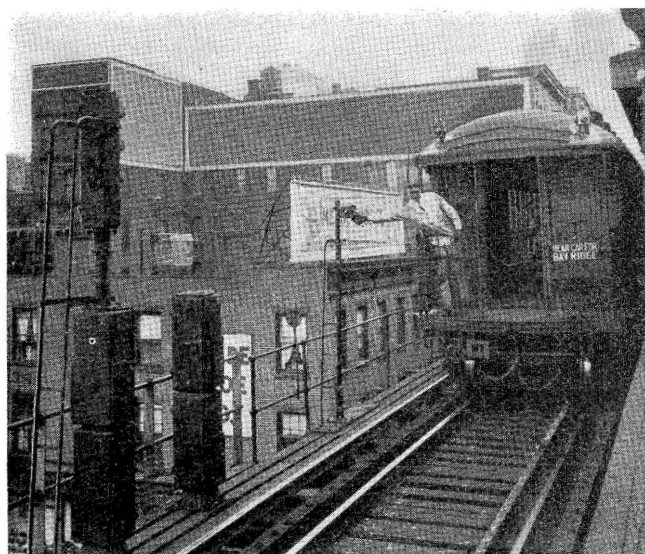


Automatic Interlocking on the Brooklyn- Manhattan Transit

Special features consist of a telephone-type relay route-selector and a time-recorder for checking operation of apparatus

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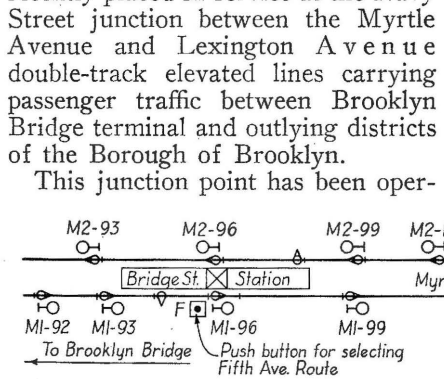


Motorman selecting Fifth Avenue route by pushing button at Bridge Street station

THE SEVENTH of a series of automatic control systems, applied to existing manually-operated interlocking plants on the subway and elevated lines of the Brooklyn-Manhattan Transit Corporation since 1922, was recently placed in service at the Navy Street junction between the Myrtle Avenue and Lexington Avenue double-track elevated lines carrying passenger traffic between Brooklyn Bridge terminal and outlying districts of the Borough of Brooklyn.

This junction point has been oper-

ated since about 1905, by a five-lever, electro-pneumatic interlocking consisting of two switches, three home signals and three dwarf signals. In 1932, when the Myrtle Avenue line was equipped with block signals, the original semaphore signals at Navy Street were replaced with color-light type signals.



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The new automatic control features for the Navy Street plant supplement the manual control; thus permitting either manual operation by a towerman or automatic operation, as desired. Selection between manual and automatic control is made by means of lever No. 1 in the interlocking machine, which serves as a transfer lever, and is electrically and mechanically interlocked with all other levers.

The track and signal arrangement

at Navy Street junction is shown in the track diagram. A two-story tower at the west end of Navy Street station contains the interlocking machine on the second floor. The lower part of the tower contains the control relay and power supply equipment.

At Bridge Street, a double-length platform permits two trains to occupy the station at the same time on either track. This arrangement, which facilitates the transfer of passengers from one line to the other, introduced several complications, particularly in

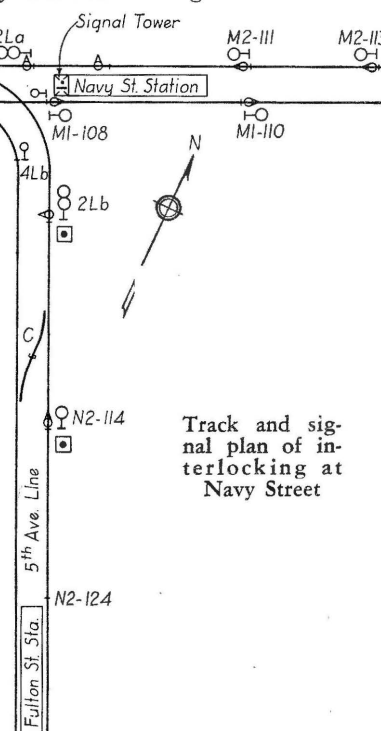
way. Train movements against the normal direction of traffic, seldom made at this junction, are not provided for in the automatic control features.

Method of Route Selection

Eastbound trains select the Myrtle Avenue or Fifth Avenue route, over switch No. 5, upon arriving at Bridge Street station; although the switch is not operated nor the home signal cleared for eastbound routes until trains proceed beyond signal location M1-102, located approximately midway between Bridge Street station and Navy Street junction. The second train to pass either of these points is the first to receive a proceed signal. The second train then automatically receives a proceed signal, unless a conflicting train movement has obtained right of

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Track and signal plan of interlocking at Navy Street

and home signal 4R, governing the route.

Motormen on trains destined for the Fifth Avenue route, after stopping at the westerly section of the station, are required to operate a pushbutton, so located as to be easily reached from the motorman's cab window. Operation of this pushbutton is the only manual feature connected with the automatic control of the interlocking plant. Trains destined for the Myrtle Avenue route automatically select this route at the instant when the forward end of the train enters upon a short track circuit immediately after passing signal location M1-96, located near the center of the platform. Electrical interconnections prevent the selection of more than one route by any particular train, or any change or cancellation of a route after selection has taken place. If a motorman's error results in the selection of the wrong route at Bridge Street, he may correct the error by stopping at home signal 4R and operating one of two auxiliary pushbuttons, provided at this location, for rectifying the route line-up.

The distance between the west end of Bridge Street station and home signal 4R, approximately 1,200 ft., is sufficient to allow three or four trains to occupy this section of track, each of which has made its route selection at Bridge Street station. It has been necessary, therefore, to make provisions for storing up the route-selection indications, for at least four trains, in the same consecutive order in which these indications are originated. The stored-up indications must then act to establish the corresponding eastbound route through the interlocking plant in the sequence determined by the relative positions of such trains. The leading train, nearest home signal 4R, which governs eastbound routes through the plant, thus receives the correct route line-up, irrespective of route selections that may have been made by following trains.

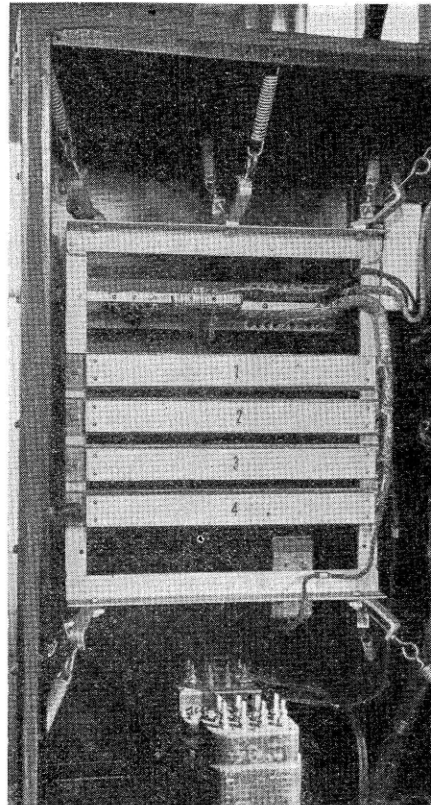
In order to accomplish this purpose, engineers of the company's signal department developed a train-sequence route-selector which will be referred to, in the following description, as the "Sequence Unit."

Description of Train-Sequence Route-Selector

The apparatus constituting the "sequence unit" consists of twenty-three 48-volt, d-c. telephone-type relays, purchased from the Automatic Electric Company, and assembled under group covers on a spring-supported frame in a dustproof metal cabinet,

located on the second floor of the signal tower. Current for operating the relays is supplied directly from a dry-plate-type rectifier connected to the 25-cycle signal power supply source:

Four groups of relays in the unit serve as registers, which receive and store up, in consecutive order, a maximum of four route-selection indications corresponding to either Myrtle Avenue or Fifth Avenue line trains. One of two route relays in register No. 1, corresponding to the route destination for the leading train, nearest 4R signal, acts auto-



The train-sequence route-selecting equipment employs telephone-type relays

matically to operate switch No. 5 and clear home signal 4R for the proper route. After the first train passes through the interlocking plant, the corresponding route indication in register No. 1 is cancelled, immediately followed by a successive transfer of route indications, that may have been stored in registers Nos. 2, 3, and 4, into registers Nos. 1, 2, and 3 respectively. The route indication corresponding to the second train then occupies register No. 1, which again establishes the correct route line-up. This registering and cancellation process continues in progressive order as long as the interlocking is under automatic control. The sequence unit continues to operate also, whenever the plant is being manually operated; in this case, the unit

serves merely to control two route-indicating lamps, located in the spotlight track diagram above the interlocking machine.

Telephone-type relay equipment was chosen for the sequence unit because of greatly reduced initial cost and space requirements, as compared with results that could be obtained with larger and more expensive relay apparatus. The telephone type of relay equipment was considered satisfactory from a safety standpoint in this instance, since the protective features associated with the automatic operation of switch and signal equipment are not in any manner involved in the operation of the sequence-unit control. Failure in the operation of this unit does not stop the operation of trains through the plant. In the event of such a failure, motormen of eastbound trains are required to stop at home signal 4R and select the proper route by means of the two pushbuttons previously mentioned.

The hand-operated crossover on the Fifth Avenue line, designated "C" on the track diagram, is used occasionally by work trains. Motormen on such trains, desiring to use the crossover, are required to operate pushbuttons, located at signal N2-114 and home signal 2Lb, in accordance with posted instructions. The purpose of these pushbuttons is to prevent trains using the crossover from interfering with the free movement of eastbound and westbound trains on the Myrtle Avenue line, while irregular train movements over the crossover are in progress.

Interlocking Protective Features

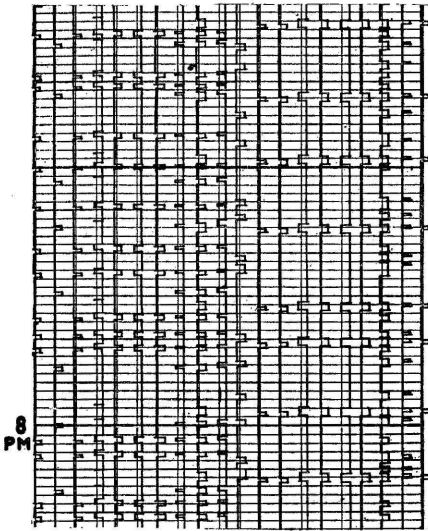
Automatic and manual control of the interlocking equipment is fully protected by approach and route locking, track-circuit detector locking and S.S. control features. Each switch is locked by at least two track circuits. The approach locking becomes effective for any route as soon as the home signal clears, and is not released until trains have progressed to a point where two track circuits, locking the switch, are occupied.

Single-break control circuits with a common return are used for the major part of the equipment. S.S. switch-repeating relays, however, are supplied with current from an insulating transformer. Two switch-repeating relays are used for each switch; one checking the normal and the other the reversed position. These relays are controlled through contacts of circuit controllers connected to switch points and switch locking bars, as well as through contacts of corresponding switch levers in the in-

terlocking machine when the plant is being manually operated by a tower-man.

Signal Equipment

Color-light-type signal equipment, including signal and interlocking control apparatus, such as a-c., motor-operated relays and train-stop mechanisms, were obtained from the General Railway Signal Company. The block signals display green, yellow and red aspects, indicating "proceed," "caution" and "stop" respectively. Home signals consist of two green, yellow and red light units with an additional yellow light, which, in conjunction with two red lights, constitutes a call-on aspect, operative only



Reproduction of sample section of record chart

while the plant is under manual control. The upper three-light unit of a home signal conveys the same information as a block signal. Green and yellow lights in the lower unit designate main and diverging routes respectively and two red lights constitute a "stop" indication.

Signals, relay cases and train-stop mechanisms are supported on steel beams riveted to the track girders. This construction permits track tie renewal without interference with signal equipment, and aids also in reducing the effects of severe vibration encountered on the elevated structures. Vibration effects are further mitigated by the use of spring supports for all stop mechanisms and all relay equipment, both inside and outside of the tower.

Wire and Cable

Aerial, braid-covered, rubber-insulated cables tied, with 5/32-in. tared hemp marlin, to a 5/16-in. stranded, Copperweld messenger, attached to the elevated structure, are used for

signal control circuits. All cable and single wire conductors consist of 19-strand flexible wires.

Track-circuit leads consist of single No. 6 A.W.G. conductors connected by bronze compression-type terminals to double-stranded steel bootleg bonds welded into 3/8-in. plugs.

Alternating current power for signal equipment at Navy Street interlocking and adjacent block signals is supplied by a 110/55-volt, 5-kv.a. transformer connected to a 2,200-volt signal feeder, which parallels the Myrtle Avenue line structure. Current for operating the two electro-pneumatic switch mechanisms is obtained from a 14-volt nickel-iron-type storage battery, trickle charged by a full-wave, dry-plate rectifier. A similar rectifier supplies d-c. energy at 48 volts to the sequence-unit relay equipment. Two 600-volt motor-driven compressors provide the necessary air supply for operating the switch-throwing mechanisms.

Alarm and Recording Apparatus

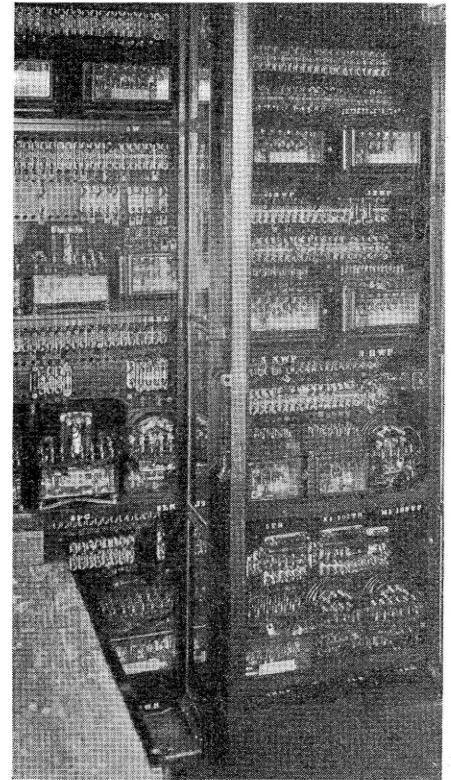
The frequency of train operation through Navy Street junction, and the consequent serious delays to traffic that would occur as a result of an interruption in the automatic-interlocking control system, rendered it advisable to provide a suitable trouble alarm and recording equipment to assist the maintenance forces. The alarm arrangement consists of a bell, together with red and green indicating lights, located in an adjacent signal tower at Brooklyn Bridge terminal, and so controlled from Navy Street tower as to give an immediate warning in case of low air pressure, a-c. power interruption or failure in the operation of the automatic control apparatus. The latter function is accomplished by means of three time-element relays, which close the alarm circuit whenever any one of the three home signals, governing train movements through the plant, fails to clear within an interval of approximately four minutes, measured from the instant at which a train arrives at the point where a clear signal should be received. A four-minute time interval is normally sufficient to allow for the completion of conflicting train movements.

An additional check on the operation of the automatic control equipment is provided by an Esterline, 20-pen strip-chart time-recorder, driven by a 110-volt, 25-cycle synchronous motor. Each of the 20 pens is so connected, through contacts on relays and other apparatus, as to record the operating time characteristics of the most important control units involved

in the route line-up for each train movement. Strip charts, 90 ft. in length, are driven at a 6-in. per hour rate, thus requiring replacement at intervals of approximately one week. The permanent record so obtained enables the maintenance forces to make a quick analysis and determination of the cause, whenever trouble develops.

The automatic control equipment at Navy Street plant has been operating since October 23, 1934, handling traffic at the rate of approximately 496 trains a day, in each direction. At the present time, the automatic feature is used 16 hours daily. It is expected, however, that continuous automatic operation will be made effective at an early date.

The saving in operating expense, under the present 16-hour daily



The relays are housed in sheet-metal cases

schedule, is equivalent to an annual interest rate, on the installation cost of the automatic system, of approximately 33 per cent. This percentage will, of course, be proportionately increased to approximately 47 per cent, when continuous automatic operation is made effective.

The saving attained by the Navy Street installation is fairly representative of the results obtained from all of the automatic interlocking applications made by the company during the last 12 years. Such projects, where feasible, are evidently well worth serious consideration.