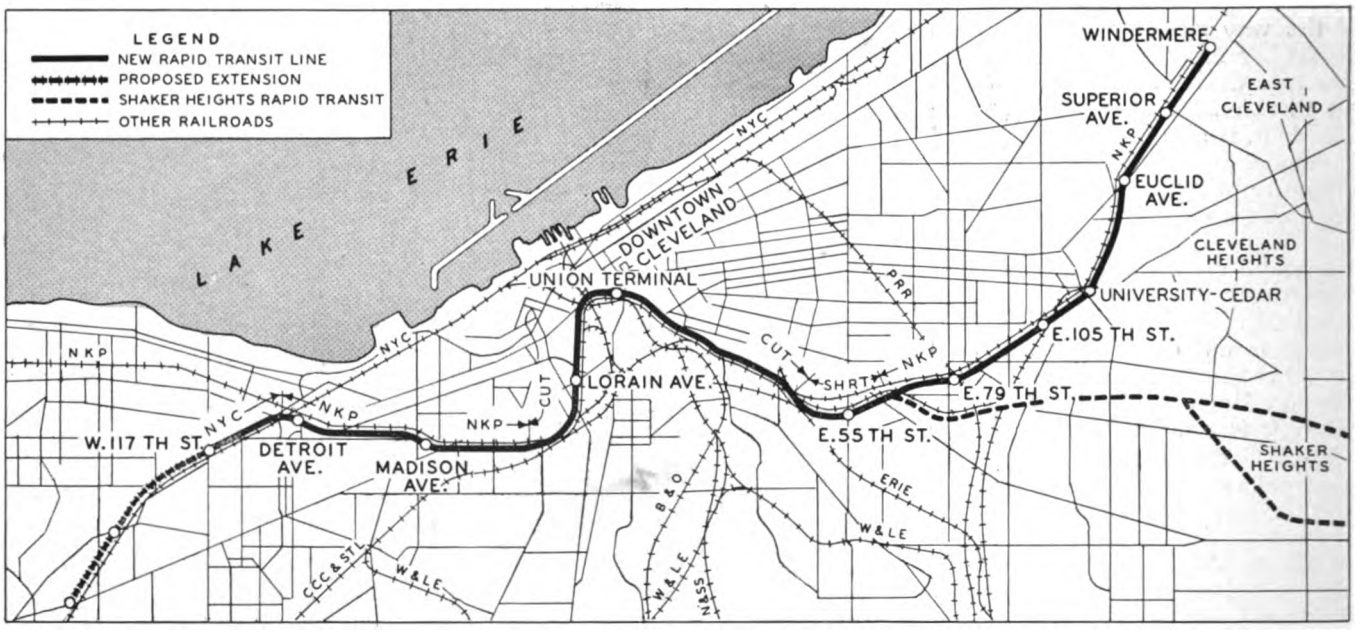


New Cleveland Transit System

Has automatic block with station-timing control, trip-type automatic train-stop, and NX interlockings with some automatically-controlled power switches at junctions and terminals

THE CITY-OWNED CLEVELAND TRANSIT System—a dream for 40 years—became a reality when the Windermere-Union Terminal section of the city-owned transit lines went in service recently. Back in 1919, when planning the Cleveland Union Terminal (used by trains of the NYC&StL, the NYC, the B&O and the Erie), provisions were made for station tracks and platforms for transit lines, and right-of-way for transit tracks was provided alongside the tracks used by railroad trains. In 1948 the city of Cleveland established a Transit Board, with finances and authority to take over the transit facilities already available, and to construct and operate a transit system.

Having finished the Windermere-Union Terminal section in March, construction is now being pushed on the section from Union Terminal to West 117th St., which will be completed in August. This entire territory—Windermere to West 117th St.—is in densely-built residential and business sections. Further extensions of the transit system eastward from Windermere, and west from West 117th St., are proposed.

Except for the limits of the Union Terminal, the transit system tracks are in the open, on-ground surface. Much of the route is in a ravine, with other sections on bridges or elevated structures, so that these tracks cross no streets or other tracks at grade. From Windermere, through the Union Terminal and west as far as 100th St., the transit tracks are along the same right-of-way as the original Nickel Plate route. From West 100th St., to West 143rd St., the transit tracks are alongside the New York Central.

As now operated, all trains stop at all the stations. The running time between Windermere and Union Terminal—8 miles—is 18 minutes. In peak periods, 7 a.m. to 9 a.m., and 4:30 p.m. to 6 p.m., trains are run about every 5 minutes each way. The signaling between Windermere and East 55th St., is arranged for a headway of as low as 3 minutes between following trains.

The transit tracks between the Union Terminal and East 55th St., are used not only by Cleveland Transit trains but also by trains of the Shaker Heights Rapid Transit, which branches off at East 55th St., and extends east for 9.5 miles to Shaker Heights and 9.8 miles to Van Aiken.

In the section between Union Terminal and East 55th St. during peak periods trains of the Shaker Heights Rapid Transit are operated about 20 per hour while Cleveland Transit Trains are run 12 per hour. Signals are spaced for 90 seconds headway.

Push-Button Interlockings

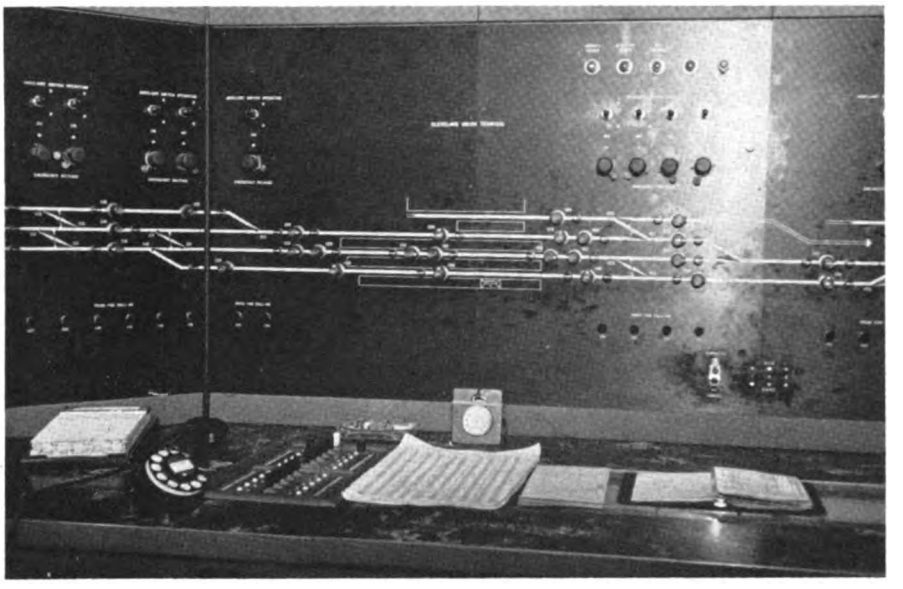
The interlockings on this rapid transit system are the modern, NX-type in which the operator at the control panel can control the switches and clear the signal for a route, merely by pushing two buttons on the track diagram, one of which represents the signal where the train will enter, and the other where the train will exit from the interlocking limits. If two or more following trains are to use the same route, the operator not only pushes the first button but turns it 90 deg., which sets up "fleeting" control so that after one train passes through the interlocking, the home signal will again clear automatically for the following train.

Large Area Controlled by One Interlocking

In the Cleveland Union Terminal, the Cleveland Transit System has three station platform tracks which are approximately 600 ft. long. North of these station tracks there is a turnaround loop and small storage yard used by Shaker Heights trains.

The NX interlocking panel in the "tower" controls the interlocking power switches and home signals not only in the terminal area but also as far east as the East 55th St. junction with the eastbound track of the

Shaker Heights line and the Kinsman Road and 65th St. junction with the westbound track of the Shaker Heights line, and as far west as the storage yard near West 30th St. There are three remote control points on the east side; crossover at 29th St. junction at 55th St. and junction at Kinsman Road. There are two remote control points on the west side, a crossover and switch at each end of the yard. Thus this NX panel controls a total of 12 single switches, 13 crossovers, 33 home signals, 30 dwarf signals and 12 approach signals.



INTERLOCKING MACHINES are the pushbutton entrance-exit type

Signals and Aspects

The signals are the colorlight type, each "head" consisting of three lens units which, from top to bottom, are a green, a yellow and a red. Below the red lens unit there is an automatic signal number plate. Each interlocking home signal has two or more "heads." The top "head" is a three-lens, automatic signal showing track occupancy on the same basis of control as for an intermediate automatic signal. The second "head" on an interlocking home signal is a three-lens interlocking signal showing the route which is set up—that is, green for the straight-track route, or yellow for the secondary route via a turnout. Under the red unit there is the interlocking signal number plate. The third "head" is a one-lens, call-on signal which, by control of the towerman, is lighted yellow (under red in both the two upper "heads"), to display a "call-on" aspect.

A fourth unit, which is used on only six of the home signals, is a one-lens, special switching signal which, when flashed red by the towerman, instructs the motorman to proceed at restricted speed through the interlocking limits and then stop, prepared to accept a signal to back up—for example, to back up over a crossover to the other main track.

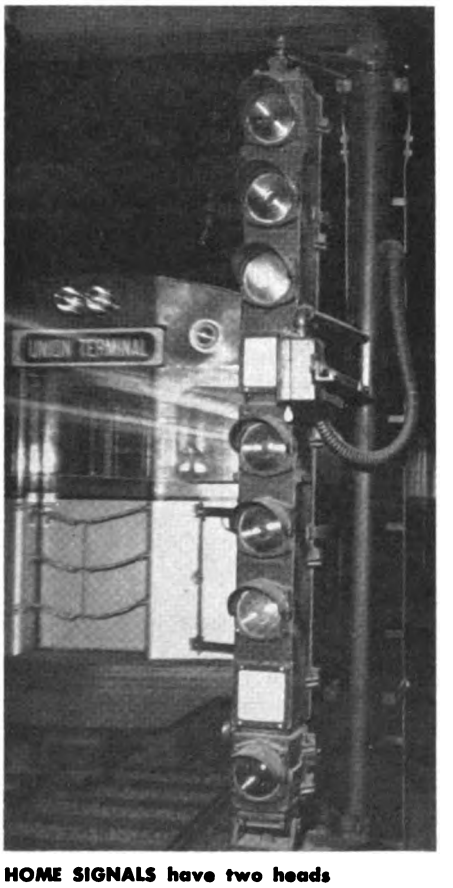
On the East side, where eastward trains of Cleveland Transit, with left-hand running, operate adjacent to the Nickel Plate eastward main with right-hand running, eastward signals of both railroads are located in the same strip between tracks. At these places, automatic signals of the Cleveland Transit System have a lunar marker to distinguish them.

Automatic Control of Junction Switches

The eastbound trains of the Cleveland Transit System and the Shaker Heights Transit use the same track for 2.36 miles from the Cleveland Union Terminal to the junction switch at East 55th St. As each Cleveland Transit train leaves the terminal, it passes signal 184; and as each Shaker Heights train leaves this terminal, it passes signal 186. In each instance, a corresponding "identification" is placed in a sequence identification system. These identifications are transmitted automatically to East 55th St. If the next eastbound train approaching the junction is to be routed on the Cleveland Transit to Windermere, the junction power switch No. 239 is controlled to the normal position, and the home signal is controlled to display a Clear aspect for the normal route. However, if the next train approaching the junction switch No. 239 is to be routed to the Shaker Heights line, the switch is controlled to the reverse position, and the signal is controlled to display a clear aspect for the secondary route. The system has a capacity to "hold" identifications for as many as 15 trains enroute between the Union Terminal and East 55th St. junction.

At Windermere, an NX interlocking panel in a "tower" at the east end of the station platform controls 2 single switches, 3 crossovers, 11 home signals and 4 dwarf signals, as well as 6 switches, 4 home signals and 6 dwarf signals at a center siding just east of the University-Cedar station. The section between the Union Terminal and the station at West 117th St., will be placed in service in August, and a further extension west to West 143rd St., will be built later. In the meantime, two crossovers at the West 117th St. station will be controlled automatically.

When a westbound train approaches the station platform, a crossover will be automatically lined for movement to the south side of the platform if the track is clear; if not, switches will be lined for movement to the north side of the platform if it is clear. A trainman at the platform will operate a pushbutton when ready to leave, which will line up the straight movement eastward on the south track or the crossover movement from the north track to the south track as required. An NX machine is provided in the "tower" which may be cut over to manual operation when it is required to op-



HOME SIGNALS have two heads

erate trains against normal direction of traffic.

The entire railroad has two main tracks. The automatic signaling is for single-direction running on each main track. In the section from East 55th St. to Union Terminal, the blocks are spaced for following trains to operate on 90-seconds headway. The automatic blocks are approximately 750 ft. long for train speeds up to 42 m.p.h.

In general, the automatic block signals have control limits extending through two blocks, so that a train is protected from the next succeeding train by two signals indicating Stop. To accomplish this result, the home control includes its own block and that of the next signal in advance, the red light being controlled through a back contact on the home relay.

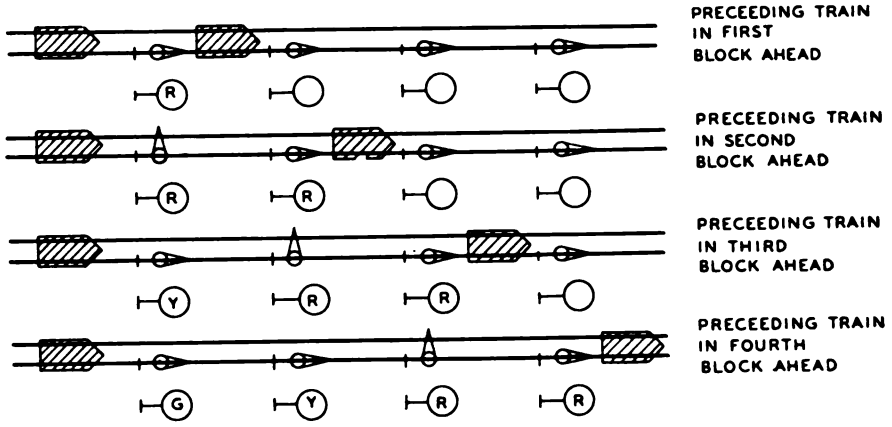


FIG. 2—OPERATION OF trip arm in conjunction with automatic signals

TRIP ARM RAISED to stop a train

Trip-Type Automatic Train Stop

At the right of the track, at each interlocking home and automatic signal, there is a power-operated trip arm. If the motorman passes a signal displaying the red aspect, the trip arm—then in the "up" position—will throw a valve handle on the leading car, and thus release the air to cause the brakes to be applied in emergency. If the signal is displaying the green or the yellow aspect, the trip arm is in the "clear" position which is "down" and therefore no brake application occurs.

The wayside trip must, of course, be in the down position to allow a train to pass the signal after stopping and enter the block. Accordingly, the control is arranged so that the trip is down while the train is occupying that block. Therefore, to provide protection, when a train is occupying a block, the signal for that block and also the block in approach, both display the red aspect, and the trip is in the "clear" position at the signal for the occupied block, but the trip is in the tripping position at the signal for the block in approach.

In order that a train may enter an occupied block, after stopping at an automatic signal indicating Stop-and-Proceed, a means is provided for automatic clearing of the trip arm just before a train passes a red signal with the trip arm in the tripping position. The insulated joint at the entrance of the block is located 10 ft. in approach to the signal, and the trip arm is opposite the signal. If the train does not stop, it will strike the trip arm, and a brake application will result. Approximately three seconds is required for the trip arm to clear after a train enters the block. If the train stops with the leading wheels in the 10 ft. between the insulated rail joint and the signal, the trip arm will be cleared automatically for passage of the train.

The addition of the automatic train stop makes some changes in the line circuit arrangement. These changes are required to check the operation of the trip arm following every train movement, and to check the position of the trip arm. In addition to the home relay, a home-stop repeater relay is used. Instead of a distant relay, a distant-stop repeater relay is used. If the trip arm fails to go to the tripping position or is latched down, the distant-stop repeater relay does not clear, and the home relay will not clear until the roadway element is restored to operating condition.

On an interlocking home signal, the red-over-red aspect indicates Stop. If a train is to be directed to enter home signal limits that are occupied, the towerman, after lining up the route by pushing the entrance and exit buttons, also pushes a separate call-on button for that signal. This causes the Call-On aspect, red-red-yellow to be displayed, but the train-stop trip at the signal remains in the tripping position. Then the motorman reaches out of his window to operate a trip release lever mounted on the signal mast. This causes the trip to be operated to the clear position, so that the train can accept the Call-On aspect to move into the interlocking limits.

Station Timing Controls

In approach to stations, the automatic block signals are spaced closely, and special timing controls are used so that when one train is making a station stop and is departing, a following train can close up, without being required to stop at red signals.

If braking distance were to be provided for normal speed, the home control would have to be extended more than two signals ahead. However, by using timing devices to check that a train is moving slowly, the caution control may be shortened to permit a slow-moving train to receive an approach indication when otherwise a stop indication would be received.

The timing relay is connected in series with a back contact of the track relay of the measuring section. The signal governing over the measuring section is controlled through a checking contact on the timing relay. If the calculated time is consumed in the measuring section, the signal in advance will indicate approach sooner than it otherwise would. This is illustrated in Fig. 3, where the

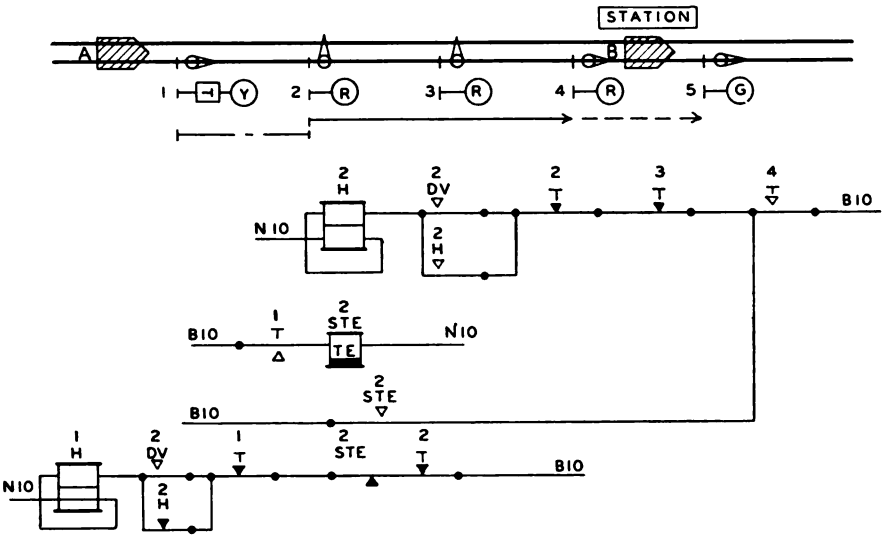


Fig. 3—TRAIN A IS AT SIGNAL 1 indicating approach at allowable speed with signal 2 which has station time element indicating Stop and Proceed, account train B at station

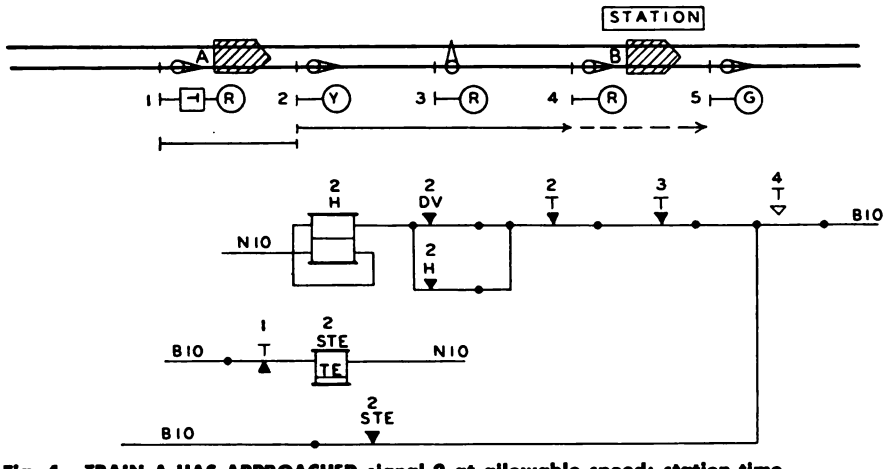


Fig. 4—TRAIN A HAS APPROACHED signal 2 at allowable speed; station time element has picked up; signal 2 indicates Approach, train A may close in

caution control of signal 2 extends to signal 5, but the portion between signal 4 and signal 5, in which the station is located, is cut off if the approaching train consumes enough time in the timing section which is from signal 1 to signal 2. The station-timing relay 2STE is energized when track relay 1T drops. The front contact of 2STE is closed when the predetermined time has elapsed. This gives an Approach aspect on signal 2, with a train in the block of signal 4.

Single-Rail Track Circuits

The trains on this transit system are made up of multiple-unit cars propelled by electric traction, using 600-volt d.c. on the trolley. One rail is used for track circuits, which are the a.c. type, and the other rail is used as a return for both the track circuit and the propulsion current.

The track relays are the two-position, vane type, with a 110-volt local coil which consumes 7.75 watts, and a track element which consumes about 0.25 watts. Adjustable 2.5-ohm resistors are connected in series with the relay track winding, and between the track transformer and rail, to limit the flow of propulsion direct current through the transformer and relay, if there is a broken bond or other break in the return rail.

Each track circuit is equipped with 600-volt, 6.25-amp. Fusetrons for the protection of equipment. A Fusetron is a combination of a fuse and a thermal cut-out, in series. Fusetrons protect equipment against short circuits just like a fuse, but the thermal element provides a time lag and will not open on momentary surges of propulsion current. The same type and capacity Fusetron is used in relay and transformer ends of each track circuit. A Fusetron is inserted between the relay track winding and the rail and between the track transformer and the rail to protect the relay and impedance and transformer from overload due to propulsion current.

As each signal track circuit is in multiple with the propulsion, direct-current, return circuit, a small amount of propulsion current will flow through the track winding of the track relay and the track transformer, even with the protective resistors. In order to prevent the direct current from affecting the operation of the track relay, a balancing impedance is used. The balancing impedance has two sections, each having equal ohmic resistance, but one section has a high impedance to alternating current. This causes the direct current to flow in equal amounts and in opposite directions to alternating current. This causes the direct current to flow in equal amounts and in opposite directions through the two relay windings, neutralizing any effect on the magnetic circuit. The alternating current is forced through one winding producing operation.

Normal signal power supply is carried at 480 volts in each direction from Cleveland Transit substations and from the Union Terminal, a total of 6 supply points. Two single conductors No. 6, No. 4 or No. 2, as required, are carried overhead by a 5/16-in. stranded messenger. Transformers 480–110 volts are located at 22 points where auxiliary power is taken at 240 volts from Cleveland Electrical Illuminating Co., and reduced to 110 volts through insulating transformers. Power transfer relays at each location, switch to auxiliary in case of interruption of normal power supply. The 110-volt signal distribution lines are carried each way from transformer locations in a two-conductor cable, conductors being No. 6, No. 4 or No. 2, as required. This cable and the signal control cable are carried overhead by a ¾-in. stranded messenger. The 110-volt supply from this cable is carried to each signal connecting to low voltage transformers to feed lamps at 10 volts, through rectifiers to feed the 10 volt d.c. for line circuits and through track transformers to feed track circuits.

In the directly-controlled interlockings at Union Terminal, Windermere and West 117th St. and in the remotely controlled interlockings at East 55th St. and Kinsman Road, the switch machines have 110 volt d.c. motors which are fed from sets of 90 cells of Edison 120-a.h. storage batteries. The coding and NX apparatus is fed from sets of 14 cells of Exide 240-a.h. storage battery. Line circuits are fed from rectifiers.

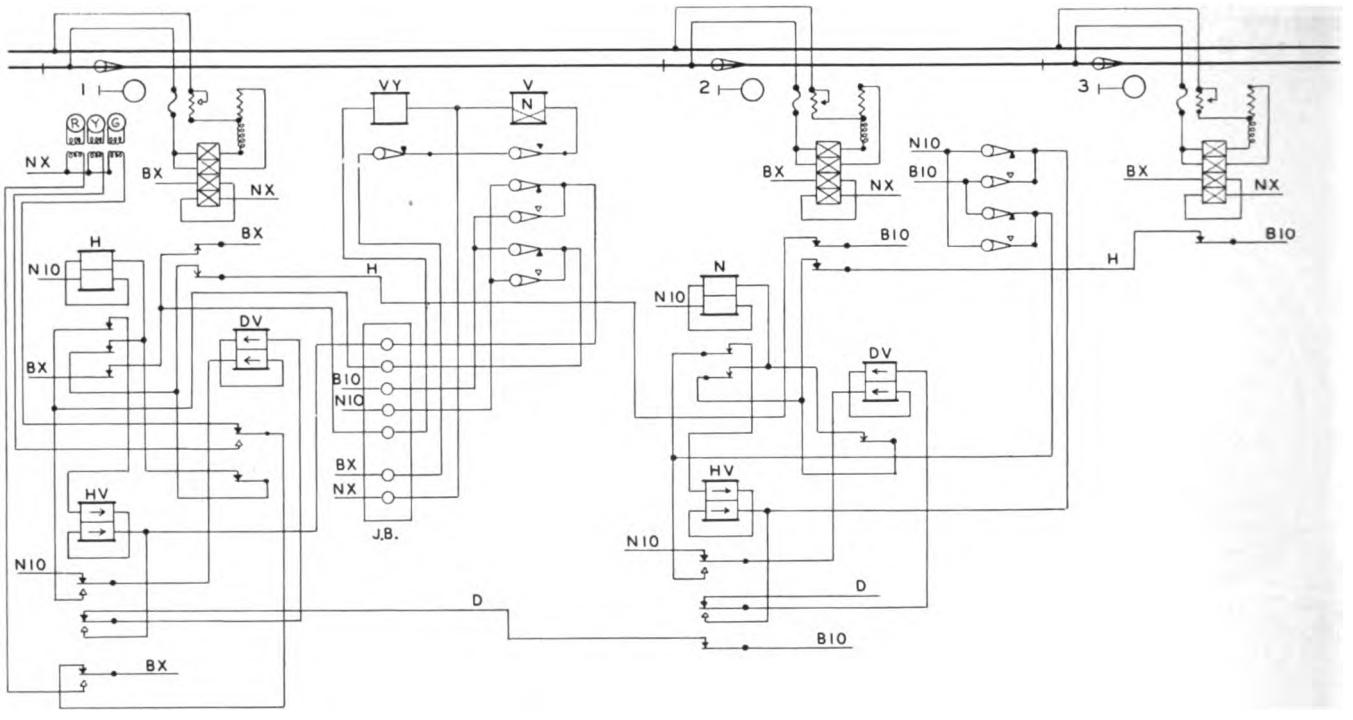


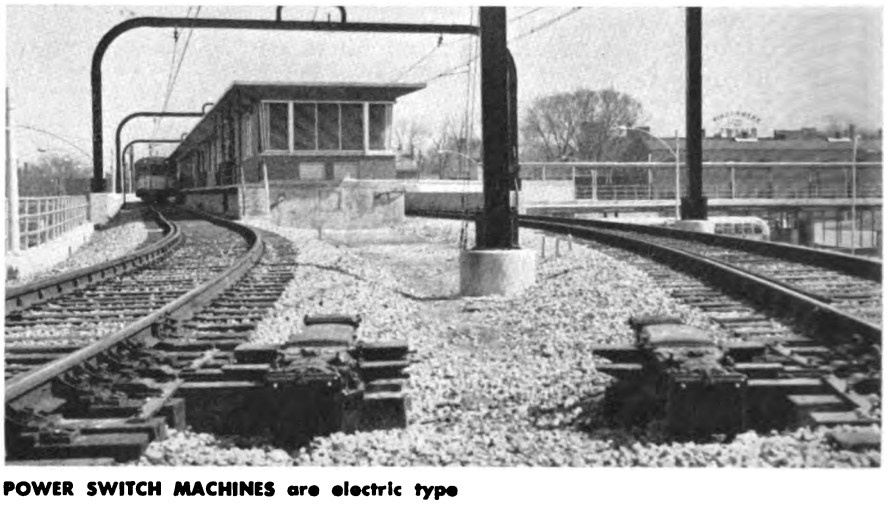
Fig. 5—COMPLETE CIRCUIT control of automatic block signals and automatic train stop

At the remotely controlled interlockings east of University-Cedar Station at East 29th St., and at each end of the West 30th St. yard, the switch machine motors are rated at 24 volts and are fed from sets of 14 cells of Exide 240 a.h. storage batteries which also feed the coding apparatus. Line circuits are fed from rectifiers. The automatic signal line control circuits are on No. 14 wire in aerial cable, which ranges up to 12 conductors.

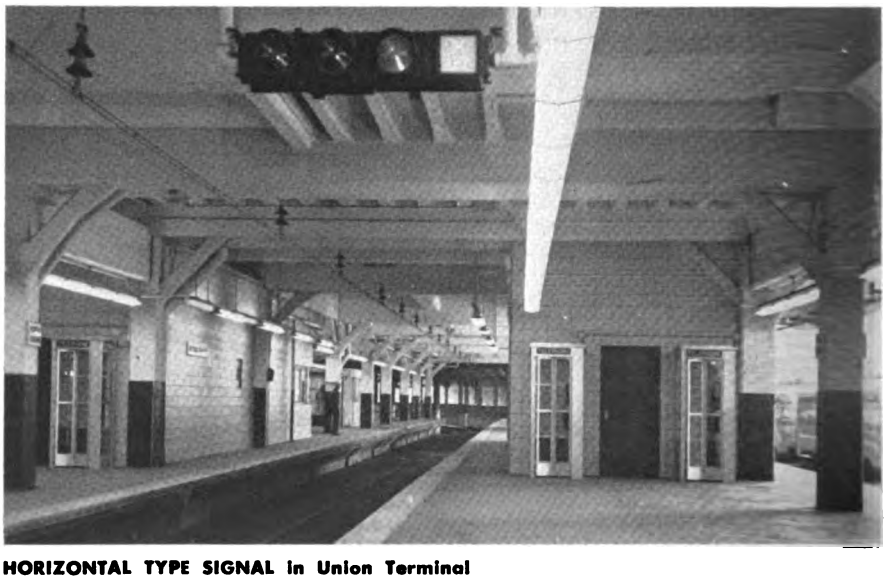
The switches and signals in the interlocking at Windermere are controlled by conventional direct-wire circuits, and Syncrostep equipment, operating on two line wires, is used from Windermere for remote control of the switches and signals at the center siding east of University-Cedar. Likewise, Syncrostep is used for remote control from Union Terminal interlocking to the crossover at 29th St. and the junctions east of East 55th St. and at Kinsman Road and for the yard entrance switches near West 30th St.

De Leuw Cather & Co. acted as consulting engineers for the Rapid Transit, J. H. Butridge, signal engineer. The General Railway Signal Company supplied all materials and Collier Construction Company made installation.

Work was done under the direction of Morse W. Rew, chief engineer, Cleveland Transit System, H. G. Morgan, electrical engineer and L. E. Madison, supervisor of signal maintenance.



POWER SWITCH MACHINES are electric type



HORIZONTAL TYPE SIGNAL in Union Terminal