CHAPTER III.

NORMAL DANGER CIRCUITS.

IN the normal danger system, the indication members are always in the danger position, except when a train is approaching them. In the last chapter, a number of such simple circuits were taken up, hence preliminary details will be unnecessary.

Figs. 32 to 35 show consecutive normal danger line-wire signal circuits as applied to a single-track line with a passing side

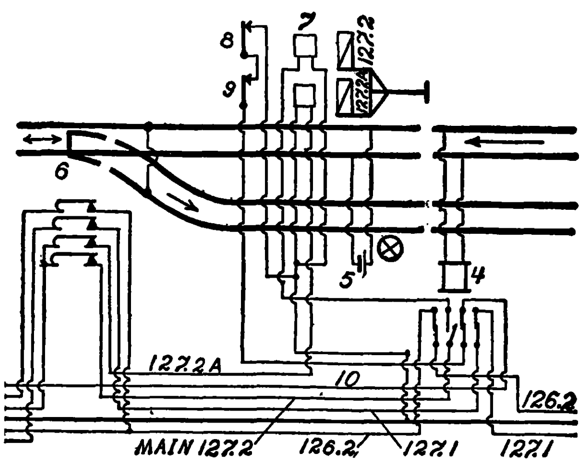


FIG. 32

track, and trains running in both directions. The signals are numbered according to miles and tenths of a mile, indicators being included at a siding. In Fig. 32, 6 is the switch leading into the main siding, while 4 is a track relay having four sets of armature contacts.

Should a train be approaching 127.2 (on the main track), the four-ohm track-relay, 4, will be short-circuited, thus causing all of its contacts to open except the second, which is a back

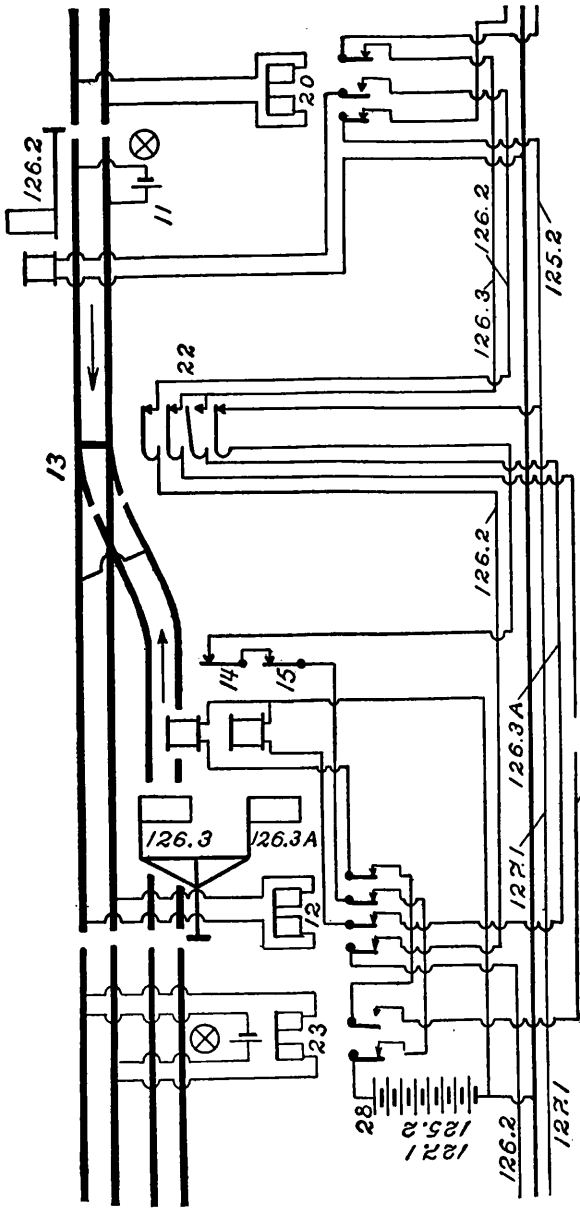


FIG. 33

contact. The closing of this latter causes a current to flow through the clearing arrangement, 7, main 127.2 line, lower contact at 6, and main battery at the preceding section, thus clearing 127.2. The controllers, 8 and 9, which are operated by the semaphores at this signal, are in series, so that when either operates, line 10 is open-circuited. The track battery, 5, is connected to both the main and siding sections by the cross bond and insulating joint at 6; so that should a train be upon either track, it will be short-circuited.

In Fig. 33, 12 is a track-relay receiving current from 11, the latter also energizing the section constituting the end of the side track. The switch, 13, leading into this siding, operates

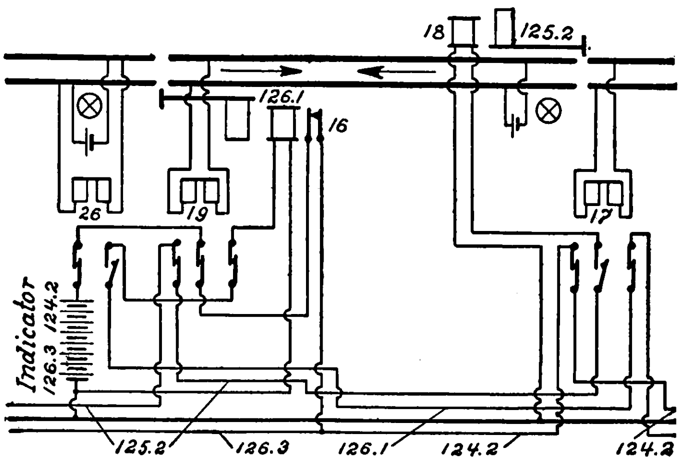


FIG. 34

four independent contacts, which are in series with the various line wires. The main battery and clearing magnets at signals 126.2 and 126.3 are connected to the common line wire, while 14 and 15 perform functions similar to 8 and 9.

Supposing that a train approaches signal 125.2, in Fig. 34, 17 will be short-circuited, thus closing the middle armature contact and clearing the signal through 18, by way of the common wire, line 125.2, first contact of 19, first contact of 20, lower contact at 22, 14, 15, third contact of 12, first contact of 23, battery 28, and returning to common.

In Fig. 35, 24 is an indicator wound to 800 ohms resistance which is connected to the indicator line-wire through the fourth armature of track relay 25 (of 4 ohms resistance), to the first armature of 17, to 16, middle armature of 19, first armature of

26, battery, and common line. The remainder of the connections are similar to those just considered.

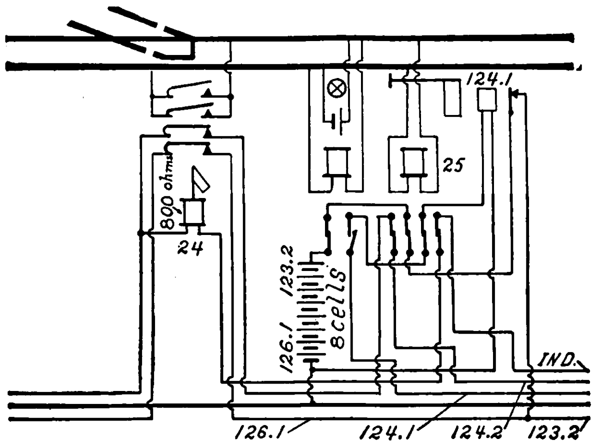


FIG. 35

In Figs. 36 and 37 the connections of a home and distant system for single-track with train movements in one direction

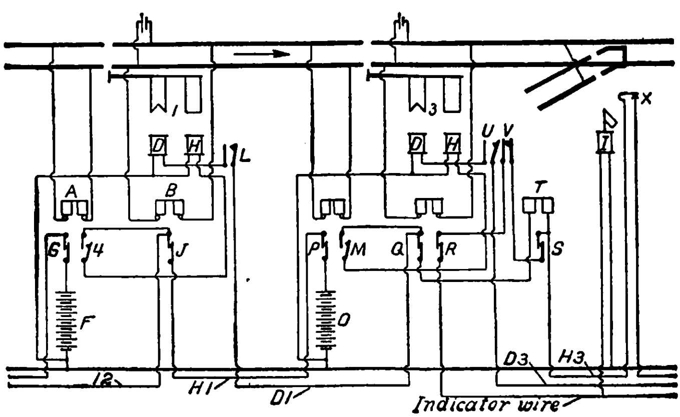


FIG. 36

are shown. At signal 1, *D* controls the distant semaphore, and *H* the home semaphore, both being mounted on a common mast. *A* and *B* are track relays, *A* having two armature contacts, and

B one. *F* is in series with the common line and armature *G*. 4 and *J* have a common connection to line 12, and are respectively connected to *H* and line H^1, while *L* is operated by *H* and controls the distant blade. With a train approaching 3, *B* and *K* will be deënergized; hence *J* will be opened, and *M* closed, *O* being disconnected from H^1 at both *J* and *P*.

When the block of 3 is clear, *Q* and *R* will be closed. *T* is in series with *H* and *M* at 3, and *D* at 1, through line D^1. *R*, *S*, and *V* are in series with the indicators, *I* and *W* (Fig. 37), through the indicator line-wire. H^3 transmits current from *Z* by way of the switch instruments, *Y* and *X*, and contact 8.

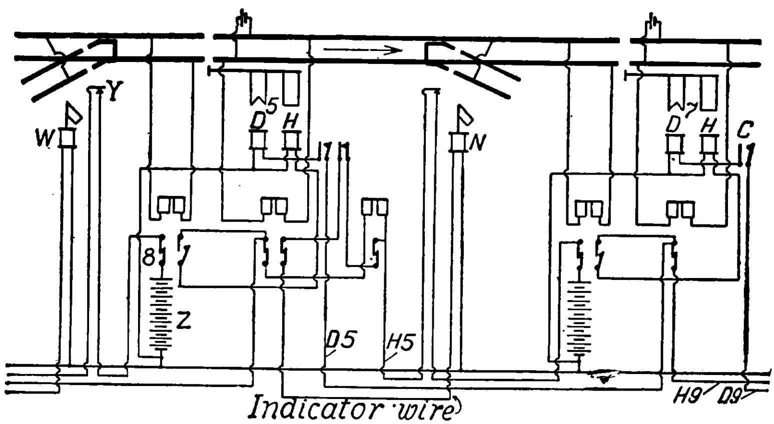


Fig. 37

At signals 5 and 7, a similar arrangement of circuits is evident, one side of the main batteries being connected as usual to the common line. At 7, a single normally open circuit-breaker, *C*, is provided, for the control of the distant head only.

Figs. 38 to 41 contemplate consecutive normal danger overlap signals such as are in use on the C. N. O. & T. single-track, with trains running in both directions; protection being afforded against both rear-end and head-on collisions. In Fig. 38, four signals, 1, 4, 15, and 17, with their connections, are shown. Four track sections, with batteries 3, 2, 18, and 16, and two relays, 7 and 6, constitute the control functions in this figure. 7 has three armatures, 13, 14, and 12, the first being connected to the main battery 5, the second to signal 4 through a line wire, and the last to a battery line. Armatures 8, 9, and 10, of track relay 6, are connected respectively in series with main battery 11 and the common line, armature 12 and signal 15, also 14 and a battery line. Thus one side of each main

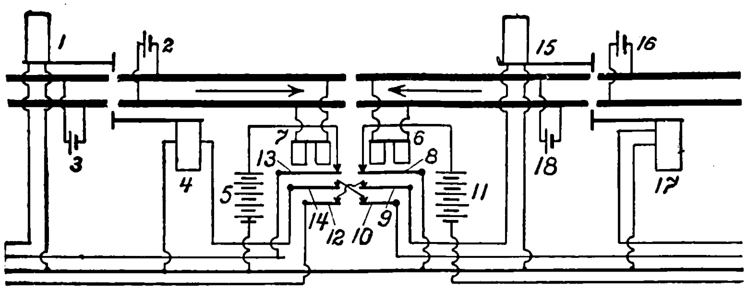


FIG. 38

battery and signal is connected to the common line, this applying to all four illustrations.

Continuing the track sections and line wires at a cut section in Fig. 39, two track relays, 36 and 37, have armatures (contacts) 38, 39, 40, and 41, 42, 43, respectively; while 44 and 45 are connected as in the preceding, 39, 43, and 40, 42, being interconnected in series.

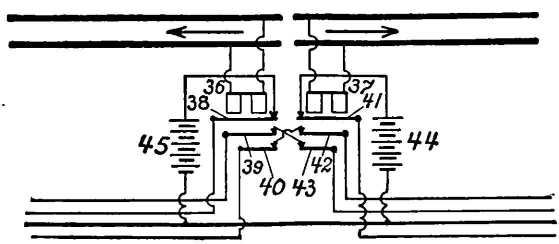


FIG. 39

In Fig. 40 a siding, 20, with switches, 21 and 22, is added, signals 19 and 23 being placed at this siding. Track relays 24 and 25, each having two armatures, 27, 26, and 28, 29, are added at the setting sections, their connections being similar to those already given. Switch instruments are not shown at 21 and 22, as they short-circuit the track in a manner similar to a train at these points, when open.

The track battery, 30, in Fig. 41, is in series with the armature, 32, thus introducing track circuit control. Signal 34 receives current from battery 44 through contacts, 41 and 29, while 35 is operated by current coming similarly over its line wire. The

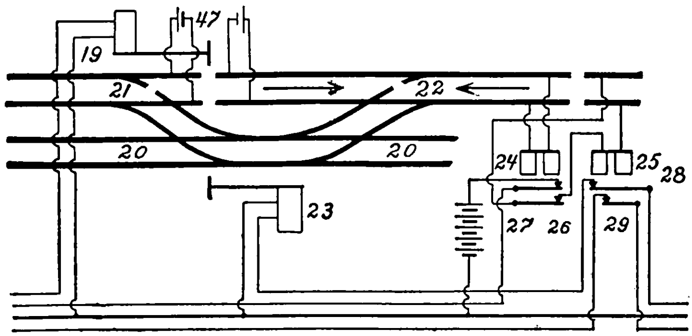


FIG. 40

main battery, 33, is in series with armature contacts 31 and an armature in the preceding block.

Suppose a train to be moving toward the west at 46 and that switch 21 is open. 47 will be short-circuited, and consequently

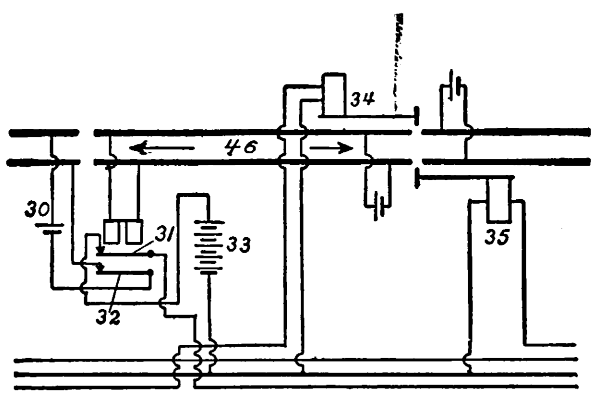


FIG. 41

37 deënergized, which causes 42 to fall, and holds 19 at danger, notwithstanding the fact that two sections intervene. As 25 is also demagnetized, 23 is held at danger by reason of the position of 28, while 29 open-circuits 44, and thus deprives 34 of current.

Another line-wire arrangement for home and distant on the same masts for one of the tracks of a double-track line is shown in Figs. 42 and 43. At the former, 1 is the distant line, 2 the home, 3 the common, and 4 the indication. Track relays 6 and 12 have a resistance of 4 ohms, 7 of 12 ohms, and 8 and 13 of 16 ohms; each of these having two sets of contacts. At section 9, for example, there are a set of binding posts, 25, which are

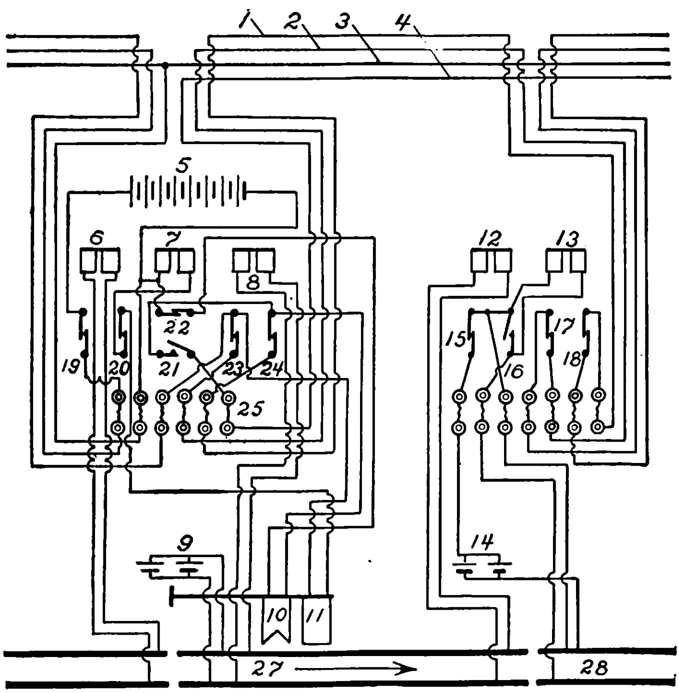


FIG. 42

mounted on the lightning arresters and connect to fuses. 16 and 21 are back contacts, while 15, 17, 18, 19, 20, 22, 23, and 24, are front contacts. 9 and 14 are track batteries, the latter in series with 15, and therefore in open circuit when a train occupies section 27. The short-circuiting of 12 also short-circuits 13 through back contact 16, the latter being in shunt with 13. When the train reaches section 28, however, 12 is energized and 16 opened, *B* receives current from 14 through the axles of the train, which thus act as a single-pole switch. 5 is a main battery, 10 the distant semaphore, and 11 the home.

In Fig. 43 much the same circuit disposition exists, an indicator, 28, and two single contact switch instruments, 29 and 30, being introduced at the main-line crossover switches, 31. Both of these latter are also in series with the home line, 2, and the semaphore apparatus at 33, which is the usual practice for main-line switches, so that when either is open the home blade at 33 will be held at danger. One side of all main batteries and switch indicators is connected to the common line. The diagrammatic arrangement of binding posts is as it actually occurs in the relay boxes.

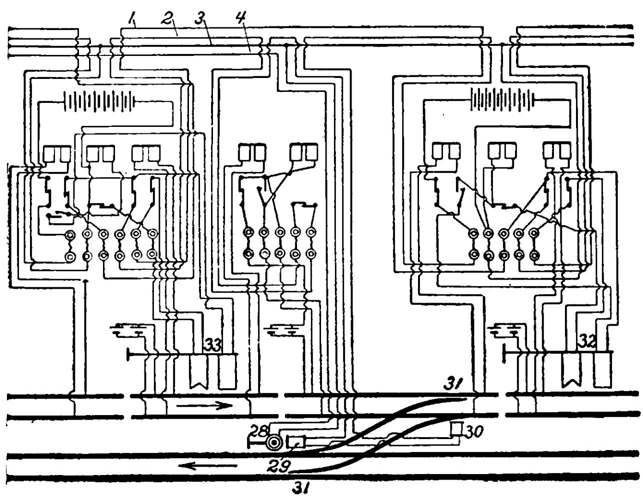


FIG. 43

A circuit arrangement for double-track application is given in Fig. 44. Two signals, 7 and 6, the latter a distant, protect a home block consisting of several sections, three of which are represented; the second containing a switch, 11. There are four main batteries, 1, 2, 3, and 4, which are, respectively, for operating the home-signal motor, control relays, switch bells, and distant signal motor. A vibrating bell, 10, is placed at the switch, which rings and consequently gives warning not to throw the switch when a train is in the second section from the latter. If the switch is thrown, however, the home signal moves to the stop position. This will be announced when the section is clear by the continued ringing of the bell, which indicates, as will presently appear, that the signal has been set.

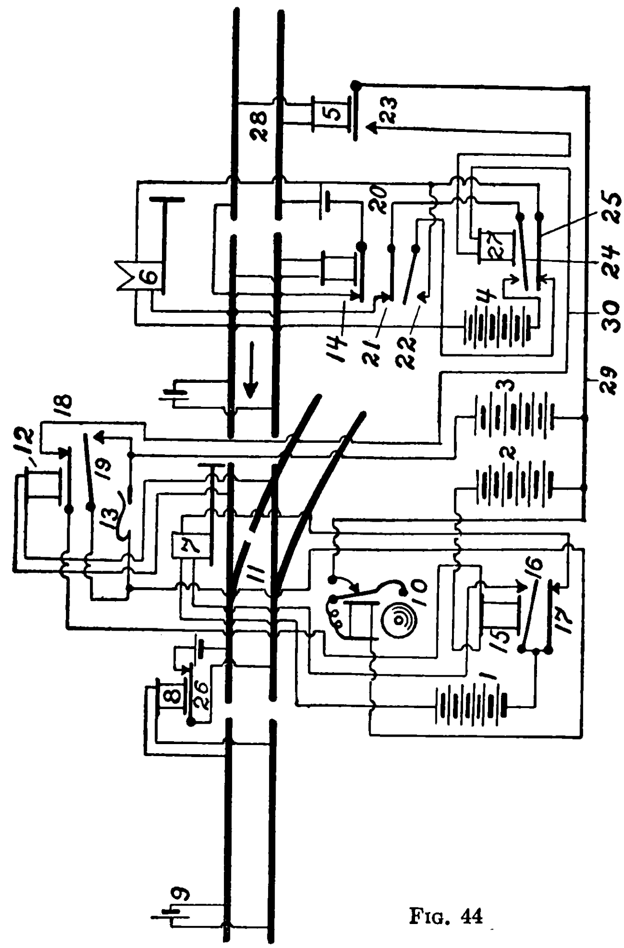


FIG. 44

When 7 is cleared, the contacts, 13, will be closed, thus ringing 10. 13 is in shunt with the armature, 19, of track relay, 12, while the armature contacts, 18, of this relay are in series with relays 15 and 27, battery 2, and armature 23 of the track section, 28, relay 5. Two line wires are used, and track circuit-control is also effected by relays 8 and 14, whose armature contacts, 26 and 20, are in series with the track batteries.

Suppose a train enter section 28. Armature 23 will fall, thus sending a current from 2 through 15 and 27, through whose front contact armature, 24, a current passes from 4 to the distant-signal motor, and from 1 to the home-signal motor, by way of 16. The latter action causes the home-circuit controller, 13, to be operated, closing the circuit of battery 3 and the bell as above shown. (If more than one switch occurs in a section, the individual bells are connected in multiple.)

As the train enters the first section of 6, 14 is deënergized, and 4 is disconnected from 6, due to the action of the front contact, 21, even though 24 be closed. At the same time 22 is closed and 20 disconnects the track battery from 5, thus maintaining 23 in its lower position. If the block of 7 is occupied or dangerous, 5 does not control 27 and 15, since 12 open-circuits battery 2, the signals both remaining in the stop or normal position, and thereby hold the train.

As the train moves into the first section of 7, the latter is deprived of current by the deënergizing of relay 12 (should the block be unoccupied), due to the circuit of battery 1 being opened at 18. The bell, 10, continues to ring, however, until the train moves out of this section, due to its circuit being completed through 19, which is in shunt with 13, and performs the same function. When a train has indirectly deprived 27 of current its lower or back-contact armature, 25, closes an auxiliary circuit through the motor of 6, which short-circuits the latter, and, by causing the counter e.m.f. of the armature to set up a heavy current, effectually retards the semaphore, preventing the inertia of the moving parts from destroying any part of the system. In shunt with 25 is the armature, 22, of relay 14, so that, when a train occupies the first section of 6 and a second train is approaching, the retarding circuit will be closed in any case, which would not be the condition if 27 were energized by the closure of 23.

The motor-control relays are similarly connected for both signals, this connection, somewhat modified, being shown in Fig. 118, Chapter IX. Relay *A* is 27 in the last figure, the two armatures, *B* and *C*, being connected to battery *D* and a stationary contact, *F*. *J* is an electromagnet which retards the motion of the armature by having a soft iron disk rotate between its poles, this disk being fastened to the armature. *E* is a contact piece moved by the semaphore's movement, and connects in an evident manner *I*, *H*, *G*, and *F*, at various parts of its stroke. In the position shown, *B* is connected to the motor, but not to the other side of the battery. If *A* is energized, *C* will connect *D* to the motor, this setting the latter's armature in motion. When *E* has passed over *F*, *D* is still connected to the motor through *G* and *H*. When *E* reaches the end of its stroke, *I* is connected with *G*, and a current passes from *D* through *J*, rapidly bringing the armature to rest, due to the eddy currents

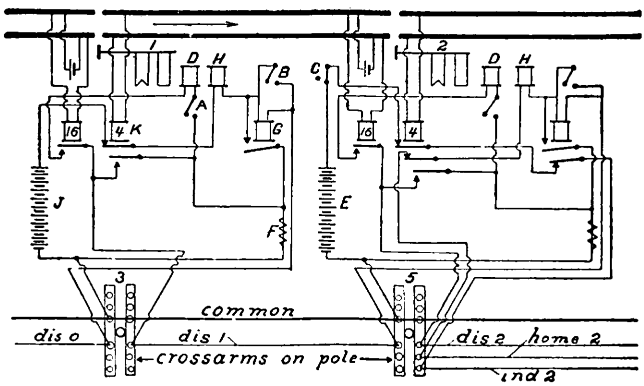


FIG. 45

set up in the disk and also to its friction on the magnet poles.

Fig. 45 is a delineation of a home and distant circuit for single track, with train movement in one direction. *A*, *B*, and *C* are operated when the home semaphore is cleared; *A* being in series with the local distant, *B* in circuit with the preceding distant, and *C* controlling the switch indicator; the latter being at danger when the home is at clear; *E* being the indicator battery. *B* is also in shunt with magnet *G*, whose armature, with the 150-ohm resistance, *F*, is connected to the common line, and the home-actuating mechanism, *H*. *G* is energized with the distant, at signal *O*, through its track-controlled relay armature. Hence, *H* is energized either from the preceding distant, or the local battery, *J*; in any case however through the front contact of the four-ohm track-relay, *K*, the back contact governing the home at signal 2.

Fig. 46 continues the above, with a siding added. *P* and *M* are switch instruments, whose functions are to short-circuit both tracks, with an open switch; and to control the home semaphore at signal 2. *N* and *O* are indicators, in parallel, which are connected to both common and indicator lines. The main battery, *I*, operates the home semaphores at 2 and 3.

Figs. 47 and 48 (etc.) show normal danger circuits in conjunction with all-electric interlocking, as more specifically set forth in Chapter XIV. These occur at Union Street, Allentown, Pa., on the Lehigh Valley Railroad, at its intersection with the Allentown Terminal Railroad; and in addition to this, several sidings and branch lines. The working-circuit network emanates

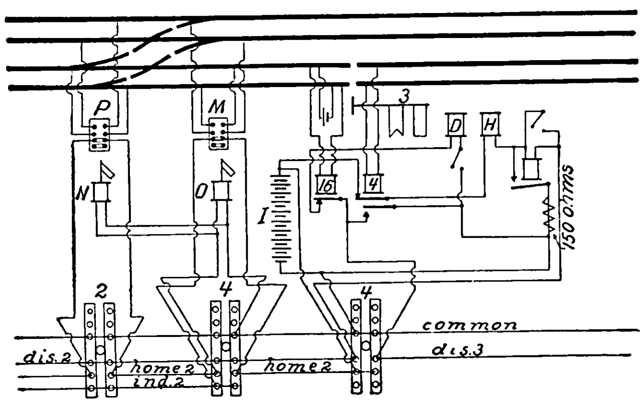
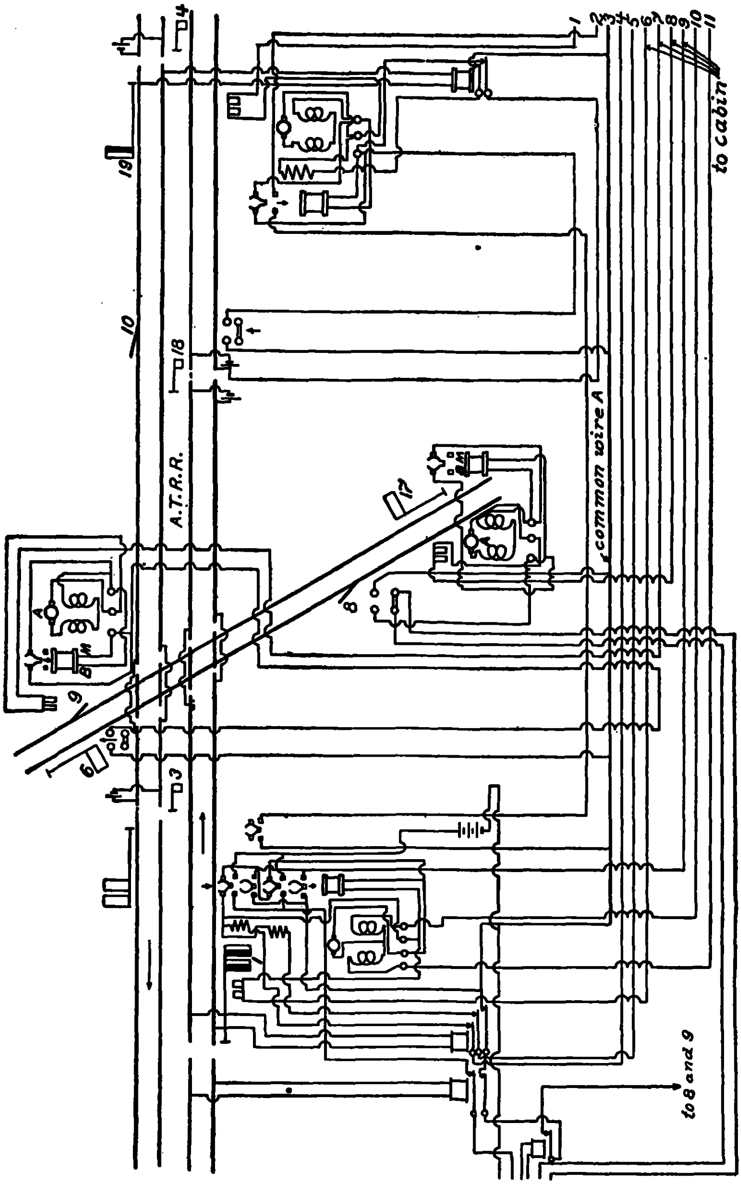


Fig. 46

from a signal cabin, within which is the interlocking machine and its accessories. Three separate common lines, *A*, *B*, and *C*, with relay control, are used. Motor armatures are designated by *A*, brake magnets by *BM*, and signals, switches, and derails by numerals. Dwarf signals, such as 4, 18, 47, etc., are used subsidiary to main and branch-line signals, and are of lesser size.

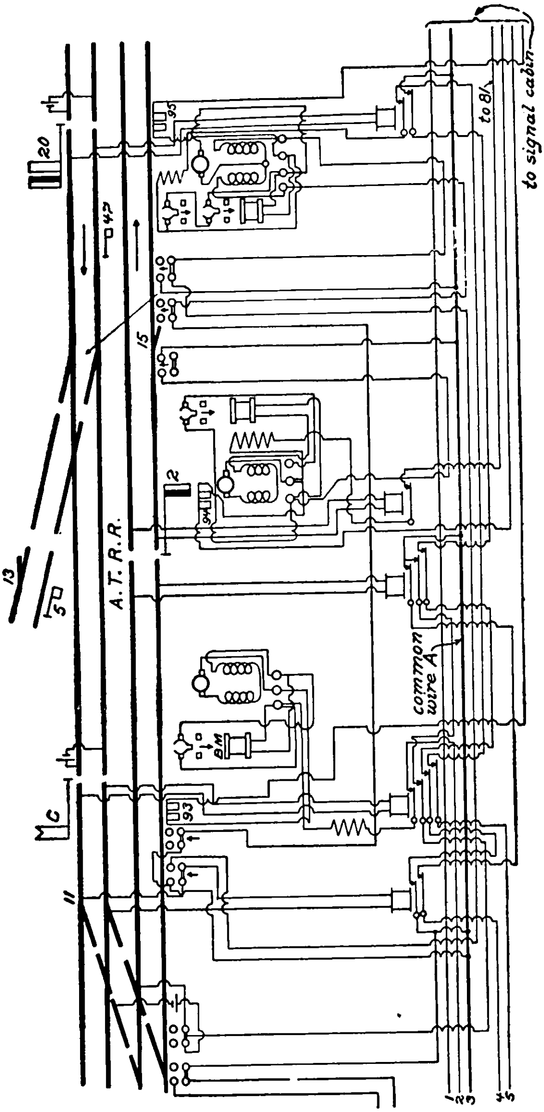
84 and 85 are vibrating bells under the control of track functions preceding those shown; 86 is a storage battery; 87 a west-bound distant indicator with shunted bell; 88 a west-bound track indicator; 89 an east-bound track indicator; and 90 an east-bound distant indicator with a bell in multiple; 931 and



FIGS. 47, 48 (I)

932 are disk signals, whose "hold clear" coils have a resistance of 600 ohms; 91 and 92 are 16-c-p. 110-volt incandescent lamps,

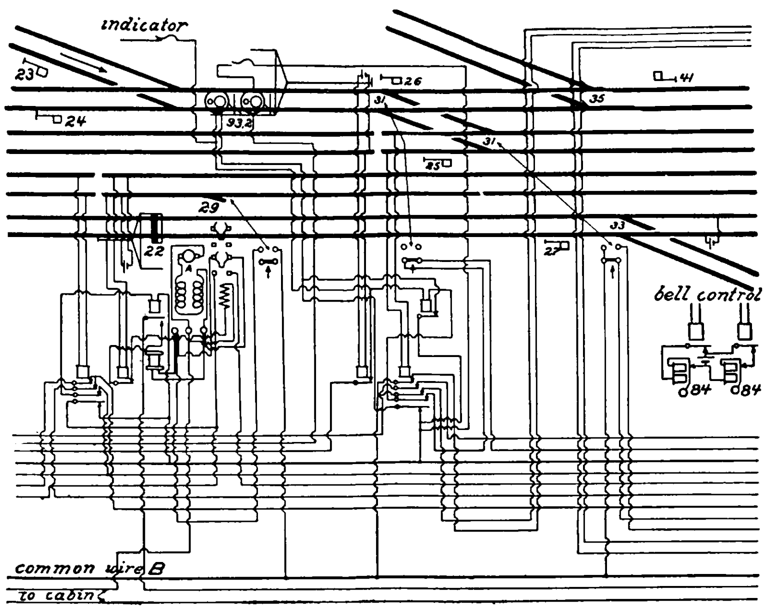
controlled by signals 1 and 51 respectively, and form a visual indication at the tower of movement thereof.



FIGS. 47, 48 (II)

93, 94, 95, etc., are slot magnets which allow the signal arm to return to stop when deënergized. The remainder of the circuits are common to those preceding, or will be more comprehensively evident on consulting Chapter XIV.

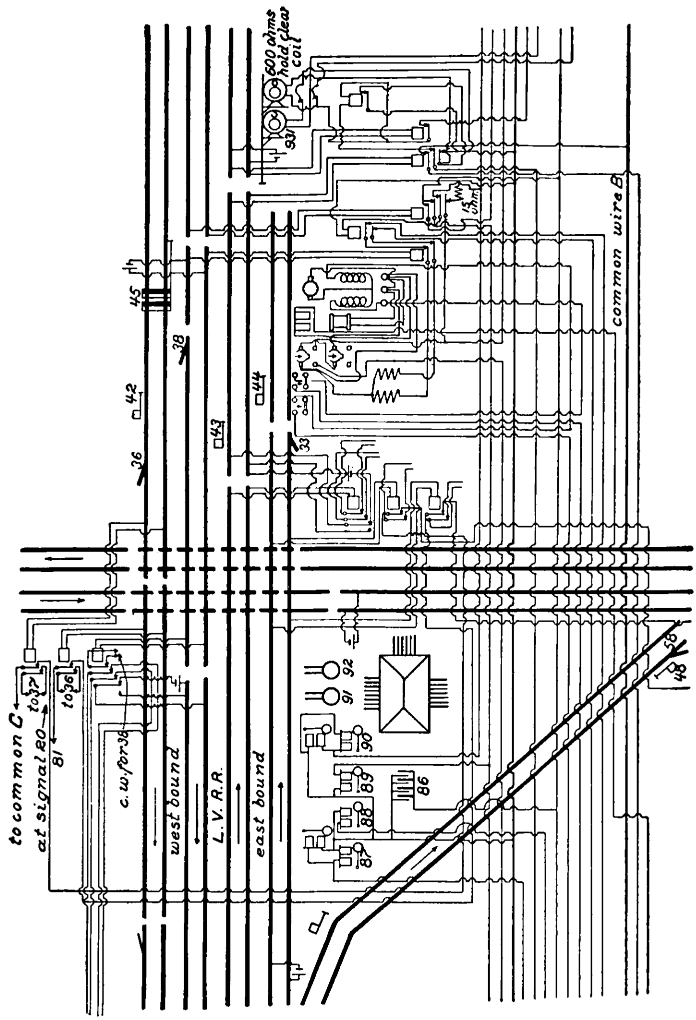
In Fig. 49 is developed a normal danger three-position signal circuit for six consecutive signals, with a train in each of the blocks of *K*, *P*, and *S*, and a crossover switch, *Y*, in that of *N*. The connections at all of the blocks are similar; with the exceptions of the functions, *D*, *E*, *F*, *G*, *H*, and *J*, which are introduced for variation. Describing the apparatus at *K*, we have,



FIGS. 47, 48 (III)

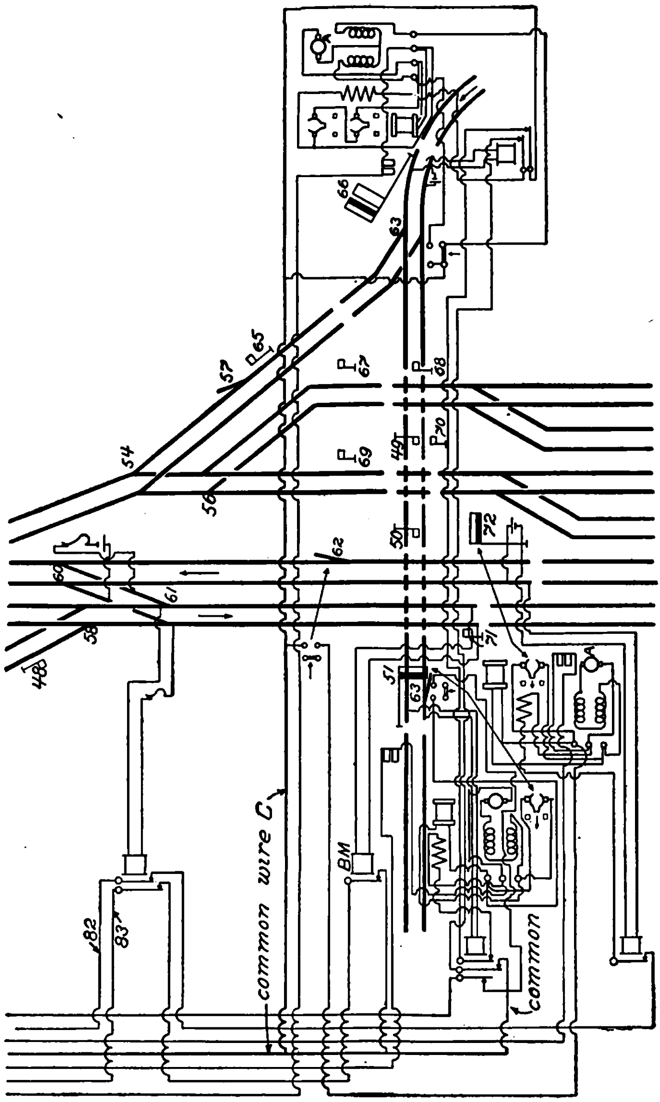
the three-position signal relay, $3P$, track relay, T, motor, M, clutch-magnet, C, lock-magnet, L, main-battery, B, and the contact-arrangement, Z, operated by $3P$. This latter changes the interconnection, so that at each indication position we have a proper circuit-arrangement. Three stages of contacts exist: (1) when the semaphore is at clear, and 4 is connected to 5, as at W; (2) when the blade is at normal or danger, as at X (a similar condition obtaining when the arm is at caution, as at 7); and (3) when the semaphore is at danger with a train in its block, as at Z; and 1 is in contact with 2.

It should be noted that the $3P$ relays are in multiple with the succeeding main batteries through the front-contact armatures, U, of the track relays; and that in order to energize the



FIGS. 47, 48 (IV)

motor, clutch, and lock magnets it is necessary for the back contacts, R, of the preceding relays to close. This energization will not occur unless all other conditions are normal, an impossibility if the track is short-circuited or open by any cause. The front contact, *A*, of the 3*P* relays is for energizing the lock



FIGS. 47, 48 (V)

magnets, and then only by way of *R* and at such times as the motor and clutch magnets are not in circuit. In this case three line wires are necessary, as 8, 9, and 10.

Fig. 50 gives the circuit connections peculiar to a control scheme for semi-automatic home, advance, and distant sema-

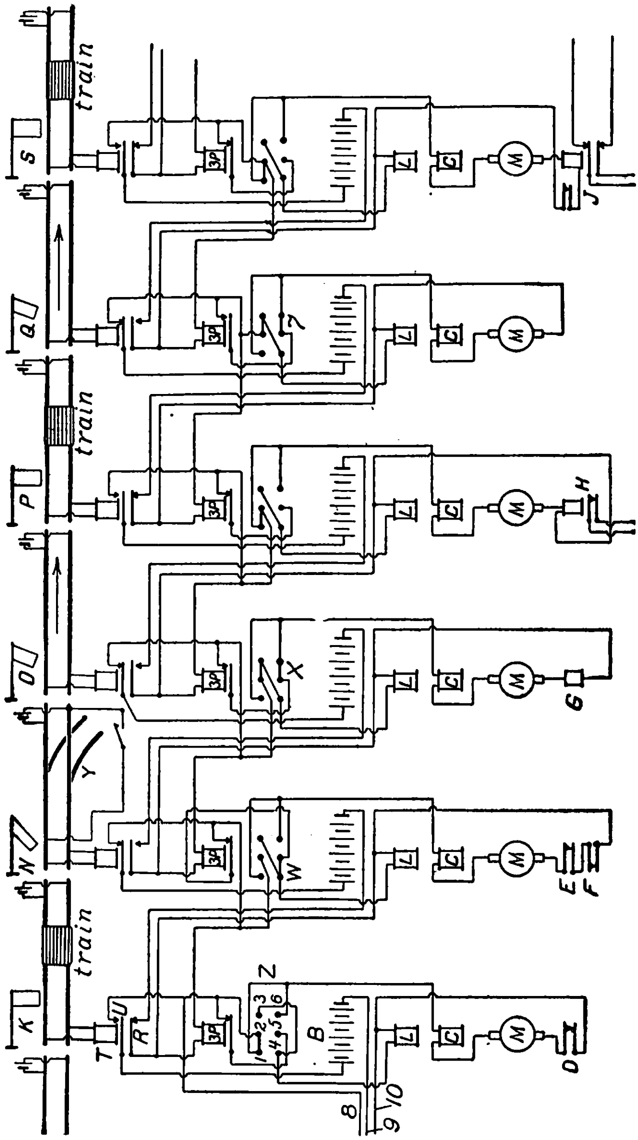


FIG. 49

phores. The home blade, N, is controlled by lever 1, and when the latter is thrown, contact C is closed; and, if D be then momentarily pressed down, B will be energized by the shunting of battery L. This causes a current to pass through A, providing K is on closed circuit, even though D be released. When lever 2 is thrown, E is closed, and if F is then closed for a moment,

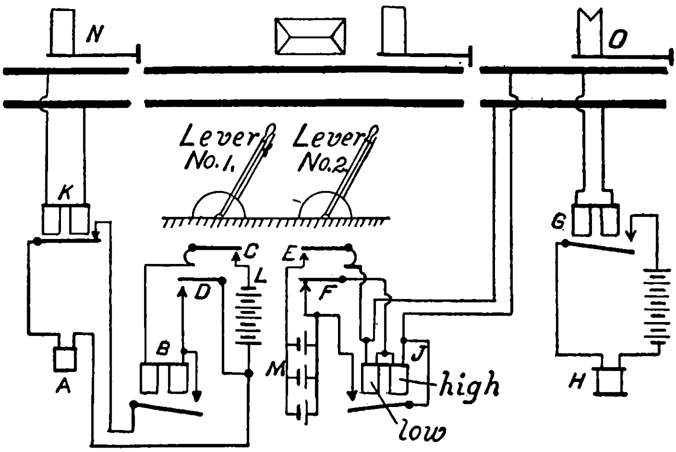


FIG. 50

a current will pass through the low-resistance winding of J from battery M. This raises its armature, throwing in circuit the high-resistance winding and the shunt-track circuit of the distant O, energizing G, and, in the proper sequence, H.