Nov. 9, 1937. L. R. ALLISON 2,098,819

CONTROL SYSTEM

Filed Jan. 4, 1936 2 Sheets-Sheet 1

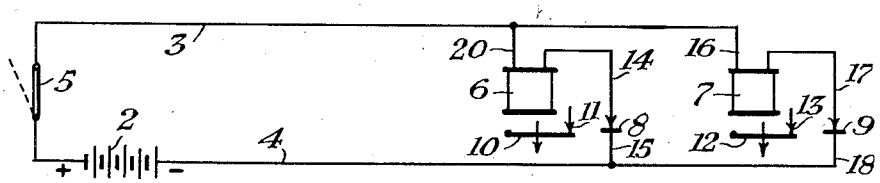



Fig. 1.

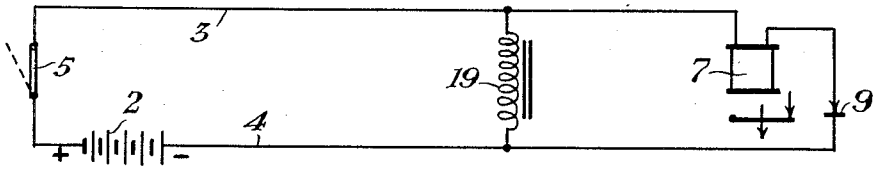



Fig. 2.

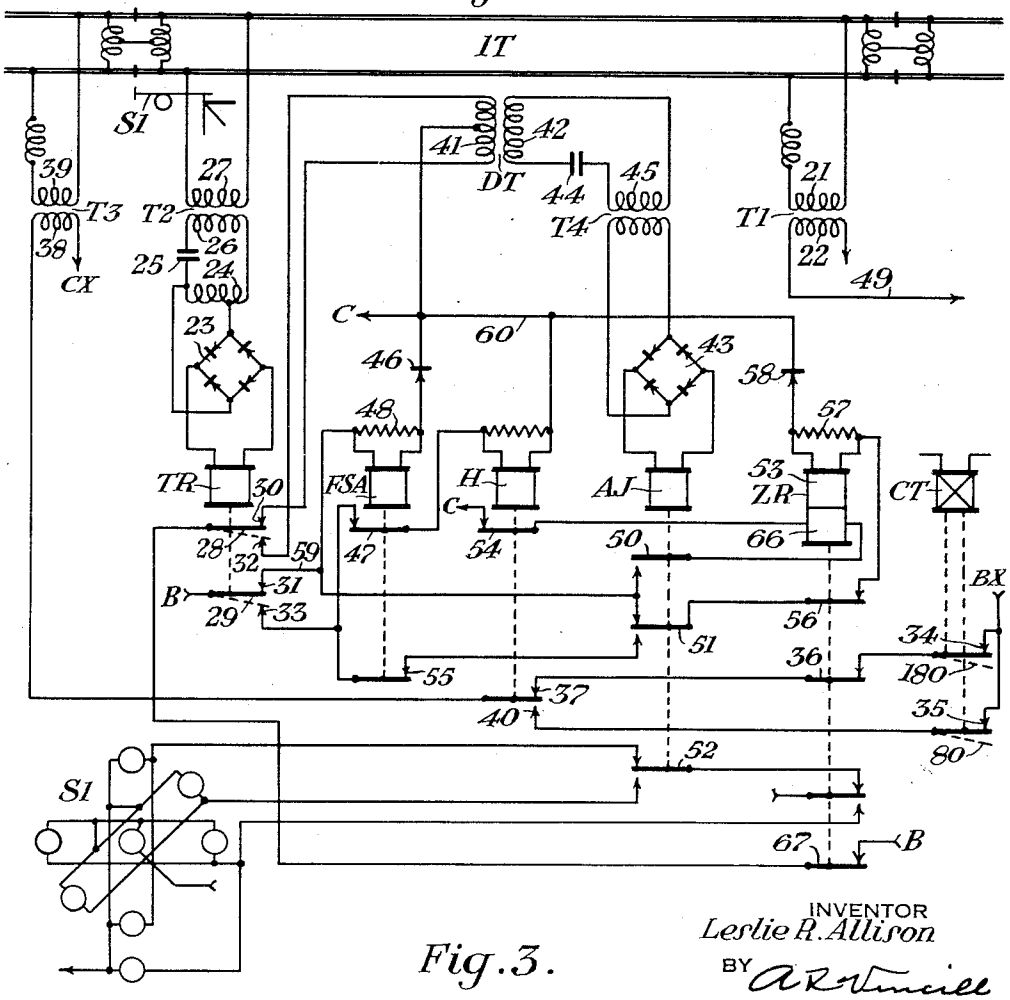



Fig. 3.

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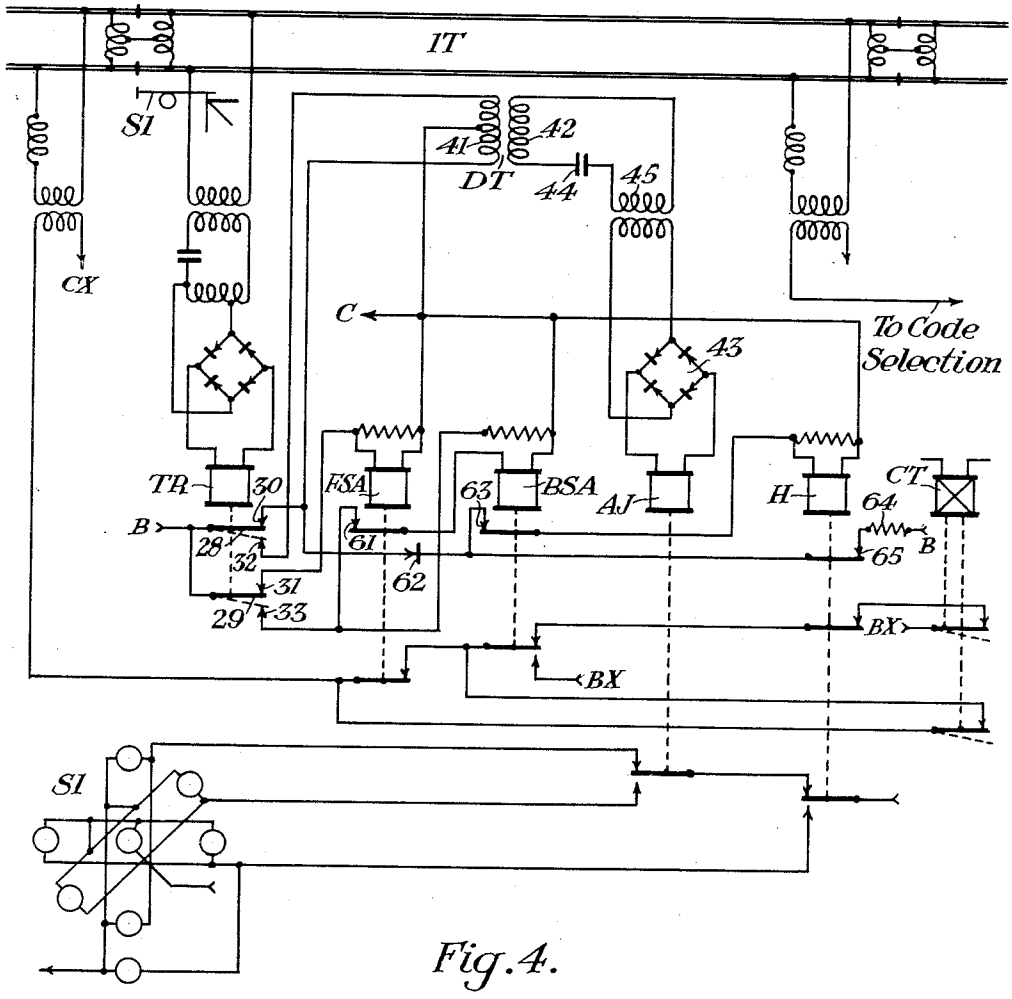



Fig. 4.

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# UNITED STATES PATENT OFFICE

2,098,819

## CONTROL SYSTEM

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Application January 4, 1936, Serial No. 57,572

4 Claims. (Cl. 246—3)

My invention relates to control systems, and particularly to control systems for electrical relays which are slow-releasing in character.

A feature of my invention is the provision of novel and improved apparatus for governing the operation of a relay characterized by being provided with a predetermined slow-release period and which relay is energized in multiple with another device possessing inductance. Other features and advantages of my invention will appear as the specification progresses.

I will describe several forms of apparatus embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view of one form of apparatus embodying my invention, and Fig. 2 is a diagrammatic view of a second form of apparatus embodying my invention. Figs. 3 and 4 are diagrammatic views of two different forms of circuits and apparatus showing applications of my invention to railway signal systems.

In the following description, reference is made to the accompanying drawings in which like reference characters designate similar parts.

In Fig. 1, a source of current such as a battery 2 is connected across two control wires 3 and 4, the polarity of the battery being as indicated by the plus and minus signs. A circuit controlling contact 5 is interposed between the battery and the control wires for governing the supply of current to the circuit. As here shown, the contact 5 is located between the positive terminal of battery 2 and the control wire 3, the contact 5 being operable to a closed position which is indicated by the solid line in the drawings, or to an open position which is indicated by a dotted line.

Two direct current relays 6 and 7 are controlled by current supplied by the battery 2 over the contact 5 by virtue of having their operating windings connected across the control wires 3 and 4 in multiple. To be explicit the left-hand terminal of the winding of relay 6 is connected with wire 3 over wire 20, and its right-hand terminal is connected with wire 4 over wire 14, asymmetric unit 8 to be referred to later, and wire 15. The left-hand terminal of the winding of relay 7 is connected with wire 3 over wire 16, and its right-hand terminal is connected with wire 4 over wire 17, asymmetric unit 9, and wire 18. These asymmetric units 8 and 9 may be of any one of several different forms such as, for example, the well-known copper oxide rectifier, and each is disposed with its forward or low resistance direction toward the control wire 4 which wire is connected with the negative terminal of battery 2. The relay 6 is provided with a circuit controlling armature 10 capable of making engagement with a front contact 11 when the relay is energized and falling away therefrom when the relay is deenergized. In like manner the relay 7 is provided with a circuit controlling armature 12 adaptable of making engagement with a front contact 13 when the relay is energized and to fall out of engagement therewith when the relay is deenergized. These contacts 10—11 and 12—13 of relays 6 and 7, respectively, may be used to govern other circuits as desired. The relays 6 and 7 are each slow-releasing in character and each is preferably provided with a particular predetermined slow-release period in accordance with what may be required to give proper operation of the circuit controlled by that relay. In other words, the slow-release periods for relays 6 and 7 may be unequal in duration. For example, the release period of relay 6 may be of the order of one second and that of relay 7 may be of the order of two seconds. It follows that when contact 5 occupies its closed position, current flows from battery 2 through the windings of the two relays 6 and 7 in multiple and the armatures of the two relays are picked up, the asymmetric units 8 and 9 not impeding the flow of current since each unit is disposed with its forward direction toward the negative terminal of the battery, but that when contact 5 is operated to its open position, current is removed from the windings of the two relays and both relays are deenergized and the armature of each relay is released at the end of the particular release period of the associated relay.

It is sometimes desirable to periodically operate contact 5 between its open and closed positions at a rate sufficient to allow one of the relays, say relay 6, to release during the open period and not relay 7, and then at other times to operate contact 5 at a rate such that both relays are released during the open period. Heretofore the operation of two or more slow-release relays with different retardations was complicated because the retardation of one relay was not independent of the electrical characteristics of the other relay operating in multiple with it. That is, without asymmetric units interposed in the circuit connections, if contact 5 were moved to its open position there would be a flow of current from the winding of one relay to the winding of the other relay due to the stored inductive energy. Assuming the polarity to be as indicated in Fig. 1 and that the asymmetric units 8 and 9 are omitted

from the circuit and contact 5 is moved to its open position, current will tend to flow from the winding of relay 6 due to the voltage of self-inductance over a circuit traced from the right-hand terminal of the winding of relay 6, wires 14 and 15, control wire 4, wires 18 and 17, winding of relay 7, wire 16, control wire 3, and wire 20 to the left-hand terminal of the winding of relay 6. In a similar manner, the voltage of self-inductance of relay 7 will tend to cause current to flow from the right-hand terminal of the winding of relay 7 over wires 17, 18, 4, 15 and 14, winding of relay 6, wires 20, 3 and 16 to the left-hand terminal of the winding of relay 7. Of course, if the characteristics of the two relays 6 and 7 are exactly alike, the voltages of self-inductance will cancel each others effects, but since it is impracticable and, as stated hereinbefore, in any cases undesirable to have the relays of like characteristics, the release time of each relay will be effected by the change of energy between the relays. It is clear that with apparatus constructed in accordance with my invention, the asymmetric unit 9 is effective to block the flow of any current caused by the voltage of self-inductance of relay 6, and the asymmetric unit 8 is effective to block any flow of current caused by the voltage of self-inductance of relay 7, and hence the release periods of the relays are independent of each other.

In Fig. 2, the battery 2 is connected with control wires 3 and 4 over the contact 5 the same as in Fig. 1. Also, the relay 7 is connected across these control wires with the asymmetric unit 9 interposed in the connection the same as in Fig. 1. A winding 19 is connected across the control wires for receiving energizing current in multiple with the winding of relay 7. This winding 19 may be included in any device which it is desired to operate by current from battery 2 over contact 5. The significant fact about the winding 19 as far as the present application is concerned is that it possesses inductance. It is clear that with contact 5 closed, current is supplied through winding 19 and to the winding of relay 7 to energize the two devices in multiple. When the contact 5 is operated to the open position, the voltage of self-inductance of winding 19 is ineffective to cause current to flow through the winding of relay 7 in a direction reverse to the direction of the energizing current due to the asymmetric unit 9, and hence the release period of relay 7 is independent of the effect of the voltage of self-inductance of winding 19. It is apparent that should it seem desirable to do so, an asymmetric unit may be inserted in the connection of winding 19 with its low resistance direction toward the control wire 4 the same as the unit 8 is interposed in the connection of relay 6 of Fig. 1, and when the apparatus of Fig. 2 is thus constructed, a flow of current back through winding 19 due to the voltage of self-inductance of relay 7 would be avoided.

Many places where my invention will be useful will suggest themselves. In Fig. 3, the invention is applied to a code wayside signal system for railways and wherein certain of the control relays are provided with predetermined slow-release periods for proper operation of the system. A stretch of railway track is formed into successive track sections by the usual insulated rail joints, there being only one section 1T together with the ends of adjacent sections shown in the drawings for the sake of simplicity. The track section 1T is provided with a track circuit consisting of a current source connected across the rails at one end of the section and a relay connected across the rails at the other end of the section. The immediate source of current for the track circuit of section 1T is the secondary winding 21 of a track transformer T1 the primary winding 22 of which is supplied with coded alternating current over wire 49 and a code selection network to be referred to hereinafter. The track relay TR is a quick acting direct current relay the operating winding of which is supplied with rectified current through a rectifier 23 the input terminals of which rectifier are connected across a reactor 24 interposed in a tuned circuit including a condenser 25 and the secondary winding 26 of a transformer T2 whose primary winding 27 is, in turn, connected across the rails of section 1T. The tuned circuit consisting of the elements 24, 25 and 26 is tuned to effectively pass current of the track circuit and which in this instance is preferably an alternating current of 100 cycles per second. It follows that as long as the rails of section 1T are supplied with alternating current of 100 cycles per second, the relay TR is energized and its contact members 28 and 29 are lifted into engagement with front contacts 30 and 31, respectively, but that during intervals no such current is supplied to the rails of the section 1T, the relay TR is released and its contact members 28 and 29 drop into engagement with back contacts 32 and 33, respectively. As will appear hereinbefore the alternating current supplied to the track circuit of section 1T is under certain traffic conditions coded at one rate which rate I shall assume to be of 180 cycles per minute, and under other traffic conditions it is coded at a second rate which rate I shall assume to be of 80 cycles per minute. Since the track relay TR is a quick-acting relay, it is a code following relay operating its contact members 28 and 29 at the rate corresponding to the code of the current supplied to the section 1T.

The apparatus for section 1T includes a code transmitter and a code selection network for supplying current to the track rails of the section in the rear, that is, the section to the left of section 1T in Fig. 3. The type of code transmitter is immaterial and, as here shown, the operating winding of a code transmitter CT is continuously supplied with current from any convenient source of current such as a generator not shown. The code transmitter CT operates two coding contact members 180 and 80, the arrangement being such that the code contact member 180 engages a stationary contact 34 at the rate of 180 times per minute and the code contact member 80 engages a stationary contact 35 at the rate of 80 times per minute. A circuit connection may be traced from the BX terminal of the source of alternating current provided for section 1T over the code contact 180—34, front contact 36 of a relay ZR to be referred to later, front contact 37 of a relay H to also be referred to later, primary winding 38 of a track transformer T3 and to the CX terminal of the current source, the secondary winding 39 of transformer T3 being in turn connected across the rails of the section to the rear of section 1T. Another circuit connection may be traced from the BX terminal of the source of current over the code contact 80—35, back contact 40 of relay H, primary winding 38 of transformer T3 and to the other terminal CX of the current source. Thus, under traffic conditions to cause both relays ZR and H to be picked up, alternating current of 180 code is supplied to

the rails of the section in the rear, and under traffic conditions that permit relay H to be released, the current is of the 80 code. The apparatus for the section in advance of the section 1T, that is, the section to the right in Fig. 3, is provided with code transmitting apapratus for supplying coded alternating current over wire 49 and the primary winding 22 of transformer 1T in the same manner as just described for the apparatus of section 1T.

The code following track relay TR governs a group of control relays consisting of relays ZR, H, AJ and FSA in a manner to be now pointed out. With relay TR operated at either the 180 or 80 code, its contact member 28 periodically reverses the flow of direct current from a source whose terminals are designated B and C in the primary winding 41 of a decoding transformer DT as will shortly be described, thereby inducing an alternating electromotive force in the secondary winding 42 of transformer DT, the frequency of which electromotive force corresponds to the code at which the relay TR is operated. The decoding relay AJ is energized through a rectifier 43 and a transformer T4 by the electromotive force induced in the secondary winding 42 of the decoding transformer DT, and is effectively energized to pick up its contact fingers 50, 51 and 52 under the 180 code only, since the circuit consisting of secondary winding 42, condenser 44, and primary winding 45 of transformer T4 is tuned to pass current at the frequency corresponding to the 180 code only.

Starting from a period when no current is supplied to the rails of section 1T, relay TR is down, all control relays are deenergized, and assuming that current of 180 code is supplied to the rails of section 1T, on the first operation of relay TR its contact 29—31 is closed with the result that current is supplied to the winding of relay FSA over a circuit traced from B battery terminal, contact 29—31, wire 59, winding of relay FSA, asymmetric unit 46, wire 60 and to the C battery terminal and that relay is picked up. It is to be noted that in accordance with my invention, an asymmetric unit 46 is interposed between the winding of relay FSA and the wire 60 leading to the C terminal of the current source. On the next operation of relay TR contact 29—33 is closed, and the relay H is energized over a simple circuit which includes B battery terminal, contact 29—33, a front contact 47 of relay FSA since the relay FSA is provided with a slow release period by virtue of a resistor 48 connected across the terminals of its operating winding, winding of relay H, wire 60 and to C battery terminal. On the third operation of relay TR, the second closing of its contact 29—31 is effective to supply current to the lower winding 66 of relay ZR, the circuit including B battery terminal, contact 29—31, back contact 50 of relay AJ, winding 66, front contact 54 of relay H which is slow-releasing in character, and to C battery terminal. Under the 180 code, the relay AJ is picked up after a few operations of relay TR subsequent to the picking up of relay ZR since with front contact 67 of relay ZR closed current is supplied from B battery terminal over front contact 67 of relay ZR, contact 28—30 of relay TR, top portion of winding 41 of transformer DT and to C battery terminal during one operation of relay TR, and then is supplied to the lower portion of winding 41 during the operation of relay TR that closes its contact 28—32. Current thus supplied to the two portions of winding 41 induces an electromotive force in winding 42 of transformer DT which electromotive force is passed by the tuned circuit consisting of elements 42, 44 and 45 and rectified current is supplied to the winding of relay AJ through rectifier 43. With relay AJ picked up the relay ZR is retained energized by code impulses supplied from B battery terminal over contact 29—31 of relay TR, front contact 51 of relay AJ, front contact 56 of relay ZR, top winding 53 of the relay, asymmetric unit 58 and thence over wire 60 to the C battery terminal. The relay ZR is provided with a predetermined slow-release period by virtue of a resistor 57 connected across the terminals of its top winding 53. It is to be noted that in accordance with my invention the asymmetric unit 58 is interposed between the top winding 53 of relay ZR and the C battery terminal. In the event the relay TR is operated at the 80 code, the relays FSA and H will be picked up in a manner similar to that described above for the 180 code current, but the relay AJ remains down. Under this condition, the relay ZR is energized by code impulses from the B battery terminal over contact 29—33 of relay TR, front contact 55 of relay FSA, back contact 51 of relay AJ, front contact 56 of relay ZR, top winding 53 of that relay, asymmetric unit 58, and to the C terminal over the wire 60.

It is to be noted that under the 180 code the two relays FSA and ZR are energized in multiple, their operating windings being connected between wire 59 leading to the contact 31 of relay TR, and wire 60 leading to the C terminal of the current source. The asymmetric units 46 and 58 are effective, however, in preventing any interchange of energy between these two relays due to voltage of self-inductance during the open periods of contact 29—31 with the result each relay FSA and ZR is operated independent of the other. These two relays FSA and ZR are so constructed and adjusted as to be provided with different predetermined slow release periods in order to provide a desired protection for signal systems of the type here involved. This protection need not be here described since it forms no part of my invention, the significant thing being that with the circuits and apparatus constructed in accordance with my invention, the asymmetric units 46 and 58 assure proper operation of the two relays FSA and ZR which, although having different electrical characteristics, operate independently of the other when connected in multiple.

Traffic through this section 1T is governed by a signal S1 which is here shown as a position light signal. The indications of signal S1 are selectively controlled by the group of control relays in a manner which will be obvious from the drawings and it is deemed unnecessary to trace the signal operating circuits in detail.

In Fig. 4, apparatus embodying my invention is applied to another form of apparatus and circuits for a code wayside signal system. In this latter system, a railway is divided into successive track sections of which only the one section 1T is shown the same as in Fig. 3. The track section 1T of Fig. 4 is provided with a source of coded alternating current and a code following track relay TR the same as in Fig. 3 except for the fact that the code selection network is modified somewhat as will be understood by an inspection of the drawings. In Fig. 4, the group of control relays include the relays FSA, H and AJ, the same as in Fig. 3, together with a relay designated by the reference character BSA. The decoding relay AJ of Fig. 4 is effectively energized through

the medium of the decoding transformer DT, tuned circuit including elements 42, 44 and 45, and a rectifier 43 when the relay TR is operated by 180 code current the same as described in Fig. 3. The relay FSA is periodically energized over the contact 29—31 of relay TR and the relay BSA is periodically energized over the contact 29—33 of relay TR, a front contact 61 of relay FSA being interposed in the circuit for the relay BSA. Hence both the relays FSA and BSA are picked up whenever the relay TR is operated under either the 180 or 80 code. With relay BSA picked up, the relay H receives an energizing impulse each time contact 28—30 of relay TR is closed over a circuit including the B terminal of the current source, contact 28—30, asymmetric unit 62, front contact 63 of relay BSA, winding of relay H, and hence to the C battery terminal. With relay H once picked up, it also receives current over a stick circuit extending from the B battery terminal, resistor 64, front contact 65 of relay H, front contact 63 of relay BSA, winding of relay H and to the C battery terminal. The relay H is provided with a predetermined slow-release period for assuring proper operation of the system. It is to be noted that the winding of relay H and the primary winding 41 of the decoding transformer DT are energized in multiple. The assymmetric unit 62 is effective, however, to prevent the voltage of self-inductance of the primary winding 41 from causing the release of the relay H during the pick-up interval of that relay and also prevents the voltage of self-inductance from varying its slow-release period.

Although I have herein shown and described only certain forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a railway track formed into an insulated section, means to supply coded alternating current to the rails of said section, a code following relay receiving current from the rails of said section for operating a circuit controlling contact member, two control relays each provided with a particular predetermined slow-release period, said two relays proportioned differently to possess different slow release periods, circuit means including a direct current source and said contact member for supplying code impulses of current to the windings of said relays in multiple, two asymmetric units one for each relay and each unit interposed in series with the winding of the associated relay and said units both disposed with their forward direction toward the negative terminal of said direct current source whereby each of said relays is operated at its particular release period, and signaling means for governing traffic through said section controlled by said relays.

2. In combination, a railway track formed into an insulated section, means to supply coded alternating current to the rails of said section, a code following relay receiving current from the rails of said section for operating a circuit controlling contact member, decoding means including a decoding transformer, a control relay having a predetermined slow-release period, circuit means including a direct current source and said contact member for supplying code impulses of current to the primary winding of said transformer and to a winding of said control relay for energizing the two windings in multiple, said two windings proportioned differently to possess different electrical characteristics as required for said transformer and said relay, and asymmetric unit interposed in series with the winding of said relay and disposed with its high resistance direction toward the positive terminal of said transformer winding whereby the voltage of self-inductance of the transformer winding is ineffective during the open periods of the contact member to influence said control relay, and signaling means to govern traffic through said section governed by said control relay.

3. In combination, a railway track formed into an insulated section, means to supply coded alternating current to the rails of said section, a code following relay receiving current from the rails of the section for operating a circuit contact member, control means including a winding, a control relay having a predetermined slow release period, circuit means including a direct current source and said contact member for supplying code impulses of current to the winding of said control means and to a winding of said control relay for energizing said windings in multiple, said two windings proportioned differently to possess different electrical characteristics as required for said control means and said relay, an asymmetric unit interposed in series with the winding of said relay and disposed with its forward direction toward the negative terminal of said direct current source whereby said relay is released independent of the voltage of self-inductance of the winding of said control means when the contact member is not operated, and two circuits one governed by said control means and the other governed by said control relay.

4. In combination, a railway track formed into an insulated section, a track circuit for the section including a current source and the winding of a track relay, said relay provided with a circuit controlling contact member operable to one position when the winding is energized and to a second position when the winding is deenergized, two control relays provided with different predetermined slow release periods, circuit means including a direct current source and said contact member in its said one position for supplying current to the windings of the control relays in multiple, said two windings proportioned differently as required to effect said different release periods for said relays, two asymmetric units one for each control relay and each unit interposed in series with the winding of the associated relay and said units both disposed with their forward direction toward the negative terminal of said direct current source whereby each control relay is released at the end of its release period independent of the voltage of self-inductance of the winding of the other control relay when said member is operated to its second position, and two circuits one governed by one control relay and the other governed by the other control relay.

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