Extensive All-Relay

Extensive layouts near Columbus, Ohio, including three connections to large yards, are controlled by one machine

New all-relay interlocking facilities, including three interlocking layouts controlled from one machine, have been installed just east of Columbus, Ohio, in a territory where the main tracks are owned jointly by the Baltimore & Ohio and the Pennsylvania. The construction of these new interlocking layouts was made necessary because of numerous changes and additions in the yards, as well as the connections between the yards and the main tracks.

The westward receiving yard, which is north of the main tracks, formerly had a capacity of only 450 cars. This yard was rebuilt to include seven long tracks and four shorter ones, totaling a capacity for 1,255 cars. A two-lane overhead highway bridge at Leonard avenue was replaced with a new bridge, allowing room for four main tracks as well as an extension of the yard farther westward.

Entire Layout 7,798 Ft. Long

The new track layout between home signals at Leonard avenue and Taylor avenue is 1,925 ft. long and includes 7 crossovers, 1 single switch, 1 switch-point derail and 11 signals. This new interlocking replaced a conventionally controlled electric plant. The new layout is known as Leonard avenue and is one of the three plants in this overall project.

At Sunbury Road there was previously a hand-operated switch at the former entrance to the westward receiving yard. As a part of the track changes, the westward freight track, No. 3, was extended through, and a new lead track was extended eastward from Sunbury Road. As a result of all these changes, the layout at Sunbury Road now includes one crossover, one single switch, one switch-point derail and five signals, which constitute the second of the three new electric interlockings in this project.

The eastward departure yard is south of the main tracks, and previously eastward trains entered the main track from the yard by a hand-throw switch located just west of Alum Creek about where the new interlocked switch No. 81 with derail is now located. In addition to this switch, the track improvements at Alum Creek included the installation of four crossovers and the two single switches with derails leading to the westward freight track No. 3 and to the yard lead. These switches, crossovers, two derails and the signals, constitute an entirely new interlocking layout which is the third of the three in this project. The three interlockings, Alum Creek, Sunbury Road and Leonard avenue, are all controlled by direct-wire circuits from a miniature-lever panel-type machine in a new tower at Alum Creek. The overall distance from the eastward home signal bridge at Leonard avenue to the westward home signal bridge at Alum Creek is 7,798 ft.

Panel-Type Control Machine

The panel of the new control machine at Alum Creek, as shown in one of the pictures, is 5 ft. long. The illuminated track diagram has lamps which repeat occupancy of various sections of track. On each line representing a track between layouts, there is a pair of blue lamps with arrows. When traffic is lined up eastward on a track between Leonard avenue and Sunbury Road, for example, the blue lamp and arrow pointing to the right are lighted. Or when traffic is lined westward on this section of track, the blue lamp and arrow to the left are lighted.

Above each switch lever there are three indication lamps. The green lamp, to the left above the normal position of the lever, is lighted to repeat the normal position of the switch, and a yellow lamp, above the reverse position of the lever, is lighted to repeat the reverse position of the switch. A red lamp, above the center of the lever, is lighted when electric locking is in effect to prevent operation of the switch even if the lever were thrown.

Above each signal lever there is a single red lamp which is lighted when the corresponding signals display the Stop aspect. When a signal is cleared, this red lamp is extinguished, and, on the track diagram, a green lamp is lighted in the symbol which represents that signal. If a signal is to be controlled to display a call-on aspect, the push-button below the lever is operated in addition to throwing the lever.

Automatic Train Graph

In the surface of the desk part of the machine there is an automatic train graph which has 14 pens that are operated to record the passing of trains through a corresponding number of track sections within the home signal limits and approach sections, while 11 other pens repeat the aspects of signals. The pens are operated on the polar principle, being moved to the right 1/8 in. when an eastward signal clears, or to the left 1/8 in. when the opposing westward signal clears. If a track section includes a switch, when the track is occupied the pen moves to the right if the switch is normal, or to the left if the switch is in the reverse position. Thus the route being used is recorded. Important reasons for providing this graphic train chart are to have a record of the passing of trains and to assist in the determination of the cause of any trouble if the information on the chart record is required.

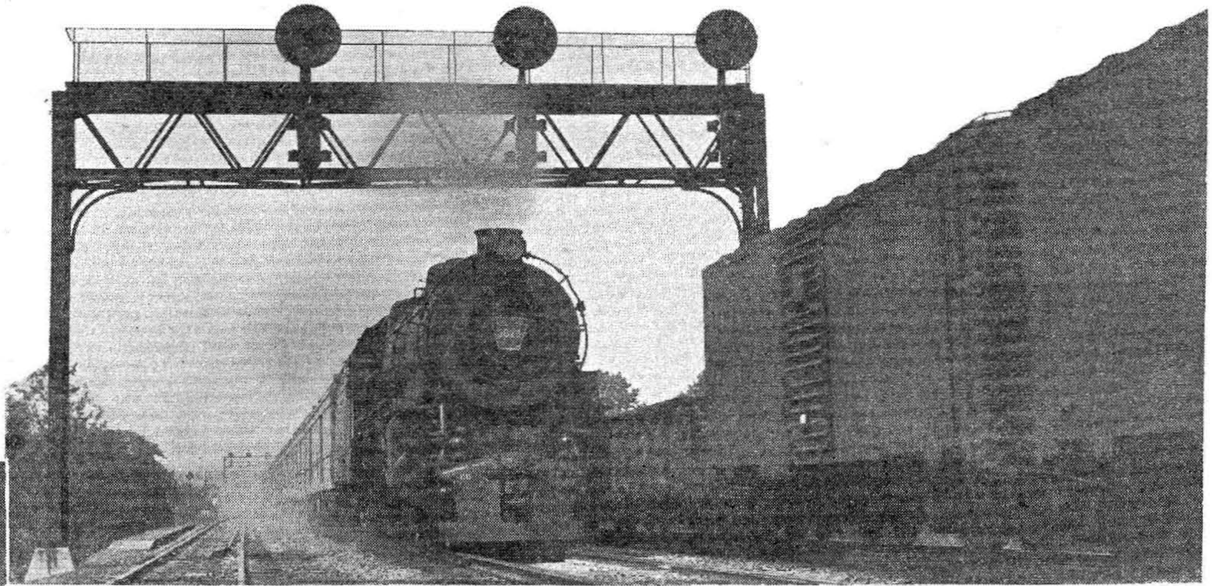
The left wing section of the control machine panel includes an enclosed loud-speaker and a new type of push-button telephone switchboard, by means of which the leverman can connect the loud-speaker and his transmitter to any one of 20 incoming telephone circuits. These connections are all established and taken down merely by push-buttons, no cords or plugs being involved.

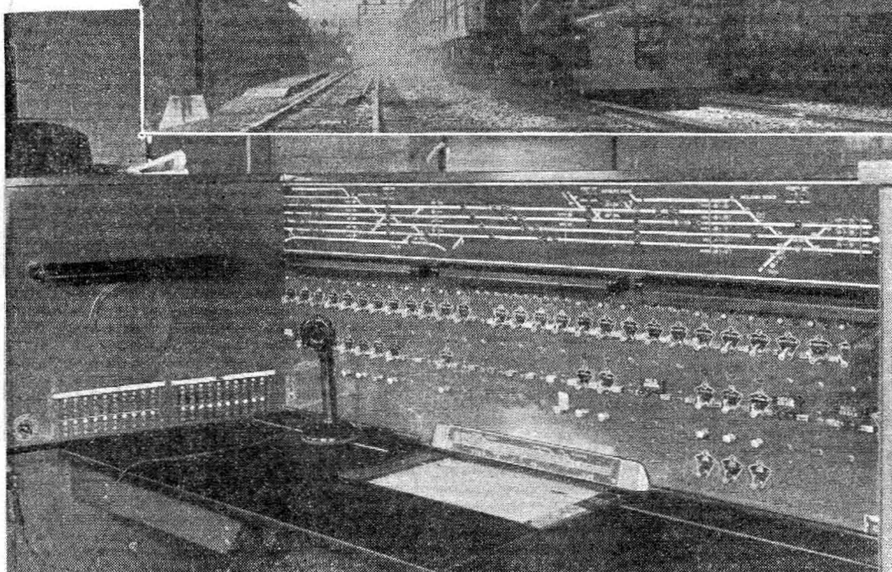
Flashing-Light Train-Order Signals

On each of the home signals at Alum Creek, there is train-order signal which consists of a separate single yellow lamp unit mounted on the mast between the upper and lower arms of the position-light signal. This train-order lamp is an ordinary position-light signal lamp unit except that its lens is yellow. The lamp in the unit is normally extinguished.

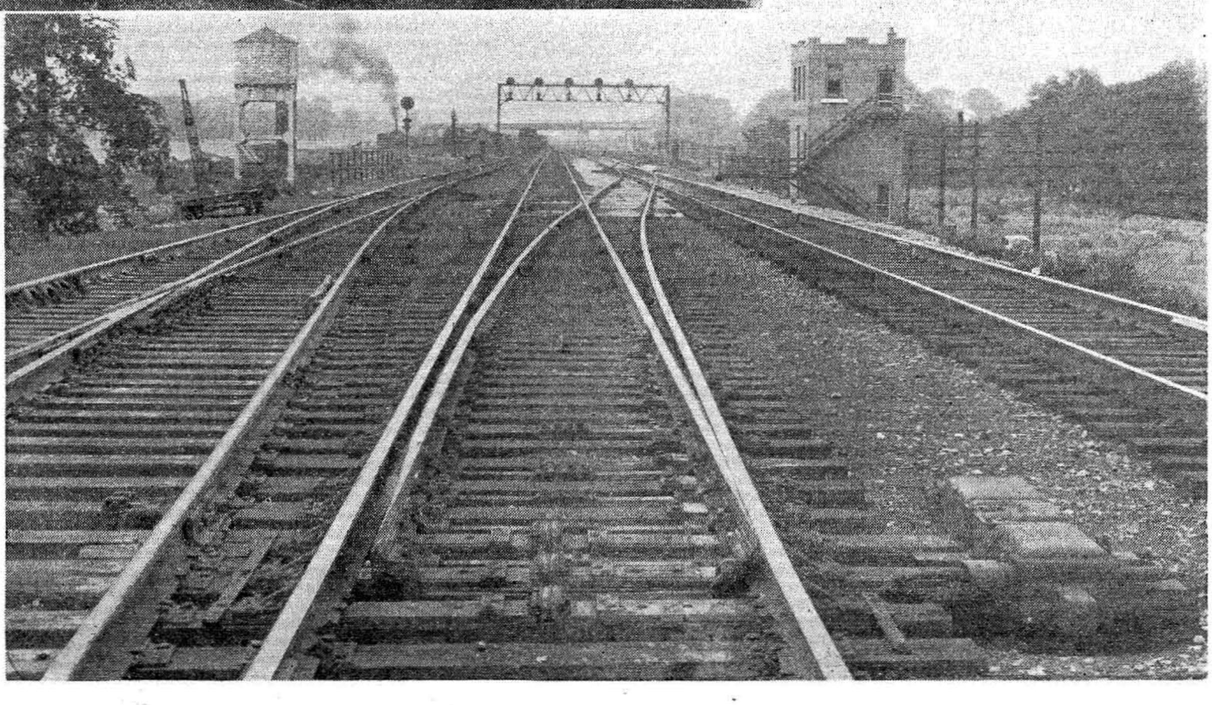
The train-order signal is controlled by a different lever from that which controls the signal. For example, one of the train-order signal levers is No. 78. This lever is normally in

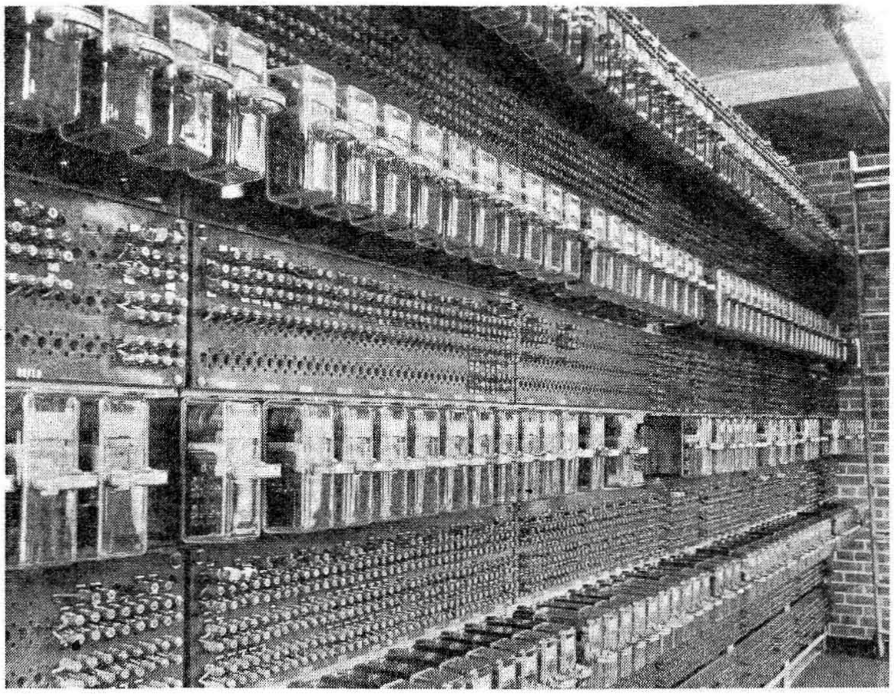
Interlocking Features Plug-In Relays





Above — Pennsylvania passenger train entering new interlocking. Left—The one control machine for entire plant 7,798 ft. long. Below—View looking west showing crossover 79 and the tower.





A portion of the racks with plug-in relays

d-c. motors rated at 110 volts. These machines are the M-2 type complete with point detectors. In each switch layout there are three insulated gage plates, 1 in. thick and 8 in. wide. Adjustable rail braces are used on three ties. On two ties the plates extend and are attached to the switch machines, thus preventing lost motion.

As a means for preventing frost trouble, a 75-watt, 110-volt electric heater unit is mounted beneath the controller and "SS" contacts in each of these switch machines. During the winter, the heaters are in service as may be required to prevent frost.

The switch machines are operated by 110-volt d-c. motors. The operation of each switch machine is controlled by a Type DP-25 d-c. polar relay and an OR11 type overload relay. For the crossovers near the Alum Creek tower, these relays are in the tower. For the switches farther away from the tower, the relays are in housings alongside the track.

the center position, and is thrown to the left to control the train-order signal on westward signal 78L, or the same lever is thrown to the right to control the train-order signal on the opposing eastward signal No. 78R.

The circuits are so designed that before the operator can secure the train-order signal to function, the switches must be properly lined and the opposing signals locked out. In addition, when the operator has train orders for an approaching train, he must operate the train-order signal in proper sequence, i.e., the train-order signal must be operated while its signal is in Stop position. After a train-order signal lever is set, the train-order lamp on the signal mast flashes approximately 40 times per minute. Below the green lamp, representing the signal on the track chart, is a green light to represent the train-order signal. When the train-order lever is set, this green light on track chart flashes 75 times per minute, indicating to the operator that he has set the train-order signal.

After a train acknowledges the train-order signal as required by Book of Rules, the operator then sets the signal to permit the train to proceed. The train-order signal will continue to flash until its lever is restored to normal position, which is done after the rear of the train has passed the signal.

Electric Switch Machines

The switch machines on this interlocking are the electric type with

No Preconditioning

The control circuit for each switch is arranged so that the levers cannot be preconditioned, i.e., if a lever is thrown while electric locking is in effect, the switch will not operate after the locking is released. The lever has to be returned to the position corresponding to that of the switch, then it can be thrown to control the switch.

In Fig. 2, herewith, relay 65WLM is controlled by the lever, 65SSK is the polar switch repeater relay, 65LR is the lock relay and 65WRE is the relay which has contacts that control the 110-volt d-c. power to the switch motor. The 65WLM and the 65SSK relays are in the tower and the 65LR and 65WRE relays

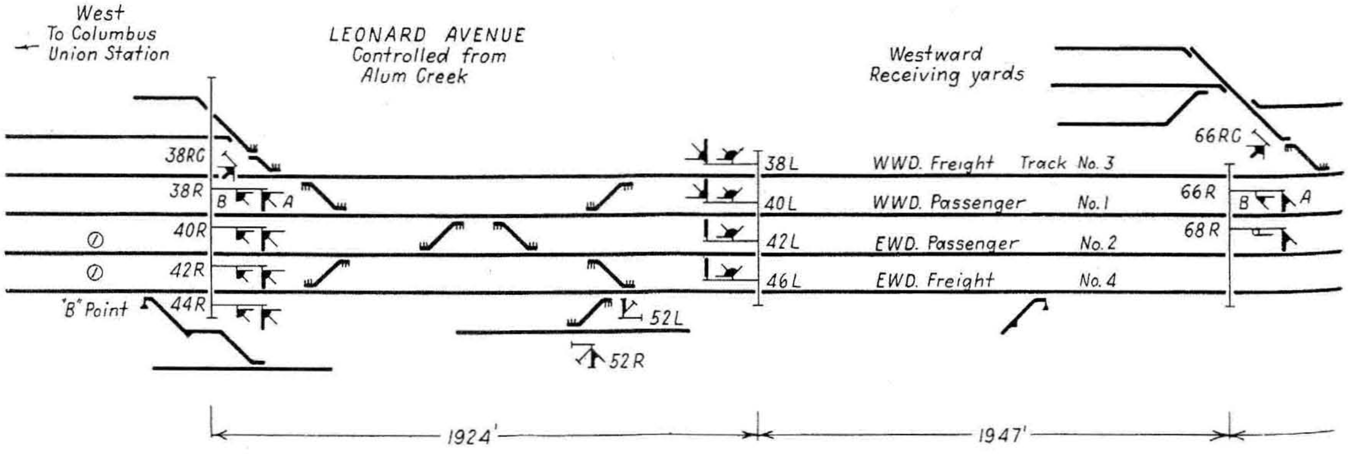


Fig. 1—Track and signal plan of the entire interlocking including the layouts

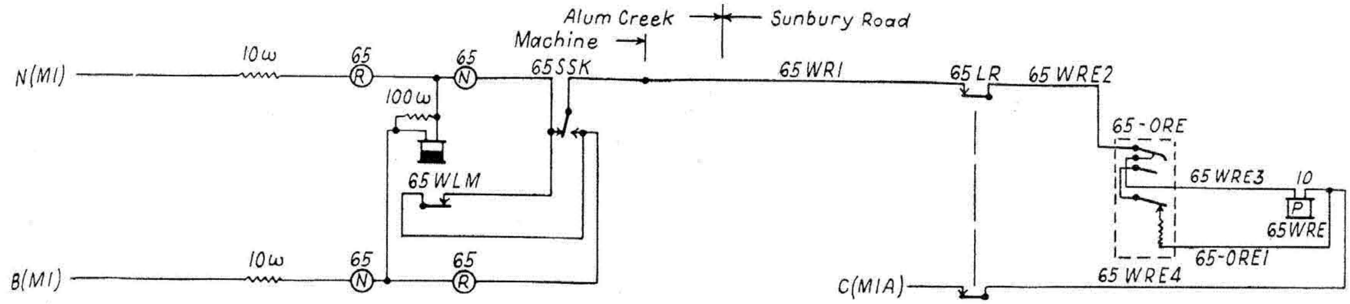


Fig. 2—Typical switch control circuit which prevents preconditioning

are in the house at Sunbury Road.

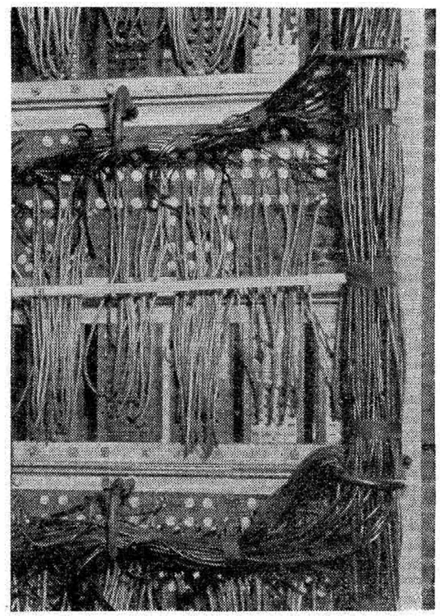
As shown in Fig. 2, the switch is normal. If the lever is thrown to the reverse position, split battery N (M1) feeds through 65 lever contact R, relay coil 65WLM, 65 lever contact R, contact of 65WLM, left polar contact of 65SSK, wire 65WRI, front contact of 65LR, contact in overload relay 65ORE, coil of relay 65WRE, wire 65WRE4, front contact of 65LR to common C (M1A). This closes the neutral contact and reverses the polar contacts in relay 65WRE, which reverses the switch. When the switch reverses, the switch repeater of the SS contacts causes relay 65SSK to reverse.

When a signal is cleared, lock relay 65LR is released and is held released by the route locking relay. The releasing of 65LR opens the circuit of 65WLM, causing 65WLM to drop or release, and this relay will stay released until the 65LR lock relay is energized again. With the contacts of 65LR open, the circuit that holds up relay 65WLM is open, causing relay 65WLM to drop, opening its stick contact. In the meantime, if the switch lever is thrown to the N position with 65LR relay down and the switch lever is left normal until 65LR picks up, the switch will not move, but will remain reversed. This is because the normal control circuit is open by the stick contact of 65WLM being opened, and 65WLM must be up to change a position of a switch. Once this relay drops, it can pick up only when the route locking relays are up and the switch lever and the position of 65SSK relay agree; i.e., the switch lever must agree with the position of switch in the field in order to pick up the 65WLM relay.

Three separate signal control networks were used on this installation: One on the control machine checks that the switches agree in position with the positions of their control levers before a control can be established to energize a signal control relay in the field. The second network, in the field, checks that all of the control elements are in agreement and that the block conditions will permit the signal to clear. When a signal control relay in this network is energized, it causes a de-energization of the various locking relays in the route so that they may be checked in the de-energized condition in the third network which actually controls the signal relays.

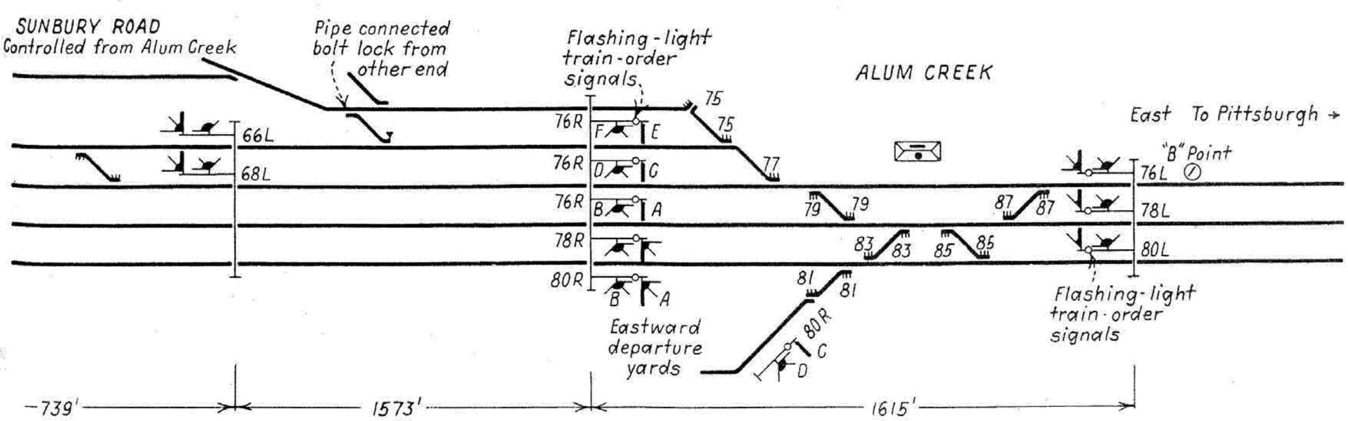
Train Movements in Both Directions On Each Main Track

In order to make run-around moves and thus use all tracks to the best advantage, all main tracks are signaled for train movements in both directions between the westward home signals at Alum Creek and the eastward home signals at Leonard avenue. On any given section of track, as for example on track No. 4 between the home signals at Alum

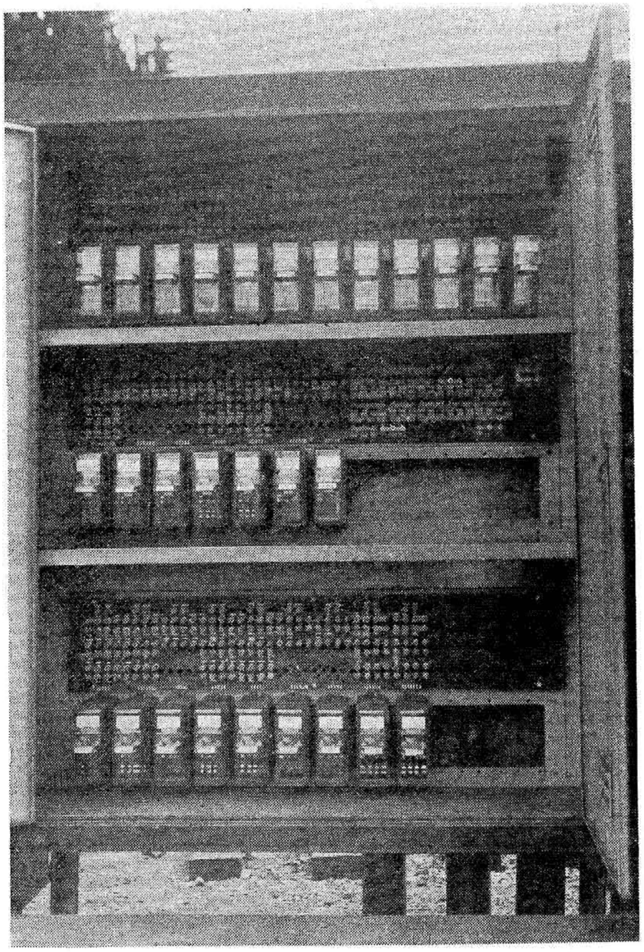


Wiring at rear of plug-in panel

Creek, the track circuit feeds from east to west to clear eastward home signal 80RA, or it feeds from west to east to clear westward home signal 80L. This requires that there be a battery as well as a relay at both ends of the circuit. Ordinarily a



at Leonard avenue, Sunbury Road and Alum Creek



Plug-in relays are used also in the outdoor cases at Leonard ave. layout

track circuit is feeding in the direction opposed to that of the last train that used this track circuit, as for example if the last train was westward on track No. 4 with signal 80L cleared, the track circuits would be feeding from signal 80R to 80L. If signal 80R is to be cleared for a train in the other direction, the first action after moving lever 80 to the R position is to actuate relays at the signal bridges which stop the code relay 83WCTM at signal 80R and then start the code relay 83ECTM at signal 80L. Track relay 83TRW is polar biased, and the energy being fed is of the polarity to hold the contacts of this relay open.

On the other hand, at the east end of the track circuit, relay 83TRE follows the 180 code, and contacts in this relay feed through decoding equipment to hold a relay energized, and it is available for detecting track-occupancy to control the signal 80L. Thus 180 code of the d-c. type is used in the track circuit normally, merely for detecting.

Coded Track Circuits

In this territory the Pennsylvania locomotives are equipped for cab signaling which requires that 100-cycle a-c. energy coded at 75, 120 or 180 times each minute must be fed from the exit end of each track circuit toward an approaching locomotive. Referring to Fig. 3, say for example that conditions are proper for a clear aspect to be displayed in the cab signal on a locomotive of an eastbound train after pasing eastward home signal 80R. The train will cause track relay 83TRW to release, which in turn will result in relay 83ETV at signal 80L controlling 100-cycle cab signal power to the track to pick up. Relay 83ETV at signal 80L at the east end of the track circuit is energized, which then energizes the primary of the 100-cycle transformer 83TPE. If the conditions are not proper for a

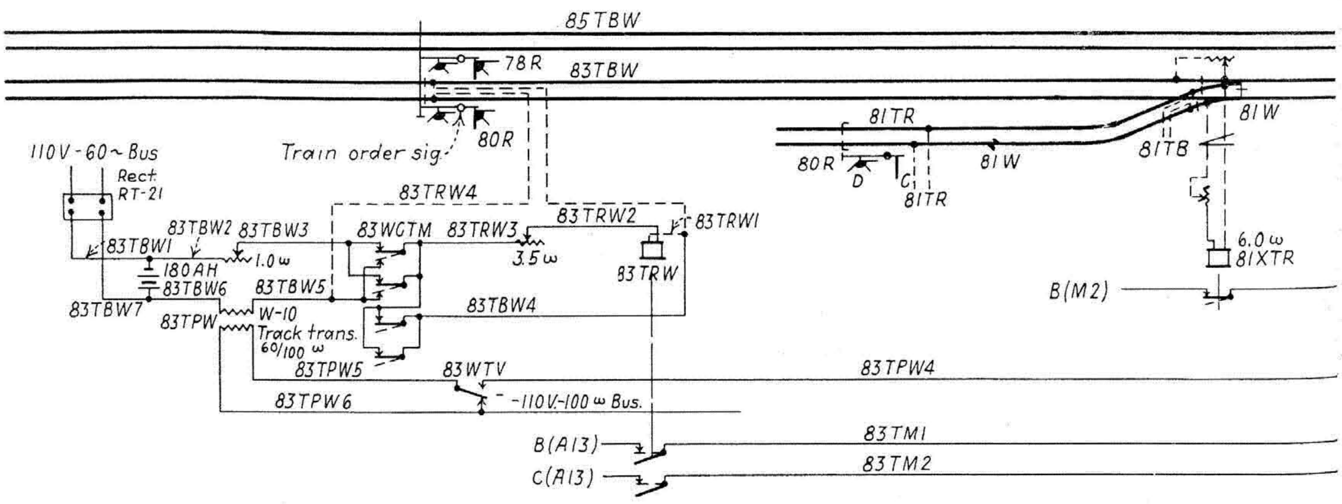
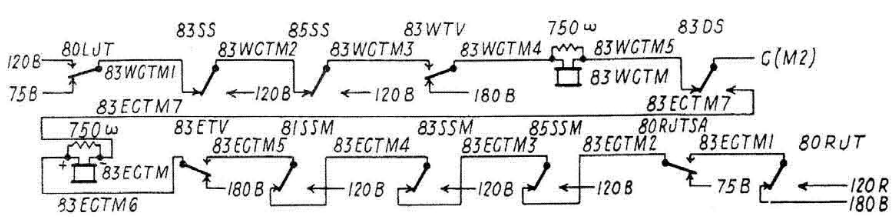
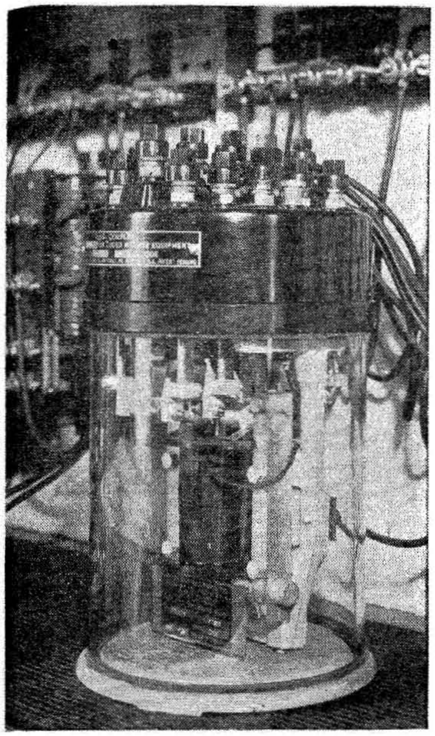


Fig. 3—Typical track and signal layout with diagram of track



Section of Fig. 3, showing control of code transmitters 83WCTM and 83ECTM clear aspect and a cab signal code of 180, then the proper code is selected over switch repeaters and advance relays. This 100-cycle a-c. energy from the secondary of the



Plug coupler on a relay

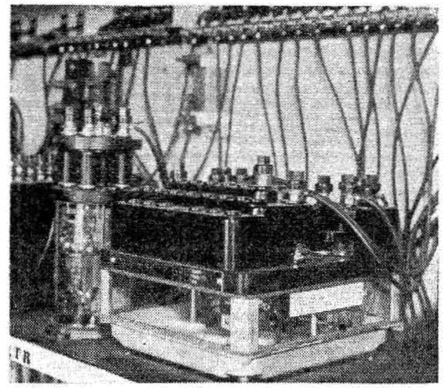
transformer feeds through the regular track battery, and both 100-cycle a-c. energy and d-c. battery are coded together to the track at the same time. The train, being on the circuit, prevents the coded d-c. battery from reaching the track relay 83TRE. After the train passes, the relay 83ETV is released so that the 100-cycle a-c. is cut off. The coded d-c. battery, after track is cleared, will pick up track relay 83TRE. All of the track circuits between home signals are of the high sensitivity shunt type as additional protection against rust and sand.

Floater Relay On Crossovers

On the west half of crossover No. 83, a so-called floater track relay is connected at the end of the fouling. This relay, 83XTR, follows the code and serves a definite purpose. It insures that a westbound train moving over 83 crossover must shunt out relay 83XTR in its proper sequence (the order in which track circuits are shunted by a train moving westbound over 83 reverse) in order to receive the proper cab signal. If a train should over-run signal 80L in the Stop position, while a westbound crossover movement is being made, it would cause both trains to receive restrictive cab signals, provided the train for which the route has been set had not reached the fouling point of crossover 83. Had the train reached the fouling point, then the train making the over-run would still receive a restrictive cab signal.

Traffic Direction Levers Between Interlockings

As previously discussed, coded d-c. track circuits feeding one way or the other are used within interlocking home signal limits, and the direction is established as the preliminary controls are established by operation of the signal lever. On the other hand, on the sections of track be-

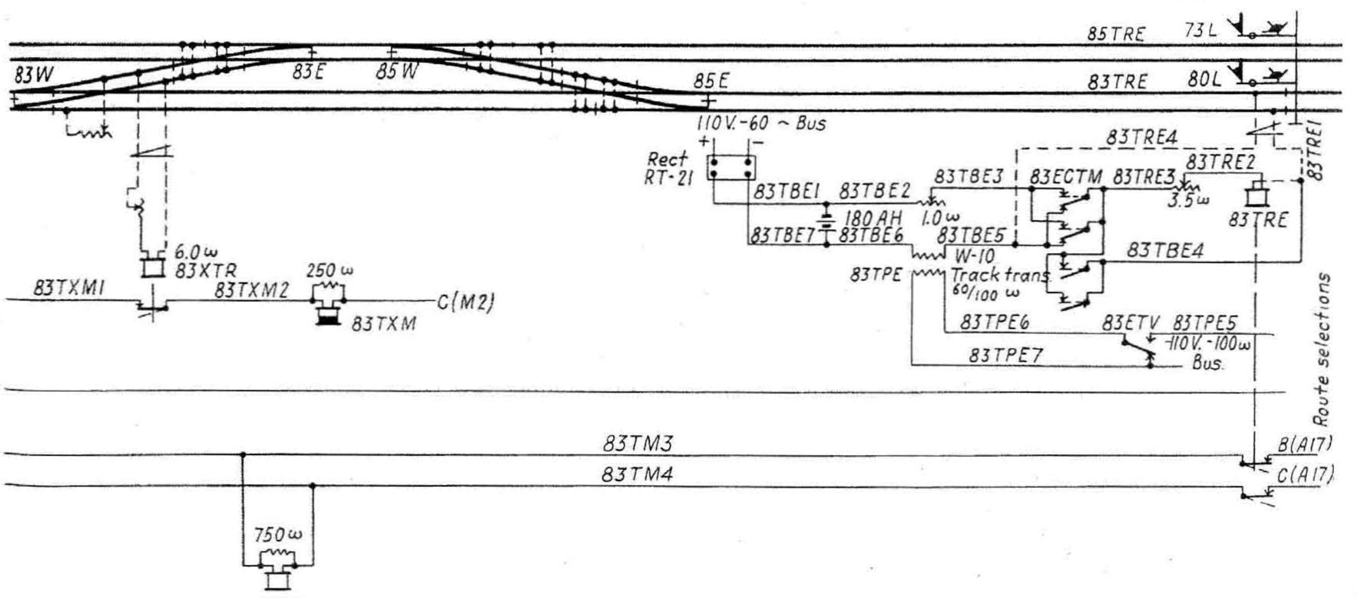


Polar relay with plug coupler

tween interlockings, as for example between Alum Creek and Sunbury Road, the track circuits are of the conventional steady-energy d-c. type, always feeding in a fixed direction. The direction of traffic is established by traffic-direction levers, there being a separate lever for each of the four tracks. When a train approaches, the 100-cycle coded a-c. energy is superimposed on the rails for control of the cab signals.

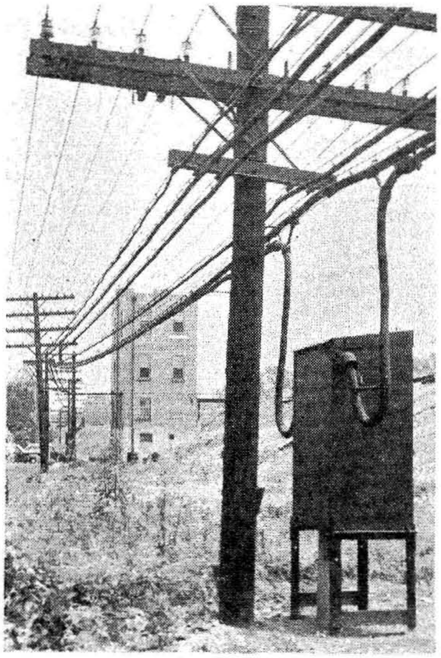
Cab Signal Code Cut-Off in Approach to Stop Signal

A new feature included in this project, and applying only to high-speed routes, is to cut off the cab signal track code for a distance of about 1,000 ft. in approach to a home signal that is displaying an aspect more restrictive than Approach. This causes the cab signal aspect to change to restricting and the whistle to blow until the engineman operates the acknowledgment valve.



circuit arrangement with floater relay on crossover

The special controls for this pre-warning are comparatively simple, provided there is no cut section between home signal and the point where cab signals are to change to restricting. When a train enters the track circuit in advance of the home signal, the relay (V relay) which causes 100-cycle energy to be connected to the track, is energized. If the home signal indication is more restrictive than approach, then the



Cables west of tower

100-cycle a-c. energy is fed directly to the track, but it is not coded, whereas normally it would be coded 75 times per minute. However, the control for a code relay, operating 75 times per minute is completed when the signal is more restrictive than approach and when V relay is picked up. This code relay is controlled over line from the home signal and is located about 1,000 ft. in advance of the signal. Every time the front contacts make, the track is shunted so that the 100-cycle feed is interrupted 75 times per minute. Thus an oncoming train gets 75 code up to that point, and steady energy only from there on up to the home signal. With steady energy in the rails, the cab signal is controlled to the restricting aspect, and the whistle is sounded when passing the cut-off point.

Construction of Tower

The tower is of concrete and brick construction 15 ft. by 23 ft. floor area, and is four stories high. The basement includes, in separate compartments, the heating plant and battery room. The second floor is the maintainer's headquarters. The third floor, which is at track level, is the relay room, and the control machine is on the fourth floor.

Plug-In Relays

Except for a few certain relays, these instruments are of the plug-in type, as shown in one of the larger pictures herewith. Each relay panel has a capacity for eight relays. Above each relay panel there is a terminal board. These relay panels and terminal boards are bolted to angle-iron uprights, thus making a rack 21 ft. wide and 9 ft. high with 4 relay panels and five terminal boards, there being two boards below the lower relay panel.

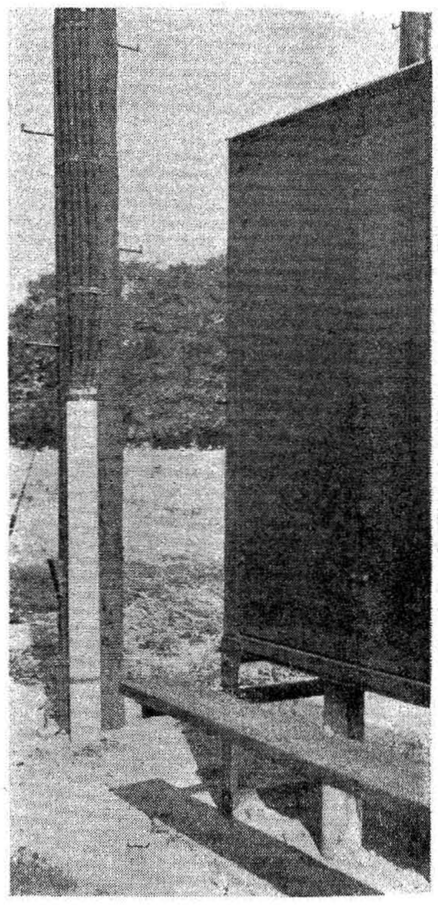
A so-called shoe-store step-ladder is provided so that a man can get within reach of any of the relays. At the bottom, this ladder has wheels to roll on the floor, and at the top there are small wheels which operate on a track hung from the ceiling. Thus the ladder can be moved back and forth along the face of the relay racks as required.

One of the accompanying pictures shows the rear of a typical relay panel and terminal board. The lugs from the receptacles extend to the rear. The end of an insulated wire is soldered to each lug and extends up and out through a hole in the terminal board and to a terminal. Then from the terminal the circuit is extended as required. These relay and terminal board racks were assembled and all the wiring was installed on the job. The jumpers between the relay receptacle lugs and the terminals is No. 16 flexible wire. Rosin-core solder was used to connect these jumpers to the lugs, and the soldered connections were washed with tetrachloride to remove the rosin. On account of the shortage of men, this soldering and wiring of jumpers was done by women. Other women made tags, acted as timekeepers and material clerks.

Certain types of code transmitters and code following relays as well as d-c. polar switch control relays are not available in the plug-in type. These instruments are mounted on shelves and certain of them are equipped with plug couplers, as shown in the pictures. These shelf-type racks are made up of angle-iron frame work, sheet-metal shelves and transite back boards which are ½ in. thick. The terminals are mounted on the face of these boards and the wires extend through individual holes to the rear.

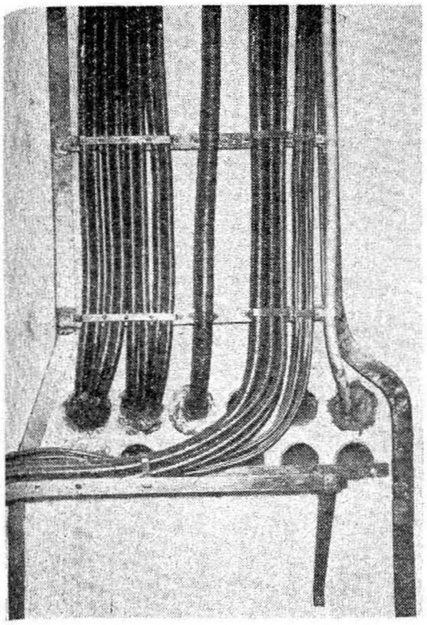
At Sunbury Road and at Leonard avenue, the instruments and batteries are located in one-story buildings constructed of concrete blocks. On account of limited space between tracks, the house at Sunbury Road is only 9 ft. wide inside and is 36 ft. long. The relays and racks in these houses are of the plug-in type, the same as at the tower at Alum Creek. At certain signals which are some distance from the houses, the relays are mounted in sheet-metal cases, as shown in some of the pictures. In these cases, the back boards for mounting terminals are made of transite board with holes for the wire to go to the rear where there is a wiring space about 4 in. deep. Access to this wire space is gained by removing sheet-metal panels at the rear of the case.

The cables from these cases extend down through sections of transite pipe 3 in. inside diameter, this



Transite pipe at ground line

pipe extending at least 1 ft. below the level of the ground. Experience indicates that cables, without protection, deteriorate most rapidly at the ground line as well as all the way up to the inside of the case. When the cables are in place in a pipe, the void spaces are filled with fine sand, and the top is sealed with compound. These sections of transite pipe were also used around cables which extend down poles and into the ground.



Cable entrance in basement

Wherever practicable, aerial cable was used for the longer runs, as for example from the Alum Creek tower west, as shown in one of the pictures. In some sections where no space was available for pole lines, the cables were placed underground for extended distances.

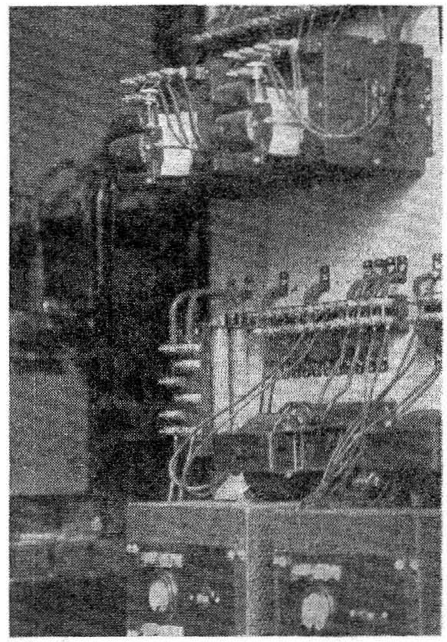
The conductors in the cables are No. 14 for control and indication circuits, and No. 6 for power circuits. The number of conductors in the cables range from 27 to 37 and up to 61. The protective coverings on the underground cables include lead sheath, steel tape, jute, etc. Some of this cable was shipped on large reels holding from 1,000 to 1,500 ft. of cable. These cables were unreeled and laid directly from the reels on flat cars, a switch engine being assigned to this work.

Special arrangements were made to support the cables inside the tower. The underground cables enter the tower through ducts in the concrete wall. The cables extending up the wall are supported by clamp straps attached to crosspieces on angle-iron upright frames. The cables running horizontal are laid on racks which are made of discarded signal ladders.

Power Supply

The 110-volt 60-cycle power is obtained by means of transformers from a 440-volt 60-cycle power supply. The 60-cycle power is used for charging all storage batteries. At Alum Creek tower, at the main relay houses at Sunbury Road and at Leonard avenue, the following batteries are in service: The 110-volt d-c. battery, consisting of 55 cells of 120-a.h. lead battery, which is used for operating switch machines. The 28-volt d-c. divided battery, 14 volts, each consisting of 7 cells, rated at 180-a.h., is used for control and indication circuits. The 12-volt d-c. battery, including 6 cells, rated at 240-a.h., is used for control of local relays. A DN46L relay is used in the charging circuit of this battery, so that if the voltage drops to a certain level, the DN46L relay will fail to pick up, which automatically increases the charge on the battery. The higher charge will continue until the battery voltage has reached the pick up value of the DN46L relay. At each signal location, there is a 12-volt, 6-cell, 240-a.h. battery, equipped with the DN46L charging arrangement.

The 110-volt, 100-cycle is obtained by means of a transformer from 440-volt 100-cycle power supply. This power is used only when cab signal energy is required. If the a-c. power fails, a tuned vibrating alternator is used to convert 12-volt d-c. to 110-volt 100-cycle power. The tuned alternator is equipped with contacts to furnish such power to two separate track circuits. In order to minimize the time during which the tuned alternator operates, the circuits are arranged for it to operate only when the supply of 100-cycle a-c. is off and the relay controlling the cab signal power to rails must be energized, i.e., when the track is occupied and a train must receive better than a restricting cab signal.

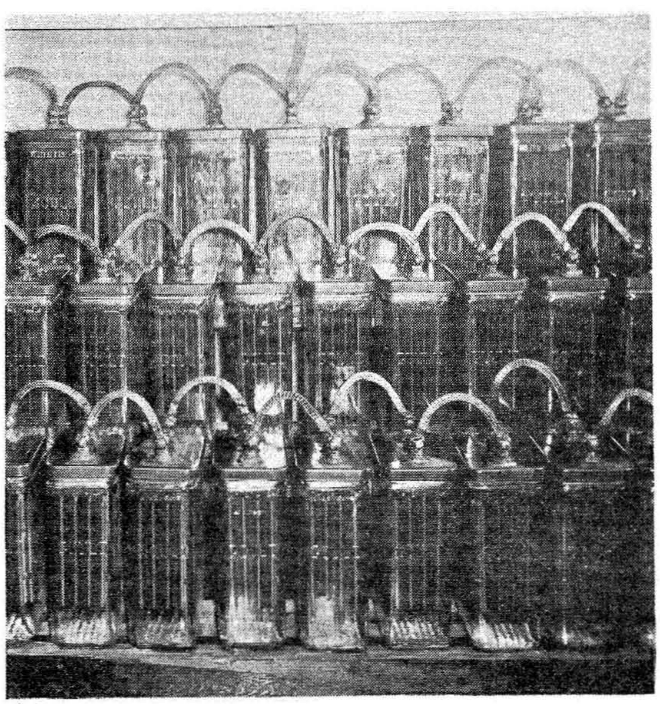


Rectifier in the tower for charging storage batteries

Sensitivity Track Circuits

Within the interlocking home signal limits all of the track circuits are of the high-sensitivity type using two 180-a.h. lead storage cells in series at each end. The track circuits between interlockings are of the d-c. neutral type, using one 180-a.h. lead cell with a one-ohm relay at the other end.

This interlocking was planned by the Pennsylvania with the co-operation and approval of the Baltimore & Ohio. The construction was handled by Pennsylvania forces, and the plant is maintained and operated by the Baltimore & Ohio.



Part of 110-volt storage battery for operation of switch machines