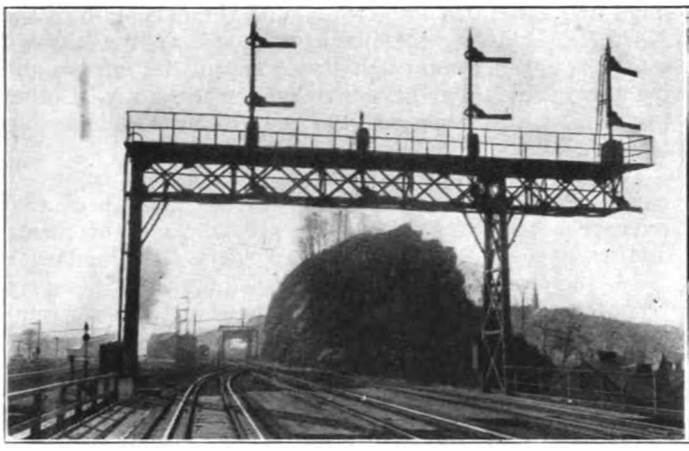
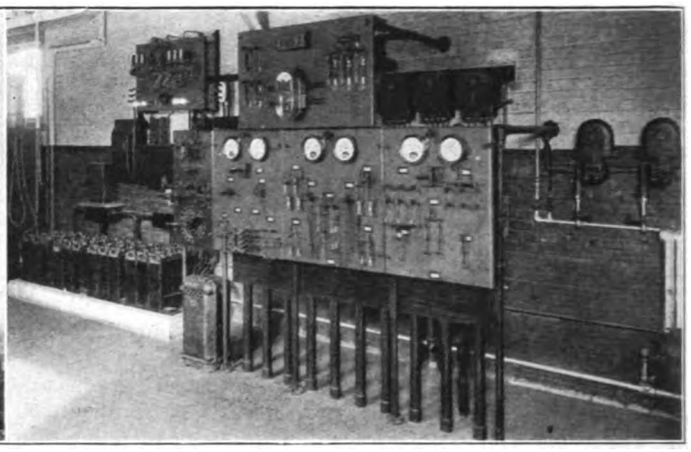


East Signal Bridge



Switch-Board and Storage Battery

New Interlocking on the C. R. R. of N. J.

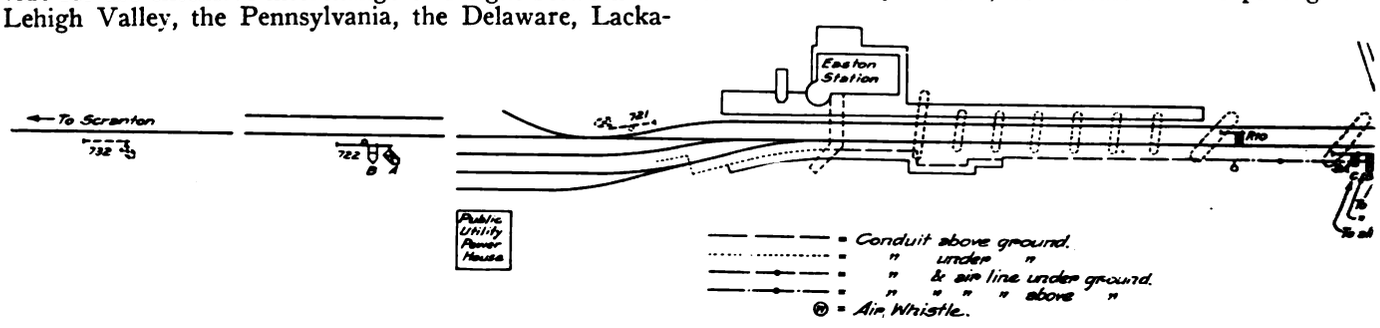
Large Electro-Pneumatic Plant at Phillipsburg, N. J., Uses New Operating Mechanisms and Lead Covered Cables

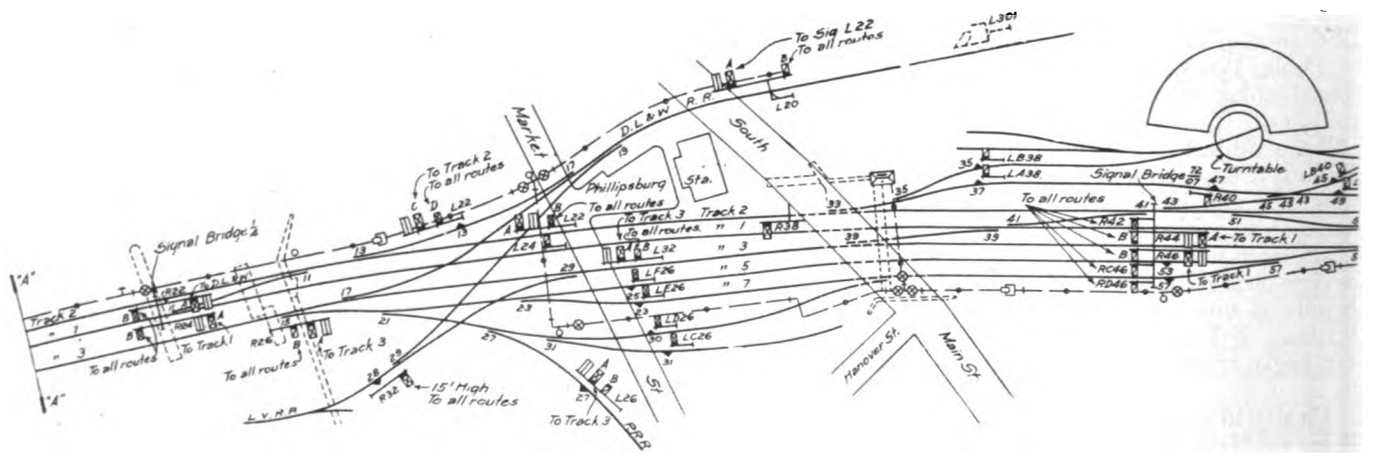
By Fred W. Bender

Signal Engineer, C. R. R. Co. of N. J., Elizabeth, N. J.

IN order to provide additional facilities for increased traffic, the Central Railroad of New Jersey erected a new double track steel bridge across the Delaware River between Phillipsburg, N. J., and Easton, Pa., in 1920, and moved the old bridge. This change required the rearrangement of tracks on both approaches and the addition of crossovers, slips and single switches to provide for the extensive interchange of freight between the Lehigh Valley, the Pennsylvania, the Delaware, Lackawanna & Western, the Lehigh & Hudson, and the Central Railroad of New Jersey.

Several schemes for the operation of the old functions, which had been operated by two mechanical plants, one at each end of the old bridge, and the additional functions were considered. The ultimate arrangement was to control all the switches between Easton station and the roundhouse, about 1,300 ft. east of Phillipsburg sta-





Track and Signal Plan Showing Signals, Switches, and Derails

tion, from one interlocking located near the station at Phillipsburg. This layout dispensed with the services of three operators and three switchmen.

In March, 1920, a contract was awarded to the Union Switch & Signal Company for the erection of their modern Type "C" electro-pneumatic interlocking. On account of the track conditions field construction was not started until September, 1920, and the interlocking was placed in service on October 2, 1921, at 8 a. m.

The tower, which is fireproof, being of steel and brick construction, is two stories high with a bay window on the upper floor which provides for the operator's clear vision of the entire plant. Access is obtained to the operating room by means of an iron stairway outside of the building at one end, thus providing more floor space in the interior. The lower floor, which is used for the power equipment, the relay rack and maintainer's work bench, is longer than the second floor. The floors are of reinforced concrete and all conduits for signal, telegraph, telephone and lighting circuits are galvanized pipe imbedded in the walls and floors. The operator's table is placed in the bay window, directly in front of the machine, thus making it convenient for one man to take care of the telegraph instruments, the telephones and the machine.

Layout and Machine Scheme

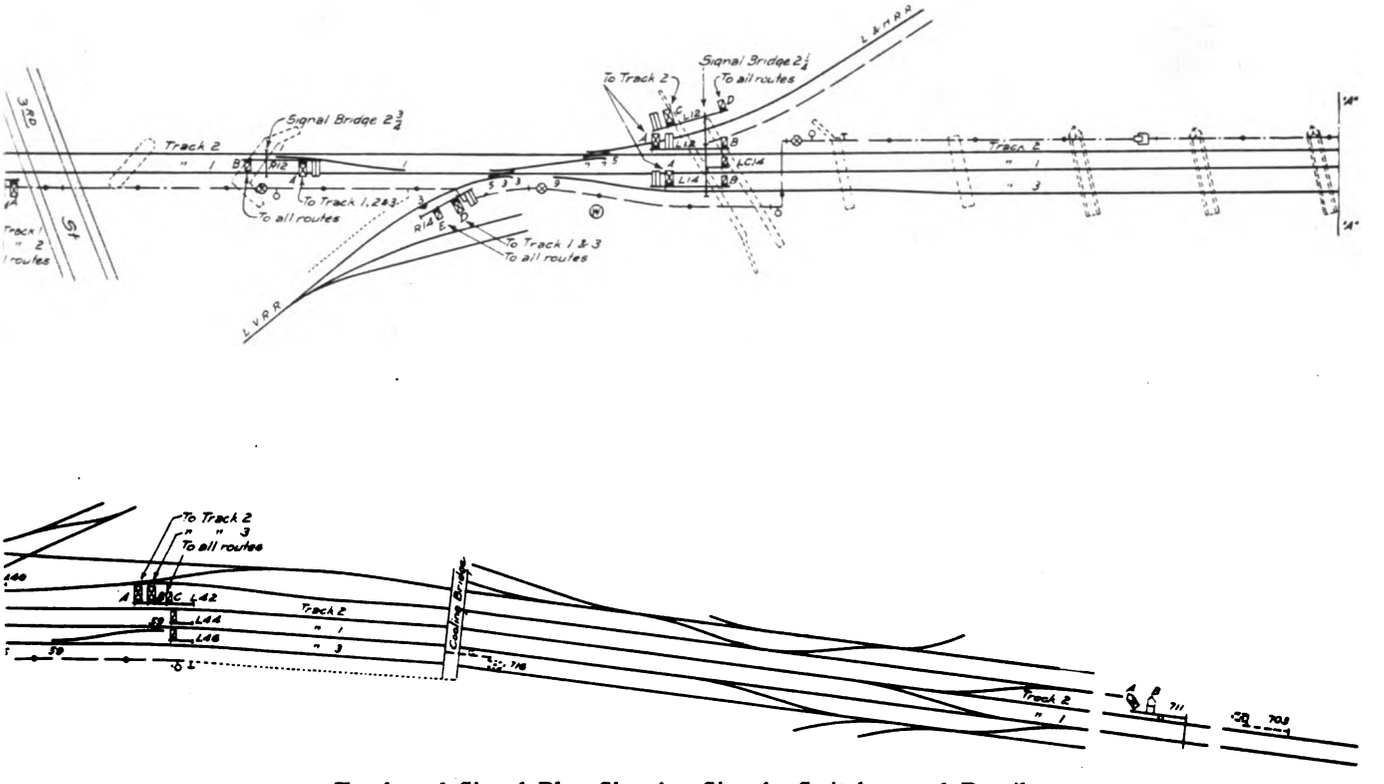
The layout is approximately 6,000 ft. between the most remote home signals. The interlocking machine is the U. S. & S. Co.'s Model 14 with steel case, having panels which, when removed, provide access to all working parts of the machine. A double row of lever lights is provided in the front of the machine directly under the levers. The lights under the switch levers, when lighted, signify that the track circuit or circuits which control the initial movement of the lever are not occupied by a train. The lights under the signal levers indicate for right and left movements of the levers and also indicate whether or not the track circuits to the next signal in advance, for the route lined up, are occupied. In addition to these indicating lamps there is placed on the machine case directly under the signal levers a light indicator with red glass which indicates whether or not the signal controlled corresponds in position with the position of the lever. The machine is a 59-lever frame, having 45 working levers, 6 spare levers and 8 spare space. There are 32 levers for 29 single switches, 16 Hayes derails, 2 double and 1 single slip with movable point frogs. Thirteen signal levers control eight 3-arm ground, nine 3-arm bridge, four 1-arm suspended bridge, one 1-arm ground and 13 dwarf signals.

A. C. Track Circuits

The tracks within the interlocking are divided into 45 sections in order to obtain speed in the sectional releasing for switch operation. Model 15, 2-position, 2-element a.c. relays having 2 front and 2 back contacts, controlled by individual track transformers and reactances, are provided. The track transformer primaries, which are 110 volts, are supplied by means of a pair of No. 2 mains extending both east and west from switches on the power board in the tower. Lead covered No. 6 solid single conductor copper wire is used for making connections between the instruments and the rails.

This wire is buried in the ground in cypress trunking treated with Victolac preservative paint, 20 in. below the base of the rail, and is brought up to the rail by means of a concrete bootleg having an opening provided in the center by a piece of 1½ in. fibre conduit. The lead sheath is cut away from the wire near the top of this conduit and the rubber covered wire is held in place by a specially constructed impregnated maple block having a galvanized sheet iron cover. A 15-in. loop is made in the lead to provide slack and the bare copper wire is attached to the rail with channel pins.

Two No. 8 E. B. B. galvanized bond wires are used for each rail joint, except in the street crossing and at solid frogs. As it was found that considerable trouble occurred in the old interlocking with bond wires breaking off in the street crossing and at the solid crossing frogs, due to rail movement, it was decided to use Ohio Brass bonds, gas welded to the outside of the ball of the

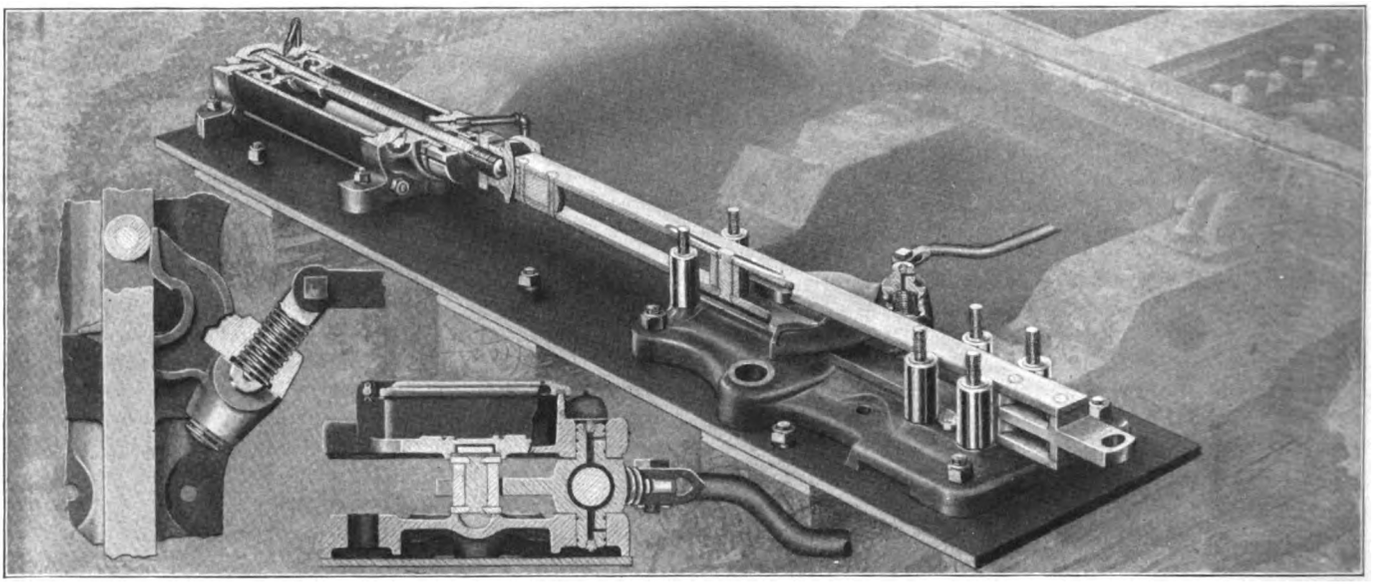


Track and Signal Plan Showing Signals, Switches, and Derails

rails. Since these were installed all trouble due to rail bonding has been eliminated. Keystone insulated rail joints were furnished for all track sections. The track relays are in instrument cases which are located as conveniently as possible to the rail connections, and Model 13 d.c. relays are used as repeaters in the tower for all of the sections.

Switches

For the operation of the switches, derails and slips, the Style A1 switch and lock movements were used. The movement is a refinement of all switch and lock movements used previously in electro-pneumatic interlocking plants. The cylinders are 5 in. in diameter for single switches and derails, 6 in. for slip switches and 8 in. for movable point frogs, having a stroke of 12 in. The first 2 in. are for unlocking, the next 8 in. are used for the operation and the last 2 in. are used for locking. Although this movement employs double the piston stroke for the same size cylinders used in previous designs for switch operation, it requires 50 per cent less pressure.



A-1 Switch and Lock Movement With Adjustable Crank

This means that it requires only 50 lb. pressure for the operation in place of 100 lb. as previously used with the Model 14 movement.

The arm of the operating (escapement) crank is adjustable, thus permitting of any desired operating rod stroke between 4 and 6 in. This eliminates energy lost in taking up excess motion between the operating rods and adjustment brackets on head-rods. A cross section view of this adjustable crank is shown. By this adjustment no energy of the piston is lost. The movement is used for right or left hand operation by changing the position of this crank and the reversing of the motion plate on the slide bar which operates the indication controller. This device has two independently moved sets of contacts which are moved at different periods of the switch stroke, one during its locking in the other position. The movements and cylinders are mounted on ⅜ in. plates attached to the ties by bolts, so that the center of the movement is 25 in. from the gage of rail and all parts are below the top of rail. The advantage in using this movement is the economy of energy.

Control Valves

The operation of the movement is controlled by the Type "C" cut-off valve, mounted separately on a concrete foundation located so that the center of the valve is 24 in. from the center of the movement and in line with the cylinder. The valve is protected by a sheet iron cover and the cast iron base upon which it is mounted has a hand hole cover for access to the air strainer and the wires. Connection is made between the valve and each end of the movement cylinder by means of ½ in. armored hose. Insulated unions were used in these connections to insulate the valve from the track. Damage to the wires used between the valve and the indication controller is prevented by the use of flexible conduit as a covering. Failure of the operation of the valves due to foreign substance is eliminated by the introduction of a strainer which is inserted in the supply pipe near the valve connection. This type of valve eliminates the losses of compressed air through the valve, the operating cylinder piston and the packing, because the only parts which are normally subjected to main line supply are the pin valve of the lock magnet and the cut-off valve operated by the lock cylinder piston. As soon as a switch operation is completed all compressed air is cut off from the valve chambers and liberated from the operating cylinder. If the switch movement is displaced from its extreme position by other than legitimate means, it is immediately restored to its proper locked position by electrical energy acting automatically on the lock magnet. This automatic restoring feature is brought into action before the switch is unlocked and is realized by the use of a back contact on the "KR" (switch indication) relay.

Signals

The high and dwarf signals, which are of both 2 and 3 position operation, are of an entirely new design arranged for operation on reduced pressure. The mechanisms for the ground, bridge and suspended signals are placed in cases at the base of poles and operate on the rack and pinion principle. They are built so that all like parts are interchangeable and accessible for maintenance. The signals which are operated in the upper quadrant are pulled to the caution and clear positions by means of a ⅜ in. rod and return to danger by gravity. The circuit controllers are similar to the ones used on the A1 movements and are actuated by means of a motion plate on the rack which is attached to the cylinder piston rod. The dwarf signals are designed on the same principle as the high signals and are mounted in cast iron cases, having the two sides and top removable so as to provide access

to all operating parts. This signal is compact, having a total height of 21 in. and an overall width of 20 in., thus providing ample clearance when located between tracks.

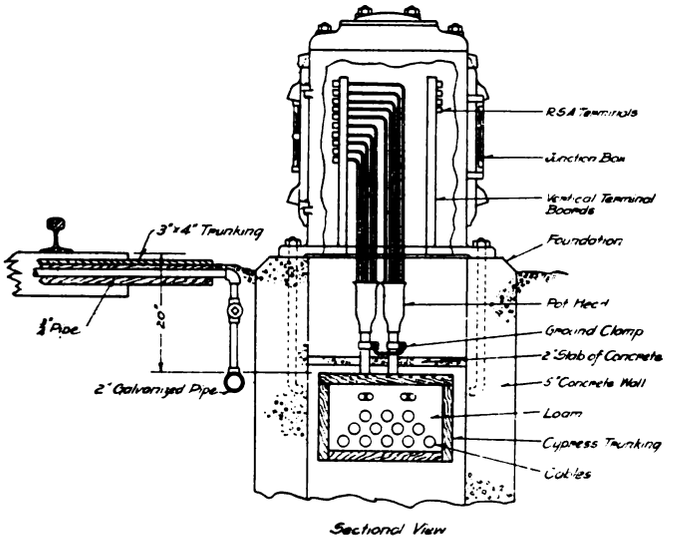
All signals are furnished with the R. S. A. design cast-iron lamp cases, in which are mounted 12-volt 2½-watt bulbs, which are protected with 5-ampere fuses. The wires between the lamps and the dwarf signal mechanism cases are protected with ¾-in. flexible conduit, while those for the high signals are installed in 1-in. conduit between the signal case and a point opposite the lamp where cable outlets are used.

The Air Line

The main air line, which is 2 in. extra heavy galvanized pipe, is installed parellel to the main tracks and extends from the eastbound dwarf signal R-10 at Easton station to the westbound home signal L-42 at Phillipsburg. It is placed in the ground 20 in. below the base of the rail, except on the bridge over the Delaware River, where it is laid adjacent to the hand rail on the platform. Before the pipe was placed in the ground it was painted with two coats of Dixon's Red Silica paint and after being placed all scars made with pipe wrenches were repainted. All joints were tested for leaks while under pressure of 110 lb. before the pipe was covered with loam. The cross leads of pipe between the main line and the functions are of ¾ in. galvanized pipe placed in cypress trunking and located above the ground just under the rails. The stop cocks for cutting off the air from the main line are located in cypress boxes.

Installation of Cables

With the exception of local wires on the signal bridges and the wires in the tower, all cables and single conductor wires are lead covered Okonite and are placed under-



Junction Box, Cable and Trunking Arrangement

ground. They are so placed that they are completely covered with loam of the same character to prevent chemical action and to protect against electrolysis. The cables are of 15, 7 and 5 conductor, and are arranged so that all conductors for signals and switches are in 15-conductor cable between the tower and the nearest junction box to the function operated. Between the junction boxes and the functions 5 and 7 conductor cables are used. The ends of all cables and single wires are provided with specially constructed pot heads, which exclude moisture. These were made by using a piece of 2-in. lead sheath formed like a milk bottle, the small end or neck being pressed into the sheath of the cable by means of a pipe cutter having flat rollers in place of cutter wheels. After the pot head was attached to the cable, it was filled with parawax and the end painted with insulating paint. The sheath of all cables is grounded with a special ground clamp connected to a ground pipe driven in the ground 6 ft. The bottom of the pits left in the center of the foundations under the junction boxes was covered with a 2-in. grouting of concrete to eliminate the source of condensation and to prevent mice from entering the trunking underground.

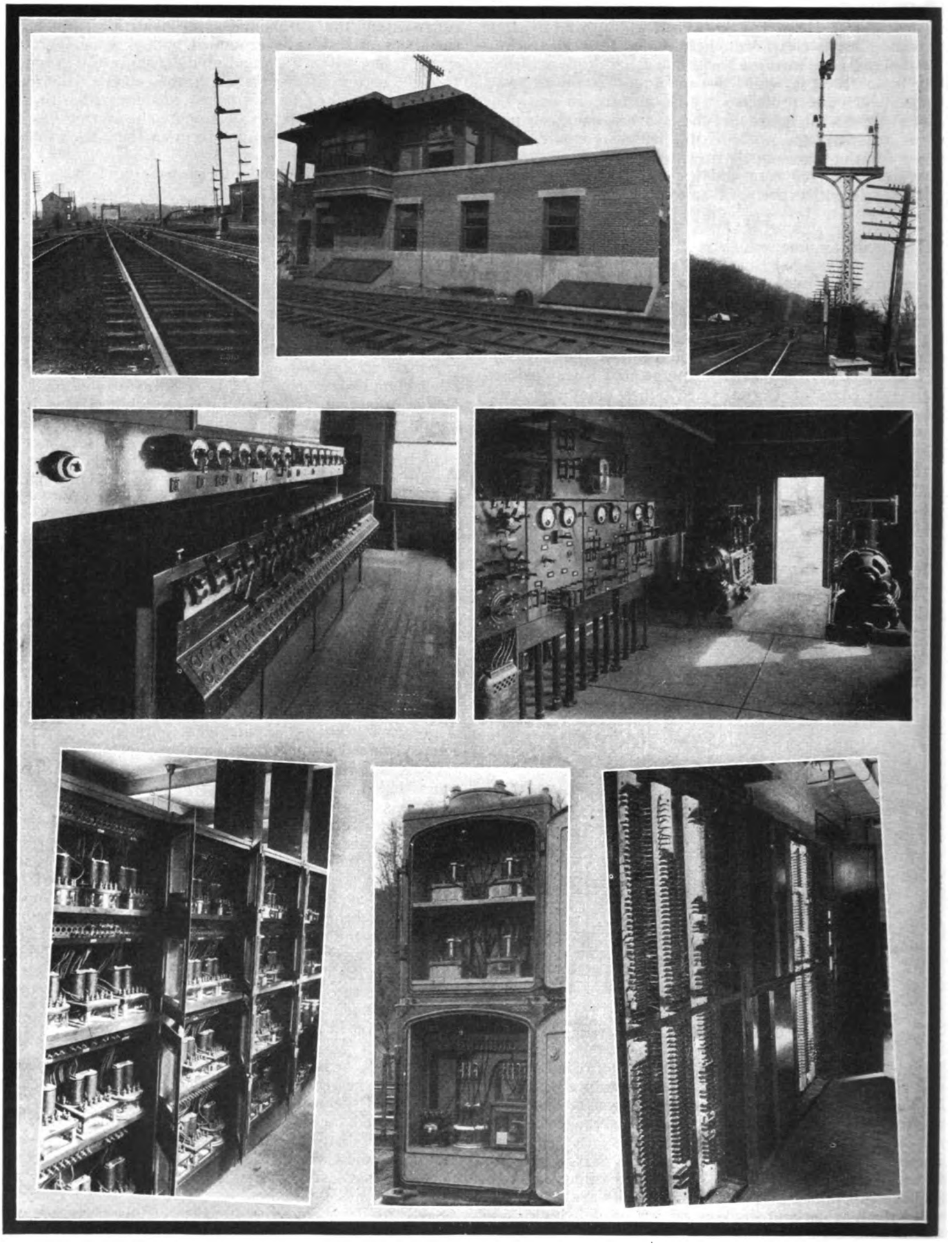
Air Compressors

Two National Brake & Electric Co.'s Type 3VS-11 motor-driven air compressors are located in one end of the lower floor of the tower. These compressors are water cooled and are operated by direct connected 220-volt a.c. 3-phase motors. The equipment is so designed that the starting current does not exceed the operating current and the motors are controlled by governors adjusted for pressure between 45 and 60 lb. The circuits controlling the motors are so arranged that only one compressor operates normally between 50 and 60 lb., the other compressor being held in reserve for abnormal demand and cuts in automatically if the line pressure drops to 45 lb. By means of a double-pole double-throw switch on the switchboard, the control of compressors can be interchanged. During normal operation only one compressor serves the plant with an average of 4 min. operation an hour. An operation of the compressor for 1 min. and 50 sec. supplies sufficient compressed air for 28 min. and 24 sec. of machine operation. As the compressor runs only about 6 per cent of the time, it is considered that the power required for supplying compressed air for a plant of this size has been reduced to a minimum. The air, after leaving the compressor, passes through a manifold condenser, which is mounted on the rear wall of the tower. This cools the warm air and the moisture caused by condensation is collected in a tank before the air enters the main air line.

Power Equipment

Power for all use in the plant is supplied from the Pennsylvania-Edison Co.'s plant at Easton from two sources at 2,300 volts and 4,400 volts, 3-phase, 60-cycle, to an "H" frame located in the rear of tower. Supported upon this frame are two sets of three each 10 k.w. oil-cooled transformers to deliver 220 volts for the interlocking. This rate of voltage is used for the compressor motors and the mercury arc rectifier. The 220-volt supply is again stepped down to 110 volts by means of two 5 k.w. air-cooled transformers, mounted on the inside tower wall behind the switchboard, in order to supply energy for the track circuits and signal lighting. The tower lighting is supplied from a separate transformer. Located on the inside wall of the tower is a small switchboard with automatic switches which cut in the reserve set of high tension transformers, providing power goes off on the set in use, and there is also a manual restoring feature.

The main switchboard consists of four panels placed parallel to the rear wall of the tower and a sufficient distance from the wall to make all parts accessible. One panel is used for the air compressor control, one for the a.c. supply distribution, one for battery charging and another is the General Electric type mercury arc rectifier panel arranged for operation on 220 volts, 60-cycle a.c. and supplying 50 amperes, 10 to 110 volts d.c. This rectifier is used for charging 48 cells of Edison storage battery, Type A-6-H, 225 A.H. The battery is arranged in 4-cell trays which are set on a 6-in. concrete base on the tower floor. It is connected 12 cells in series, two sets in multiple, with switchboard circuits arranged to charge one set, while the other set is being discharged. The main



Middle of Plant
Interlocking Machine
Relay Cabinet

Tower

Relay Location

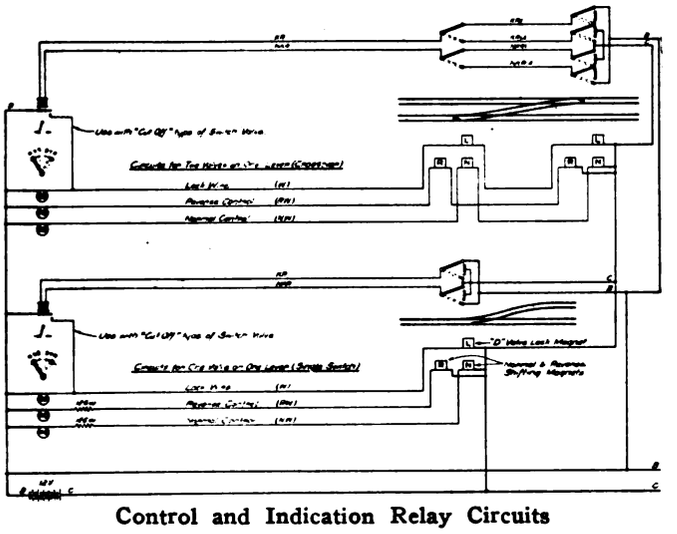
Automatic Signal
Air Compressors
Terminal Board

distribution panel for the interlocking and the automatic signals is located above the interlocking switchboard.

All lead-covered cables which enter the tower through a concrete manhole in front of the building are connected to R. S. A. terminals having fibre tags, mounted on vertical asbestos terminal strips 6 in. wide. The wires are brought through holes drilled in these strips opposite the terminal binding posts, so as to provide a support for them. Two sheet iron cabinets with four doors each enclose the terminal boards. The cables are arranged so that those from the east of the tower are in one cabinet, while those from the west of the tower are in the other. Connections between these terminals and the terminals in the relay rack are No. 16 A. W. G. Okonite and are placed in 3-in. galvanized conduit laid in the concrete floor. A sectional street relay cabinet with glass doors is located directly under the interlocking machine. This cabinet consists of 32 sections placed two high, eight long, and back to back, and holds 181 relays. Between each two sections there is a vertical chase which provides ample room for all wires used between the relays. Four vertical steel chases are used for covering the wires between the machine and the case. Each shelf of the cabinet has an impregnated maple terminal board which provides for a maximum of 73 R. S. A. terminal binding posts. Only one solid wire is connected to a terminal and where taps were required, additional terminals were used and these were joined by copper bus strips. Connections to the binding posts of relays were made with No. 14 flexible wire having brass eyelets on the ends.

Circuits

The switch indication magnets are selected over the polar contacts on the KR switch indication relay. This relay is controlled by circuit controller attached to the "A-1" movement. The controller has two independently



Control and Indication Relay Circuits

operated contacting devices which are moved at different periods of the stroke of the movement, one during the locking in the normal position and the other during locking in the reverse position. When the switch is locked in its normal position, a current of a given polarity is established within the indicating system; when in the reverse position a reverse polarity in the indicating wires is provided. During transit of the movement between locking positions, both sets of contacts act to interrupt the flow of indicating current and to short circuit the two wires controlling the KR relay.

This KR relay also acts as the (SS) signal selection relay. By this means all signal control wires are carried over the polar contacts directly from the tower to the signals without selecting through switch circuit controllers attached to the switches, thus providing trailing point as well as facing point protection for all train movements.

Sectional route locking is effected by means of a.c. track circuits for each switch lever and the operator receives a lever released visual indication from a light which is mounted directly under each lever.

Approach locking for signals R-14, L-20 and L-42 on the main tracks of the C. R. R. of N. J. and the D. L. & W. connection, is controlled from the first track section in the rear of the respective distant signals. This circuit is so arranged as to lock a call-on signal, irrespective of the condition of the block in advance of the signal. Approach locking for most all of other signals is obtained from short track sections in the rear of the signals. As the length of track in the rear of signals L-38, L and R-40 did not allow for the installation of a short section for electricially controlling the approach locking, the levers for these signals were equipped with mercury time releases, adjusted for an interval of 60 sec.

At each end of this case there is mounted a key switch for the control of the signal lights east and west of the tower. The signal lighting, which is 12 volts, is obtained from a lighting transformer located in the instrument case adjacent to the signal which it supplies. The primaries of these transformers are 110 volts and are connected to a pair of No. 6 mains.

Placing in Service

It will be of interest to note that all functions in this interlocking, with the exception of one switch, No. 9, and one crossover, No. 1, which could not be installed on account of track changes, were operated from the machine one hour after the time given for placing the plant in service. This was accomplished by the field construction force having previously adjusted and then connected all switches to the movements, shutting off the air to the valves after the movements had been placed on center, and then connecting hand-throw switch stands to the switch rods. When the time set for placing the plant in service arrived it was necessary only to disconnect the switch stands and turn on the air to put the switch under the control of the operator. After the new functions were under the control of the new machine, the C. R. R. of N. J. signal force dismantled the old mechanical towers, switches and signals, and by 4 p. m. there was not an indication that mechanical interlocking plants ever existed at Easton and Phillipsburg.

Automatic Signals

At the time this plant was placed in service, new automatic signals were included east and west of the interlocking for a distance of approximately five miles in each direction. This installation consisted of the replacing of the old home and distant lower quadrant signals with eleven Style "S" 3-position upper quadrant low voltage d.c. signals controlled by means of polarized a.c. track circuits. The power for these track circuits and the signal lights is obtained from Phillipsburg interlocking switchboard over line wires at 220 volts. Double cases were used at all locations for the instruments required and a uniform arrangement of wiring was used. The terminals and jumper wires were installed before the cases were shipped from the factory. The work of installing these signals was performed by the railroad company's signal force. The field work for the interlocking and automatic signals was handled by the following men:

For the Signal Company—W. J. Lee, foreman; Jas. Thompson, assistant foreman.

For the Railroad Company—John R. Myers, circuit engineer; F. F. Nolan, electrical inspector; J. Fred. Jacobs, superintendent of signals; Chas. W. Walck, foreman, and R. B. White, leading signalman.