SOLENOID SIGNALS

By W. K. WALDRON

The Interboro Rapid Transit Company, of New York, has in service on its elevated lines a system of automatic electric signals operated by solenoids, the current being taken from the third-rail D. C. track circuit. These signals, while very simple in construction, are very efficient and have been giving entire satisfaction since their installation, several years ago. The machines numbering about forty in all, are installed at all dangerous curves on the four lines of the Manhattan Elevated system. As many of the readers of this journal are engaged in the installation and maintenance of electric railway signals, a detailed description of this system may be of practical use to those interested.

Fig. 1 shows a front view and Fig. 2 a side view of the signal. The former view shows the two front doors of the mechanism case open, giving a view of the solenoid coil, circuit breaker, dash pot and machinery frame in the lower part of the case, and the two relays in the upper part. Figs. 10 and 11 show details of signal post and mechanism case.

Fig. 3 shows a diagrammatic view of the mechanism arrangement and wiring connections in the mechanism case. This view will be made clear by a study of the wiring diagram Fig. 4, which shows a wiring diagram of the regular single service signal. In this diagram the signal is located at A, the block being from A to B. The direction of traffic is indicated by the arrow. At the release end of the block as at B is located a resistance grid which is connected with the third rail, block rail, and common rail, as shown. The third rail circuit has a voltage of about 600 volts and the connections to the block and common rails are made so as to give a voltage of 14 volts in the track circuit. A 600-volt, 10-ampere fuse is placed in the lead from the third rail to the grid. Near the entrance end of the block a lead is taken from the block rail and connected with the track relay which is also connected with the common rail or ground, as will be seen in the diagram. The track relay is placed in the upper part of the machinery case, as shown in Fig. 1. A 10-volt, 3-ampere fuse is placed in the lead to the track relay. Current flowing in this circuit causes the track relay to pick up, which in turn completes the circuit for the solenoid relay.

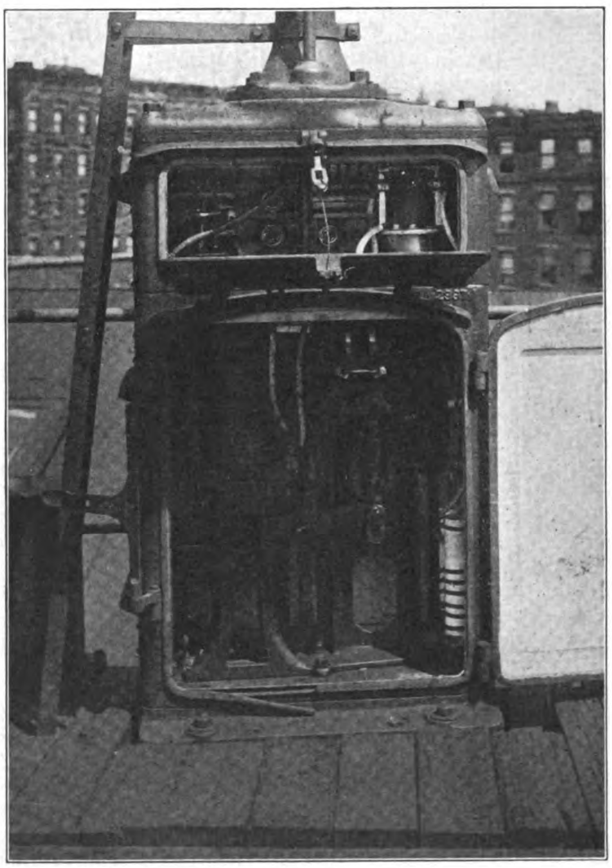

Fig. 1.

Near the entrance to the block a second tap is made to the third rail. This lead is provided with a 600-volt, 3-ampere fuse and passes into the mechanism case, where it is divided into three circuits, solenoid relay circuit, solenoid circuit, and light circuit, each of which has a snap switch. The solenoid circuit has a 4-ampere fuse, and the others have each a 3-ampere fuse as indicated at the top of Fig. 3. In tracing the solenoid relay circuit, it will be seen that a resistance tube of 1,800 ohms is placed directly after the 3-ampere fuse. The circuit then leads through the track relay causing it to pick up, thus completing the solenoid circuit. From this relay the solenoid relay circuit joins the common and is led to the ground in the event of the track relay not being picked up. The solenoid relay circuit is through a resistance tube of 1,200 ohms to the ground, as shown in the diagram, thus placing a resistance of 3,000 (1,800 + 1,200) ohms between the third rail and the ground when the track relay is down.

Returning to the point where the circuits branch, the solenoid circuit, it will be seen, passes through the solenoid relay thence through the circuit breaker, thence through solenoid coils to the ground. It will be noted that this circuit contains no resistance, thus allowing the flow of a strong current to the solenoid coil in order to start the plunger to lift the semaphore. After the plunger has about completed its stroke, the circuit breaker which is connected with the semaphore lift rod is opened. The current is then led through a resistance tube of 3,000 ohms, which is in circuit, reducing the current to what is needed to hold the semaphore clear.

The light circuit has a resistance tube of 2,100 ohms placed after the snap switch and fuse. The lead then passes to the top of the semaphore post

Fig. 2.

and enters the light box, where it is divided, and, after passing through two 7-ampere fuse plugs, feeding two 3-candle-power lamps, it is grounded. The semaphore is so constructed that unless the weight of the spectacle casting is supported by

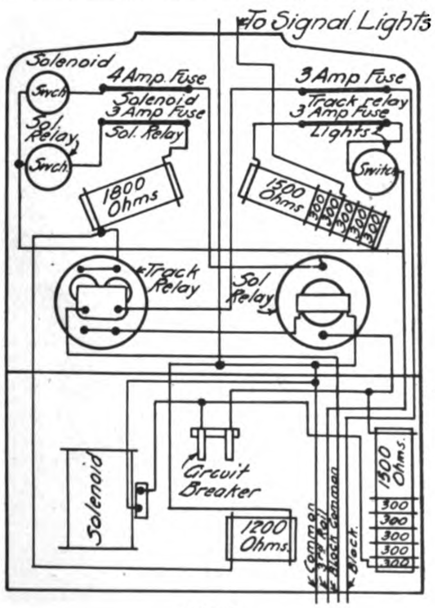

Fig. 3.

the lift of the solenoid plunger the semaphore will go to "danger." Thus any defect in the signal mechanism is at once indicated by the signal itself.

Experience in signal maintaining, as in all other lines of work soon enables one quickly to locate trouble in the mechanism of these machines. Many of these troubles arise from carelessness on the part of employes not directly connected with the signal department. The most prolific source of trouble lies in the track circuit, where the track gang may make a ground by thoughtlessly dropping a bar or driving a spike so as to connect the block rail with the structure or other ground connection. These troubles are generally soon located and rectified.

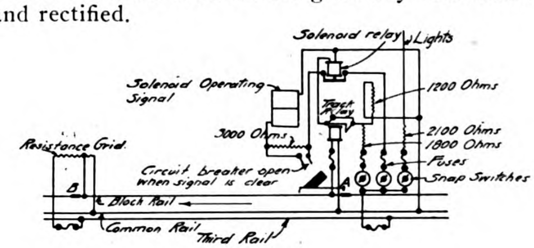

Fig. 4.

The above description applies to all these signals but in some instances the arrangements of the circuits are somewhat more complicated on account of having the operation of one or more signals dependent upon the operation of a distant signal. Examples of this duplex control can be seen at 129th street on the Third avenue line. At 129th street station the south bound track approaches the Har-

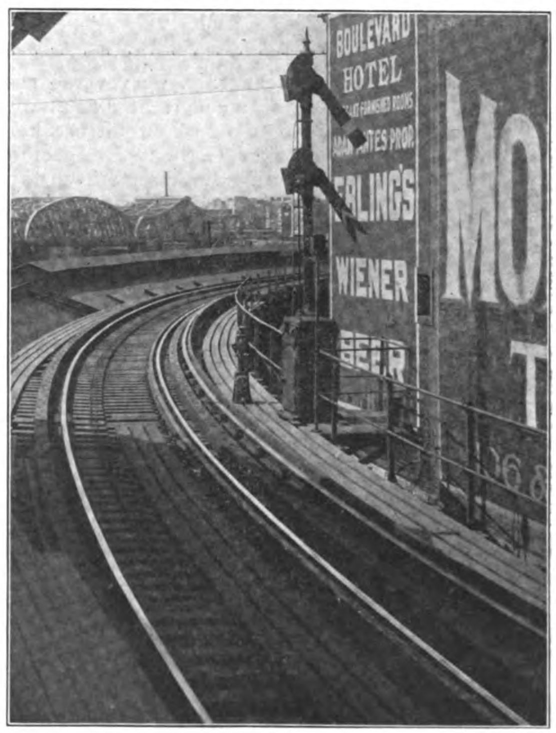

Fig. 5.

lem river bridge rounding a curve which begins at the station. This necessitates a distant signal to warn the motorman that although the first block may be clear, a train may be held up by the open bridge-draw. To meet this requirement, a double signal machine is placed at the station, operating a home semaphore and a distant semaphore. At the release end of the block is placed a single signal machine. Fig. 5 shows a view of the double signal machine at the station, while the signal machine is shown in Fig. 1. Fig. 6 shows a wiring diagram of these signals, the arrow indicating the direction of traffic, C the home station, D the distant station. The details are the same as shown on Fig. 4, except for the additional circuit breakers and solenoids.

The sequence of operations is as follows: The circuit breaker M, at the home station, being con-

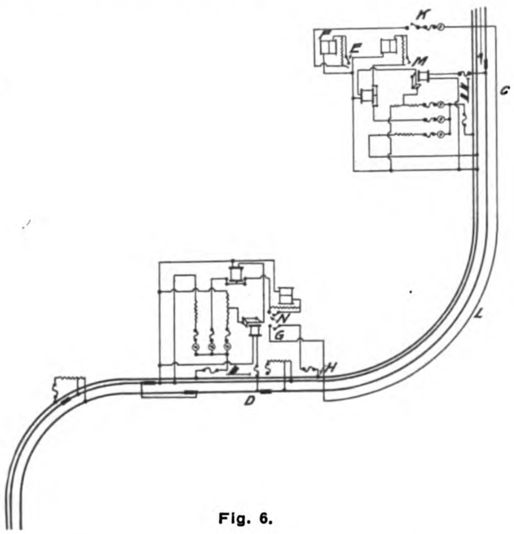

Fig. 6.

nected with the circuit breaker K, by reverse action closes the circuit at K when it breaks at M. Now if signal at D goes to "danger" circuit breaker N closes and circuit breaker G, being connected with N, also closes, completing the circuit from the third rail connection H through line L, and circuit breaker E to the solenoid coil F of the distant signal at the home station. Thus it will be seen that the action of the distant signal station is dependent upon the action of the home signal.

At 110th street and 9th avenue, a double service system of signals is installed. The center track being used for the express trains, the traffic is south bound in the morning and north bound in the evening over the same track. At this point there are two curves which are protected by one signal for each curve for each direction, making four signals in all. These four signals are controlled by five block sections, three of which are used by both the north and the south bound signals. The remaining two blocks, being at the extreme north and south ends of the protected portion of the line, are used as release blocks to indicate when a train has passed a sufficient distance beyond the curve to allow the following train to advance; the southern block controlling the southern south bound signal, and the northern block controlling the northern north bound signal.

In the single service signals each track circuit is controlled by a single track relay, while in the double service signal each track circuit is controlled by two track relays. The semaphores at 110th street also differ from those shown in Figs. 1 and 2, being smaller and being placed centrally on the signal post, as shown in Fig. 10. These signal posts are located between the tracks when space is very limited. Only about 5 ft. of the upper end of the post extends above the track level, the machinery case being beneath the track, and supported on a platform built underneath the structure. The semaphore consists of two arms, one on each side of the signal post and hinged near the post. This arrangement allows the ends to swing in either direction in the event of its being struck by a passing train, thus preventing frequent breakage.

Fig. 9 is a wiring diagram of the four signals at 110th street. The direction of signaling is controlled from the switchman's box at 115th street, where a three-point switch is located which, as shown, governs the feed for the two sets of signals, the lead being connected with the third rail at the point shown.

The switch as set in the diagram is feeding signals for southbound trains. Following this feed wire, a branch leads off at B connecting with the common rail at C. This branch has a 3-ampere, 500-volt fuse, snap switch and resistance tube of 3,000 ohms. At the 1,800 ohm point a lead is taken off, which after passing through the track relay at D and E picks up the solenoid relay of the signal at F and passes the ground at H, thus allowing the current from G to operate the signal. Returning to point B in the main feed line and continuing to point J, there is connected at the latter point a branch similar to that at B leading to the common rail at K. The lead from the resistance passes through relays L and M, picking up the solenoid relay of signal N and connecting with the common rail at O and thus completing the circuit from the third-rail connection at P to the solenoid which operates signal N, which is the signal in advance of

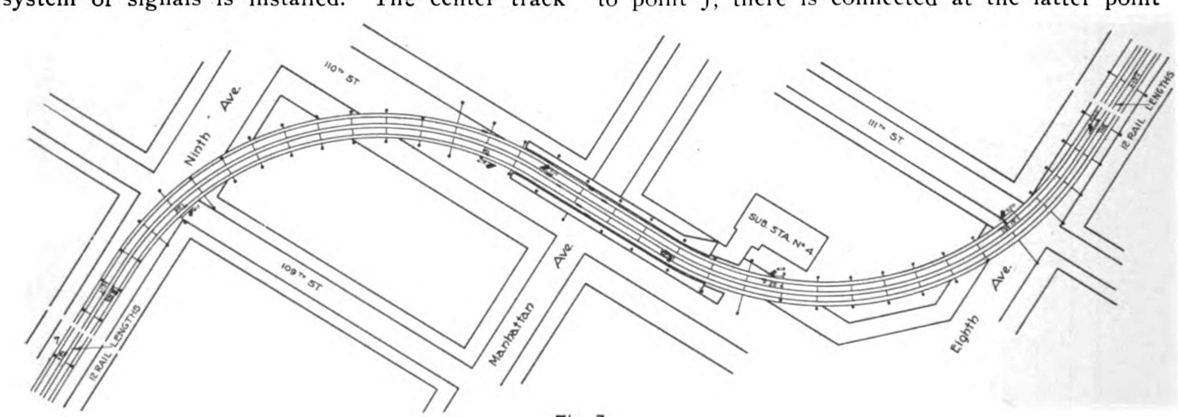

Fig. 7.

F, indicating for the same direction of traffic. This description shows the sequence of operations when the track is clear and both the south bound signals at "proceed"; the north bound signals are "dead," and at "danger."

The block section Q-R is also used to indicate to the tower man at 115th street when a north bound train has reached said section. The indication is given by a bell in the tower, which is run through back connections on relay D, the feed for the bell being connected to the third rail at S.

L picks up and the signal at N goes to "proceed" position. From the above it will be noted that each of the signals at F and N is controlled by two track relays: also that block TX is not used by south bound trains.

When the north bound traffic starts, the switch at 115th street tower is thrown over to feed into the norh bound signals: the south bound signals are now "dead" and stand at danger, and the north bound signals go to "proceed" position if the line is clear. Assuming that the switch at the 115th

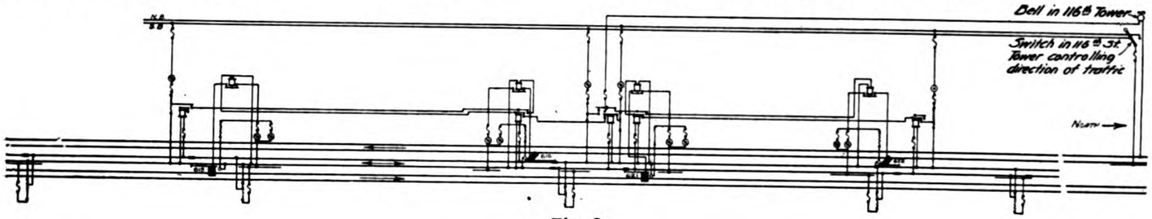

Fig. 8.

The action of signals on the passage of a south bound train is as follows: When a train enters block T-Q, relay E in the north bound signal case drops, thus breaking the circuit BDEH and causing the signal F2 to go to "dan~er." When the train enters block QR relav D also drops, thus making two breaks in the above-mentioned circuit. The train, advancing, enters block UV, causing relay M to drop, breaking the circuit BJLM and putting signal N to "danger." Both signals F and N are now set at "danger" since the distance from R to U is less than a train's length. After the train passes R, signal F goes to "proceed" position, and

street tower is thrown over so as to feed into the north bound signals, the circuits will be as follows: From switch, following line marked NB, a lead is taken off at B_2 connecting with the common rail at C_2. This branch is similar to BC and JK, as described in the southbound system. From the tap on the resistance the line passes through relay M_2, then relay E, thence through solenoid relay of signal N_2, passing to the ground at H_2, thus allowing the current from the third rail at P_2 to operate the signal N_2. From B_2 the circuit runs to J_2, where another branch corresponding to BC passes to the ground at K_2. Again from resistance

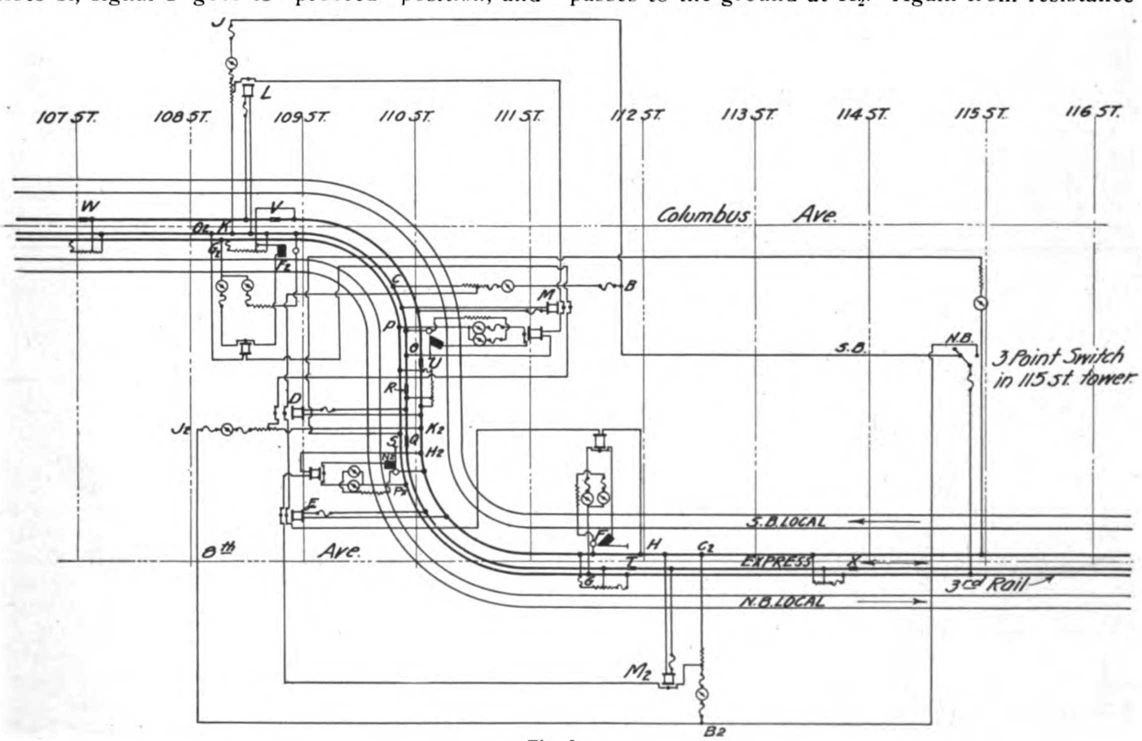

Fig. 9.

when the train enters block VW the relay L drops, making a second break in the circuit BJLM. After the train passes joint V, relay M picks up, but as relav L is still dead the signal N remains set at "danger." When the train passes joint W, relay

tap the line passes through relay D, relay M, and through the solenoid relay of signal F_2, thence to the ground at O_2, allowing the current from the third-rail connection G_2 to operate the signal F_2. It will be observed from this description that relays E, D and M have each two circuits under control.

When the north bound train enters the block VU, the relay M drops, breaking the feed circuit to the signal F_2, which goes to "danger." The train entering the block R-Q causes the relay D

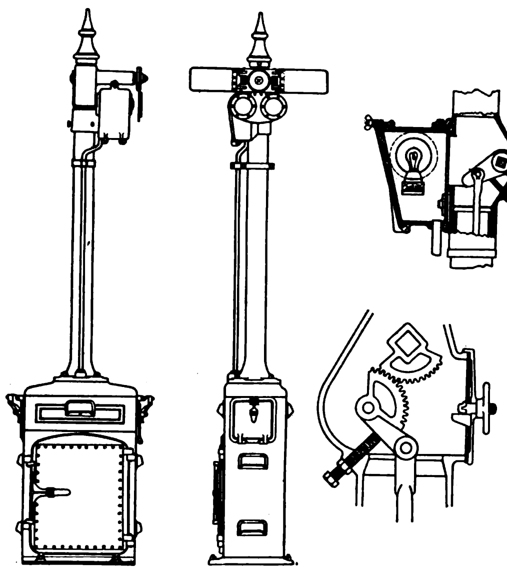

Fig. 10.

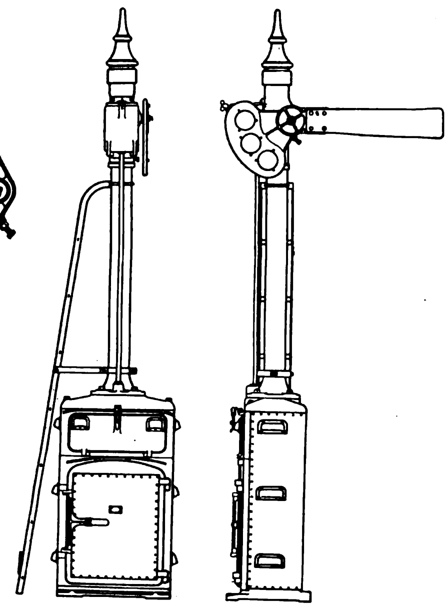

Fig. 11.

to drop which, by its back connections, rings the bell in the tower at 115th street. Relay D, in dropping, also makes a second break in the feed circuit of signal F_2. When the train enters the block QT, relay E drops and puts the signal N_2 at "danger." When the rear end of the train passes out of the block VU, the relay M will pick up, but the signal F_2 will not go to the "proceed" position until the relay D also picks up, which it cannot do until the rear end of the train has passed out of the block R-Q. When the train enters the block TX, relay M_2 drops, making a second break in the feed circuit of the signal N_2, and when the rear end of the train passes out of the block QT, relay E picks up; and after the train passes out of the block TX, relay M_2 picks up which, completing the feed circuit of the signal N_2, allows this signal to go to the "proceed" position. In this case it will be noted that the block WV was not used.

The purpose of the bell in the 115th street tower is to call the attention of the towerman to the approach of the north bound express. The 116th street station being between the local tracks the express train must be switched to the north bound local track and the bell, therefore, notifies the towerman to give the express the right of way.

THE TIME LENGTH OF CONTACT

By E. E. HUDSON

The lack of uniformity in the time length of contact on engines of the "make and break" type seems to furnish a subject for discussion that should result in material benefit to all parties interested in the gas and gasoline engine industry.

On account of the great diversity of contact lengths found in the different engines in general use, it is impossible to devise a standard ignition outfit suitable for "make and break" engines of all makes, without sacrificing efficiency in the majority of cases; since with a combination of battery and spark coil that will give satisfactory service with an engine having a minimum length of contact, there must necessarily be a considerable waste of battery energy when this outfit is used with an engine on which the duration of contact is greater. On the other hand, an outfit designed for an engine having a minimum contact length would contain a greater number of cells than necessary for use with an engine of longer contact, and in the latter case would cost the user more than is necessary for his particular engine.

In some cases where a sparking outfit is used with a marine engine having variable speed, it is found that satisfactory results are obtained on low speed, but that the spark fails to ignite the mixture on the higher speed. This is especially true of engines on which the igniter mechanism is operated by an eccentric from the crank shaft. As is general with such engines, not only is the length of contact reduced because of the increased speed, but the angle of contact is also decreased: for the reason that in advancing the spark only the contact "break" is advanced and the contact "make" occurs at the same point in the revolution as on low speed. Thus, an engine of this type having a contact length equal to one-eighth of a revolution would have a time length of contact, at a speed of 300 revolutions per minute, of .025 of a second, but if the speed of the engine is increased to 400 revolu-