June 23, 1925. 1,543,461

W. J. UNDERWOOD

CONTROL OF RAILWAY TRAINS

Filed July 12, 1923 2 Sheets-Sheet 1

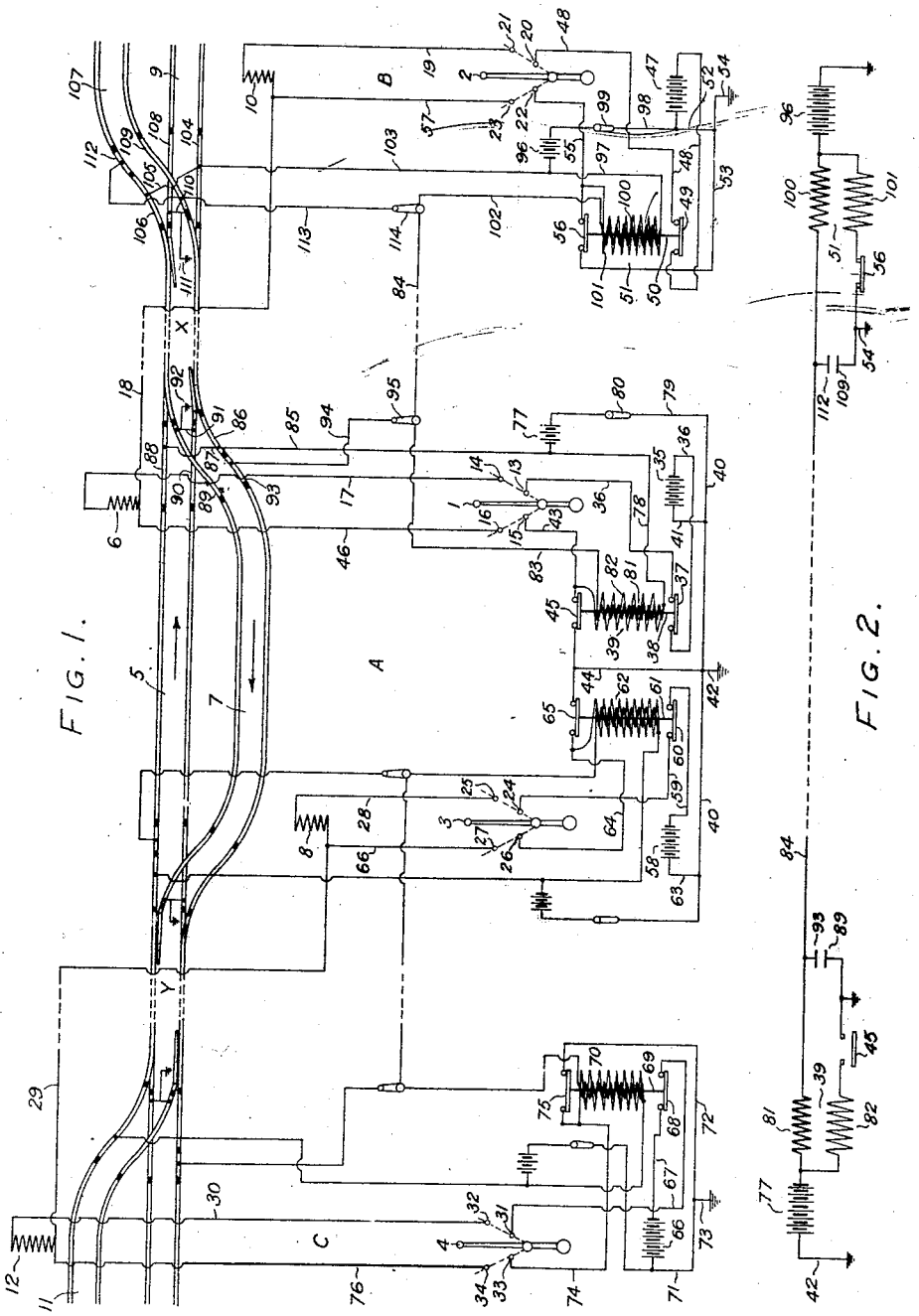


FIG. 1.



FIG. 2.

INVENTOR:
Walter J. Underwood
By Wm Wallace White
ATTY.

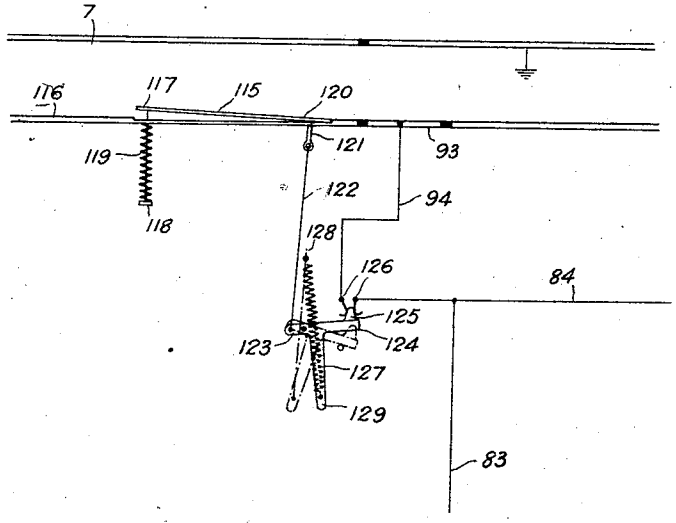
June 23, 1925. 1,543,461

W. J. UNDERWOOD

CONTROL OF RAILWAY TRAINS

Filed July 12, 1923 2 Sheets-Sheet 2

FIG. 3.




INVENTOR:
Walter J. Underwood
BY Wm Wallace White
ATTY.

Patented June 23, 1925. 1,543,461

# UNITED STATES PATENT OFFICE.

WALTER JOHN UNDERWOOD, OF LONDON, ENGLAND.

## CONTROL OF RAILWAY TRAINS.

Application filed July 12, 1923. Serial No. 650,984.

*To all whom it may concern:*

Be it known that I, WALTER JOHN UNDERWOOD, of 24 Stanley Crescent, Notting Hill, London, W. 11, England, a subject of the King of Great Britain and Ireland, have invented certain new and useful Improvements in and Relating to the Control of Railway Trains, of which the following is a specification.

This invention relates to the control of traffic on single track railways and has for its object to provide means enabling a foolproof method of control similar to that described in my copending application Serial No. 539834 filed on the 28th February, 1922, to be applied without requiring the rails of the single track sections intermediate the various stations to be bonded, that is, to be made electrically continuous throughout each section.

The present improvement consists in the provision of an electromagnet at each station normally energized and controlling the main operating circuits and so connected to a source of current and to appropriate portions of the track that on a train leaving a station the electromagnet is de-energized and opens the operating circuits connecting the said station with the next station to which the train is proceeding and said electromagnet cannot again be energized to close the said circuit until the train arrives at the said next station, thus preventing the possibility of a second train being inadvertently started, either from the said next station in the opposite direction, or from the first mentioned station in the same direction until the single track section connecting the two stations has been completely cleared by the first train, but without requiring the rails of the single track section to be bonded.

In order that the nature of the invention may be clearly understood an arrangement in accordance therewith will now be described with reference to the accompanying diagrammatic drawings in which—

Fig. 1 shows the connections according to the invention for one complete station and the two single track sections extending therefrom, one in each direction;

Fig. 2 is an explanatory diagram showing the effect upon the circuits when a train passes from one station to the next station;

Fig. 3 shows an optional detail which may be employed in connection with the invention.

Referring to the drawings, a station A is shown in Fig. 1 connected by a single track section X with a station B on the right, and by a single track section Y with a station C on the left.

The switch 1 in the signal cabin at station A is used in conjunction with the switch 2 in the signal cabin at station B for the control of traffic passing in both directions between stations A and B along track section X, and the switch 3 in the signal cabin at station A is used in conjunction with the switch 4 in the signal cabin at station C for the control of traffic passing along track section Y in both directions between stations A and C. It will of course be understood that the single track sections X and Y may be of any indefinite length, usually amounting to at least several miles.

For the purpose of illustration it will be assumed that the traffic controlling devices which are to be directly operated by means of the foolproof arrangement according to my aforesaid pending application are of the nature of moveable trip devices having a safety and a danger position and designed to produce signalling indications on the passing trains, or to stop a train if danger conditions prevail on the track ahead of the train.

The traffic starting from branch track 5 at station A towards station B is controlled by a track trip having an operating coil 6 and the traffic starting from branch track 7 at station A towards station C is controlled by a track trip having an operating coil 8.

Similarly the traffic starting from branch track 9 at station B is controlled by means of a track trip having an operating coil 10, and traffic starting from branch track 11 at station C towards station A is controlled by means of a track trip having an operating coil 12.

The controlling switch 1 at station A is provided with contacts 13 and 14 on the right hand side and with contacts 15 and 16 on the left hand side. Contact 14 is connected by a wire 17 to one end of the trip operating coil 6 the other end of which is connected by a line wire 18 to one end of the trip operating coil 10 at station B.

The other end of trip coil 10 is connected by a wire 19 to contact 21 on the right hand side of controlling switch 2 which is also provided on the same side with the co-acting contact 20, and on the left hand side with contacts 22, 23.

The controlling switch 3 at station A is provided on the right hand side with contacts 24, 25 and on the left hand side with contacts 26, 27. The contact 25 is connected by a wire 28 to one end of the trip operating coil 8, the other end of which is connected by a line wire 29 to one end of the trip operating coil 12 at station C. The other end of trip coil 12 is connected by a wire 30 to contact 32 on the right hand side of controlling switch 4 which is also provided on the same side with the co-acting contact 31, and on the left hand side with contacts 33, 34.

At station A in connection with controlling switch 1 a battery or other suitable source of current 35 is provided for supplying current to the trip coil 6, and the positive pole of this battery is connected by a wire 36 to the contact 13 of switch 1 through the lower contact 37 connected to the core or armature 38 of the solenoid or electromagnet 39 when the latter is energized as shown in Fig. 1. The negative pole of battery 35 is connected to the earthed wire 40 by a wire 41, the wire 40 being connected to earth at 42. The contact 15 on the left hand side of controlling switch 1 is connected to earth 42 through wires 43 and 44 and through upper contact 45 of solenoid core 38 when the solenoid 39 is energized as shown, the contact 45 being carefully insulated from the said core and from lower contact 37. The contact 16 of switch 1 is connected to the line wire 18 by a wire 46.

At station B in connection with controlling switch 2, which must be used in co-operation with switch 1 at station A to control the traffic on single track section X, a battery or other suitable source of current 47 is provided for supplying current to trip coil 10. The positive pole of battery 47 is connected by a wire 48 to the contact 20 of switch 2 through the lower contact 49 connected to the core or armature 50 of the solenoid or electromagnet 51 when the latter is energized. The negative pole of battery 47 is connected by a wire 52 to the earthed wire 53 which is connected to earth at 54. The contact 22 on the left hand side of controlling switch 2 is connected to earth 54 through wires 55 and 53 and upper contact 56 carried by the core 50 of solenoid 51 when this is in energized condition, the said contact 56 being carefully insulated from the core 50 and thence from the lower contact 49. The contact 23 of switch 2 is connected to the line wire 18 by a wire 57.

Referring again to station A, in connection with controlling switch 3 a battery 58 is provided for supplying current to the trip coil 8, the positive pole of this battery being connected by a wire 59 to the contact 24 of switch 3 through the movable lower contact 60 on the core 61 of the solenoid 62 when the latter is energized. The negative pole of battery 58 is connected by a wire 63 to the earthed wire 40 and earth 42. The contact 26 on the left hand side of switch 3 is connected to earth 42 through wires 64, 44, and upper contact 65 of the core 61 when the solenoid 62 is energized, the contact 65 being carefully insulated from the core 61 and thence from the lower contact 60. The contact 27 of switch 3 is connected to the line wire 29 by a wire 66.

At station C in connection with controlling switch 4, which must be used in co-operation with switch 3 at station A to control the traffic on single track section Y, a battery 66 is provided for supplying current to trip coil 12. The positive pole of battery 66 is connected by a wire 67 to the contact 31 of switch 4 through the lower contact 68 on the core 69 of the solenoid 70 when this is energized. The negative pole of battery 66 is connected by a wire 71 to the earthed wire 72, which is connected to earth at 73. The contact 33 of controlling switch 4 is connected to earth 73 through wires 74 and 72 and upper contact 75 on the core 69 of solenoid 70 when this is energized, the contact 75 being carefully insulated from the core 69 and lower contact 68. The contact 34 of switch 4 is connected to the line wire 29 by a wire 76.

With the exception of the solenoids 39, 51, 62 and 70, and their operation by the movements of the trains as hereinafter explained, the apparatus described above, comprising the switches 1, 2, 3, 4, their contacts, and connections to the trip coils and to the line wires, is similar in arrangement and operation to the corresponding apparatus shown in Fig. 1 of my aforesaid pending application. It is therefore unnecessary to more minutely describe the said parts herein. But in the present improvement the return of all line circuits is through the earth and the bonding of the track rails of the single track sections is entirely dispensed with, the safety of the system being automatically effected by the trains by the following means.

At station A in connection with controlling switch 1 and solenoid 39 an additional battery 77 is provided the positive pole of which is connected to the windings of the solenoid by a wire 78, while the negative pole is connected to earth 42 by the earthed wire 40 and a wire 79, preferably through a switch 80 the object of which will be pointed out hereinafter.

The solenoid 39 has two windings, one 81 of thick wire and relatively low resist-

ance, and the other 82 of thin wire and relatively high resistance. The winding 81 is so designed and dimensioned that its ampere-turns are sufficient to lift the core 38 from its de-energized to its energized position when the said winding is directly connected between the battery 77 and earth: but the said winding 81 is unable to lift the core 38 if any considerable amount of resistance is connected in circuit therewith, such for instance as the resistance of the thin wire winding 82. The winding 82 is formed of a wire having a cross sectional diameter which may be only a fraction, for example 1/8th, of that of the wire forming the winding 81 and is so dimensioned that its ampere-turns are sufficient to hold up the core 38 when connected directly between the battery 77 and earth, that is, without any relatively considerable amount of resistance being connected in series therewith. To give numerical examples, merely by way of illustration, the lifting winding 81 might be of copper wire having a resistance of approximately 6 ohms per mile; the holding winding 82 might be of copper wire having a resistance of approximately 135 ohms per mile. The ampere-turns of winding 82 when connected directly between the battery 77 and earth must not in any case be sufficient to lift the core 38 from its lower to its raised position, but only to hold the core in the latter position after it has been raised thereto by the thick wire winding 81.

The thick wire winding 81 is connected by a wire 83 to a second line wire 84 extending to the next station B, while the thin wire winding 82 is connected to wire 43 and thence to earth 42 through the upper contact 45 of solenoid 39 and wire 44 when the said solenoid is energized.

The positive pole of the battery 77 is connected by a wire 85 to an outer length of rail 86 leading from the single track section X to the branch track 7 at station A, and the rail 86 is also connected electrically by a wire 87 to an outer length of rail 88 leading from the branch track 5 at station A to the single track section X, the two rails 86 and 88 being carefully insulated from earth and defined by track insulation of any usual kind as shown. The inner rail length 89 leading to track 7 from the single track section X and the inner rail length 90 leading from branch track 5 to the single track section X are connected electrically by a wire 91 and to earth at 92 as shown. Adjacent to the home end of the rail 86 to be finally left by a train arriving at station A from station B is a short length of rail 93 which is insulated from earth and from the adjacent rail 86 by track insulation as shown, the track insulation being so arranged that as long as a wheel on an axle of a vehicle is in contact with rail 93 the other wheel at the opposite end of said axle will be in contact with the rail 89 and thence with earth 92. The rail 93 is electrically connected to the line wire 84 by a wire 94, preferably through a switch 95 for a reason hereinafter explained.

Similar arrangements and connections to those described above in connection with controlling switch 1 are also provided in connection with controlling switch 3 at station A, in connection with switch 2 at station B, and again in connection with switch 4 at station C.

Referring to the arrangements at station B, an additional battery 96 is provided the positive pole of which is connected to the windings of the solenoid 51 by a wire 97, while the negative pole is connected to earth 54, through wires 98, 52, and 53, preferably through a switch 99. The thick wire winding of solenoid 51 is shown at 100 and the thin wire winding at 101, the former being connected by a wire 102 to the line wire 84, while the thin wire winding 101 is connected to the wire 55 and thence to the earth 54 through the upper contact 56 of the solenoid core 50 and wire 53 when the solenoid is energized.

The positive pole of battery 96 is connected by a wire 103 to an outer rail length 104 leading from branch track 9 to the single track section X, the rail 104 being also connected by a wire 105 to an outer rail length 106 of the branch track 107 leading from the single track section X to station B, the two rails 104 and 106 being carefully insulated from earth and from the adjacent rail lengths by track insulation of any suitable kind, as shown. The inner rail length 108 of branch track 9 and the inner length of rail 109 of branch track 107 are electrically connected together by a wire 110 and thence to earth at 111. Adjacent to the arrival end of rail length 106 to be finally left by a train arriving at station B from station A is a short length of rail 112 which is insulated from earth and from the rail length 106 by track insulation as shown, the arrangement being such that as long as one wheel of a vehicle axle is in contact with rail length 112 the wheel on the other end of the axle will be in contact with the earthed rail 109. The rail length 112 is electrically connected to the line wire 84 by a wire 113, preferably through a switch 114.

In describing the operation of the system it will be supposed that a train is standing on branch track 5 at station A waiting for permission to start towards station B and another train is standing on branch track 9 at station B waiting for permission to start towards station A, and the signalmen at stations A and B have agreed to despatch the first mentioned train first. The single track section X is clear and solenoids

39 and 51 are energized. The core 38 of solenoid 39 is held up by the current from battery 77 traversing the thin wire winding 82 and returning to the negative side of the battery through the upper contact 45 and wires 44, 40 and 79, and through switch 80. The core 50 of solenoid 51 is held up by the current from battery 96 traversing the thin wire winding 101 and returning to the negative side of said battery through the upper contact 56 and wires 53, 52 and 98 and through switch 99. No current normally passes through the thick wire windings 81 and 100 of the respective solenoids 39 and 51 as these windings are connected in series with one another by the line wire 84 between the mutually opposing batteries 77 and 96 as seen in the diagram of Fig. 2.

The signalman at A turns the switch 1 to the right to bridge the contacts 13 and 14, and the signalman at B turns the switch 2 to the left to bridge the contacts 22, 23. A current passes from the positive pole of battery 35 through wire 36 and lower contact 37 of solenoid core 38 to contact 13 through blade of switch 1, contact 14, wire 17, trip coil 6, line wire 18, wire 57, contact 23, blade of switch 2, contact 22, wire 55, upper contact 56 of solenoid core 50, wire 53, to earth 54, and thence by earth 42 and wire 40 to the negative side of battery 35. Thus the trip coil 6 is energized, the trip is moved to safety position, the points are adjusted and the signal (not shown) lowered, and the train starts.

As soon as the front wheels of the train connect the insulated lengths of rails 88, 90, the battery 77 is short-circuited through the wires 85, 87, rails 88, 90, wire 91, earth 92, earth 42, wires 40 and 79 and switch 80. The solenoid 39 is therefore de-energized and the core 38 drops, thus opening the circuit of the trip coil 6 at the lower contact 37.

The signalmen at A and B release their respective switches 1 and 2 and the train proceeds along the single track section X. In the meantime no further train movement in either direction between A and B can take place as both of the trips corresponding to coils 6 and 10 stand at danger position and neither the operating circuit of the one or the other can be closed until the solenoid 39 is again energized and the circuits again closed by the upper and lower contacts 45 and 37.

On the train approaching station B it passes to the branch track 107. On the front wheels bridging the insulated rail lengths 106, 109 the battery 96 at station B is short circuited through wires 103, 105, rails 106, 109, wire 110, earths 111 and 54, wires 52, 98 and switch 99. Hence the solenoid 51 is de-energized and its core 50 drops, thus opening the respective circuits controlled by the lower and upper contacts 49 and 56. If the train fails to pass completely off rail length 106 the battery 96 remains short circuited and the switch 2 continues to be inoperative. On the last pair of wheels of the train passing from rails 106 and 109 and connecting rails 112 and 109 the said short circuit is broken and the circuit of the thick wire winding 100 of solenoid 51 is supplied with current as follows, from the positive pole of battery 96, through wire 97, winding 100, wire 102, switch 114, wire 113, rail 112, rail 109, earths 111 and 54, wires 52, 98 and switch 99, to the negative pole of the battery. On the core 50 being lifted the circuit of the thin wire winding 101 is completed to earth through the upper contact 56, the core 50 is maintained in raised position, and the circuit of the thick wire winding 100 is again opened by the last pair of wheels of the train passing off the rail lengths 112 and 109.

At station A, as soon as the front pair of wheels of the train bridge the rails 112 and 109 the circuit of the thick wire winding 81 of the solenoid 39 is completed through wire 83, line wire 84, switch 114, wire 113, rails 112 and 109, and earths 111, 42, back to the negative pole of battery 77. Hence the thick wire winding 81 of solenoid 39 is fully energized, the core 38 is raised and the maintaining circuit is closed through the thin wire winding 82, upper contact 45 and wires 44, 40, 79 and switch 80; immediately afterwards the last wheels of the train pass off the rails 112 and 109, the thick wire winding 81 is again deprived of current, and the two switches 1 and 2 can again be operated to move the train waiting on track 9 from B to A.

For this purpose the signalman at B moves switch 2 to the right and the signalman at A moves switch 1 to the left. A current passes from the positive pole of battery 47 through wire 48 and lower contact 49 of solenoid core 50 to contact 20, thence by blade of switch 2 to contact 21, through wire 19, trip coil 10, line wire 18, wire 46, contact 16, blade of switch 1, contact 15, wire 43, upper contact 45 of solenoid core 38, wire 44, earths 42 and 54 and wire 52 back to the negative side of battery 47. The trip coil 10 is thus energized, the corresponding trip moves to safety position, the points are adjusted and the starting signal (not shown) is lowered, and the train starts from B towards A. On the front wheels of the train engaging the insulated rail lengths 104 and 108 the battery 96 is short-circuited through wire 103, rail 104, rail 108, wire 110, earths 111 and 54, wires 52, 98, and switch 99. The solenoid 51 is therefore de-energized and its core 50 drops thus rendering switch 2 inoperative for any further train movement over single track section X

until the said solenoid is again energized. In the meantime the train proceeds along section X towards station A.

On the train approaching station A it passes to the branch track 7 and on the front pair of wheels connecting rail lengths 86 and 89 the battery 77 is short-circuited through wire 85, rail 86, rail 89, wire 91, earths 92 and 42, wires 40, 79, and switch 80. The solenoid 39 is therefore de-energized and drops its core 38, ensuring that switch 1 is inoperative as long as any part of the train is in contact with rails 86 and 89. On the last pair of wheels of the train leaving rails 86 and 89 and connecting rails 93 and 89 the above short circuit is broken and the circuit of the thick wire winding 81 of solenoid 39 is made through wire 78, winding 81, wire 83, switch 95, wire 94, rails 93 and 89, and earths 92 and 42 as previously traced. The solenoid 39 is therefore again energized and lifts its core thus closing the local maintaining circuit through the thin wire winding 82 as before. The thick wire winding 81 is again cut out of operation when the last pair of wheels of the train passes off the rails 93 and 89.

At station B, as soon as the front pair of wheels of the train bridge the rails 93 and 89 the circuit of the thick wire winding 100 of solenoid 51 is completed through wire 102, line wire 84, switch 95, wire 94, rails 93 and 89, earths 92 and 54, wires 52, 98, and switch 99, back to the negative side of battery 96. The solenoid 51 being fully energized lifts its core 50 and closes the local maintaining circuit through the thin wire winding 101 as has been previously traced. On the last pair of wheels of the train passing off the rails 93 and 89 the thick wire winding 100 is again rendered currentless, and the two switches 1 and 2 can again be operated to effect a train movement over single track section X.

Referring to the diagram in Fig. 2 it will be seen that on the solenoid core 38 dropping and opening contact 45, as a train starts from A towards B, the thick wire winding 81 of solenoid 39 is connected between the battery 77 and earths 54 and 42 in series with the line wire 84, the thick wire winding 100 and the thin wire winding 101 of solenoid 51 at station B, as long as the solenoid 50 maintains the contact 56 closed. As the resistance of the thin wire winding of any one of the solenoids is several times as great as that of the corresponding thick wire winding (and all the solenoids are of similar design), it will be clear to every electrician that it is quite easy to so design the solenoids that the winding 81, for instance, is unable to lift its core 38 under the conditions shown in Fig. 2 with the same certainty as if the circuit to earth from said winding was open, and in fact so that the said winding is only able to lift its core when the circuit to earth is closed either at 112 and 109, or at 93 and 89, by the passage of a train thus shunting the greater part of said resistance.

It is essential that a train arriving at station A from station B should pass completely clear of the insulated rails 93 and 89. Similarly it is essential that a train arriving at B from A should pass completely clear of the insulated rails 112 and 109. Supposing for instance, that the last pair of wheels of a train on branch track 7 at A is bridging the rails 93 and 89, and a train is started from branch track 5 towards station B. The latter train on engaging the insulated rails 88, 90 short circuits the battery 77 and de-energizes the solenoid 39 in the manner described above. On the train completely clearing the said rails 88, 90 the solenoid 39, would again be energized owing to the circuit of the thick wire winding 81 being completed through the rear wheels of the train standing on track 7. This may easily be prevented from happening by arranging the track insulation in such a manner that a train arriving on branch track 7 from station B must necessarily leave the rails 93, 89 to enable another train proceeding from A to B from track 5 to clear the rear vehicle of the train on track 7. Similarly in the case of the track insulation for rails 104, 106, 108, 109, 112, at station B, and at all other stations.

The switches 80 and 99 are provided in the signal cabin to enable the signalman concerned to open the circuit of battery 77 or 96 in case he observes a train or vehicle come to a standstill and likely to remain for some time in a position short circuiting the battery; thus these switches enable the signalmen to prevent unnecessary waste of current.

The switches 95 and 114 give the signalmen control over the connections of the insulated rails 93 and 112 with the line wire 84 and enable them to open said connections under certain irregular or unforeseen circumstances, such as, experience shows, will happen occasionally in the control of railway trains. For instance, supposing a train has arrived from station B at side track 7 of station A and after having duly cleared the insulated rails 93 and 89 as described above a train is despatched from side track 5 at A towards B. If, while the latter train is proceeding along the single track section X, the train on track 7 is backed so as to bridge the rails 93 and 89, this would have the effect of energizing the solenoid 39 and thus interfering with the automatic control thereof by the train proceeding to B in the intended manner. If however the signalman opens the switch 95 on observing, or perhaps authorizing, this backing movement of the

train on track 7, this interference with the intended automatic safety control is prevented, but without opening the saftey circuit from the thick wire winding 81 of solenoid 39, through wire 83, line wire 84, wire 113, rails 112, 109 at station B, to earth. Thus the intended operation of the system as regards a train proceeding from the station A, is in no way interfered with by the opening of the switch 95.

In addition to, or instead of, the provision of the switch 95, a simple automatic device of the kind shown in Fig. 3 may be provided adjacent to the rail 93, for example. This figure illustrates an automatic circuit-opener which is operated by a train or vehicle when proceeding in one direction only, but is not affected by the vehicle moving thereover in the other direction. Referring to Fig. 3, a thin iron bar 115 is arranged on the inside of the track rail 116 adjacent to insulated rail 93 and is arranged at such a level that it is mechanically engaged by the flanges of the wheels of a train. The rail 116 is somewhat recessed on its inner side to enable the bar 115 to be forced into the recess as a train passes without appreciably altering the gauge of the track rails at that point.

The end 117 of the bar 115 is connected to a transverse bar 118 passing through a hole in the web of rail 116 and to the outer end of bar 118 one end of a tension spring 119 is secured the other end of the spring being fixed to the outer side of rail 116, the arrangement being adapted to normally maintain the end 117 of bar 115 such a distance, say 2½ or 3 inches, away from the rail 116 that the flange of a wheel moving from left to right, will pass with certainty between the bar 115 and rail 116. The other end 120 of bar 115 is adapted normally to rest in the recess of the rail 116 after being once brought into this position by hand, and is connected to a short transverse bar 121 passing through a hole in the web of rail 116. A flexible wire 122 is connected at one end to the transverse bar 121 and at the other end to the short arm 123 of a pivoted lever, the long arm 124 of which carries a movable contact 125 adapted normally to bridge the fixed contacts 126 inserted in the connection 94 (Fig. 1). An off-centre tension spring 127 is connected between a fixed point 128 and the outer end of a third lever arm 129 fixed to, or integral with, the arms 123 and 124. The spring 127 is so arranged that when the contact 125 is bridging the contacts 126 the said spring passes to the right of the pivot of the levers 123, 124, 129, thus tending to maintain the contacts closed. At the same time the bar end 120 is drawn close against the rail 116 and the wire 122 is so adjusted that it has no undue slack in the said position of the parts.

It will be seen that as the wheels of a vehicle move over the device from right to left the flanges of the wheels force the bar 115 against the rail 116, the end 117 of the bar springing away from the rail to its normal position shown in the drawing after each wheel flange disengages therefrom. Thus the switch contact 125 is not affected thereby. If however a wheel of a vehicle moves over the device from left to right the wheel flange engages between the bar 115 and the rail 116 and forces the end 120 of bar 115 away from the rail 116; this movement is transmitted by the bar 121 and wire 122 to the short lever arm 123, thus rotating the device to open the contact 125. The device must be reset by hand.

The operation of the system between stations A and C being exactly similar to that above described for stations A and B, it is unnecessary to describe herein in detail the said operation between stations A and C as the circuits involved will be easily traced from the drawings.

What I claim and desire to secure by Letters Patent is:—

1. For controlling the traffic on single track railways, the combination with the single track section and a signalling station at each end of the same, of an electrically controlled track device at each station governing the movement of the trains from the station on to the single track section, an operating circuit for each said track device comprising a line conductor connecting the two track devices, means for energizing one at a time the operating circuits to enable a train to move from one station on to the single track section, an electromagnet at each station controlling the operating circuits, a connection to the track at each station for de-energizing the corresponding electromagnet on a train passing from the station on to the single track section, and a connection from the electromagnet through a second line conductor to the arrival track at the other station enabling the circuit of the said electromagnet to be again closed by the train on its arrival at the said other station.

2. For controlling the traffic on single track railways, the combination with a single track section and a signalling station at each end of the same, of a departure branch track and an arrival branch track at each station, an electrically controlled track device at each station governing the movement of trains from the departure branch track on to the single track section, an operating circuit for each said track device comprising a line conductor connecting the two track devices, means for energizing one at a time the operating circuits to enable a train to move from the departure branch track at one station on to the single track section, an electromagnet at each station controlling the operating circuits, said

electromagnet having two coils, one of low resistance referred to as the lifting coil and the other of relatively high resistance referred to as the maintaining coil, a source of current for the operating circuits, a separate source of current for energizing the controlling electromagnets, a connection from the energizing source of current to the departure branch track at each station enabling said source of current to be short circuited on a train passing from the said branch track on to the single track section and consequently the operating circuits to be opened, and a connection from the energizing source of current through the lifting coil of the electromagnet and a second line conductor to the arrival branch track at the other station causing the lifting circuit of the electromagnet to be again closed by the train on its arrival at the said other station.

3. For controlling the traffic on single track railways, the combination with a single track section and a signalling station at each end of the same, of an electrically controlled trip device at each station, means normally holding each trip device in its danger position, an operating circuit for each trip comprising a line conductor connecting the two trips, means for energizing one at a time the operating circuits to lower one trip to its safety position to allow a train to pass from the corresponding station on to the single track section, an electromagnet at each station controlling the operating circuits, a connection to the track at each station for de-energizing the corresponding electromagnet on a train passing from the station on to the single track section to cause the operating circuit to be opened and the trip device to return to its danger position, and a connection from the electromagnet through a second line conductor to the arrival track at the other station enabling the circuit of the said electromagnet to be again closed by the train on its arrival at the said other station to enable another train movement on to the single track section to take place.

4. For controlling the traffic on single track railways, the combination with a single track section and a signalling station at each end of the same, of electrically controlled track devices and operating circuits therefor for passing one train at a time on to the single track section, an electromagnet at each station controlling said circuits, connections to the track enabling a train to successively de-energize both electromagnets as it leaves one station and arrives at the other station, re-setting circuits for the two electromagnets, connections at each station to an insulated length of rail forming part of the re-setting circuits to enable a train arriving at the station to close both re-setting circuits in parallel, and means on the track to prevent the arriving train, after clearing the said insulated length of rail, from again closing the re-setting circuits by running back on to the said insulated length of rail.

In testimony whereof I have signed my name to this specification.

WALTER JOHN UNDERWOOD.