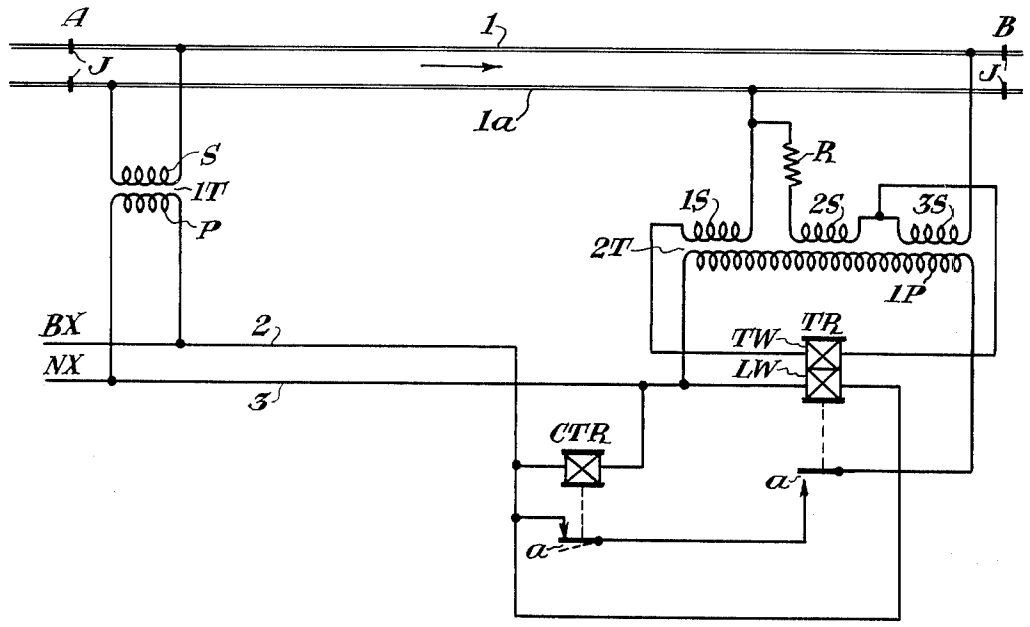
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RAILWAY TRACK CIRCUIT APPARATUS

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RAILWAY TRACK CIRCUIT APPARATUS

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My invention relate to railway track circuit apparatus, and particularly to an organization of such apparatus especially applicable to train control or cab signal systems of the coded continuous inductive type. More particularly, my invention relates to a novel organization of apparatus comprising a combination of an alternating current track relay and a source of cab signal or train control energy connected across the rails at the exit end of a section of railway track in a railway installation provided with a train control or cab signal system of the coded continuous inductive type, and in which track section the source of track circuit current is connected across the rails at the entrance end of the section.

In signaling systems of the type mentioned above, in which the track circuit current and the train governing current are of the same frequency, or in which the track relay employed is of a type responsive to various frequencies and is, therefore, responsive to the train governing current employed, it must be assured that the track relay does not become picked up in response to the train governing current supplied across the rails of the track section at the end thereof to which the track relay is connected, and at the same time it must be assured that the track relay does become picked up in response to the track circuit current when a train vacates the track section. It is, therefore, the object of my invention to provide a novel organization of apparatus in which an alternating current track relay responsive to alternating track circuit current does not become picked up in response to alternating train control current supplied across the rails of the same end of a section of railway track to which such track relay is connected.

In accomplishing the above object of my invention I provide a train control or cab signal energy transformer having a single primary winding and three equal secondary windings, such secondary windings being so connected to each other and across the control winding of an alternating current relay and the rails of a section of railway track that the alternating current relay will not become picked up in response to alternating current supplied to the primary winding of said transformer, but will become picked up in response to alternating current received over said track rails from the end of the track section opposite from that to which the transformer and relay are connected.

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

The single accompanying drawing is a diagrammatic view showing one form of apparatus embodying my invention.

In the drawing, reference characters 1 and 1*a* designate the rails of a stretch of railway track over which traffic normally moves in the direction indicated by the arrow disposed on the drawing between rails 1 and 1*a*. These rails are divided by insulated joints J, at locations A and B in the track stretch, into a series of track sections of which only the section extending from location A to location B is shown completely. This track section is provided with an alternating current track circuit comprising, at the entrance end of the track section for said direction of traffic, a transformer 1T having a primary winding P and a secondary winding S; and at the exit end of the track section, an alternating current track relay TR. The primary winding P of transformer 1T is

connected across the terminals BX and NX of a suitable source of alternating current which, for purposes of simplification of the drawing, is not shown therein. As indicated in the drawing, alternating current from such source is also provided over conductors 2 and 3 to the apparatus at the exit end of track section A–B. The secondary winding of transformer 1T is connected across the rails of track section A–B at said entrance end thereof.

Track relay TR located at the exit end of track section A–B is, as indicated by the diagonal lines drawn through the geometric rectangles representing the windings of the relay, an alternating current relay of the two-element type, that is, a relay having a first or a local winding LW; and a second, or a control or track winding TW. The local winding LW of relay TR is connected, by means of the previously mentioned conductors 2 and 3, across terminals BX and NX of the previously mentioned alternating current source. Alternating current relays, such as relay TR, are well known in the art and the relay may, for example, be similar to that shown and described in Letters Patent of the United States No. 1,682,749, issued September 4, 1928 to Robert M. Gilson for an Electrical Relay. Such relays may be employed as two-position or three-position relays. Back contact *a* of relay TR, disposed on the drawing beneath the relay, occupies its open position, as shown, whenever the alternating current supplied to the right-hand side of each of the relay windings, as such windings are shown on the drawing, is of the same relative instantaneous polarity. Since only contact *a* of relay TR is shown in the drawing, it will be readily apparent to those skilled in the art that the relay is employed in the apparatus of my invention as a two-position relay only.

There is also shown at location B a code generator or transmitter relay designated CTR. The control winding of relay CTR is continuously energized by connecting such winding across conductors 2 and 3 and thereby to terminals BX and NX of the alternating current source. Contact *a* of the relay, shown beneath the geometric rectangle representing the winding of the relay, is, therefore, continuously operating at the respective code rate of the relay. Such contact is illustrated by showing a solid line for the movable portion of the contact closed against the front contact point, thereby indicating that the winding of relay CTR is continuously energized; and by showing a dotted line for the movable portion of the contact in the open condition of the contact, thereby indicating that, although the relay is continuously energized, the contact is operating at the respective code rate of the relay. As will be apparent to those skilled in the art, the code rate of relay CTR is selected in accordance with the train-carried cab signal or train control apparatus employed on the trains which may travel track section A–B, such apparatus in itself forming no part of my present invention.

The alternating current for the operation of train control or cab signal apparatus employed on the trains to traverse the track section A–B is supplied to the rails at the exit end of the track section by a transformer 2T having a primary winding 1P and three equal secondary windings 1S, 2S and 3S. Secondary windings 2S and 3S are connected in a series aiding relationship with each other, and through a resistor R across rails 1 and 1*a* of track section A–B. The series connection between windings 2S and 3S is also connected to the right-hand side, as shown on the drawing, of track winding TW of track relay TR. The other side of such track winding is connected to one end of secondary winding 1S so that windings 1S and 3S are connected, through winding TW of relay TR, in a series opposing relationship with each other. The other end of secondary winding 1S is connected to rail 1*a* of track section A–B.

Primary winding 1P of transformer 2T is provided with

an energizing circuit which extends from conductor 2, and thereby from terminal BX of the alternating current source, over front contact *a* of relay CTR and back contact *a* of relay TR to the right-hand side of winding 1P as shown on the drawing, and from the left-hand side of winding 1P to conductor 3 and thence to terminal NX of the alternating current source. It will be noted that the energization of primary winding 1P over such circuit induces a voltage in the secondary windings 2S and 3S of transformer 2T which supplies a current to the rails that is of the same relative instantaneous polarity as that supplied to rails 1 and 1*a* by the secondary winding of transformer 1T at location A.

Having thus described the organization of the apparatus of my invention, I will now describe the operation of such apparatus when a train traverses and leaves track section A–B.

The apparatus is shown in the drawing in the condition it occupies when track section A–B is unoccupied by a train. Under such conditions track relay TR is in its normally picked-up position and back contact *a* or relay TR is, therefore, open. As an example of the reason that relay TR is picked up at such time, it will be assumed that relative positive and negative instantaneous polarities are supplied from terminals BX and NX, respectively, of the alternating current source to the primary winding P of transformer 1T, thus inducing in the secondary winding S of transformer 1T a current of such relative instantaneous polarity as to supply positive and negative relative instantaneous polarities to rails 1 and 1*a*, respectively, of track section A–B. This current flows over rail 1 to location B, through winding 3S of transformer 2T in a first direction, through track winding TW of relay TR in a direction from right to left as shown on the drawing, through winding 1S of transformer 2T in a direction opposite to said first direction, and thence to rail 1*a* and secondary winding S of transformer 1T. It will be noted that the instantaneous current flow through windings 1S and 3S of transformer 2T is, at this time, in opposite directions. However, the impedance presented to current flow through windings 1S and 3S will be substantially the resistance of the windings, since the induced magnetic fluxes are in opposite directions and thus cancel. Therefore, there is no reactive inductance present. However, the flow of current through winding 2S is subjected to the impedance of that winding, since there is no cancelling of magnetic flux. Moreover, resistor R adds a further impedance to the flow of current through winding 2S. This impedance is relatively high since the primary is open circuited. It will be also noted that the relative instantaneous polarity supplied to winding LW of relay TR is in the same direction as that supplied to winding TW of the relay and, therefore, as previously discussed, relay TR is picked up and back contact *a* of the relay is in its open position. It is also readily apparent that the apparatus operates in a similar manner when the relative instantaneous polarities are opposite to those set forth in the example just discussed.

When a train moving in the direction indicated by the arrow enters track section A–B, track relay TR becomes released due to the track circuit energy from secondary S of transformer 1T being short-circuited by the wheels and axles of the train. The release of track relay TR will close, at back contact *a* of that relay, the previously traced energizing circuit, including front contact *a* of code generator relay CTR, to the primary winding 1P of transformer 2T. The energization of primary winding 1P by the coded alternating current induces, in secondary windings 2S and 3S, pulses of alternating current having such relative instantaneous polarities that the pulses are additive. These alternating current pulses are supplied across the rails 1 and 1*a* of track section A–B. The pulses of alternating current induced at this time in windings 1S and 3S are of opposite relative instantaneous polarities. Therefore, no current flows through winding TW of track relay TR since the pulses of current from windings 1S and 3S are in opposing relationship to each other. The pulses of alternating current supplied under this condition to rails 1 and 1*a* are received by inductive cab signal or train control apparatus carried on the front of the train traversing the stretch, and control such apparatus in the manner well known to those skilled in the art. As previously mentioned, such apparatus forms no part of my present invention and, therefore, is not shown in the drawings.

When the train exits from track section A–B and the rails of such track section are, therefore, no longer shunted, the alternating current from transformer 1T can again flow in rails 1 and 1*a*. During an "on" period of the code pulses supplied to the rails from transformer 2T, the current from winding S of transformer 1T is opposed to the current from windings 2S and 3S of transformer 2T and little or none of the track circuit current from transformer 1T flows through winding TW of relay TR. However, during an "off" period of the code pulses, that is, during a period when contact *a* of relay CTR is open, no current is supplied to winding 1P of transformer 2T. Winding 2S again presents a high impedance to the flow of the alternating track circuit current supplied to rails 1 and 1*a* from transformer 1T. However, windings 1S and 3S again present a low impedance to the flow of such current since windings are connected with each other in an opposing relationship and, therefore, as previously discussed, there is little or no inductive reactance factor to be considered. At such time, therefore, the track circuit current from transformer 1T flows through winding TW of relay TR to cause the relay to become picked up. The picking up of relay TR opens, at back contact *a* of the relay, the energizing circuit to winding 1P of transformer 2T and, thereafter, the track circuit current from transformer 1T continues to flow through winding TW of relay TR and maintain the relay picked up. The apparatus is now in the condition existing prior to the entrance of the train into track section A–B.

From the foregoing description it is apparent that, with the apparatus of my invention as shown in the drawing of this application, I have provided a novel organization of track circuit apparatus for controlling the supply of coded alternating current train control energy across the rails of a section of railway track, while at the same time assuring the correct operation of the track relay of an alternating current track circuit provided in said track section.

While I have shown and described only one form of apparatus embodying my invention, it should be 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. Railway track circuit apparatus comprising, in combination:

(a) a section of railway track over which trains travel in a predetermined direction,

(b) a source of alternating current connected across the rails at the entrance end of said section,

(c) an alternating current track relay,

(d) transformer means having a primary winding and a plurality of secondary windings,

(e) means including a back contact of said track relay for supplying coded alternating current from said source to said primary winding,

(f) circuit means including a first selected group of said secondary windings connected across the rails at the exit end of said track section for supplying coded alternating current to said rails when said relay is deenergized, and

(g) other circuit means including a second selected group of said secondary windings for connecting said relay across the rails at said exit end so that said

relay responds only to current supplied from said alternating current source at said entrance end.

2. Track circuit apparatus comprising, in combination:
(a) a section of railway track,
(b) a source of track circuit alternating current connected across the rails at a first end of said track section,
(c) an alternating current track relay,
(d) a transformer at the second end of said track section having a primary winding and first, second, and third equal secondary windings,
(1) said first and third secondary windings in series opposing relationship connected in series with the control winding of said relay across the rails of said track section at said second end,
(2) said second and third secondary windings in series aiding relationship also connected across the rails of said track section at said second end, and
(e) means including a back contact of said track relay for supplying periodically interrupted alternating current from said source to the primary winding of said transformer.

3. In combination:
(a) a railway track section,
(b) means for supplying alternating current across the rails at one end of said track section,
(c) an alternating current track relay at the other end of said track section;
(d) a transformer having a primary winding and three equal secondary windings at said other end of the track section, the first and third of such secondary windings in series opposing relationship being connected in series with the control winding of said relay across the rails of said track section, and the second and third of the secondary windings in series aiding relationship also being connected across said rails; and
(e) means including a back contact of said track relay for supplying coded alternating current to the primary winding of said transformer.

4. In combination:
(a) a section of railway track over which trains travel in a predetermined direction,
(b) means at the entrance end of said track section for supplying alternating current of a preselected phase across the rails of the section;
(c) a transformer at the exit of said track section having a primary winding and first, second and third equal secondary windings;
(d) an alternating current track relay;
(e) a first circuit connected across the rails at the exit end of said track section and including said first secondary winding, the control winding of said relay, and said third secondary winding, said first and third windings being connected in series opposing relationship;
(f) a second circuit connected across the rails at the exit end of said track section and including said second and third secondary windings connected in series aiding relationship; and
(g) means including a back contact of said track relay for supplying pulses of alternating current to the primary winding of said transformer in such direction that the alternating current supplied across said rails from said second and third secondary windings is of said preselected phase.

5. In combination:
(a) a section of railway track,
(b) a first transformer at one end of said track section connected for supplying alternating current across the rails of the section,
(c) an alternating current track relay,
(d) a second transformer having a primary winding and three equal secondary windings,
(e) a resistor,

(f) circuit means including said resistor for connecting first and second ones of said secondary windings in series aiding relationship across the rails at the other end of said track section,
(g) circuit means including the control winding of said relay for connecting said first and the third of said secondary windings in series opposing relationship across the rails at said other end of the track section,
(h) a coding relay having a predetermined code rate of operation, and
(i) circuit means controlled by said coding relay and by a back contact of said track relay for supplying pulses of alternating current to the primary winding of said second transformer at said predetermined code rate and of a preselected phase relationship to the current supplied by said first transformer.

6. The combination comprising:
(a) a section of railway track over which trains move from an entrance end toward an exit end,
(b) means for supplying alternating current of a known phase across the rails of said section at the entrance end thereof,
(c) an alternating current track relay;
(d) circuit means, including first and second equal secondary transformer windings connected in series opposing relationship, for connecting the control winding of said relay across the rails of said track section at the exit end thereof;
(e) transformer means, including said second secondary winding and a third equal secondary winding connected in series aiding relationship, for supplying alternating current of said known phase across the rails of said track section at the exit end thereof; and
(f) means, including a back contact of said track relay and the primary winding of said transformer means, for inducing code pulses of alternating current of said known phase in said second and third secondary windings.

7. In combination:
(a) a section of railway track;
(b) a transformer having a primary winding and first, second and third equal secondary windings;
(c) an alternating current track relay,
(d) first circuit means for connecting one side of said first secondary winding to one rail of said track section at one end thereof and to one side of said second secondary winding,
(e) second circuit means for connecting the other side of said first secondary winding to one side of the control winding of said relay,
(f) third circuit means for connecting the other side of said control winding to one side of said third secondary winding so that the first and third secondary windings are connected in series opposing relationship through the control winding of said relay,
(g) fourth circuit means for connecting said one side of the third secondary winding to the other side of said second secondary winding so that the second and third secondary windings are connected in series aiding relationship,
(h) fifth circuit means for connecting the other side of said third secondary winding to the other rail of said track section at said one end thereof,
(i) means including a back contact of said track relay for supplying coded alternating current to said primary winding of said transformer; and
(j) means for supplying alternating current across the rails of said track section at the end thereof opposite said one end, such alternating current having a predetermined phase relation with the coded alternating current induced in said second and third secondary windings of said transformer by the coded alternating current supplied to said primary winding.

8. Railway track circuit apparatus comprising, in combination:

(a) a section of railway track over which trains travel in a predetermined direction,

(b) a source of alternating current connected across the rails at the entrance end of said section,

(c) an alternating current track relay,

(d) transformer means having a primary winding and a plurality of secondary windings,

(e) means including a back contact of said track relay for energizing said primary winding with coded alternating current, and

(f) means including said secondary windings for connecting said relay across the rails at the exit end of the track section so that said relay becomes energized by the alternating current source connected

across the rails at the entrance end of the section when and only when said primary winding is de-energized and said track section is unoccupied by a train.

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