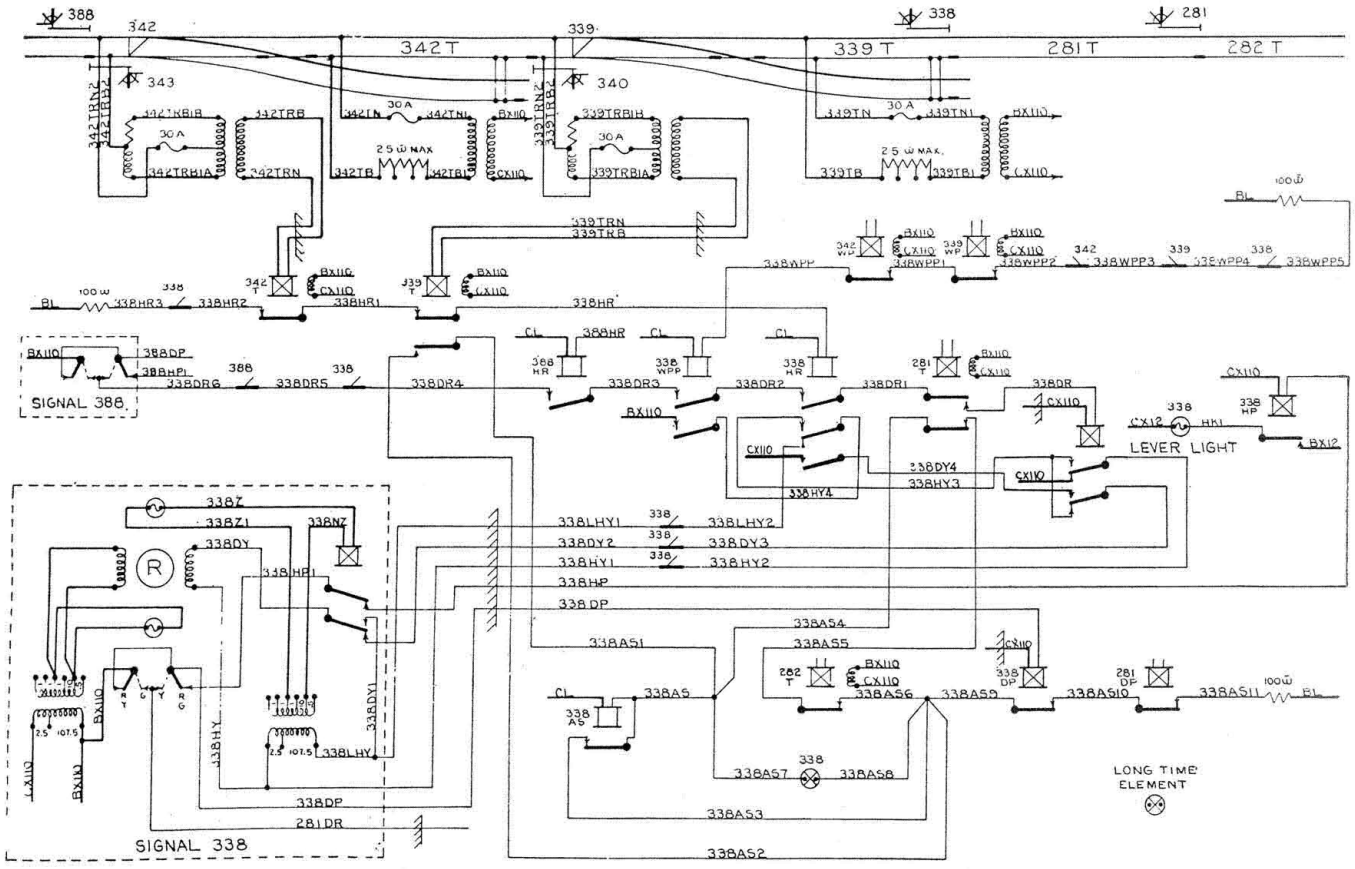


Fig. 3—Typical signal control circuits

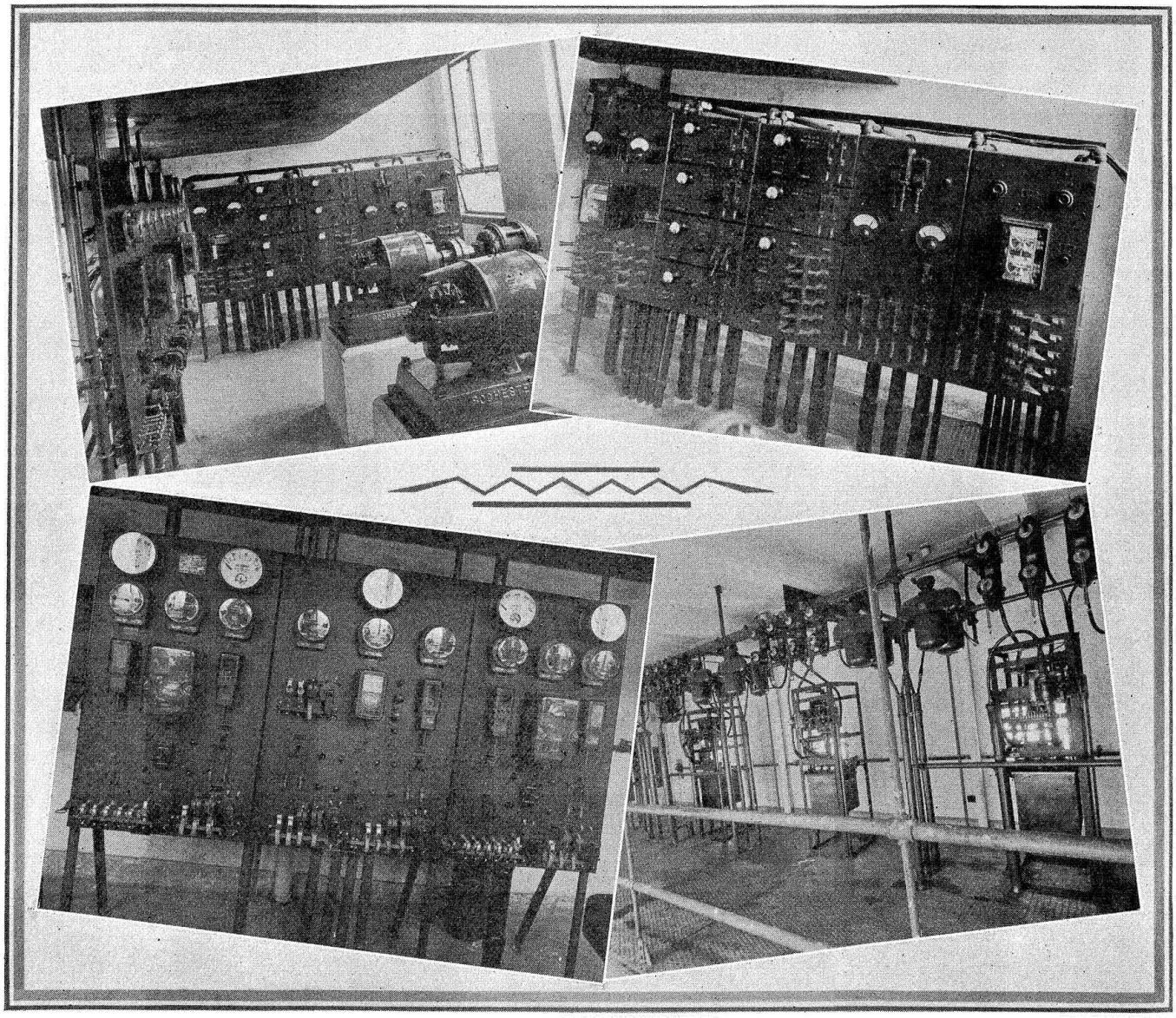
Another feature of the four-indication dwarf signal is that the filament of the lamp in the red unit is checked so that a less-restrictive indication will not be displayed if the filament of the red indication lamp should burn out while the red-over-yellow indication is being displayed; also the relay which was used in series with the filament of the red unit is checked after each operation to determine that the relay operates in accordance with

the sequence of the indication to be displayed. It will be noted that the control for the line element of the SA signal is taken through the front or the back contact of this relay, according to the sequence of the operation, which is dependent upon whether the HR relay is energized, or whether only the WPP relay is energized. In addition, the HP or signal repeating circuit for the signal in question is also cut through the back contact of this control relay, thus insuring that the information repeated to the leverman is checked through all of the moving parts of the signal.

The time-contactor shown as 338 is adjusted to 90 sec., and under the conditions of restoring signal 338 being effective, but 10 sec. is required to elapse before the route locking is free; if however, the approach locking relay has become de-energized, due to the signal clearing and the signal is restored to its most restrictive indication, the long-time element remains effective until the full timing, at which it is set, has elapsed.

Battery and Power Equipment

The 220-volt switch operation batteries are arranged on the two shelves of the four walls of the battery room, and the 12-volt batteries for operation of the secondary apparatus are on the center table. All cells are 280-a. h. capacity at the 8-hour rating. The batteries are the



Upper left—Motor-generator sets for charging batteries
Lower left—The signal-transmission automatic switching panel
Upper right—Battery-charging panels of switchboard
Lower right—The main and individual circuit-breakers

with signal 281 clear or displaying a green indication, it will be necessary for the operator to wait 90 sec. before the approach stick relay will pick up, thus insuring the route against being changed until the proper timing has elapsed. The long-time and short-time time elements shown in Fig. 3, which are operated by lever 338, are operated simultaneously, a single-clock mechanism operating the movement for controlling the time. The short- and long-time contactors are adjusted separately so that in the event of the approach locking not

Electric Storage Battery Company's EMGO-15 Manchester box-plate type, with sealed covers, and in addition, sand trays are provided to further protect against grounds, etc. All wiring between the power room and the battery room are in concealed conduit.

Several views of equipment in the power room are shown in one of the large illustrations. The upper left view of this group shows in the foreground the motor-generator sets for charging and floating the 220-volt battery for switch operation. In the background are

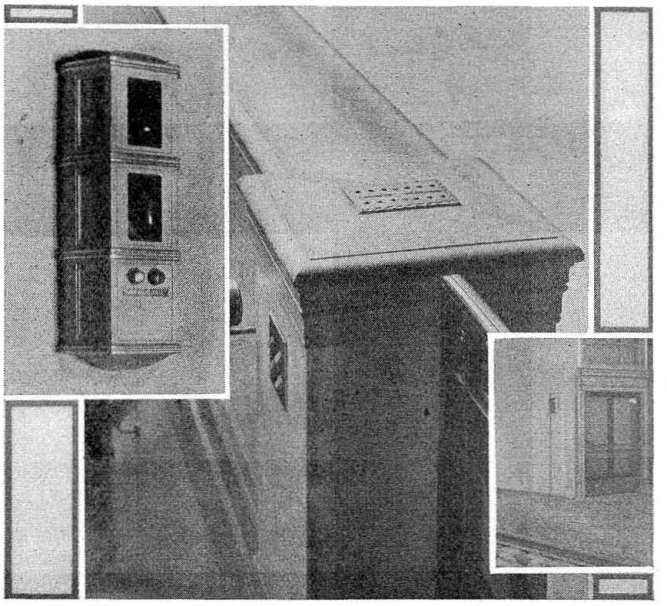
shown the panels for the battery charging in connection with the interlocking facilities. At the left is shown the automatic switching panel for the 4,400-volt high-tension signal transmission line.

The upper right view shows a close-up of the battery-charging apparatus. The panel at the right is for the control of the motor-generator sets, it being provided with an automatic compensator with starting and stopping push buttons. The next panel is used for the 220-volt charging apparatus. The next two panels are used for the 12-volt low-voltage charging of batteries for the various busses used for the control of the d-c. relays which are used as secondary apparatus. The large lower panel, at the left of the 220-volt d-c. switch-operating battery panel, is provided with a six-way heel- and toe-switch, which is normally on a very low floating charge, but is available for providing end cells for the main battery under extreme conditions. The other small panels in the group, control individual 12-volt batteries which are charged on a voltage-step basis for the coarse adjustment and a rheostat for the fine adjustment of the charging rates. With the small switch, shown under the ammeter on each of these panels, in the position shown in the figure, the ammeter indicates the charging rate of the batteries; while, if the switch is thrown to the opposite position, it indicates the discharge rate of the busses at the time the reading is taken. The panel at the extreme left is provided with an Esterline Angus graphic meter for the purpose of checking the high-tension signal transmission voltage. The chart for this meter has a scale of 0—5,000 volts; the meter itself operating on 110 volts from a transformer across the 4,400-volt line. On this same panel it will be noted that there are four two-pole heel and toe interlocked switches; these being provided to enable the signal maintainer to obtain energy for specified busses should it be required for any reason to remove anyone of the transformers regularly furnishing service to such busses.

The lower left view shows a close-up of the 4,400-volt high-tension signal-transmission automatic-switching panel. The panel on the right supplies energy to the high tension signal line from the Cleveland Union station to Linndale, inclusive; the one on the left supplies energy to the high-tension signal line from the Cleveland Union station to Collinwood, inclusive. The center panel is one which was first used and designed in connection with this installation and it has been designated as a cut-through panel.

Each of the panels have been furnished with a voltmeter and ammeter, together with the necessary relays for automatic switching, and in addition, there is an automatic re-set providing for three re-sets before permanent lockout is obtained.

The preferred source of energy is furnished from these panels; emergency sources being provided at Linndale and Collinwood. The operation for this layout generally is in accordance with the following: Energy is fed from the central location toward the extreme ends. In case of a power failure at the local or preferred source, emergency power apparatus of the same character as shown in the figure has been provided to establish emergency service. The automatic re-set feature provides that in the event of, say, a momentary short circuit, causing the contactors on the panel feeding Linndale to open and thus permitting Linndale to come in, should the cross persist, the panel shown in the figure would attempt to come in through the large relay located in the center of the panel. If the cross still existed it would cause the contacts on this panel to again open and the functioning of the apparatus at Linndale and the preferred source would continue to operate for three periods at each point, or a total of six attempts, before the apparatus would be permanently locked out. After the functioning of this panel to the point of locking-out had occurred the cut-through panel which is located in the center would then come into operation through the panel serving the Collinwood end of the power line. The same operation would occur until the center panel had been permanently locked out, at which time the source of energy then available through the sequence of operation would cause the line between the signal station at the



Train starting signals and control buttons

Cleveland Union Terminal and Collinwood to remain energized. It would be necessary to remove manually the cross on the west line before the breakers on the panel at the signal station or emergency source at Linndale would again permit the west line to be energized.

Train Starting Signal System

A complete train-starting signal system was installed as a part of the signal layout. The conductor's signal unit, shown at the upper left in the accompanying illustration is mounted on the platform level on the wall of the stairway as shown in the lower left view. This unit has two buttons and two lights. The button to the right provides communication to the gate and indicates to the conductor that he has informed the gateman that he is ready to leave. This is indicated by a red light at the top of the unit. The bottom is a green light indicating to the conductor or trainman that the gate is closed. The button on the left communicates with the signal station director and informs him that the train is ready to go. The platforms are divided theoretically in the center of the station and there are two of these indicator plates at the bottom of each stairway, the one being used for eastbound movement on the track adjacent and one for westbound movements on the same track shown.

The signals and switches shown in the center view are located on the top of the balustrade at the top of the stairs in the concourse level. The plates are oriented with reference to direction, also with reference to track number. The plate located on the column of the balustrade, house the push button to enable the

gateman to communicate with the platform. These are oriented top westward, bottom eastward. The instruction for the operator of the train-starting system is as follows:

(1) Conductor presses button marked "Gate" for track on which train due to leave, thus lighting the red light at the platform and gate. This notifies the gateman that the train is ready to leave as scheduled and gives a record of the action at the platforms.

(2) The gateman, after closing the gate, allows sufficient time to elapse for last passenger to reach the train, then presses the button extinguishing the red light and lighting the green light at the platform and gate.

(3) The conductor presses the buttom marked "Tower" for the track on which the train is due to leave, lighting the opal light at the platform and a light in the tower indicator. This notifies the director that the train is ready to leave as scheduled and gives a record of the action at the platform.

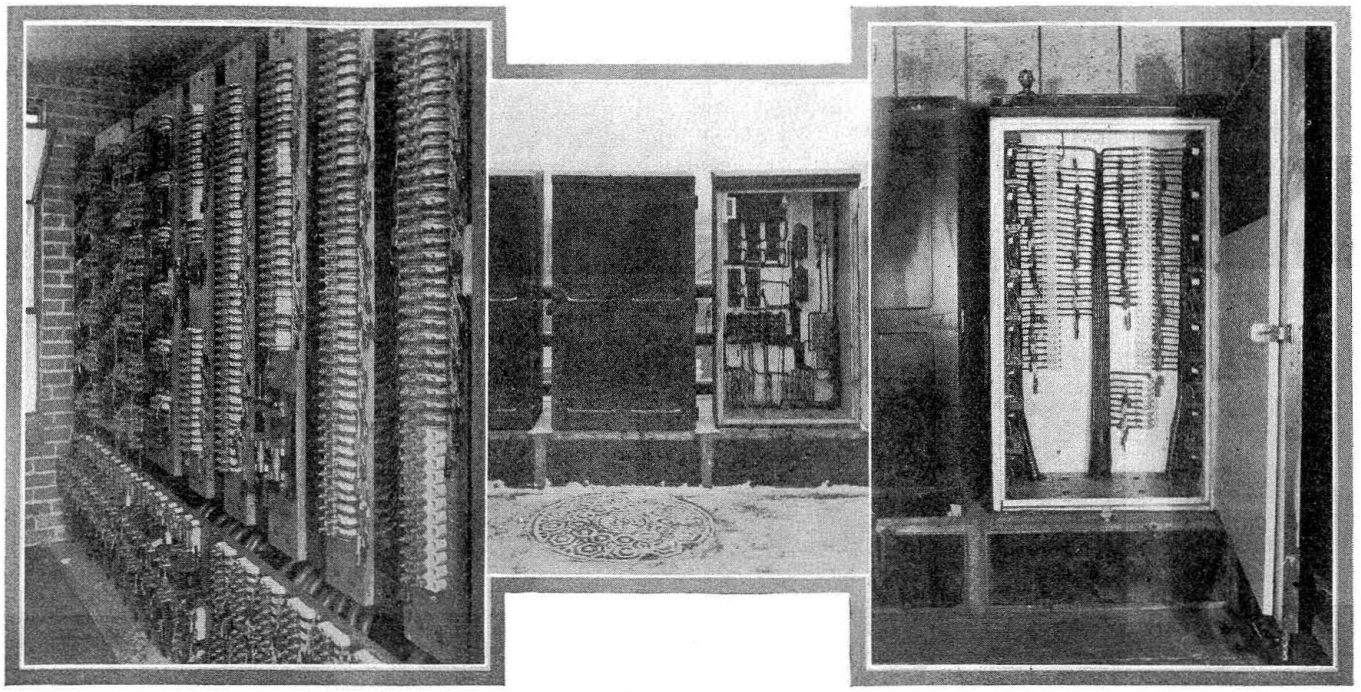
Duct lines extend from the east limits of the terminal to a point just east of the pedestrian passage. On account of voltage differential between the different types of circuits the signal and communication ducts are in one bank and the power ducts are in another. Lines running east from the signal station consist of 24 ducts for the signal department, 12 for communication circuits and 16 for the power circuits. Separate splicing chambers are provided for the power circuits. The duct line extending west consists of 39 ducts for signal, 12 ducts for communication and 16 ducts for power circuits. The ducts for signal and communication are of 3½-in. Bermico laid in a concrete envelope, while the power ducts are 4-in. using the same character of encasement.

Cable terminal houses, 8 ft. 4 in. long, 6 ft. 6 in. wide and 7 ft. 10 in. high, are located on the duct lines where required. The lead-covered cables are terminated on A. R. A. terminals on vertical strips. The balancing impedances and step-up transformer for the relay and of the track circuits, together with the resistors, are located on vertical boards. The track transformers for the energy end of the track circuits are located on the terminal board at the bottom.

Each distribution box location consists of a standard wood relay box mounted on a unit-type concrete slack box. These locations house the track transformer, resistor, etc., for the energy ends of track circuits, step-up transformers for the relay end of track circuits, terminals for distribution to operated units and for terminating lead and parkway cable. The cast iron covers for the splicing chambers were designed to represent the appearance of a Renaissance mat.

In connection with the installation, wire and cable were used as follows: 700,000 ft. of No. 12 rubber-covered single-conductor wire made in accordance with A. R. A. Signal Section specifications; 182,500 ft. of parkway cable of all sizes in accordance with the parkway cable specification of the Cleveland Union Terminals Company. This cable consisted of the following: Single- and two-conductor cable for track circuit connections between distribution points and the track rails; eight-conductor cable for switch controls between distribution points and the switch; three-conductor cable used for the switch controls; two-conductor cable used for the a-c. energy; one-conductor cable used for the switch-repeating relays. Six-conductor cable was used for the control of four-position signals. The parkway cable required 13,200 ft. of trenching. The greater part of the 153,745 ft. of lead-covered cable that was installed consisted of 45-conductor, with the capacity averaging 40-conductor.

The wire and parkway cable was furnished by the Rome Division of the General Cable Company. The lead-covered cable was furnished by the Rome Division of the General Cable Company, the Kerite Insulated Wire & Cable Company and the Simplex Wire & Cable Company. The signal material was furnished by the General Railway Signal Company and the plans were prepared and the work installed by the Cleveland Union Terminals Company forces under the supervision of the assistant signal engineer of the Terminals Company with E. N. Bousquet, assistant engineer in charge of field operation.



Interior of cable-terminal house | Distribution box location | Terminal box on plant