April 12, 1966 A. G. EHRLICH 3,246,141

CODED TRACK CIRCUIT APPARATUS

Filed Dec. 12, 1961

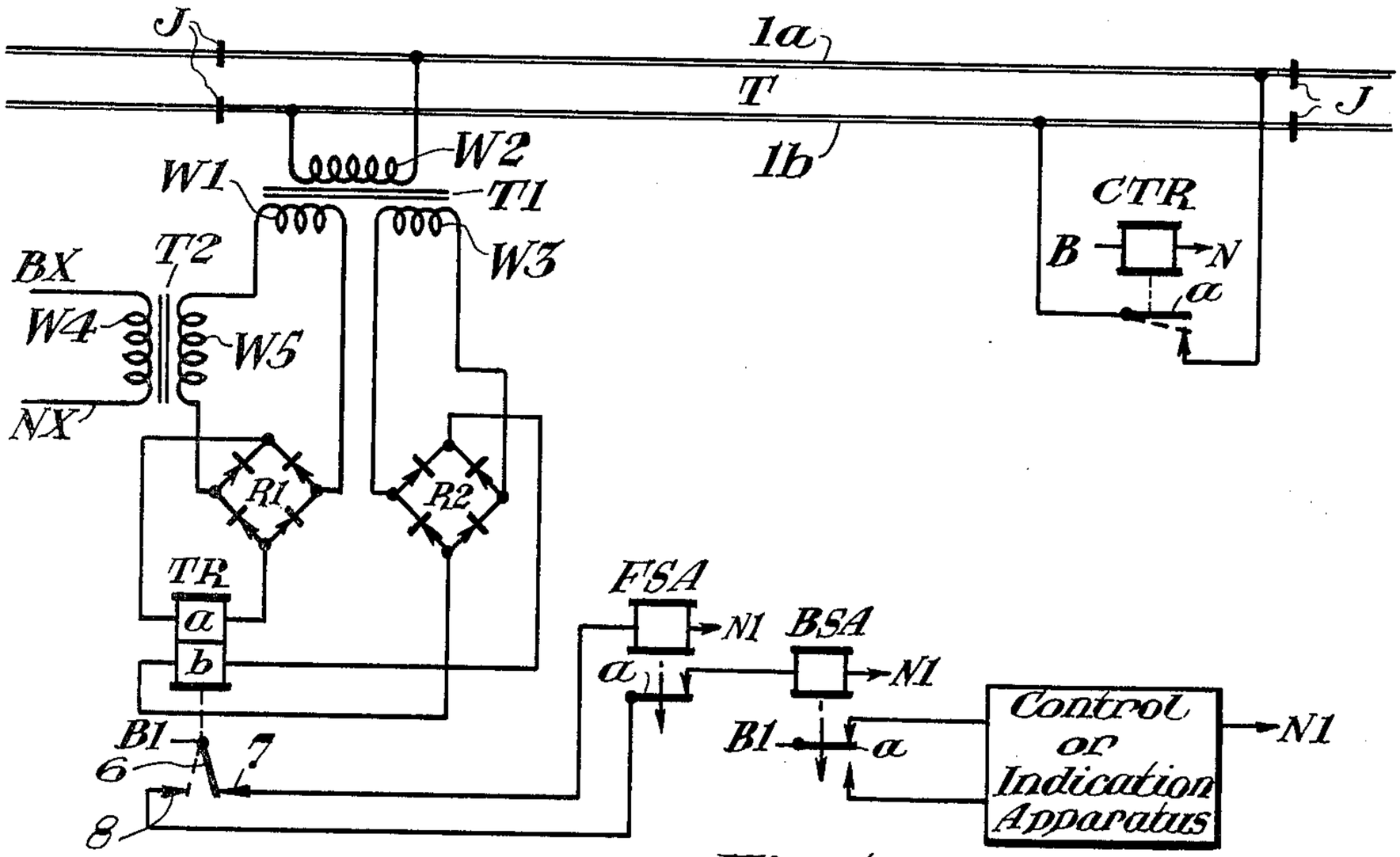

Fig. 1.

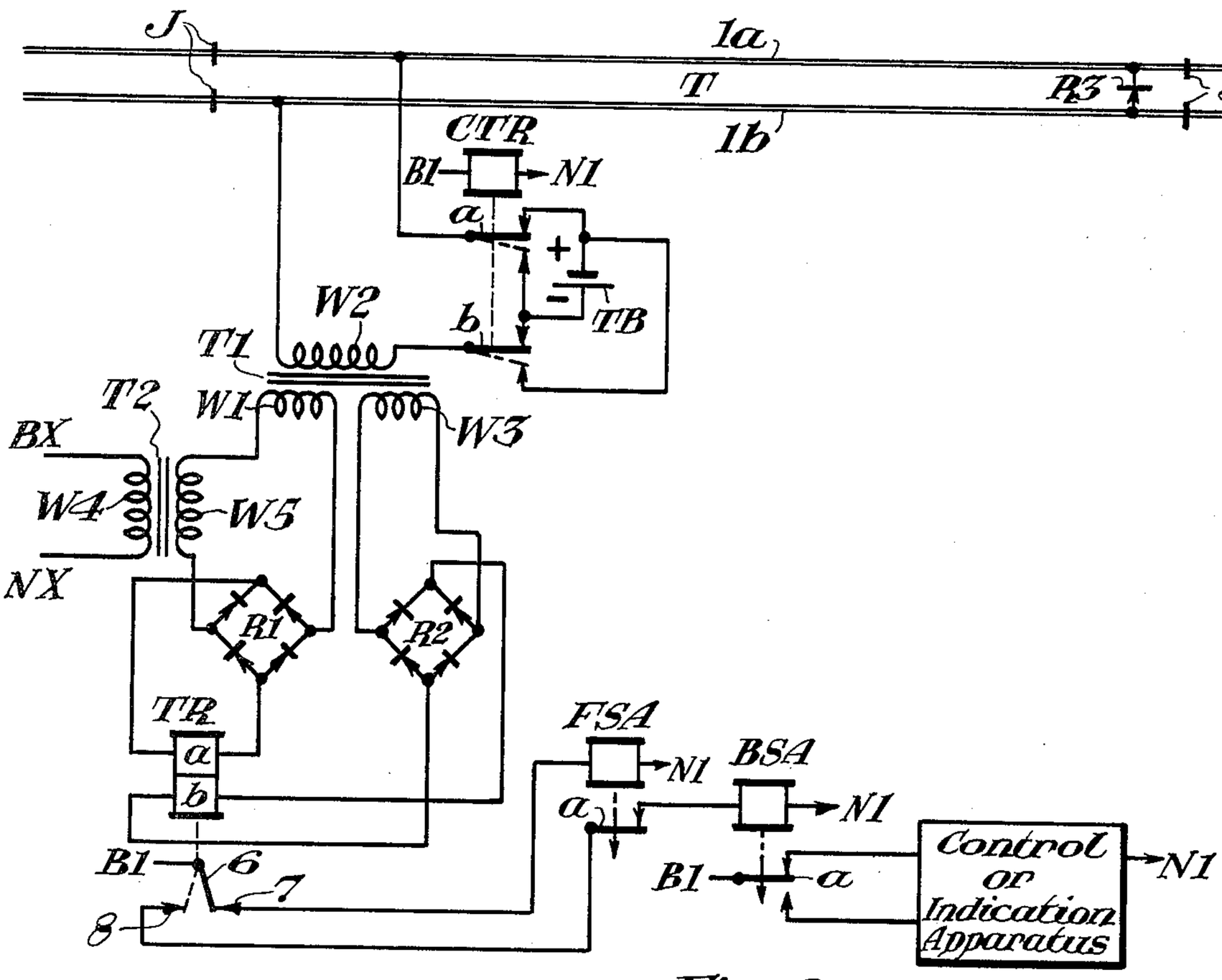

Fig. 2.

United States Patent Office

3,246,141

Patented Apr. 12, 1966

3,246,141

CODED TRACK CIRCUIT APPARATUS

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Filed Dec. 12, 1961, Ser. No. 158,703

9 Claims. (Cl. 246—34)

My invention relates to coded track circuit apparatus. More specifically my invention relates to an alternating current coded track circuit for the detection of occupancy by a train of a section of railway track.

One object of my invention is to provide novel alternating current coded track circuit apparatus in which the consumption of track circuit energy is greatly minimized because energy is not transmitted over the rails from a remote source but, rather, is supplied to the relay from a local source, and also because a train shunt does not place a heavy current drain on the power supply.

Another object of my invention is to provide an alternating current coded track circuit having high shunting sensitivity characteristics since a high rail voltage can be provided for the purpose of puncturing rail film.

A third object of my invention is to provide an alternating current track circuit which provides broken-down insulated joint and foreign current protection.

Another object of my invention is to provide an alternating current track circuit which can distinguish a broken rail from a train shunt.

In accordance with my invention I provide alternating current coded track circuit apparatus, including a transformer having a secondary winding connected across the rails of a section of railway track, which operates on the principle of intermittently changing at a predetermined code rate the impedance presented to said secondary winding by the rails of the track section.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

I shall first describe two embodiments of my invention and shall then point out the novel features thereof in claims.

In the accompanying drawings FIG. 1 is a diagrammatic view of a first form of apparatus embodying my invention.

FIG. 2 is a diagrammatic view showing a modified form of the apparatus shown in FIG. 1.

In each of the two views similar reference characters are used to designate similar parts.

Referring to FIG. 1, there is shown a section of railway track designated T comprising track rails 1*a* and 1*b* separated from the rails of the adjoining track sections by insulated rail joints J. A contact *a* of a code generator or transmitter relay CTR is connected across the rails of the track section T at one end thereof, and the winding of relay CTR is connected across the positive and negative terminals B and N, respectively, of a source of direct current, such as a battery of proper voltage and capacity, provided for operation of the code transmitter relay. For the purpose of simplicity this direct current source itself is not shown in the drawings. By the arrangement described it is readily apparent that the rails of track section T are being intermittently shunted at the code rate of code transmitter relay CTR.

There is shown at the other end of the track section T a first transformer T1 having a primary winding W1, and first and second secondary windings W2 and W3, respectively; a second transformer T2 having a primary winding W4 and a secondary winding W5; first and second full wave rectifiers R1 and R2, respectively, and a code following track relay TR of the magnetic stick type and shown as having two separate windings *a* and *b*. The track relay may, however, be provided with only a single winding having a center tap if desired.

Relay TR is provided with a movable member or contact 6 which alternately establishes contact with fixed members or contacts 7 and 8 when the relay is following code. Said contact 6 of the track relay controls code detecting relays FSA and BSA which are of the slow release type as indicated by the arrows drawn through the movable part of the contacts of these relays and pointed in the downward direction, that is, the direction in which the relays are slow acting. Such FSA–BSA relay code detecting schemes are well known in the art and relay BSA is energized in an obvious manner when, and only when, track relay TR is responding to coded energy.

It should be pointed out at this time that a source of direct current energy, such as a battery of proper voltage and capacity, and a source of alternating current energy are provided at the track relay end of the track section for operating of the direct current apparatus and the alternating current apparatus, respectively, at that location. However, for purposes of simplicity these sources are not shown in the drawings but the positive and negative terminals of the direct current source are designated B1 and N1, respectively, and the terminals of the alternating current source are designated by the reference characters BX and NX.

Relay BSA actuates control or indication apparatus as shown in the drawing, the circuit for actuating such apparatus extending from terminal B1 of the direct current source over the front or back contact points of contact *a* of relay BSA to the control or indication apparatus and through such apparatus to battery terminal N1. The control or indication apparatus is, therefore, actuated in accordance with the picked-up or released condition of relay BSA as will become more apparent hereinafter.

Returning to transformer T1 in FIG. 1, the primary winding W1 is connected in a series circuit with the secondary winding W5 of transformer T2 and across the input terminals of full wave rectifier R1. The first secondary winding W2 of transformer T1 is connected across the rails of track section T and the second secondary winding W3 of T1 is connected across the input terminals of full wave rectifier R2. The primary winding W4 of transformer T2 is connected to terminals BX and NX of the alternating current source and an alternating current is thereby induced in the secondary winding W5 of transformer T2.

The output terminals of rectifier R1 are connected across winding *a* of relay TR so that the polarity of the direct current supplied to winding *a* from rectifier R1, in the manner hereinafter described, is such as to actuate movable contact 6 of relay TR to its left-hand position as shown by the dotted line in the drawing, that is, to a position so as to make contact with fixed contact 8 of relay TR. The output terminals of rectifier R2 are connected across winding *b* of relay TR so that the output from that rectifier, produced in the manner hereinafter described and supplied to said winding *b*, is of such a polarity as to actuate movable contact 6 of relay TR to its right-hand position as shown in the drawing, that is, to a position so as to make contact with fixed contact 7 of relay TR.

The windings of transformers T1 and T2 and those of relay TR are so proportioned that the following operation of the apparatus takes place when there is no train in track section T.

When contact *a* of code transmitter or code generator relay CTR is closed, a low impedance is presented to winding W2 of transformer T1 by the rails of track section T so that a negligible voltage appears across windings W1, W2 and W3 of transformer T1. Substantially all of the output of winding W5 of transformer T2 is, therefore, supplied to rectifier R1 and a direct current voltage, sufficient to cause contact 6 of relay TR to move to its left-

hand position, is supplied across winding *a* of relay TR. Since a negligible voltage appears across winding W1 and, therefore, winding W3 at this time, the output of rectifier R2 at this time may also be considered negligible.

When contact *a* of code generator relay CTR is open, a high impedance is presented to winding W2 of transformer T1 by the rails of track section T so that the voltage supplied to rectifier R1 from winding W5 of transformer T2 is substantially reduced due to the voltage drop across winding W1 of transformer T1. At this time a substantial voltage is induced in winding W3 of transformer T1 and is supplied to rectifier R2 where it is rectified and supplied across winding *b* of relay TR. This voltage supplied to winding *b* of relay TR is sufficiently greater than that supplied to winding *a* of the relay at this time that contact 6 of the relay is actuated to its right-hand position. It is, therefore, readily apparent that contact 6 of relay TR follows the coding action of contact *a* of code transmitter relay CTR due to the intermittent change in impedance presented to winding W2 of transformer T1 by the shunt circuit intermittently closed across the rails of track section T by said contact *a*.

Contact 6 of relay TR being intermittently closed against fixed contact points 7 and 8 alternately energizes slow release relays FSA and BSA in the well known code detection manner, and contact *a* of relay BSA is maintained in its closed position against its front contact point. The control or indication apparatus is actuated over the front point of contact *a* of relay BSA at this time to indicate the non-occupancy of track section T.

The entrance of a train into track section T or a broken rail in the track section will cause the impedance presented to winding W2 of transformer T1 to be substantially constant, that is, contact *a* of relay CTR no longer changes the impedance presented to said winding under such conditions, since it is in effect no longer in the circuit from winding W2. Under these conditions contact 6 of relay TR will cease its code following action. If the cessation of the code following action of relay TR is due to track section T being occupied by a train, the impedance presented to winding W2 of transformer T1 will be a constant low impedance (similarly to when contact *a* of relay CTR is closed) and contact 6 of relay TR will remain in a closed position against fixed contact point 8. If the cessation of the code following action of relay TR is due to a broken rail in track section T, the impedance presented to winding W2 of transformer T1 will be a constant high impedance (similarly to when contact *a* of relay CTR is open) and contact 6 of relay TR will remain in a closed position against fixed contact point 7.

Under the above-described conditions the pickup circuit for relay BSA will be opened at fixed contact point 8 of relay TR or at front contact *a* of relay FSA, and relay BSA will release following the expiration of its slow release period. The release of relay BSA transfers contact *a* of that relay from its front contact point to its back contact point to actuate the control or indication apparatus to indicate the occupancy of track section T by a train or a broken rail in the track section as the case may be. It will be readily understood that, if desired, an additional contact may be provided on relay TR and employed in conjunction with the back point of contact *a* of relay BSA to distinctly indicate the occupancy of track section T by a train or a broken rail in the track section, according as such additional contact remains in a closed position against fixed contact point 8 or 7, respectively, when relay BSA is released.

Referring to FIG. 2 of the drawings, it will be readily apparent that, with the exception of the apparatus connected across the rails 1*a* and 1*b* of track section T, including the connections of winding W2 of transformer T1 across the track rails, the apparatus of FIG. 2 is identical to that of FIG. 1 and, therefore, only the arrangement of the track circuit itself will be discussed in detail.

In FIG. 2, code generator or code transmitter relay CTR has been moved from its former location as shown in FIG. 1 to the opposite end of track section T, and a half wave rectifier R3 is connected across the track rails at the former location of relay CTR. Winding W2 of transformer T1 is connected across the rails of track section T through contacts *a* and *b* of relay CTR and through a track battery TB. In other words track battery TB is connected, through contacts *a* and *b* of relay CTR, in series with winding W2 and the connections of that winding across the rails of track section T. In the apparatus of FIG. 2 transformer T1 is preferably, but need not necessarily be, a saturable transformer.

When back contacts *a* and *b* of code generator relay CTR are closed, direct current energy from track battery TB flows from the positive terminal of the battery over the back point of contact *b* of relay CTR, winding W2 of transformer T1, rail 1*b* of track section T, rectifier R3 in its low resistance direction, rail 1*a* of track section T and over the back point of contact *a* of relay CTR to the negative terminal of track battery TB. This flow of direct current through rectifier R3 forward biases the rectifier and a low impedance is presented to winding W2 of transformer T1 during that portion of a cycle of the alternating voltage across that winding that the sum of the instantaneous alternating voltage and the voltage of battery TB forward biases rectifier R3. Therefore, the apparatus of FIG. 2 operates in a manner similar to that in which the apparatus of FIG. 1 operates when contact *a* of relay CTR in FIG. 1 is closed, and contact 6 of relay TR in FIG. 2 is actuated to its left-hand position at this time.

When front contacts *a* and *b* of code generator relay CTR are closed, as shown in FIG. 2, the direct current from track battery TB is prevented by rectifier R3 from flowing through winding W2 of transformer T1 and the rails of the track section and, therefore, a high impedance is presented to said winding W2 during that portion of a cycle of the alternating voltage across that winding that the sum of the instantaneous alternating voltage and the voltage of battery TB reverse biases rectifier R3. At this time, that is, at the time front contacts *a* and *b* of relay CTR are closed, contact 6 of relay TR is actuated to its right-hand position, as shown in the drawing. Thus, when front contacts *a* and *b* of relay CTR are closed, the apparatus of FIG. 2 operates in a manner similar to that in which the apparatus operates when contact *a* of relay CTR in FIG. 1 is open.

It was previously stated that, in the apparatus of FIG. 2, transformer T1 is preferably but not necessarily of the saturable type. Assuming transformer T1 to be of such a type, when the back points of contacts *a* and *b* of relay CTR are closed and the direct current from battery TB is, therefore, not prevented from flowing by rectifier R3, such current will tend to or will saturate winding W2 of transformer T1 and a still lower impedance will be reflected by such winding into winding W1 of transformer T1. As is apparent such lower impedance will aid the operation of the apparatus. When track section T is occupied by a train, current from battery TB will saturate transformer T1 whether contacts *a* and *b* of relay CTR are in either of their positions, that is, throughout the period of occupancy. Therefore, any alternating current energy applied to winding W2 from the rails at this time will have no effect on windings W1 and W3 and the associated circuitry. It follows that such a circuit provides both broken-down insulated joint protection and foreign current protection.

From the foregoing description it is apparent that, with the apparatus of my invention shown in FIGS. 1 and 2 of the drawings of this application, I have provided new and original alternating current coded track circuit arrangements.

While I have shown and described only two forms of apparatus embodying my invention, it is to be understood that various changes and modifications may be made therein in 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 with an insulated section of railway track, a coded track circuit comprising; a first transformer having a primary winding, a first secondary winding connected across the rails of said track section and a second secondary winding; a source of alternating current energy, a second transformer having a primary winding connected to said energy source and a secondary winding connected in a series circuit with said primary winding of said first transformer, a relay, a first rectifying means connecting said series circuit to said relay, a second rectifying means connecting said second secondary winding of said first transformer to said relay, a code generator, switching means connected in a series circuit with said first secondary winding of said first transfomer and the rails of said track section for intermittently conductively completing said last-mentioned series circuit, said switching means being responsive to the coding operation of said code generator for periodically changing the impedance presented to said first secondary winding of said first transformer by the rails of said track section.

2. In combination with a section of railway track; a first transformer having a primary winding and a first and second secondary winding, said first secondary winding being connected across the rails of said track section; a source of alternating current energy, a second transformer having a primary winding connected to said energy source and a secondary winding, a first series circuit having a relay with at least one winding, said first series circuit including said primary winding of said first transformer, said secondary winding of said second transformer and said winding of said relay, a second series circuit including said second secondary winding of said first transformer, and said relay, a code generator relay, switching means connected in a series circuit with said secondary winding of said first transformer and the rails of said track section for intermittently conductively completing said last-mentioned series circuit, said switching means being responsive to the coding operation of said code generator relay for periodically changing the impedance presented by the rails of said track section to said secondary winding of said first transformer.

3. In combination with an insulated section of railway track; a transformer having a primary winding, a first secondary winding connected across the rails of said track section at one end thereof and a second secondary winding; a relay having first and second windings, first rectifying means connected to said first winding of said relay, a source of alternating current energy, a second transformer having a primary winding connected to said energy source and a secondary winding connected in a series circuit with said primary winding of said first transformer and said first rectifying means, second rectifying means connected in a series circuit with said second winding of said relay and said second secondary winding of said first transformer, a code generator relay including a contact opened and closed at a predetermined code rate, said contact being electrically connected across the rails of said track section at the end thereof opposite said one end for intermittently short-circuiting the rails of said track section at the code rate.

4. In combination with an insulated section of railway track; a first transformer having a primary winding, a first secondary winding connected across the rails at one end of said track section and a second secondary winding; a source of alternating current energy, a second transformer having a primary winding connected to said energy source and a secondary winding connected in a series circuit with the primary winding of said first transformer, switching means connected across the rails at the end of said track section opposite said one end for intermittently short-circuiting the rails of the track section at a predetermined code rate, and means connected to the primary winding and the second secondary winding of said first transformer for detecting the intermittent change of impedance at said predetermined code rate presented by the rails of said track section to the first secondary winding of said first transformer.

5. In combination with an insulated section of railway track, a coded track circuit comprising; a first transformer having a primary circuit means, a first secondary circuit means connected across the rails of said track section at one end thereof and second secondary circuit means; a relay having first and second windings and a contact that is actuated to a first position when energy of a first polarity is supplied to said first winding and to a second position when energy of a second polarity is supplied to said second winding, a source of alternating current energy, a second transformer having a primary circuit means connected to said energy source and a secondary circuit means in a series circuit with said primary circuit means of said first transformer, first rectifying means connecting said first winding of said relay with said series circuit so as to supply energy of said first polarity to the first winding, second rectifying means connecting said secondary circuit means of said first transformer with said second winding of said relay so as to supply energy of said second polarity to the second winding, code detection means responsive to code following operation of said contact of said relay, switching means connected in a series circuit with said first secondary winding of said first transformer and the rails of said track section for intermittently conductively completing said last-mentioned series circuit, said switching means periodically changing the impedance presented to said first secondary winding of said first transformer by the rails of said track section.

6. In combination with an insulated section of railway track, a transformer having a primary winding and first and second secondary windings, a half wave rectifier connected across the rails of said track section at a first end thereof, a coding relay, a source of direct current, means comprising a first series circuit including at least one contact of said relay and said current source for alternately supplying through the first secondary winding of said transformer current of first and second polarities across the rails of said track section at the second end thereof, an alternating current source, a second transformer having a primary winding connected to said alternating current source and a secondary winding connected in a second series circuit with the primary winding of said first transformer, a second relay, first rectifying means connecting said second series circuit to said second relay, second rectifying means connecting said second secondary winding of said first transformer to said second relay, and code detection means actuated by a contact of said second relay.

7. In combination with an insulated section of railway track, an asymmetric unit connected across the rails of said track section at a first end thereof, a first transformer having a primary winding and first and second secondary windings, a code generator relay, a source of direct curent energy, circuit means comprising a first series circuit including at least one contact of said relay for alternately connecting energy of first and second polarities from said source through the first secondary winding of said transformer and across the rails of said track section at the second end thereof, a source of alternating current energy, a second transformer having a primary winding connected to said alternating current source and a secondary winding connected in a second series circuit with the primary winding of said first transformer, another relay, first rectifying means connecting said other relay with said second series circuit, second rectifying means connecting said other relay with the

second secondary winding of said first transformer, and code detection means actuated by a contact of said other relay.

8. In combination with an insulated section of railway track, a transformer having a primary winding and first and second secondary windings, a coding relay, circuit means including at least one contact of said relay for periodically closing a first series circuit comprising the first secondary winding of said transformer and the rails of said track section, and an impedance means electrically connected between said rails, said impedance means variable between a low impedance and a high impedance, an alternating current source, a second transformer having a primary winding connected to said alternating current source and a secondary winding connected in a second series circuit with the primary winding of said first transformer, a second relay, first rectifying means connecting said second series circuit to said second relay, second rectifying means connecting said second secondary winding of said first transformer to said second relay, and code detection means actuated by a contact of said second relay.

9. In combination with an insulated section of railway track, a first transformer having a primary winding and first and second secondary windings, a code generator relay, circuit means including at least one contact of said relay for periodically closing a first series circuit comprising the first secondary winding of said transformer and the rails of said track section, and an impedance means electrically connected between said

rails, said impedance means variable between a low impendance and a high impedance, a source of alternating current energy, a second transformer having a primary winding connected to said alternating current source and a secondary winding connected in a second series circuit with the primary winding of said first transformer, another relay, first rectifying means connecting said other relay with said second series circuit, second rectifying means connecting said other relay with the second secondary winding of said first transformer, and code detection means actuated by a contact of said other relay.

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