Jan. 9, 1945. F. X. REES 2,366,988

CODED TRACK CIRCUIT FOR RAILROADS

Filed Oct. 16, 1942 2 Sheets-Sheet 1

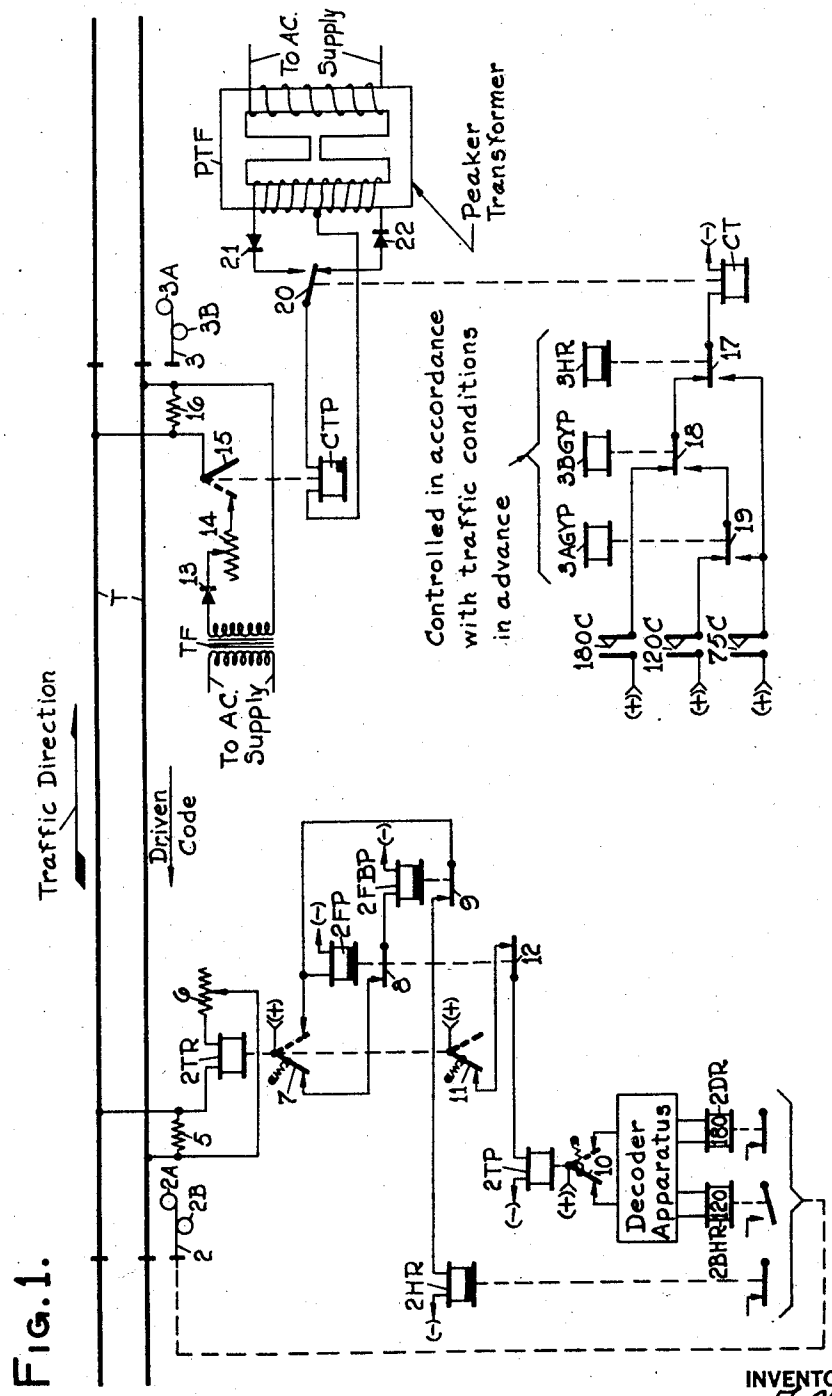


FIG. 1.

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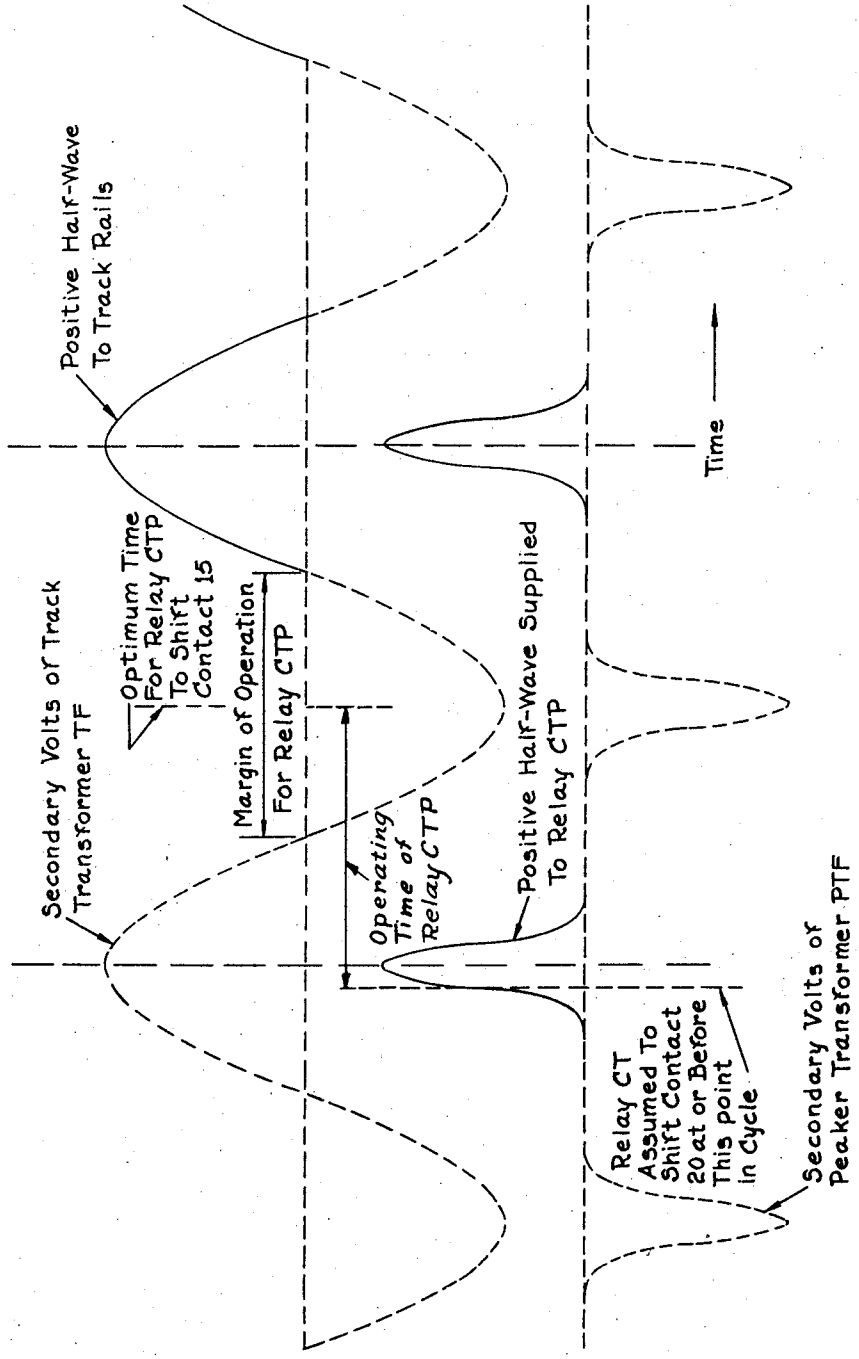


FIG. 2.

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UNITED STATES PATENT OFFICE

2,366,988

CODED TRACK CIRCUIT FOR RAILROADS

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Application October 16, 1942, Serial No. 462,225

13 Claims. (Cl. 246—34)

This invention relates to coded track circuits for railroads, and more particularly pertains to an improved manner of impressing coded impulses on a coded track circuit.

In my prior application, Ser. No. 453,313, filed August 3, 1942, now Patent No. 2,353,930, granted July 18, 1944, coded track circuits are disclosed in which the energy used for the code impulses is of the pulsating type. More specifically, alternating current is used as a source of energy with a half-wave rectifier so employed as to allow only one polarity of the alternating current wave to be impressed during a code impulse on the track circuit. This not only provides better shunting sensitivity for the track circuit, but also provides that train control or cab signal apparatus can be controlled by the coded track circuit impulses as well as wayside signals. No claim to this feature is made in this application.

The object of the present invention is to provide improved means of applying coded impulses of this pulsating current to the track circuit so as to avoid either making or opening the control contact for such pulsating track circuit current while current is actually flowing. It is, of course, well known that when contacts open a circuit in which current is flowing, an arc occurs in accordance with the potential of the energy; but it should also be appreciated that when contacts close, there is a certain amount of "bounce" of the movable contacts which causes miniature arcs to be made. These miniature arcs would be of relatively small importance in the usual control circuits, but in coded track circuits where the contacts are being opened and closed substantially continuously, these miniature arcs tend to pit the contacts and otherwise deform the contacting surface. Inasmuch as it is desirable that these coding contacts last over a long period of time, it is desirable to arrange the apparatus and circuit so as to minimize the arcing at the code transmitting contacts. This is especially desirable when a train is in a track circuit shunting the rails as the current supplied to the track through the coding contact is at a maximum under such circumstances and is of a very substantial value.

The present invention proposes to reduce the arcing or sparking of the coding contacts by determining that these contacts shall actually open and close only while there is no current flow through such contacts, and this is accomplished in accordance with the present invention by applying energy to the code transmitting relay at proper times so that its coding contacts will shift only while there is no current flowing through them. This can be accomplished because the pulsating current has periods when no current flows through the coded track circuit including the coding contacts.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings and in part pointed out as the description of the invention progresses.

In describing the invention in detail, reference will be made to the accompanying drawings, in which:

Fig. 1 shows a stretch of single track divided into track sections, each track section comprising a track circuit between successive signal locations in a coded track circuit signalling system; and

Fig. 2 shows a diagram of certain operating relationships appertaining to the embodiment of the present invention.

With reference to Fig. 1, a track section T is shown extending between signal locations 2 and 3. Each of these signals are assumed to be of the color light type having upper and lower arm signal mechanisms such as signal mechanism 2A and 2B for the signal 2. Although each of these signal mechanisms is assumed to be of the multiple aspect type as shown, for example, in the prior patent to O. S. Field, Patent No. 1,835,150, dated December 8, 1931, it should be understood that any suitable mechanism may be employed, and that any desired type signal may be used in place of the type shown.

The upper and lower arms of each signal, such as 3A and 3B for the signal 3, are controlled to give in combination four distinct indications, namely, red over red indicating stop; yellow over red indicating stop at the next signal; yellow over yellow indicating stop at the second signal; and green over green indicating proceed. All of this has been described in detail in my above mentioned prior Patent No. 2,353,930. It is believed to be sufficient for an understanding of the present invention to know that when the signal 3 indicates red over red or stop all of its associated signal repeating relays 3AGYP, 3BGYP and 3HR are deenergized. When the signal 3 gives any less restrictive indication, the relay 3HR is picked up; but if such less restrictive indication is yellow over red then the relay 3AGYP is picked up while the relay 3BGYP remains deenergized; and if the indication is yellow over yellow then both of the relays 3AGYP and 3BGYP are picked up.

It will be seen from Fig. 1 of the drawings, that the left-hand end of the track circuit T is provided with a track relay 2TR connected across the track circuit having in multiple therewith a bleeder resistor 5 and in series therewith a variable resistor 6. This track relay 2TR is of the polarized type having its polar contacts biased to one position so that it is actuated to an opposite position only upon the reception of polar impulses of a particular polarity.

Associated with this track relay 2TR are two neutral front and back repeating relays 2FP and 2FBP respectively. These relays are, of course, slow acting relays and the relay 2FP is picked up when the contact 7 of the track relay 2TR is actuated to the right, so that with the relay 2FP picked up the relay 2FBP is energized while the contact 7 of the track relay 2TR is in its normal biased position. This circuit for the relay 2FBP includes front contact 8 of relay 2FP. These relays 2FP and 2FBP are thus continuously energized whenever the track relay 2TR is receiving code over the track section T, but if the track relay 2TR is continuously deenergized then both of these relays are dropped away. In such a case, the relay 2FP drops away first followed by the dropping of the relay 2FBP upon the opening of front contact 8. If, on the other hand, the track circuit including the track section T should become erroneously energized with steady energy of the proper polarity to maintain the polar contacts of the track relay 2TR in actuated position, the relay 2FBP would drop away although the relay 2FP would remain picked up. In either case, it would be apparent that the relay 2HR would not receive energy because of the open condition of the front contact 9 of the relay 2FBP.

While the track relay 2TR is responding to any code, its operations are repeated by a two-position polarized relay 2TP which has polar contact 10 biased to a normal position. This repeating relay 2TP is controlled by polar contact 11 through a circuit including front contact 12 of relay 2FP, as shown in my above mentioned Patent No. 2,353,930, but, if desired, the "Decoder apparatus" may be directly controlled by contact 11 without the repeater relay 2TP.

When the track repeating relay 2TP is operated in accordance with the reception of a code by the track relay 2TR having 75 impulses per minute, the decoding apparatus is not effective to energize the relays 2BHR and 2DR, but the relay 2HR is maintained energized. This would cause the signal 2 to display the aspect of yellow over red. On the other hand, if the track repeating relay 2TP is being actuated with code impulses at the 120 rate, then the relay 2BHR is caused to be energized by the decoder apparatus while the relay 2DR remains deenergized. It is of course understood that the relay 2HR is picked up by impulses of any code rate being received. Thus, the signal 2 is caused to display a yellow over yellow aspect. When the 180 code rate is received by the track repeating relay 2TP, then the decoder apparatus causes the relay 2DR to be picked up while the relay 2BHR is deenergized. This relay 2DR in combination with the relay 2HR causes the signal 2 to display a green over green aspect. It is to be understood that the nature of the decoding apparatus and the control of the signal mechanisms 2A and 2B of the signal 2 is immaterial to the present invention and therefore have not been shown in detail, but reference may be made to my above mentioned application for all such details desired.

At the transmitting end of the track circuit, a track transformer TF has its primary winding supplied with alternating current energy and its secondary winding is connected across the track section T in series with a rectifier unit 13, a variable resistor 14, with polar contact 15 of the transmitter relay CTP in an actuated position. A multiple bleeder resistance 16 is connected across the track circuit. It is thus seen that half-wave alternating current pulses are applied to the track circuit when the front contact 15 of relay CTP is closed.

The transmitter relay CTP is of the stay-where-put magnetic stick type relay, that is, its polar contacts are operated to the right or to the left in accordance with the polarity of energy applied to this relay, and its contacts remain in the positions to which they are last operated.

The transmitter relay CTP is controlled by a neutral transmitter relay CT by energy supplied from the secondary winding of a peaker transformer PTF. This neutral transmitting relay CT is controlled through contacts 17, 18 and 19 in accordance with the indications of signal 3 subject of course to traffic conditions in advance of that signal. Thus, the relay CT may be operated in accordance with a 75 code rate, a 120 code rate, or a 180 code rate as supplied by the coding contacts 75C, 120C and 180C respectively depending upon the particular traffic conditions then existing. The particular structure of the coding contacts 75C, 120C and 180C is believed to be immaterial to the present invention and has not been shown in detail, it being assumed that these contacts may be operated continuously for the purposes of the present disclosure, although such coding devices might be set into operation only as required by suitable approach control.

The peaker transformer PTF has been diagrammatically illustrated as having a primary winding connected to an alternating current supply. Its secondary winding is provided with a mid-tap connected to one side of the transmitting relay CPT. The outer terminals of this secondary winding of the peaker transformer are respectively connected through rectifier units 21 and 22 as selected by the position of contact 20 of the relay CT to the other terminal of the transmitter relay CTP. This peaker transformer PTF is for the purpose of changing the usual alternating current sine wave to an abrupt or peaked wave form, as more completely described in my prior Patent No. 2,123,965, dated July 19, 1938. This peaked type of wave form has also been shown in the diagram of the accompanying Fig. 2. Inasmuch as the primary winding of both of the transformers TF and PTF are connected to the same alternating current supply, the voltages of their respective secondary windings are in time phase. In the diagram of Fig. 2 the wave forms are assumed to be voltage wave forms, although they could also be assumed to be current wave forms, as the inductive characteristics of the circuits have been neglected for the sake of simplicity in the present discussion.

For the purpose of the present disclosure it is assumed that the alternating current supply to the primary windings of these transformers TF and PTF is of the usual 60 cycle current commercial supply, although it should be understood that any other suitable frequency might be employed. Inasmuch as the coding contacts 75C, 120C and 180C are operated by oscillator mechanisms wholly independent from the character of alternating current supply, the opening and closing of the contact 20 of the transmitter relay CT will bear no particular relation to the current flow in the peaker transformer PTF. However, it is assumed that the contact 20 is shifted in accordance with the particular code rate then selected and when it closes either front or back points, the next positive half-wave of current

supplied by the secondary of the peaker transformer PTF flows through the particular rectifier unit in the circuit then closed by contact 20 in a direction to act upon the transmitter relay CTP to cause it to shift its contacts to the opposite position.

More specifically, let us assume that the upper end of the secondary winding of the peaker transformer PTF is the positive terminal with respect to the center-tap, then current will flow through the rectifier unit 21 and the transmitter relay CTP when front contact 20 is closed only during the positive half of each alternating current cycle. Similarly, let us assume that the center-tap of the secondary of transformer PTF is positive with respect to the lower terminal, then current will flow through the rectifier unit 22 and the transmitter relay CTP in an opposite direction when back contact 20 is closed but only during the positive half of each alternating current cycle. Thus, during the positive half-wave of any alternating current cycle, the relay CTP can be shifted to either its right or left-hand position, dependent upon whether the contact 20 of the relay CT is closed in a front or a back point position. On the other hand, it is seen that regardless of the position of contact 20 of relay CT, no current can flow through the relay CTP during the negative half-wave of any alternating current cycle due to the rectifier units 21 and 22.

Although the rectifier unit 13 is connected in its circuit to permit the positive half-waves of alternating current from the secondary of the transformer TF to flow to the track rails when contact 15 is closed, the shifting of the contact 15 of relay CTP in response to a positive half-wave does not actually occur until that positive half-wave has ceased and the negative half-wave period is present. This is indicated in Fig. 2 by showing that the relay CTP may have its circuit closed by contact 20 at or before the wave front of the peaked positive wave from the secondary winding of the peaker transformer PTF, but it does not shift its contacts until some time during the succeeding negative half-wave period due to the electrical impedance of the relay and the inertia of its armature and contact structure. This operating time of relay CTP is indicated in the drawing of Fig. 2 by an arrow with suitable legend. The optimum time at which the contacts of the relay CTP should shift is assumed to be at the median of the negative half-wave, but it is of course understood that such contacts may shift any time during such negative half-wave and there will be no current flow through the coding contact 15 and the track circuit by reason of the rectifier unit 13. This is indicated in Fig. 2 by the arrow having the legend "margin of operation for relay CTP," which arrow is adjacent the curves for the voltage of the secondary of transformer TF.

It should be noted in this connection, however, that the current is assumed to be in phase with the voltage, and if such current is not in phase with the voltage then the margin of operation for the relay CTP shifts relative to the voltage wave indicated in Fig. 2. But inasmuch as the relay response is dependent upon the current in its circuit, and so long as the current phase displacement is substantially the same in the circuit for relay CTP as in the track circuit, the phase displacement of such current is immaterial to a consideration of the operation of the circuit arrangement thus provided.

From the above, it will be understood that the relay CTP may be operated to either position in accordance with the position of contact 20 of the relay CT by the next succeeding positive half-wave of alternating current flowing through its circuit following the shift of the contact 20. Then due to the time lag of the contacts of the relay CTP, its contact 15 will not shift (either open or close) until the following negative half-wave of the alternating current at which time there is actually no current flow through such contact 15 due to the rectifier unit 13. Obviously, if there is no current flow through contact 15 when it shifts to an opposite position, there is no current to be broken and no arcing can occur. It should be understood that the relay CTP not only receives energy from the first positive half-wave of alternating current following the shift of the contact 20, but also receives the successive positive half-waves of alternating current in the direction then established until the contact 20 is again shifted to a new position at which time the positive half-waves of alternating current are passed through the relay CTP in the opposite direction. Likewise, it should be understood, that throughout the time that the contact 15 of the relay CTP is in its left-hand position, positive half-waves of alternating current are applied to the track circuit T. In other words, the coding contacts such as 75C, 120C and 180C open and close at regular intervals and depending upon the particular coding contacts then selected by the traffic controlled relays 3AGYP, 3BGYP and 3HR, the contact 15 of relay CTP is opened and closed at the same regular intervals as the coding contacts then selected. During each period of the closed condition of contact 15, a succession of positive half-waves of alternating current are applied to the track circuit T to comprise the "on" period of the code. Thus, the contact 15 may be operated in accordance with the coding contacts at any selected rate and apply code pulses to the track circuit each comprising a series of alternating current half-waves.

It is of course understood that the alternating current supply may be of any suitable frequency, but it may happen that if a sufficiently high frequency is selected, the relay CTP will not receive sufficient energy during any one half-wave of alternating current to actuate its contacts within the time period indicated in Fig. 2. In such a case, it may be desirable to change the relationships between the rectifier 13 and the rectifiers 21 and 22 so as to energize the relay CTP during a negative half-cycle while current is not flowing through its contact 15 and then regulate the time response of the relay CTP accordingly so that the contact 15 will not respond to shift its contacts until a later negative half-cycle while current is not flowing through the rectifier 13 and contact 15. It will thus be appreciated that certain variations in the characteristics of the apparatus may be provided for in practice in order to accomplish the purposes and features of the present invention, and all such variations are of course assumed to be within the scope of the present invention.

Although in accordance with the present invention, it is desirable to employ a peaker transformer, so as to accentuate the effect of an alternating current half-wave upon the transmitter relay CTP, and so as to be able to more accurately determine the time at which the relay contacts will actually shift, it should

be understood that the use of a peaker transformer is not absolutely essential to the practice of the invention. In other words, the invention should be considered sufficiently broad to include the use of usual transformer in the organization as shown in Fig. 1 in place of the peaker transformer PTF.

Thus, a coded track circuit has been provided for controlling wayside signals by coded impulses of pulsating current that will also govern train control or cab signalling apparatus, and these pulses of coded energy are impressed upon the track circuit of such a system in a manner to prevent arcing at the code applying contacts and thereby provides a more reliable system operable over a considerably longer period of time than the usual systems now known.

Having described the circuits and apparatus for applying impulses to a coded track circuit signalling system as one specific embodiment of the present invention, it is desired to be understood that this form is selected merely to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume; and it is to be further understood that various modifications, adaptations and alterations may be made to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the invention except as limited by the appended claims.

What I claim is:

1. In a coded track circuit for railroads, a section of track having code receiving means connected to it at one end, and code transmitting means at the other end comprising a source of alternating current, a half-wave rectifier, electro-responsive contact means for connecting and disconnecting said source and said rectifier in series across said track rails, and circuit means for at times causing said electro-responsive contact means to make said connection and to at other times break said connection, said circuit means being connected to said source and responsive only to particular half-cycles of said alternating current so as to cause said electro-responsive contact means to make or break said connection only when alternating current is blocked by said half-wave rectifier.

2. In a coded track circuit for railroads, a section of railway track having code receiving means connected across the rails at one end, and code transmitting means associated with the other end of the section comprising a source of alternating current, a half-wave rectifier, contact means for connecting said source and said rectifier in series across said track rails to apply half-cycles of a particular polarity to said rails, and circuit means for periodically causing said contact means to be effective to establish said connection, said means being actuated by alternating current from said source in a manner to initially effect such connection only during half-cycles of alternating current from said source which are not passed by said half-wave rectifier.

3. In a coded track circuit, an insulated track section of railroad track, a source of alternating current, a half-wave rectifier, coding contacts and a transmitting relay associated with one end of said track section, circuit means causing said coding contacts to operate said transmitting relay to its opposite positions at selected rates substantially lower than the rate of said alternating current, said circuit means initially operating said relay to one position or the other only during a negative half-wave of said alternating current, circuit means controlled by said transmitting relay in one position for connecting said alternating current source and said half-wave rectifier in series across the rails of said track section to apply positive half-waves of alternating current, whereby said connection and disconnection of said alternating current to said rails is effected only during the absence of current flow to such rails, and code receiving means at the opposite end of said track section connected across the rails thereof and distinctively responding to the code impulses each comprising a series of positive half-waves of alternating current.

4. In a coded track circuit for railroads, an insulated section of railroad track having code receiving means connected at one end, and code transmitting means associated with the other end comprising, a source of alternating current, a half-wave rectifier, a transmitting relay of the two-position polarized type acting when in one position to connect said source of current in series with said rectifier across the rails of track section, coding contacts operated at predetermined selected rates, and circuit means including a peaker transformer and rectifier means for causing said transmitting relay to be periodically operated to its two positions alternately in accordance with the operation of said coding contacts, such circuit means causing said transmitting relay to be initially operated to a new position only during a half-cycle of alternating current during which current is prevented from flowing to the rails of said track section from said alternating current source by said half-wave rectifier.

5. In a coded track circuit for railroads, a section of track the rails of which have a code receiving means connected across one end and code transmitting means connected across the other, said code transmitting means comprising a source of alternating current, a half-wave rectifier unit, a transmitting relay of the magnetic-stick type acting when in one position to connect said source of current in series with said rectifier unit across the rails of said track section, a peaker transformer having a primary winding energized from said source and having a secondary winding with a mid-tap connected to one terminal of said magnetic-stick relay, circuit means connecting the other terminal of said magnetic-stick relay to the opposite terminals of said secondary winding through oppositely poled rectifier units at different selected rates in accordance with predetermined codes, to thereby cause said transmitter relay to initially shift its contacts to new positions only while current flow to the rails of said track section is prevented by said half-wave rectifier unit.

6. In a coded track circuit for railroads, a track section, means including a code applying circuit for applying code impulses to one end of said track section each impulse comprising a succession of half-cycles of alternating current of one relative polarity, said means acting in such a way as to make or break the code applying circuit only during the absence of such half-cycles of alternating current, and code receiving means at the other end of said track section responsive to the code impulses received over the rails of such section for controlling the indications of a traffic governing signal.

7. In a coded track circuit for railroads, a section of railway track having a signal at the entrance thereof for governing traffic into such

section, code transmitting means at the exit end of said section comprising a source of alternating current, a half-wave rectifier, means connecting and disconnecting said source and said rectifier in series across said track section at regular intervals at a selected rate, said means performing such connecting and disconnecting function only during the half-wave of any alternating current cycle during which said rectifier will not pass current, and code receiving means at the entrance end of said section responsive to the half-cycles of alternating current received over the track rails at the intervals of the selected rate for controlling the indications of said traffic governing signal.

8. In a coded track circuit for railroads, a section of railway track having code receiving means connected across the rails at one end, and code transmitting means associated with the other end of the section comprising a source of alternating current, a half-wave rectifier, contact means capable of being rendered effective to connect said source and said rectifier in series across said rails, coding contacts operating at different predetermined code periods, and circuit means controlled by said coding contacts with alternating current energy from said source for rendering said contact means effective during said code periods but being initially rendered effective for each code period only during that portion of an alternating current cycle during which current is prevented from flowing by said half-wave rectifier, whereby half cycles of alternating current are applied during the successive code periods, and whereby said source and said half-wave rectifier are initially connected across the rails for each code period during the absence of current flow to thereby prevent arcing of said contact means.

9. In a coded track circuit for railroads, a section of railway track having code receiving means connected across the rails at one end, and code transmitting means associated with the other end of the section comprising, a source of alternating current, a half-wave rectifier, contact means capable of being rendered effective to connect said source and said rectifier in series across said rails, coding contacts operable at predetermined code rates to measure off code impulse periods, a peaker transformer having a primary winding energized from said source and having a secondary winding, and circuit means including rectifier means for connecting the secondary of said peaker transformer through said coding contacts for governing said contact means to render such contact means initially effective for each impulse period only during that portion of an alternating current cycle during which current is prevented from flowing by said half-wave rectifier though the rail circuit.

10. In a coded track circuit for railroads, a section of railway track, a source of alternating current, a half-wave rectifier, coding means including coding contacts operable to measure off recurring code periods, a transmitting relay including contacts operable to be effective to connect said source and half-wave rectifier in series across the rails at one end of said track section, circuit means controlled by said coding contacts for at times energizing said transmitting relay from said source to render its contacts effective during said code periods, said circuit means including asymmetric units permitting said transmitting relay to be energized from said source only at a time to cause its contacts to be initially rendered effective or ineffective only during that portion of an alternating current cycle during which current is prevented from flowing to said track section by said half-wave rectifier, and code receiving means at the opposite ends of said track section connected across the rails thereof and distinctively responding to the energization thereof from said source at said one end of said track section.

11. In a coded track circuit for railroads, a section of railway track having code receiving means connected across the rails at one end, and code transmitting means associated with the other end of the track section comprising, a source of alternating current, a half-wave rectifier, coding means including coding contacts operable to measure off code periods, a transmitting relay of the two-position magnetic-stick type having contacts for in one position connecting said source and said half-wave rectifier in series across the track rails of said section, and circuit means controlled by said coding contacts to energize said transmitting relay in opposite directions alternately from said source only during particular half-cycles of said alternating current to cause the contacts of said transmitting relay to be actuated to opposite positions only while said half-wave rectifier prevents the flow of current from said source to said track section.

12. In combination, a source of alternating current, a rectifier unit of the half-wave type, a load circuit, electro-responsive circuit controlling means for connecting and disconnecting said alternating current source and said rectifier unit in series across said load circuit, movable control contacts, asymmetric circuit means, and circuit means governed by said movable control contacts for at times connecting said source through said asymmetric circuit means to said electro-responsive circuit controlling means in such a manner as to operate it to cause said connection or disconnection dependent upon the position of said movable control contacts and at a time that current is blocked by said rectifier unit of the half-wave type.

13. In a track circuit for railroads, an insulated section of railway track having a track relay connected across the rails at one end and transmitting means associated with the other end of the section comprising, a source of alternating current, a rectifier unit of the half-wave type, electro-responsive contacts operable to one position for connecting said alternating current source and said rectifier unit in series across said track section and operable to the opposite position for opening such connection, movable control contacts operable to different positions, asymmetric circuit means, and circuit means for connecting said source through said asymmetric circuit means to said electro-responsive contacts in such a manner as to cause said electro-responsive contacts to be operated to said one position to make said connection or to its opposite position dependent upon the different positions of said movable contacts and to initially cause the operation of said electro-responsive contacts at a time that current is prevented from flowing through said rectifier unit of the half-wave type irrespective of the time of the operation of said movable contacts to their different positions.

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