# CHAPTER XIV.

## ALL-ELECTRIC INTERLOCKING.

NUMEROUS types of interlocking are in use, in which the operative agencies are either partly mechanical, or mechanical with electrical control. The General Railway Signal Co., however, manufacture apparatus in which both working and control functions are electrical, a mechanical interlocking frame being used as an auxiliary to the levers. An early form of this apparatus (known as the Taylor) will first be described.

In Fig. 173 the connections at a double route signal, 37, having two home blades, one of which protects the main track and the other a diverging track, 44, are shown. A derail, 28, is also in the block of 37, and is operated by a motor, 12. This diagram is completed by Fig. 174, which represents the connections at the interlocking cabin pertaining particularly to 37. The motor, 49, operates 44; 28 is thrown by 12, while both arms of 37 are cleared by 31. The line wires, 1, 2, 3, 4, 5, 6, 7, 8, and 9, pass to the interlocking machine, 45 and 38 running to the distant signal protecting the home block of 37.

The motor, 31–32, operates either of the home semaphores, according to which selector magnet, 29 or 30, is energized. A circuit controller, 33, is in circuit with the motor, 31, and the brake magnet, 26. The contacts, 46, are in series with the wire feeding, 31 and 26, and are provided so that a clear signal will not be given when the derail is open. Should the derail be in the opposite or safe position, these contacts will be closed. Such a precaution is necessary in high-speed train movements, as an open derail would cause a wreck.

The track is energized by the battery, 27, the relay being omitted. The rotation of 12, and consequently the throwing of 28, moves the pole changer, 18, the function of which will be shown later. At 44, the motor, 48–49, is also connected to a pole changer operated by the switch movement. Contacts 11 are controlled by 44, being closed when the latter is open, while the contacts, 10, are at the same time open. 10 is in series with 30, and 11 in series with 29, so that when one semaphore at signal 37 is cleared, the other cannot be, since but one route at a time can be set up.

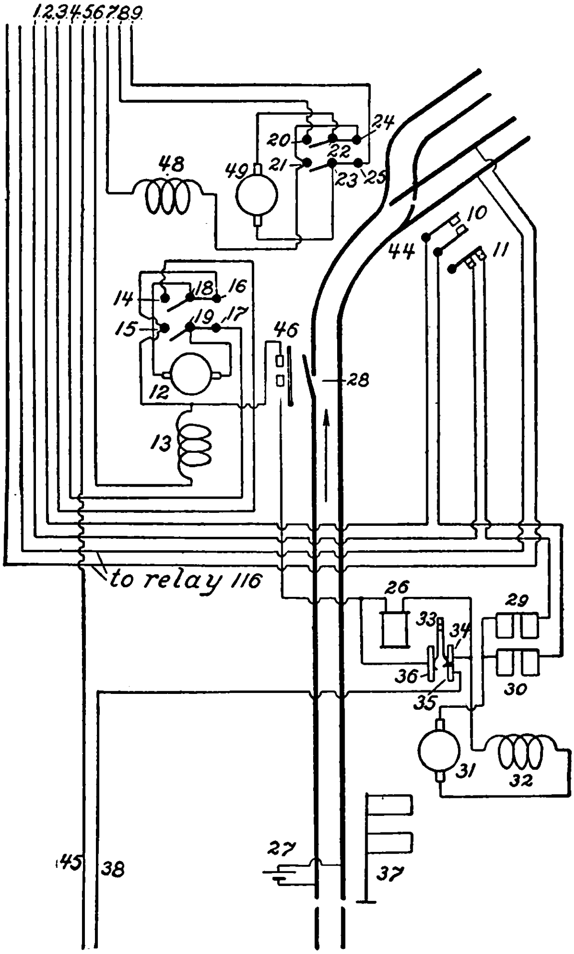


FIG. 173

In Fig. 174 the connections at the cabin are shown. *B* is a 60-volt storage battery; 115, 116, 117, and 118 are track relays, having contact armatures, 133 to 136, for carrying heavy currents; 119 to 122 are latch-releasing magnets, which when ener-

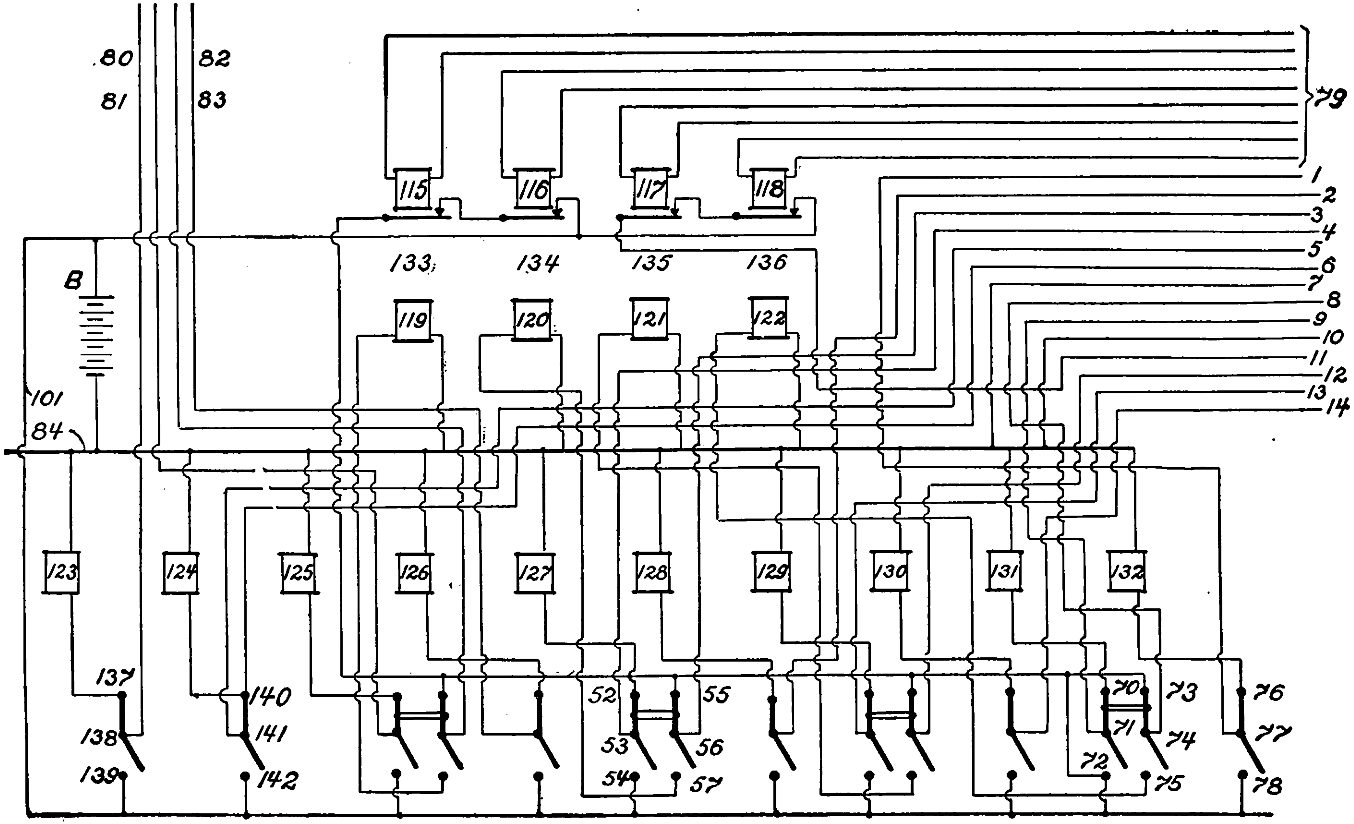
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FIG. 174

gized permit the levers (bars with handles, having a horizontal movement) to which they are connected to be moved; 123 to 132 are indication magnets, which give an indication of switch or signal movements; while the row of switches in the lower part of the figure are pole chàngers and connectors actuated by the levers themselves when the latter are thrown. The wires, 79, pass to the ends of the sections in which the track relays are introduced; the lines, 1 to 14 (only 1 to 9 are relevant to this description), run to the arrangement given in the preceding figure, and have the same significance; 80 and 83 pass to preceding switches, while 81 and 82 are signal wires. 84 is a common wire connecting one side of the battery, all the electromagnets, and several of the line wires. There are 10 lever (the levers themselves being omitted) circuits; they being distinguished by the fact that each has an indication magnet; signal levers opening one contact and closing another, while the switch levers open two circuits and close two during movement.

The armatures, 153 and 136, also 133 and 134, are in series, so that should either fall the circuit will be opened. Lines 7 and 10 are connected to 84; while 11 is a battery line in series with 135 and 136; 12 and 13 being switch lines and 14 a signal line. In tracing up a lever's circuit, it should be remembered that the order is changed after a rail switch or signal has been thrown, by reason of the electric switches thus opened or closed, and that single switches are for signal, and double switches for switch movement.

Consider, for instance, signal lever 123. (The levers are supposed to have the same numbers as the indication magnets.) When the lever is " thrown " 137 will be disconnected from 138, and 123 therefore deënergized. Immediately after, 138 will be connected to 139, and a current flow from *B* to line 80, and the signal (provided conditions are safe) at the latter.

Considering switch lever 131: When the switch is closed by the lever a current flows from *B* through 134 and 133–72 and 71–line wire 9– to Fig. 173–25 and 23–49–22–21–24–48–line 7–Fig. 174– common wire 84, and back to *B*. Since 48–49 begins its rotation, the switch is thrown and the current reverser 20–25 is operated, so that the next time 131 is thrown the motor armature will revolve in the opposite direction, and consequently moves the switch back to its former position. The current will then pass through line 8 instead of 7. The switch movement cannot occur unless 115 and 116 are both energized, which requires of course a clear track and the absence of conflicting routes. Relay 116 is connected to track battery 27 through the rails of the track between 37 and the next signal, while 115 is connected to the side route extending beyond switch 44. Hence when either 115 or 116 is deënergized, 44 cannot be thrown.

The reverse and normal currents to switch 44 are through the contacts, 133 and 134, as train movement over this switch may take place in either position, since it joins two routes. The reverse current is not required through the relay contacts in case of a derail, as a train does not move over such a switch when normal; and sometimes it is necessary to reverse it when the block is occupied, that is, when the track relay is deënergized.

Lever 127 is for switch 28, and levers 132 and 128 are for 30 and 29 respectively of the semaphores at signal 37. Tracing up the connections for 127, we have, considering that this lever has been pulled outward (and consequently contacts 52 and 53, 55 and 56 separated; with 53 connected to 54, and 56 to 57), *B*-101-54-53-line 4-Fig. 173-17-19-12-18-16-15-13-line 6-Fig. 174-140-124-84-*B*. By reason of the movement of the switch, by the rotation of 12, the polarity changer, 18-19, is reversed, so that 18 and 19 are disconnected from 16 and 17 and connected to 14 and 15. This closes the indication circuit and causes a current to flow from the switch motor, 12, through 18-14-line 3-56-57-120-84-line 6-Fig. 173-13-15-18. Thus 120 is energized, the lever latch is released and the latter can complete its stroke. This releases the lever of 30 (132) so that the lower semaphore of 37 can be cleared. When 132 is reversed, 77 is disconnected from 76 and connected to 78. A circuit is thus closed including *B*-101-78-77-line 1-Fig. 173-line 1-contacts 11, (which are under the control of 44)-29-31-32-34-33-36-46-13-line 6-Fig. 174-140-124-84-*B*.

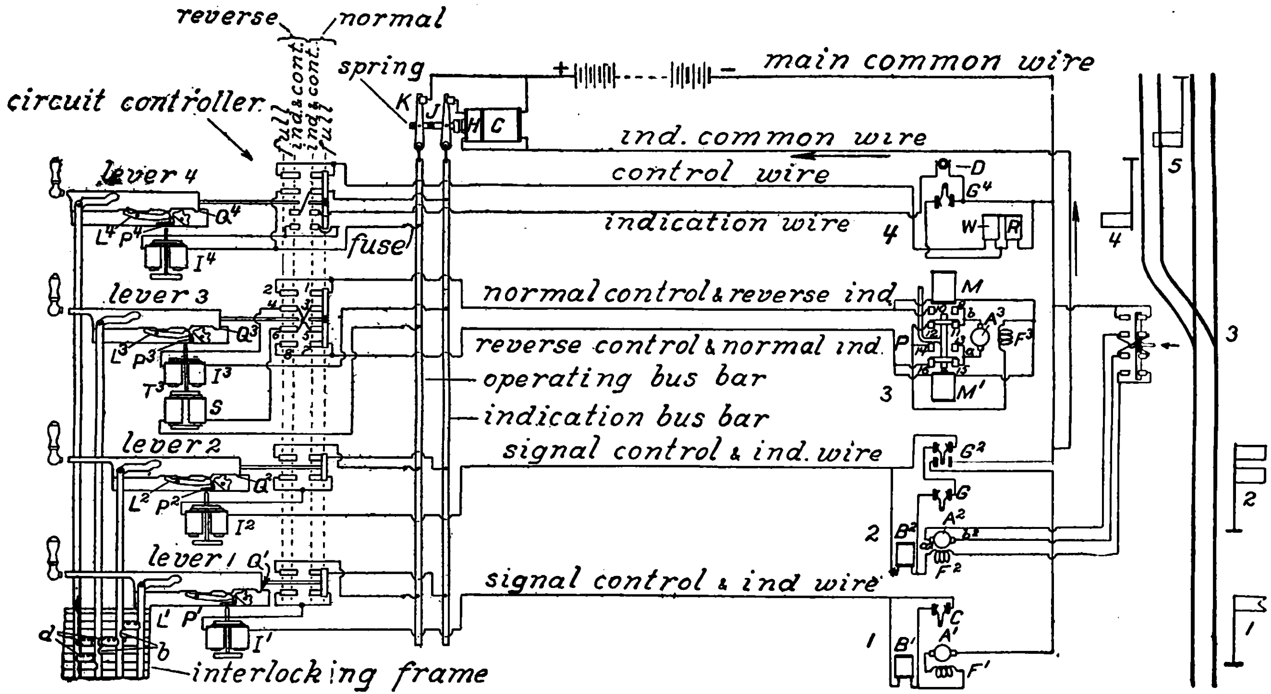
The clearing of the semaphore connected to 29 moves 33 in a downward direction and thus shunts the above circuit with the brake magnet, 26. As long as 132 is reversed, the upper semaphore of 37 will be at clear, while the connecting of 35 with 36 clears the distant signal preceding 37. Should 132 be returned to its normal position, 77 will be in contact with 76, as in the figure. When the signal is returning to danger, 33 again connects 34 and 36, thus closing the circuit through the motor 31–32, and the indication magnet, 132, of Fig. 174.

The effect of gravity is to give the armature, 31, a rapid rate of revolution, which sets up a counter current and dampens the fall of the blade. This current passes momentarily through the brake magnet, 26, which in addition to the retardation of the motor armature, prevents injury to the moving system from inertia. The energization of 132 also releases the lever latch and allows the lever to complete its movement, which could not occur did this release current not flow.

It will be noted that the indication furnishes to the operator the right to complete the lever stroke, since it occurs after the lever has started. This is similar in function to that of other schemes of power interlocking, the indication showing that the switch has completed its movement. This indication is used only on the switch levers, as will be noted in Fig. 174, there being but four such indication magnets.

A later development of the above circuit arrangements is shown in Fig. 175, in which the track circuits (which may be either polarized or neutral) are not considered. In defining the functions and their relativity, the previous figures will not be considered, although an extension of the principle to a more elaborate though concentrated and isolated case is the object in view. Two sets of interconnected (by eight lines or wires in underground conduits) circuits are shown: first, those at the interlocking cabin; and second, those at a distant signal, 1, a high home signal, 2 (protecting two separate routes), a switch movement, 3, and a dwarf signal, 4 (the single semaphore home signal, 5, being for movements in the opposite direction, and its circuits therefore not shown).

The tappet bars are given a vertical movement by the levers; cross locking being effected by the dogs, *d*, which are affixed to sliding horizontal bars, and the recesses, *b*, cut in the tappet bars. If a dog engages with a recess, and the former is immovable, it is evident that the lever to which this locked tappet bar belongs cannot be moved. In the figure, levers 1, 2, and 4 are immovable; that is, they are mechanically locked in position. Lever 3 is movable, however, since it is not engaged by any dog, and if it be pulled outward, its tappet bar will


reverse
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full & ind. & cont.
ind. & cont. full
spring
main common wire
circuit controller
ind. common wire
control wire
indication wire
fuse
lever 4
lever 3
lever 2
lever 1
normal control & reverse ind.
reverse control & normal ind.
operating bus bar
indication bus bar
signal control & ind. wire
signal control & ind wire
interlocking frame


Fig. 175

rise, thus unlocking levers 1, 2, and 4, since their dogs are now released by the action of the recesses. The levers operate the signals and switch of the same numbers, hence the latter are locked in the same fashion. It is thus evident that switch 3 must be thrown before the signals can be cleared, this sequence being manifestly required.

The cam slot in the lever transmits an intermittent motion to the corresponding tappet bar, which is for the purpose of preparing for a change in the circuits to which the lever is mechanically connected. The circuit controller consists of stationary and movable contact pieces, whose relation, though not their actual construction, is as shown.

The dwarf signal lever (4) and the switch lever (3) have each eight stationary contacts; the two remaining levers having but four, the reasons for which will appear later. The first half of the outward movement of levers 1, 2, and 3 produces no change in the connections, since the movable contacts engage the same brushes, and constitute the preliminary locking movement for the conflicting routes affecting this lever.

The central part of the lever stroke moves the contact pieces to the sets of brushes on the opposite side the tappet bar being stationary. The further motion of the lever is opposed by the latch, $L$ (or $L^1$, $L^2$, etc.), which can only be released by the energization of the indication magnet, $I$, which will allow of its travel being continued until the end of the stroke is reached. This final movement further raises the tappet bar, releasing the dogs and bars controlling conflicting routes, and preserving the connections obtaining at the beginning of the last half of the stroke. The switch movement will first be considered.

To the main common line the indicator common, all the signals, and the switch movement are connected, either directly or through a circuit-breaker contact. The switch movement is controlled by two other wires, through which the indication current passes, with the indicator common. The control wire in the normal position is, in the reverse position, the indicator wire, both being used at a time. These two wires are connected to opposite brushes of the circuit controller, so that reversal of polarity can be effected by straight motion of the controller rod from the lever. In the position shown (which is normal) the indicator wire is connected to the indication common through the indication magnet, $I^3$, and the indication bus-bar, while the control wire is connected to the positive side of the battery through the safety magnet, *S*, and the operating bus-bar. In the reverse position these connections are reversed, as above stated.

Additional control of the switch movement is effected by the polarity changing arrangement, *P*, which is operated by the switch-lock bolt after it has passed through the lock rod and adjacent plates. This pole changer has eight fixed contacts and two movable contact plates. Each of the motor armature terminals is connected to two of these fixed contacts, each control wire to one, and one of the field terminals to the remaining two, the other field terminal being joined to the main common. This connection arrangement, through the action of the other movable contacts, connects in the one case (that shown, or normal) *A* to the indicator wire and *b* to the field, $F^3$; and in the reverse position, *A* to the field and *b* to the reverse indicator wire. In the former position, also, the pole-changing switch is disconnected from the normal control; no current flowing, although this control is connected to the battery. Reversal of the switch lever, however, will connect the reverse control wire with the battery, a current flowing through the following circuit:

Battery–*K*–operating bus–safety magnet, *S*–circuit controller contacts, 6 and 8–reverse control wire–contacts 16 and 15–$A^3$–contacts 11 and 12–$F^3$–main common–battery. When the switch has completed its movement and is locked in position, the lock rod throws the pole changer, so that contact 9 is connected to 10, and 13 to 14. The reverse control wire is thus disconnected from the armature, *b*, and connected to the reverse indication wire, while *a* is connected to the field coils; the reasons for which will appear shortly.

The safety magnet, *S*, and the indication magnet, $I^3$, both have their poles facing, and capable of acting upon the armature, *T*; this armature normally resting upon the poles of the safety magnet, which is in series with the battery and both control wires; the one in circuit depending upon the positions of *P* and the switch lever circuit controller. Should a break occur in any of these wires or in the safety magnet, coils *S* will not be energized.

If a cross or short circuit occurs between the control wires, the total current, both that passing to the switch motor, and that through the indication magnet, will pass around $S$, so that should all the current pass through the indication magnet on return, it will not exceed the current in the former; hence the armature will be held by $S$, and the indication cannot be given. As the armature normally rests upon the poles of $S$, in which case the air-gap is zero, and the magnetic reluctance low, this probability is further increased. Thus it is practically impossible for a cross to set up a false indication.

A motor when operating sets up a counter electro-motive force which opposes that of the operating current. If the latter be suddenly cut off and the armature immediately connected to an independent circuit, a current will flow in the latter (its strength determined by the counter e.m.f. and total resistance in the circuit) in the opposite sense to that of the driving current; and will be maintained by the inertia of the armature and mechanically connected parts. This is precisely the effect which is utilized to give an indication through $I^3$, the proper connections being effected by the pole changer. The circuit thus formed for the indication current is: terminal $a$–$F^3$–main common–indicator common–magnetic cut-out, $H$–switch $J$–indication bus–$I^3$–circuit controller contacts 4 and 2–reverse indication line–pole changer contacts 10 and 9–armature terminal $b$. The current thus flows in the same direction as before through the field, hence its magnetic flux is unaltered, while the indication magnet releases the switch lever by reason of the following:

Normally, the latch, $L^3$, is held in the position shown by the dog, $P^3$, and prevents full outward movement of the lever by the engaging of projection $Q^3$ with the projection on the right-hand end of $L^3$. When $I^3$ is energized, however, $T^3$ is moved upward, and its rod strikes dog $P^3$ so that $L^3$ is released and allowed to drop, permitting the completion of the lever stroke. (It should be remembered that the travel of the lever has already been traced to its middle position.) Hence the indication current cannot be set up before the motor-operating current has been cut off, the indication wire connected to one side of the armature, and the connections between armature and field reversed. The cessation of operating current might be produced by a broken conductor, which is a highly improbable condition, while crosses are guarded against by $S$.

The magnets, $M$ and $M'$, are in series and connected to the indicator and control line-wires, their junction being also in connection with one terminal of $F^3$ and consequently the main common. By means of these magnets, the movement of $P$ is under the control of lever 3, at such times as it is not operated automatically by the lock rod. When the battery is connected to the normal control wire, current energizes $M$; but when the reverse control wire is in connection with the battery, $M'$ is energized. These currents shift the pole-changer mechanism in the direction of the magnet through which the current circulates, hence movement can be effected at any time during the switch- and lock-rod-movement, except at the very beginning and ending of the latter. If the lever is used to reverse the switch, current passes through the motor and through $M'$; this current so holds the pole changer that the operating current will be maintained. Should it be desirable to throw the switch normal before this reverse movement has been completed (which contingency might arise from snow, ice, or other obstruction between the main and point rails), the lever is merely pulled back to the normal position, thus energizing $M$ through the normal control wire and throwing the switch back. This is effected by $M$ shifting $P$ to its former position, sending current through the motor in the proper sense by way of the normal control wire; the pole changer being again shifted to the position shown, thus setting up the indication current. When $M$ shifts $P$, current does not pass through $I^3$, since the lever controller is not in the proper relation with the pole changer, and current is not set up if the magnet refuses to operate, on account of the reversed armature connections. A circuit-breaking device is in series with $M$ and $M'$, so that when the switch has fully moved and is locked in either position, the current is cut off from these magnets. This does not alter the rest of the diagram, however.

When the lever, 3, is moved to the normal position, the battery is connected to the normal control wire through $S$, thus sending a current through the switch motor, which starts at $a$ and returns to $b$, in the opposite sense to that used in reversing the switch, the field current maintaining its proper course. The armature thus revolves in the opposite direction, the switch rails being thereby thrown normal, and at the completion of this movement, $P$ is shifted to the position shown in the diagram, the indication current being thereby set up. Terminal $b$ is thus open-circuited, while $a$ is put in series with the normal indication wire, which at first was the reverse control line.

The switchbox contains a pole-changing device which controls the motor of the two-home-arm high signal, 2. When the motor revolves in one direction, one of the semaphores is cleared, and when in the other direction, the remaining blade. This switch thus acts selectively, the semaphore being connected by a chain to opposite sides of a sheave wheel driven by the motor through reduction gearing. Hence, when one semaphore is cleared, the other must be at danger, gravity producing this latter condition through the medium of counterweighted levers, which are mechanically connected to the blades.

Each semaphore operates a circuit breaker, the upper arm having two sets of contacts, and the lower one set. One of the former closes the circuit of the distant signal, 1, the lower arm not having a distant function. The lever, 2, which controls this home signal, operates a controller having one reverse and one normal pair of fixed contacts, but one movable piece being used. Only one line wire, the control and indication, passes to 2, and is in series with $I^2$ and the lower set of fixed contacts. One of the upper contacts is connected to the indicating bus, and the other to the operating bus. When lever 2 is reversed, the positive side of the battery will be connected to $I^2$ and the control line, a current flowing through the circuit including $I^2$–control line–$G^2$–$G$–$F^2$–switchbox–$a^2$–$A^2$–$b^2$–switchbox–main common–battery. If the switchbox is in its normal condition, the upper arm at 2 will be cleared. Upon the completion of the movement to clear, $G^2$ opens the home circuit and closes the distant circuit, the motor-brake magnet, $B^2$, being in shunt across this break, this magnet having a comparatively high resistance and bringing the motor armature to a stop, holding the signal at clear as long as lever 2 is in this reverse position.

As $I^2$ is energized, $L^2$ releases the lever, so that the full movement to the reverse position can be made. This energization does not constitute an indication, as such is not required, since locking is not released. The movement of the distant signal, 1, to the clear position is the only indication required of the proper clearing of this upper blade, this being accomplished by the interposed circuit-breaker. When lever 2 is pushed back to normal, the brake-magnet circuit is broken, and the indication magnet connected to indication common and the control line. Hence the brake mechanism is released, the blade returning to normal by the action of gravity on the counterweight. This sets the train of gears and motor armature into rotation, developing a counter e.m.f., the circuit-breaker, $G^2$, also closing the indication circuit in its upper position. This circuit includes $A^2$–$b^2$ switchbox–main common–indication common–$H$–$J$–indication bus–$1^2$–control line–$G^2$–$G$–$F^2$–switchbox– and $a^2$. The latch, $L^3$, is thus released, so that the final part of the stroke of the lever, 3, can be made. The energy expended in this releasing circuit retards the moving armature and prevents a blow being delivered by the moving parts.

If the switchbox switch is reversed when lever 2 has been reversed, the current will pass through the armature from $b^2$ to $a^2$, in the opposite direction to that above shown. This, therefore, causes the armature to revolve in the opposite direction, thus clearing the lower arm, the indication current being developed in the same manner as above described, the brake magnet, $B^2$, being put in circuit by the action of $G$, with which it will be in shunt. The indication current is also in the opposite direction in the armature and switchbox.

The dwarf signal, 4, is not thrown to clear through the aid of a motor, but directly by the movable magnetic circuit of a heavy solenoid. This solenoid has two distinct windings, represented in the diagram by $R$ and $W$. $R$ is the retaining coil, and is of high resistance, holding the small semaphore at clear, while $W$ is the working or clearing coil, and of comparatively low resistance. The indication current is taken directly from the working battery by way of the signal's lever, 4, instead of utilizing the counter e.m.f. of a motor, it serving equally well. The circuit controller has eight stationary and two movable contacts as before; four of these fixed contacts being shorter, however, so that the movable pieces will not dwell upon the former more than a predetermined time.

A normally fixed connection exists between the indication magnet and the positive side of the battery, the indication line being connected to but one of the short fixed contacts. The indication line is connected to a circuit-breaker, $D$, at the dwarf signal, another circuit-breaker, $G^4$, being in series with the working coil. The latter is closed only when the signal lever is reversed, while $D$ is closed only when the signal is normal. When the lever is at the normal indication position, the control line is connected to the indication bus, and the other end of the indication magnet to the indication wire. At the reverse indication position (when the movable contacts are in the dotted line denoting the reverse indication and control points) the positive side of the battery is in connection with the control wire, the indication magnet being in series with the indicator and main common lines, and the negative side of the battery.

At the full normal and reverse point, the indication magnet is open-circuited, and the control wire is connected in a manner similar to the indication and control positions. When lever 4 is reversed, current flows through the control wire to $W$, to the main common battery, and circuit-breaker, $G^4$, thus clearing the semaphore; $G^4$ then opening, cutting in $R$ (and $W$, which is in series with it, although now having but little magnetizing effect) which retains the blade in the clear position. The clearing current is about 6 amperes, and the retaining current .25 ampere.

The indication current, which is sent through the indication magnet when the lever has reached the normal indication position, is not set up for any other purpose than to release the lever and allow the full reverse movement to be made, as in the case of the high signal, the reason for this being that an interlocking function is not to be released. When the lever is moved back to normal, $R$ is open-circuited, and the blade moves to danger, thus closing the circuit-breaker, $D$, and connecting the main common line to the indication line. A latch releasing current then flows through $I^4$, because the latter has been connected to the indication line by the movement of the lever to normal.

The indication common is not connected to the main common at the cabin; but is run out to a point where the effects of voltage drop in the main common, due to the heavy current taken by the motors, etc., will be at a minimum. Should this line be near the battery, the drop in potential would have a tendency to cause a current flow back over the indication lines of the levers not being operated, and might open the safety cut-out (to be described) when not required, resulting in considerable annoyance.

This cut-out is provided to eliminate the evil effects resulting from crosses between any of the various wires. *J* and *K* are two switches connected respectively to the indication and operating buses, being normally held open by a spring, and closed by current in the coil, *C*. When *K* is open, it cuts the battery off from all functions, while *J* opens all of the indication circuits. Coil *C*, which is of high resistance, is connected across the battery through the main and indication common lines. *H* is a low-resistance coil, wound differentially with respect to *C*, so that the greater the current in *H* in a given direction, the greater the opposition to the flux of *C*, and consequently the less the pull on the armature. *H* is in series with the indication common, so that all indication currents must pass through it, these currents moving in the direction of the arrows, and assisting *C* to maintain the contacts at *K* and *J* closed. Any current flowing from the positive side of the battery through *H*, due to a cross, will pass in the opposite direction to the arrows, and consequently tend to neutralize the flux set up by *C*, and open the cut-out, as the indication common, to which *H* is permanently connected, is on the negative side of the battery. All wires connected to the interlocking machine which are functionally operative are connected to the negative battery terminal through the indication bus, *J*, *H*, indication, and main common; hence, current passing from any line-wire to these will set up a current which produces a flux in opposition to *C* and thus opens *K* and *J*. *H* has a low resistance, hence the greatest percentage of the current resulting from a cross will flow through it, and if this current be of sufficient strength to cause rotation of a motor armature, it will certainly open the cut-out.

In Fig 176 a portion of a standard all-electric interlocking machine is shown. A rear view, showing the fuse and terminal board, is at 1; 2 is a typical section, and 3 a partial front view of the locking. Besides a supporting frame, there is a terminal board, *A*, the controllers, *C*, levers *D*, lever guides *E*, locking *G*, case *H*, and indication and safety magnets, *I* and *S*. The case is provided with glass doors, for ready inspection and repairs, and the fuse board contains all fuses, buses, terminal posts and connections. The upper bus is the switch operating, the lower the signal operating, and the central is the common indication bus. *B* is an indication selector, which is used only on switch

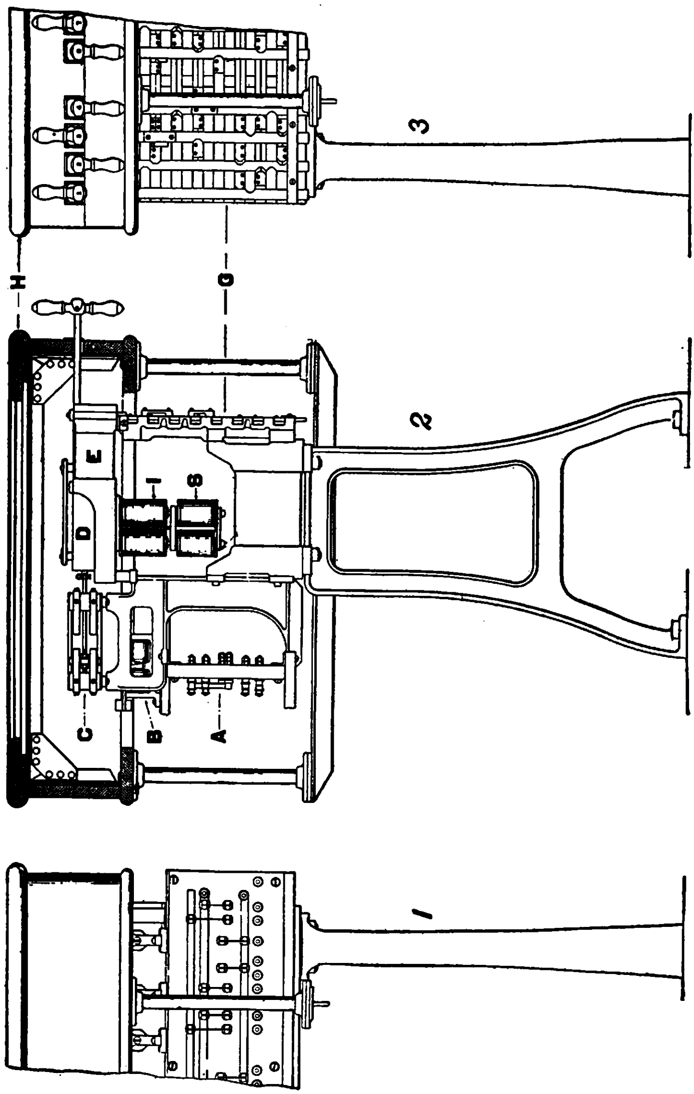


Fig. 176

levers, consisting of electromagnets operated by the working current, moving an armature in one direction when the switch lever is normal, and in the other direction when at reverse. It closes the indication circuit corresponding to the lever position, leaving the other open.

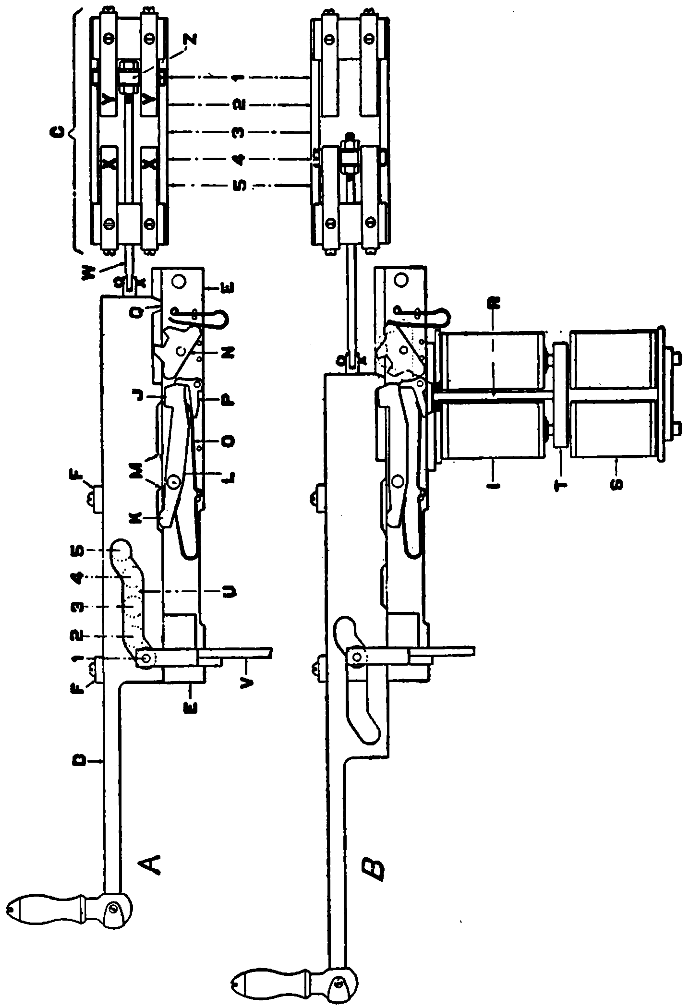


Fig. 177

In Fig. 177 the appurtenances directly common to the levers and their relation are shown. *A* shows a lever entirely in, and *B* the same four-fifths out. *D* is held in the guides, *E*, by the bars, *F*, and is provided with a slot, *U*, which imparts variable motion to the tappet bar, $V$, the respective positions being numbered 1 to 5. The moving contact block, $Z$, receives motion from $D$ by the rod, $W$. $I$ and $S$ are the indication and safety magnets respectively, and impart motion to rod $R$ through the armature, $T$. $X$ and $Y$ are stationary contacts connected to the various functions, as shown in the diagram, Fig. 175. $R$ engages with $P$, which is held down by the spring, $O$, the latter also acting against the pivoted latch, $L$.

The raising of the tappet bar, by the movement from 1 to 2, locks all the conflicting levers, the projection, $M$, then striking $K$, and tilting the latch, $L$, to a nearly horizontal position, causing $J$ to be struck by $Q$, thus retaining the lever. When moving from 2 to 3, $Q$ also meshes with the teeth on $N$, thus causing the latter to rock about its axis, and by throwing dog $P$ into engagement with $L$, locking the latter, as at $B$. From 3 to 4, $N$ continues its revolution, being stopped by $Q$ striking $J$. Here an indication current passes through $I$, releasing $L$ by reason of $R$ striking $P$, allowing the motion from 4 to 5 to take place, thus unlocking the unconflicting levers by the upward motion of $V$. Hence, $D$ will be immovable when conflicting routes are set up, and cannot move from 4 to 5 without an indication; while if it is moved to or beyond 3 it cannot pass 4 nor return to 1 without an indication, which will not occur unless the function controlled is locked in the position corresponding to that of the lever.

The switch and lock movement for a left-hand slip switch is shown in Fig. 178, and consists of the motor, $A$, and connecting shaft $B$, pole-changer $C$, gear frame $F$, driving rod $G$, lock movement $H$, and cover $L$. The motor is of enclosed and weatherproof construction, and operates the entire arrangement. The gear mechanism, $F$, reduces the speed of the motor armature for the required slow movement of the detector bar and switch, and disengages the motor after the full switch movement has taken place. This latter is effected by the cam, $D$, which is on the same shaft as the main gear, by the clutch shifter, $V$ (which allows the shaft to revolve without affecting the pinion), and by toothed clutches, not detailed. Unless the pinion engages with one of the clutches, it is loose on the shaft, so that when the stroke is completed the clutch is moved transversely by a shifting-cam on the main gear, after which the indication is given. The main gear-pin, *E*, moves the lock plunger, detector bar, and switch, through the rod, *G*, and crank cam, *D*. The lock movement, *H*, directly operates the pole

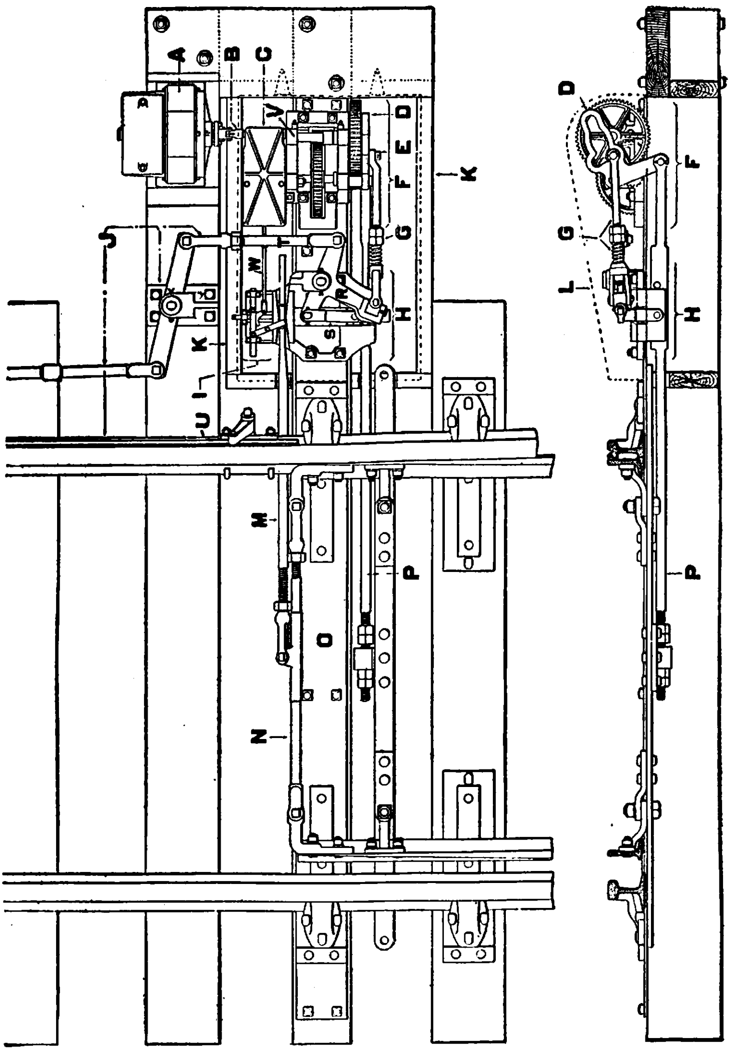

FIG. 178

changer, detector bar, *U*, and lock plunger. *G* throws *R*, and consequently *S* and *T*, so that the switch cannot be thrown if a train be passing it. *C* is moved through the medium of the pole-changer movement, *I*, after the lock rod, *M*, is held by the lock plunger. The pole changer moves in one direction when the switch is moved normal and in the opposite direction at reverse, with results already shown diagrammatically.

The operation of the switch movement is as follows: When the switch lever has been thrown, and the motor connected to the battery, the armature drives the main gear through

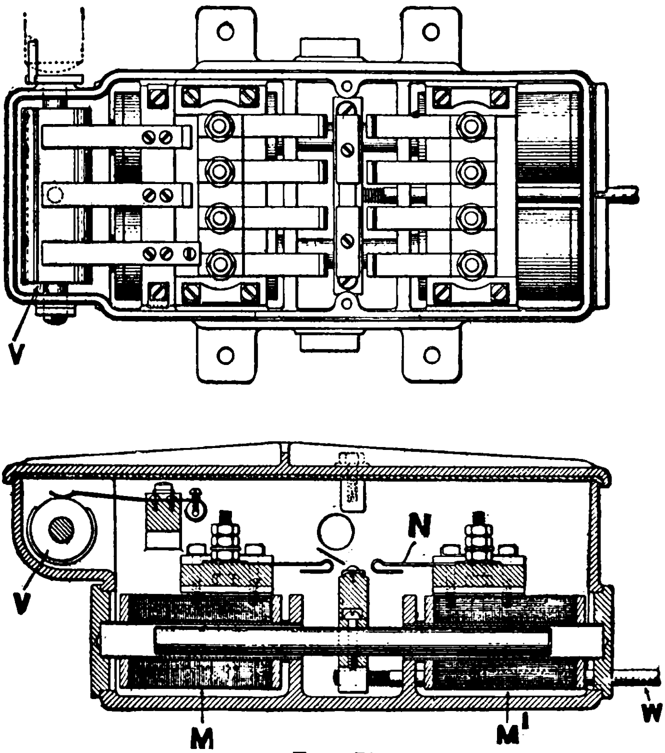


FIG. 179

one revolution. At the first part of its revolution the lock bolt is released, and the detector bar raised. The pin, *E*, then strikes the outer end of the pivoted cam, *D*, thus throwing the switch, this taking approximately one-third of a revolution. The remaining third of the revolution results in the lowering of the detector bar, and setting of the lock bolt, the pole changer being thrown as soon as the plunger passes through the lock rod, the motor disengaged, and the indication given.

The reversible pole-changer mechanism, shown in outline and connection at the switch machine and designated by *P* in the diagram, is illustrated in plan and elevation in Fig. 179. Rod *W* is connected mechanically to the lock bolt, and operates the movable contacts, which engage the fixed contact-fingers *N*. *V* is a control drum, acting as a circuit-breaker, which is operated by the shaft (shown dotted) carrying the main gear and cam so that the magnets, *M*, are open-circuited when the switch is home and locked. The movable cores, to which the moving contact blocks are secured, are under the control of the magnets when the switch is to be thrown. These magnets are shown at *M* and *M′* in the circuit diagram also.

A Taylor switchbox (or ground selector) is shown in Fig. 180. The movement of the switch rails throws the link, *C*,

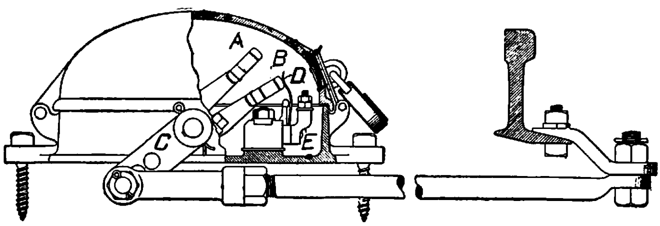


FIG. 180

thereby bringing the movable contact members, *B*, into connection with the row of stationary clips, *D*, closing the desired circuits. When the switch is thrown in the other direction the contact strips, *A*, engage with a similar row of contacts on the opposite side of the box. This device is used for any application of functions depending upon switch or other movement for their control.

Fig. 181 shows a Taylor hook selector, suitable for fastening to a signal pole and controlling a semaphore. *B* is the counterweighted lever, which normally has no connection with lever *D*. The latter is keyed to the shaft, *F*, while *B* moves about *F* as a center merely. When the electromagnet is energized, the armature, *E*, is raised, causing hook *C* to be thrown directly in the path of a cross piece, fastened to *B*, so that movement of the latter cannot occur without *D* being moved. Hence, when *B* is pulled in the direction of the arrow by the motor, the signal will be cleared, if *A* is energized. When the interlocking lever for the signal is thrown, current passes through the proper selector magnet, through the motor and circuit

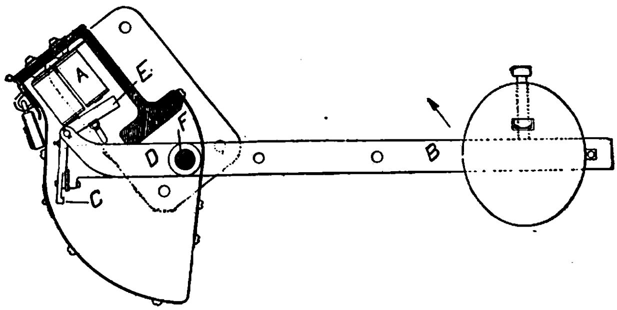


Fig. 181

breakers. This clears the signal, the indication being given in the usual manner. From two to five arms may thus be operated, and if ground selectors are used, but one interlocking lever is required.