

July 19, 1955

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2,713,633

CODED IMPULSE RAILWAY TRACK CIRCUITS

Filed March 14, 1950

2 Sheets-Sheet 1

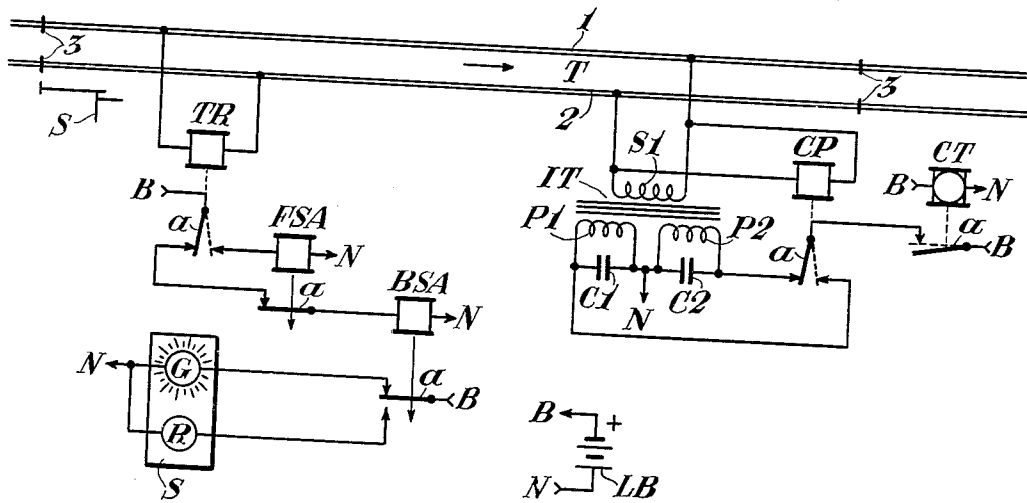


Fig. 1.

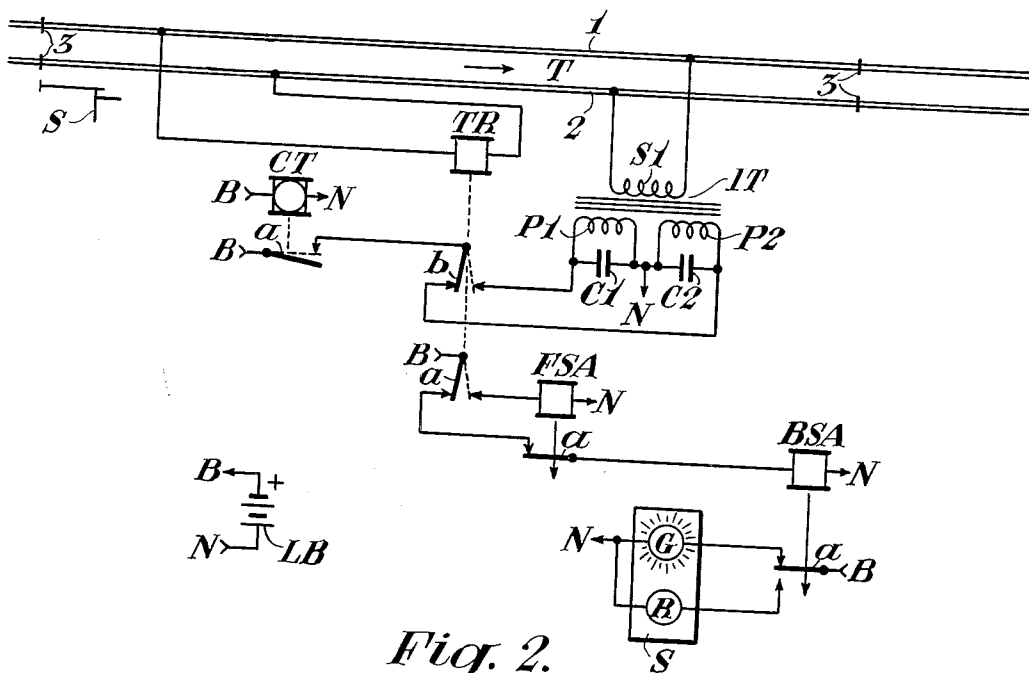


Fig. 2.

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2 Sheets-Sheet 2

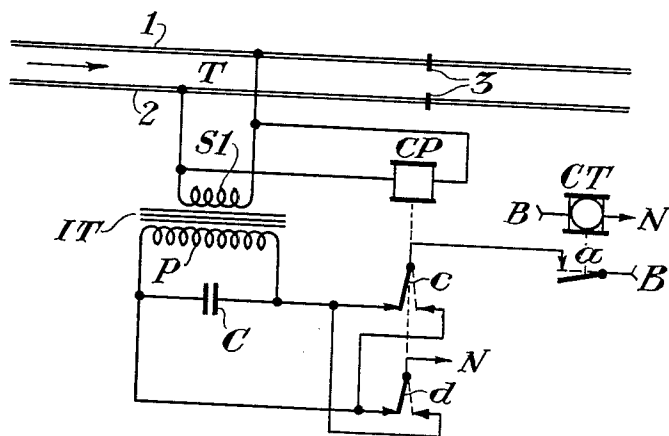


Fig. 3.

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CODED IMPULSE RAILWAY TRACK CIRCUITS

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20 Claims. (Cl. 246—34)

My invention relates to railway track circuits, and particularly to railway track circuits of the coded type employing a trackway code comprising short impulses of alternate polarity.

It has previously been proposed to provide coded railway track circuits of the type described in which short impulses of energy of alternate polarity are supplied to the rails of the railway track circuit by means including an impulse transformer having a secondary winding connected to the track rails and having one or more primary windings to which pulses of direct current energy are supplied by a circuit including the contacts of a recurrently operated coding device. In such arrangements, it has generally been proposed to supply direct current energy over a contact of the coding device closed in one of its two positions to a first primary winding of the impulse transformer and to supply direct current energy over a contact of the coding device in the other of its two positions to a second primary winding of the impulse transformer. The apparatus is constructed and proportioned so that the energy induced in the secondary winding when the contacts of the coding transmitting device close is of relatively small magnitude compared to the energy induced in the secondary winding when the supply of energy to the primary windings is interrupted by the opening of the contact of the coding device. The impulse transformer has its windings constructed and arranged so that the energy induced in the secondary winding when the current to one of the primary windings is interrupted is of one polarity, and is of the opposite polarity when the current supplied to the other primary winding is interrupted. Accordingly, it will be seen that when the code transmitting device opens its contact from a first position, energy of one polarity will be induced in the secondary winding of the impulse transformer, but when the contact of the coding device opens from its other position, energy of the opposite polarity will be induced in the secondary winding of the impulse transformer. It has been found that with the usual type of code transmitting device employed in such systems, the time interval between the opening of the code transmitting contact from its one position to the closing of the code transmitting contact in its other position is insufficient to allow the flux previously generated in the transformer core to decay sufficiently, so that the operation of such an arrangement may be relatively unstable at times. That is, assuming the presence of flux of one polarity in the transformer core which has not completely decayed, when the coding contacts are closed in the position to build up flux in the opposite direction, it is first necessary that the residual flux be reduced to zero, so that the energy supplied to the transformer at this time must overcome the residual flux in the core which remains from the last energization. Accordingly, the energy induced in the secondary winding under these conditions is relatively lower than that which would be obtained if the flux in the impulse transformer core were to decay completely or almost completely between the impulses of

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energy supplied to the primary windings of the transformer.

Additionally, it has been found that with code transmitting devices of conventional construction, the speed of operation is such that where apparatus of this type is operated from primary batteries, there is a relatively large amount of energy required from the battery due to the relatively high speed of operation.

Accordingly, it is an object of my invention to provide an improved type of coded polar impulse railway track circuit in which the time interval between the supply of impulses to the primary windings of the impulse transformer is considerably increased, so as to permit the decay of the flux in the impulse transformer core caused by the previous energization of the transformer.

Another object of my invention is to provide an improved type of railway track circuit of the type described in which the speed of operation is relatively slower than that commonly obtained.

A further object of my invention is to provide an improved railway track circuit of the type described in which the frequency of the impulses supplied to the track circuit is one-half the frequency obtained with previous arrangements employing conventional coding devices.

Still another object of my invention is to provide an improved railway track circuit of the type described in which more stable operation is secured by obtaining longer time intervals between the impulses of energy which are supplied to the track rails.

Still another object of my invention is to provide an improved type of railway track circuit of the type described in which the impulses supplied to the track rails are at a relatively low frequency, thereby effecting a saving in the power supplied to the apparatus.

Other objects of my invention and features of novelty therein will be apparent from the following description taken in connection with the accompanying drawings.

In practicing my invention, I provide, in addition to the usual coding device and impulse transformer, an auxiliary polar stick relay, that is, a relay having contacts which stay in the position to which they were last moved until an impulse of energy of opposite polarity moves them to their other position, such relays operating their contacts in a manner sometimes referred to as "stay-where-put." The code following polar stick relay is supplied with energy from a secondary winding of the impulse transformer, and the parts are arranged so that the relay is operated to its two positions in response to the polarity of impulses supplied from the secondary winding of the impulse transformer. A contact of the polar stick relay is employed in the circuits for supplying energy to the primary windings of the impulse transformer, in such manner that the primary windings are alternately supplied with energy depending upon the position of the contact of the polar stick relay, each time that the contact of the coding device closes in one of its two positions, so that the flow of energy in the primary windings of the transformer is effectively reversed by operation of the polar stick relay. The parts are constructed and arranged so that the impulses of energy supplied to the polar stick relay operate the contact of the polar stick relay to the position in which they connect the primary winding which will supply an impulse of the polarity opposite to that which moved the contact of the polar stick relay to that position. Accordingly, each time that an impulse of energy is supplied from the impulse transformer, the contacts of the polar stick relay are shifted to their opposite position so that the next time the coding device contact closes, energy will be supplied to the other primary winding of the impulse transformer, and when the coding device opens its contact from that position,

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an impulse of energy will be induced in the secondary winding of the impulse transformer which causes the contacts of the polar stick relay to be moved to the opposite position. It will be seen therefore that the apparatus continues to operate recurrently in the manner described, and additionally, since the impulses of energy which operate the polar stick relay are induced in the secondary winding upon recurrent opening of the contact of the code transmitter from its one position, the polar stick relay operates at one-half the speed of the operation of the coding device contact. The impulses of energy of alternate polarity are supplied to the track rails of a section of railway track, and cause a code following polar stick relay at the opposite end of the section to be operated between its two positions in response to the impulses of alternate polarity.

In a modification of my invention, which may be employed where the track section is sufficiently short so that all the apparatus may be located at a single location, a contact of a code following polar stick track relay may be employed to shift the connections between the two primary windings of the impulse transformer, thereby eliminating the need for an extra polar stick relay.

I shall describe three forms of coded polar impulse railway track circuits which embody my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings,

Fig. 1 is a diagrammatic view showing a track circuit which incorporates the improvements of my invention and employs an auxiliary polar stick relay at the feed end of the track circuit in conjunction with an impulse transformer and coding device, and

Fig. 2 is a diagrammatic view illustrating a modification of the arrangement shown in Fig. 1 in which all of the apparatus associated with the track circuit is disposed at a single location, and a contact of a code following polar track relay is used in conjunction with the contact of the coding device to supply energy to the windings of the impulse transformer.

Fig. 3 is a fragmentary diagrammatic view illustrating a modification of the arrangement shown in Fig. 1, in which an impulse transformer with a single, two-terminal primary winding is employed.

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

Referring first to Fig. 1, there is shown a section of railway track T having the track rails 1 and 2 which are separated from the rails of the adjoining section by the usual insulated joints 3. Traffic normally moves through this section in a direction from left to right, as shown by the arrow, and there is provided at the entrance or left hand end of the track section T a signal S which is here shown as a conventional color light signal having a green lamp G and a red lamp R, which signal governs the movement of traffic into section T. At the entrance end of section T, there is also provided a code following polar stick track relay TR, and a pair of slow release relays FSA and BSA, which detect the code following operation of the track relay TR. At the exit end of the section there is provided a coding device CT, having contacts which are recurrently operated between their two positions at some specified rate, for example, 180 times per minute. Additionally, there is provided an impulse transformer IT having two primary windings designated by the reference characters P1 and P2, each of which is bridged by a condenser C1 and C2, respectively, and having a secondary winding S1 which is connected to the track rails 1 and 2 of section T and is additionally connected to the winding of a code following polar stick relay CP. The two primary windings may be replaced by their electrical equivalent, a single center-tapped winding, if desired.

Energy for the operation of the apparatus at each location may be furnished by a suitable source of low

voltage direct current, such as a battery LB, having positive and negative terminals which are designated by the reference characters B and N, respectively.

The apparatus is shown in its normal condition, with the section T unoccupied. The code transmitter CT has its operating winding continuously connected across the low voltage source as shown by the drawing, so that its contact *a* is recurrently closed at a specified rate, and, as previously pointed out this rate may be, for example, 180 times per minute. The primary windings P1 and P2 are supplied with energy from the direct current source by a circuit including contact *a* of the code transmitter CT closed in its picked up position, and a contact of the polar stick relay CP. When the contact of the polar stick relay CP is closed in its left hand or normal position, energy is supplied to the primary winding P2 of the impulse transformer IT each time that coding transmitter contact *a* is closed. When the contact *a* of polar stick relay CP is closed in its right hand or reverse position, energy is supplied to the primary winding P1 of transformer IT each time that coding device CP closes its contact *a*. Accordingly, it will be seen that the windings P1 and P2 may be energized alternately by operation of the contact *a* of relay CP, each time that contact *a* of code transmitter CT is picked up. The primary windings P1 and P2 are so arranged that the alternate supply of energy thereto causes a magnetic flux of alternate polarity to be built up in the core of the impulse transformer IT. The parts are proportioned and arranged so that the energy induced in the secondary winding S1 during the time that current is increasing in the primary windings P1 or P2 is of relatively small magnitude, due to the inductance of the primary windings retarding the rate of increase of the current in the primary windings. When the contact *a* of code transmitter CT opens, the supply of energy to the windings P1 or P2, whichever may be connected in the circuit by the contact of relay CP, is interrupted and the magnetic flux in the transformer core rapidly decays, so that a relatively large impulse of energy is induced in the secondary winding S1. It will be seen that the polarity of the energy induced in the secondary winding S1 depends upon which of the primary windings P1 or P2 was previously energized. The winding of the polar stick relay CP is connected across secondary winding S1 as shown, so that the impulses of energy induced in the secondary winding S1 are supplied to the winding of polar stick relay CP, and the relay is connected in the circuit in such manner that the impulses operate the contact of relay CP between its normal and reverse position, depending upon the polarity of the impulse. Moreover, the apparatus is arranged so that the impulses of energy supplied to the polar stick relay CP are of the polarity effective to move the contacts of the relay to the position opposite to that which they then occupy. For example, with the contact of relay CP in its normal position as shown, energy will be supplied to the primary winding P2 of transformer IT when the contact *a* of code transmitter CT is closed. When contact *a* of code transmitter CT opens, the energy induced in the secondary winding S1 of transformer IT will be of the polarity which will cause relay CP to operate its contact *a* to its reverse or right hand position. When contact *a* of code transmitter CT again closes, energy will then be supplied to the primary winding P1 of transformer IT, and upon the opening of contact *a* of code transmitter CT with contact *a* of relay CP in its reversed position, the impulse of energy induced in the secondary winding S1 as a result of the interruption of the current flowing in the primary winding P1 of the transformer will cause the contacts of relay CP to operate to their normal or left hand position.

The condensers C1 and C2 connected across the primary windings P1 and P2 to transformer IT are for the purpose of reducing the arcing which would other-

wise occur when contact *a* of the code transmitter CT interrupts the supply of energy to the primary windings of the transformer IT. Such arcing, if permitted, causes a loss in the power delivered by the transformer T, and therefore, to obtain optimum operation, some type of arc suppressing means, such as the condensers shown, is required.

It will be obvious to those skilled in the art that a transformer with a single primary winding may be employed instead of two separate primary windings, or a single center tapped winding, by providing an additional contact on the relay CP and arranging the circuit so that the contacts of relay CP function as a conventional pole changer to reverse the polarity of the energy supplied to the primary winding, as will be subsequently explained in detail.

From the foregoing, it will be apparent that the continued operation of the apparatus will cause the contact of relay CP to be alternately shifted between its two positions, each time that contact *a* of code device CT opens. Thus, the contact of relay CP is operated at one-half the speed of operation of the contacts of code transmitter CT. Although the peak voltage of the impulses supplied from transformer IT is relatively high, the pulses are of relatively short duration, and as explained above, occur at a relatively slow rate, compared with the impulses employed in the usual type of impulse track circuit. Accordingly, the average power required from the direct current source is relatively small. This is of considerable advantage, especially where the direct current energy is supplied by primary batteries, since the useful life of the batteries is thereby increased, with resultant savings in cost and labor of battery removal.

As shown by the drawing, the secondary winding S1 of transformer IT supplies energy not only to the winding of the polar stick relay CP, but also to the track section T. Thus, with the apparatus operating as described above, impulses of energy of alternate polarity are supplied to the rails 1 and 2 of section T at the exit end of the section. These impulses of energy are supplied over the rails 1 and 2 of section T to the code following polar stick relay TR connected across the rails at the entrance end of section T. The code following polar stick relay TR is constructed and arranged so as to be capable of transferring its contacts from one position to the other rather rapidly and in response to only a short application of energy to the winding of the relay. Inasmuch as a shift from one position to the other takes place within the limits of the relatively short pulses of trackway energy, the operation of the track relay is exactly the same as were each of the pulses to be of a longer duration.

Accordingly, at this time the track relay TR will operate its contact *a* between its normal and reverse positions in response to the pulses of energy of alternate polarity, supplied thereto from the exit end of section T.

If as previously assumed, the frequency of operation of the coding device CT at the exit end of the section is 180 times per minute, the frequency of the impulses of like polarity supplied to the track rails will be 90 per minute and accordingly, the contact *a* of relay TR will be operated between its normal and reverse positions 90 times per minute.

Any suitable type of code detecting apparatus may be employed to detect the recurrent operation of the track relay, and the arrangement shown is of the well known FSA—BSA relay type.

When contact *a* of relay TR is in its reverse position, an obvious circuit is established for supplying energy to the winding of the first slow release relay FSA, and when the contact *a* of relay TR is in its normal position, a circuit is established for supplying energy to the winding of the second slow release relay BSA, which circuit includes front contact *a* of relay FSA. The relays FSA and BSA are constructed and arranged so that their con-

tacts are slightly slow in releasing, and as a result the contacts of these relays will remain picked up in the intervals during which there is no supply of energy to the relay winding, provided these intervals do not exceed the normal time interval of the operation of the contacts of the relay TR.

Accordingly, at this time with contact *a* of relay TR being recurrently operated between its two positions, the relays FSA and BSA will be energized and their contacts will be picked up. When contact *a* of relay BSA is in its picked up position, an obvious circuit is established for supplying energy to the green lamp G of the signal S, so that the signal displays a green aspect denoting an unoccupied track section.

When a train moving from left to right passes the signal S and enters the section T, the wheels and axles of the train shunt the supply of energy from the winding of the track relay TR, and accordingly its contacts will remain in the position to which they were last operated. If the contact *a* of relay TR should stop in its normal position, the supply of energy to relay FSA is interrupted and after a short time interval the contact *a* of relay FSA releases and interrupts the circuit for supplying energy to the relay BSA. If contact *a* of relay TR stops in its reverse position, relay FSA will continue to remain energized, but the supply of energy will be cut off at the normal contact *a* of relay TR and as a result relay BSA will no longer receive energy and after a short time interval its contacts will release. It will be seen therefore that the cessation of operation of the contact of relay TR will result in the eventual release of relay BSA, no matter in which position the contact *a* of relay TR remains. When relay BSA releases, its contact *a* interrupts the supply of energy to the green lamp G of signal S and establishes a circuit for supplying energy to the red lamp R of the signal, so that the signal displays a red aspect indicating an occupied track section.

When the train moving through the section clears the exit end of the section, impulses of energy are again supplied to the winding of the code following track relay TR and its contact *a* is again operated between its normal or reverse position, so that the relays FSA and BSA become picked up, and as a result, the circuit for establishing energy to the green lamp G of signal S is again established and the circuit for supplying energy to the red lamp R of the signal is interrupted, so that the signal once more displays a green aspect indicating an unoccupied track section.

It will be obvious to those skilled in the art, that the arrangement shown on Fig. 1 may be modified in a number of ways in order to provide for various well known features. For example, the code transmitter CT may be of the type which operates at a number of different frequencies, depending upon traffic conditions ahead, so that the frequency of the impulses of energy supplied over the section rail T is varied in accordance with traffic conditions in advance of section T. In such case, supplemental decoding equipment is provided at the exit end of the section which is responsive to frequencies in accordance with those transmitted over the track rails, so that the apparatus may be used in the usual well known manner to provide multiple aspect signaling.

Moreover, it is to be understood that the arrangement of the impulse transformer and its associated apparatus is not limited to that shown. For example, as previously pointed out, the primary windings of the transformer, here shown as separate windings P1 and P2, may be replaced by a single winding having a center tap. Moreover, it is not necessary to employ but a single secondary winding as shown, but separate secondary windings may be employed for the operation of the polar stick relay CP and the supply of energy to the track rails T, where the conditions require that a relatively high resistance relay must be operated from the secondary winding of the impulse transformer.

It will be seen from an inspection of the drawings that the windings of the code following relay TR at the entrance end of section T, and the winding of the polar stick relay CP at the exit end of the section are actually connected in multiple, so that both of the relays are operated in synchronism by energy supplied from the winding S1 of transformer IT. Where conditions are such that the apparatus for both the entrance end and the exit end of the track section may be located within a single instrument housing, such as, for example, where a relatively short track section is used, it is possible to dispense with the auxiliary code following polar stick relay CP per se, and to employ an additional contact of the code following track relay TR to act as a selector contact for selecting the primary windings of the impulse transformer.

Such an arrangement is shown in Fig. 2, where the code following polar stick track relay TR is provided with an additional contact *b*, which operates in the same manner and has the same function as the contact *a* of the code following polar stick relay CP of Fig. 1.

When contact *a* of the code transmitter CT picks up, energy is supplied to one or the other of primary windings P1 and P2 of the transformer IT, in accordance with the position of the contact *b* of the code following polar stick track relay TR. When the contact *a* of code transmitter CT opens, an impulse of energy is supplied from the secondary winding S1 of the transformer to the track rails, and thence to the winding of the track relay TR, and the apparatus is arranged so that this energy causes the relay TR to operate its contacts to their other position. Upon the next closure of the contact *a* of code transmitter CT, the other primary winding of the transformer is supplied with energy, and when the contact of the code transmitter opens, an impulse of opposite polarity is supplied over the track rails to the track relay, to thereby cause the track relay to operate its contacts to their former position. The contact *a* of the track relay TR governs the slow release relays FSA and BSA in a manner similar to that previously described in connection with Fig. 1 of the drawings.

The operation of the apparatus shown in Fig. 2 when a train occupies section T is similar to that previously described in connection with Fig. 1, and a detailed description is deemed unnecessary.

It will be seen from the foregoing that with a track circuit provided with apparatus as shown in Fig. 2, all of the advantages of operation of the arrangement shown in Fig. 1 are secured, and the arrangement shown in Fig. 2 does not require the auxiliary polar stick relay CP which is employed in the arrangement shown in Fig. 1.

Fig. 3 shows a modification of the arrangement shown in Fig. 1. In Fig. 3, a single primary winding is provided for the transformer IT, and the circuit for supplying energy to the transformer is carried over a pair of contacts on the CP relay, in addition to the front contact *a* of coding device CT.

As shown, the contacts of the relay CP are occupying their left-hand or normal position. When the contact *a* of coding device CT closes, current from the low voltage direct current source flows through the circuit which may be traced from terminal B at contact *a* of coding device CT, over normal contact *c* of relay CP, through the primary winding P of transformer IT from right to left, and over normal contact *d* of relay CP to terminal N. Accordingly, energy is stored in the magnetic circuit of transformer IT by the creation of flux which flows in a given direction in the core structure. When contact *a* of the code transmitter opens, the energizing circuit for the primary winding of transformer IT is interrupted. The consequent rapid decay of flux in the core causes an impulse of energy to be induced in the secondary winding S1 of transformer IT, and the parts are constructed and arranged so that this impulse is of the polarity effective to operate the contacts of relay CP to their right-hand or reverse position.

When the contact *a* of code transmitter CT again closes,

energy is supplied to primary winding P of transformer IT by the circuit which is traced from terminal B at contact *a* of code transmitter CT, over reverse contact *c* of relay CP, through the primary winding P of transformer IT from left to right, and over reverse contact *d* of relay CP to terminal N. The flow of current in the primary winding of the transformer causes the build up of flux in the transformer core, which flux is in the opposite direction from the previous direction caused by current flowing in the primary winding from right to left. When contact *a* of code transmitter CT releases, the flux decays rapidly and induces an impulse of energy in the secondary winding S1 of the transformer which impulse is supplied to the winding of relay CP. This impulse will have a polarity opposite to that of the impulse previously generated when the contacts of relay CP were in their normal position, and, accordingly, will cause the contacts of relay CP to operate to their normal position. Upon the reclosing of contact *a* of code transmitter CT, the operation first described is repeated. Subsequent operations occur cyclically in the manner described above, with the impulses of energy of opposite polarity being generated at a rate one-half the rate of operation of code transmitter CT.

The impulses from secondary winding S1 may also be supplied to the rails of a track section T, as shown, and the apparatus at the opposite end of the track circuit, not shown, may be arranged as shown in Fig. 1.

As in Figs. 1 and 2, arc suppressing means may be provided for reducing the arcing at the code transmitter contacts, and is shown in Fig. 3 as a capacitor C connected across the primary winding P of transformer IT.

From the foregoing description of the drawings, it will be seen that my invention provides a coded impulse railway track circuit which has the advantage of operating at a frequency which is relatively low, so that the total amount of power required for the operation of the equipment is relatively small, compared with that required for the operation of the usual type of coded track circuit. Furthermore, it will be seen that by providing a sufficiently long interval between the impulses of energy which are generated by the impulse transformer IT, there is sufficient time allowed for the magnetic flux to fully decay in the magnetic structure of the transformer, so that more reliable and stable operation of the track circuit apparatus is secured.

Although I have herein shown and described only three forms of coded impulse railway track circuit embodying my invention, it is to 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. In combination, a transformer having a first and a second winding, a source of electrical energy, means for periodically supplying energy from said source to said first winding, and means responsive to the polarity of the energy induced in said second winding when the energy to the first winding is interrupted for reversing the direction of the flow of energy in said first winding.

2. In combination, a transformer having a first and a second winding, a source of electrical energy, means for recurrently supplying impulses of energy from said source to said first winding, and means for reversing the direction of flow of said impulses in said first winding comprising means connected to said second winding of said transformer and uniquely responsive to the polarity of the energy induced in said second winding when the flow of energy in said first winding is interrupted.

3. In combination, a transformer having a core, a primary winding and a secondary winding, a source of electrical energy, means for periodically supplying energy from said source to said primary winding, whereby energy is induced in said secondary winding each time the flux in said core generated by current flowing in said primary winding collapses as a result of the interruption of the

current flowing in said primary winding, and means responsive to the relative polarity of the collapsing flux in said core for reversing the direction of flow of current in said primary winding.

4. In combination, a transformer having a primary and a secondary winding, a polar stick relay having contacts which are moved to a normal or a reverse position according as energy of normal or reverse polarity is supplied to the relay winding, a coding device having a contact recurrently operated between a first and a second position, a circuit including a contact of said polar relay and effective when the contact of said coding device is in its first position for supplying to the primary winding of said transformer energy effective to develop flux of one or the other polarity in the transformer core according as said polar relay contact is in its reverse or its normal position, and means for supplying from the transformer secondary winding to the winding of the polar stick relay upon movement of the coding device contact away from its first position energy of the polarity effective to move the relay contacts to the position opposite to that occupied by the relay contacts while energy was being supplied to the transformer primary winding.

5. In combination, a transformer having a primary and a secondary winding, a relay having contacts which are moved to a first or a second position according as energy of normal or reverse polarity is supplied to a winding of the relay, a coding device having a contact recurrently operated between a first and a second position, a circuit including a contact of said relay and effective when the contact of said coding device is in its first position for supplying to a primary winding of said transformer energy effective to develop flux of one or the other polarity in the transformer core according as said relay contact is in its second or its first position, and means for supplying from the transformer secondary winding to a winding of the relay upon movement of the coding device contact away from its first position energy of the polarity effective to move the relay contacts to the position opposite to that occupied by the relay contact while energy was being supplied to the transformer primary winding.

6. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a core, a primary winding, and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, means including a contact of said coding device closed in one of its two positions for recurrently supplying impulses of energy from said source to said primary winding, means responsive to the polarity of magnetic flux generated in the core of said transformer for alternately and effectively reversing the polarity of the energy supplied to said primary winding each time the flux collapses, and means connected across the track rails at the other end of the stretch for detecting the recurrent supply thereto over the rails of pulses of energy of alternate polarity.

7. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a core, a primary winding, and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, means including a contact of said coding device closed in one of its two positions for recurrently supplying impulses of energy from said source to said primary winding, means responsive to the polarity of magnetic flux generated in the core of said transformer for alternately and effectively reversing the polarity of the energy supplied to said primary winding each time the flux collapses, arc suppressing means connected across said primary winding, and means connected across the track rails at the other end of the

stretch for detecting the recurrent supply thereto over the rails of pulses of energy of alternate polarity.

8. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a core, a primary winding, and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, means including a contact of said coding device closed in one of its two positions for recurrently supplying impulses of energy from said source to said primary winding, means responsive to the polarity of magnetic flux generated in the core of said transformer for alternately and effectively reversing the polarity of the energy supplied to said primary winding each time the flux collapses, arc suppressing means connected across said primary winding, means connected across the track rails at the other end of the stretch for detecting the recurrent supply thereto over the rails of pulses of energy of alternate polarity, said last named means comprising a polar stick relay having its winding connected across the track rails, and means including a slow release relay for detecting the recurrent operation of said polar stick relay.

9. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a primary winding and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, a polar stick relay having a contact operated between a first and a second position in accordance with the polarity of the energy supplied to a winding of the relay from said secondary winding, means including a contact of said coding device closed in one of its two positions for recurrently supplying impulses of energy from said source to said primary winding, means including the contact of said polar stick relay for recurrently reversing the direction of the flow of energy in said primary winding, and means connected across the track rails at the other end of the stretch for detecting the recurrent supply thereto over the rails of pulses of energy of alternate polarity.

10. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a primary winding and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, a polar stick relay having a contact operated between a first and a second position in accordance with the polarity of the energy supplied to a winding of the relay from said secondary winding, means including a contact of said coding device closed in one of its two positions for recurrently supplying impulses of energy from said source to said primary winding, means including the contact of said polar stick relay for recurrently reversing the direction of the flow of energy in said primary winding, arc suppressing means connected across said primary winding, and means connected across the track rails at the other end of the stretch for detecting the recurrent supply thereto over the rails of pulses of energy of alternate polarity.

11. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a primary winding and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, a polar stick relay having a contact operated between a first and a second position in accordance with the polarity of the energy supplied to a winding of the relay from said secondary winding, means including a contact of said coding device closed in one of its two positions for recurrently supplying

impulses of energy to said primary winding, means including the contact of said polar stick relay for recurrently reversing the direction of the flow of energy in said primary winding, means connected across the track rails at the other end of the stretch for detecting the recurrent supply thereto over the rails of pulses of energy of alternate polarity, said last named means comprising a polar stick track relay having its winding connected across the track rails, and means including a slow release relay for detecting the recurrent operation of said polar stick track relay.

12. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a primary winding and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, a polar stick track relay having its winding connected across the rails at the other end of said stretch and having contacts operated between a first and a second position in accordance with the polarity of the energy supplied thereto from said secondary winding over the rails of the stretch, means including a contact of said coding device closed in one of its two positions for recurrently supplying impulses of energy from said source to said primary winding, means including the contact of said polar stick track relay for recurrently reversing the direction of the flow of energy in said primary winding, and code detecting means governed by a contact of said polar stick track relay for detecting the recurrent operation of the contacts of said relay between their first and their second position.

13. In a coded track circuit railway signaling system, in combination, a stretch of railway track, an impulse transformer having a primary winding and a secondary winding, said secondary winding being connected across the track rails at one end of said stretch, a coding device having a contact recurrently operated between a first and a second position, a source of direct current, a polar stick track relay having its winding connected across the rails at the other end of said stretch and having contacts operated between a first and a second position in accordance with the polarity of the energy supplied thereto from said secondary winding over the rails of the stretch, means including a contact of said coding device closed in one of its two positions for recurrently supplying impulses of energy from said source to said primary winding, means including the contact of said polar stick track relay for recurrently reversing the direction of the flow of energy in said primary winding, and code detecting means governed by a contact of said polar stick track relay for detecting the recurrent operation of the contacts of said relay between their first and their second position.

14. In combination, a stretch of railway track, an impulse transformer having a first and a second primary winding and a secondary winding, said windings being constructed and arranged so that energy of one polarity is induced in said secondary winding when the flow of current in said first primary winding is interrupted and energy of the opposite polarity is induced in said secondary winding when the flow of current in said second primary winding is interrupted, a coding device having a contact recurrently operated between two positions, a source of direct current, an auxiliary polar stick relay having a contact operated to a first position when energy of said one polarity is supplied to a winding of the relay and operated to a second position when energy of said other polarity is supplied to said relay winding, a first circuit including a contact of said auxiliary polar stick relay closed in its first position for supplying energy to said second primary winding of said impulse transformer each time the contact of said coding device closes in one of its two positions, a second circuit including a contact of said auxiliary polar stick relay closed in its second position for supplying

energy to said first primary winding of said impulse transformer each time the contact of said coding device closes in said one of its two positions, means for supplying energy from said secondary winding to the rails of said stretch at one end thereof and to said winding of said auxiliary relay, and means located at the other end of said stretch for detecting the recurrent supply thereto over the rails of the stretch of impulses of energy of alternate polarity.

15. In combination, a stretch of railway track, an impulse transformer having a first and a second primary winding and a secondary winding, said windings being constructed and arranged so that energy of one polarity is induced in said secondary winding when the flow of current in said first primary winding is interrupted and energy of the opposite polarity is induced in said secondary winding when the flow of current in said second primary winding is interrupted, a coding device having a contact recurrently operated between two positions, a source of direct current, a polar stick relay having its winding connected across the rails of said stretch at one end of said stretch and having contacts operated between a first and a second position according as energy of said one polarity or said opposite polarity is supplied to the winding of the relay, said secondary winding being connected across the rails of said stretch at the other end of said stretch, a first circuit including a contact of said polar stick relay closed in its first position for supplying energy to said second primary winding of said impulse transformer each time the contact of said coding device closes in one of its two positions, a second circuit including a contact of said polar stick relay closed in its second position for supplying energy to said first primary winding of said impulse transformer each time the contact of said coding device closes in said one of its two positions, and means for detecting the recurrent operation of the contacts of said polar stick relay.

16. In combination, a transformer having a first and a second primary winding and a secondary winding, said windings being constructed and arranged so that energy of normal polarity is induced in said secondary winding when current of a given polarity flowing in said first primary winding is interrupted and energy of reverse polarity is induced in said secondary winding when current of said given polarity flowing in said second primary winding is interrupted, a coding device having a contact which is operable between two positions at a given code rate, a polar relay having a contact which is operated to a normal or reverse position according as energy of normal or reverse polarity is supplied to a winding of the relay, said relay winding being connected across said secondary winding; a first circuit including said contact of said coding device closed in one of its two positions, a normal position contact of said relay and said second primary winding; and a second circuit including said one position of the contact of said coding device; a reverse position contact of said relay and said first primary winding.

17. In combination, a transformer having a ferromagnetic core, a source of electrical energy, means including a winding on said transformer core for periodically supplying energy from said source to said transformer, said energy being effective to cause flux in said core in one direction or the other direction, and means responsive to the decay of the flux in said transformer core for reversing the direction of flux in said transformer core.

18. In combination, a transformer having a ferromagnetic core, a source of electrical energy, circuit means including a first winding on said transformer core for recurrently supplying energy from said source to said transformer, said energy being effective to cause magnetic flux in said core in one direction or the other direction, a second winding on said transformer core, relay means supplied with energy from said second winding and having contacts which are operated between a first and a

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second position only when the flux in said core is decaying, and circuit means governed by said relay contacts for causing the flux in said transformer core to be recurrently reversed in direction.

19. In combination, a transformer having a ferromagnetic core and a secondary winding, a relay having a winding connected to said secondary winding and having contacts which are operated to a first position or a second position in accordance with the polarity of an impulse of energy induced in said secondary winding when and only when the flux in said transformer core is decaying, the polarity of said impulses corresponding to the direction of flux in said core, a source of electrical energy, circuit means including contacts of said relay and at least one primary winding of said transformer for reversibly supplying energy at recurrent intervals to said transformer to recurrently cause magnetic flux in the core of said transformer in alternate directions.

20. In combination, a stretch of railway track, a polar

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stick relay, an impulse transformer having a secondary winding connected across the rails of said stretch at one end thereof and to a winding of said polar stick relay, said transformer and said secondary winding being constructed and arranged so that an impulse of energy of one polarity is supplied to said track rails and the winding of said polar stick relay when the flux in said transformer decays in one direction, and so that an impulse of energy of the opposite polarity is supplied to said track rails and the winding of said polar stick relay when the flux in said transformer decays in the opposite direction, means for recurrently causing magnetic flux in said transformer, and means responsive to the operation of said relay for reversing the direction of flux in the transformer.

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