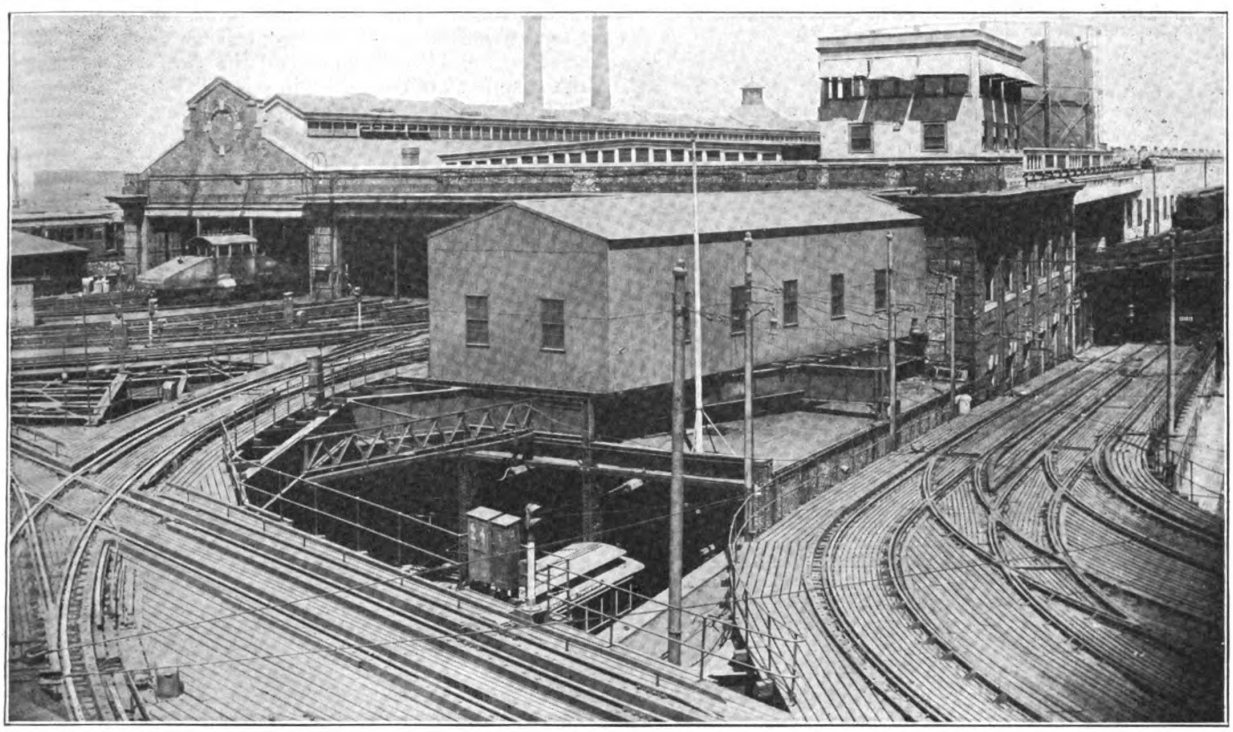

General View, Showing Incline to Street Level, Tower and Shops.

New Interlocking on the Boston Elevated

Electro-Pneumatic Plant With A. C. Control and Color Light Signals Gives Speed Signaling Indications

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THE Boston Elevated Railway Company has recently completed and put in operation an extension of its rapid transit lines from Sullivan Square, Charlestown, to a temporary station in Everett. This extension is a continuation of the elevated structure with a 5 per cent incline at its northerly end, descending to grade just before reaching the station, and was constructed with the intention of eventually further extending the rapid transit system to Malden by subway from the present terminal, a distance of about three miles, at which time the temporary Everett Terminal will be abandoned and an underground station located about one-half mile further north will take its place.

Since June 10, 1901, Sullivan Square had been the northern terminal of Boston's original rapid transit system, which now extends to Forest Hills on the south side of the city, a distance of 7½ mi. via elevated structure and tunnel.

Type of Interlocking

An electro-pneumatic interlocking of the d.c. type was originally installed at Sullivan Square to handle train movements on the main line, to and from storage yard and car shops and also movements of surface cars which connect with the rapid transit lines at this point. On account of additional train movements being introduced by the Everett extension and the storage yard facilities being greatly increased, the original interlocking was inadequate and a new interlocking plant was installed with tower located so as to enable the leverman to have a good view of the greater part of the track layout included in the interlocking. This interlocking is known as Tower A. One point of switch 29 may be seen in the extreme left of the illustration, while Tower A is shown in upper right position.

Interlocking Layout

In line with the company's policy of using alternating current for its new signal and interlocking installations, an a.c. electro-pneumatic interlocking system was selected. The signal and interlocking equipment was furnished by the Union Switch and Signal Company.

While the interlocking machine has been installed with complete locking and combination to handle the ultimate layout, as shown in the track diagram, those signals shown in dotted lines and switches shown closed are not controlled from the interlocking machine at present. These functions will be connected to the machine as soon as conditions will permit.

Interlocking Machine

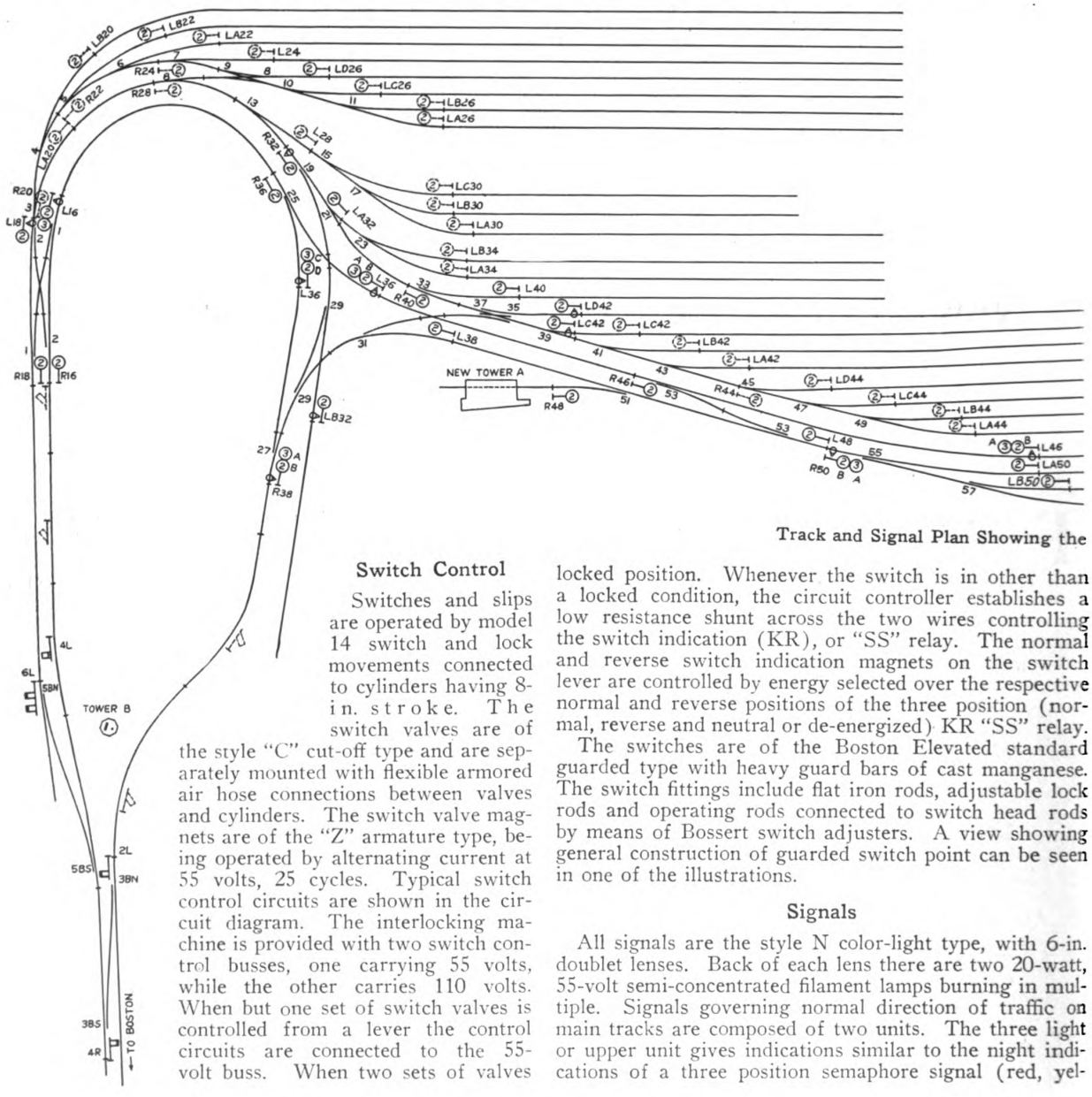
The interlocking machine is of the standard model 14, electro-pneumatic type, equipped with a.c. magnets for all electric lock and indication purposes. The machine is made up as follows:

47 levers for 47 switches, 3 double slips, 1 single slip.
26 levers for 83 signals.
1 lever for bridge lock.
74 levers working.
1 spare lever.
4 spare spaces.
79 total lever frame.

In addition to the above functions, there are 20 automatic stops within the interlocking limits, these being controlled indirectly from the interlocking machine through the medium of the signals at their respective locations. This makes a total of 159 functions controlled from 74 working levers, requiring an interlocking machine having an overall length of 17 ft. 3 in.

That portion of the ultimate layout which is now in service requires the following combination of levers:

20 levers for 21 switches, 2 double slips, 1 single slip.
16 levers for 49 signals.
1 lever for bridge lock.
37 working levers.



Track and Signal Plan Showing the

Switch Control

Switches and slips are operated by model 14 switch and lock movements connected to cylinders having 8-in. stroke. The switch valves are of the style "C" cut-off type and are separately mounted with flexible armored air hose connections between valves and cylinders. The switch valve magnets are of the "Z" armature type, being operated by alternating current at 55 volts, 25 cycles. Typical switch control circuits are shown in the circuit diagram. The interlocking machine is provided with two switch control busses, one carrying 55 volts, while the other carries 110 volts. When but one set of switch valves is controlled from a lever the control circuits are connected to the 55-volt buss. When two sets of valves are controlled from the same lever, as in the case of crossover layouts, the control circuits are connected to the 110-volt buss and the two sets of switch valve magnets are connected in series. This arrangement results in using the same 55-volt valve magnet in all cases, regardless of whether the valves are involved in a single switch or a crossover layout. Compressed air at 85 to 90 lb. pressure per sq. in. is taken from the company's main air line, which also supplies air for many other purposes.

Switch Indication

Each switch and lock movement is equipped with a pole changing switch indication circuit controller which is operated by positive mechanical connections to the slide bar of the movement. The circuit controller functions establish one polarity on switch indicating circuit with the switch in one extreme locked position and the opposite polarity with the switch in the other extreme locked position. Whenever the switch is in other than a locked condition, the circuit controller establishes a low resistance shunt across the two wires controlling the switch indication (KR), or "SS" relay. The normal and reverse switch indication magnets on the switch lever are controlled by energy selected over the respective normal and reverse positions of the three position (normal, reverse and neutral or de-energized) KR "SS" relay.

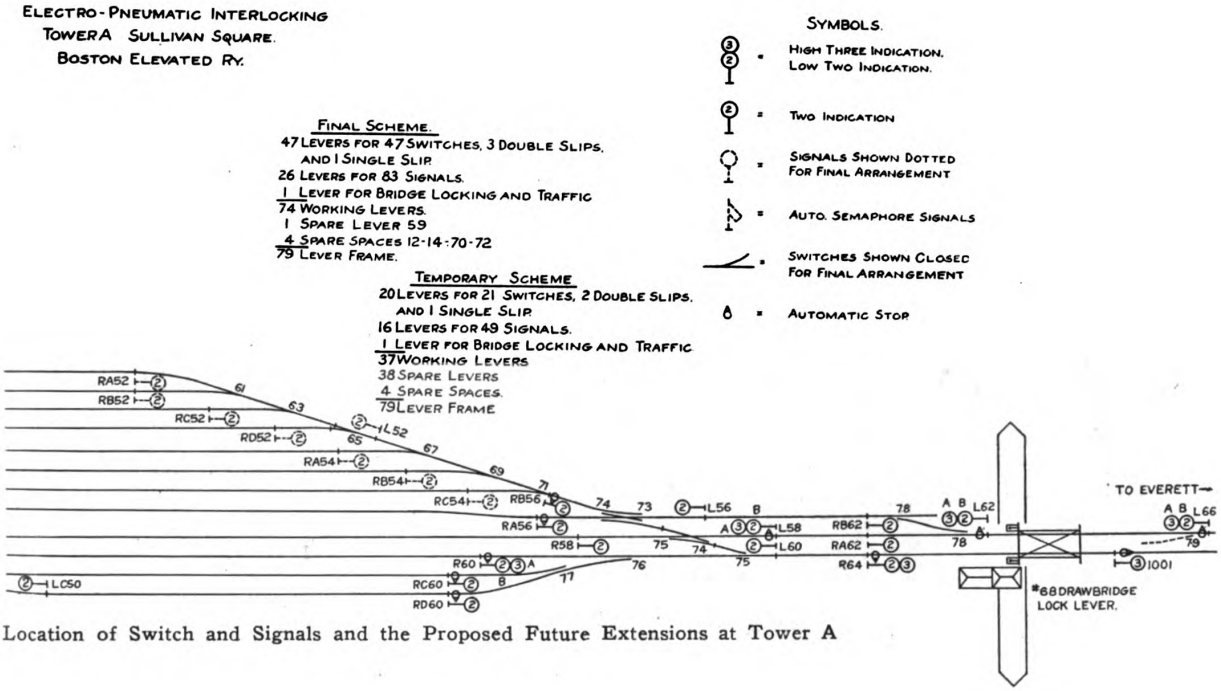
The switches are of the Boston Elevated standard guarded type with heavy guard bars of cast manganese. The switch fittings include flat iron rods, adjustable lock rods and operating rods connected to switch head rods by means of Bossert switch adjusters. A view showing general construction of guarded switch point can be seen in one of the illustrations.

Signals

All signals are the style N color-light type, with 6-in. doublet lenses. Back of each lens there are two 20-watt, 55-volt semi-concentrated filament lamps burning in multiple. Signals governing normal direction of traffic on main tracks are composed of two units. The three light or upper unit gives indications similar to the night indications of a three position semaphore signal (red, yel-

low and green) and is used to govern movements on main tracks. The two-light or lower unit displays red or yellow indication and is used to govern movements into yard tracks or for "call-on" purposes. The single unit, two-light type of signal is used to govern reverse movements on main tracks and movements from all yard tracks. These signals display a red or yellow indication.

Signal R-38 governs entrance to the interlocking from the northbound station track and is typical of all main line signals, the aspect of which is normally a double red light, that is, one red in each unit. The top unit, R-38-A, governs train movements over switch 27 normal or reverse, with a yellow or green indication, depending on the indication of the next signal in the route as set up. The yellow indication of the lower unit governs movements to yard tracks over switches 27, 29, 31, 35 and 37 in one direction or over switches 27, 29 and 19 in the other direction, and it is used also for "call-on" movements. The upper unit of all two-unit or main line signals has semi-automatic stick control.



Location of Switch and Signals and the Proposed Future Extensions at Tower A

Track Circuits

A total of 64 track circuits are involved within the interlocking limits in the ultimate layout, 29 of which are now in operation. All track circuits are fed from 55-volt, 25-cycle mains, three pairs of which are taken from the tower so as to result in approximately one-third of the track circuit load being on each pair of mains. The mains are separately fused on the main distribution panel in the tower. The track circuits are of the single rail type. Model 15 vane two-element, two-position relays are used for all track circuits. Fifty-one of the 64 relays are involved are located in the tower, while the other 13 are sheltered in instrument cases in that part of the interlocking adjacent to and including Mystic river draw. Each track circuit is fed from an individual air-cooled track transformer with a 55-volt primary. Four taps on the secondary provide a range of voltage from 1.5 to 15 volts. A resistance unit with 5 ohms total resistance with taps at 1.67 and 4.17 ohms is connected in series with the secondary of each track transformer for the adjustment of the track circuit as to phase and voltage. A view of the arrangement of the track transformers and resistance units, as installed in instrument shelters, is shown in one of the illustrations.

Principal Features

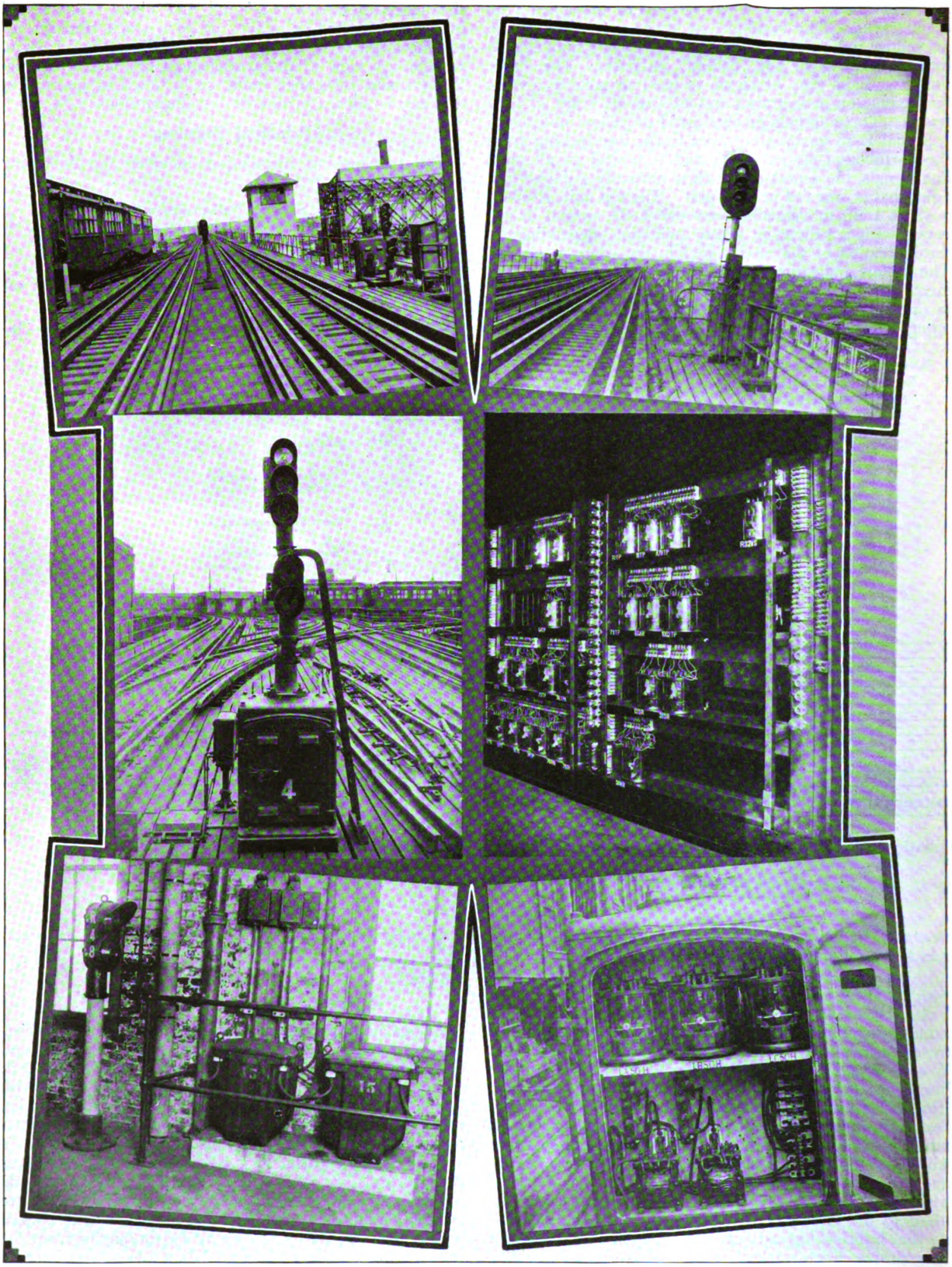
The interlocking installation includes the following principal features:

(1) Semi-automatic control of all main track signals.
(2) Automatic stops at all signals governing movements in normal direction of traffic on main tracks.
(3) Section locking.
(4) Sectional route locking.
(5) Approach locking for all main line signals governing entrance of trains into interlocking.
(6) Illuminated track diagram.
(7) Light indicators on all switch levers to show whether the track section in which the switch is located is occupied or unoccupied.
(8) Inter-communicating system between towers "A," "C" and "M."

Relay and Terminal Case in Tower

Relays in the tower are housed in a cabinet consisting of two riveted angle iron frames 25 ft. long and 8 ft. high by 12 in. deep, placed back to back with a 2-ft. space between. The entire outer surface is enclosed with $\frac{1}{16}$-in. sheet steel doors. A partial view of the relay rack with the outer case removed, showing the construction, is shown in one of the illustrations.

Each frame consists of five 4-in. sections of 4 shelves each for relays and five 12-in. sections for the vertical wire chase and terminals. Horizontal wire chases are provided both above the top shelf and below the bottom shelf. Two 1¼-in. by 1¼-in. by 1¼-in. angles form the relay shelves and are so spaced that the square base of the model 15 relays rest upon the lower legs of angles and are held in place by the channels formed by turning the vertical legs upward. On shelves carrying the round



Two-Light Signal
Main Line Two-Unit Signal
Main Transformers

Typical Automatic Signal
Relay Case in the Tower
Track Relays and Transformers

base repeater relays this channel is filled with 7/8-in. hard pine. Standard R. S. A. terminals with porcelain base, mounted on 1¼-in. maple strips, are used throughout the case.

All signal and switch cables terminate on strips in the vertical wire chases and are continued to the machine and relays with single wire. Flexible jumper wires with eyelets connect all relay terminals with wire terminals on horizontal strips above each shelf. One pair of No. 4 B. & S. gage wires above each half of the case supplies 55-volt energy for the local side of all track relays and all other circuits originating or terminating in the case. These two pairs of mains are separately fused on the distribution board, and one side of each is again fused at each shelf. Track circuit resistance units and fuses are mounted on the steel frame back of the corresponding relay.

From the relay case terminals to the interlocking machine on the floor above wires are run through porcelain insulated rings to the ceiling and through the floor in iron pipe nipples with bushings on both ends, from which point they are fanned out to terminals on the combination board.

The relay case was designed to house all relay equipment contemplated for future requirements and is, therefore, larger than needed for the present. In arranging the location of the present relays the contemplated plant has been considered, so that each one now occupies its permanent space.

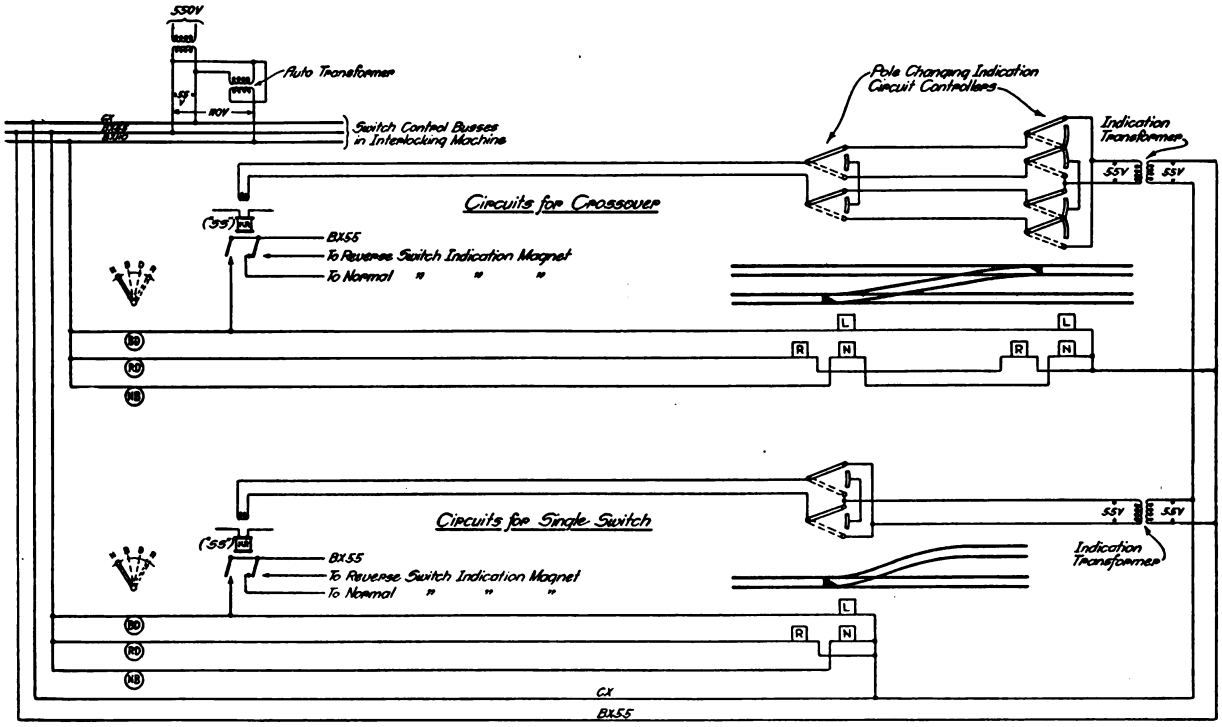
Track Model

The main track model is of the spot-light type, having 76 track sections, and is made in the form of a shallow steel box 5¼ in. deep by 8 ft. 9 in. long and 2 ft. 9 in. high. Tracks, switches and signals with their numbers are painted in white on a flat black background. Adjacent track circuits are shown by distinctive colors. Lamp sockets are of the Western Electric Company's No. 16 telephone type, fastened to the back of the front plate with the rim of the socket extending through a 9/16-in. hole and flush with the front of the plate. A 12-volt 3.2-watt lamp covered with a 9/16-in. white opalescent cap gives ample illumination so that the motorman may readily see the indication the required distance during daylight hours.

Lamps are normally lighted by current over front contacts of the track or repeater relays. Interlocking track section lamps are supplied with energy from a special transformer operating on a 55-volt primary current with a 12-volt secondary, while a few of the block sections in use are fed from a 55-volt circuit with resistance in series.

The track model is located at the rear of the interlocking machine and is supported on a pipe and angle iron frame with its top edge against the ceiling of the operating room. The supporting frame is the same length as the interlocking machine, and the track model, being centrally located, leaves a space on either end which has been filled in with finished oak boxes with removable doors at the back to conform to the general appearance of the track model itself. These spaces are used for mounting a smaller track model having 12 block sections on the Charlestown section. This model is similar to the larger model in design. Nine clockwork time releases for approach locking for main line signals; bells; an emergency switch for the bridge lock and a route sign, operated by the director for the instruction of operators, are also installed in these spaces. Four 2-in. iron pipes support the frame and also serve as wire ways to the models and other apparatus. All apparatus is back connected, which results in all of the wiring being entirely concealed. This method of construction makes a very neat appearance.

Track models of the same design, including all interlocking and block sections described, are located in the train starter's office at the southbound Sullivan Square station and in the train dispatcher's office. These lights are fed from the 12-volt circuit and are operated in mul-



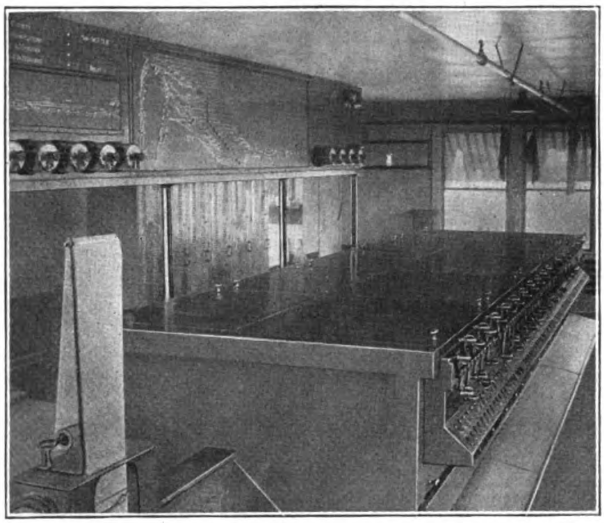
Circuit Diagram of the Switch Controls

tiple with those in the tower, and in series with the ones on the 55-volt circuit.

Mystic River Draw

A 95-ft. single span lift-bridge of the Strauss Bascule type spans the Mystic river at the northerly end of the interlocking, and is protected by signal L-66 on the north side and signal R-64 on the south side. Lever 68 at Tower A locks the bridge by controlling the d.c. motor feed of the bridge operating mechanism through a contactor, the operating coil of which is actuated by 575-volt d.c. energy through the contacts of a 55-volt a.c. relay operated from 68 roller contact.

Bridge lock lever 68, in turn, is locked by a circuit originating at the roller contact of machine lever No. 5 at Tower M on the Everett side of bridge, which passes through front contacts of block signal track relays 1010, 1008, 1006, 1004, 1002, interlocking track circuit relays for signal L-66, L-62 on the southbound track,



Interlocking Machine and Illuminated Track Diagram

and the interlocking track circuit relays of signals R-60 and R-50 on the northbound track.

Upon reversing lever 68 at Tower A to unlock the bridge, lever 5 at Tower M is locked reverse with semi-automatic signal 1010 at stop and the derail switch, operated from lever 4, open.

An emergency by-pass switch at Tower A provides a means of unlocking the bridge in case lever 68 cannot be released as a result of the tracks being occupied due to a circuit failure. Another emergency by-pass is in the bridge operating tower to enable the bridge operator to lift the bridge in case of the failure of the 55-volt a.c. relay circuit. Both of these emergency switches are under seal, with instructions not to be operated unless directed to do so by the train dispatcher. Semi-automatic signal R-64 is really a block signal within interlocking limits; it being used otherwise only for stopping a train on the main line when it is required to make a reverse movement to the yard over the ladder track.

Inter-Communicating System

A call bell system between the bridge operating tower and Tower A and a private telephone line between towers A and M are used in preparing for bridge openings. As northbound trains pass the junction at Tower C, about two miles south of Tower A, their number, time and route is indicated at Tower A in advance of their arrival by means of the telautograph system. The director receiving this information and transmits it to the levermen by means of a small destination sign at the left of the track model which illuminates a small lamp at the left of the route called for.

Three telephone instruments connect Tower A with all points on the system through the main switchboard and direct private lines connect it with the more important officers, such as the train starter's, yard master's, bridge tower's, Tower M, etc.

Power Supply

Power for this plant is taken from the company's main a.c. propulsion system generated at its South Boston station at 13,200 volts and stepped down at the Charlestown power station to 550 volts, at which it is transmitted to Tower A. Duplicate transformers of 15-k.v.a. capacity supply the greater part of the energy at 55 volts for the entire plant; one 2-k.v.a. and two 0.6-k.v.a. transformers are located at outlying points. As an emergency source of a.c. supply, a 600-volt d.c. to 550-volt a.c. motor-generator set which can be operated on the 600-volt d.c. propulsion power is located at the Charlestown power station.

Automatic Block Signals and Stops

Between the interlockings at towers A and M the double track is protected with 12 block signals spaced approximately 700 ft. apart. The signals are of the three color-light, style "N" type, indicating red, yellow and green, with protecting hoods and background. Two 55-volt, 25-watt, semi-concentrated lamps burning in multiple illuminate the 6-in. doublet lenses. A typical automatic signal installation is illustrated.

Signals are mounted on pipe mast on top of the instrument case with the center of top lens 8 ft. 6 in. above the top of rail, which is average height of motorman's eyes when standing in cab of the car. Track circuits are of the single rail a.c. type, controlling signal lights through model 15 vane relays, having 8 front and 4 back contacts. Full block overlaps give two red and one yellow signal back of each train. On the elevated structure all block and interlocking signal bases are supported on a special steel frame built onto the structure so that in renewing ties and guard timbers the signals will not have to be moved or disturbed.

The 550-volt No. 0 feeders and 27-wire signal cable are located in a special wireway, the top of which forms the walk between the north and southbound tracks. The feeders are supported by two piece porcelain and the cable by two piece maple cleats at 10-ft. intervals. Cable terminal boxes, transformers and primary cutouts are located below the feeders, with special platforms and steps giving easy access through traps in the footwalk.

Automatic stops of the double arm electro-pneumatic type are used in connection with all automatic block signals and are operated by separately mounted jaw-type magnet valves. Emergency release keys are provided at each valve to enable train crews to key their train past a defective signal or stop after waiting the prescribed three minutes and determining that the entire block ahead is unobstructed.

The Swiss Federal Government has authorized the Marconi Wireless Telegraph Company to construct a wireless telegraph station near Berne, about 1,800 ft. above sea level. Marconi valve continuous wave transmitters of 25 kw. capacity will be used and the aerial is to be carried on two towers, each 300 ft. high. Besides handling commercial telegraph service to European countries, the new station will afford special facilities for press traffic and will be ready for the use of journalists at the second session of the Assembly of the League of Nations next September.