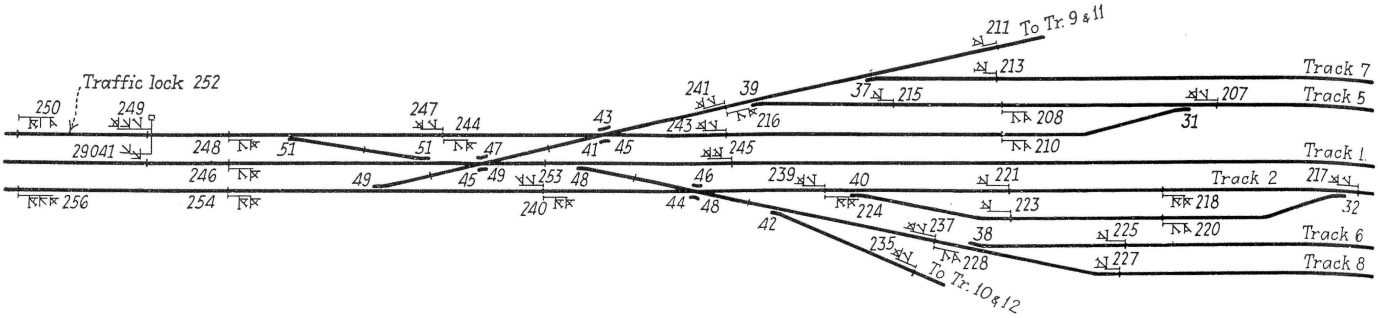
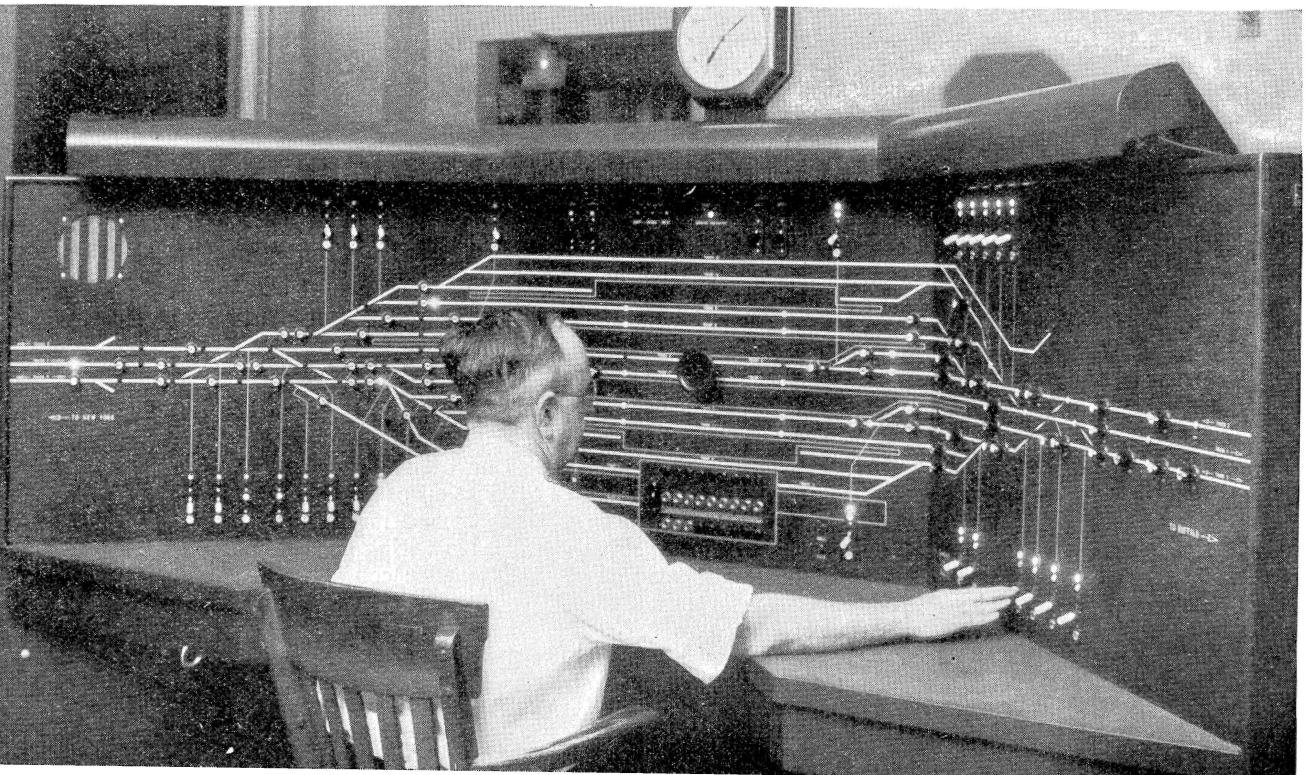


All-Relay Interlocking

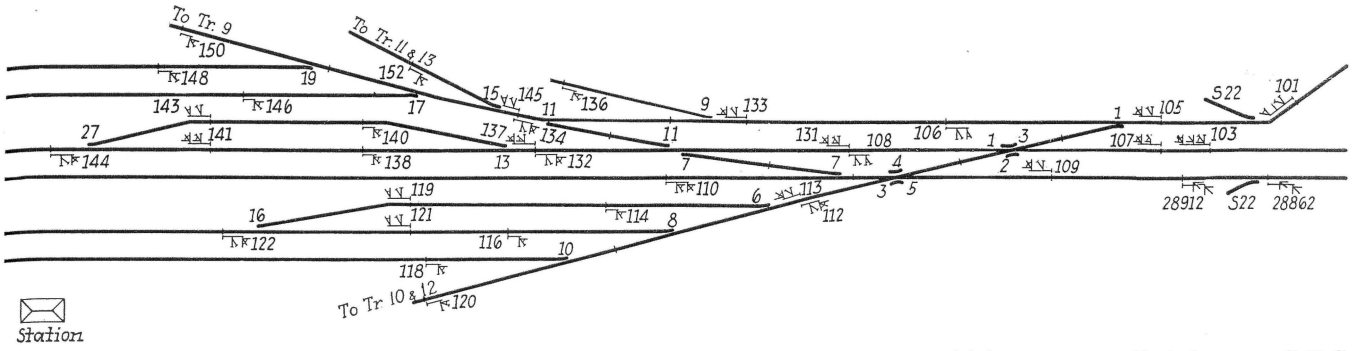
C.T.C. panel-type interlocking machine with miniature non-interlocked levers—Dwarfs used as home signals—Operating and control circuits normally fed from rectifiers

As a part of a major improvement, involving a new grade separation throughout the main section of the city of Syracuse, the New York Central has constructed a new passenger station including a new track layout, an important part of the project being the installation of a General Railway Signal Company electric interlocking. The new track construction extends for about five miles between a connection with the old line at Signal Station 48 at the east end of the project, and another connection with the old line at Signal Station 2 at the west end of the improvement. In this area, the new three-track line is elevated on new bridge structures over 23 streets, while 1 street crosses overhead.

Three tracks extend throughout the elevation for five miles between Signal Stations 2 and 48. Tracks No. 1 and 2 are through passenger tracks. The third track, No. 5, extends from Signal Station 48 westward for about 0.4 mile to a connection with a coach yard. From this yard, track No. 5 extends westward through the station layout, and from the station westward to Signal Station 2, track No. 5 is a running track for St. Lawrence division trains to and from the passenger station. As shown in the diagram, the station layout includes 10 through tracks, 5 stub-end sidings for coaches or express cars, 3 double-end sidings for two coaches each and 1 for three coaches. For the present, it is not planned to use the four outside tracks, No. 10, 12, 9 and 11, for regular train movements and, therefore, the switches leading to these tracks are equipped with hand-throw stands. Ordinarily, through passenger trains will be handled on tracks No. 1 and 2. Counting branch line trains as well as



The miniature-lever type machine with no mechanical locking controls the entire interlocking in station area



On N.Y.C. at Syracuse

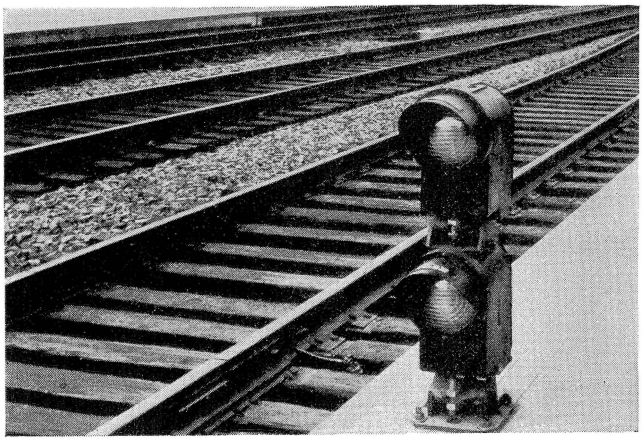
through trains, about 100 trains will use the station daily.

In the interlocking limits, between home signals 105 and 254, all of the signals are of the dwarf type. About two-thirds of these dwarf signals are provided with two operative units, and a considerable number of the units operate to three colors, while others operate to only two. The aspects and indications are explained in the accompanying table. An interesting feature of the signaling arrangement is that the two main tracks, No. 1 and 2, are signaled for through nonstop train movements at maximum authorized speed, signals 254, 240, 224, 218, 110, 107, 131, 137, 141 and 245 displaying an aspect of green over green for these movements.

The Control Machine

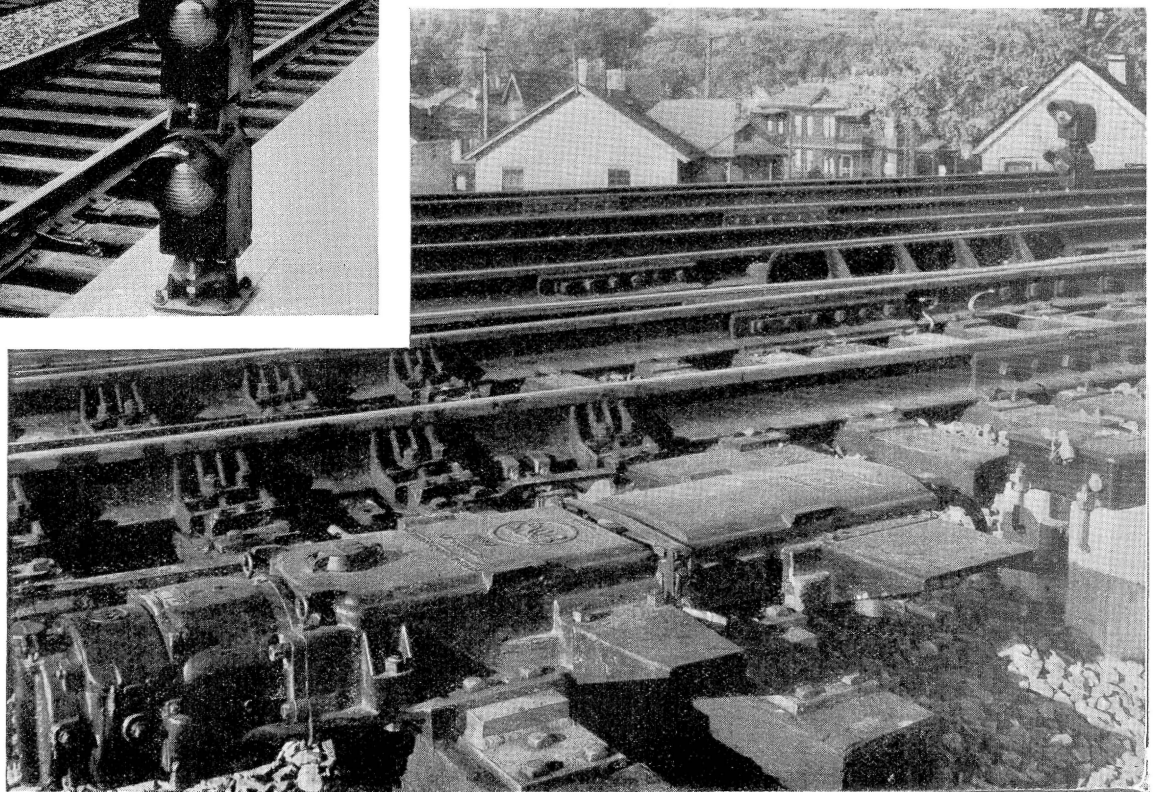
The interlocking limits between home signals 105 and 254 include 60 signals and 41 power-operated switches, slips and frogs, all of which are controlled from a C.T.C. panel-type control machine located in Signal Station 1, the operating room forming the top floor or penthouse on the track side of the station building as shown in one of the illustrations. This room has four windows on each of three sides, facing to the track and in each direction along the tracks, so that the operator has a view of the station track layout. The control machine is arranged in three panels, the end panels being set at an angle of 45 deg. with the center section, so that the operator can reach all of the controls without leaving his chair. Each section of the panel is 27 in. high and 36 in. long.

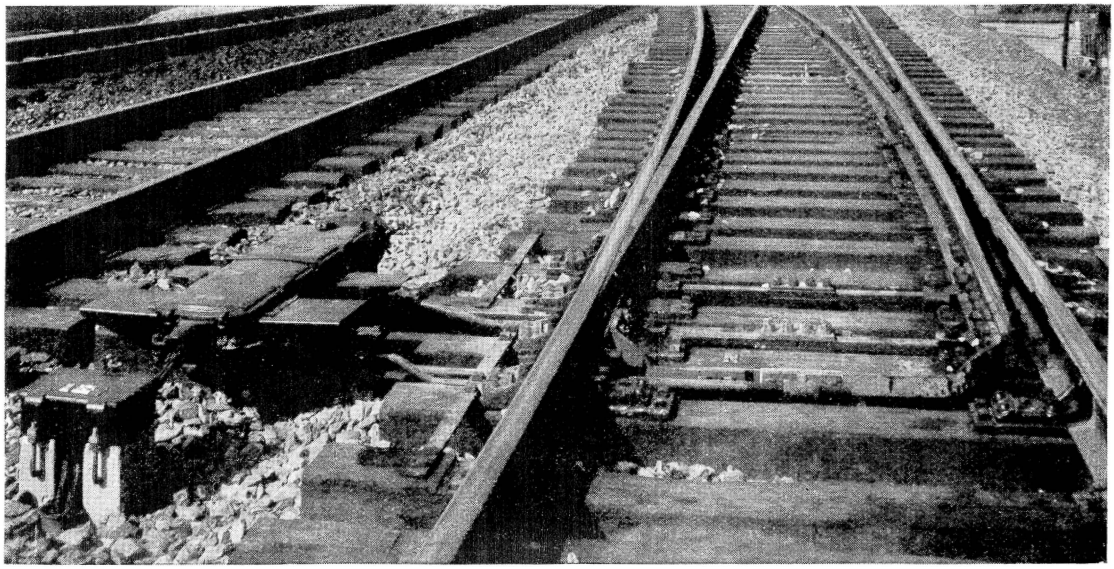
As shown in the illustration, each track in the layout is represented on the panel by a white line. The occupancy of each track section on the plant is repeated on the diagram by a normally-extinguished red lamp, mounted in the line representing the track, and lighted during the time the track section is occupied. Each



Two-"arm" dwarfs provide a complete range of multiple aspects

The switch machine fits between blocks which are welded to the tie plates





The switch layouts are well constructed — Note inside brace on tie ahead of the points

signal control knob is located on the board in a position corresponding to that of the signal on the ground, and its normal position is marked by a white dot. The indication is given by the knob being rotated one-quarter turn to bring this dot to the top. The circuits are so arranged that, when the knob is turned up, the semi-automatic indication will be displayed if the track section is unoccupied, and the restricted speed indication will be displayed if the track section is occupied. However, if a train passes a signal into an unoccupied track section, the signal displays a stop indication behind the train and it is necessary to restore the signal control knob to the normal position and again operate the knob in order to display a restricted speed indication into the occupied track section. A frosted glass in the center of each knob has a black arrow indicating the direction for which the signal is displayed, this arrow being illuminated when the signal is indicating proceed.

Switch Operation

Each switch or crossover is operated by a small lever located on the control board either above or below the track diagram, a line extending from the lever to the diagram showing which switch is controlled. The lever operates to two positions, in a vertical direction, down for the switch normal and up for the switch reverse. Two small lamps are located just above each switch lever. The top one, which is yellow, is lighted when a switch is out of correspondence with the lever and is extinguished only when the switch movement is fully completed and is again in correspondence with the lever. The lower one of the two lamps is red and is lighted when conditions are such that no action would result from the operation of the lever. This lamp, known as the "hands-off" light, informs the operator either that he has a signal cleared over that route, thus locking the switch in its present position, or that there is a train occupying the track, which likewise locks the switch. Therefore, nothing would be accomplished by operating the lever. Moreover, the "hands-off" light is lighted and the switch is locked when the signal lever for that route is operated. The only way to produce operation of a switch is to move the lever from the in-correspondence position when the red light is not lighted. If the switch lever is moved when the switch is locked (red light is lighted), the correspondence light also lights and both lights remain lighted, even though the condition which originally lighted the red light is corrected. Under such circumstances, proper operation can be effected by replacing the lever to the other position and starting over again.

Movable switch points are provided in the track diagram, these miniature points being moved by magnets which are controlled from the switch-lever repeating relay, the points on the diagram moving to the corresponding position of the switch, the result being that the operator can glance down the track line on the diagram and follow through the entire route which is lined up. This, then, is an efficient means of checking routes, as compared with having to check lever positions.

An important feature of this plant is that there is no mechanical locking, as ordinarily used in interlocking machines. The operator is free to move any control at any time, incorrect operation being prevented by the interconnections of the control circuits. For example, if the operator lines up a switch and clears a signal for the route over the switch, he may again operate the switch lever, but the switch will not operate until he has replaced the signal control knob to normal and again moved the switch lever, thus changing the indication to *stop* and enforcing the elapse of a time-locking period before the switch can be moved. One of the advantages of having no mechanical locking is that the levers can be operated quickly without waiting for indications and without being confined to a certain sequence in the operation of the controls, all of which facilitates the changing of line-ups, thus preventing train delays.

The operation of the control machine is very simple. To bring a train into the station on either of the two main tracks, No. 1 or 2, would require only the operation of the control knobs to clear the signals for the route. The departure of the train on either of these tracks requires only the operation of one signal. To run a train into or out of any of the other tracks requires the operation of one or more switch levers in addition to the signals.

Accessory Equipment on Machine

A special study was made to mount all of the accessory control and communication equipment in the face of the control panels so as not to have various pieces of apparatus attached to the machine in an unsightly manner. The telephone transmitter is mounted behind the center of the control panel with the mouth piece in front of the panel directly before the operator. The jack box for connecting the operator's phone to various circuits is mounted behind the panel so that the jacks are flush

with the face of the board and concentrated in a small area in the center lower section of the panel.

The operator's head-set receiver is cord connected and, when not in use, hangs on a hook at the left of his chair. A loud-speaker is mounted behind a grill in the upper left section of the control panel. This loud-speaker is normally connected to a circuit extending to the dispatcher's desk as well as to outdoor type phones located at home signals, passenger station gates, on columns near the end of each track platform, and in the relay room, so that the dispatcher, train conductors, gatemen, or the maintainer can talk directly to the operator.

At the top of the center section of the panel there is a set of switches and lamps, for the control and indication of feeds for certain power circuits. The two switches at the left control the dimming of the signal and machine lamps at night, and the two at the right are for the control of power to the switch machines, one for the east end, the other for the west end. The indicator lamp, illuminated in the illustration, indicates whether power is feeding on the main a-c. supply.

A channel reflector, with lamps, across the top of the entire board, affords direct illumination over the control panels without shining in the eyes of the operator. An electric clock, painted to match the color of the control cabinet, is mounted above the machine. This clock is driven by an a-c. synchronous motor and, as explained later, a-c. is always available so that the clock will not stop if the main a-c. supply is cut off. Thus the entire control machine is complete in all details and presents a uniformly neat appearance.

Control Circuits

Although the control machine is of the C.T.C. panel type, the circuits of the Syracuse plant do not utilize coding equipment but are based on complete two-wire circuits throughout. The locking for routes and between opposing signals is effected by circuits through relays which repeat track circuits, switches and signals.

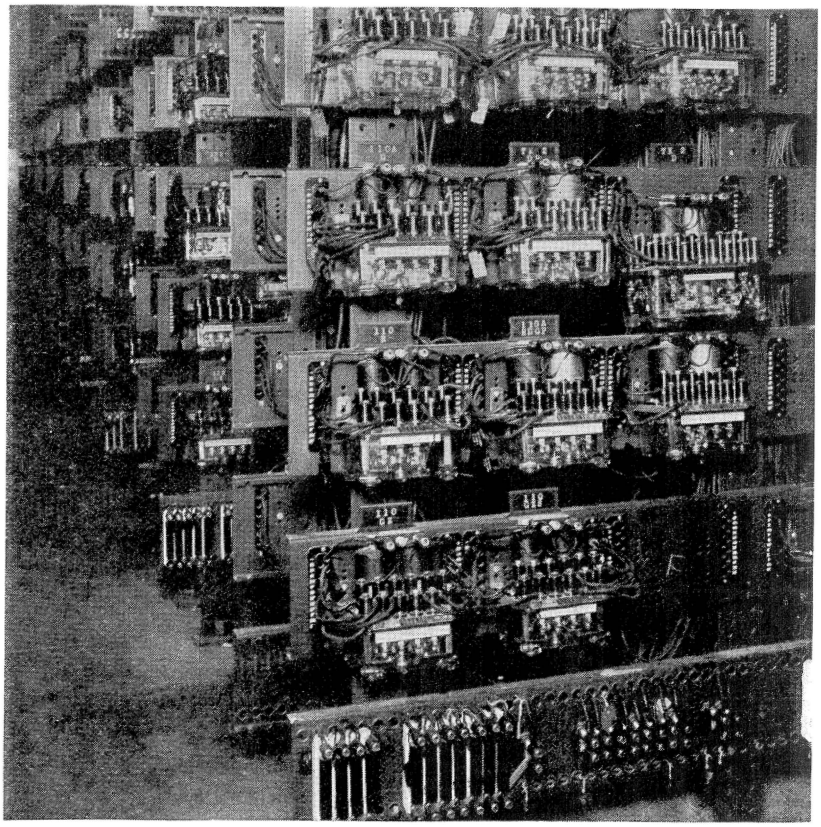
The switch machines are the Model 5-A with brake, equipped for operation on 110 volts d-c. An important feature of this Syracuse plant is that the so-called master relay, ordinarily housed in this type of switch machine, has been eliminated. The relay performing this function is housed in the relay room at the signal station, each switch being controlled and operated by a two-wire, 110-volt d-c. circuit from the signal station to the switch. The pole-changers in the switch machine are of the type which automatically center so as to open all circuits if a mechanical connection to the pole changer becomes disconnected.

The indication as to the position of the switch and the point-detector is carried from the switch on a separate two-wire d-c. circuit, controlling a d-c. polar relay, known as the WP switch-position relay. Signal circuit controls over any given switch check not only the contacts of this WP relay, but also those of the relay indicating the position of the lever controlling the switch, assuring the correspondence of the switch and its controlling element. Time locking, to prevent changing the position of a switch in a route for a certain period after a signal is taken away, is provided for all signals by means of 15-sec. thermal releases. In addition to this, 3-min. clock-work releases are provided for high-speed through movements on tracks No. 1 and 2 when signals indicate green over green.

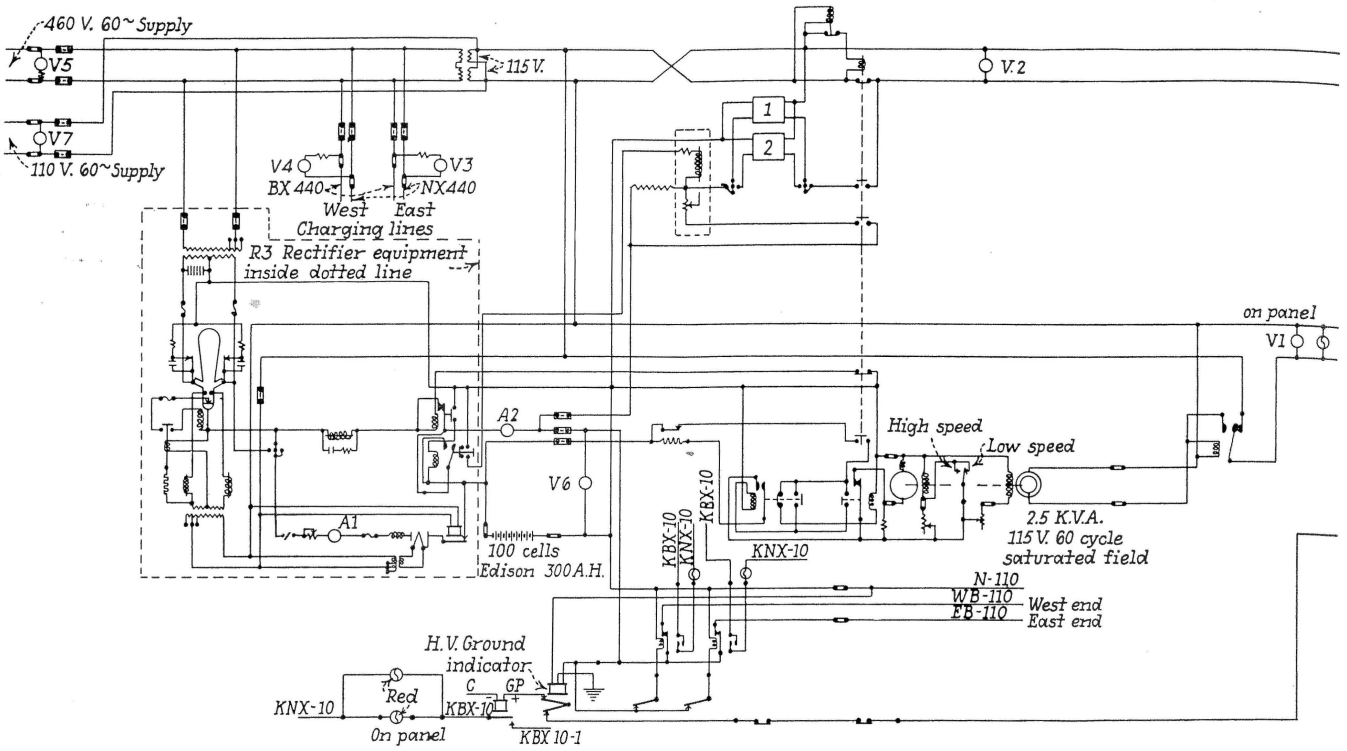
Construction in Relay Room

All of the relays for the entire plant, totaling 1,072 relays, are housed in a room 20 ft. wide and 60 ft. long, which forms the entire floor of the building just beneath the control room. These relays are of the wall-mounted, spring-supported type, and are attached to sheet-metal panels supported by angle-iron uprights extending from the floor to the ceiling, which go to make up the Raco metal relay racks. The face of each panel is 8¼ in. high. The first panel is set 16 in. from the floor and there is 4-in. vertical space between each of the seven panels, the top edge of the upper panel being 30 in. from the ceiling.

The racks are set back to back 21 in. apart, with 3/16-in. through bolt spacers, each surrounded by a hard fibre tube, the space between the racks being used for wire and cable runs which are supported by the insulated spacer bolts. There is a total of seven sets of racks, a space of 49 in. being allowed from the face of one rack to the next. Wires coming from above the racks are terminated on terminals on the top panel and wires or cables coming in from below are terminated on the bottom panel, the five intermediate panels being used for relays. Alongside the space for each relay there is a bakelite template with holes through which the wires are carried, each hole being stenciled to designate the wire identification. A matter of special interest is that, after the wires are in place on the relay, each post is equipped with a Raco insulated top nut which prevents accidental shorting of the terminal posts. The



Sheet-metal racks are used in the instrument room in the main signal station



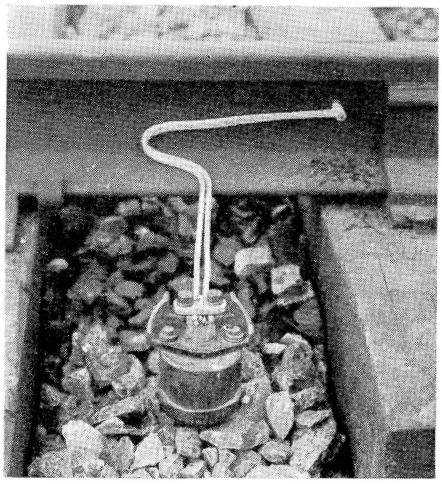
wiring in the relay racks and up to the control machine is No. 14, 19-strand flexible wire with 4/64-in. rubber wall insulation, with braid especially treated to make it non-flammable.

All of the relays associated in the control of a switch and the signals governing routes over the switch are assembled together on one section of a rack, and the Raco enclosed fuse plug cut-out for the switch operating circuit is mounted on the bottom panel below the switch relays. With this arrangement, a maintainer can make inspections or locate improper operation quickly.

Main Wire Distribution

The main distribution of the circuits from the instrument room over the plant area is in rubber-insulated, lead-covered cable, made up according to New York Central specifications and furnished by two manufacturers, the General Cable Company and the Anaconda Copper Company. In order to obtain uniformity, the cables were made up so that the outside diameter is about 2 in. and the weight about 4 lb. per foot. From the instrument room, the cables run down a vertical shaft to the track level, and are then supported in hardwood clamps which are spaced 3 ft. apart and are attached to the ceiling of a hallway extending to each end of the building. A concrete retaining wall extends about 500 ft. in each direction from the building, a duct line for the signal cables being provided in this wall when it was constructed. From the end of this wall a duct line of fibre conduit laid in concrete was extended as required for the lead-covered signal cables. From manholes on this line, underground cable extends to the switches, signals and track connections.

An important feature of the construction is the method of pot-heading the lead-covered cables. In the tower, instrument cases or junction boxes, wherever such a cable terminates, the complete cable is run as near as possible to the terminal board. The lead cover and outer protection is removed and a pot-head sleeve applied. The bare insulation on each of the separate insulated conductors extending beyond the lead cover is then protected by a cotton fabric sleeve, one end being sealed in the pot-head and the other end painted with insulating paint.



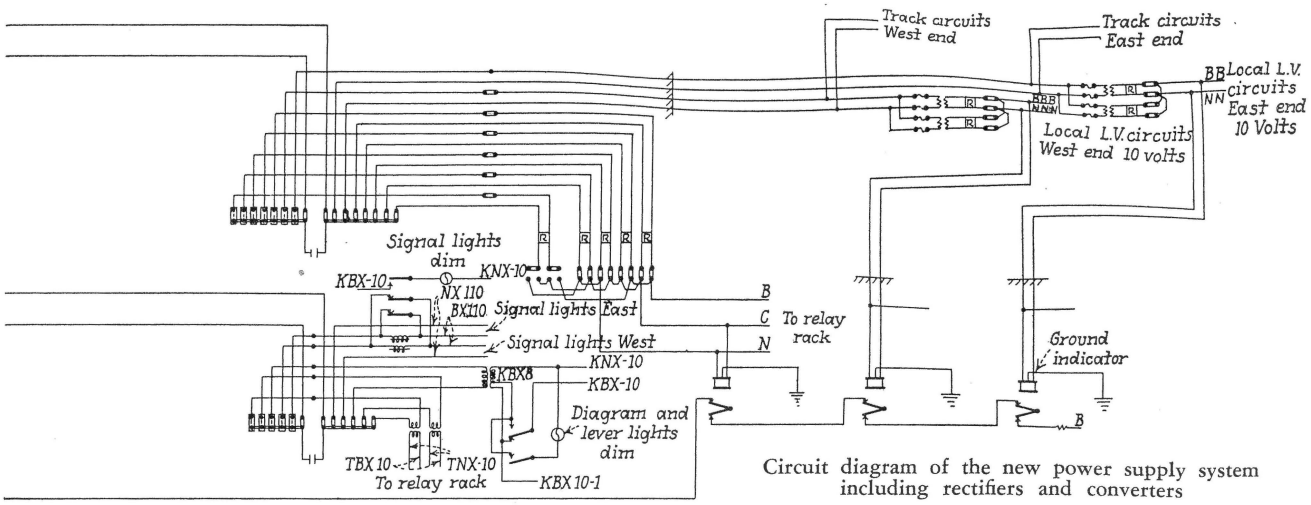
Parkway bootleg outlet and rail connections are readily inspected

Switch Construction

The mounting of the switch machines on the ties is of special interest. Each switch machine is supported on two ties, being mounted on ¾-in. tie plates 7 in. wide made up with 2-in. butt straps welded in place so that the switch machine fits snugly between these blocks. Each tie plate is fastened to the tie by three ¾-in. by 6-in. lag screws at each end, and in addition, four lag screws extend through the switch machine lugs and tie plate to the tie. With this construction the machine is held rigidly in place.

Where clearance was available, the switch machines were set outside of the clearance line with the center line of each switch machine 3 ft. 11 in. from the gage of the rail so that it was unnecessary to frame the tie. Where clearance was not available, the center line of the switch machine was placed 3 ft. from the gage of the rail and the ties were framed 2¾ in. in order that the switch machine would not extend above the top of the rail.

The tie plating and the rail bracing for the switches is in accordance with New York Central System standards for all main line switches and includes adjustable rail braces on six ties, including the one ahead of the switch point. In addition, a fixed rail brace is located on the gage side of the rail on this tie. Raco



Circuit diagram of the new power supply system including rectifiers and converters

switch adjusters are used, and Raco self-adjusting controller sockets and connections are used for the point detector connections.

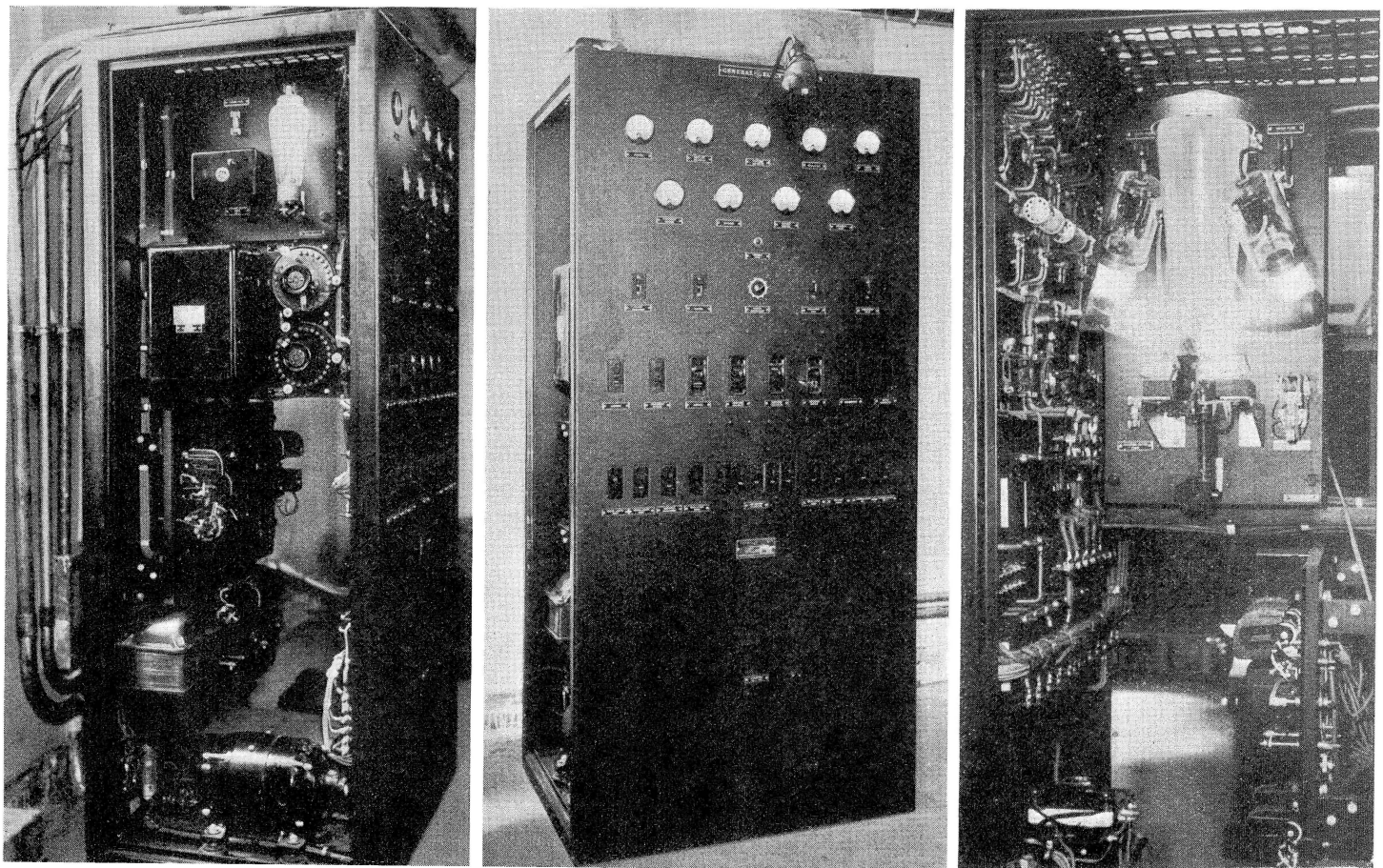
Special System of Power Supply

The system of power supply used at this Syracuse installation represents a further application of new types of equipment, such as mercury pool rectifiers, phanotron tubes, dry-plate rectifiers and motor-generators. The special feature of this new installation over and above systems installed previously is that the track circuits and d-c. control circuits are fed from rectifiers, not only normally but also in case of a power outage, no directly connected stand-by batteries being provided for these circuits.

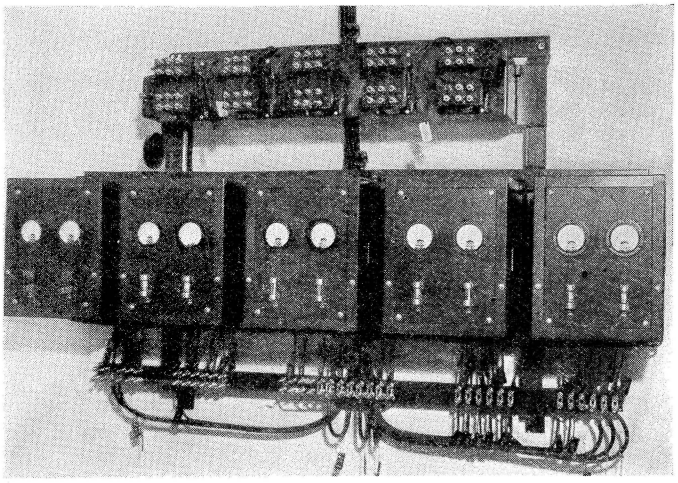
The 110-volt d-c. bus for feeding the switch machines is normally supplied with power from a mercury pool rectifier, rated at 50 amp., 120 volts output. This rectifier normally operates constantly. However, when no switches are being operated, the no-load loss of the tube and tube auxiliaries is about 250 watts. The starting of the mercury-pool rectifier is automatic, using a scheme in which, by means of an electro magnet outside the tube, a contact over the mercury pool is drawn down into the mercury to strike the arc. The mercury-pool tube is of a design specified by the signal department of the New York Central, differing from the conventional type of mercury-arc rectifier tube in that the anodes are sealed in with fernico, a metal having the same expansion characteristics as glass, thus permitting peak currents several times those permitted with a conventional pinched glass seal. A new feature on this tube is that automatically-controlled electric heaters are provided for the anodes.

Only one battery is provided for the entire plant, and this is a set of 100 Edison nickel-iron cells, Type-A8H, rated at 300 a.h. The battery is on a floating charge of intermittent direct current taken from the

Power supply unit showing face of panel and a view from each side showing tubes, controller and converter



peaks of the cycles of positive current from the rectifier output. This result is effected by a FG-104 phanotron tube which acts as a valve, allowing current to flow into the battery when the instantaneous value of the rectifier output exceeds the battery voltage. With his arrangement, the potential of the high-voltage bus for the feed to the switch machines is maintained at only the desired voltage, as it is not affected by the charging voltage of the battery. The phanotron tube is rated at 6 amp. output, but the normal battery charging rate is about 1 amp.

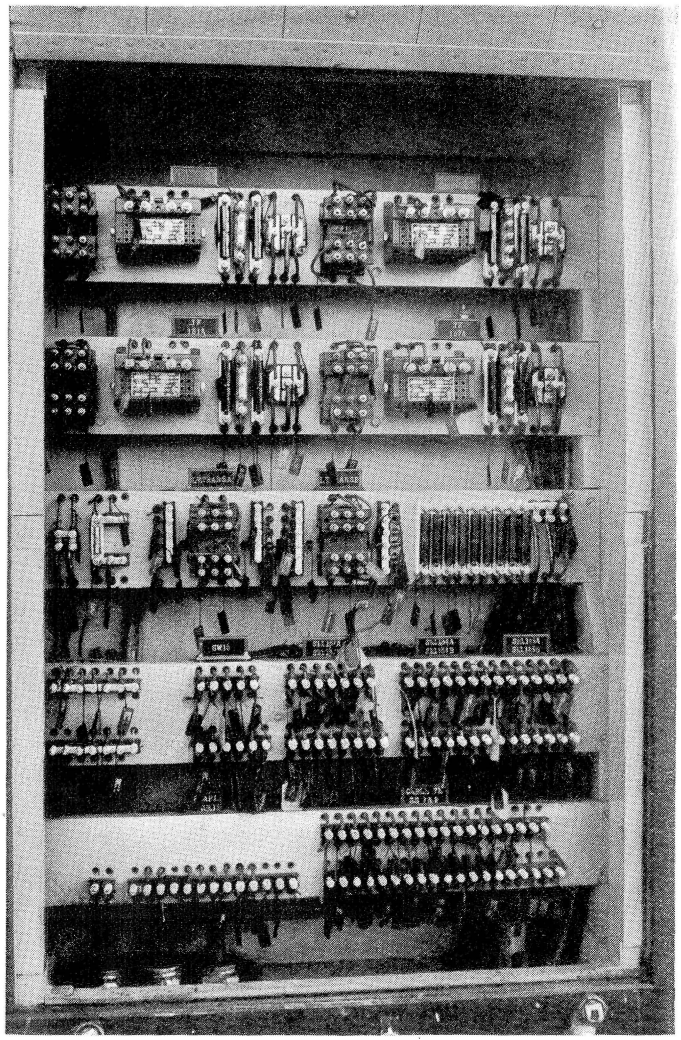


Transformers and rectifiers are used for low-voltage control circuits

Low Voltage Rectifiers

The low-volage d-c. control circuits are normally fed from a group of four G.R.S. Type-BPA, Size-248 dry-plate rectifiers, as shown in one of the illustrations. Each track circuit is fed by a G.R.S. Type-B-116, half-wave rectifier. Since the development of this system of feeding track circuits was developed, as explained in an article on page 363 of the July, 1935, issue of *Railway Signaling,* the benefits in improved shunting sensitivity have proved highly satisfactory on the New York Central.

It is of special interest to note here that these track rectifiers, with transformers and limiting resistances, are the only control apparatus located on the plant other than in the signal station building. The track circuit feed equipment for a dozen or more circuits is grouped in one case, as shown in one of the illustrations.

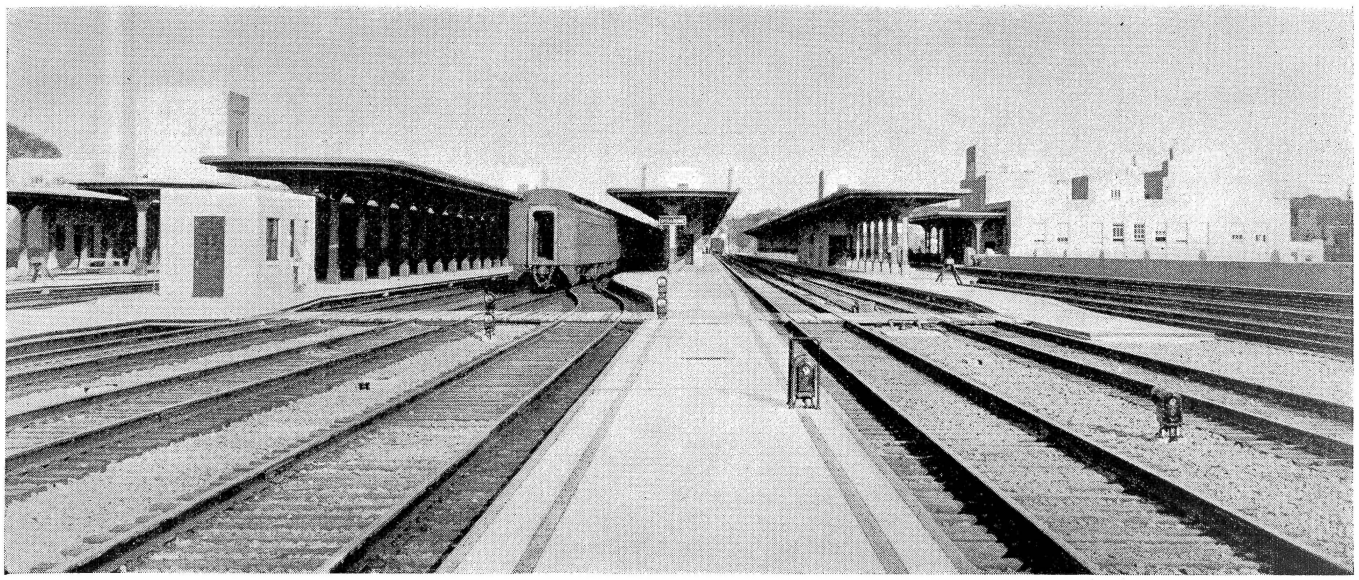


Interior of a field case for housing transformers and rectifiers for the track circuits

Track Circuit Reserve Power

As mentioned previously, the outlying rectifier-fed track circuits are not protected by a local battery stand-by. In case the main incoming sources of a-c. to the signal station all fail, the a-c. load of the track circuits and control circuits is switched automatically to the output of an inverted converter rated at 700 volt-amp. This small machine, shown near the floor in the illustration, is normally operated on a no-load output at about 3,700 r.p.m., being fed direct current from the mercury tube rectifier. In case the a-c. power goes off, a resonant relay releases to switch the feed for the track and control circuit rectifiers to the a-c. output of this small converter set, the d-c. motor end of the machine being fed from the 110-volt storage battery. The action of the resonant relay and attendant circuit controller is so fast that this change-over is accomplished within three cycles, or, in other words, within 1/20 of a second. Therefore, the d-c. track relays or the d-c. control relays fed from rectifiers do not drop during this change-over. This resonant relay also acts as a low-voltage, cut-over control. If the 110-volt feed drops to approximately 90 volts, the relay drops and functions as explained previously.

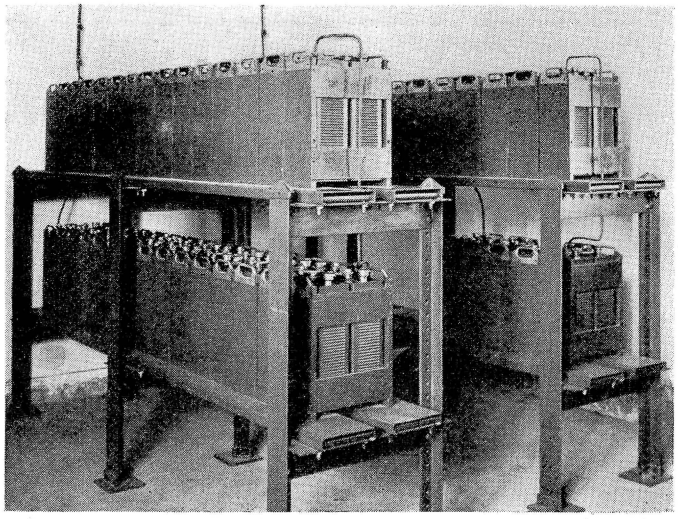
As the load is thrown on the converter, it slows down from 3,700 r.p.m. to 3,600 r.p.m., thus being exactly in step for 60 cycles. An automatic voltage regulator of the d-c. supply functions to maintain the correct speed. When the incoming a-c. power is restored, the normal a-c. feed circuit to the rectifiers is again reconnected automatically, and when the mercury tube rectifier is restored to normal operation, the feed for the d-c. motor end of the



View looking east—control station is in top floor of station building at right of tracks

converter is switched from the battery to the output of the rectifier. A duplicae converter is provided as a stand-by, each machine being run every other day.

So far no reference has been made to the signal lamp feed and the other illumination essential to the operation of the interlocking. Each of the SA-type signal units on the plant is equipped with a 10-volt, 15-



Only one battery is used for the entire interlocking

3.5 watt, double-filament lamp. These lamps are fed from 110-10 volt transformers located at central points over the plant area, the total signal lamp load being about 13 amp. at 115 volts. Obviously, this load could not be taken from the special 700-watt capacity converter mentioned previously. On the other hand, it is not necessary that the stand-by supply for the lamps cut in instantly, i.e., within a few cycles. Therefore, as an emergency supply for the a-c. signal lamp distribution circuits, a motor-generator was provided. The a-c. alternator end of this machine, rated at 2.5 kv.a. at 115 volts, is directly connected to a 5-hp. d-c. motor. When the main a-c. source of power is cut off, quick-acting relays connect the 110 volts d-c. from the main battery to start and run this motor-generator to supply 115 volts a-c. for the signal lamps. This motor-generator will start and attain speed so as to take on the load in a period of about 2 sec., so that there is no perceptible discontinuance of the signal aspects.

This interlocking was planned and installed by the signal department forces of the New York Central, Lines East, the major items of the interlocking equipment being furnished on contract by the General Railway Signal Company. Several crews, each under the direction of an assistant supervisor, were employed on different phases of the work, as many as 115 men being employed during the peak of the construction. First materials were received July 12, and construction was finished Septem-

Aspect	Indication
GREEN OVER GREEN OVER RED	PROCEED
GREEN OVER GREEN— DWARF SIGNAL	PROCEED
GREEN OVER GREEN— STAGGERED	PROCEED
YELLOW OVER YELLOW— STAGGERED	PROCEED PREPARED TO STOP AT SECOND SIGNAL
YELLOW OVER YELLOW— DWARF SIGNAL	PROCEED PREPARED TO STOP AT SECOND SIGNAL
YELLOW OVER YELLOW OVER RED	PROCEED PREPARED TO STOP AT SECOND SIGNAL
GREEN OVER YELLOW OVER RED	PROCEED, APPROACHING SECOND SIGNAL AT MEDIUM SPEED
RED OVER YELLOW OVER YELLOW	PROCEED PREPARED TO STOP AT SECOND SIGNAL; MEDIUM SPEED WITHIN INTERLOCKING LIMITS
YELLOW OVER RED OVER GREEN	PROCEED, APPROACHING NEXT SIGNAL AT SLOW SPEED
RED OVER YELLOW OVER GREEN	PROCEED AT MEDIUM SPEED, APPROACHING NEXT SIGNAL AT SLOW SPEED

ber 4, so that the plant was installed in less than 60 days.