

May 26, 1931.

P. J. SIMMEN

1,806,831

CIRCUIT CONTROL OF TRAIN CONTROL SYSTEMS

Original Filed Sept. 26, 1921

2 Sheets-Sheet 1

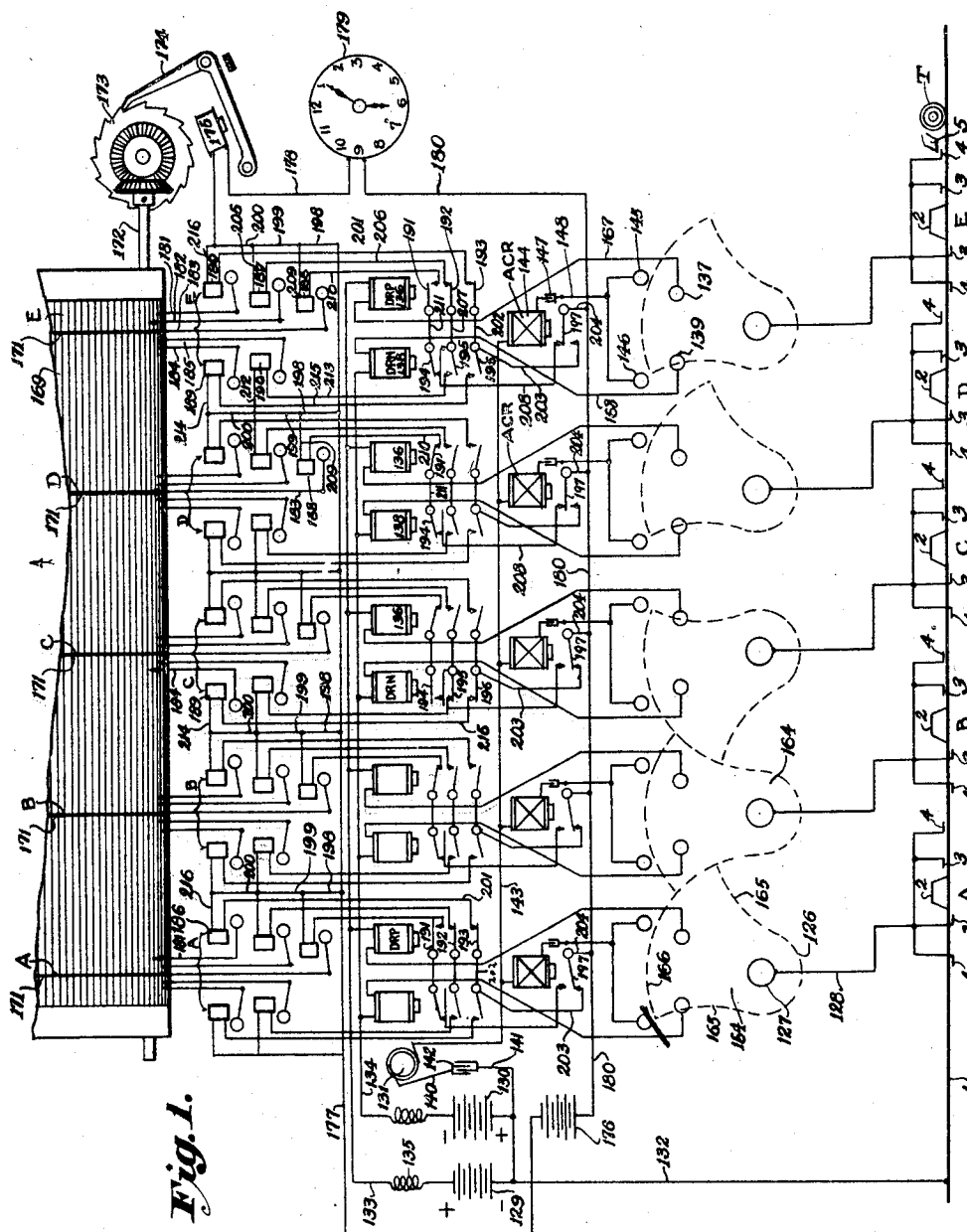


Fig. 1.

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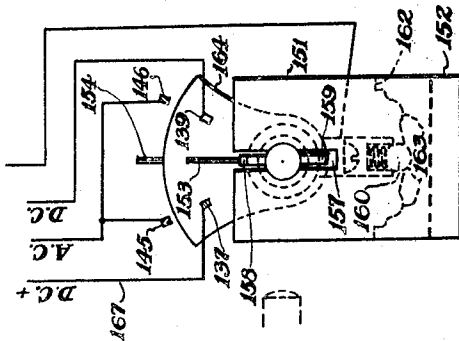
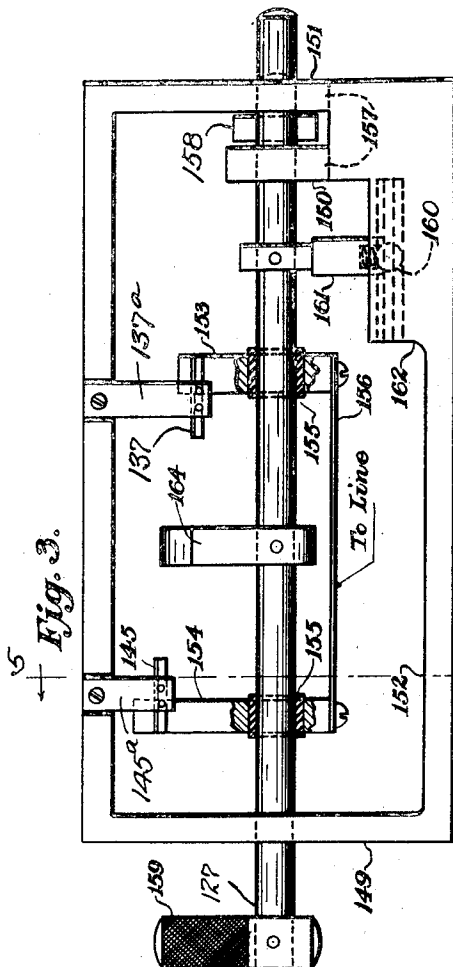
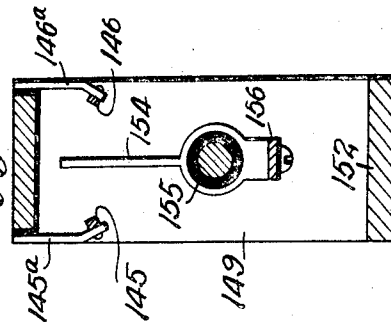


Fig. 4.

Fig. 5.



UNITED STATES PATENT OFFICE

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CIRCUIT CONTROL OF TRAIN CONTROL SYSTEMS

Continuation of application Serial No. 503,235, filed September 26, 1921. This application filed April 23, 1928. Serial No. 272,210.

This application is based upon my co-pending application for Letters Patent No. 503,235, filed September 26, 1921, relating to train control systems. The invention herein contained relates to electrical switches employed in a central or dispatcher's office to control a signal circuit which governs the movement of a train or trains along a trackway.

One of the objects of this invention is to provide a switch of the character described capable of establishing more than three conditions, including a de-energized condition, in a train control circuit employing electric currents of different kinds, such as alternating currents of different frequencies and voltages, or direct currents, either continuous or pulsating, or of different polarities, and by means of which switch the circuit may be completely de-energized or certain of such currents or certain combinations thereof may be utilized according to existing traffic requirements.

Another object of the invention is to provide a switch by means of which a large number of different signals may be utilized for imparting various information to the engineer and in which said signals may be selected with a minimum of time and effort and with the elimination, to a large extent, of critical errors.

A further object of the invention is to provide a switch of the character described capable of being employed with other similar switches and which is so constructed that when it occupies a position in which a particular electrical condition of the control circuit of a certain block or section is created, the switches controlling the circuits of the immediately adjacent blocks or sections can not be moved to positions in which they may establish conflicting electrical conditions therein, such as may interfere with the safe movements of the train or trains.

An illustrative embodiment of the invention is disclosed in the accompanying drawings, wherein:

Fig. 1 is a diagram showing the apparatus at the dispatcher's office in relation to the track of the railroad.

Fig. 2 is a diagram showing the cab circuits and equipment.

Fig. 3 is a side elevation of one of the dispatcher's operating switches.

Fig. 4 is a rear elevation of the same.

Fig. 5 is a transverse cross-sectional view taken on the line 5-5 of Fig. 3.

The devices for regulating train movements are preferably signals and are further preferably located in the cab.

For the transmission of the signal currents I show for the purpose of illustration, short signal rails or ramps. Along the track 1, which may be assumed to run east and west, are a number of stations A, B, C, D, E, etc., which may be actual stations or other convenient dividing points between blocks, such as sidings 2 as diagrammatically shown in Fig. 1, station A being assumed to be a terminal of the road or of a division thereof. The signal rails are also provided at each station and preferably and in accordance with known practice are connected in pairs, each pair comprising a "home" rail 3 and a "distant" rail 4, these rails being provided for each direction of train movement and conveniently located on the right hand side of the track in relation to the movement of the train which they control. The car or locomotive indicated diagrammatically by the showing of the truck T is provided with a movable shoe 5 for engagement with the signal rails, the arrangement of which is such that the shoe 5 will first engage the distant rail and thereafter the home rail.

The different cab circuits are controlled by different electrical conditions of the rails 3 and 4. These conditions involve the use of currents of different characteristics, e. g. either alternating currents of different frequencies or voltages or direct current of different polarity or voltages, either continuous or pulsating, or any other electric current capable of operating a relay or other electrical device designed to be operated by a current of a particular characteristic only or by the absence of an electrical current.

The cab circuits and the devices for regulating the train movements, in the present instance signal lamps, are shown in Fig. 2.

The car carries relays A R and D R which are used to control the operation of such lamps. The relay A R is double wound, that is to say it has a coil 39 which is energized by alternating current and a holding coil 40 which is energized by direct current. This relay has two armatures 41 and 42 which are in the upper position, as shown, when either of the coils 39 or 40 is energized but which move to their lower positions when both of the coils are de-energized. The relay D R has neutral armatures 43, 44 and 45 which, when the relay is energized, are in the upper positions, as shown, but when the relay is de-energized are in their lower positions. The relay D R is also provided with polarized armatures 46, 47, 48 and 49. These armatures swing from left to right as viewed in the drawing. When the relay D R is energized positively, that is to say when the current enters relay D R by the wire 50, then all of the armatures 46 to 49 inclusive swing to the left to the positions as shown in the drawing. When, however, the relay D R is negatively energized, that is to say when the current leaves by the wire 50, then all the armatures 46 to 49 inclusive swing to right hand positions. To insure that the coil 39 of relay A R is operated by alternating current only a condenser 51 is inserted between the wires 52 and 53; and to insure that the relay D R is operated by direct current only, an impedance coil 54 is inserted between the wires 50 and 55.

The positions of the several armatures controlled by both the relays A R and D R establish six different circuits, in which circuits are placed electrical devices 80, 81, 76, 77, 78 and 79 which may be either lamps or other devices designed to either give certain instruction or information to the engineer or to otherwise control the movement of the train.

The devices 80, 81, 76, 77, 78 and 79 may be operated through their respective circuits by permanently connecting the wires to the respective contact points of the relay armatures but when switch S is not used, the circuits through the devices remain the same for east and west bound trains.

While the relays A R and D R are preferred to be placed on the car so as to control cab indications, it is readily understood that these relays could be permanently located along the track, and from their location control six indications of fixed signals. In this system wire 128 leading from the dispatcher's office to the particular section of track to be controlled, would be connected directly by wires 53 and 55 to the relays A R and D R (on the track) instead of the circuit being made through the signal rail or ramp and the contact shoe, as shown in my co-pending application Serial No. 618,193 filed February 10, 1923.

If fixed signals are used the signal indication circuits are permanently connected for signals governing east bound train movements in the same manner as the circuits are established when switch S is in the position for use for an east bound train and for signals governing west bound movements these circuits are permanently connected in the manner as the circuits are established when switch S is in the position for use for a west bound train.

For the control of the circuits of certain of the signal lamps where a selection of the direction of the train movements is desired, as hereinafter pointed out in detail, I provide a four-pole double throw switch S, the arms of which may be assumed to be in the right hand position on east bound trains and in the left hand position on west bound trains. The switches S of opposing trains insure that the energy in a signal rail which will produce the operation of a particular lamp in an east bound train will produce in a west bound train the operation of a different lamp. In other words the switch S provides that when an east bound train receives a clear signal a west bound train will receive, at the same station, a signal other than clear, such as a stop signal.

Assuming that alternating current is supplied to a signal rail and that the car T is advancing with its shoe 5 in contact with such rail and the signal rail and a rail of the track 1 are terminals of the generator, under such conditions the alternating current will flow via the signal rails 3 or 4, the shoe 5, a wire 53, condenser 51 and wire 52 through a coil 39 of relay A R and thence by wires 39a and 57 to a rail of the track 1 (i. e. through the axle and wheel of the car). The resultant energization of relay A R causes armatures 41 and 42, if in their lower positions, to be raised, or, if already raised, to be held in raised positions. Each signal rail is, as usual, inclined on both ends and this permits shoe 5 gradually to lower as the car T passes, whereby the insulated metallic plate 60 mounted on the shoe connects wires 61 and 62 before the shoe actually leaves the ramp. The connection of wires 61 and 62 by the shoe 5 while the armature 41 is in a raised position causes a stick circuit to be formed through the coil 40 of the relay A R, which circuit maintains the relay A R energized until the advancing car T causes the shoe 5 to contact with another signal rail. This stick circuit is as follows, the diagram of Fig. 2 being also considered and it being assumed that the last previous energization of the relay D R was positive: one terminal of battery 68, wires 69 and 70, armature 47 in the left hand position, wires 71 and 65, armature 41 in a raised position, wire 62, plate 60, wire 61, coil 40, wires 64, 57, 66 and 73, armature 46 in the left hand position and wire 74 to the other terminal of

battery 68. If, however, the last previous energization of the relay D R was negative, the stick circuit is traced in the opposite direction and through the armatures 46 and 47 in their right hand positions, that is to say, from one terminal of battery 68, wire 69, armature 46 in the right hand position, wires 73, 66, 57 and 64, coil 40, wire 61, plate 60, wire 62, armature 41, wires 65 and 71, armature 47 in the right hand position and wire 74 to the other terminal of battery 68.

Assuming that the signal rail is positively energized and in contact with the shoe 5 of the advancing car T and that said signal rail and a rail of the track 1 are battery terminals, direct current will flow through the relay D R entering by wire 50. The circuit is as follows: signal rail, shoe 5, wires 53 and 55, impedance coil 54, wire 50, relay D R and wire 66 to track rail 1. As the car passes beyond the ramp the shoe 5 will make contact with the wire 67 so that the armature 43 being in a raised position, a stick circuit for relay D R will be formed as follows: one terminal of battery 68, wires 69 and 70, polarized armature 47 in the left hand position by reason of the previous positive energization of the relay D R, wires 71 and 72, armature 43, wire 67, shoe 5, wires 53 and 55, impedance coil 54, wire 50, relay D R, wires 66 and 73, polarized armature 46 in the left hand position and wire 74 to the other terminal of battery 68. Assuming that the signal rail is negatively energized and in contact with the shoe 5 of the advancing car T and that said signal rail and a rail of the track 1 are battery terminals, direct current will flow through the relay D R, entering by the wire 66. In such a case the circuit will be as follows: from the rail 1, thence through wire 66, relay D R, wire 50, coil 54, wires 55 and 53 and shoe 5 to the signal rail. The stick circuit which becomes effective when shoe 5 leaves the ramp is as follows: one terminal of battery 68, polarized armature 46 in the right hand position by reason of the previous negative energization of relay D R, wires 73 and 66, relay D R, wire 50, coil 54, wires 55 and 53, shoe 5, wire 67, armature 43 in its raised position, wires 72 and 71, armature 47 in the right hand position and wire 74 to the other terminal of battery 68.

It will, of course, be understood that whether relay D R is energized positively or negatively, the neutral armatures 43, 44 and 45 will be in the upper positions and it will be only when relay D R is not energized at all that these armatures are in the lower positions. It will also be understood that polarized armatures 46 to 49 inclusive will remain in the positions to which they have last been moved until the relay D R has been reversely energized. Furthermore it is obvious that by the elimination of the A C relays and A C

generator the system is operative for three signals.

The cab circuits described provide for six different circuit conditions pursuant to which six phases of train movement regulation, each responsive to a particular circuit condition, may be utilized in the embodiment disclosed. As shown the train movement regulating devices consist of signal lamps which may have any desired significance. The lamps are designated 76 to 81 inclusive and in the diagram, Fig. 2, where the use of switch S is assumed, the lamps respond to cab circuit conditions established in the following order, namely, the lamp 76 of an east bound train when alternating and positive direct current is supplied to the signal rail, and of a west bound train when alternating and negative direct current is supplied, the lamp 77 of an east bound train when alternating and negative direct current is supplied to the signal rail, and of a west bound train when alternating and positive direct current is supplied, the lamp 78 of an east bound train when positive direct current only is supplied to the signal rail, and of a west bound train when negative direct current only is supplied, the lamp 79 of an east bound train when negative direct current only is supplied to the signal rail, and of a west bound train when positive direct current only is supplied, the lamp 80 of an east or west bound train when alternating current only is supplied to the signal rail and the lamp 81 of an east or west bound train when the signal rail is de-energized. It is further to be noted that the circuits of the lamps 76 to 79 inclusive are completed by the reversing switches in either position of its arms. As stated, the signal lamps may have any desired significance and for the purpose of illustration colors and meanings may be assigned to them as follows: lamp 76, green for "clear", lamp 77, red for "stop—no right of way", lamp 78, purple for "take siding", lamp 79, white for "take main track", lamp 80, orange for caution or "call at once" and lamp 81, red, for danger.

In the case of lamps 76 to 79 inclusive an electrical condition in the signal rail which will cause the lighting of a particular lamp in an east bound train will cause the lighting of a different lamp in a west bound train because the arms of the reversing switch are in left hand positions on east bound trains and in right hand positions on west bound trains. Thus the cab circuits for the lamps are such that when alternating and positive direct current is supplied to the signal rails it will cause the lighting of lamp 76 (the clear sign) in an east bound train and of lamp 77 ("no right of way") in a west bound train; when alternating and negative direct current is supplied to the signal rails it will cause the lighting of lamps 76 and 77 in reversed relation, that is to say the lighting of lamp 77 in an east bound

train and of lamp 76 in a west bound train; when positive direct current only is supplied to the signal rails it will cause the lighting of lamp 78 ("take siding") in an east bound train and of lamp 79 ("take main track") in a west bound train; and when negative direct current only is supplied to the signal rails it will cause the lighting of lamps 78 and 79 in reversed relation, that is to say the lighting of lamp 79 in an east bound train and the lighting of lamp 78 in a west bound train.

For greater convenience the various electrical conditions of the signal rails and the lamps responsive thereto in east bound and west bound trains are set forth in the following table:

Condition of signal rail	East bound train	West bound train
A C and D C positive.....	Lamp 76.....	Lamp 77.....
A C and D C negative.....	Lamp 77.....	Lamp 76.....
D C positive only.....	Lamp 78.....	Lamp 79.....
D C negative only.....	Lamp 79.....	Lamp 78.....
A C only.....	Lamp 80.....	Lamp 80.....
De-energized.....	Lamp 81.....	Lamp 81.....

If a clear signal is to be given an east bound train by means of the lamp 76 alternating and positive direct current is supplied to the signal rails and, the arms of the switch S being in left hand position and the signal rail and one of the track rails 1 being assumed as the opposite terminals of the source of current supply, relay A R is energized, relay D R is positively energized, and the armatures 46 to 49 are moved to the left, as shown. Under these conditions a circuit is formed through the lamp 76 as follows: battery 68, wires 69 and 70, polarized armature 47, wire 71, armature 42, wire 98, armature 44, wire 84, polarized armature 49, wire 85, neutral pole 110 of reversing switch, through the corresponding arm of said switch in left hand position, contact 111, wire 86, lamp 76, wires 76a, 57, 66 and 73, polarized armature 46 and wire 74 to the other terminal of battery 68.

If the train be west bound and its shoe 5 is in contact with a signal rail to which alternating and positive direct current is supplied, the arms of the switch S will be in right hand position and lamp 77 will glow, the circuit being as follows: battery 68, wires 69 and 70, polarized armature 47, wire 71, armature 42, wire 98, armature 44, wire 84, polarized armature 49, wire 85, neutral pole 110 of the reversing switch, through the corresponding arm of said switch in right hand position, contact 112 interconnected wires 113 and 87, lamp 77, wires 77A, 57, 66, and 73, polarized armature 46 and wire 74 to the other terminal of battery 68.

If a clear signal is to be given a west bound train by means of the lamp 76 alternating and negative direct current is supplied to the signal rails and, the arms of the switch

S being in the right hand position, relay A R is energized, relay D R is negatively energized, and the armatures 46 to 49 are moved to the right. Under these conditions a circuit is formed through the lamp 76 as follows: battery 68, wire 69, polarized armature 46, wires 73, 66, 57 and 76a, lamp 76, interconnected wires 86 and 114, contact 115 of reversing switches, through the corresponding arm of said switch in its right hand position, neutral pole 116 of reversing switches, wire 97, polarized armature 49, wire 84, armature 44, wire 98, armature 42, wire 71, polarized armature 47 and wire 74 to the other terminal of battery 68.

If the train be east bound and its shoe 5 is in contact with a signal rail to which alternating and negative direct current is supplied, the arms of the switch S will be in left hand position and the lamp 77 will glow, the circuit being as follows: battery 68, wire 69, polarized armature 46, wires 73, 66, 57 and 77a, lamp 77, wire 87, contact 117 of reversing switches, through the corresponding switch arm, neutral pole 116 of reversing switches, wire 97, polarized armature 49, wire 84, armature 44, wire 98, armature 42, wire 71, polarized armature 47 and wire 74 to the other terminal of battery 68.

If the signal "take siding" is to be given an east bound train by means of the lamp 78, positive direct current only is supplied to the signal rails, the arms of the switch S are in left hand position, and the relay A R is de-energized because its stick circuit is broken by the raising of the shoe 5 consequent to its contact with the ramp, while relay D R is positively energized and the armatures 46 to 49, inclusive, are moved to the left hand positions as shown in the drawings. The circuit thus established may be traced as follows: battery 68, wires 69 and 70, polarized armature 47, wire 71, armature 42 in its lower position, wire 96, armature 45, wire 99, polarized armature 48, wire 100, neutral pole 118 of reversing switches, through the corresponding switch arm in the left hand position, contact 119, wire 88, lamp 78, wires 78a, 57, 66 and 73, polarized armature 46 and wire 74 to the other terminal of battery 68.

If the train be west bound and its shoe 5 is in contact with a signal rail to which positive direct current only is supplied, the arms of the switch S will be in right hand position and the lamp 79 will glow, the circuit being as follows: battery 68, wires 69 and 70, polarized armature 47, wire 71, armature 42 in the lower position, wire 96, armature 45, wire 99, polarized armature 48, wire 100, neutral pole 118 of reversing switches, through the corresponding switch arm in the right hand position, contact 120 of the reversing switch, interconnected wires 121 and 89, lamp 79, wires 79a, 57, 66 and

73, polarized armature 46 and wire 74 to the other terminal of battery 68.

If the signal "take siding" is to be given to a west bound train by means of the lamp 78, negative direct current only is supplied to the signal rails, the arms of the switch S are in the right hand position, and the relay A R is de-energized because its stick circuit is broken by the raising of the shoe 5 consequent to its contact with the ramp, while relay D R is negatively energized and the armatures 46 to 49, inclusive, are moved to the right hand positions. The circuit thus established may be traced as follows: battery 68, wire 69, polarized armature 46, wires 73, 66, 57 and 78a, lamp 78, interconnected wires 88 and 122, contact 123 of reversing switch S, through the corresponding arm of said switch in its right hand position, neutral pole 124 of the reversing switch, wire 101, polarized armature 48, wire 99, armature 45, wire 96, armature 42 in the lower position, wire 71, armature 47 and wire 74 to the other terminal of battery 68.

If the train be east bound and its shoe 5 is in contact with a signal rail to which negative direct current only is supplied, the arms of the switch S will be in left hand position and the lamp 79 will glow, the circuit being as follows: battery 68, wire 69, polarized armature 46, wires 73, 66, 57 and 79a, lamp 79, wire 89, contact 125 of the reversing switch S, through the corresponding switch arm, neutral pole 124 of reversing switch, wire 101, polarized armature 48, wire 99, armature 45, wire 96, armature 42 in the lower position, wire 71, armature 47 and wire 74 to the other terminal of battery 68.

If alternating current only be supplied to the signal rails, the lamp 80 will be lighted whether the train be east bound or west bound, and whether the armatures 46 to 49, inclusive, are in their left or right hand positions. In this case relay A R is energized but relay D R is de-energized, because its stick circuit is broken at the plate 60 by the raising of the shoe 5 by the signal rail. Assuming that the last previous energization of relay D R was negative, so that the armatures 46 to 49, inclusive, are in their right hand positions, the circuit may be traced as follows: battery 68, wire 69, polarized armature 46, wires 73, 66, 57 and 80a, lamp 80, wire 102, armature 44 in its lower position, wire 98, armature 42, wire 71, polarized armature 47 and wire 74 to the other terminal of battery 68. If, however, the last previous energization of the relay D R was positive, so that the polarized armatures 46 to 49, inclusive, are in their left hand positions, the circuit may be traced as follows: battery 68, wires 69 and 70, polarized armature 47, wire 71, armature 42, wire 98, armature 44 in its lower position, wire 102, lamp 80, wires 80a, 57, 66, and 73, polarized armature 46 and

wire 74 to the other terminal of battery 68.

If the signal rails are de-energized, the lamp 81 will be lighted whether the train be east bound or west bound. In this case the relays A R and D R are both de-energized, the armatures 41 to 45, inclusive, are in their lowered positions and the armatures 46 to 49, inclusive, are in either right or left hand positions accordingly as the previous energization of the relay D R was negative or positive. Assuming that the armatures 46 to 49 are in their left hand positions, as shown, consequent to the last energization of the magnet D R being positive, the circuit thus established may be traced as follows: battery 68, wires 69 and 70, polarized armature 47, wire 71, armature 42 in its lower position, wire 96, armature 45 in its lower position, wire 103, lamp 81, wires 81a, 57, 66 and 73, polarized armature 46, and wire 74 to the other terminal of battery 68. If, however, the last previous energization of the relay D R was negative, so that the polarized armatures 46 to 49, inclusive, are in their right hand positions, the circuit may be traced as follows: battery 68, wire 69, armature 46, wires 73, 66, 57 and 81a, lamp 81, wire 103, armature 45 in its lower position, wire 96, armature 42 in its lower position, wire 71, armature 47 and wire 74 to the other terminal of battery 68.

It will thus be seen that for each of the oppositely moving trains there are, in the present embodiment, by the use of switch S, six operative cab circuit conditions; and that each of a group of the signal lamps, that is to say the lamps 76 to 79, inclusive, has two circuits controlled by the reversing switch and operative for east and west bound trains respectively. It will further be seen that the signalling current supplied to the rails for causing the lighting of any of the signal lamps 76 to 79, inclusive, selectively differentiates between the lamps of east and west bound trains and co-ordinates the lamps thus selected whereby the signals on opposing trains are appropriate to one another.

In the embodiment disclosed the electrical condition of the signal rails is controlled by switches at the dispatcher's office and which are designated generally as 126. There is a switch for each station or block division A—E, etc., of the road and for convenience each switch is shown in the diagram of Fig. 1 immediately above its corresponding station. The switches 126 include rocker shafts 127 by which they are mounted and each shaft 127 is connected by a line wire 128 to the signal rails 3—4 of the corresponding station.

The signalling currents are supplied by batteries 129 and 130 and by an alternating current generator 131, all of which are connected by a line wire 132 to a rail of the track 1, the wire 132 being connected to the negative pole of battery 129 and the positive pole

of battery 130. At their other poles the batteries 129 and 130 are connected to wires 133 and 134, respectively, in each of which is arranged an impedance coil 135. Magnets 136, one for each station of the road, are bridged across the wire 133 and right hand contacts 137 of the switches 126 and magnets 138 are similarly bridged across the wire 134 and left hand contacts 139 of the switches 126. The generator 131 is connected to the wire 132 by wires 140 and 141 between which is arranged a suitable condenser 142. The other terminal of the generator 131 is connected to a wire 143 and magnets 144, one for each station of the road, are bridged across this wire to right and left hand contacts 145 and 146, respectively, of the switches 126, a condenser 147 being interposed in the wire 148 which connects each magnet 144 and the contacts 145 and 146.

Each switch 126 has rocking movement about the axis of the shaft 127 and longitudinal movement in the direction of said axis. As thrown either to the right or to the left the switch has three position in its longitudinal range of movement, in the first of which it engages only one or the other of the contacts 137 or 139, in the second of which it engages the pair of contacts 137 and 145 or the pair of contacts 139 and 146 and in the third of which it engages only one or the other of the contacts 145 or 146. The structural details of the switches are shown in Figs. 3, 4, and 5. The shaft 127 is mounted in a front bearing 149 and in rear bearings 150 and 151 which bearings are carried by a suitable supporting bracket 152. The shaft 127 is provided with contact arms 153 and 154 which are insulated from said shaft by bushings 155 and carry a bus bar 156 to which the line wire 128 is connected. The arm 153 is arranged to engage either of the contacts 137, 139 accordingly as it may be moved to the right or to the left (Fig. 1 being considered) and the arm 154 is similarly arranged to engage either of the contacts 145, 146.

In order to support the various switch contacts, the bearings 149 and 151 may be extended upwardly a suitable distance, and be interconnected by the longitudinally positioned bridge 152a which overhangs the base member 152. Supporting arms 137a, 145a and 146a, (see Figs. 3 and 5), project downwardly from the bridge 152a, and to them are secured the respective contacts 137, 145, and 146. The supporting arm for the contact 139 is not illustrated, it being understood that it is disposed directly in back of the arm 137a shown in Fig. 3, and is secured to the bridge 152a in like manner to the other supporting arms. All of the supporting arms are suitably insulated from the bridge 152a or the contacts. The supporting arms are not illustrated in Fig. 4, wherein the electrical connections to the various contacts is more clearly

illustrated. Other methods of mounting the contacts may be employed, that herein described being expressed simply for the purposes of explanation.

The contacts 137 and 145 comprising the pair at the right hand limit of the pivotal movement of the switch 126 and the contacts 139 and 146 comprising the pair at the left hand limit of the pivotal movement of said switch are of such length and relative arrangement that their engagement by the corresponding switch arms will be as follows in the various operative positions of the switch: Assuming that the switch is in either of its right or left hand position—when the shaft 127 is in its intermediate longitudinal position as shown in Fig. 3, both arms 153 and 154 will engage corresponding contacts of either pair, that is to say if the switch is thrown to the right the arm 153 will engage the contact 137 and the arm 154 will engage the contact 145 and if the switch is thrown to the left the arm 153 will engage the contact 139 and the arm 154 will engage the contact 146; when the shaft 127 is in its forward longitudinal position the arm 153 alone will be operative and will engage the contact 137 or 139 as the case may be, the arm 154 being located out of the path of its corresponding contacts 145 and 146; and when the shaft 127 is in its rearward longitudinal position the arm 154 alone will be operative and will engage the contact 145 or 146 as the case may be, the arm 153 being located out of the path of its corresponding contacts 137 and 139.

It is further to be noted that the switch 126 has an intermediate pivotal or neutral position in which the arms 153 and 154 are inoperative; and as shown and preferred the construction is such that when changing from one longitudinal position of the shaft 127 to another longitudinal position of said shaft the switch must first be brought to neutral position and maintained in such position throughout the shifting movement of the shaft, advantages in safety and certainty of operation and control being thereby secured, since only one of the six circuit conditions can be established at one time. For these purposes the bearings 150 and 151 are provided with vertical slots 157 and the shaft is provided with a key 158 which, when the switch is in neutral position, aligns with said slots and may be moved through them but when the switch is in either right or left hand positions lies athwart them and prevents endwise movement of the shaft. As shown, the shaft 127 is in intermediate longitudinal position and the key 158 is intermediate the bearings 150 and 151. The manipulation of the shaft is provided for by a suitable handle 159 mounted on its front end, and, if it be desired to move the shaft longitudinally in either direction from the position shown in Fig. 3, the switch must first

be turned to neutral position whereby to align the key 158 with the slots 157, after which the shaft 127 may be moved forward or rearward accordingly as it may be desired to operate only the arm 153 or only the arm 154. In like manner in either of the forward or rearward positions of the shaft the switch must first be moved to the neutral position before the shaft can be shifted to intermediate or the opposite extreme longitudinal position.

It is also preferred to provide means for holding the switch against accidental pivotal movement in any longitudinal position of the shaft 127. For this purpose a friction latch may be employed which, as shown and preferred, comprises a spring pressed ball 160 fitted in a socket at the end of an arm 161 secured fast to the shaft 127, and a base 162 having longitudinal grooves 163 corresponding to the right, neutral, and left position of the switch and in which the ball 160 engages, the grooves 163 conforming in length to the range of longitudinal movement of the shaft 127. It will be apparent that the frictional engagement of the ball 160 in any one of the grooves 163 will not interfere with an intentional turning movement of the shaft as effected by the handle 159 but will prevent an accidental turning movement of said shaft.

In the forward longitudinal position of the shaft 127 direct current only will be supplied to the signal rails, positive if the switch be turned to the right, and negative if it be turned to the left. In the rearward longitudinal position of the shaft 127 alternating current only will be supplied to the signal rails in either the right or left hand positions of the switch. In the intermediate longitudinal position of the shaft 127 combinations of alternating and direct current will be supplied to the signal rails, alternating and positive direct current if the switch be turned to the right and alternating and negative direct current if the switch be turned to the left.

It is preferred to provide means which are effective in corresponding longitudinal positions of two or more adjacent switches for interlocking them against certain pivotal movements relatively to the neighboring switch or switches. For this purpose interlocking segments 164 are employed. These segments are mounted on the shafts 127 and are each provided with concave lateral edges 165 and a convex intermediate edge 166. To illustrate the cooperation of the interlocking segments it may be assumed that the switches for stations A, B and C are in corresponding, e. g. intermediate, longitudinal positions in which case the segments 164 prevent any manipulation of these switches which will give clear signals to opposing trains. For example, if the switch for station C be in the left hand position, as shown, to give a clear signal to a west bound train the switch for

station B can not be set in the right hand position to give a clear signal to an east bound train; and in like manner if the switch for station A be set in the right hand position, as shown, to give a clear signal to an east bound train, the switch for station B can not be set in the left hand position to give a clear signal to a west bound train.

Where alternate switches are set to give a clear signal to opposing trains, as, for example, the switches for stations A and C in the diagram of Fig. 1, the intermediate switch is interlocked in neutral position in which the signal rails of its corresponding block are de-energized to give a danger signal and such switch can not be moved either to the right or to the left. The segments 164 cooperate in the same way if the adjacent switches are both or all in forward or both or all in rearward positions, that is to say, as between two switches arranged to the left and right of one another, the switch at the left can not be turned to its right hand position if the switch at the right be in neutral position or turned to its left hand position and, conversely, the switch at the right can not be turned to its left hand position if the switch at the left be in neutral position or turned to its right hand position.

If it be desired to supply positive direct current only to the signal rails of a particular station, the switch for that station will be shifted to its forward longitudinal position and turned to the right so as to engage its arm 153 with the contact 137. The battery 129 is the source of positive direct current and it may be assumed that the switch of station A has been manipulated as described to supply positive direct current only to the signal rails of that station. Under these conditions a circuit for positive direct signalling current only is established as follows: battery 129, impedance coil 135, wire 133, magnet 136 corresponding to station A, wire 167, contact 137, switch arm 153, bar 156, wire 128, any signal rail at station A, shoe 5, thence through the cab as previously described to a rail of track 1 and by wire 132 to the other terminal of battery 129.

If it be desired to supply negative direct current only to the signal rails of a particular station, the switch for that station will be turned to the left in its forward longitudinal position so as to engage its arm 153 with the contact 139. The battery 130 is the source of negative direct current and it may be assumed that the switch of station C has been manipulated as just described to supply negative direct current only to the signal rails of that station. Under these conditions a circuit for negative direct signalling current only is established as follows: battery 130, wire 132, a rail of track 1, thence through the cab, as previously described, any signal rail of station C, wire 128, bar 156, switch arm

153, contact 139, wire 168, magnet 138 of station C, wire 134, and impedance coil 135 to the opposite terminal of battery 130.

If it be desired to supply alternating current only to the signal rails of a particular station, the switch for that station will be turned either to the right or to the left in its rearward longitudinal position. The generator 131 is the source of alternating current and it may be assumed that the switch of station D has been manipulated as just described to supply alternating current only to the signal rails of that station. Under these conditions a circuit for alternating signalling current only is established as follows: generator 131, wire 143, magnet 144 corresponding to station D, condenser 147, wire 148, either of the contacts 145, 146, according as the switch may be turned to the right or to the left, switch arm 154, bar 156, wire 128, any signal rail at station D, thence through the cab as previously described, a rail of track 1, wires 132, and 141, condenser 142 and wire 140 to the other terminal of generator 131.

If it be desired to supply a combination of direct and alternating current to a particular station, the switch for that station is set in its intermediate longitudinal position, and it is turned to the right if the direct current be positive and to the left if the direct current be negative. In the diagram of Fig. 1 it is assumed that the switch for station E has been manipulated to provide for the supply of alternating and positive direct current to the signal rails of that station in which case its arm 153 engages the contact 137 and its arm 154 engages the contact 145. The respective currents, positive, direct and alternating, flow in the two paths previously traced for stations A and D respectively. In like manner if the combination of negative direct and alternating current be supplied to the signal rails, the respective currents, negative direct and alternating, will flow in the two paths previously traced for stations C and D respectively. In any case where a combination of alternating and direct current is supplied to the signal rails the alternating current is prevented from flowing through the batteries by the impedance coils 135 and the direct current is prevented from flowing through the generator 131 and the magnets 144 by the condensers 142 and 147.

According to the invention the signals and the movements of trains in relation thereto are recorded or indicated at the dispatcher's office. For this purpose I preferably employ a chart 169 in the form of a web which is trained over any suitable arrangement of guiding and winding rollers and which bears regularly spaced transverse or horizontal lines 170, indicative of divisions of time, and longitudinal or vertical lines 171, indicative

of the stations to which they severally correspond, as indicated in the drawings by the letters A, B, C, D and E. The shaft 172 of the winding roll of said web may be clock driven in any suitable manner but it is preferably geared to a ratchet wheel 173 which is operated by a pawl 174 carried by the armature of an electromagnet 175. Current for the operation of the magnet 175 is supplied by a battery 176 and flows by a wire 177 to the magnet 175, thence by a wire 178 to a clock switch 179, shown conventionally, and thence by a wire 180 to the other terminal of battery 176. The chart 169 is employed in connection with a series of perforating punches which operate adjacent the station lines 171 to record different signals given at the several stations and the movements of the trains in relation to such signals.

The operation of the perforating punches is electrically controlled and according to the invention the circuit which governs the operation of a punch intended to record a particular signal is co-ordinated to the operation of that signal. As shown and preferred this co-ordination is effected by means of the dispatcher's switches in connection with main relays of which three are preferably provided for each station, one being a positive direct current relay D R P and of which the magnet 136 is an element, the second being a negative direct current relay D R N of which the magnet 138 is an element and the third being an alternating current relay A C R of which the magnet 144 is an element. The perforating punches for each station preferably correspond in number to the five electrically energized conditions of the signal rails, the punch 181 being operative when positive direct current only is supplied, the punch 182 when a combination of alternating and positive direct current is supplied, the punch 183 when alternating current only is supplied, the punch 184 when negative direct current is supplied and the punch 185 when a combination of alternating and negative direct current is supplied. The punches 181 to 185 inclusive are respectively operated by magnets 186, 187, 188, 189 and 190, the circuits of which are selected by the main relays D R P, D R N, and A C R.

The relay D R P includes three armatures 191, 192 and 193, the relay D R N includes three armatures 194, 195 and 196, and the relay A C R includes a single armature 197. The armatures 191 to 193, 194 to 196 and 197 are raised when their respective operating magnets 136, 138 and 144 are energized and are lowered when the magnets are de-energized.

As a matter of convenience and for a clearer understanding of the diagram of Fig. 1, the punch 183 which operates when alternating current only is supplied to the sig-

nal rails is shown as arranged in alinement with the station line 171, the two punches 181 and 182 which operate when positive current is supplied to the signal rails are shown as arranged at the right of the corresponding station line and the two punches 184 and 185 which operate when negative current is supplied to the signal rails are shown at the left of the corresponding station line. In the diagram of Fig. 1 it is assumed that the chart 169 is being driven in the upward direction as indicated by the arrow and it may also be assumed that stations A and E are the western and eastern terminals of the line or division thereof. Under such conditions the perforations which are records of the movements of east bound trains will follow a generally oblique path extending downward from left to right of the chart and the perforations which are records of the movements of west bound trains will follow a generally oblique path extending downward from right to left of the chart. In this way the dispatcher or official can tell whether the perforations were made by east or west bound trains and the relative location of the perforations on the chart will also indicate the character of signalling current supplied to the train and hence the particular signal which the train received.

Since the circuits for the operating magnets 186 to 190 inclusive may be closed only when one or more of the relays D R P, D R N and A C R are energized and since these relays are energized according to the particular energization of a signal rail only when a shoe 5 is in contact with such rail to close a circuit through the cab, it follows that the recording perforation of a particular punch will be made only when the shoe 5 is in contact with a signal rail of the corresponding station but that a punch will be made each time that the shoe 5 passes over a signal rail of that station, so long as the rails are energized.

Assuming that positive direct current only is supplied to the signal rails, when the shoe 5 contacts with such rails the circuit of relay D R P of the corresponding station will be closed and the armatures 191, 192 and 193 will be raised while the circuits of the other main relays will remain open and their armatures will be lowered. This relation is shown in Fig. 1 in connection with the main relays of station A. Under such conditions the operating magnet 186 of the perforating punch 181 will be energized by current supplied by the battery 176 to cause said punch to make a perforation in the chart 169, the circuit being established as follows: battery 176, wires 177, 198, 199, 200 and 216, magnet 186, wire 201, armature 193 in its upper position, wires 202 and 203, armature 197 in its lower position, and wires 204 and 180 to the other terminal of battery 176.

Assuming that the combination of alternating and positive direct current only is supplied to the signal rails of a particular station, when the shoe 5 contacts with such rails the circuits of relays D R P and A C R of the corresponding station will be closed and the armatures 191, 192, 193 and 197 will be raised while the circuit of the relay D R N will remain open and the armatures 194, 195 and 196 will be lowered. This relation is shown in Fig. 1 in connection with the main relays of station E. Under such conditions the operating magnet 187 of the perforating punch 182 will be energized by current supplied by the battery 176 to cause said punch to make a perforation in the chart 169, the circuit being established as follows: battery 176, wires 177, 198, 199 and 205, magnet 187, wire 206, armature 192 in its upper position, wires 207 and 208, armature 197 in its upper position, and wires 204 and 180 to the other terminal of battery 176.

Assuming that alternating current only is supplied to the signal rails, when the shoe 5 contacts with such rails the circuit of relay A C R of the corresponding station will be closed and the armature 197 will be raised while the circuits of the other main relays will remain open and their armatures will be lowered. This relation is shown in Fig. 1 in connection with the main relays of station D. Under such conditions the operating magnet 188 of perforating punch 183 will be energized by current supplied by the battery 176 to cause said punch to make a perforation in the chart 169, the circuit established being as follows: battery 176, wires 177, 198 and 209, magnet 188, wire 210, armature 191 in its lower position, wire 211, armature 194 in its lower position, wire 208, armature 197 in its upper position, and wires 204 and 180 to the opposite terminal of battery 176.

Assuming that the combination of alternating and negative direct current is supplied to the signal rails, when the shoe 5 contacts with such rails the circuits of relays D R N and A C R of the corresponding station will be closed and the armatures 194, 195, 196 and 197 will be raised while the circuit of the relay D R P will remain open and the armatures 191, 192 and 193 will be lowered. Under such conditions the operating magnet 190 of the perforating punch 185 will be energized by current supplied by the battery 176 to cause said punch to make a perforation in the chart 169. The circuit thus established may be readily traced in connection with the relays of station E by keeping in mind that the armatures 194, 195 and 196 are assumed to be raised while the armatures 191, 192 and 193 are assumed to be lowered. Such circuit is as follows: battery 176, wires 177, 198, 199 and 212, magnet 190, wire 213, armature 195 in its upper

position, wire 208, armature 197 in its upper position and wires 204 and 180 to the other terminal of battery 176.

Assuming that negative direct current only is supplied to the signal rails, when the shoe 5 contacts with such rails the circuit of relay D R N of the corresponding station will be energized and the armatures 194, 195 and 196 will be raised while the circuits of the other main relays will remain open and their armatures will be lowered. This relation is shown in Fig. 1 in connection with the main relays of station C. Under such conditions the operating magnet 189 of the perforating punch 184 will be energized by current supplied by the battery 176 to cause said punch to make a perforation in the chart 169, the circuit being established as follows: battery 176, wires 177, 198, 199, 200 and 214, magnet 189, wire 215, armature 196 in its upper position, wire 203, armature 197 in its lower position and wires 204 and 180 to the other terminal of battery 176.

It will be understood that the invention is believed to be of considerable breadth in its particular field and hence that no specific description herein contained is intended to put any limitation upon the scope of the appended claims or to be taken otherwise than for the purpose of exposition.

I claim as my invention:

1. In a system of train control a central office switch having three longitudinal positions and including a pair of stationary contacts and arms cooperating therewith and relatively arranged whereby in one longitudinal position both contacts are engaged, in another longitudinal position only one contact is engaged and in a third longitudinal position only the other contact is engaged.

2. In a system of train control, a central office switch having three longitudinal positions and including a pair of stationary contacts and arms cooperating therewith and relatively arranged whereby in the intermediate longitudinal position both contacts are engaged, in one of the extreme longitudinal positions only one contact is engaged and in the other extreme longitudinal position only the other contact is engaged.

3. In a system of train control, a central office switch having at least two angular positions and two longitudinal positions and including pairs of stationary contacts, each pair of contacts being operative in a corresponding angular position of said switch, said switch in one longitudinal position engaging one of the contacts of a pair and in the other longitudinal position engaging the other contact of a pair.

4. In a system of train control, a central office switch having two angular and three longitudinal positions and including a pair of stationary contacts for each angular position and arms cooperating therewith, said

contacts and arms being relatively arranged whereby in one longitudinal position both contacts are engaged, in another longitudinal position only one contact is engaged and in a third longitudinal position only the other contact is engaged.

5. In a system of train control, a central office switch having two angular and three longitudinal positions and including a pair of stationary contacts for each angular position and arms cooperating therewith; said contacts and arms being relatively arranged whereby in the intermediate longitudinal position both contacts are engaged, in one of the extreme longitudinal positions only one contact is engaged and in the other extreme longitudinal position only the other contact is engaged.

6. In a system of train control, a central office switch having two angular positions, one of which is a neutral position, and also having longitudinal positions, stationary contacts and arms cooperative in the other angular position and in any longitudinal position, and means for holding the switch against longitudinal movement in its operative angular position and for permitting such movement only in the neutral angular position.

7. In a system of train control, a central office switch having two angular positions, one of which is a neutral position, and also having longitudinal positions, said switch including an operating shaft, a bearing in which said shaft is rotatably and slidably mounted, stationary contacts and arms cooperative therewith in the other angular position and in any longitudinal position, and a key projecting radially from said shaft, one of the bearings having a slot through which the key is movable only in the neutral position of said switch.

8. In a system of train control, a central office switch having three angular positions, the middle of which is a neutral position and the extreme of which are operative positions, said switch also having longitudinal positions, stationary contacts and arms cooperative in either extreme angular position and in any longitudinal position, and means for holding the switch against longitudinal movement in either of its extreme angular positions and for permitting such movement only in the neutral angular position.

9. In a system of train control, a central office switch having movements in two directions and in its movement in the first direction having an operative position and a neutral position, means for preventing movement of said switch in the other direction except as it is first brought to neutral position by a movement in the first direction and contact means engageable in any operative position of said switch.

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