CHAPTER V.

SEMI-AUTOMATIC CIRCUITS.

A SEMI-AUTOMATIC signal is one having automatic appurtenances, but controlled from a manually operated signal, circuit controller, or similar devices. These are most frequently used in connection with interlocking or manual signal towers, and constitute either an adjunct or an extension of the latter. Manual signaling cannot be effected over any great length of track on either side of a cabin; hence semi-automatic distant signals have been applied to most of such cases.

An interlocking plant having mechanical fixtures with electrical control, may frequently be combined with an automatic section. Fig. 72 illustrates such a composite arrangement, with

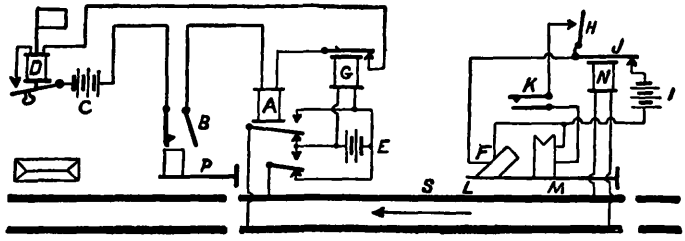


FIG. 72

a mechanical signal at danger, and a home and distant automatic signal protecting the block immediately preceding the former. *N* is a polarized track circuit relay, and *G* is a neutral relay. When the track section, *S*, is in its normal condition, and the mechanical signal is at danger, the neutral relay, *A*, is deënergized, hence its back armature contacts control the track polarity. Relay *N* receives a current of this polarity, and its neutral armature closes the circuit of the main signal battery, *I*, thus sending a current through *L* and holding it at clear.

When the home signal, *P*, is cleared, the circuit controller, *B*, is closed, which raises the armature of *D*, thus closing the circuit

of C and sending a current through A. This reverses the polarity of the track, and closes the polar contact, H, which throws M to the clear position, by sending a current from I through J, H, K, M, and I. The controller, K, is operated by motion of F, it being thus necessary for the home semaphore to clear first. The momentary cessation of current produces no effect upon the home automatic blade, because it is equipped with a slow releasing slot or magnet. This retardation of movement is produced by using in N a solenoid of high self-induction, wound upon copper tubes, which thus opposes any rapid change in the magnetic flux. G has a relatively high resistance, so that when a train enters the section, S, it controls, it will open the circuit of A and D. Hence the armature of D must be returned to its upper position when A has been energized, in

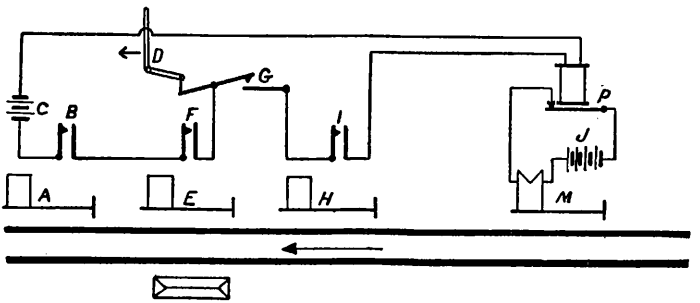


FIG. 73

order to close the circuit of C. Thus every train movement requires that the operator raise the armature of D, otherwise danger indications will be given. F and M thus operate automatically when the mechanical signal, P, is properly manipulated.

Frequently, a distant signal must be operated after several home signals have been cleared. For this purpose a device, erroneously termed a commutator, is placed upon each home signal in such a series. This consists merely of a make and break, similar to a controller. A series of this kind is shown in Fig. 73; B, F, and I are commutators, which are fastened to the masts of the home signals, A, E, and H, respectively. D is an interlocking lever, which controls through G the electrical functions, and is dependent on the positions of the contacts of the commutators. The local circuit, J, of the distant signal, M, is

controlled by the line relay, *P*, which is actuated by the main battery, *C*. It is evident that there may be any number of similarly connected home signals in such a system.

In Fig. 74 a circuit controller is connected mechanically to the lever, *A*, for the purpose of controlling the current from the battery, *B*, the latter having in circuit the commutator, *G*, on

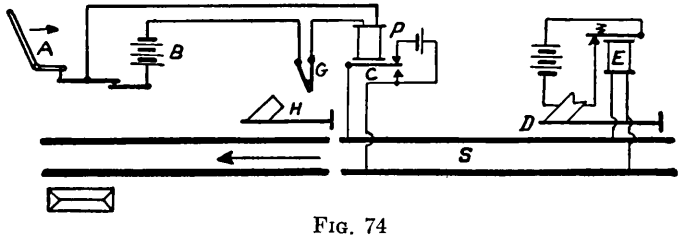


FIG. 74

the cleared mechanical home signal, *H*, and a line relay, *P*. The armature, *C*, of the latter alternately connects and disconnects the track battery at *H* from the track relay, *E*, controlling the distant signal, *D*, short-circuiting the section, *S*, in its lower or back-contact position. Current is passing through the three circuits, both signals therefore being in the clear position.

In order to shunt the contacts of a relay, so that a control outside of that produced by the energizing of the relay under operative conditions can be effected, a spring key is used. The circuit arrangement in Fig. 75 utilizes such a device. Across,

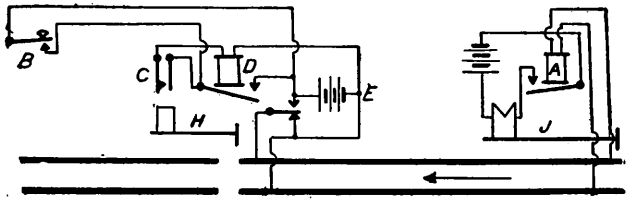


FIG. 75

or in shunt with, the upper armature of the magnetic circuit-controller and indicator, *D*, the spring key, *B*, is connected. The lower armature is connected across, and thus short-circuits the track in its lower position, and connects the track to the battery, *E*, in its upper position. *C* is a circuit controller closed by the clearing of the home signal, *H*, and is in series

with *D*. *E* energizes the track relay, *A*, at the distant signal, *J*.

When *B* is pressed downward, and *C* is closed by clearing the home signal, a current passes through *D* which lifts its armatures, the upper one maintaining the current initiated by *B*, and the lower one sending a current through *A*, thus clearing *J*.

Fig. 76 represents a scheme of connections introducing a combined indicator and magnetic circuit controller into the circuit of the line relay, *P*. This, given at *I*, consists of a solenoid, *I*, whose armature or core carries an indicating banner, *F*, to which is pivoted a lever, *G*, provided with a knob. *I* is in series with the contacts closed by movement of *G*, hence when the latter is in its lower position, current cannot pass through the circuit of the line battery, *B*.

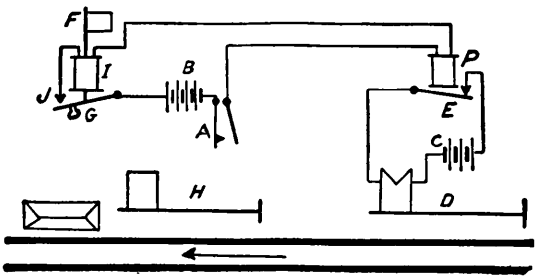


FIG. 76

When *G* is raised, the circuit is completed at *J*, and if the circuit controller, *A*, is closed, a current will pass around *I*, and, the core being energized, will maintain this condition until *A* is open-circuited. When this current flows, *D* is thrown to the clear position by current from the local battery, *C*. *A*, therefore, must be closed (by movement of the home signal) before *G* is moved; should this sequence of events not occur, *D* cannot be cleared. Since *A* is closed by the action which clears *H*, it is evidently impossible for an approaching train to pass *D*, without receiving a cautionary signal, unless a clear condition at the cabin obtains.

Somewhat similar to the above in the arrangement of accessories and circuits, is that shown in Fig. 77. In addition, a circuit controller, *P*, having a positive connection to the home

signal lever, B, is included. When B is thrown in the direction of the arrow, H is moved to the clear position, and the contacts at P closed. Unless the armature of the indicator, A, is raised, however, E will not receive current from the line battery, C,

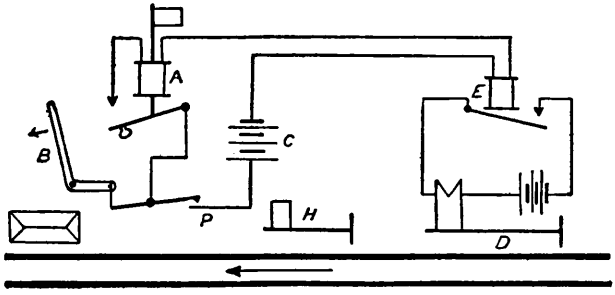


FIG. 77

hence D cannot be cleared. The banner on the indicator may be in the form of a miniature semaphore, or a small banner which appears before a glass-covered aperture in the case.

Adding a circuit controller, C, to the above, the arrangement produced in Fig. 78 is evident. This comprehends, as above

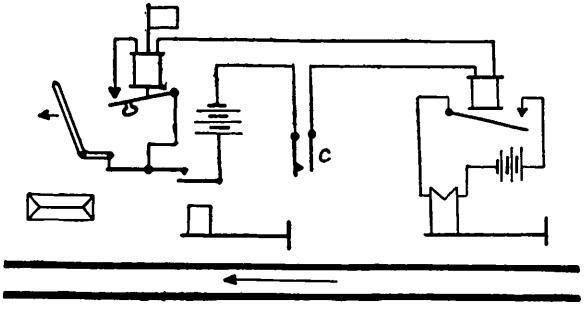


FIG. 78

stated, the addition of a protective or interlocking function, the principle of the working circuits being unchanged.

An indicator and magnetic circuit controller may have its movements automatically governed by the use of a setting track section, in which the movement of a train sets up conditions that actuate this mechanism. In Fig. 79, D is a short setting section having the battery, G, and the track relay, F. This

section may be of any required length, but as only a momentary initial current is required for setting this function, it usually is of but several rail lengths.

If the section, *D*, is occupied, the circuit controller, *A*, and the indicator, *C*, have no control over *E*. But should it not be occupied, then, if the operator raises the armature of *C*, with *H* at

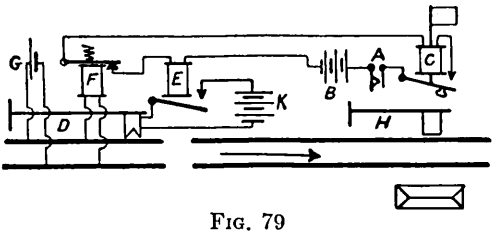


FIG. 79

the clear position, *E* will raise its armature, thus sending current from *K* to *D* and clearing the latter.

Extension of the above principle produces the circuit diagram given in Fig. 80. The lever *E* at the block tower is for the express purpose of operating the controller with which it is associated. When the home signal, *H*, is cleared, the contacts at *G* will be closed. *E* is then thrown in the direction of the

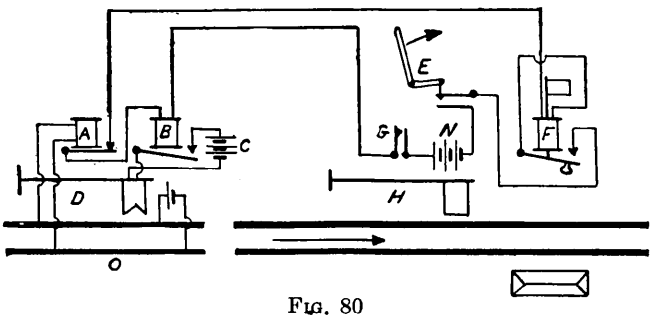


FIG. 80

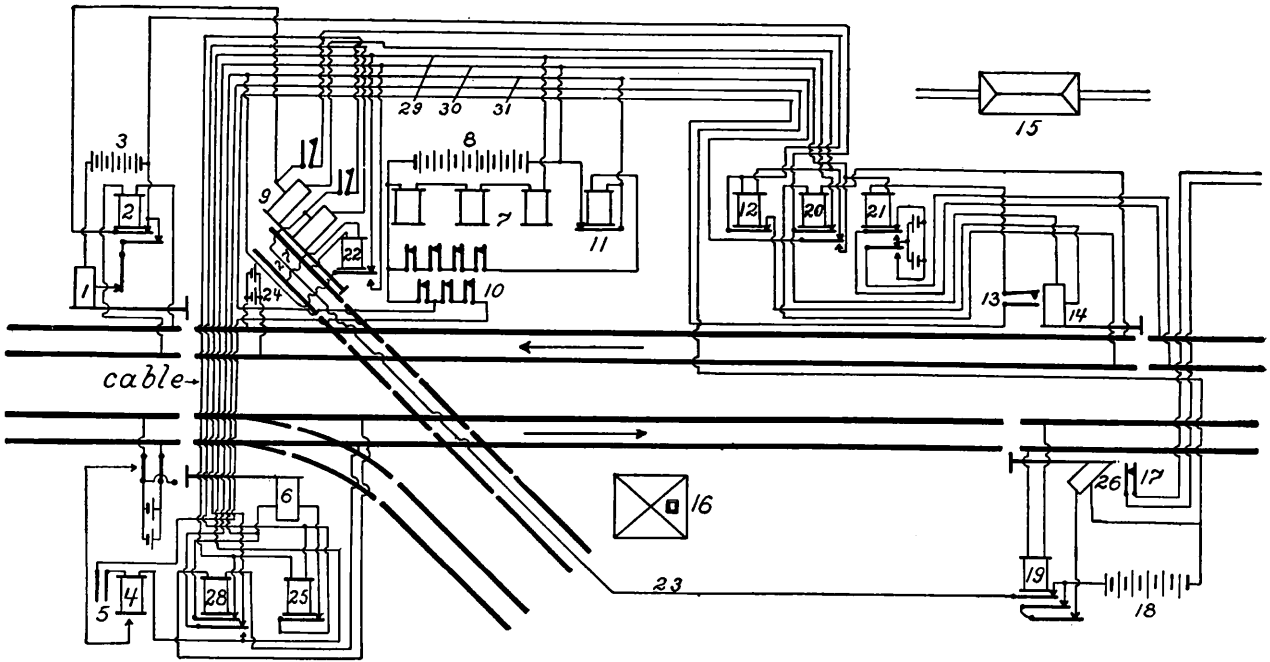
arrow, which will cause a current to flow from *N* through *F* and *B*, if the setting section, *O*, is unoccupied. Should a train be in this section, however, *A* will be deënergized, and, by its armature's falling, open-circuit *N*, thus depriving *F* and *B* of current, and preventing *D* from being cleared by *C*. If the armature of *F* be restored, the same condition will obtain, since the circuit is still open at the armature of *A*.

The circuits at a representative mechanical interlocking tower, 16, are shown in Fig. 81. 15 is a charging plant from which power lines run to the various storage batteries. At the east-bound signal, 6, the track polarity is under the control of the arrangement, 4, the operating magnet being in series with the contacts, 5 (closed when 6 is clear), two of the controller contacts, 10, battery 8, and the cable. Signal 6 is operated by battery 18, through line 23 and armature of 25, and signal 1 (at clear) by battery 3, through the polar contacts of the polarized relay, 2. The latter receives current from a track cell and reverser in the rear, while 24 energizes 20. Relay 21 operates a reverser connected to a section preceding 14, the latter receiving current from 3 through the interlocking tower.

A circuit controller, 17, is opened when the signal, 26, is at danger, and is in series with the next signal in the rear. A track relay, 22, is connected to the crossing track, 27, its armature contact being in series with the front contacts of 20 and 28. The series electric locks, 7, applied to mechanical levers, are connected to battery 8 through lines 29 and 31 and common line 30. Controller 13, operated by 14, is in series with controllers 10, contacts 5, relay 4, and 21. Considering the circuits already described, no difficulty should be encountered in comprehending the entire arrangement. It is evident in the above circuit diagrams that a common main battery may be used for numerous functions. In practice a single battery is often employed to furnish current for a multiplicity of such receptive devices, and sometimes to energize an entire circuit network of great complexity.

The normal clear circuits at the Newark drawbridge of the D. L. & W. over the Passaic River are shown in Figs. 82 to 87. The plans are consecutive from *A* to *J*, lines and other circuit wires being numbered to render easy tracing up possible. No. 7 is the common line and its connections, and is shown heavy.

In Fig. 82 signals *M* 81 are for west-bound movements, and *M* 82 for east bound, all four being placed upon a signal bridge. Relays marked *NP* are both neutral and polarized, while those marked *H* are neutral only, and have resistances of four ohms. The distant blades at *M* 82 are semi-automatic, 40 being controlled by the armature contacts of the 500-ohm slow releasing relay 42, through the circuit breaker, 43 (operated by the home


cable
1
2
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10
11
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14
15
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FIG. 81

blade), the line 28, and east-bound hand switch, *E*, at the mechanical interlocking tower of Fig. 84. The home blade, 44, operates two circuit breakers, 45 and 46, they being connected in series with the distant and line 32, the latter passing to the middle east-bound distant at the next bridge west. Line No. 35

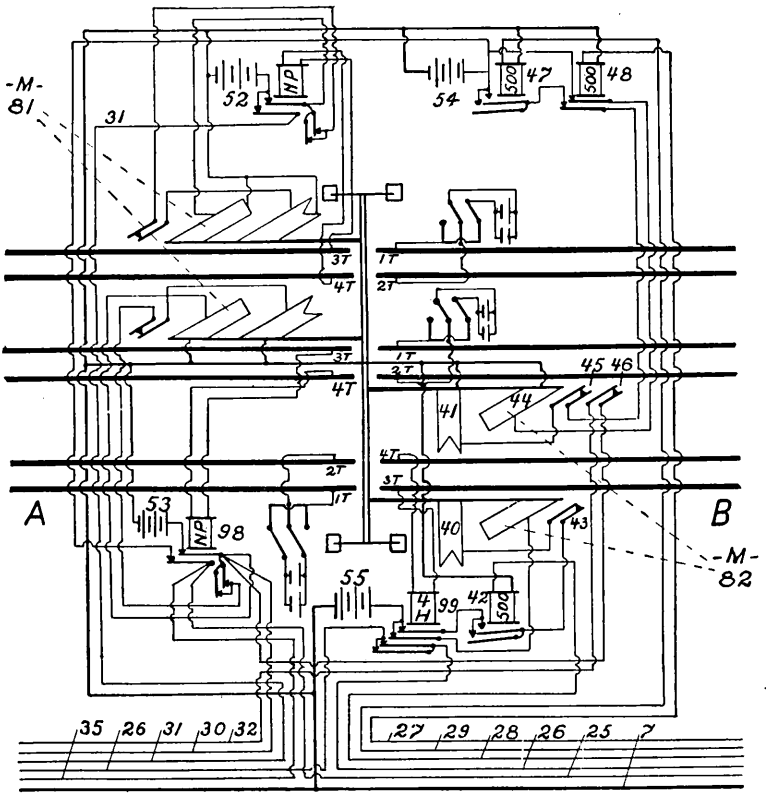

FIG. 82

passes to the west-bound middle track distant indicator for Roseville Avenue, No. 26 to the east-bound distant indicator, No. 31 to the west-bound (outside track) distant indicator for Roseville Avenue, No. 30 to the operating mechanism of the middle east-bound home signal at the next bridge west, No. 32 in series with the operating devices at the distant of the same signal, and *A*-50 to the transmitter, *T*, at Fig. 84.

The 500-ohm slow releasing relay 47 is energized through lines 29, the circuit breaker 49 at mechanical signal 16 of Fig. 83, the middle east-bound hand switch, *M.E.*, at *E–F*, and batteries 50; returning through the common, to which all working batteries and most of the other accessories have one side connected. Its armatures are in series with 41 through 45. Relay 48 is controlled from the armature of 51 at *C–D* through line 27, and controls, through its armature, both 41 and 44. The signal batteries 52–53–54–55 operate the signal mechanisms

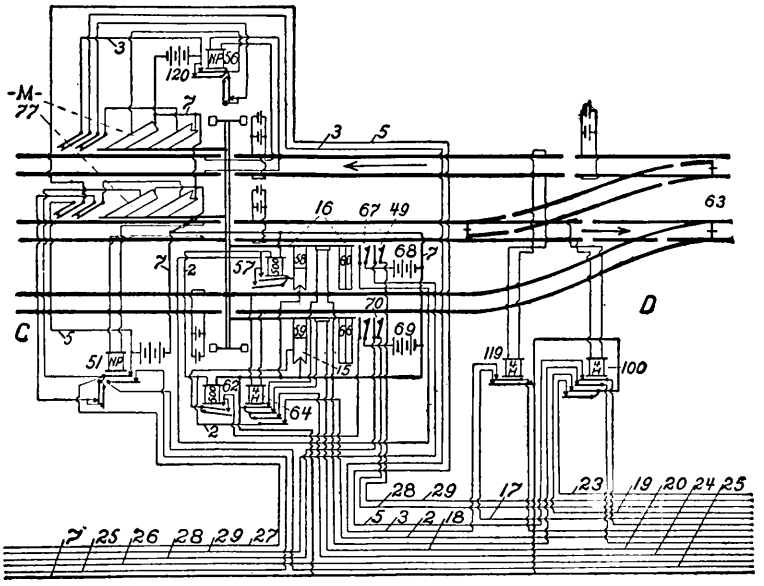

FIG. 83

they are adjacent to, the polarity reversers being operated by the home blades of these signals.

In Fig. 83 the west-bound signals, *M* 77, are purely automatic, and controlled by the polarized track-relay 56; while 15 and 16 are semi-automatic, and under the control of electric slots in series with lines 18 and 20. Relays 57 and 62 are in multiple, and connected to common and line 2, in series with the lower armature or front contact of east-bound track-relay 64. Line 2 runs to the circuit breaker 82 of 1 *D* at *E–F*, and the track-relay contact 86 at this point; the slow releasing relay 57 controlling

the distant arm 58 through the circuit breaker 67; 60 and 66 being thrown by levers; 59 is controlled by 62, and is clear whenever 58 is, since 62 and 57 are in multiple.

At 63 a switch merges the east-bound and middle tracks, thus removing the necessity for four-movement indication. 68 is the independent local battery for 58, and 69 for 59. Neutral track relays, 100 and 119, produce the required track circuit and line-wire control. Although it is possible to use a smaller number of batteries, line wires, relays, etc., in such a complicated situation and produce the same results, crossing of circuit wires would set up conditions that would entail considerable vexation in eradicating, while, by the use of as many independent circuits as is consistent with economy, such troubles seldom occur, and are more readily traced. The use of common wires has often led to troublesome conditions, but such is usually the result of poor insulation and careless installation or maintenance.

In Fig. 84 the circuits at the mechanical interlocking tower are given. *E*, *M.E.*, *W*, and *M.W.* are the east, middle east, west, and middle west-bound control line switches. One side of each of the east switches is connected to the common battery wire, *B*, and the multiple batteries at 50, the other sides being connected to lines 28 and 29, in series with circuit breakers 49 and 70, and through additional circuits already traced. An intercommunicating telephone instrument, 71, is in circuit with 72 at the drawbridge (*G*–*H*) so that communication can be carried on between these points. 73 to 79 are indicators, 73, 74, 75, and 79 having contact armatures, the energization of the magnets thus clearing not only their banners but raising also these armatures. A sixty-ohm bell, 80, is closed by a back contact of either 73 or 74, 81 being energized through the back contact on 79.

73 receives current from battery 54, through line 25, and the front neutral contact of polarized track relay 98 at *A*–*B*, and is the middle east-bound indicator; 75 is the east-bound home through battery 50, line 24, contact of relay 64, and common; 76 the east-bound advance by way of line 22, contact of 86, and common; 77 the middle home through line 23 front contact of 100, and common; 78 the west-bound home by line 21, front contact of 90, and common; 79 the west-bound distant

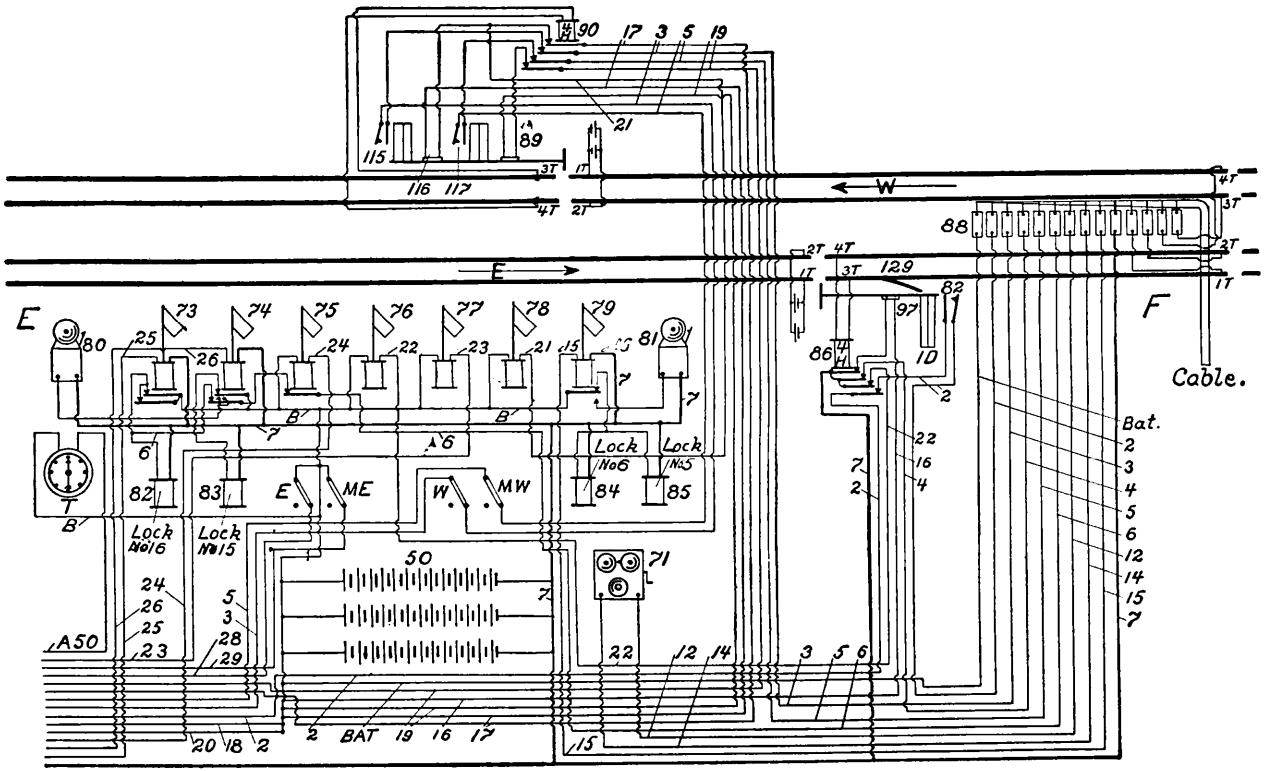
E
W
E
F
Cable.
Bat.
Lock No16
Lock No15
Lock No6
Lock No5
E
ME
W
MW
50
71
A50
BAT

FIG. 84

by line 15, contact 15, cable, west-bound home indicator contact of 101, to battery by the front contact of 106.

82 is the lock magnet on mechanical lever No. 16, which operates the home semaphore, 16, at *C–D*, and is energized from 50 through the front contacts of 73 and 74 in multiple; that is, it releases the lever whenever either its east-bound middle or east-bound distant is cleared; 83 is the lock for lever 15, or east-bound outside semaphore at *C–D*; 84 for No. 6 at 116; and 85 for No. 5 at 116. Unless 90 is energized the semaphores at 117 will be in the stop position, because of the slots, 89 and 116, which are thus controlled by a track circuit. Circuit breaker 115 is in series with line 3 and one front contact of 90, also one contact of 119, circuit breaker at *M–77*, battery 120 and common, and on the other side through line 3, and connector 3 at 88, and cable. 117 is in series with one of the front contacts of 90, line 5, 5 at 88, cable, circuit breaker 126 at *IJ*, 500-ohm relay 130, and common. A slot, 97, also controls 1 *D* (at which a derail appears) through 86, line 16 and battery *B*. Subsidiary devices do not enter in this case, as the track circuit at the approach and over the draw perform all the necessary functions. The cable is carried to the center of the draw, the track circuit connections being made so that the track forming part of the draw is electrically continuous with that at the abutments. The circuit breaker, 82, is in series with line 2, front contact of 86, common, 2 at 64, east-bound hand-control switch 113, connector 2, cable, circuit breaker 122 at *M–74* (*I–J*), battery 121, and common. At 127 there is a derail, as also at 129.

Continuing on Fig. 85 (*G–H*), the bridge controller lock, 112, is in series with a circuit breaker on lever No. 5, which is open when the bridge is locked, so that when the former is energized, the bridge is not in its safe position. A single-stroke bell, 107, is connected to the armature contact of approach indicator 105, so that when the latter has a current passed through its coils, the gong will be struck once, this occurring through line 37, whose connections will be shown later. 109 receives battery current through the back contact of the west-bound distant indicator, 106, and 108 through the same contact of the east-bound distant indicator, 102. The bridge indicator, 104, is in series with the wire 36 and the signal battery at 9 *D*, through the cables;

103 is the east-bound home indicator connected to battery 50 and line 4; the circuit being completed through one of the front contacts of 86 and common. The lock magnet, 111, is connected

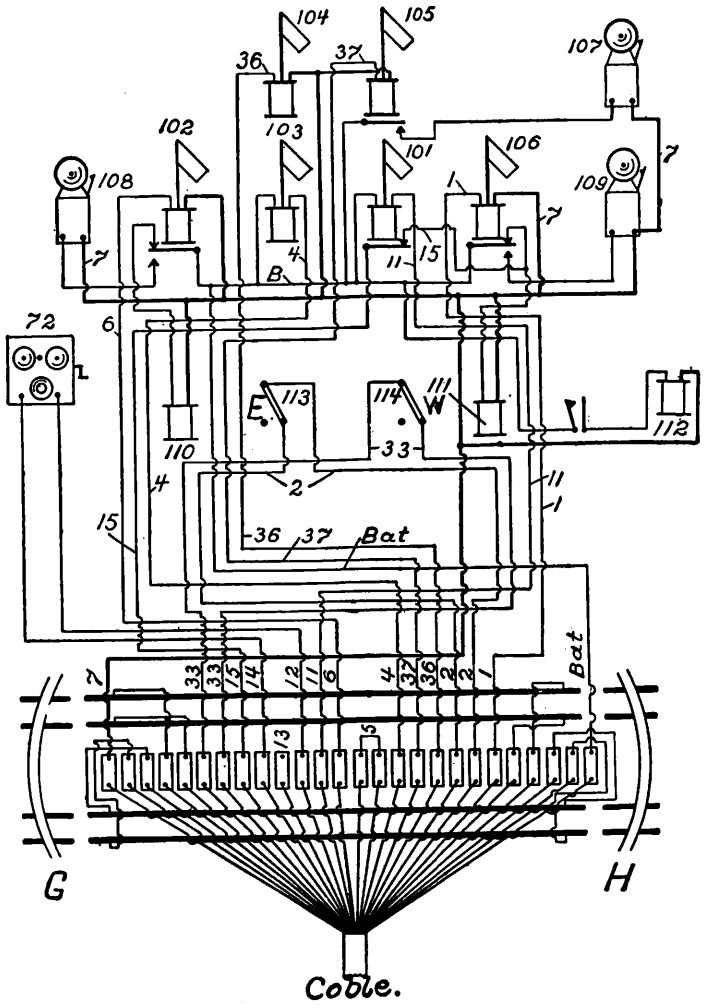

FIG. 85

to lever 9 of that signal, and is in series with the front contact of 106. The west-bound distant indicator 106 is connected by line 1 to the cable, one contact armature of 135, and to the west-

bound home indicator at Harrison, the next signal point east line 11 *E*, operating the west-bound distant signal at this point.

In Fig. 86 (*I–J*) the east end of the cable and connections

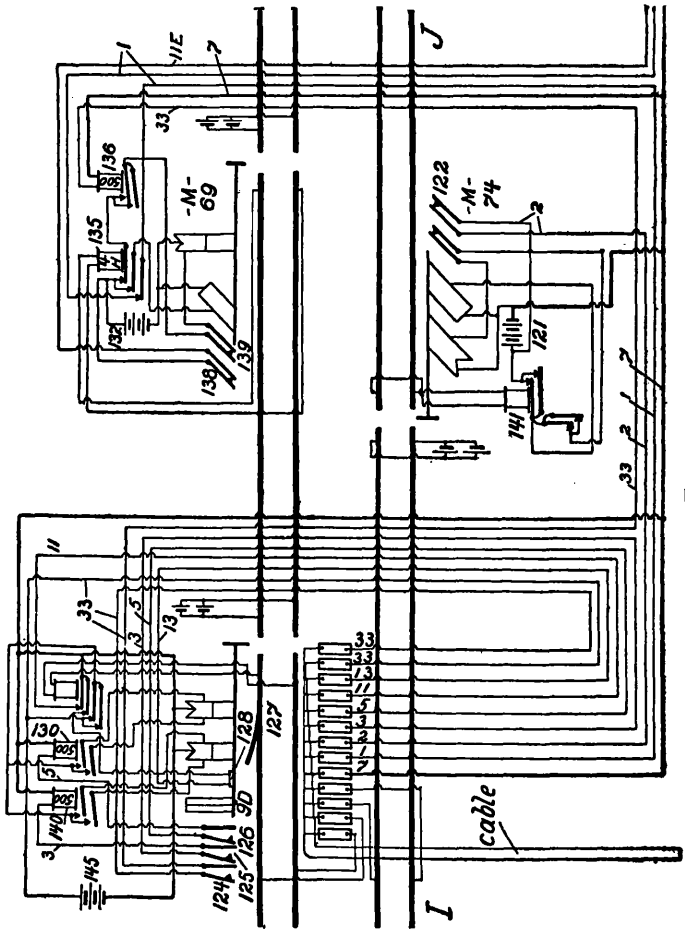

Fig. 86

are shown with the mechanical semaphore, 9 *D*, and the automatic signals, *M*–74 and *M*–69. The four-ohm track relay, 135, controls east-bound signal *M*–69, 137 being the working battery. A high-resistance slow-releasing magnet, 136, is in series with line

33, circuit breaker 124, cable, west hand-switch 114, and battery 145; while a similar magnet 130 is in series with the circuit breaker, 126, and line 5 (all three circuit breakers are closed when 9 *D* is cleared). 9 *D* is also under the control of slot 128, which is energized through the track relay contacts. Circuit breaker 125 controls 140, and 138 the preceding distant sema-

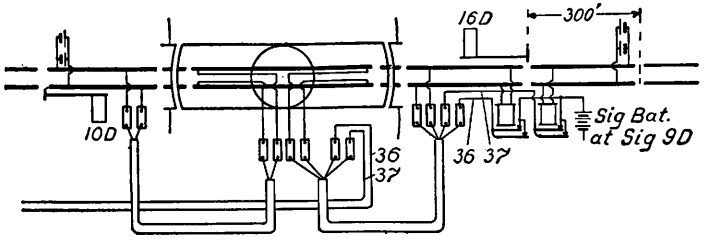

FIG. 87

phore, while 139 is in series with the distant at *M*–69. A polarized relay, 141, is used at *M*–74, battery 121 operating both home and distant semaphores.

The track circuit and other connections at the lower deck of the draw appear in Fig. 87, with two manual signals, 9 *D* and 10 *D*. With the foregoing description in view, it need not be dissected.