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RAILWAY TRAFFIC CONTROLLING APPARATUS

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Fig. 1

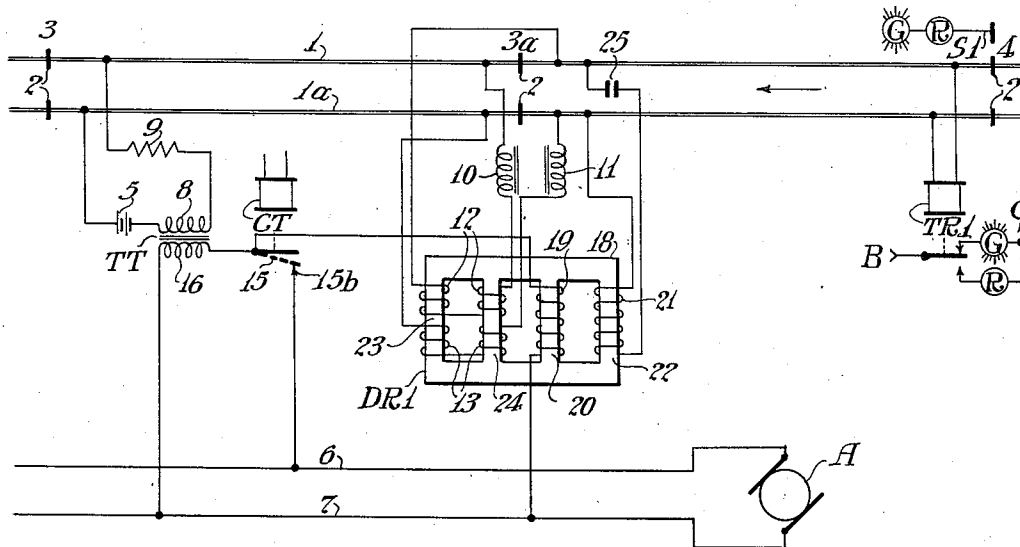
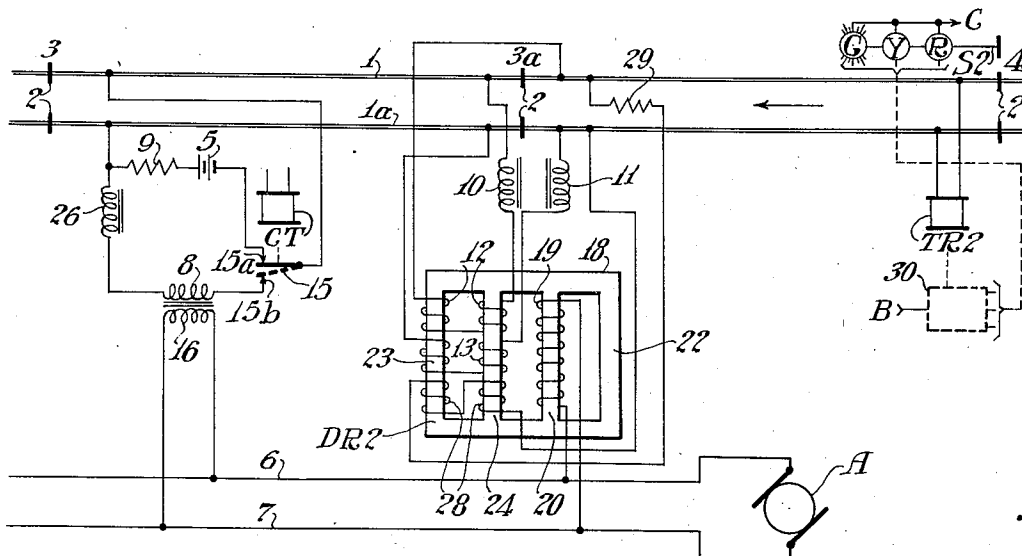


Fig. 2



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RAILWAY TRAFFIC CONTROLLING
APPARATUS

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Application September 9, 1939, Serial No. 294,157

11 Claims. (Cl. 246—34)

My invention relates to railway traffic controlling apparatus, and has particular reference to the provision of means for supplying both direct current and coded alternating current to the track rails of a section, the direct current being employed for controlling wayside signals and the supply of alternating current to the rails, and the alternating current being employed for controlling train carried apparatus which governs cab signals and/or automatic train control apparatus.

In railway signaling, it is known that good shunting and effective broken rail protection can be obtained in relatively long direct current track circuits, whereas the equivalent shunting and rail protection is afforded only by considerably shorter alternating current track circuits. For example, where 100 cycle alternating current is employed, the effective length of a track circuit may be only one-half that of direct current track circuits. Thus, under certain conditions of ballast and rail resistance, a direct current track circuit of the order of 11,000 feet in length may give satisfactory shunting and broken rail protection while if 100 cycle alternating current is employed, the equivalent broken rail protection may be obtained only for circuits of the order of 5500 feet in length.

In view of the foregoing, it is an object of my invention to provide novel and improved means for supplying both direct and alternating current to the track rails of a stretch of railway track in such manner as to provide a track circuit of maximum length for each form of current.

Another object of my invention is the provision of novel and improved means for supplying the rails of a track section with direct current throughout its entire length, and also for supplying alternating current to the rails of each of the subsections forming the track section.

A further object of my invention is the provision of novel and improved means controlled by the direct current supplied to the rails of a section for controlling the supply of alternating current to the rails of a portion or portions of such section.

An additional object of my invention is the provision of novel and improved means for utilizing coded direct current supplied to the rails of a section for coding the supply of alternating current to the rails of a portion of that section.

Other objects and advantages of my invention will be apparent from the following description taken in connection with the accompanying drawing.

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

In the accompanying drawing, Fig. 1 is a diagrammatic view showing one form of railway traffic controlling apparatus embodying my invention. Fig. 2 is a diagrammatic view showing a modified form of the apparatus shown in Fig. 1 and also embodying my invention.

Similar reference characters refer to similar parts in each of the two views.

Referring first to Fig. 1, the reference characters 1 and 1a designate the track rails of a stretch of railway track over which I shall assume that traffic normally moves in the direction indicated by an arrow in Fig. 1, or from right to left in the drawing. The track rails 1 and 1a are divided by means of the usual insulated rail joints 2 into a plurality of successive adjoining track sections, of which only one section, 3—4, is shown complete in the drawing. Section 3—4 further is divided into adjoining advance and rear subsections which are electrically separated from each other by means of insulated rail joints 2 interposed in rails 1 and 1a at cut-section location 3a.

I shall assume that the length of section 3—4 is less than the maximum limits within which good shunting and effective broken rail protection are afforded by track circuits supplied with direct current, so that when the rails of the section are incorporated in a manner to be pointed out shortly into a track circuit supplied with direct current, such circuit provides satisfactory shunting and broken rail protection. I shall also assume that the length of section 3—4 is in excess of the maximum limits within which effective broken rail protection is afforded by track circuits supplied with alternating current of the frequency or frequencies normally employed, but the lengths of subsections 3—3a and 3a—4 I shall assume to be such that, when the rails of the subsections are supplied with alternating current, each subsection is provided with an alternating current track circuit which provides satisfactory shunting and effective broken rail protection.

The section 3—4 is provided with two sources of trackway energy, one being a source of direct current shown, for example, as a battery 5, and the other being a source of alternating current shown as a generator A having its opposite terminals connected to two power line wires 6 and 7.

Section 3—4 is provided throughout its entire length with a direct current track circuit supplied with energy from battery 5. This circuit,

as shown, comprises battery 5 connected in series with a secondary winding 8 of a track transformer TT and a current limiting resistor 9, across the trail rails of section 3-4 adjacent its exit end 3, a track relay TR1 connected across the rails of section 3-4 adjacent its entrance end 4, and includes means for by-passing the direct current around the insulated joints 2 located at cut-section location 3a.

The means for by-passing or transferring the direct current around the insulated joints 2 interposed in the rails of section 3-4 comprises two impedance bonds 10 and 11, one bond 10 in series with a winding 12 later to be referred to, connecting the adjacent ends of track rail 1, and the other bond 11 in series with a winding 13 referred to later, connecting the adjacent ends of track rail 1a. The bonds 10 and 11 are of the usual construction and comprise an iron core coil designed and proportioned to have relatively little resistance and relatively large inductance, so that the bonds readily permit the flow of direct current but oppose and block the flow of alternating current therethrough.

The reference character S1 designates a wayside signaling device provided for section 3-4. Device S1, as shown, comprises a two-position color light signal having a red lamp R and a green lamp G, which lamps, when illuminated, indicate "stop" and "clear," respectively. The particular indication displayed by signal S1 is controlled, as can readily be seen from an inspection of Fig. 1, by relay TR1.

Each of the subsections of section 3-4 also is supplied with coded alternating current, the supply circuit for each subsection being periodically completed through the medium of a coding contact 15-15b controlled by a continuously operating coding device or coder CT. It is to be understood, of course, that the rate at which coder CT operates its coding contact or contacts may be selectively controlled in the usual manner by traffic conditions in advance of section 3-4 through the medium of apparatus not shown in the drawing since it forms no part of my present invention.

Contact 15-15b of coder CT in its lower position periodically completes an obvious circuit whereby primary winding 16 of track transformer TT is supplied with alternating current from line wires 6 and 7, thereby causing secondary winding 8 of transformer TT to supply the rails of subsection 3-3a with coded alternating current having a code rate determined by the rate at which contact 15-15b is operated by coder CT.

The supply of alternating current to the rails of subsection 3a-4 is controlled by a relay DR1, which in turn is controlled by its two control windings 12 and 13 hereinbefore referred to. Although relay DR1 may be of the usual tractive armature type having an armature operated to its attracted position when the two windings 12 and 13 are energized, I prefer to employ a relay of what I shall term the "front contact" saturation relay type.

The particular saturation relay illustrated in Fig. 1 is of the type disclosed in the copending application for Letters Patent of the United States, Serial No. 280,731 filed by Claude M. Hines, and comprises a four-legged magnetizable core 18 having a local input or primary winding 19 disposed on an inner leg 20, and an output or secondary winding 21 disposed on the adjacent outer leg 22 of the core. Control winding 12 of relay DR1 comprises two coils one

disposed on each of the other two legs 23 and 24 of the core and connected in series in such manner that when supplied with direct current, the coils act cumulatively to circulate a flux through a closed magnetic path provided by the two legs 23 and 24 and the adjoining top and bottom portions of the core. The other control winding 13 of the relay also comprises two coils connected in series and mounted one on each of the two legs 23 and 24 in a manner similar to the two coils of winding 12. The arrangement of the coils of windings 12 and 13 is such that when windings 12 and 13 are connected in series and supplied with direct current, the two windings create additive fluxes which are circulated through the two parallel legs 23 and 24 and the adjoining top and bottom portions of core 18.

Relay DR1 operates as follows: When input winding 19 is supplied with alternating current, a primary flux is set up in core 18 which divides between two paths one of which includes the two parallel legs 23 and 24 and leg 20 and the other of which includes leg 22 and leg 20. Under this condition, the major portion of the flux circulates through the two parallel legs 23 and 24 by virtue of the lower total reluctance of that path. The arrangement of the coils of windings 12 and 13 on legs 23 and 24 is such that opposing electromotive forces are induced in the coils of each winding by the primary flux, so that the resultant of such electromotive forces is substantially zero. With the major portion of the primary flux circulating through the two parallel legs 23 and 24, a relatively small electromotive force is induced at this time in output winding 21 by the primary flux circulating in leg 22.

If, now, windings 12 and 13 of relay DR1 are supplied with direct current of a magnitude selected to cause the flux created thereby and circulated in legs 23 and 24 of the core to magnetically saturate that portion of the core, the major portion of the primary flux then circulates through leg 22 and as a result a relatively large electromotive force is induced in output winding 21.

As is readily apparent from an inspection of the drawing, the control windings 12 and 13 of relay DR1 normally are supplied with direct current due to the action of impedance bonds 10 and 11 transferring the direct current from the rails of advance subsection 3-3a around insulated joints 2 into the rails of rear subsection 3a-4, and as a result, the magnetic path including legs 23 and 24 is saturated and a relatively large electromotive force is induced in output winding 21 of relay DR1, which is connected through a condenser 25 to the rails of subsection 3a-4 adjacent its exit end 3a, whenever primary winding 19 of relay DR1 is supplied with alternating current.

Primary winding 19 of relay DR1 is supplied with periodically interrupted or coded alternating current from the line wires 6 and 7 over an obvious circuit including coding contact 15-15b of coder CT. It follows, therefore, that when control windings 12 and 13 are supplied with direct current from the rails of section 3-4, coded alternating current of relatively large magnitude is supplied by output winding 21 of relay DR1 to the rails of subsection 3a-4, the code rate of such current being determined by the rate at which contact 15-15b is operated by coder CT.

It should be pointed out that in the event a tractive armature type relay is employed in place

of the saturation type relay just described, local input winding 19 and output winding 21 of relay DR1 then would be constructed in the form of the usual track transformer and the connection of output winding 21 with the rails of subsection 3a-4 would include a front contact of the tractive armature relay.

In the particular embodiment of my invention illustrated in Fig. 1, it is contemplated that the coded alternating current supplied to each subsection will be utilized during the interval that a train traverses a subsection to control train carried apparatus such as cab signals and/or automatic train control apparatus, as will be made clear presently.

The apparatus of Fig. 1 is in its normal condition, as illustrated in the drawing, when section 3-4 is unoccupied. In this condition of the apparatus, the track rails of section 3-4 are supplied throughout their entire length with direct current from battery 5, and relay TR1 is held energized by virtue of the direct current received from the rails of the section to control signal S1 to display its "clear" indication. Coded alternating current is supplied by transformer TT to the rails of advance subsection 3-3a, but due to the choking action of the impedance bonds 10 and 11, relatively little of this alternating current flows in the rails of subsection 3-3a. The rails of subsection 3a-4 also are supplied with alternating current from output winding 21 of relay DR1, which current is limited to the rails of subsection 3a-4 by virtue of the impedance bonds 10 and 11. However, due to the relatively high impedance of the windings of relay TR1, relatively little alternating current flows at this time in the rails of subsection 3a-4, even though control windings 12 and 13 of relay DR1 are energized to condition the relay to cause electromotive forces of relatively large magnitude to be supplied from output winding 21. It should be noted that condenser 25 (which is interposed in the connection of output winding 21 of relay DR1 and the rails of subsection 3a-4) functions to prevent the flow of direct current through winding 21 from one rail of subsection 3a-4 to the other, but is effective to permit winding 21 to supply the rails of subsection 3a-4 with alternating current.

When a train enters section 3-3 at its entrance end 4, the direct current is shunted away from relay TR1 which accordingly releases to control signals S1 to its "stop" indication. The control windings 12 and 13 of relay DR1 are still energized by direct current received from the rails of section 3-4, so that relay DR1 is conditioned to cause coded alternating current to be supplied to the rails of subsection 3a-4. This coded alternating current may be picked up from the rails of rear subsection 3a-4 by apparatus of the well-known form carried by the locomotive of the train and may be utilized to control cab signals and/or automatic train control apparatus.

When the train enters advance subsection 3-3a, the train shunt there established forms a low resistance path for the direct current, and as a result relay TR1 remains released since the rails of rear subsection 3a-4 no longer are supplied with current from the rails of the advance subsection. Also, relay DR1 is controlled to limit the energy induced in output winding 21 of relay DR1 to its minimum value since windings 12 and 13 are deenergized and legs 23 and 24 are unsaturated. The coded alternating current sup-

plied by track transformer TT to the rails of subsection 3-3a at this time, however, may be picked up by the train carried apparatus and utilized to control apparatus carried by such train.

Then, when the train vacates section 3-4, relay TR1 becomes picked up due to the direct current received by the relay from the rails of section 3-4, and transformer TT and relay DR1 supply the rails of subsection 3-3a and the rails of subsection 3a-4, respectively, with coded alternating current.

From the foregoing, it is readily apparent that section 3-4 is provided throughout its length with a direct current track circuit, and that, in effect, two shorter alternating current track circuits are provided for the section. Accordingly, it can be seen that since the direct current energizes relay TR1 only when the section is unoccupied, relay TR1 provides not only an indication of traffic conditions in the section, but also indicates the condition of the rail elements throughout the entire length of the section. However, since the alternating current supplied by relay DR1 to subsection 3a-4 is utilized only when a train occupies that subsection and picks up such energy from the rails, the alternating current supplied to the rails of subsection 3a-4 when the section is occupied provides both traffic indications and broken rail protection for the length of subsection 3a-4. Similarly, the alternating current supplied to subsection 3-3a is utilized only when that subsection is occupied, and affords both traffic indications and broken rail protection for that subsection.

An advantage of apparatus embodying my invention is that such apparatus permits direct current and alternating current track circuits to be combined in such manner as to obtain the maximum operative length of both types of circuits. Thus, the entire length of the rails of a section are incorporated into a direct current track circuit, and at the same time alternating current track circuits are restricted to selected portions or subsections of the section.

Another advantage of apparatus embodying my invention is that the supply of alternating current to one of the subsections is controlled by the transfer of the direct current around the insulated joints separating that subsection from the adjacent subsection. Accordingly, the supply of alternating current is substantially discontinued when the train occupies the adjacent subsection, thereby reducing the power consumption of that alternating track circuit during the period such energy is not utilized.

Referring now to Fig. 2, the apparatus shown in Fig. 1 is modified to provide coded direct and alternating current track circuits. In Fig. 2, battery 5 is connected over a circuit including resistor 9 to the rails of subsection 3-3a during the interval that front contact 15-15a of coder CT is closed, while secondary winding 8 of transformer TT is connected in circuit with a current limiting impedance 26 to the rails of subsection 3-3a during the interval that back contact 15-15b of coder CT is closed. The rails of subsection 3-3a are, therefore, supplied with coded direct current and with coded alternating current. Usually, the code rate at which the direct and alternating currents are supplied to section 3-4 will be controlled by traffic conditions in advance of section 3-4.

Preferably, secondary winding 8 of transformer TT and impedance 26 are designed and proportioned to have relatively little resistance, so that

when coder CT disconnects battery 5 from the rails of section 3—4 and connects the alternating current source to the rails of the section, a low resistance path is established across the rails through impedance 26 and winding 8, thereby counteracting the effect of so-called "storage energy" in section 3—4. This storage energy might be built up in the rails and ballast of the section as a result of the coded direct current supplied thereto, and unless protected against, the storage energy might reach a value sufficient to maintain a code following track relay, connected in circuit with the rails of the section, picked up during the "off" period of the direct current code. By virtue of the circuit pointed out, however, such storage energy is discharged through the low resistance path during each "off" period of the direct current code.

Relay DR2 shown in Fig. 2 is similar to relay DR1 previously described, except that output winding 28 of relay DR2 comprises two coils mounted respectively on legs 23 and 24 of the core 18 of relay DR2, the coils being connected in series in such manner that the electromotive forces induced therein by the primary flux threading legs 23 and 24 in multiple are additive. This construction provides a "back contact" saturation type relay, which is characterized by the fact that when primary winding 19 of relay DR2 is energized, an electromotive force of relatively low or high magnitude is induced in winding 28 according as control windings 12 and 13 of relay DR2 are or are not energized by direct current.

Local input winding 19 of relay DR2 is constantly supplied with energy from a source of alternating current, thereby setting up a primary flux in core 18 of relay DR2. However, control windings 12 and 13 of relay DR2 are supplied with code impulses of direct current from the rails of section 3—4, and consequently cause alternating voltages to be periodically induced in output winding 28 of relay DR2 due to the periodic variations in reluctance in core 18 established by the coded direct current supplied to windings 12 and 13. Output winding 28 of relay DR2 is connected in series with a resistor 29 across the rails of subsection 3a—4, the resistor 29 being proportioned to prevent short-circuiting of the direct current in the rails of subsection 3a—4 but permitting winding 28 to supply such rails with coded alternating current.

It should, of course, be understood that a tractive armature type code following relay having as its control windings the two windings 12 and 13, may be employed in place of relay DR2 just described, and which relay then would have a code following contact interposed in the circuit connection of winding 28 (which then would correspond to a secondary winding of a transformer having winding 19 of relay DR2 as its primary winding) with the rails of subsection 3a—4. However, I prefer to employ a saturation type relay at cut-section location 3a since such relay follows and reproduces the coded energy received by its control windings without requiring any mechanically moving parts. Accordingly, such saturation relay will operate without danger of loss of adjustment due to the parts getting out of alignment or wearing.

Track relay TR2 shown in Fig. 2 is a code following relay responsive to the coded direct current received from the rails of the section. As shown, relay TR2 may be of the tractive armature type, or may, if desired, be of the saturation relay type similar, for example, to relay DR1

or DR2 hereinbefore described. Relay TR2, as shown, is adapted to selectively control a multiple indication traffic controlling signal S2, through the medium of the usual decoding apparatus 30. The details of decoding apparatus 30 are not shown in the drawing since they form no part of my present invention, but it should be pointed out that relay TR2 sets up a lighting circuit for one or another of the lamps G, Y or R of signal S2 in accordance with the rate at which the direct current received by the relay from the rails of section 3—4 is coded. The decoding apparatus also usually controls the code rate at which the direct and alternating current is supplied to the track section next in the rear of section 3—4, or the section lying immediately to the right of section 3—4 as viewed in the drawing.

It is believed that the operation of the apparatus shown in Fig. 2 will readily be apparent from an inspection of the drawing together with the foregoing description of Fig. 1, it being noted that the coded direct current flowing in control windings 12 and 13 of relay DR2 causes coded alternating current to be supplied by output winding 28 of relay DR2 to the rails of subsection 3a—4. Thus, the impedance bonds 10 and 11 function to permit direct current to be supplied to the rails of section 3—4 throughout its entire length, and restrict the alternating current supplied to subsections 3—3a and 3a—4 to an operative value only to the subsection to which it is applied. Also, the windings 12 and 13 connected in series with bonds 10 and 11, respectively, function in response to the supply of coded direct current supplied to the rails of section 3—4 to code the supply of alternating current to the rails of rear subsection 3a—4.

It can be seen from the foregoing that apparatus embodying my invention provides novel and improved means whereby the track rails of a section are provided with coded direct and alternating current in such manner that the maximum length of track circuit is provided for each type of current. In addition, it can be seen that my invention requires the minimum amount of apparatus to be used to provide maximum length track circuits for each type of current.

Although I have herein shown and described only two forms of railway traffic controlling 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 a signaling system of the type in which wayside signals are controlled by direct current and train carried cab signals are controlled by alternating current, the combination of, a section of railway track provided with a source of direct current and a source of alternating current, said section being divided into adjoining advance and rear subsections by insulated rail joints, means for supplying the track rails of said advance subsection at its exit end with current from each of said sources, means positioned at said insulated joints and effective to permit the transfer of direct current around such joints but preventing similar transfer of alternating current, a relay responsive to the transfer of direct current around said insulated joints, and a source of alternating current connected to the track rails of said rear subsection over a circuit controlled by said relay.

2. In combination, a section of railway track divided into advance and rear subsections by insulated rail joints, a source of direct current and a source of alternating current, a circuit continuously completed for connecting said direct current source to the rails of said advance subsection, a continuously operating coding contact, a circuit completed by said contact when in one position for connecting said alternating current source to the rails of said advance subsection, means effective to transfer said direct current around said insulated joints from said advance subsection into said rear subsection but ineffective to transfer alternating current around said joints, another circuit set up by said coding contact when in its said one position for connecting said alternating current source to the rails of said rear subsection, and means controlled by the transfer of said direct current around said insulated joints and arranged to render said other circuit active when and only when direct current is transferred from said advance subsection into said rear subsection.

3. In combination, a section of railway track divided into adjoining advance and rear subsections by insulated rail joints, means for supplying direct and alternating current both coded at similar rates to the rails of said advance subsection at its exit end, means for transferring said direct current from said advance subsection into said rear subsection around said insulated joints but effective to block the transfer of alternating current around said joints, and means controlled by the transfer of such direct current for supplying the track rails of said rear subsection with alternating current coded at a rate corresponding to the code rate of said direct current.

4. In combination, a section of railway track divided into advance and rear subsections by insulated rail joints, a source of direct current and a source of alternating current, a coding contact continuously operated at a predetermined rate, a circuit completed by said contact when in one position for connecting said direct current source to the rails of said advance subsection, another circuit completed by said contact when in another position for connecting said alternating current source to the rails of said advance subsection, means effective to transfer direct current around said joints from said advance subsection into said rear subsection but ineffective to transfer alternating current around said joints, and means controlled by the transfer of such direct current for supplying the rails of said rear subsection with alternating current which is coded at said rate.

5. In combination, a section of railway track divided into adjoining advance and rear subsections by insulated rail joints, impedance bonds for connecting together the adjoining ends of the track rails of the two subsections, means for supplying direct current to the track rails at one end of said section, means for supplying the track rails of said advance subsection with alternating current, a relay having a control winding connected in series with at least one of said impedance bonds, and means controlled by said relay for supplying alternating current to the track rails of said rear subsection.

6. In a signaling system of the type in which wayside signals are controlled by direct current and train carried cab signals are controlled by alternating current, the combination of, a section of railway track provided with a source of direct current and with a source of alternating current,

said section being divided into adjoining advance and rear subsections by insulated rail joints, means for supplying the track rails of said advance subsection at its exit end with current from each of said sources, impedance bonds positioned at said insulated joints for transferring said direct current around said joints from said advance subsection into said rear subsection but effective to block the transfer of alternating current around said insulated joints, a relay having windings connected in series with said impedance bonds and energized by the transfer of direct current from said advance subsection into said rear subsection, and means controlled by said relay for supplying the track rails of said rear subsection at its exit end with alternating current.

7. In combination, a relatively long track section having a length within the maximum limits which affords effective broken rail protection for direct current track circuits but exceeding the maximum limits which affords effective broken rail protection for alternating current track circuits, means for supplying both direct current and alternating current to the exit end of said section, a relay, limiting means associated with said section and including a winding of said relay for restricting said alternating current to a selected portion of said section but permitting said direct current to be effective throughout the entire length of said section, said limiting means being associated with said section in such manner that said section is divided into successive portions each having a length within the maximum limits which affords effective broken rail protection for alternating current track circuits, and means controlled by said relay when energized by said direct current for supplying alternating current to the exit end of the remaining portion of said section.

8. In combination, a relatively long track section having a length within the maximum limits which affords effective broken rail protection for direct current track circuits but exceeding the maximum limits which affords effective broken rail protection for alternating current track circuits, means for supplying direct current and alternating current both periodically interrupted at similar rates to the rails of said section at its exit end, limiting means associated with said section and including the winding of a code responsive relay for restricting said alternating current to be effective only in a selected portion of said section but permitting said direct current to be effective throughout the entire length of said section, said limiting means being associated with said section in such manner that said section is divided into successive portions each having a length within the maximum limits which affords effective broken rail protection for alternating current track circuits, and means controlled by said code responsive relay and responsive to said direct current trackway energy for supplying alternating current to said succeeding portion of the section and for periodically interrupting the supply of such alternating current at a rate corresponding to the rate at which said direct current is interrupted.

9. In combination, a relatively long track section having a length within the maximum limits which affords effective broken rail protection for direct current track circuits but exceeding the maximum limits which affords effective broken rail protection for alternating current track circuits, means for supplying direct current and alternating current both periodically

interrupted at similar rates to the rails of said section at its exit end, insulated rail joints disposed in the rails of said section in sets of two joints one for each track rail for dividing the rails of said section into successive adjoining subsections each having a length within the maximum limits which affords effective broken rail protection for alternating current track circuits, impedance bonds associated with said insulated rail joints for connecting the adjacent ends of the track rails of each two adjoining subsections in such manner that direct current is transferred around said insulated joints from one subsection into the next adjoining subsection but alternating current is blocked, a code responsive relay associated with each set of two insulated joints and operatively associated with the impedance bonds associated with that set of joints in such manner as to be responsive to the transfer of the direct current trackway energy around the associated set of insulated joints, means controlled by each of said code responsive relays for supplying alternating current to the exit end of the adjacent subsection and for periodically interrupting such supply at a rate corresponding to the code rate at which said direct current is interrupted, and railway traffic controlling apparatus receiving energy from the track rails of said section adjacent its entrance end.

10. In combination, a section of railway track having at least one rail thereof provided with an insulated joint intermediate its ends, a source of direct current and a source of alternating

current connected across the rails at one end of said section, an impedance bond and a control winding of a direct current control relay connected around said insulated joint, a direct current track relay connected across the track rails at the other end of said section, and a source of alternating current connected over a circuit governed by said control relay across the rails of said section adjacent said insulated joint intermediate said joint and said other end of said section.

11. In combination, a section of railway track having at least one rail thereof provided with an insulated joint intermediate its ends, a source of direct current and a source of alternating current connected across the rails at one end of said section, a control device having a magnetizable core provided with an input winding supplied with alternating current and an output winding, said control device also having a control winding disposed on said core for controlling the inductive coupling of said input and output windings in response to the supply of current to said control winding, an impedance element of the class adapted to block direct current connected in series with said output winding across the rails intermediate said insulated joint and the other end of said section, an inductance connected in series with said control winding around said insulated joint, and a direct current track relay connected across the track rails at said other end of said section.

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