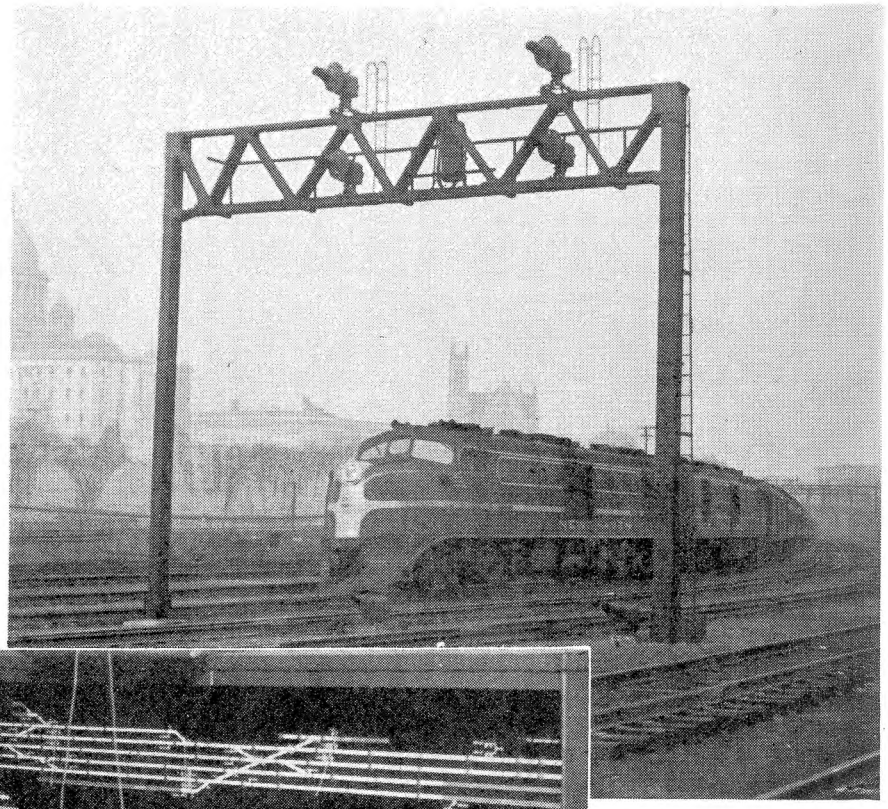
New All-Relay Interlocking at Providence, R. I., on the New Haven

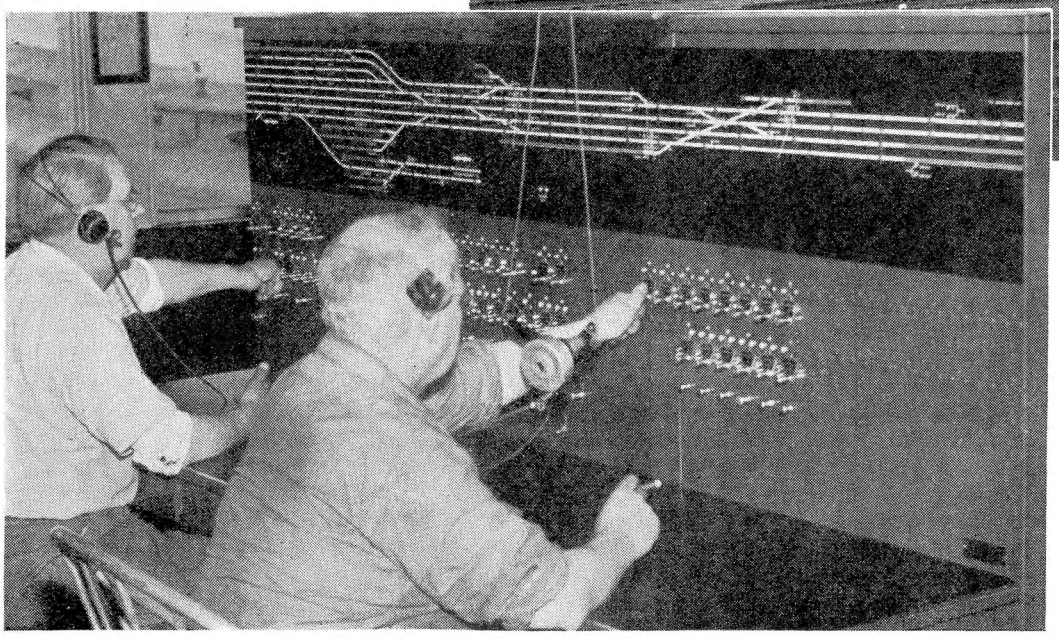
One new machine controls track and signal layouts which were formerly two interlockings, thus facilitating operations and reducing delays

THE New York, New Haven & Hartford has installed a modern all-relay interlocking at Promenade street in Providence, R.I., to replace two previous interlockings, the first of which was a 77-lever electric plant with the machine in the same tower where the new all-relay machine is now located, and the second was a 40-lever mechanical interlocking with the machine in a tower at Orms street, 3,200 ft. east of the new control machine at Promenade street.

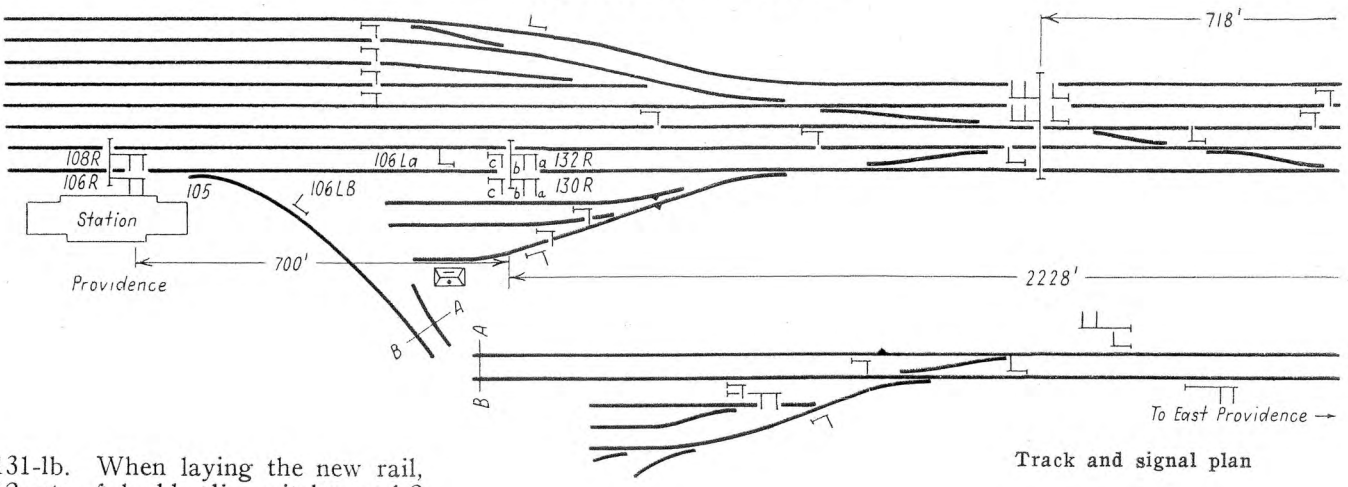
The old mechanical plant at Orms street had been in service more than 50 years and included detector bars, wire-connected semaphore signals and other items which were not in accordance with modern practices. The electric plant at Promenade street had been in service since 1909, was equipped with detector bars, and was in need of extensive replacements.

The construction of the new all-relay plant to replace the two old interlockings was a part of a project including the replacement of the rail on the four main tracks, as well as a simplification of the track layout through this area. The old rail was 107-lb., which was replaced with





Above — Westbound train passing the eastward signals 132R and 130R. Left—The new all-relay interlocking machine



Track and signal plan

131-lb. When laying the new rail, 12 sets of double-slip switches and 2 pairs of rigid crossing frogs were eliminated, being replaced by 11 crossovers and 2 single switches, the new track layout throughout being shown in the accompanying diagram.

This layout includes all the tracks at the east end of the Providence station, which is of the through type, other interlockings being in service at the west end of the station. Eight tracks extend through the station, with four main tracks eastward toward Boston. Also a single-track connects to a double-track line to East Providence.

This interlocking at Providence is on the main line which handles all the through traffic between New York and Boston including 72 through passenger and 40 through freight trains in addition to numerous local switching moves.

Power Switches

The new plant as a whole includes 11 single switches, 12 crossovers, 1 double-slip and 1 derail, thus requiring a total of 39 power switch machines, which are the Type-M2, rated at 110-volt d-c. The Type-F controllers are in separate cast-iron cases on foundations near the switch machines. The switch layouts are equipped with heavy plates and adjustable rail braces on three ties. On two ties the plates extend under the switch machines thus preventing lost motion. On some of the storage tracks, Hayes derails are pipe-connected to and operated by the switch machine at the turnout switch.

Plug-in Searchlight Signals

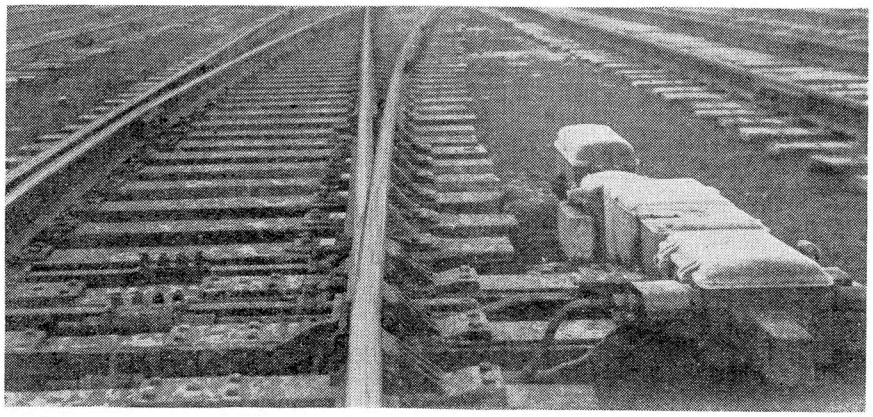
The new signals are the searchlight type with H-5 plug-in mechanisms, which can be changed out quickly without removing wire connections. The home signals governing movements on the four main tracks are all high signals on overhead signal bridges as, for example, one of the accompanying pictures shows the eastward home signal bridge with signals 130R and 132R. Each of these signals on the bridges consists of two searchlight heads. Both the upper and lower heads can display green, yellow or red. On the ground below each of the two signals on the bridge there is a dwarf signal which normally displays purple and can be controlled to display yellow as the call-on aspect or for slow diverging moves. Similarly the other high signals each have two operative searchlight heads, and a dwarf signal of the same number, when required, is located on the ground beneath each corresponding signal. Searchlight dwarf signals also govern moves from sidings, slow speed tracks and reverse moves. The complete layout is shown on the accompanying track and signal plan.

New All-Relay Machine

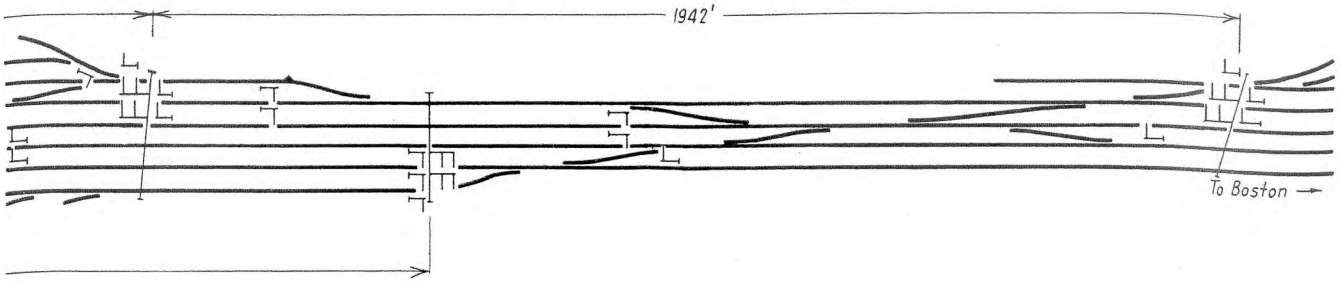
The new interlocking machine is of the panel type with miniature levers which have no mechanical locking between levers or electric lever locks, the interlocking being accomplished by interconnections of circuits. The panel of the machine, as shown in the accompanying illustration, is 30 in. high and 90 in. long. The illuminated track diagram on the upper section of the panel includes lamps which are lighted to repeat occupancy of the 49 corresponding track circuits in the entire plant and approach sections.

The switch levers, 25 in number, and 1 electric lock lever are located in the first row under the track diagram. These 25 levers control 11 single switches, 12 crossovers, 1 double-slip switch, 1 derail and 1 electric lock. Each switch lever has three indication lamps. When the switch controlled by a lever is in the normal position, a green lamp is lighted above the normal position of the corresponding lever. When a switch is in the reverse position, a yellow lamp above the reverse position of the lever is lighted. When WPR relay, switch repeater, is de-energized, neither indication lamp is lighted. When electric locking is in effect to prevent the operation of a switch, even if the lever were thrown, a red lamp is lighted above the lever.

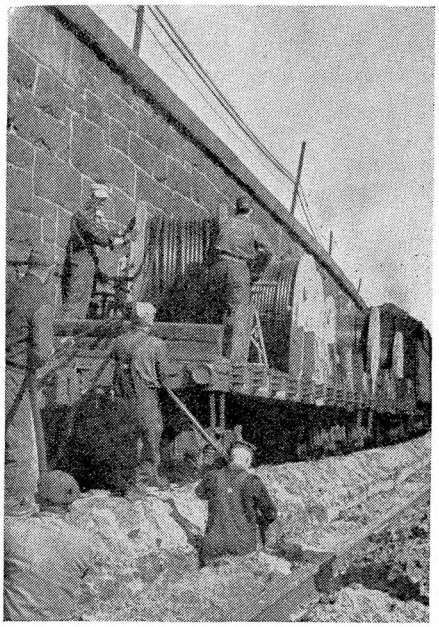
Directly below the switch levers there is a row of 21 signal levers which control 68 searchlight signal units and two traffic levers for special controls. The signal levers stand normally on center, being operated to the left to control westward signals



New electric switch machine was installed



and to the right to control eastward signals. The Stop aspect of signals is repeated by a red lamp over the center position of the corresponding lever. The proceed aspect of the signal is repeated by a lunar white lamp above the left or the right position of the signal lever.



Method of laying cables

When a signal cannot be cleared because a train is occupying a track circuit in the interlocking limits, a Restricted-Speed, call-on aspect can be displayed by positioning the switch and signal levers and then pushing a button below the signal lever.

A-C. Track Feeds to D-C. Relays

The track circuits are fed from 60-cycle mains through transformers and rectifiers without batteries. The track relays of the plug-in type are 4-ohms with a 12-ohm adjustable resistor in series. Number 14 copper wires in cables are used between the nearest relay or terminal case and the track relay. Where the distance is not more than 2,000 ft. the track relays are located in the tower, in other instances the track relays are located in relay cases and repeaters are installed in the tower.

The arrangement of transformers with several secondary taps to which the rectifiers are connected provides for applying a voltage to the rectifier suitable for the varying lengths of track circuits and relay leads so that the adjustable resistor can be set at a uniform value and allow a good margin of adjustment for final setting. A 1-ohm resistor is used between the rectifiers and track. This arrangement provides good shunting characteristics and is economical in power requirements.

The 60-cycle mains, which are a three-wire circuit, also supply power to all the searchlight signal lamps through step-down transformers.

Switch and Signal Controls

The 110-volt d-c. power from storage battery in the tower is distributed on bus wires to the various switch locations, and the feed to each switch machine is controlled by a Type-F controller, which in turn is controlled through a d-c. 400-ohm polar relay designated as WR. Each WR relay is controlled by a two-wire polar circuit through contacts of a lock stick relay LSR and through lever contacts to low-voltage battery. Thus each switch is under direct control of its respective lever at all times except when its lock stick relay is de-energized.

If a route is lined up, a train has accepted the signal and is occupying the home signal limits, and if the operator inadvertently throws a switch lever, that switch will not operate even after the train clears the track circuits and releases the detector locking. This prevention of precondition of switch control is accomplished by controlling the lock stick relay so that relay will not be energized until the switch lever is placed in the position corresponding to that of the respective switch. The position of each switch is repeated in the tower by a polar d-c. relay (WPR) which is controlled by an individual two-wire circuit from the switch to the tower.

For each of the searchlight signals which operate to three positions there is two-wire d-c. polar circuit from the tower to the mechanism coil, and for each searchlight signal that operates to only two positions there is a two wire neutral d-c. circuit from the tower to the signal. In the tower, d-c. neutral relays control each signal aspect.

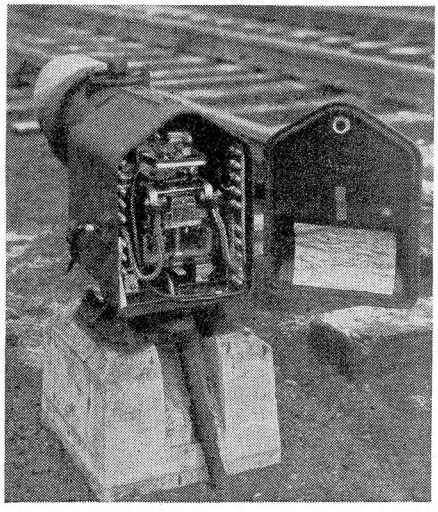
Signal Repeater Circuits

A neutral d-c. repeater relay in the tower, controlled by a two-wire circuit, is provided to repeat each yellow and each green aspect of every searchlight high signal. For a high signal, including two searchlight signal heads, the green and the yellow of each head are repeated separately as required.

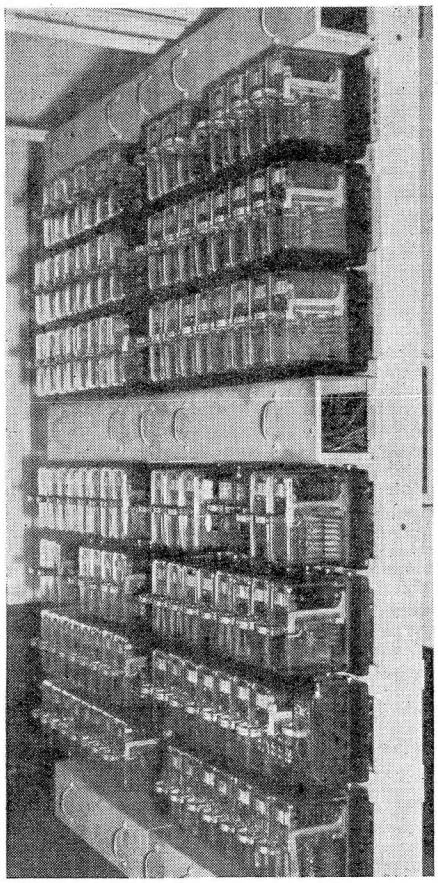
From the discussion so far it is evident that all the relays are in the tower with the exception of some lightout relays and the few track relays beyond 2,000 ft. limit distance from the tower, and these are repeated in the tower. With all these relays in the tower, the circuit interconnections to accomplish the locking are located in the relay room, which is on the ground level floor of the tower.

The signal controls in the tower are arranged as networks, which means that the portion of a circuit which is the same for two or more signals is used in the control of those signals, thus saving wire, reducing the number of contacts required, and improving the safety of the circuits.

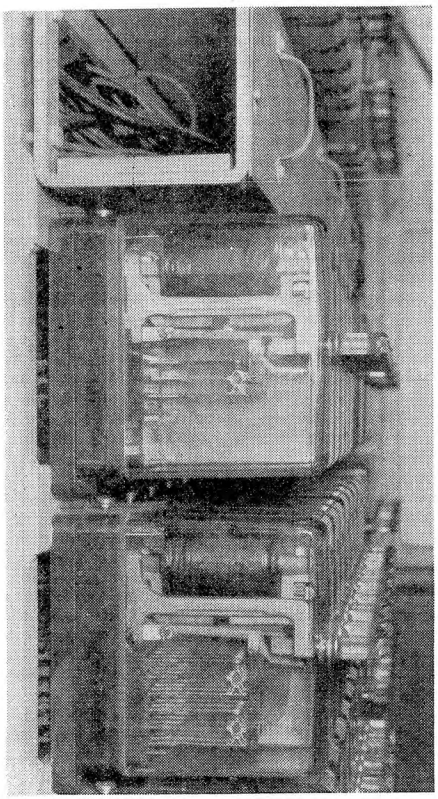
Two signal networks are used, the

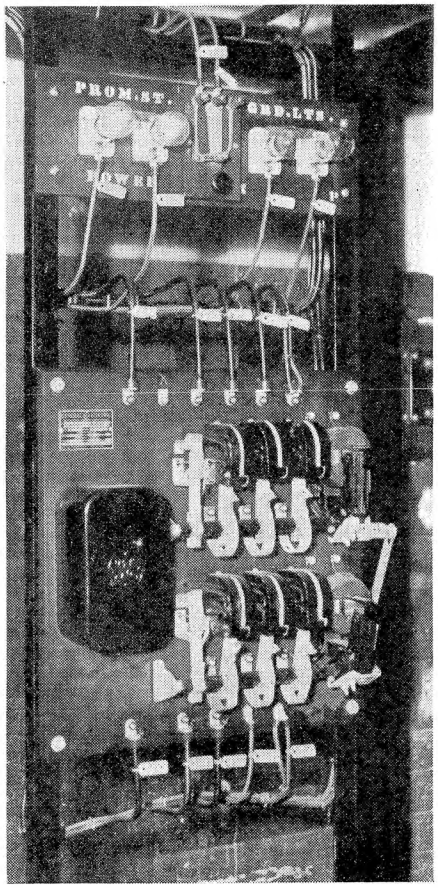


The searchlight signals are the plug-in type



Left—A rack including two panels of plug-in relays. Below—Side view of relays. Right—Automatic switching panel for feeding a-c. power

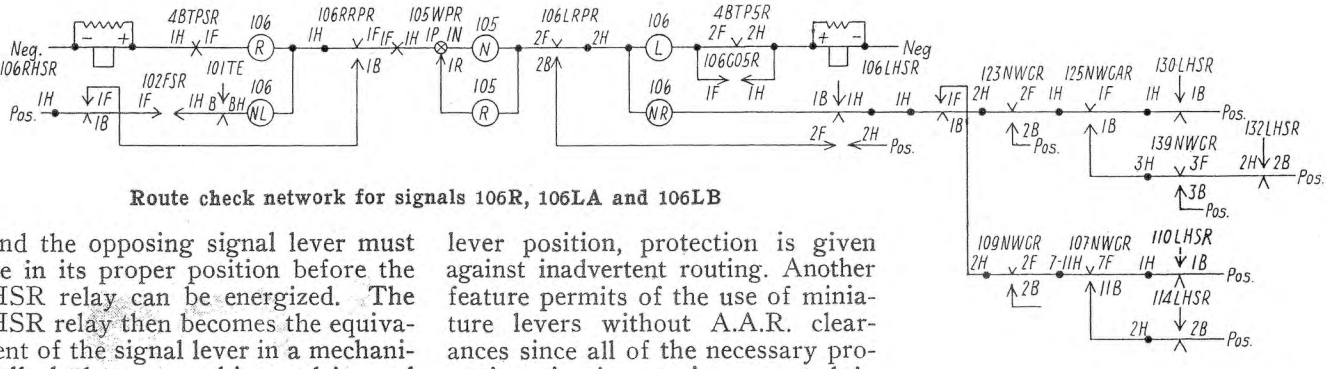




first or preliminary network being the "Route Check" network and the second being the standard, usual network which is taken over contacts having A.A.R. clearances.

The "Route Check" network provides the equivalent features of a mechanically-locked type of machine with indication magnets on the levers, in that the switch lever and switch must move into agreement switch levers, the signal will clear without waiting until all of the switch indications are received before the signal lever can be moved. Since the switches must move into or remain in agreement with the switch the route then set up does not affect the signal.

The diagram herewith shows the network circuits for signals 106R, 106LA and 106LB. A point of interest is that neutral and polar contacts of switch-repeater relay 105WPR, as well as switch lever contacts 105N and 105R, are included in this signal control circuit in a manner such that the position of the switch lever



Route check network for signals 106R, 106LA and 106LB

and the opposing signal lever must be in its proper position before the HSR relay can be energized. The HSR relay then becomes the equivalent of the signal lever in a mechanically-lock type machine and is used as such in the second or standard network. The route check network also provides other features not ordinarily found in a mechanically-locked machine, one of which permits of the rapid movement of the switch levers in a line up followed immediately by the movement of the signal lever to the position which is used to clear the signal and as soon as the switches in the operated route move into correspondence with the lever position, protection is given against inadvertent routing. Another feature permits of the use of miniature levers without A.A.R. clearances since all of the necessary protective circuits are incorporated in the second network.

When the HSR relay becomes energized, it remains energized over a stick circuit closed with the signal repeating relay de-energized, the first track circuit ahead of the signal unoccupied, the signal lever in the signal clear position, and the front contact of the HSR closed. Thus the HSR relay control is divorced from the rest of the network so that moving any lever which conflicts with must correspond with that of the switch in order to energize signal relay 106LHSR or 106RHSR.

Relays in the Tower

The relays are in a room on the ground level floor of the tower. All the relays are the plug-in, quick-detachable type to provide easier maintenance as they can be replaced quickly without the necessity for

changing wire connections. These relays are mounted on panels arranged on racks, as shown in one of the accompanying pictures. The wiring between the racks, and to the interlocking machine on the floor above, are in sheet-metal ducts.

The main power supply is from a signal power line between Providence station and East Providence, equipped with automatic switchboard at each end. This line is normally energized from Providence station. In case of power failure of normal supply, the line will be energized from East Providence. A third source of power is available at the east end of the plant, which will automatically be connected to energize the track circuit and lighting mains.

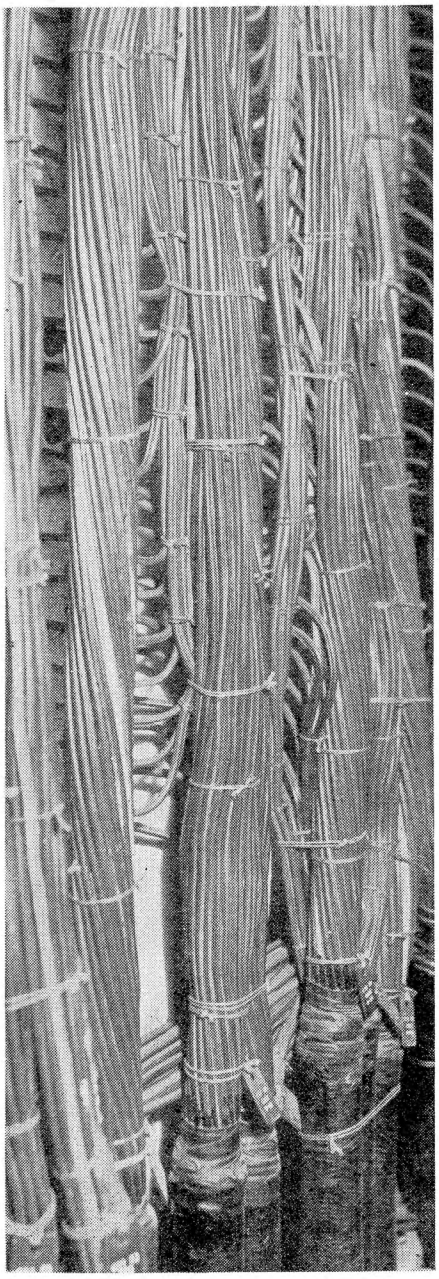
If the power is off or should the A-C voltage drop below a value which would allow the track relays to drop out a quick acting A-C SLV13 vane power-off relay having a high release value will drop out. Front contacts of this relay are used in series with the back contacts of the track relays in the automatic releasing of the approach and time locking stick relays. If this were not done, it would be easily seen that a dangerous condition would be set up should a signal be clear and a power interruption would occur which would allow the approach locking to be released in advance of an approaching train. Should a power interruption occur under these circumstances, the time element relay must function to obtain a release of the approach locking. After the release of the approach locking by time element, the power off relay can again be energized if the power is restored.

The signal lamps are the single-filament type rated at 10 volts, 25 watts. Each lamp is fed by a separate circuit from the secondary of a transformer in the tower or relay case. In series with each high signal lamp feed there is an RQ5 rectifier to energize a 4-ohm light-out relay. If the filament in a lamp fails, the light-out relay is released. Release of this relay establishes locking to prevent changes in switches or signals conflicting with the established route, the same as a back-lock circuit. All other circuits on this interlocking are of the direct-current type and are fed from storage batteries either in the basement of the tower or from a small battery house at the east end of the plant. These batteries in the tower are the Exide Type EIG9 rated at 252 a.h. on the 72-hour rate. The switch operating battery includes 60 cells. The 10 to 12 volt control relay and signal circuits are fed from different sets of cells. Batteries are charged by rectifiers from main power supply.

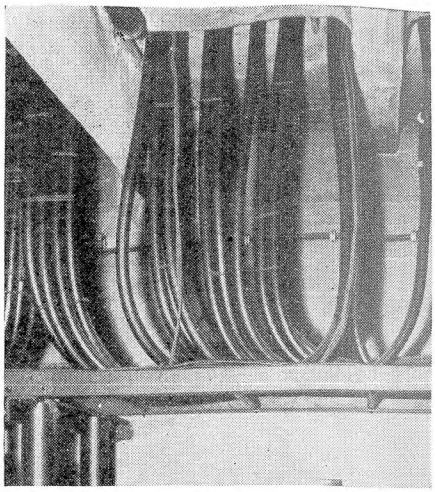
Cables and Wiring

Between the tower and the various junction boxes, switches and signals, the wiring is in underground cable, manufactured by the Okonite Company. In order to conform with wartime requests to save copper, all the control and indication circuits in these cables are No. 14 wire, but No. 6 was required for the 110-volt a-c. power distribution circuit and No. 6 for the 110-volt d-c. switch operating feed circuit.

The cables were laid in trenches at a depth of at least 30 in. below the level of the rail. Most of the cables were made up as 37-conductor, and the cables came in maximum lengths on large reels loaded on flat cars. By using jack stand bearings at the ends of a shaft through a reel, the reel could be raised and allowed to revolve to pay off the cable into the trench as the locomotive pulled the car along the track. Two or more cables, depending on the number of men available, could thus be laid with one trip. This method minimized the hard work and heavy lifting involved, and also reduced the chances for damage to the cable.



Cables of rear of terminal board



Iron rack in basement to support the cable and riser to board on floor above

At the tower, the cables were taken through underground holes at each end of the building which extend into the basement. Inside the basement, the cables are supported on a rack, made of a framework of second-hand angle-iron with 1-in. pipe crosspieces, all supported on old 3-in. boiler flue sections set upright. From this rack, the cables extend up through the floor, as shown in one of the views, to a terminal board on the ground level floor. At the rear of the board, the outer covering of each cable is removed and taped up, the individual insulated conductors being laced up and fanned out so that each goes through an individual hole in the board. This terminal board is made of ¾-in. fransite asbestos board bolted to angle iron upright supports.

On the front of the board a wedge-on connector is fitted to each wire end, and the lug of the connector is placed under the nuts on an A.A.R. single-post terminal. An identification tag is slipped over each wire and held in place flat against the board by means of a small tack.

This interlocking was planned and installed by the signal forces of the New York, New Haven & Hartford, under the jurisdiction of R. E. Taylor, Signal Engineer, the major items of equipment being furnished by the Union Switch & Signal Company.