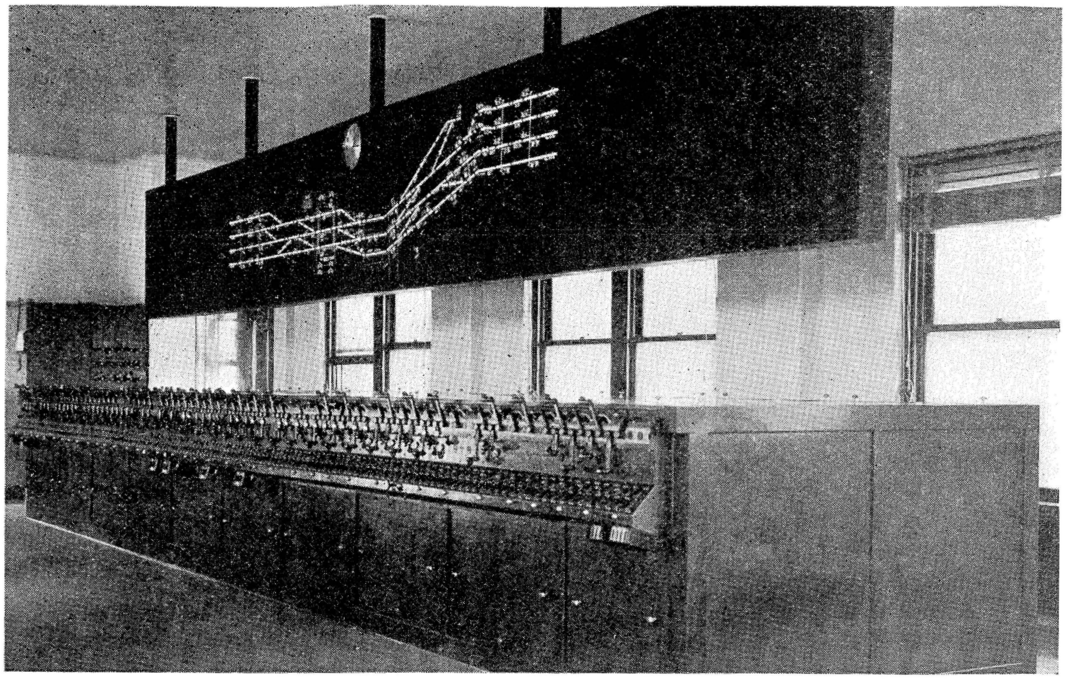
Railway Signaling



View of 155-lever machine—the model board includes pilot lights for the 11,000-volt trolley

New Electro-Pneumatic Plant On Pennsylvania at Newark

By H. T. Fleisher

Telegraph & Signal Department
Pennsylvania Railroad

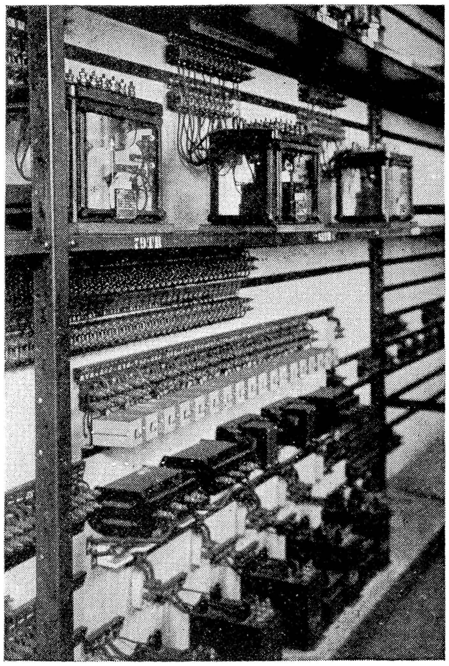
Three-track drawbridge over Passaic river, signals, switches and 11,000-volt trolley controlled from "Dock" tower in electrified cab-signal territory—Coded track-circuit control and electro-pneumatic switches used

At Newark, N.J., on the electrified line between New York and Philadelphia, the Pennsylvania has completed the first step in a program of improvements to the operating facilities at this point. These improvements include a new passenger station, a new three-track lift bridge, which is the longest of its type in the world, and a new 155-lever electro-pneumatic interlocking plant which controls the associated signal facilities. Newark, with a population of 450,000 is located in the metropolitan area of northern New Jersey and is served by 219 regularly scheduled trains per day.

The old facilities, recently replaced, had become inadequate for the volume of traffic handled at this point. In the old track arrangement there were four tracks east and west of the Newark station, while through the station proper there were three tracks, only two of which could be used for platforming trains. Over the Passaic River drawbridge, approximately 1,300 ft. east of the station, there were only two tracks. The signal facilities were formerly controlled by a 35-lever electro-pneumatic interlocking called "CK", located immediately west of the Passaic River drawbridge.

The first part of the new layout as completed consists of three tracks through the station, all of which can be used for platforming trains, the middle, or No. 3 track, being signaled for traffic in either direction. This track is used for eastward trains in the morning and westward trains in the afternoon, corresponding with the prevailing traffic. The new three-track drawbridge at the east end of the station allows trains to enter and leave the station promptly. Station tracks are signaled for a speed of 45 m.p.h. The entire track structure for a distance of two miles through the city is elevated on a concrete-supported fill, eliminating all interference with vehicular traffic.

The new interlocking station, which is called "Dock," is located immediately east of the Passaic river, approximately 1,500 ft. east of the new passenger station. It is a three-story brick structure, the basement and first



The instrument racks in the tower are fireproof

floor being 123 ft. 8 in. long by 25 ft. wide, and the second and third floors being 74 ft. 4 in. long by 25 ft. wide. All wires and cables within the structure are carried in steel or transite ducts and wireways in the walls or floors of the building. Separation is provided at all times between dissimilar cables.

Power Supply at Dock Tower

The basement houses, principally, electrical cubicles, buses, circuit closers and related equipment. Space is provided for a locker room and work shop for the signal construction forces, which have their headquarters at this point, and also for a track department storeroom. The east end of the basement is occupied by two 226-cu.ft. air compressors which are driven by 40-hp. 25-cycle 220-volt motors equipped with automatic controls. The normal air pressure for the interlocking is 85 lb. per square inch and the No. 1 machine is set to cut in at 70 lb., while the No. 2 machine comes on the line if the air pressure falls to 65 lb.

The first floor, which is at ground level, is the power generating floor, supplying power for the operation of the drawbridge and for the station building. The drawbridge motors operate on 550-volt direct current, which is supplied by either of two 1,000-amp. generators, direct connected to 750 hp., 2,300-volt 25-cycle, 1-3-phase motors, one of which is for stand-by. The power for the passenger station is supplied at 4,150 volts, 62½ cycles, generated by either of two 61.7 amp. generators direct connected to 565-hp., 25-cycle motors, one being standby.

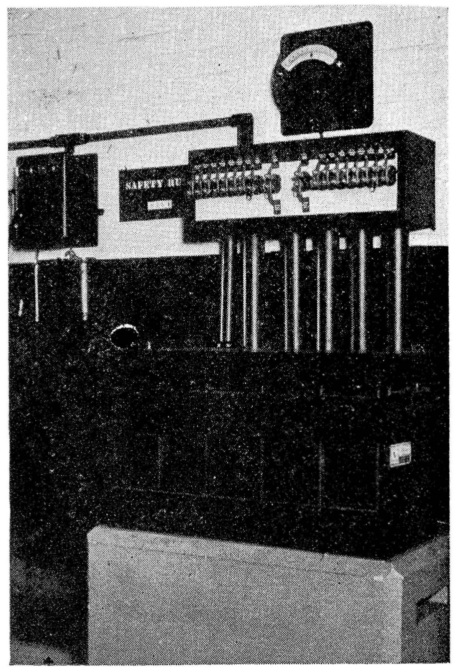
Four Power Sources

The units have four independent sources of power, two single-phase and two three-phase, all from railroad company substations supplying electric traction current. The choice of power source is determined in each case by operating conditions. The 11,000-volt energy is brought to a transformer substation at the east end of the tower where it is reduced to a 2,300-volt potential and then fed to the motor generators. A special feature of the motor-generator sets is the fact that the motors are capable of operating on either the single-phase or the three-phase power. This made it unnecessary to provide duplicate motor-generator sets to be operated on the two different types of power.

The generator control board is energized by a bank of 60 lead storage cells. This battery is carried on a floating charge by either of two motor-generator sets rated at 2.5 kw. at 140 volts, which allows the board, in case of emergency, to be operated from either the battery or the battery-charging machine. The control board includes a power-transfer relay which, in case of a lighting power failure in the interlocking station, will open and feed such lights as are essential from the control battery. A 15-ton electrically-operated overhead crane on the first floor facilitates the replacement or repair of any of the generating equipment, while a 15-ft. vertical rolling door in the west end of the building provides ready access to this floor for large equipment.

Space for 800 Relays in Tower

The second floor is occupied by the relay room. The relay rack is built in four sections of pressed-steel frames having shelves adjustable to 2-in. variation, which allows the shelf spacing to be set conveniently for the size of the relay or other apparatus it contains and also provides greatest flexibility in changes necessitated by new work or revisions. Each relay rack is 40 ft. long and 12 ft. 7 in. high, with six shelves providing space for 200 relays per rack or a total of 800 relays in the room. The first shelf is 3 ft. 6 in. from the floor, providing space below it for cable termination, rectifiers, and local lighting transformers. The remaining shelves are spaced 22 in. apart so as to provide ample headroom above all relays for

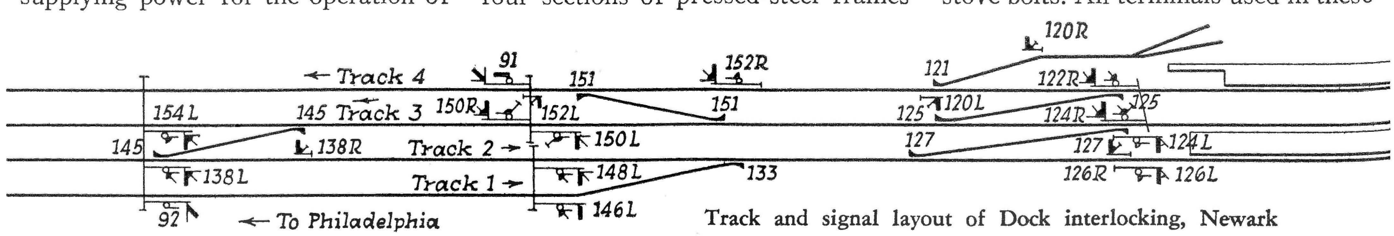


Meter and terminal layout at lock battery set

the double row of terminals necessary to carry the circuits in a minimum of shelf space.

The relay racks are 14 in. deep, two sections being placed back to back with a 3-ft. walkway between them. The two cases resulting from this combination are placed parallel on either side of the room with a 4-ft. walkway down to the center and 5 ft. from either wall.

The relay racks are backed with ½-in. transite board on which the terminals are bolted with 3/16-in. stove bolts. All terminals used in these



Track and signal layout of Dock interlocking, Newark relay cases are of the black bakelite multi-unit type, as they lend to greater speed in mounting and allow for a larger number of wires per foot of terminal space.

The relay leads are No. 16 flexible wire, using a reinforced tinned-copper eyelet for attachment to the terminals or relay posts; the case wiring is No. 16 flame-proof office wire. An unusual method of forming the wires in the back of the racks has been developed by using ⅜-in round iron placed 3 in. out from the back of the rack in the wireway. These bars carry an insulating tubing of fibre on which the wires are laced with waxed linen cord, forming the wires neatly and making unnecessary the use of bridle rings or other supports. Each wire, as it comes through the transite board from the terminal, is taken along a horizontal rod to vertical runs either up or down the rack as its destination requires. As none of the wiring runs at an angle across the rack a very neat appearance is produced as well as facilitating the tracing of wires through the rack. All interconnections between racks are carried overhead in transite wireways.

Track- and Switch-Repeating Relays Have Indicating Lights

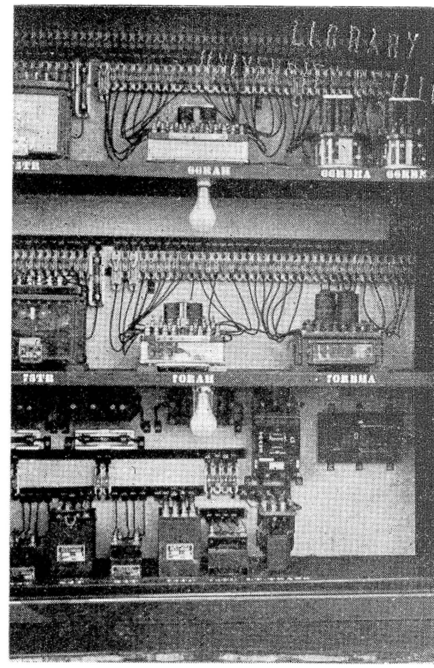
The relays are of the shelf type placed on ¾-in. sponge-rubber pads to reduce vibration caused by passing trains or the generating equipment on the floor below. Red indication lights are provided above all track-repeating and switch-repeating relays to denote when these relays are de-energized. This allows a great saving of time in the maintenance of equipment and in checking operations.

The local battery consists of two trays of 300-a.h. nickel-iron-alkaline cells floated across a 15-amp. copper-oxide rectifier. The feed from this battery is divided through terminals on the charging panel so that it is possible to test on the charging panel for control power to any individual section of the relay case. The center line of the relay case on the south side of the tower is directly under the rear of the interlocking machine, located on the floor above, allowing all wires to be carried through short lengths of 3-in. transite duct set in the concrete floor vertically into the wireway of the machine.

Operating and Communication Equipment

The west end of the second floor contains the telephone equipment for the operation of Dock tower, consisting of the relays, condensers, patch circuits, etc., necessary for this interlocking and making it independent of any other telephone equipment location. Facilities are provided for 30 magneto lines, 5 incoming selector circuits, 5 P.B.X. lines, 5 holding circuits and 35 patch circuits, all of which equipment is terminated in the operators' concentration unit. An independent power plant is provided for this equipment with all of the ringing being done from ringing generator sets. All telephone equipment is mounted on standard angle-iron distribution frames.

The third floor of the interlocking station is the operating floor. Numerous windows allow unrestricted vision in all directions and provide a maximum of daylight. The walls are painted a flat cream and the lighting fixtures are of the indirect type. The interlocking machine is a Model-14 electro-pneumatic 155-lever unit, which in the final layout will control an interlocking of 6 tracks east and west of the station, and 8 tracks in the station proper, extending over a length of 3.4 miles. The present interlocking includes 3 tracks, 5,700 ft. in length, and uses 39 levers, of which 19 govern 44 signals, 14 govern 23 switches, 3 govern 4 smashboards, 1 is a check lever, 1 is a traffic lever and 1 is a bridge master lever. At present, the interlocking frame includes 96 spare levers and 20 spare spaces. The machine carries the usual indication lights which provide an accurate check of the condition of the interlocking. A color scheme is used in painting the levers, whereby the function of any particular lever can be easily identified. Yellow is used for signal levers, black for switches,

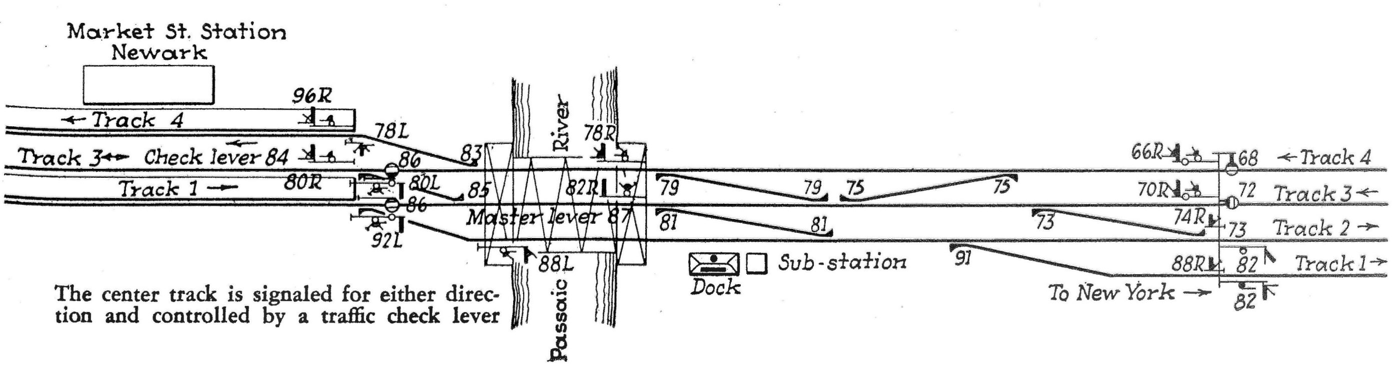


Typical outside instrument housing

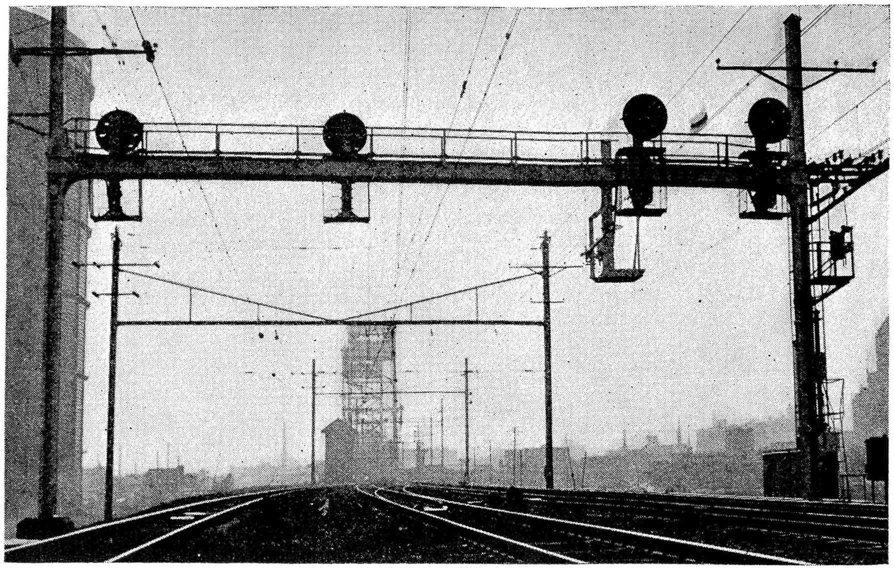
red for smashboards and white for spares.

A unique system of time-release operation is used on the machine. There are three time-releases for the control of all levers in the frame, which are mounted in the machine proper so that only the operating handles are visible immediately below the bank of lever indication lights. Each release has two separate time settings, accomplished by the use of mid-point contacts. The releases are normally run down and when operated the short time, which comes in at the mid-point contacts, are used for the control of low home signals for reverse running, while the long time, which is at the end of the stroke, is for the control of high home signals governing trains moving in the normal direction of traffic.

The flashing-light train-order signals are controlled from two-pole interlocked buttons mounted under the indication light cabinet on the front of the machine. The model board, located above and toward the rear of the machine, is 33 ft. long and 4 ft. high, suspended at five points from the ceiling above. The board, which



The center track is signaled for either direction and controlled by a traffic check lever



Looking westward toward the tower and drawbridge —the overhead smash-board is suspended from the signal bridge

was constructed of aluminum to reduce weight, was treated with acid before being given the final three coats of ebony flat black paint which forms the background. The completed layout was reproduced in flake white on this background. All wires to the board are carried through the supporting pipes from the ceiling above.

Three sets of indications are shown on the model board, the usual track-circuit and signal indications, and also the indication of the trolley sectionalizing set-up. All indication lights are of the 18-24-volt type set flush with the face of the board, using various colored bezels according to the function being indicated. The color scheme used is yellow for track circuits, green for signals, purple for traffic check locking, and red for trolley sectionalizing. All lights on the model board are normally dark.

Teletype Equipment Provided

The operating desks are located on the north side of the room on an elevated platform. At the present time the operating staff consists of a block operator who is also the drawbridge operator, a telephone operator who keeps the block sheet, and a leverman. Each of these men has before him a 120-line telephone cabinet which provides for all possible telephone connections. The lines are all magneto and selector type with the exception of the Newark P.B.X. lines, which are common-battery dial type.

The operating equipment also includes a five-station selector teletype system with machines located as follows:

Movement director's office, Jersey City, N.J.
Station master's office, Pennsylvania station, N.Y.
Station master's office, Newark, N.J.
Train-Information board, Newark station
Dock interlocking station

An interesting experiment has been made on the teletype machine on the train-information board. A 12-in. lens was mounted over the machine carriage so as to make the information coming in on the machine visible to the attendant from a distance. Lights are mounted over the carriage and the message is clearly legible at a point 15 ft. in front of the machine.

An air pressure gage is mounted on the wall in the rear of the operator's position, providing a ready check at all times. This gage is equipped with a contact that closes at 65-lb. pressure and causes an electric bell to ring, thus giving an audible warning of low air pressure which might result in failure if not handled promptly.

The bridge-operating mechanism is located at the west end of the operating floor. The control board accommodates the necessary switch controls for the equipment on the power generating floor below. The position of the operating board gives the man an unrestricted view of the drawbridge and river at all times.

At the east end of the operating floor a trolley sectionalizing board is operated by the block operator from instructions given by the power director. This board controls the energizing of the 11,000-volt overhead trolley section for the a-c. electric propulsion, which is used exclusively through this territory. The remotely controlled sectionalizing switches for the 6,600-volt signal line are also operated from this board.

The outside instrument cases are constructed of 14-gage steel with hinged doors front and back, and 3/8-in. transite false backs 5 in. from the rear door. These cases, which are conveniently located to terminate the control cables to the switches, signals and track, also house the relays, transformers and other wayside equipment. Each case is located over a manhole in the low-tension duct line and faces toward the tracks. The relay case foundations were poured as an integral part of the manhole top slab.

Standard A.A.R. porcelain-base terminals are used throughout and are bolted to the transite terminal board with stove bolts. The heads of the bolts are in the back of the case and countersunk to prevent damage to the case wiring. The wires from the terminals to the relays are 17-strand No. 16 flexible, with tinned-copper eyelets used to connect leads to the relays and terminals. Adjustable slide-wire 4.5-ohm resistance units, used for control of the voltage to the signal light circuits, are protected by a strip of asbestos over the resistance wire, thus eliminating any possible hazard from overheating or short circuits. The relays are all of the shelf type set on 3/4-in. sponge-rubber pads to dampen train vibration. The case wiring is done with No. 14 rubber-covered cable wire, which presents distinct advantages over the tape and braid wire used for outside wiring.

All cables from the duct line, entering the instrument cases from the manholes underneath, are brought into the 5-in. wireway between the transite false back and the rear doors. Each cable is terminated as a unit on a row of terminals in the bottom shelf and from this point interconnections to the relays begin. All spaces around the cables are closed tightly with asbestos cement, making the cases vermin and moisture proof. Platforms with guard rails are provided on all cases where the clearance is close or the ground slopes away sharply. These platforms are of all-steel construction with checker-plate floor and angle-iron guard rails.

Position-Light Signaling

The signals are of the standard position-light type, mounted either on the catenary bridges or ground masts as the location requires. The use of the standard signal bridge in electrified territory has been discontinued and instead a beam bridge between the catenary poles is used for signal mounting, resulting in a substantial reduction in construction costs. The walkway on top of the beam is 29 in. wide, with the signal suspended from the face of the beam in the inter-track space. The signal supports are provided with two checker-plate platforms, the one for the top unit being level with the walkway of the bridge itself. All bottom arms of signals on catenary bridges and all other signals located where it would be possible for a man to come closer to the energized wire than the safety rules allow, are protected by barriers of ¾-in. galvanized mesh panels.

Each home signal nearest the interlocking station for each track is provided with a flashing-light train-order signal placed 3 ft. 6 in. below the center of the top arm. A Style-NF flasher relay is used in the control circuit for the signal, the relay being modified, however, so as to use only one set of contacts with a counter-balance to make it return to the open position when de-energized. The signal is made up of a position-light unit with a yellow cover glass and is illuminated only when the relay is energized.

At several locations in the interlocking, it has been necessary to modify the standard position-light signal because of close clearance at platforms or to prevent the signal from being obscured by columns of the structure. For use at these locations, a special signal has been constructed using the standard position-light unit with the spacing between units in the aspect reduced from the standard of 18 in. to 12 in., and the distance between the top and bottom arms reduced to 5 ft. This signal is easily read and mounting conditions are greatly improved.

E-P Switch Movements

The electro-pneumatic switches are operated by A-5 switch and lock movements equipped with point detectors, controlled by Style-CP valves. All No. 20 crossovers are equipped with 45-ft. switch points and an additional operating rod placed 22½ ft. back from the point, this second operating rod being pipe-connected to the switch movement. Air is furnished to the switch movements by ¾-in. laterals connected to a 2-in. air line running through the interlocking. The air is normally supplied from the compressors located in the basement of the interlocking, but the air line for this plant is actually part of an air line system 24.5 miles in length, running from New York and Jersey City to "Lane" interlocking, North Elizabeth. The air can be fed in an emergency from any combination of the seven supplies available for this line. This air line is a multiple-feed channel, having two main 2-in. runs, one on either side of the right-of-way, and numerous cross-runs for interconnection and sectionalizing. The main air line is carried above ground on concrete foundations while the cross-runs, which can be fed from either main line, are buried in sand or clay at least 30 in. below the top of the ties. All connections to switch movements are made with flexible connectors. The switch movements are fastened to the ends of the switch timbers, with the control valves on a concrete foundation as near to the movement as practicable.

All track circuits are double-rail, end-fed normally at the leaving end, adjacent track-circuit polarity being staggered at the block joints to provide protection against failure of the insulated joints. The track-circuit current is 100-cycle and the track relays are of the two-element centrifugal type.

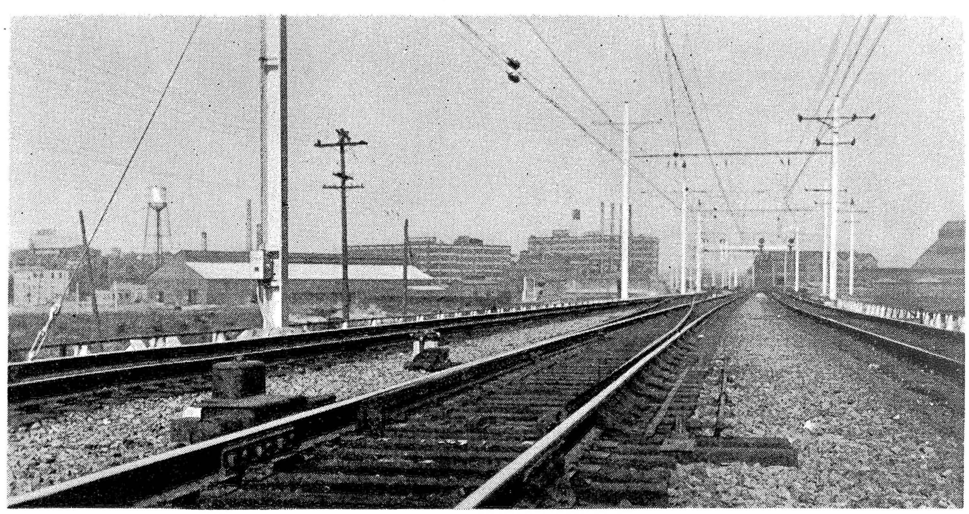
The rail is bonded with A.A.R. heavy-duty galvanized-copper plug bonds and the impedance bonds, around the block joints for propulsion current return, are of 1,500 amp. capacity per rail, having a very low resistance. All switch and signal control cables from relay locations are bronze-taped lead-covered parkway carrying No. 14 wire, and the track wires are No. 6 parkway. This parkway is buried in sand or clay 30 in. below the top of the ties and is protected at points of possible damage by capping placed on the cables. A fused bootleg riser is used to eliminate possible damage to the control equipment by a part of the propulsion return current entering the relay case over the track wires.

Coded Track Circuits

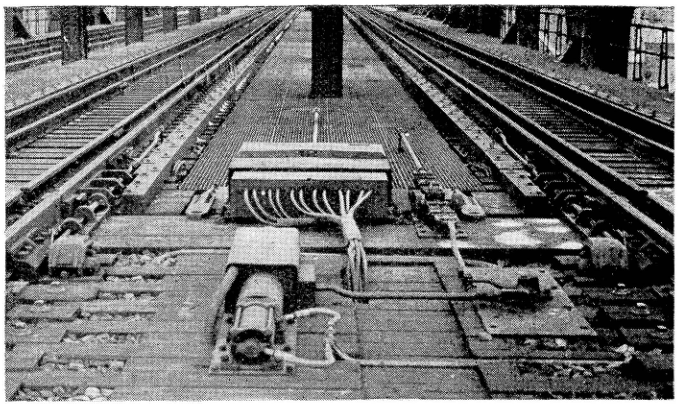
All track circuits are coded for four-indication cab signals with the code frequencies on 100-cycle current of 180 interruptions per minute for "Proceed" code, 120 for "Approach Restricting" and 80 for "Approach." No current or continuous current provides for "Caution-Slow-Speed." The three codes are produced in a code-transmitting relay operated by a small induction motor with cam shafts for making the interruptions. Five code-transmitting relays are used for the entire interlocking. The code selection for an individual track circuit is made over the signal control relays and this code carried to a d-c. code-following relay at the location from which the track feed emanates.

An additional circuit is run through the code-following relay, from the local 100-cycle power source which supplies the code to the track, an auto-transformer being used to secure proper regulation of current values. The advantage of this system of code-current transmission is that a much better control of the code to the track is made possible by reducing the number of contacts in the circuit, reducing the length of the track local circuit and making synchronous coders unnecessary.

The power for the operation of the signal facilities is secured from either



One of the electro-pneumatic switch layouts



Switch machines at each end of the draw span actuate six rail locks, circuit closers, and bridge latch

of two substations, one located 2.6 miles east and the other 3.8 miles west of Dock interlocking station and is supplied at 6,600 volts, 100 cycles, by two 1/0 copper wires carried on the catenary structure except through the station where it is in the high-tension duct line. Sectionalizing switches remotely controlled from the interlocking station are provided at each signal location to facilitate line operation.

The transformers are connected to this line between pairs of disconnecting switches and have a rating of either 5 or 10 kv.a. 6,600 to 220/110 volts. Primary fuse cut-outs with 5-amp. link fuses as well as crystal valve lightning arresters are provided at each location for transformer protection. Intercase power feed in an emergency is made possible by a 2-conductor No. 0 cable which is looped into each location, the transformers being of sufficient capacity to carry an adjacent location as well as the local load.

Cables in Duct Lines

Two duct lines were built through the interlocking, one for low-tension cables and the other for high-tension cables. Both are 3½ in. vitrified clay ducts laid on 6 in. centers encased in concrete with manholes spaced 350 to 400 ft. apart. The low-tension duct line consists of 32 ducts from the eastward home signal to the interlocking station, and 20 ducts from the interlocking station to the westward home signal contain the telephone and signal cable. This duct line is also used for the control cables for the operation of the trolley sectionalizing switches. The signal cables westward from the interlocking station consist of four 91-conductor No. 14 wire cables for switch and signal control; two 44-conductor cables made of 42 No. 14 wires and two No. 4 wires, the No. 14 wires used for control circuits and the two No. 4 core wires for direct-current battery and common; and one 2-conductor No. 0 used for 110-volt, 100-cycle power transfer from one signal location to another.

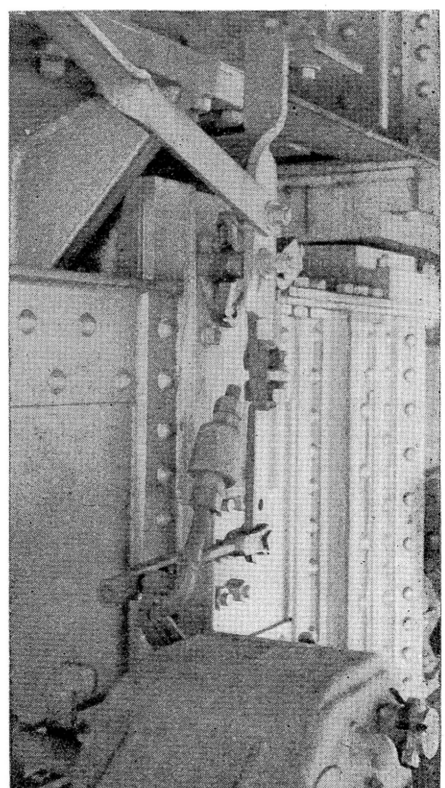
The signal cables eastward from the interlocking station consist of one 91-conductor, one 2-conductor No. 4 and one 2-conductor No. 0 lines. The 2-conductor No. 4 line runs from home signal to home signal, either in the 44-conductor cable or as a separate cable; the 2-conductor No. 0 line is also continuous through the interlocking, both breaking at each relay location. The larger signal cables go to locations through the interlocking, with inter-location cables of size as required. The signal cables are all rubber insulated with lead-sheathing protection. There are 368 cable pairs for telephone and telegraph lines through the low-tension duct line in paper-insulated lead-sheath cable.

High-Tension Cable

The high-tension duct line, consisting of 12 ducts from a point 300 ft. east of the interlocking station to the eastward home signal, contains the following cables: A 2/0 cable for the 6,600 volt 100-cycle signal power line; a 2/0 cable for 6,600-volt 100-cycle emergency lighting of the passenger station; a 250,000 c.m. cable for 11,000-volt 25-cycle power for drawbridge operation; two 3/0 cables for station lighting; and two 750,000 c.m. propulsion-return cables. These cables are oil-filled and paper insulated with lead sheathing. The high-tension cables in the manholes are fireproof, having burlap and asbestos cement to reduce the possibility of a fault on any one cable spreading to an adjacent cable. The manholes are provided with trench drains. Insulated cable racks are used in manholes and all cables are racked close to the walls to provide as large a clear space in the manholes as possible so as to permit easy passage.

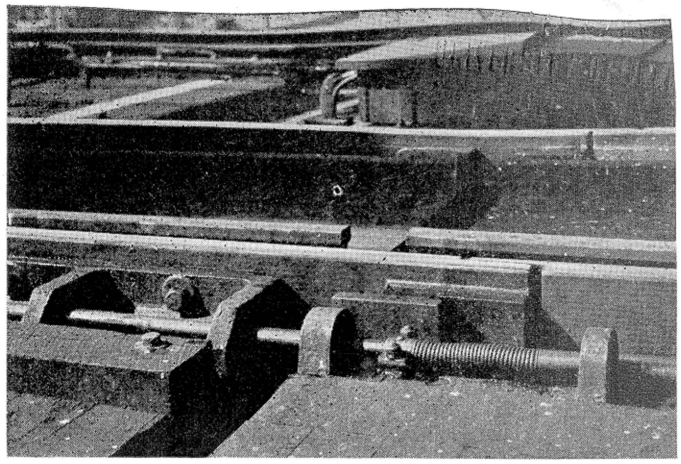
In the old layout all power and signal lines crossing the Passaic river were carried either in submarine cables laid on the bed of the river or through cables laid on the deck of the drawbridge with circuit closers at the ends of the swinging span. In the new layout all circuits, including signal, telephone, electric traction and station lighting are carried under the river in a tunnel of 6 ft. inside diameter, 600 ft. long, located approximately 50 ft. north of the new drawbridge. This tunnel, which is essentially a reinforced-concrete pipe with a 12-in. wall poured in place, was constructed under air pressure employing steel liner plates for a shield. It has a concrete-encased duct line on either side, one of 32 ducts for the low-tension cable and the other of 12 ducts for the high-tension cable, with a 2½-ft. passageway between them. At the ends, the tunnel is connected to the surface by vertical concrete shafts 10 ft. square and approximately 55 ft. deep with individual splicing chambers for the high- and low-tension cables directly above. Forced ventilation is supplied by blower fans to clear the tunnel of dead air when it is necessary for workmen to enter.

The cables used in this tunnel are of a special manufacture with a layer of steel armor strand to withstand the strain of the vertical run up the shafts. All cables were supplied in lengths to make the complete run from one splicing chamber down the shaft, through the tunnel and up to the splicing chamber on the other side, thus eliminating all splices in cables



Circuit controller and lever mechanism for checking the bridge seating in the tunnel itself. The cables are anchored at the top of either shaft by a holding collar which fits down tightly over the entrance ducts. Electric lights with gas-proof fixtures are provided in the passageway, making it unnecessary to carry any type of light into the tunnel.

The three-track drawbridge, operated by 550-volt direct current, is a vertical lift span rising to a height of 135 ft. above mean high water level. This bridge is a steel truss designed for expansion in an easterly direction only. Bridge circuit controllers are provided at the ends of the span to carry the track circuit and rail return currents. At the east end of the movable span the circuit closer is set on a channel-iron runway with 3-in. centering pins on the fixed span, which holds the female portion of the circuit closer by means of guide arms in the same relative position at all times regardless of the movement of the bridge longitudinally due to expansion or contraction.



One of the six rail locks at each end of the span

Drawbridge-Operation Checked

The bridge circuit closers and rail locks are operated by electro-pneumatic switch movements controlled over the bridge master lever, one movement being used to operate the circuit closer and six rail locks at each end of the span. Each rail lock is checked by a circuit controller connected to an extension of the rail lock itself so that the rail lock must pass through the locking slot in order to operate the circuit controller and produce a clear indication.

The bridge latching at the center of each end of the span is accomplished by a 6 in. by 4 in. beveled steel bar inserted through the latch tongue and operated by a 10-in. switch cylinder. All of these units are indicated in the normal or reverse position to control following operations. The seating of the bridge is checked for signal purposes by means of a six-way circuit controller mounted in front of the latch at either end of the bridge and pipe-connected to an escapement crank, which is engaged by a roller mounted on the bridge latch block of the movable span, allowing for adjustment to ½-in. of bridge travel. A counterweight is provided on the operating arm to insure positive operation of the contacts even under excessive vibration. Circuit controllers are provided on the brakes and the bridge power is relay controlled. The emergency operation of the bridge is by means of a gasoline engine located on top of the movable span, equipped with an electric lock on the clutch operating handle, which prevents the clutch from being engaged unless the bridge master lever in the interlocking machine is in the full normal position.

Sequence of Bridge Operations

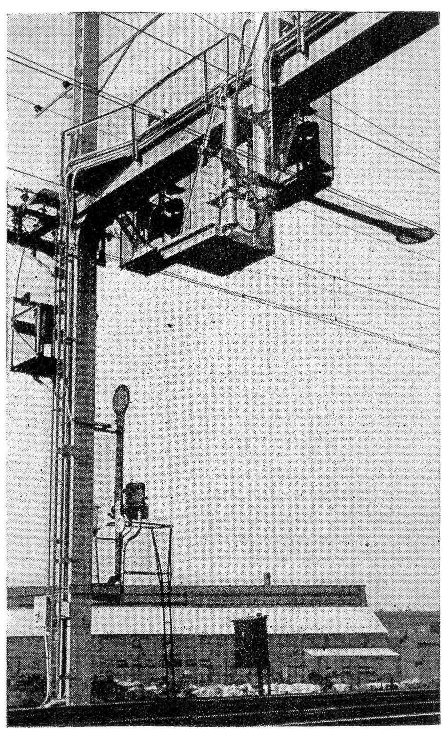
The entire drawbridge operation is electrically indicated and supervised by the signal equipment, and consists of the following steps:

For raising the span—

1. All home signals governing bridge movements must be at "stop" with the corresponding signal lever "normal."
2. All track circuits between the home signals governing bridge movements must be unoccupied.
3. The smashboards may then be lowered.
4. The bridge master lever is then operated to the "normal" position which opens the bridge circuit closer and withdraws the rail locks and span locks.
5. If all the above units indicate a complete normal operation, the bridge power control relay is energized, allowing the lift motors to operate as directed by the lift controller.

For lowering the span—

1. The bridge being properly seated must be indicated by the bridge seating circuit controller, the brakes must be applied and all power removed from the motor controllers.
2. The master lever is operated to the reverse position, which closes the bridge circuit closers and drives the rail and span locks.
3. If all the above units indicate a complete reverse operation, the smashboards may be raised allowing the signals to be cleared and trains operated.



The overhead smashboard applies to the center track

All of the indication circuits for the bridge are split, those on the east end of the span going to one check relay and those on the west end to another, permitting a very definite check of bridge operation to be made.

The smashboards are lever controlled from the interlocking machine, the same lever being used for the two smashboards on the same track. The smashboards are air-operated by two special cylinders with a 2-in. bore and 3⅛-in. stroke, having individual control magnets. The operating pistons are rack-and-pinion connected to the smashboard arm. The smashboards are held in the clear position by air and lowered by gravity, their position being checked by a four-way circuit controller connected to the pivot arm. At the westward home signal bridge, because of the lack of space between the two westward tracks, it was necessary to provide a smashboard which operated from above the tracks, on the inside track. Because of the catenary wires, it was impossible to use the conventional cross-track board, hence a smashboard was designed using a catenary bridge signal support with a standard smashboard mechanism and a 12-ft. protection arm. This arm, which is provided with a counterbalance weight to reduce load on the mechanism, swings down from above in a plane parallel to the rails.