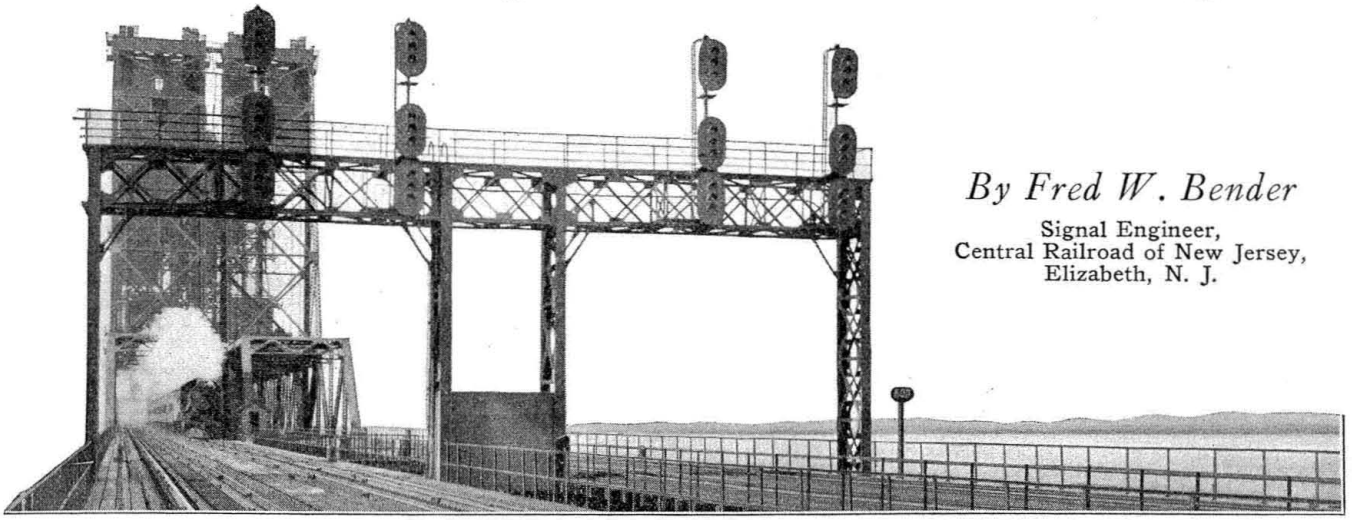
C. N. J. Completes Interlocking to



By Fred W. Bender
Signal Engineer,
Central Railroad of New Jersey,
Elizabeth, N. J.

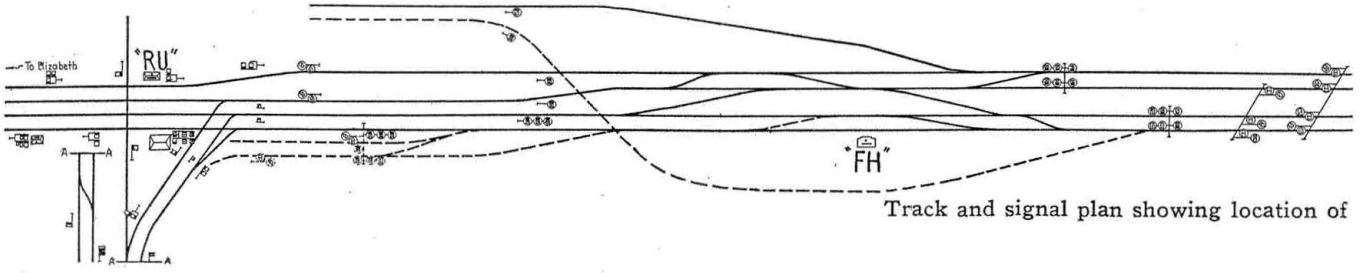
Home signal bridge in foreground with train approaching

THE Central of New Jersey's new four-track bridge, with its four lift spans over Newark Bay, was formally opened to traffic on November 27, 1926. This bridge spans Newark Bay between Bayonne, N. J., on the east and Elizabethport on the west side of the bay, and replaces two rolling lift bridges, erected in 1904, which provided two 85 ft. channels. Its construction was necessary to meet the increasing boat traffic in the bay and the constantly growing suburban, through passenger and freight traffic on the railroad.

In order to provide the maximum of safety and flexibility to train operation and in keeping with the progressive policy of the Central to install modern appliances, an electro-pneumatic interlocking plant was installed. The interlocking for the bridge, constituted but a part of the extensive signal program for this territory. The east approach to the bridge is controlled by "BV" tower which has a 47-lever electro-pneumatic interlocking machine. This interlocking also handles traffic from West 8th street and Avenue A passenger yards at Bayonne. The west approach to the bridge is governed by "FH" tower with a 51-lever electro-pneumatic interlocking machine. This plant, in addition to controlling the west approach to the bridge, also governs traffic to handling the suburban and through traffic three of the four tracks are signaled for train operation in either direction. Three tracks are used for eastward train movements in the morning and three for westward moves during the evening rush.

In addition to the Central of New Jersey trains, the Baltimore & Ohio and the Reading also operate trains over the present bridge. There are approximately 218 passenger trains a day consisting of through, local and suburban trains and about 80 freight trains each 24 hours. The average number of scheduled passenger trains passing over the bridge during the first trick are 58 eastbound and 57 westbound; on the second trick, 31 eastbound and 49 westbound; on the third trick, 12 eastbound and 11 westbound. In addition, about 28 freight trains each trick pass over the bridge. As the former draw consisted of only two tracks, it was necessary to suspend freight traffic during the morning and evening rush hours but this is no longer necessary.

Some idea of what the new bridge does in eliminating train delays may be gained by making a comparison between the number of times the old two-track bridge was opened and the operation of the new bridge for a similar period. For the month of December, 1925, the old



Track and signal plan showing location of

and from Elizabethport shop yard entrance. In addition to the interlockings in this territory, Style-R2 colorlight automatic signals giving a 3-block indication have been installed between Bayonne, N. J. and Elizabethport as part of this development program.

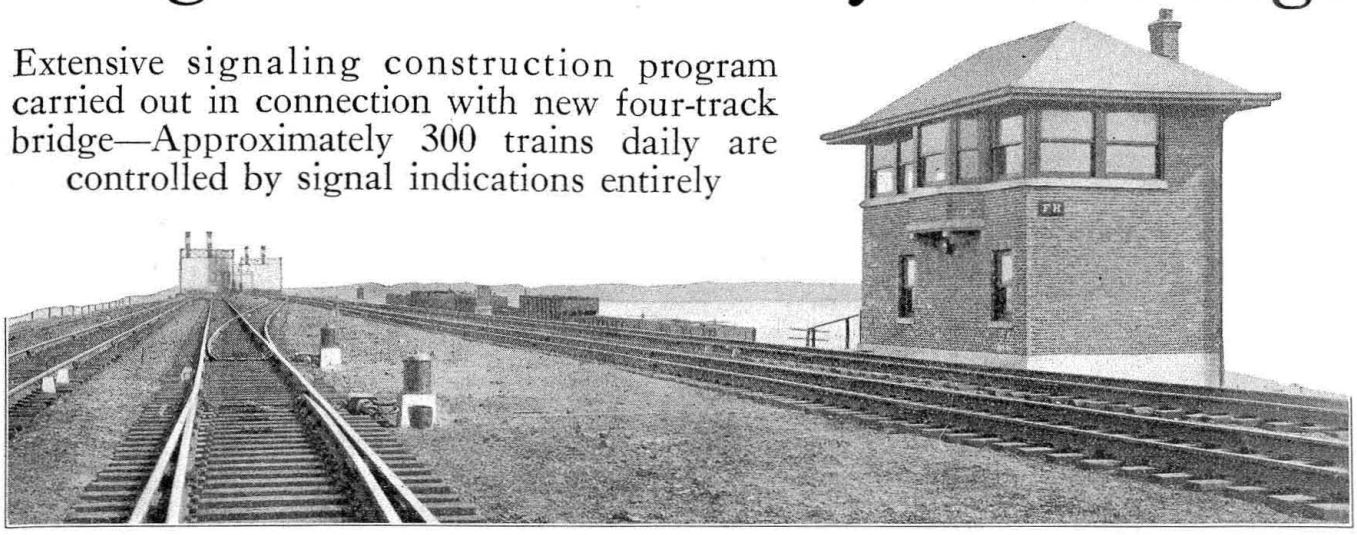
Train Operation

Approximately 300 trains a day pass over the drawbridge, and all train movements are controlled by signal indication. In order to provide maximum capacity for bridge was opened 1,400 times while in December, 1926, the new bridge was operated about 700 times. During the first 15 days of January 1927, 342 lifts were made and 1,062 craft passed through the bridge. Of the 1,062 craft, 588 passed under the bridge while the draws were lifted for the passage of 474 boats. This indicates that from 50 to 60 per cent of the craft were able to pass under the 35-ft. head room clearance without the necessity of interrupting railway train traffic.

The fact that the new bridge had to have 35 ft. clear

Safeguard Newark Bay Drawbridge

Extensive signaling construction program carried out in connection with new four-track bridge—Approximately 300 trains daily are controlled by signal indications entirely



Tower west of bridge controlling west approach to Newark Bay draw

head room made it necessary to raise the grade of the present tracks about 32 ft. above the track level of the old bridge. This entailed extensive changes in the approaches at a distance of a mile to the east and a mile and a quarter to the west, making the present gradient not to exceed 0.4 per cent for westward trains and 0.3 per cent for eastward trains.

Electro-Pneumatic Interlocking Machines

The three interlocking plants which were installed in connection with the development program through the territory of which Newark Bay Draw is a part, are provided with the Union Switch & Signal Company's Model-14 electro-pneumatic type machines. Tower apparatus is enclosed in steel cases and includes 110-volt, 60-cycle magnets for a-c. operation.

The interlocking machine located in "BV" tower has a total of 31 working levers and 16 spares. Fifteen levers handle 26 derails and switches, 12 signal levers control 10 dwarf signals and 12 high signals. In addition, there are 4 traffic levers for traffic locking between "BV" tower and the plant on the bridge.

The interlocking machine and attendant apparatus located in "FH" tower is for the control of trains at the west approach of Newark Bay draw. This interlocking machine has a total of 27 working levers and 24 spare levers. There are 14 switch levers for 24 switches and derails, 9 signal levers for 18 high signals and 4 dwarf signals and also four traffic levers for traffic locking.

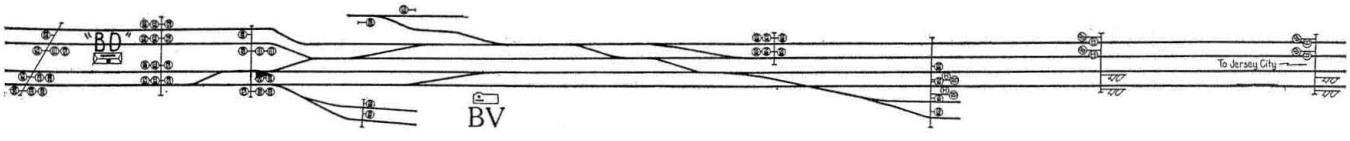
The circuits for "BV" and "FH" interlockings, in general, are similar to those used on the drawbridge. The home signal circuits consist of the regular semi-automatic stick control with "KR" selection over switches and derails, while the distant controls provide for 3-block indication as do the home signals. The regular approach locking of signal levers, flashing lights under the signal levers and push button control for call-on indications are similar to those on the bridge. These plants have sectional route locking of the switch levers with lever lights on the machine to repeat the sectional route locking control. The signal levers are

Working Levers at Newark Bay Interlocker

6 Signal levers, 4 for railway and 2 for navigation traffic
7 Derail levers
4 Rail lock levers
4 Bridge lock levers
4 Power current oil switch levers
4 Bridge operating controller levers
4 Emergency cabin controller levers
4 Traffic locking levers

equipped with lights which indicate track occupancy for the routes controlled by the signal levers. As stated elsewhere, traffic locking exists between these two plants and the bridge. Alternating current for track circuits, switch movements, signal controls, locks, and all other apparatus is used for the three interlockings and automatic signals.

All signals are of the color-light type with individual transformers and are of U. S. & S. Co. Type-R2 construction mounted on signal bridges where possible.



Signals and interlockings on bridge and approaches

They are operated on the 3-block principle with block lengths averaging about 3,000 ft.

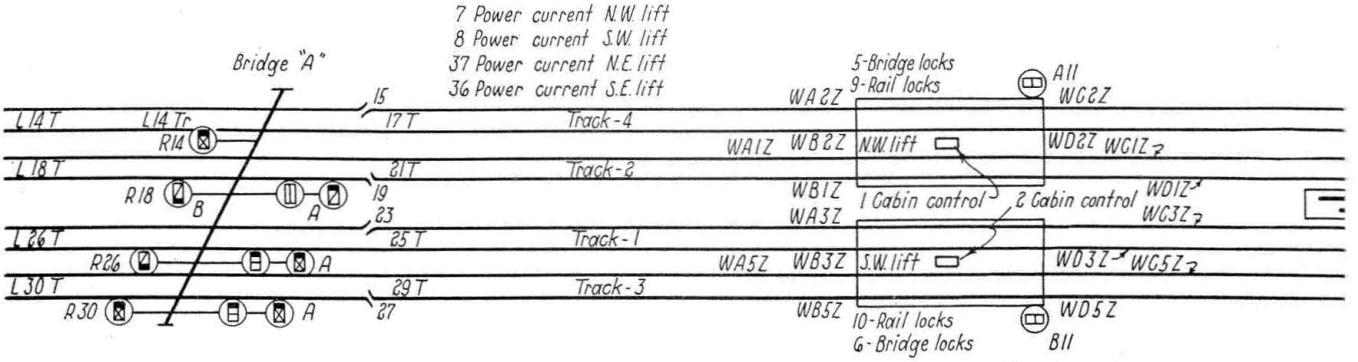
The Interlocking on the Bridge

The interlocking machine and the apparatus for controlling the operation of the bridge are located in the operating tower mounted over the pier and above the tracks between the two pairs of lift spans. All functions of the interlocking such as the main oil switches, the draw span locks, rail locks, derails, etc., are electro-pneumatic, all electrical equipment being designed for alternating current operation.

The interlocking machine on the bridge has a 43-lever frame with a total of 37 working levers.

In addition the machine has stick push button circuit controllers for signal levers and three rows of lever lights on the machine.

Provision is made in the operating tower for dimming the lights on the signals and on the machine at night to approximately one-half the day power. The relays in the tower are housed below the operating room in two sectional steel relay cabinets, each consisting of 12-relay



Track and signal plan of inter

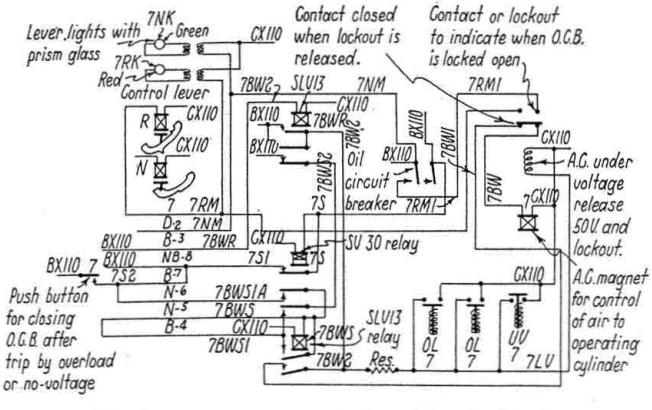
case sections. These cabinets are equipped with glass panel doors and are assembled back to back.

The track circuits are supplied with 60-cycle, alternating current. Within the interlocking limits 2-position relays are used with repeating relays in the tower. All circuits exterior to the tower and from cable housings to functions are run in submarine cables except on signal bridges where they are carried in Parkway cable.

In planning the drawbridge interlocking, other conditions different from those encountered in ordinary interlocking design, had to be met. These led to special circuits which had to be developed for controlling the operation of the draw, signals and other apparatus. These special circuits, which are of interest, are discussed under their respective heads.

Oil Circuit Breaker Controller

Power is supplied for the operation of the lift spans through four oil switches, one for each lift span. These



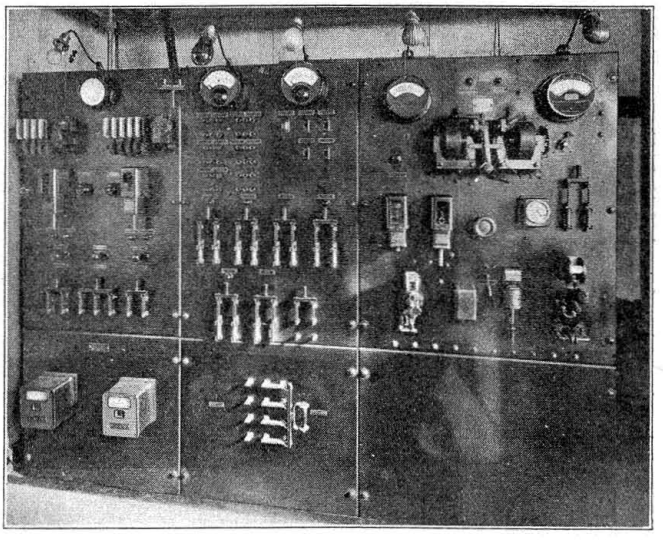
Oil circuit breaker control and lock circuits

switches are controlled by levers in the interlocking machine which cause them to close when power is to be supplied to the bridge machinery for raising the spans. The circuit breakers will open on overload or undervoltage but may be restored from an over-load kick-off by means of push buttons on the interlocking machine, providing the levers in the machine are in proper position.

The circuit breakers open after the spans have been lowered in place and the levers in the interlocking machine have been partially reversed. When the circuit breakers are locked in their open position, the interlocking machine levers can then be continued to their full reverse position. This prevents any possibility of power reaching the bridge operating mechanism when routes are lined up for train movements. Red indicating lights under the interlocking machine levers burn at all times when the oil circuit breakers are open and locked open; green lights burn when the circuit breakers are closed.

Electrically Locked Bridge Operating Controllers

Four levers in the interlocking machine govern the electric locks on the bridge operating controllers in the interlocking tower. When the levers in the interlocking machine are normal, the electric locks on the operating controllers are released and the operator can reverse his controllers for raising the lift spans. When the



Interlocking power boards—Matthews unit board on right

controllers are reversed, the interlocking machine levers are locked normal electrically. These levers are maintained locked while the controllers are reversed and released after the controllers are put normal and the electric lock levers on the controllers are reversed.

The indicator lights on the bridge operating controller electric locks burn when the corresponding levers in the interlocking machine have been put normal and the electric lock levers on the bridge operating controllers are reversed. On starting to reverse the interlocking levers, the lights under the respective levers are

illuminated if the electric locks on the operating controllers have been reversed and the detector track section relays are energized.

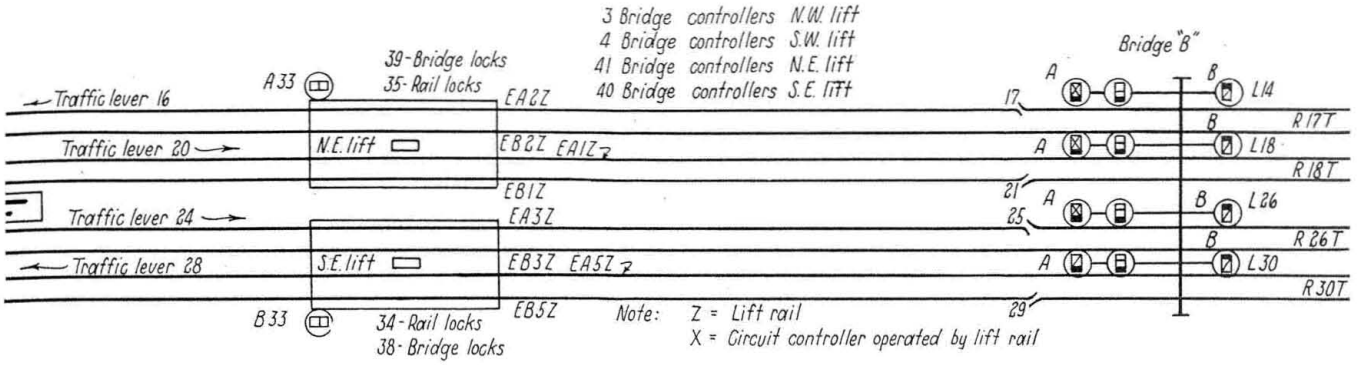
Emergency Control

The emergency equipment is located in cabins on the lift spans. If the normal power supply fails, the emergency equipment is then used to operate the spans. Electric locking is provided between the interlocking machine and the emergency equipment through the use

After the emergency equipment has been used and then is restored to normal, indicating lamps on the interlocking machine light when those interlocking levers governing the emergency equipment are returned to the indicating position, providing the detector track section relays are energized.

Bridge Lock Control and Indicating Circuits

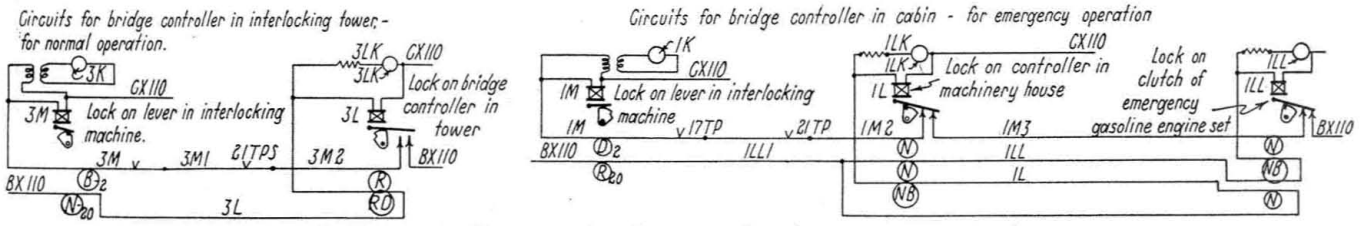
The special bridge locking apparatus of the electro-pneumatic type is well shown in the illustration. The



locking on Newark Bay Draw

of certain levers in the interlocking machine. The reversal of the lock levers on the emergency controller or gasoline engine set electrically locks the corresponding interlocking machine levers in their reverse positions. When the interlocking machine levers required for emergency operation are reversed, the locks on either the gas engine clutches or the emergency controllers are

bridge lock is first unlocked, operated and locked. The bridge locks are controlled by four levers in the interlocking machine. Partially reversing the levers operates the bars which unlock the bridge-locking plungers, then the electro-pneumatic equipment operates the bridge locking plungers. After these moves are made, the locking bars in turn lock the bridge locking plungers.

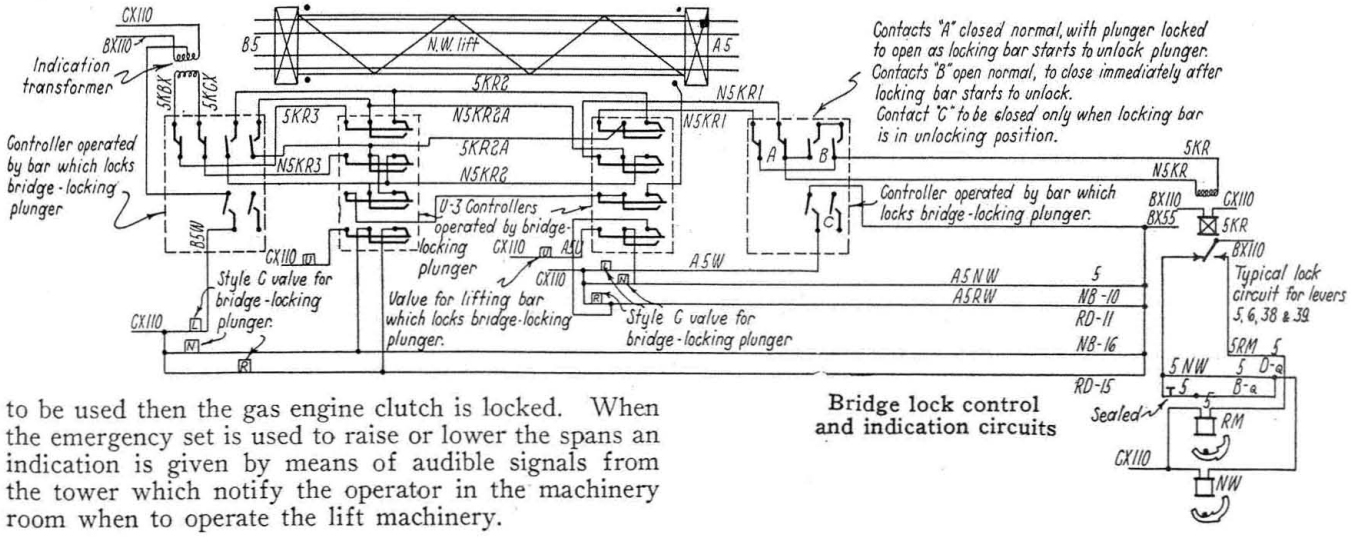


Bridge controller operation for normal and emergency operation

released; the indicator lights on these locks then light up showing that the emergency apparatus is ready for operation.

When the emergency gas engine equipment is to be used, releasing the lock on its clutch, locks the emergency controller or if the emergency controller is

Referring to the circuit, the *KR* relay is controlled through the *U-3* controllers, which are operated by the bridge lock plungers, and through other controllers operated by the bars which lock the bridge lock plungers. The *KR* relay is a 3-position relay. When the plungers lock the bridge, the *KR* relay contacts will be closed in



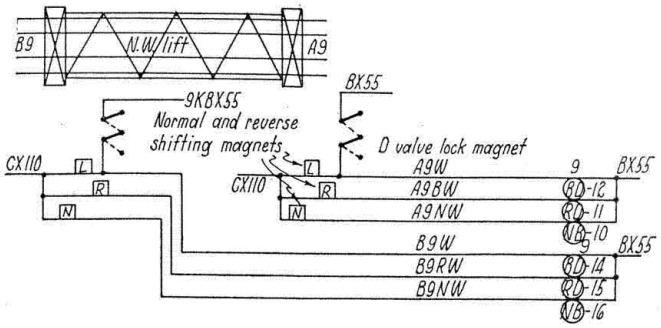
Bridge lock control and indication circuits

to be used then the gas engine clutch is locked. When the emergency set is used to raise or lower the spans an indication is given by means of audible signals from the tower which notify the operator in the machinery room when to operate the lift machinery.

a position corresponding with the position of the bridge lock plunger, thereby energizing the reverse magnet on the machine lever, permitting its movement to be completed to the reverse position.

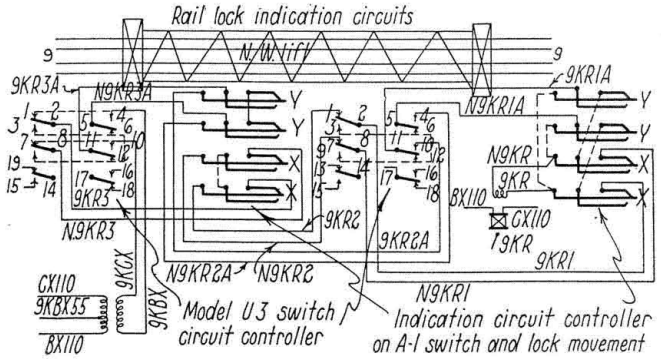
Rail Lock Control Circuits

Four interlocking machine levers are used for the operation of the rail locks. The rail lock control circuits are similar to the standard electro-pneumatic switch



Rail lock control circuits

control circuits, except that instead of the locks at both ends of a draw span being controlled in series over the same wires, as for a crossover, there are three separate wires to each end of the span. The rail lock indication circuits are standard indication circuits except for the addition of the *U-3* circuit controllers. The circuit controllers give a check on the position of the rail locks.

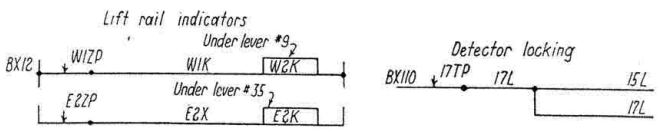


Rail lock indication circuit

The track circuits are maintained around the miter rails from the movable span to the fixed end by mercury box contactors.

Electric Locking and Other Circuits

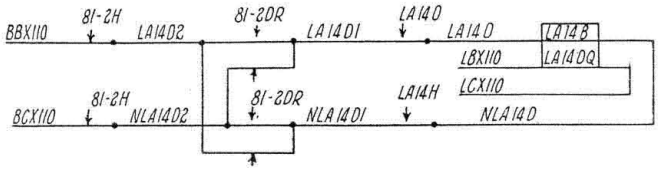
Approach and route locking is in use on the bridge. Approach locking becomes effective at the entrance of the third block in the rear of the home signal. There is a flashing light under each lever in connection with the signal lock circuit which indicates when the lever and the relays which the lever controls do not corres-



Lift rail indicators and detector locking

pond. As soon as they correspond as to position the light goes out. Two other lights under the lever indicate whether the block controlled by the *L* or *R* position of the lever respectively, is clear or occupied—when the light is energized the block is clear.

The home signal control circuits are standard semi-automatic stick controls with KR selection on derails. The circuits also provide KR protection over the bridge locks and rail locks. Stick push buttons under signal levers on the machine control the call-on signals. The call-on signal indication is two red lights over a yellow.



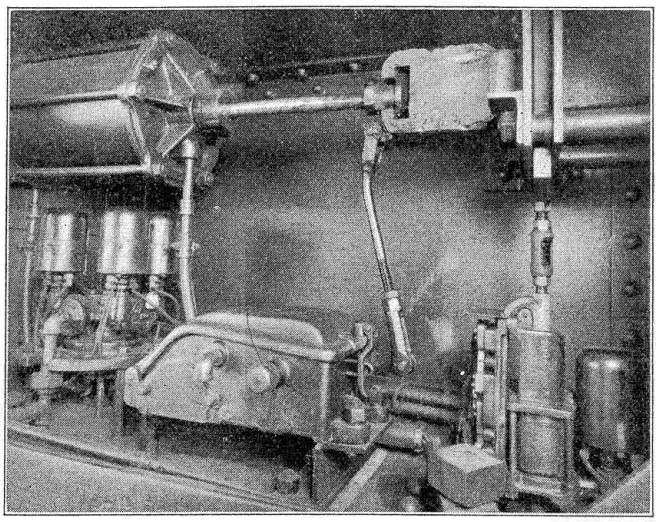
Westbound distant signal controls for north track on bridge

The stick push buttons, after having been operated to clear the call-on signals, are restored to normal when the signal levers are returned to their normal position.

The distant control circuits are polarized line circuits. The distant signal indications are obtained by means of a three-position relay and a two-position relay at each signal location. The control of the two-position relay is obtained locally through the polarized relay at each location. The three-position relay is controlled by polarized line circuits. It is through this method of control that the three-block indication is obtained.

Traffic Locking

Traffic locking is provided between Newark Bay draw, "BV" and "FH" towers. The traffic levers are equipped with indicating lights to show, when they are in their indicating position, that the lever stroke can be completed, either normal or reverse.



Electro-pneumatic bridge locking apparatus—Locking plunger at upper right

The navigation signals indicate to water traffic which span will be raised. There are two navigation signals for each span in each direction, making a total of 8 signals. The navigation signal indications are white. One light is continuously lighted as a marker. When navigation traffic is to be established through a given span another white light shows approximately 20 ft. above the marker light. The marker light is located at deck level.

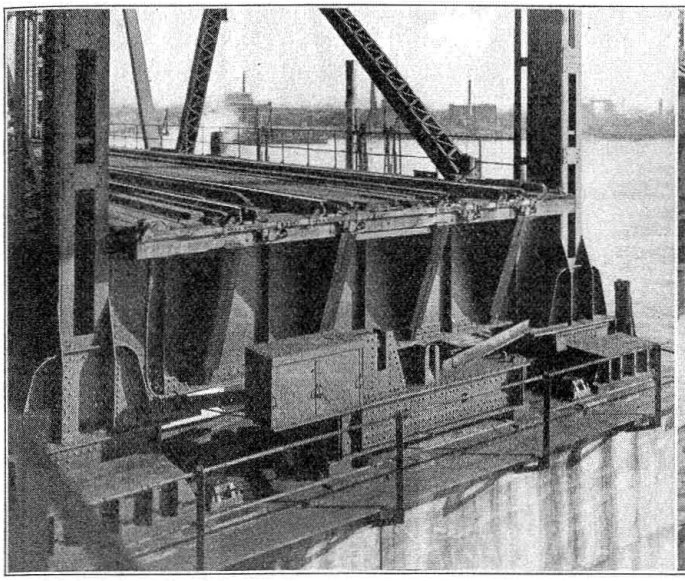
Lift Rail Detector Relays

The lift rail detector relays are governed by circuit controllers operated by the lift rails. The relays are also controlled through contacts on the bridge lock levers in the reverse position. They are energized when the bridge lock levers are reversed and the controllers, operated by the lift rails, are in their normal position.

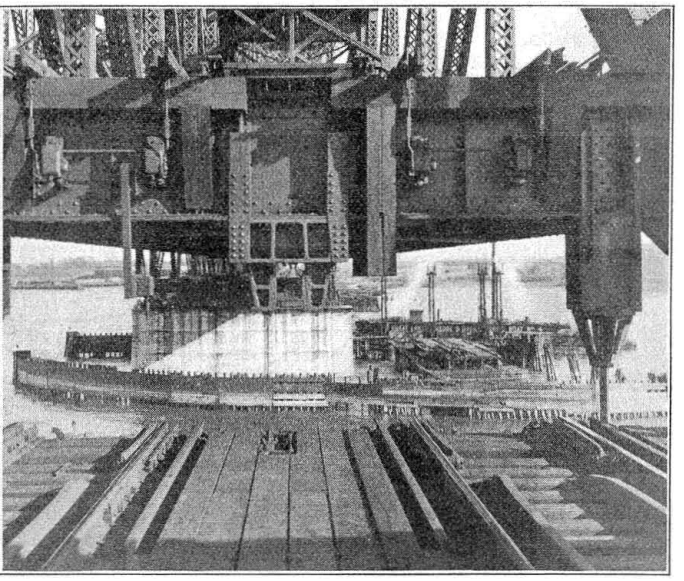
These relays control indicator lights under the rail lock levers on the machine to indicate that the rails are in proper position. When the bridge lock levers are normal the lights are out. These relays also enter into the signal control circuits.

Track Indicator Diagram and Annunciators

The track indicator diagram is provided with detector section indicator lights and also approach indicator lights indicating when the track sections are clear. The lights are normally burning but are out when the sections are occupied. But one annunciator is used for each track and it will indicate only for the direction in which traffic moves. When a train enters each approach section it is indicated by a short ring of the annunciator bell. Thus the bell will ring as the train enters each block starting at a point three blocks distant from the home signals. As the annunciator control is through the traffic levers, but one annunciator is needed for each track to provide for directional indications.



Bridge from draw showing rail and bridge locking apparatus, latter in case below left track



Draw partly raised—circuit controllers on miter rails operate only should miter rails become displaced

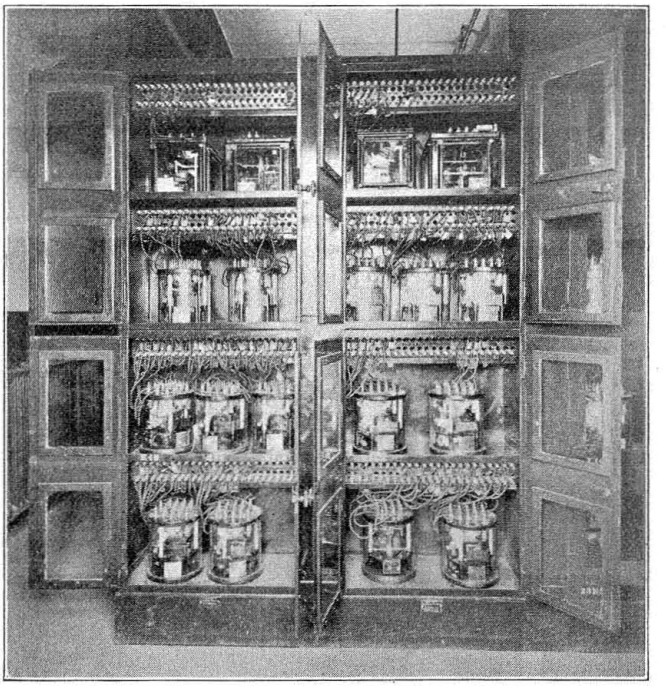
Interlocking Power Equipment

The power boards used for the normal power supply have 60-cycle 3-phase 3-wire connections and 60-cycle single phase 2-wire connections. Air for the operation of the plants is normally supplied from the main air line which extends through this territory. The emergency air compressor is the Type N5-7½ as manufactured by the Westinghouse Traction Brake Co., having a 50 cu. ft. piston displacement and furnishing air at pressures up to 90 lb. A 220-volt, 60-cycle 3-phase motor is used for operating the compressor with one pressure governor and intake strainer.

A Matthews emergency unit is installed at the draw bridge interlocking to provide power for the plant in emergency. This unit includes the engine—generator set, a starting battery, and a switch board on which is mounted starting equipment such as control apparatus and an automatic throw-over switch. Should there be a failure in the main source of supply a specially arranged voltage relay is operated. This relay in turn does two things. First, it operates the automatic throw-over switch, the functions of which are to disconnect the load from the main source of supply and transfer it to the auxiliary or standby source, which is the engine-generating system. The second thing that happens when this voltage relay operates is to start automatically a sequence of operations through starting contactors which cause the storage battery to crank the set and start it so that in the shortest possible time the set is running and ready to assume the load. The average time required for the set to take over the load is 20 sec. On the switchboard, used in connection with this unit, are two indicator lamps which repeat on the operator's panel in the interlocking tower. A green light indicates that emergency power supply is available; the red light indicates that emergency power supply is being used.

Telephone Facilities

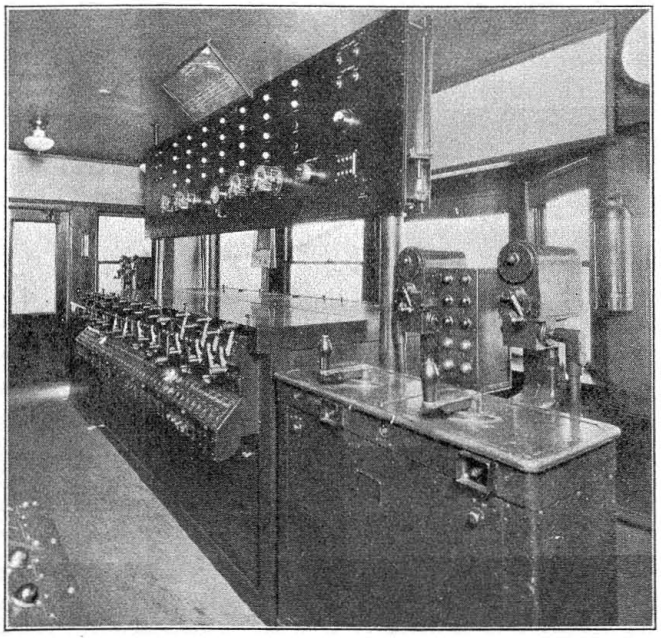
To provide for a rapid means of communication, telephones have been placed at every signal bridge. These connect into two central stations, into the three



Relays are located in steel lockers fitted with doors having glass panels for visual inspection

towers locally and also to the two railroad stations at Bayonne, N. J. and Elizabethport. These phones also can be connected into the Bell System. The phones are located at strategic points over the entire territory between 25th street, Bayonne and Elizabethport, there being 15 outside phones in this territory. Loud speakers on the "train" wire are used in the towers.

All circuits are carried in cables. The tower is on pier 8 while the channel spans are between piers 6 and 7 and between 9 and 10. Submarine cables run from the tower to pier 5 on one side and pier 11 on the other side. Circuits are carried back to the rail locks to piers 6 and 10 in Parkway cables supported on the bridge structure. All line circuits are carried beyond home signal limits in submarine cable similar to those through the channels. After reaching shore, all circuits are carried underground in Parkway cable. Submarine cables are terminated in metal housings built on the bridge piers.



Interlocking machine with track diagram—Electric controllers for eastward bridge lift spans in foreground

Electric locks with indicator lights are back of controllers for locking them—Between electric locks is bank of indicator lights showing approximate height of draw spans, one row for one eastward draw and the second for the other eastward draw. These indicate draw closed, ¼ up, ½ up, ¾ up and full up

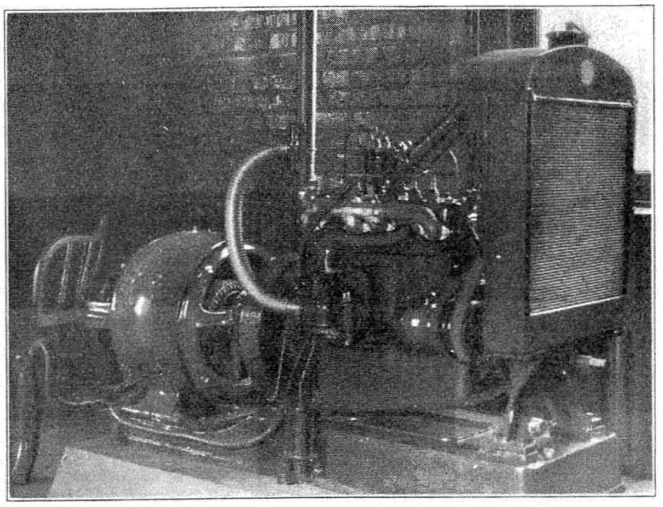
General Features of the Newark Bay Bridge

The present four-track bridge with its approaches is 7,411 ft. long, costing approximately $14,000,000. This structure is considered one of the world's important bridges, it being one of the longest four-track bridges in the country and has the largest drawbridge assembly in the world. The draw spans consist of an assembly of four 2-track electrically operated vertical lift bridges on concrete piers founded on bed rock, crossing two channels 125 ft. and 200 ft. in width between the fenders. The draw spans provide a clearance of 135 ft. above high water in the open position, and 35 ft. when closed. The time of operation for the easterly channel spans to go from their normal closed position to the 135-ft. clearance is 75 sec. while that for the westerly channel spans is 90 sec. The importance of a minimum time requirement for the operation of the spans may be gained from the fact that approximately 300 trains a day operate over the bridge.

Power Supply and Equipment for Bridge

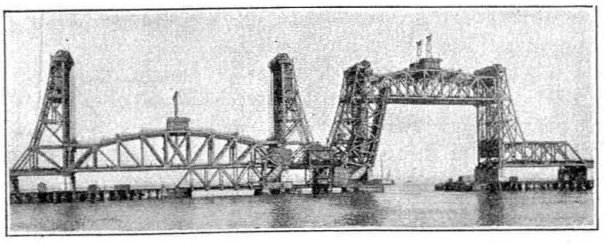
The 3-phase, 60-cycle alternating current for bridge operation is delivered to a substation at the west end of the bridge at 24,400 volts. It is stepped down to 2,300 volts and transmitted to the motors through two 3-conductor cables of 500,000 c.m. These cables are carried to the westerly draw span on supports connected to the bridge. From this point submarine cables are laid to reach the central towers between the draw spans. From the tops of the towers of each span, the 2,300-volt conductors are carried to the tops of a rocker bent mounted at the top of the machinery house. This bent is equipped with a unique device for keeping the conductors tight in all positions of the span as it is being raised and lowered. The maximum demand when all four spans are raised simultaneously, is 1,700 kw.

The lift spans are raised and lowered by power equipment in houses mounted on the top chords over the middle panel. The four winding drums on each span are operated by two, 200-hp. Westinghouse high-speed electric motors designed for 2,300-volt, 60-cycles, alternating current. Through the use of this high potential current it was not necessary to install a substation on the bridge. The two motors are geared to the drums and are designed to operate in unison under normal conditions; each motor, however, is capable of handling the span alone.



Matthews gas-electric generating set for emergency power supply to the interlocking facilities

An auxiliary power unit for use in the event of the failure of current supply has been provided on each span in the form of a four-cycle Sterling engine. Six-cylinder, 180-hp. engines are used for the long spans, and those for the shorter spans are four-cylinder, 140-hp.



Newark Bay bridge with one draw open, old bridge in foreground