CHAPTER VIII.

CONTROLLED MANUAL SYSTEMS.

In the manual system of block signaling, the signals are operated and controlled solely by the tower attendant, there being no automatic control of the indicating functions. In the controlled manual system, which is intended for long block sections, the movements of the signals are effected by the operator, but these movements are controlled by electrical devices whose sources of current are in various track and line circuits.

In its usual form, this latter system consists of a number of electromagnets whose moving systems are so mechanically connected to the levers they control, that movement of the latter is prevented unless the block covered is in the proper condition for such movement. This is effected by giving the operator at one end of the block electrical control over the lever movement at the other end.

Thus, if the operator at 17 allows the movement of a train to 18, and then throws his signal to the danger position, he cannot throw the latter to clear until the operator at 18 unlocks his lever (17's), which 18 will not do until the train has passed out of the block, automatic arrangements preventing this unlocking, even if it were attempted. These latter accomplish this object by an electromagnet controlling the lever at 17, in series with which is a battery at 18, the line wire of this circuit being either broken at one of the various cut sections of the block, or at the section of the next block at 18, which has a track-relay back-contact in series with this battery, so that the locking magnet is not demagnetized until a train enters this section.

This latter arrangement is given in diagrammatic form in Fig. 105. Track relay *b*, at section 18*a*, normally holds its armature in the position shown. When a train, passing from 17 to 18, arrives at 18*a*, by short-circuiting track battery *c*, *b's* armature

closes the circuit of *d*, thus energizing *a* and releasing the locking function, *e*.

Under the permissive system, however, this arrangement would not give adequate protection, for, should a train be allowed to pass 17 before the previous train has reached 18, then when the latter arrives at 18 the locking function at 17 is released, thus giving a clear signal to the next train entering front section 17–18. To prevent this confusion, a track relay and contacts may be interposed in the latter section, thereby approaching more closely to an automatic system. This would be disadvantageous, however, in taking away, in this case, the requisite control of conditions from the tower operator.

In the manual control system brought out by Coleman, a combined track and wire circuit is used to control the movement of

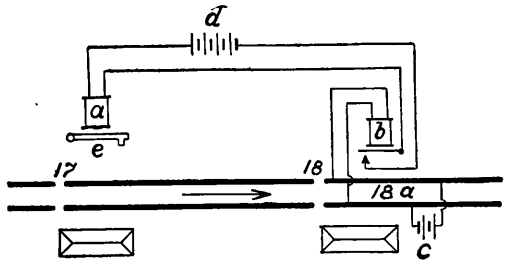

FIG. 105

mechanical signals. This arrangement will now be outlined, but not the actual mechanical construction of the devices used; the relations of the circuits and functions to automatic circuits being the principal object of this description.

In Figs. 106, 107, and 108 the arrangement of connections and a diagrammatic representation of the functions of the apparatus is shown. Fig. 106 gives the circuits at the first block station considered; Fig. 107, at the second station; and Fig. 108, at the third station, the fourth and all subsequent stations being entirely similar to the third in the arrangement of accessories and circuits.

In Fig. 106 signal arm 5, controlling the home block, is operated by lever 1, which is pivoted at 2, through the interposition of the usual mechanical accessories, and also the electric slot, 13. This slot prevents electrically the movement of the

signal arm when unfavorable conditions exist, as will be shown later. The locking arrangement consists partly of a sector casting, 6, having a lug, 10, which is connected by a link to the slotted section, 18, the latter being moved whenever the signalman, by squeezing the hand piece, 3, attempts to unlock the lever and subsequently throw the latter. The movement of the sector is governed by the electromagnet, 9, through the finger, 7, and the links, 8, connected to its armature.

In addition to 9, there is a circuit-control electromagnet, 12, and also the relay, 14, connected to the track. The arrangement of accessories at station 2 is somewhat similar to the above, and

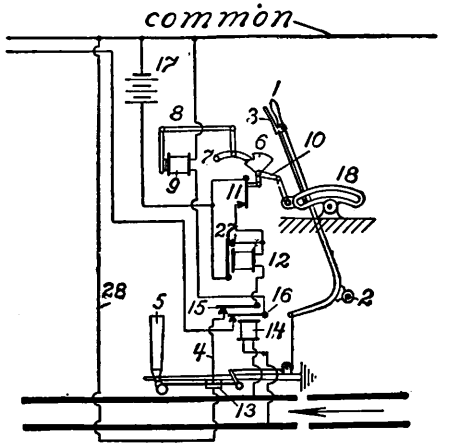

FIG. 106

contemplates in addition a sliding semaphore, 26, and a switch, 19. The connections of the electric slot at this signal are not shown, as it should be remembered that these circuits are traced out only so far as they affect the signal at station 1.

The electromagnet, 9, is connected in series with the line wires and with one of the front contacts of the track relay, 14. The line wires pass to the make and break arrangement 20, operated indirectly by the switch lever at station 2, the battery, 21, being in this circuit; hence 9 will not be energized unless the sector block, 22, is in the normal or danger position, as shown. The circuit of 9 will thus be broken at 20, and finger 7 will prevent motion of the sector block, 6, thus effectually locking signal 5 in the danger position.

Hence, before 5 can be cleared, the operator is required to summon the operator at station 2 to put his signal in the normal or stop position. Thus the apparatus requires that the block covered by 5 be closed at its outgoing end, thereby preventing a train from receiving a single permission to pass through two blocks. When a train is to pass from 1 to 2, all conditions being favorable, the operator throws lever 1, and consequently signal 5, the train then passing this signal. This causes the track battery 25 to be short-circuited, thus deënergizing relay 14, thereby breaking the circuit of 9. This allows the finger, 7, to drop, preventing motion of sector block 6, and consequent

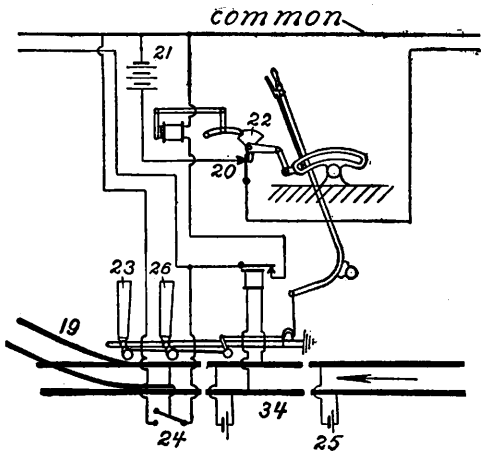

FIG. 107

unlocking of the lever. Thus signal 5 cannot be thrown to the clear position until the train has passed out of the block and restored contact 16 to its normal position by removing the short circuit from the battery.

Since the train cannot pass out of the block until the signal, 23, has been cleared, it follows that when this occurs the circuit of 9 will be opened at 20; hence, before the signal, 5, at station 1 can be again cleared, the train must pass out of the block of 23, and 23 must be thrown to the danger position. It is evident that a careless operator might throw the signal at station 1 to the clear position, and thus allow another train to enter the block before the first had passed out of it. But this is prevented by the

action of the electric slot, which throws the signal to the stop position when a train has entered its block independently of the operator. Thus the connection between the lever and the semaphore is not positive, but depends upon the electrical conditions of the block. The circuit of this slot (which is operated by an electromagnet) is composed of the wire, 4, the second front contact of track relay 14, electromagnet 12, armature contact 27, battery 17, common line-wire, and wire 28.

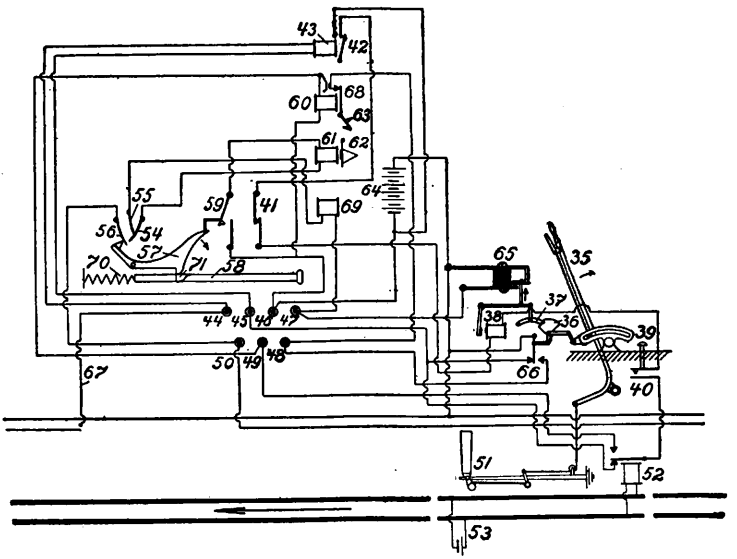

FIG. 108

When a train enters the block of signal 5, track relay 14 is short-circuited, thus breaking the slot magnet circuit at 15, and simultaneously at 27. This causes 5 to pass to the danger position, independent of the position of lever 1. The reason for interposing the independent double break is to preclude the possibility of the operator's throwing forward the lever to the normal position as soon as the train has passed into the block protected by 23, as this latter position of the train will restore the break in the circuit at 15 by the action of 14. Thus the connection between the lever and its semaphore is effectually broken until the proper conditions obtain. The consent of the

operator at 2 to allow movement of the signal lever at 1 is usually given by an electric bell or telegraph code.

It is evident that the circuit cannot be closed at 27 except by a current passing through the circuit independent of its own armature and contact. This latter circuit is formed by the wire, 4, passing from the slot magnet of 13, and includes also make-and-break arrangement 15, magnet coils 12, make-and-break mechanism 11, battery 17, common line-wire, and wire 28. Since 11 is controlled by sector block 6, and the links, 10, attached to 18, when the lever, 1, has been thrown to its normal or stop position, the circuit is closed at this point, it being open when 5 is in the clear position.

The motion of the hand piece, 3, which is necessary in order that the lever may be unlocked preparatory to its movement, produces motion in the slotted casting, 18, which indirectly breaks the circuit at 11, providing the sector block, 6, does not meet with the free end of the finger, 7. The closing of the circuit at 11 causes a current to pass through the coils of 12, thereby closing the circuit of slot 13 at 27. This becomes necessary in order that the slot mechanism may be held locked when lever 1 is to be moved. Otherwise the signal could not be cleared, since the mechanical connection is through the interposition of the slot. As 27 is in shunt with 11, the circuit is not broken by the opening of 11, so that the current from 17 continues to pass around the coils of 12.

As already stated, this system is applied to block sections of great length, so that if a continuous rail circuit were used, it would become needlessly expensive and complicated. As this combination of wire and track circuits is more readily comprehended, and simplifies what will follow, the above description has included it. In the circuits given with those at station 3, the track circuit will be omitted, except for a short working or setting length at each signal.

It has been shown that when a train passes signal 23 the control of 5 is restored to the operator at station 1, provided the operator at 2 has put his lever in the normal position. At station 3, on the other hand, 23 cannot be unlocked at once by the passing train, only the plunger, 58, being released. This latter must be actuated by the operator before the train passing signal 23 can short-circuit the track relay and produce an automatic

set of conditions at station 2. The operator at station 3 must actuate the plunger, 58, at the request of the operator at station 2, so that the latter may give a clear signal to the next train to occupy the block. In addition, the former must throw his signal to danger.

Since a train cannot pass 34 until 23 is cleared, and since 23 has been placed in the danger position to allow of 5's being unlocked, it cannot be thrown to the clear position without the permission of the operator at station 3. The apparatus by which this permission is given constitutes Coleman's machine, the mechanical construction of which will not be taken up.

Again considering the arrangement at station 3, it is evident that lever 35 cannot be thrown until the sector block, 36, can clear 37; that is, until a current passes through the electromagnet, 38. The floor knob, 39, is then pressed downward, which closes the contacts at 40 and connects one side of 38 with the common line-wire. When this occurs, we may trace up the circuit to the closed contacts at 41 and the open contacts at 42. These latter must be closed by energizing the electromagnet, 43, before the circuit can be completed through the battery, 64, and the common line return. As 43 is in shunt with the binding posts, 44 and 45, a current must come in over the line wires from station 2, and on the common line side through the armature contacts of relay 52. Hence, it is necessary that 52 be in an energized condition, that is, with no train on the section of track-battery 53. At station 2, 20 must be closed, then a current from 21 will flow through 43. With these conditions fulfilled, 51 can be cleared by throwing 35.

As above stated, 58 is a plunger which is moved in the direction of the arrow, normally held in the extreme inner position by a spring, 70, this plunger being provided for the purpose of allowing the signal at the next station to be unlocked. When 58 is pulled out to the position shown, the projection on the dog, 57, drops within the aperture, 71, in 58, thus breaking the contact of spring 55 with 54, and connecting 56 with 54. The spring contacts, 59, are closed, at the same time those at 41 being opened. The former is effected by the action of the rock shaft carrying the dog, 57, and the latter by the movement of a train.

The resistance coil, 69, is interposed in the circuit of 61, while 61 is an electromagnet which has an armature provided with a

swinging carrier, 62. When 60 is energized, its armature, 63, which carries a retaining catch, closes the contacts, 68, thus connecting 48 with 49. When 37 is raised by 38, the contacts of 65 are opened, thus disconnecting 47 from 64. When the train passes, 52 is energized, and its armature closes the lower contact, the operator returning the lever to its normal position. This opens the retaining circuit at 66, and in consequence, electromagnet 60, releasing the catch 63, allowing the word "Free" on a banner to pass before a glass aperture in the housing, which denotes that the lever at station 2 may be unlocked for a second train. Thus the dependence of one operator upon the other is shown. By tracing up the circuits, the reader will be able to deduce the remainder of the functions. A complete description of the apparatus would be too lengthy for this book.

On single-track lines, a modified form of lock and block arrangement must be used if the controlled manual system is employed. Trains bound in both directions must run alternately into sidings to allow passing, these sidings being governed by signals which are interconnected electrically. Block towers are placed as near as convenient to overlapping opposite sidings, into which trains proceed under given conditions. The operator at block tower 23, for example, governs the levers at 24, this consecutive arrangement being necessary for safety. It is evident, also, that each operator has control over trains moving in both directions.

In Fig. 109 the relation of such a single-track system, with the Leonard scheme of control, is shown. D is a track instrument (a device which closes a circuit when the wheels of a train pass over the end of a projecting lever whose other end operates a spring contact, as in Fig. 95) which closes the circuit of the battery, F, through the lock instrument, E. In this same circuit is a circuit breaker, G, which disconnects E from F. A circuit closer, A, is situated at the ends of the east- and west-bound sidings, and is connected to E and F by the line wires, K, L. (The west-bound apparatus is distinguished by small letters.)

The operator, to allow an east-bound train to proceed from 23, unlocks the signal lever at the latter point. The unlocking current passes over the line wires w, which connect successive towers. This function then remains locked until released by the track instrument, due to the effect of the passing train.

The line circuit at the same time is opened (by the circuit breaker, *G*, of the signal *C*), so that a west-bound train cannot enter the section, because the west-bound signal, *B*, is at danger, it being controlled by the battery at 23. If the locking function is not released by *D*, the train enters the side track, and the switch, *S*, must be closed by the brakeman immediately after the train passes the derailing switch, which is at *A*. This operation closes for an instant the unlocking circuit at *A*, which sends a current to the lock instrument from the battery, *F*.

If a west-bound train is to be allowed to proceed, permission and unlocking is first received from 25. The signal, *C*, is then cleared, which breaks the circuit of the track instrument

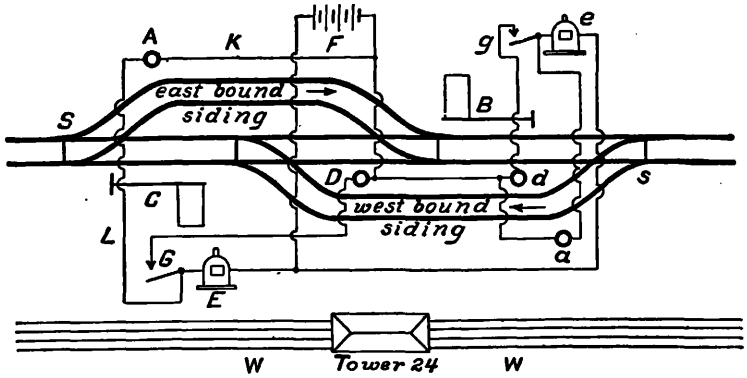

FIG. 109

and prevents the signal from being unlocked by a train until it has first been thrown to the stop position. Indicators are used at the switches to apprise the conductor as to whether he may proceed on the main line or take a siding.

The electric slot is a controlling device which automatically causes a mechanical semaphore to move to the danger position after a train has passed this signal. This arrangement prevents negligence on the part of the signal operator causing a rear end collision. Its function is thus similar to the rod slot which has been in use for many years on purely mechanical systems. Fig. 110 represents the application of a Union electric slot to a triple-lens mechanical signal. The semaphore, *S*, is secured to a pivoted casting carrying three lenses, *L*, night

indications being given by the lamp, *A*, the white light from which must pass through a lens when the signal is in a full or partial stop position.

This blade is operated by the rod, *C*, which passes into the slot box, *D*, and is connected mechanically (when a train is not in the block of the signal) with the rod, *C*. The latter

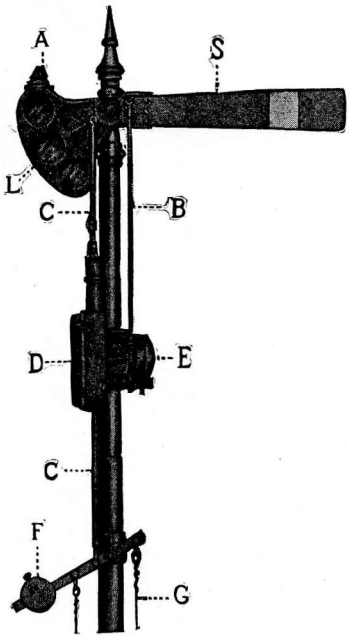

FIG. 110

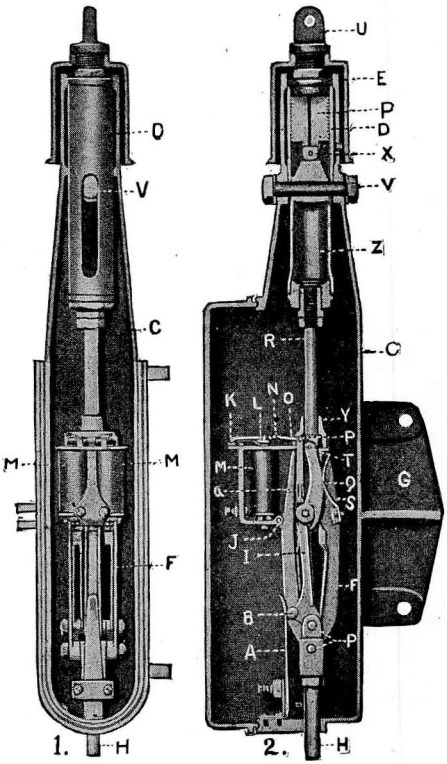

FIG. 111

is pivoted to a rocking lever counterweighted at *F*, which is connected to the signal lever by the steel wires, *G*. *E* is a circuit controller connected to the slot or control circuit of other signals, as will be shown later.

The slot structure and its weatherproof housing is shown in part section and part elevation in Fig. 111; 1 being a side and 2 a front view. When motion is imparted to the rod, *H*, by

the signalman, the frame, *F*, and the accessories attached to it move. The rods, *R* and *H*, are not connected unless the electromagnet, *M*, is energized, when the signalman has full control of the semaphore. On the other hand, if *M* be deënergized, the connection between *R* and *H* is broken and movements of the latter will in no wise affect the former, hence the blade cannot be moved.

To the frame, *F*, the electromagnet, *M*, spring *S*, pivots *P*, and guide sleeve, *Y*, are secured. The link, *I*, moves around the upper pivot as a center, while the spring piece, *A*, by pressing against the projection, *B*, holds *I* in the position given. The roller, *W*, which is attached to *I*, engages in a recess with the pawl, *Q*, the latter being pivoted in a recess on the rod, *R*, at *T*. When current is not passing through *M*, the centers of *T*, *W*, and *p* are not in the same straight line. Therefore, if a pressure be applied upward on *H* (which will occur when the signalman attempts to clear the signal), the roller will move to the left by the action of the link, *I*, on its pivot. Hence this roller disengages with the pawl (which cannot move further to the left) due to the weight of the unbalanced semaphore; and *H* moves up or down without engagement. The electromagnet has a movable armature, which is held at one end by the stationary pivot, *K*, and at the other end by a movable pivot, *N*. *O* is a short link secured rigidly to the lever, *a*, these being pivoted at *P*. The armature is normally held upward, and away from the pole tips by the spring, *L*. The pivots, *K*, *N*, and *P*, are normally out of line, hence, when an attempt is made to force *W* upward, *a* allows *Q* to be disengaged, thereby preventing motion of *R*.

If *M* be energized, due to the block protected by the signal being clear, the tension of *L* will be overcome and the armature will be in its extreme lower position. This forces the roller into the recess in *Q*, and if movement be imparted to *H*, *Q* will also move, and consequently *R*. If this motion were too rapid, due to too energetic motion of the signal lever, it is evident that the inertia of the parts would in all probability break some part of the mechanism. To prevent this occurrence, a damping cylinder or dashpot is interposed. It consists of a shell, *D*, having a carefully fitted plunger, *P*, the latter being stationary, and pivotally secured to the bolt, *V*. The shell is fastened to the coupling, *U*, connected to the semaphore rod, and has an

extension, Z, which is slotted and forms a guide with the bolt, V. An adjustable valve, X, through which the entrained air (on the downward motion) bleeds out with more or less rapidity, according to the retardation desired, is provided; and a shell, E, forms a protection from the weather. The case, C, is bolted to the signal mast by the lug, G.

When R is moved upward, the entire frame and its appurtenances, such as the magnet and pawl, also move. The spring, A, only presses upon B at the commencement of the motion, so that in case M were demagnetized by the presence of a train in the block or an opened switch, when the signal was at clear, its armature would rise, and the pawl be released, thus causing the signal to assume the danger position independent of the operator. The latter then replaces his lever upon receiving the indication by the action of the circuit controller. If the signalman attempted to throw the signal to the clear position, he could not succeed, since H has no connection with R. However, H, M, F, and the roller will move upward, but this does not affect the semaphore's position. The electric slot and its modification occupies an important position in composite manual and automatic signaling, and is employed extensively on signals governed from centralized towers.

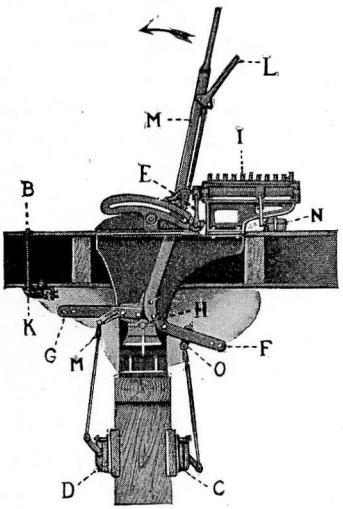

FIG. 112

The method of applying circuit controllers to the levers of the controlled manual and semi-automatic systems is shown in Fig. 112. The lever, M, pivoted at H, has two extensions, F and G, to which the wires or bars operating the signal are secured. In order to unlock this lever, the latch must be opened by moving the pivoted member, L, in the direction of the small arrow. N is an electric lock or slot, connected by a link to one of the rock shafts of the interlocking machine, I. This rock shaft is also linked to the unlocking segment of the lever by the rod, E.

C and *D* are circuit controllers operated respectively by the toes, *O* and *M*. *B–K* is a floor button which closes a circuit connected to the distant cabin, and serves as a means of communication and releasing between the operators. The functions and operation of this arrangement will be apparent from descriptions already given.

One application of a duplex rotary circuit-controller, *E*, is shown in Fig. 113, it being fastened to the signal pole and operated through the home semaphore by the rod or connecting link, *M*. *I* is a mechanically operated home and distant, the electric slots, *A* and *C*, securing the semi-automatic control, and being energized by battery *D* through the interposition of the

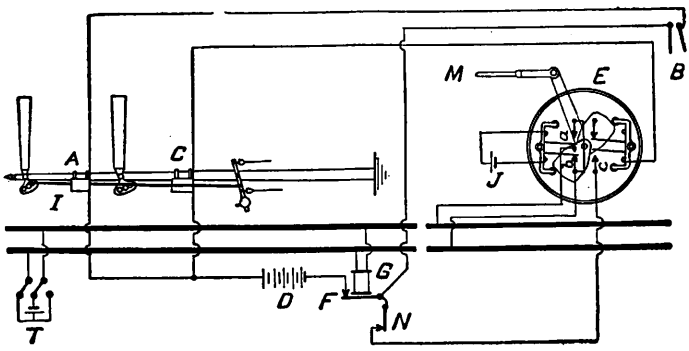

FIG. 113

polarized relay, *G*. *A* is controlled by the neutral armature, *F*, and *C* by both the polarized, *N*, and neutral armatures in series. The controller, *B*, is in series with the home slot, and by being open when the semaphore is not at clear, effects a saving in current consumption, besides giving an additional manual control if desirable.

When the home blade is at stop, contact *B* is open, hence *C* is deënergized, so that the distant cannot be cleared unless the former is clear; a similar condition existing when either *F* or *N* is open, which will occur if *T* is short-circuited or of the wrong polarity. Contacts *a* and *b* effect a polarity reversal of the track battery, *J*, by motion of *M*. This polarity change occurs at every motion of the home blade, thus controlling the preceding signal. The fourth contact of the controller is unconnected,

the construction allowing a nearly complete stroke of M before a change in connection takes place.

A circuit controller for operation by the foot is shown in section and elevation in Fig. 114. To the floor or other convenient support, B, the pivoted lever or foot piece, A, is secured. The opposite end of this foot piece carries a roller, H, which presses against a curved spring strip, G. Normally, G is in contact with F, or E is connected to D. When A is forced downward, E is connected to C, and D is open-circuited. This device is applied wherever it is desired to close one circuit simultaneously with the opening of a normally closed circuit.

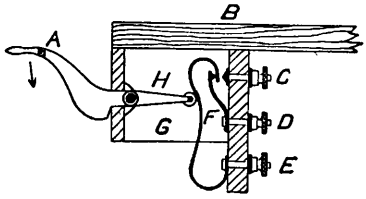

FIG. 114