CHAPTER XV.

THREE-POSITION SIGNALS.

THREE-POSITION semaphores eliminate the distant blade and still give an indication of the condition of the distant block. This is accomplished by using three distinct positions of the semaphore: the all-clear being vertical; the caution diagonal; and the stop position horizontal, or nearly so. The control and operation may be effected by either line or track circuits,

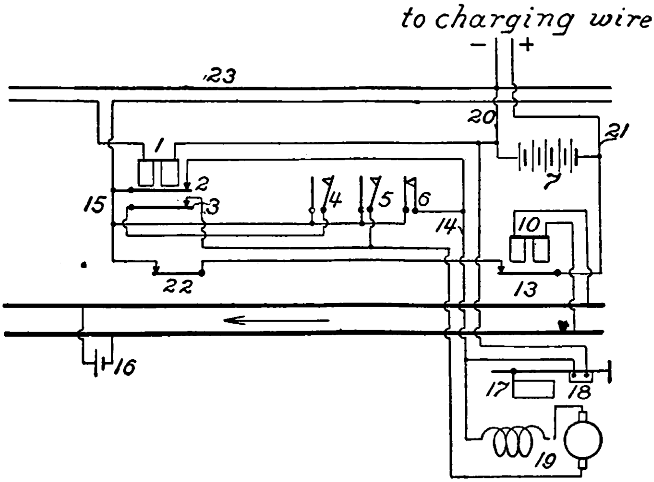

FIG. 182

the former being first described. Considering three consecutive signals, No. 3 being occupied, 1 and 3 will be controlled by the track circuits in the blocks they protect, while 2 will be controlled by line wires from 3.

Figs. 182 and 183 show the consecutive circuits employed in the Grafton arrangement of such signals. Fig. 182 gives the connections at the first signal considered; the semaphore, 17, being operated by a motor, 19, of about .1 horse power, its position and movement being governed by the slot instrument, 18. The armature contacts, 13, of the track relay, 10, are in series with the cut-out, 22 (operated by the motion of the signal mechanism), and one side of the main or storage battery, 7, the latter being located at the signal, and charged by feed wires running on poles from a central generating plant, one side of this battery being connected to the common line, 23. If the contacts, 6, are closed, a current will pass through 18, which locks the signal and holds it in the clear position shown.

Should 10 be deënergized, however, by reason of 16 being

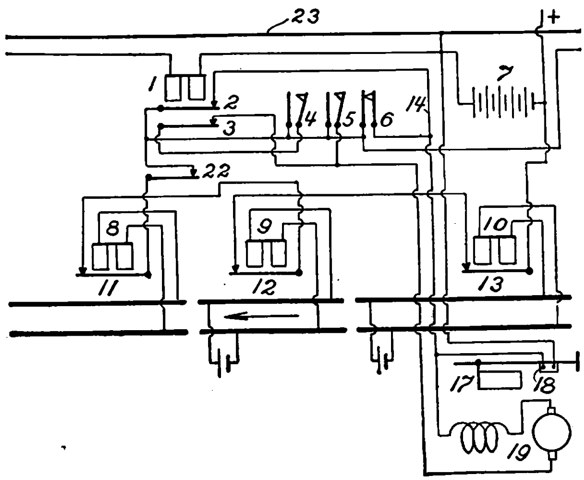

FIG. 183

short-circuited by a train in the section, 18 will be released and 17 will return to the stop position. Circuit-breaker 4 is closed when the signal is in either the stop or the caution position, but is opened in the clear position; while 5 is closed only in the stop position, and 6 closed in the clear and caution positions. The three-position relay, 1, is in series with the line wires, and has two armatures, 2 and 3; the former shunting the circuit-breakers, and the latter connecting the motor to one side of the battery through 4, 22, and 13. If the wires, 15 or 14 (Fig. 183), should be broken it is evident that 7 would be continually passing a heavy current. To guard against such an occurrence, the circuit opener, 22, operated by the signal mechanism, is provided.

The armatures, 11, 12, and 13, of relays 8, 9, and 10, are in series with this device.

The special parts of the signal mechanism are shown in Fig. 184. The semaphore is connected to the rod which is fastened to the sleeve, *F*, the accessories being secured to the latter, and move with it when the semaphore is cleared. The rod, *M*, is operated through a train of gears by the electric motor, there being three stationary positions. *B* is the slot magnet, whose armature affects the position of the lock block, *L*, through the toggle arrangement, *C–D–K*. *A* is a dashpot, whose piston is stationary, it being required to prevent spasmodic movements of the moving system, and prevent the inertia of the latter from injuring the mechanism. *N* and *J* are latches which engage with *F* at its various positions and relieve the motor and gearing of the weight of the apparatus when at rest.

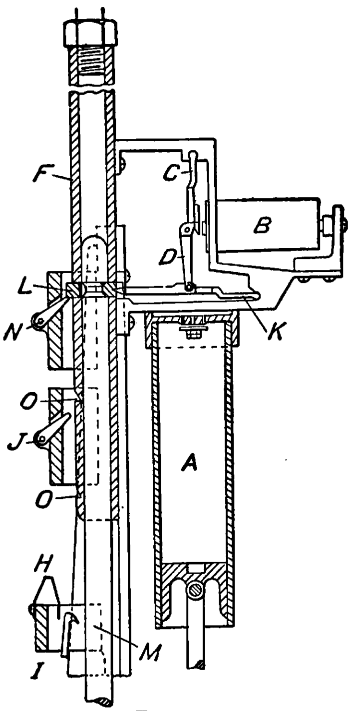

Fig. 184

When *B* is energized, *L* is forced into engagement with a recess upon the upper end of *M*, so that motion of the latter results in motion of the former, their tendency being to disengage. The circuit-breakers not shown are operated by an extension of the sleeve, *F*, while *I* is the armature extension of a catch magnet, which, when deënergized, prevents *F* from moving upward by the hooked end of the armature being forced into the notches, *O*, by the spring, *H*. The operation of the signal should be readily perceived from the above description, a rather complicated application in conjunction with semi-automatic signals being now taken up.

In Figs. 185 and 186, the connections of two automatic three-position signals on double track, and their relation to mechanical semaphores, moved by levers from a cabin at a junction, are shown. Both 2 and 4 are electrically operated, but are also under the control of the signalman; while 1 and 2 are entirely automatic. In order to trace out the connections most expeditiously, Figs. 182 and 183 should again be consulted. Both diagrams are similarly arranged, and are connected by the line wires, 1 to 7.

At 10 in Fig. 185, the circuits at signal 1 are shown, the remainder of the figure being devoted to the connections of 2 and the interlocking functions. The circuit-breakers, 16 and 17, are opened when the semaphore of 1 is moving to the clear position, while 18 is closed,the three-position relay, 19, controlling signal 1, current being derived from the main battery, 11. Circuit-breakers 22, 23, and 24 are similar in function and operation to those operated by 1, while 25 is in series with one of the contacts of the circuit controller, 14. The latter is operated by the lever which throws 4 of Fig. 186 to the clear position, at which time the breaking device, 31, is closed. This effects a cautionary indication through the distant line wire.

The lock magnet, 27, is for the purpose of securing the lever for 4 in the stop position, unless it is energized by way of the common and No. 4 line wires, through 13 and the first of the set of contacts 32. When the lever of 4 is reversed, the lever relay, 28, is energized and acts as a controlled function; the stick relay, 38, through its lower armature, being interposed for accomplishing this purpose. The latter must be energized before the signal can again be cleared.

In tracing up the circuits it should be remembered that 2 is controlled in a manner similar to 4, and that while its connections are shown, only those of the latter are described. As the latch of the lever for 4 is lifted the circuit controller, 13, is shifted, so that the stick relay, 15, is connected through contacts, 36, and the upper armature of 15 and its coils, line-wire 4, and the storage battery. The lever relay, 28, has been closed through the storage battery, armature 37 of the control relay, 35 (of signal 4), line 7, 36, lower armature of 15, line 5, lever relay 33, line 3, and to the battery. When 13 is not shifted, we have from the battery, 37, line 7, 36, upper armature of 15, 15, line 4 to battery.

As 33 is on closed circuit when the signal latch is raised, it

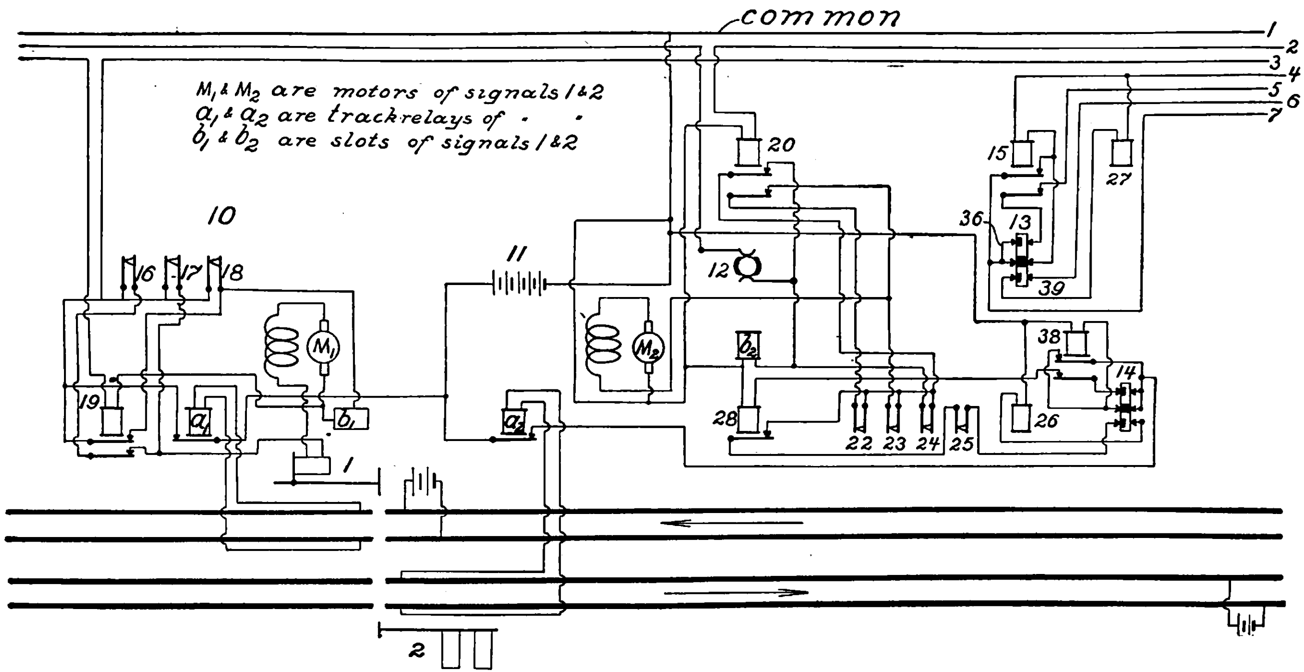
common
1
2
3
4
5
6
7
M1 & M2 are motors of signals 1&2
a1 & a2 are trackrelays of " "
b1 & b2 are slots of signals 1&2
10
11
12
13
14
15
16
17
18
19
20
22
23
24
25
26
27
28
36
38
39
M1
M2
a1
a2
b1
b2
1
2

FIG. 185

performs the office of a track relay, the motor and other circuit being closed by its armature, thus allowing the semaphore to be cleared. With a train between 1 and 4, track relay 35 is short-circuited, which open-circuits 33 and 15, thus causing 4

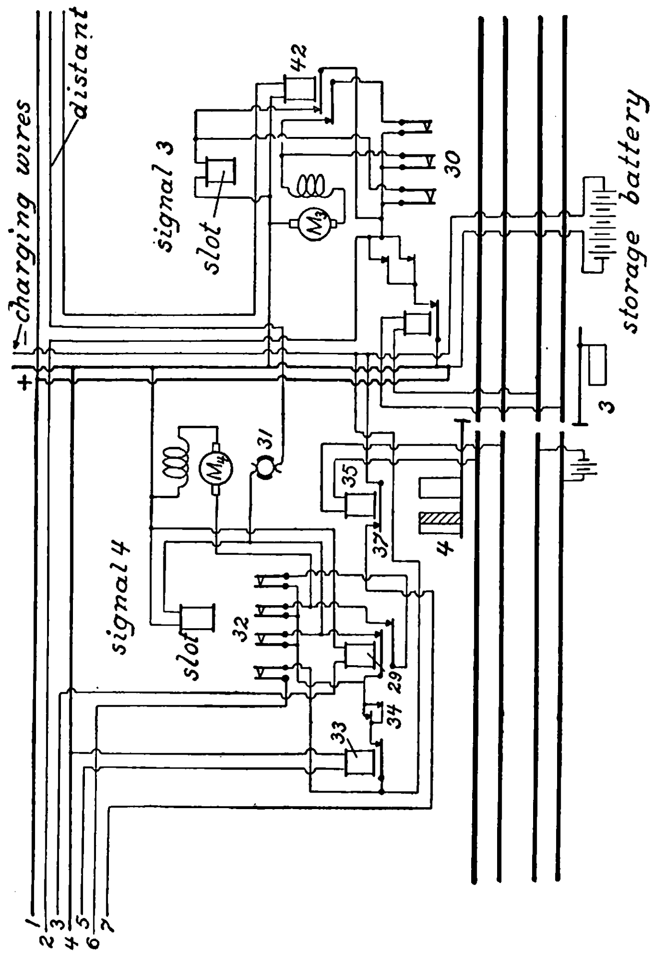

Fig. 186

to move to the stop position.. When the lever of 4 is put into its normal position, 15 will be energized by reason of 36 being connected to 39 (13 and 14 are supposed to move vertically). It will be evident that these semi-automatic signals are thus returned electrically to the stop position, and cleared mechanically.

When 33 is energized, 4 cannot be cleared unless the block ahead is clear, because of the track relay introduced; which is also the case in the automatic control of signal 1. The lever of 4 is locked in its stop position by the deënergization of the lock magnet, 27; hence the latter must have its circuit to battery closed through 39, the first left-hand set of the contacts, 32, line 6, battery, and line 4. The first set of contacts at 32 will not be closed, however, unless 4 is in the stop position.

Slot circuit-closers 32 are operated in a manner similar to the three-position contactors that have been described. With a clear track, the signalman must first clear 4 before a train can enter the block. The unlatching moves 13, and simultaneously 31, thereby throwing the signal, by sending a current from the battery through the motor circuit. The circuit closer, 31, is similar to 12, while 29 and 42 are three-position relays. The contractors, 30, are operated by signal 3; and 14 is a circuit controller, similar to 13, operated by movement of 2. The respective signal slots are b_1, b_2, etc., the track relays, a_1, etc.

In Fig. 187, the connections of three consecutive G. E. three-position signals, 75, 85, and 95, appear. Two line wires, 1 and 2, interconnect the various signals, these being in series with the three-position relays, *R*. The contacts of the latter are closed when the semaphore is in the clear and danger positions, and open when in the caution position. The controller, *A*, is an arrangement with movable sectors and stationary contacts; and rotates in an opposite sense (in the diagram) to the semaphore. The lock magnet, *L*, holds the semaphore in position, and the clutch magnet, *C*, in series with the motor, *M*, engages the semaphore operating gear at its various positions of rest.

When the semaphore is at clear, 7 is connected to 8, and the lock-magnet and three-position relay (at 65) are in multiple, being energized by the power battery, *P*, at 75. The lock magnet holds the semaphore at clear, and opposes the tendency of gravity to move it to the stop position. As *R* is energized, the current to the lock magnet, *L*, is in series with its armature.

With the semaphore at caution, 6 and 7 and 4 and 5 are connected. The three-position relay, *R*, at 85 is deënergized, since the track battery, *T*, at 95, is short-circuited. Current thus

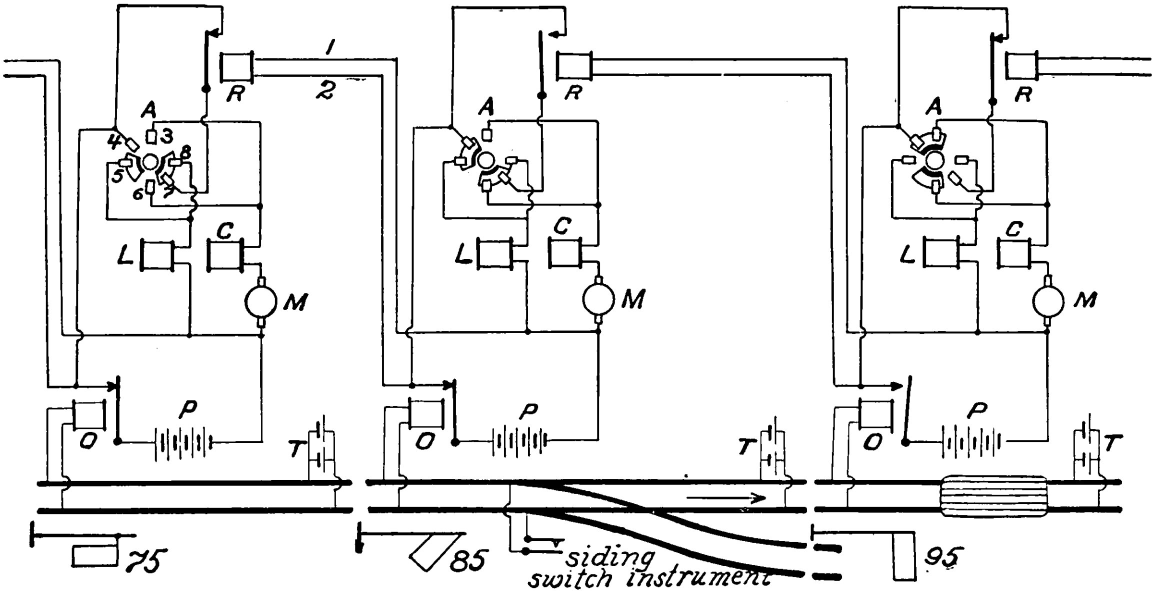

FIG. 187

passes through *R* (at 75) and the lock magnet in parallel, the motor, *M*, being out of circuit at this moment.

When the semaphore is at danger, as at 95, the track relay, *O*, is short-circuited, thus cutting the motor out of circuit with the power battery. The three-position lock and clutch magnets are thereby deënergized, and the semaphore is acted upon only by gravity. It should be remembered that all movements toward full clear are performed by the motor, and all toward danger by gravity. Thus the return from clear to caution is effected by gravity under the control of the lock magnet.

In Fig. 188 a later modification of the above is shown. The power battery, *P*, in this case is disconnected from the motor circuit by a quadruple break as are also the stationary contacts, 4 and 7, of the controller. These contacts carry the heavy working current, the actual construction being shown in Fig. 190.

One form of G. E. top post, automatic, three-position signal, such as is used in connection with signal bridges, is illustrated in Fig. 189. The glass spectacles are removed, the semaphore being in the caution position. The return to stop is assured (by reason of a preponderance of weight on the left side) after the lock magnet has released.

The internal mechanism of the top post three-position signal is shown in Fig. 190, the doors of the housing being thrown open. The small series-wound motor, *M*, drives the main gear, *G*, which is indirectly connected to the semaphore shaft. Secured to this same shaft are the contact sectors of the controller, *S*, which engage with fixed clips during rotation. An intermediate shaft gear and pinion exist to further decrease the motor speed. *D* is a dashpot, whose piston rod is connected to a crank, carried by the semaphore rock shaft, to prevent injury to the parts when the blade returns to stop. *C* is the lock and *L* the clutch magnet, whose connections were shown in Fig. 187. The stationary contacts of the controller are connected to the track-relay armatures, lock and clutch magnets, battery and lines, in the order shown in the latter circuit diagram. The clutch magnet operates a toggle clamp which holds the semaphore in its proper position.

The lock magnet is in circuit when the blade is at clear and caution, but not when in the stop position; the clutch magnet being in circuit whenever the motor is, since it is in series with

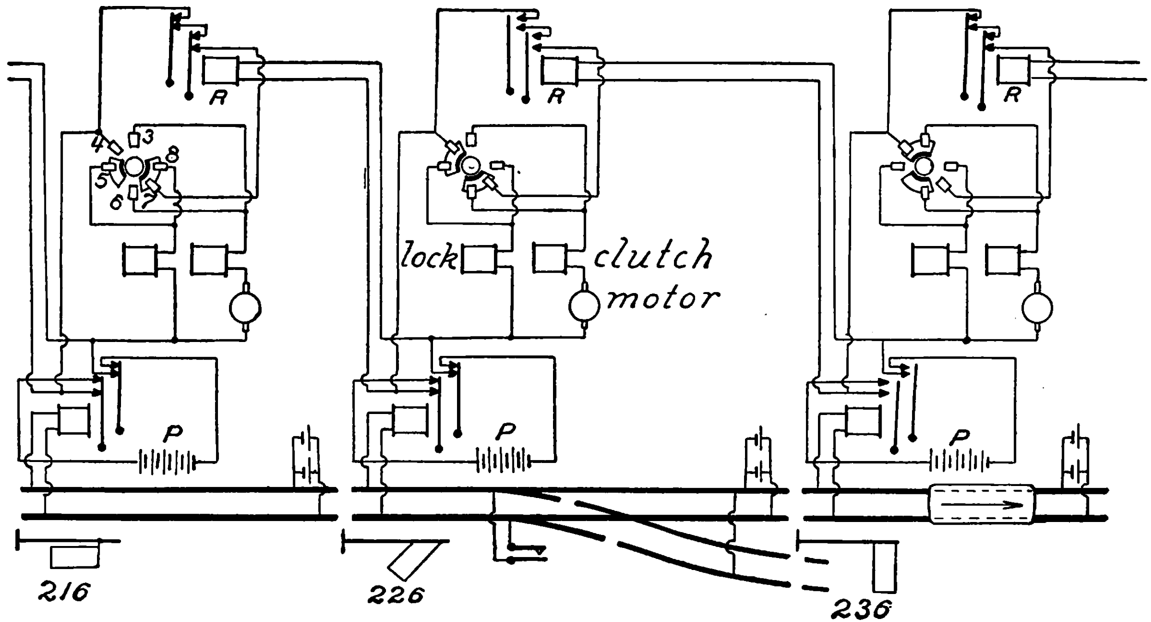

FIG. 188.

the latter. The circuit is broken by a spring action quick break, so that burning of the contacts will be minimized.

A later development of the above three-position (normal clear) operating structure, appears in Fig. 191. The 14-volt series motor, *A*, drives the train of gears and pinions, *C*, *D*, *E*, *F*, thereby transmitting a rotary movement to the clutch wheel, *H*, which is free to move on the semaphore shaft, *J*. The inner face

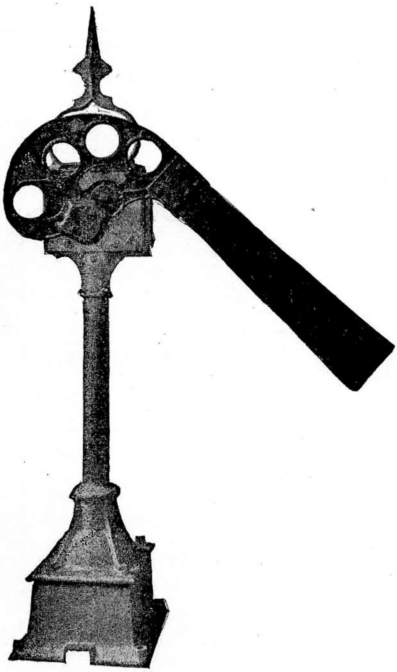

Fig. 189

of this clutch gear contains a plurality of V–shaped bosses, *B*, with which the clutch structure, *K*, engages, when the operating magnets, *M–M′*, are energized. These magnets, with their armature and toggle levers, are mounted on a sector frame, *S*, which is rigidly keyed to the shaft, *J*, and thus gives motion to the semaphore, the latter being attached at *Q*. The motor and clutch magnets, as shown in the diagram, are connected in series, so that when the motor is operative, these coils are energized, thus causing the toggle levers to force the working end into engagement with the bosses on the clutch wheel, which is then revolved in the direction of the arrow by the motor, thereby throwing the semaphore to the caution or clear direction. This locking sector, *S*, mounted directly on the shaft, *J*, is provided with bosses (not evident in the position given)

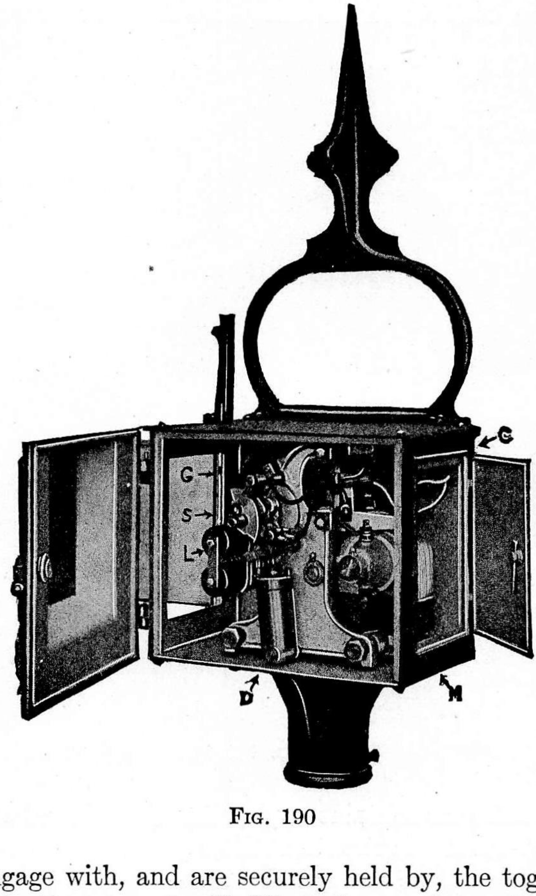

Fig. 190

which engage with, and are securely held by, the toggle levers operated by the magnets, *N*–*N′*, at the caution and clear positions. By the action of the control contacts, *a*, *b* (and four others at the rear of *P*), and the segments, *U* and *U′*, the motor is thrown in and out of circuit. In the caution position *N*–*N′* is energized and the lock toggles (counterweighted at *O*), engage with the boss on the locking sector, thus holding the semaphore at the 45° position. With the track circuit justifying a clear indication (which is normal); a similar scheme of connections obtains, with the same sequence.

The contact segments, U, U', and U'', effect the proper variation of interconnection with the contact fingers, a, b, c, d, etc.,

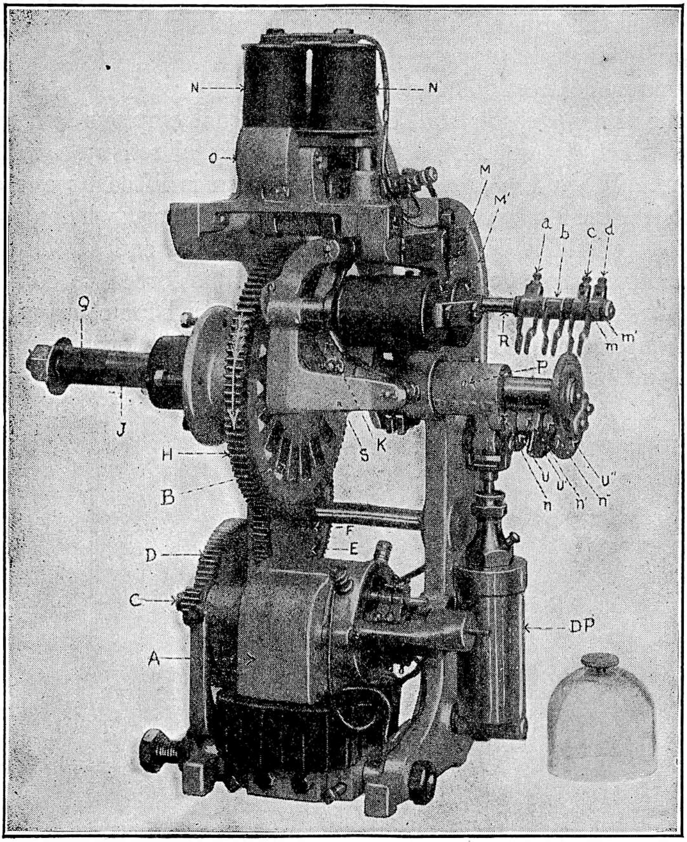

Fig. 191

and are mounted on the shaft sleeve, P (keyed to J), carrying the plunger of the oil filled dashpot, DP, and insulated by the moulded collars, n, n', and n''. The remaining connections and especially those made by the fingers and posts hidden from view, are effected as in the diagram and preceding mechanism. An additional adjustable control segment, U'', and fingers, c and *d*, constitute an auxiliary control feature, for purposes of indication at a block tower or similarly appointed location.

By arranging the mechanism adjacent to the semaphore, with the rock shaft of the latter driven directly by the gearing, a remarkably self-contained unit is assured. This, in combination with the three-position arrangement, marks a step forward in the standardization of automatic signals. The energy taken by the motor is also greatly reduced, owing to the absence of clumsy connections and accessories.

The three-position Hall electro-gas signal employs two cylinders which are connected to the single signal rod by a walking beam. When the home clears, the beam is lifted at one end, the signal rod moving half its distance, the fulcrum being at the distant cylinder. When the latter clears, the end at the home cylinder is the fulcrum, the rod being thus forced to complete its stroke. About three seconds are required for clearing such a semaphore, a single cylinder moving its entire stroke in from one to two seconds.