March 13, 1945. N. D. PRESTON 2,371,263

CODED TRACK CIRCUIT SIGNALING SYSTEM

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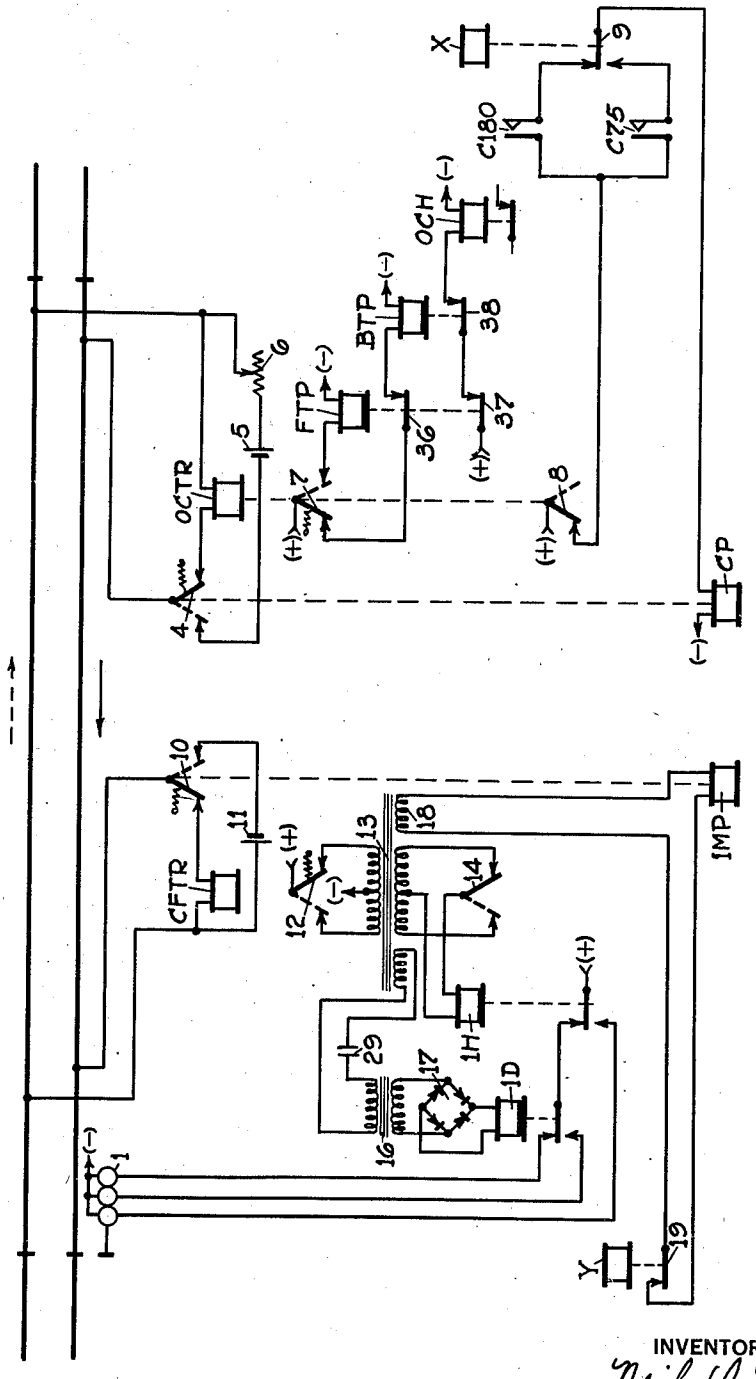


FIG. 1.

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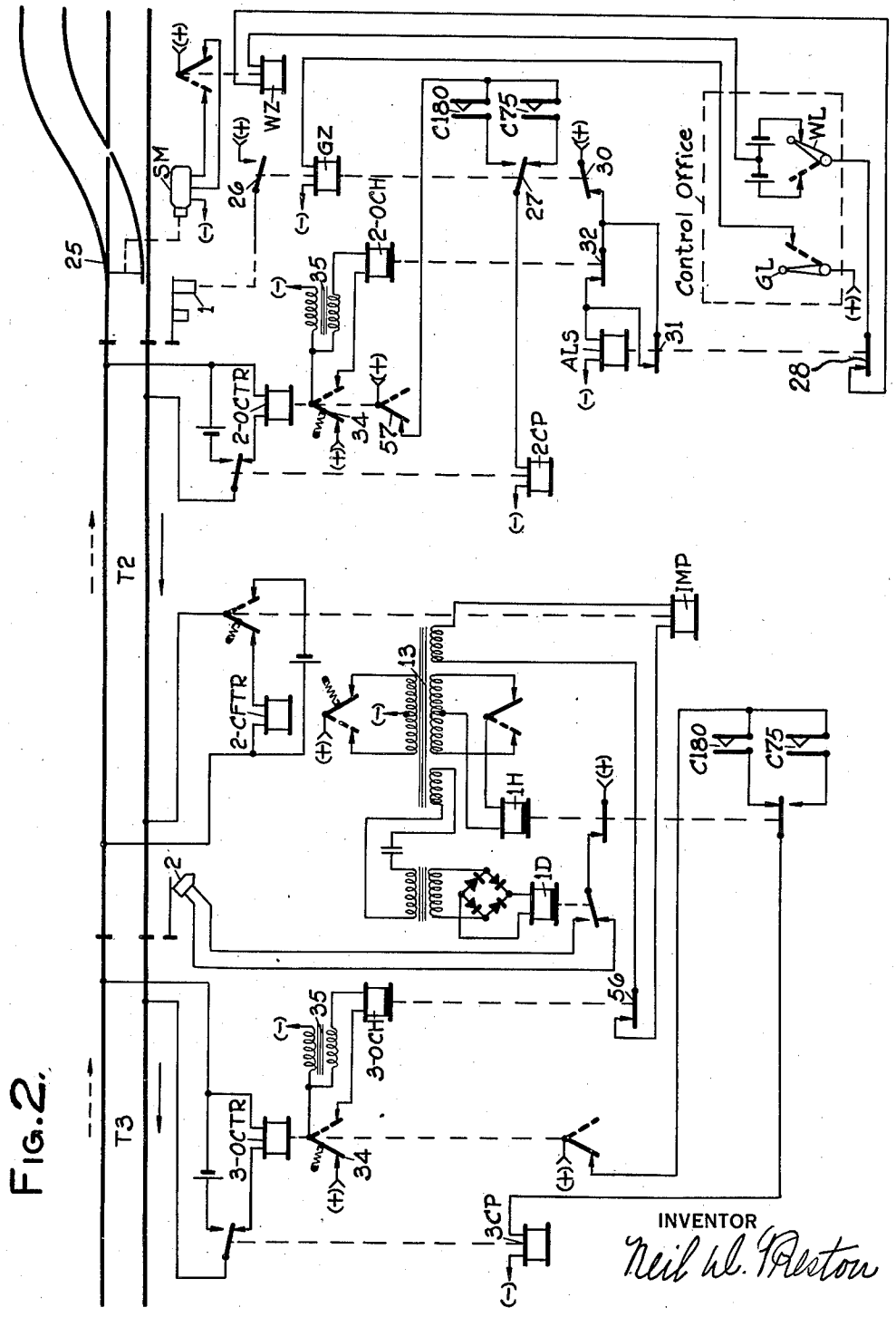


FIG. 2.

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FIG. 3.

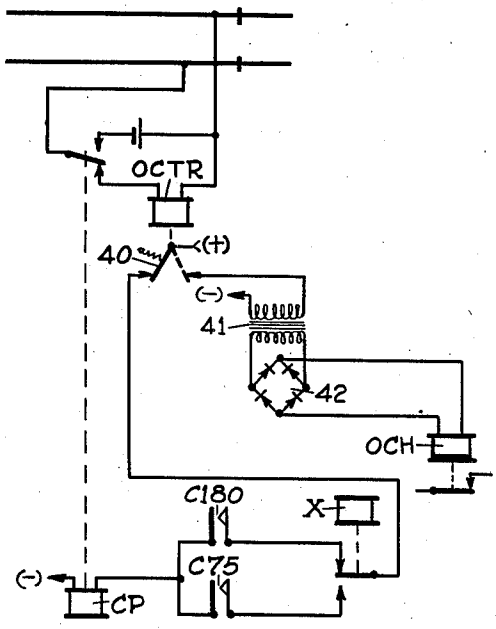
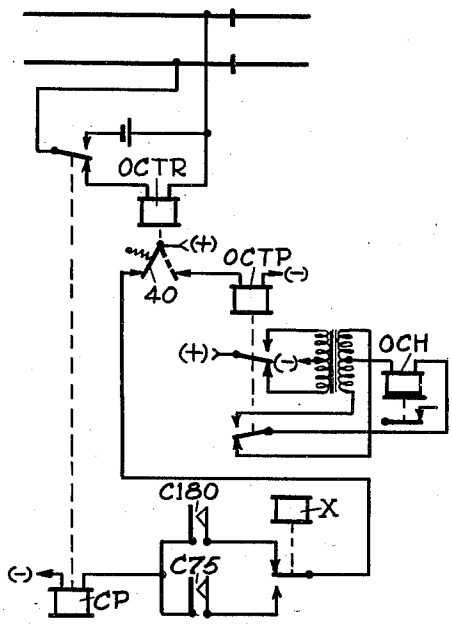


FIG. 4.



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UNITED STATES PATENT OFFICE

2,371,263

CODED TRACK CIRCUIT SIGNALING SYSTEM

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Application November 9, 1940, Serial No. 365,065

14 Claims. (Cl. 246—38)

This invention relates to so-called coded track circuits for railroads, and more particularly to the provision of means for protecting the track relay operated by the inverse or off-code pulses from being improperly coded if a stray or extraneous potential across the track rails should exist at a time when the inverse pulses are cut off and this track relay should not operate.

In the conventional coded track circuit, to which this invention relates, a battery or other source of current at one end of a track section is intermittently applied across the track rails to energize and deenergize a code following track relay at the other end of the section in accordance with a suitable code pattern, which is usually the rate of the intermittent energization. The character or rate of this transmitted or driven code may be changed to conform with traffic conditions, or the like, and thus provide for the transmission over the track rails of different conditions of control for governing the indication of signals, or the like, as well as detecting the occupancy of the track section. In certain applications of such coded track circuits, it is desirable to provide another track relay at the feed or driving end of the track section which is energized by what may be termed inverse or off-code pulses existing during the deenergized or off periods of the regular driven code, so that a relay means at the exit end of a track section may also respond to the occupancy of the section, or other control of the inverse or off-code pulses. In other words, in this type of coded track circuit a driven code of a selected code character is transmitted in one direction over the track section to govern decoding means at one end, and an inverse code is transmitted in the opposite direction during the off intervals of the driven code to govern decoding means at the other end of said section.

In the usual arrangement for a coded track circuit of this character, the track relay at the feed or exit end of the track section and normally responding to the off-code pulses, is intermittently connected across the track rails; and it can be readily seen that, if some extraneous stray potential should exist across the track rails of the proper polarity and intensity to energize this off-code relay, it will be automatically energized and deenergized intermittently as it is connected to and disconnected from this stray potential by operation of the code transmitter, and will not stop its coding operation as it should when the off-code pulses cease. In other words, the code transmitter for the driven code may act in the presence of a stray current to cause a false self-coding action of the off-code track relay intended to respond to only the off-code pulses transmitted from the other end of the track circuit, and thereby create an unsafe condition if the inverse code is relied upon for safety.

This false self-coding of the off-code track relay by a stray current is particularly objectionable where the inverse code is cut off before a train enters the section for the purpose of relaying some desired control over a plurality of track circuits. When a train enters a coded track circuit section at the end receiving the transmitted or driven code, it of course tends to shunt the off-code track relay at the other end; but it may happen that the linear impedance of the rails, particularly if there is high resistance bonding, together with a sufficient inter-rail stray potential maintained in spite of the wheel shunt, will allow sufficient current to flow through the off-code relay to cause its improper operation.

The primary object of the present invention is to provide a coded track circuit organization affording an inverse or off-code which is automatically checked or protected against false coding operation in the presence of a stray current, so that the inverse code may be relied upon safely to govern approach locking relays, indications of opposing signals, or the like.

Generally speaking, and without attempting to define the exact nature and scope of the invention, it is proposed to protect against such improper coding of the off-code track relay in the presence of stray current by requiring this relay, in order that its operation will be effective to indicate the presence of the inverse code, to release positively during each off period of the transmitted code, such release occurring in the case of the legitimate inverse code pulses, but not in the presence of a stray current capable of falsely energizing said relay when the inverse code pulses are removed.

In one embodiment of the invention, whenever the off-code track relay fails to release during the off period of the driven code, the operation of the transmitter relay or equivalent means intermittently connecting this relay to the track rails is automatically stopped, so that there can be no self-coding of this relay. In this embodiment of the invention, a stray current capable of causing improper self-coding of the off-code track relay acts to stop coding in both directions, putting to stop the signal governed by the driven code and creating a condition showing that a stray current exists.

In another embodiment of the invention, the

off-code track relay must release during the off period of the transmitted code as determined by the transmitting relay or equivalent, in order to produce any effect upon the relay means or decoding apparatus governed by said track relay, so that if this track relay is held up by the stray current until after the transmitter has acted to disconnect it from the track rails, there is no decoding action and no false indication of the presence of the legitimate inverse code pulses.

Various other objects, characteristic features, and attributes of the invention will appear as the description progresses.

The accompanying drawings illustrate in a simplified and diagrammatic manner various specific embodiments of the invention, the nature of the illustration being designed to facilitate an understanding of the principles and mode of operation of the invention rather than to show the exact arrangement and construction of the parts that might be employed in practice. In these drawings, Fig. 1 illustrates one embodiment of the invention in a simple form applicable to various conditions and systems of traffic control for railroads; Fig. 2 illustrates the organization of Fig. 1 used for approach locking control; and Figs. 3 and 4 show various variations and modifications in the specific arrangement of parts for receiving the off-code pulses.

Referring first to the embodiment of the invention illustrated in Fig. 1, it is assumed that the coded track circuit is of the conventional direct current type, using primary batteries, or trickle-charge storage batteries as a source for the track circuit current, but it should be understood that the same principles may be applied to coded track circuits energized from alternating current sources. It is also contemplated that transmitted or driven codes of different rates, such as 75 and 180 on and off periods per minute, will be obtained from a suitable code generating device, such as a code oscillator, in accordance with the usual practice, the contacts of such an oscillator being illustrated diagrammatically as C180 and C75. For the purpose of this disclosure, contacts C180 and C75 are assumed to be on separate oscillators which are normally operating at their respective rates. The selection between the different code rates to be effective at any given time for determining the indication of the signal or other means governed by the driven code may be accomplished in any suitable manner, and the relay X is typical or illustrative of a means suitable for this purpose.

In the particular arrangement illustrated in Fig. 1, it is assumed that a transmitted or driven code from right to left, as indicated by the solid arrow, will be employed for governing indications of a wayside signal 1, and that an inverse or off code in the other direction, as indicated by the dotted arrow, will be employed to control the energization of a relay OCH controlling the indications of some other signal, the approach locking equipment for a switch, or for some other purpose. It is further contemplated that the inverse or off code may be controlled by the presence of a train in one or more adjoining track sections, or in some other manner, dependent upon the use of the coded track circuit; and the relay Y in Fig. 1 is typical or illustrative of such a means for cutting off the inverse code prior to and independently of the entrance of a train into the section.

In the arrangement illustrated, the coder or oscillator contacts C180 or C75 as selected by relay X energize a repeater or transmitter relay CP, assumed to be of the two-position biased polar type, which when energized with its operating polarity shifts its contact finger 4 to the left to connect the track battery 5 across the track rails in series with a limiting resistance 6 in accordance with the usual practice, and when deenergized moves its contact finger 4 to the right to the biased position to connect an off-code track relay OCTR across the track rails with or without a series resistance in accordance with the characteristics of the track circuit. This track relay is also of the two-position biased polar type, and when its contact finger 7 is moved to the right from its biased position, energizes a front contact repeater relay FTP, and when moved to the left to the biased position energizes a back contact repeater relay BTP, provided the front contact repeater relay FTP is then energized to close contact 36. If both of these repeater relays are energized to close contacts 37 and 38, the relay OCH is energized. This is merely representative or typical of one type of means for detecting that the off-code track relay OCTR is intermittently operated by the inverse code pulses. It can be readily seen that if this track relay is steadily energized or deenergized, one or the other of its repeater relays is deenergized, and the relay OCH accordingly released.

The significant feature characteristic of this invention is that the energizing circuit for the transmitter relay includes a back contact 8 of the off-code track relay OCTR, the circuit being readily traced from (+), through the contact 8 of relay OCTR closed with the armature of this relay in its biased or deenergized position, through the coding contacts C180 or C75, front or back contact 9 of relay X, as the case may be, through the transmitter relay CP, to (—). In other words, the off-code track relay OCTR must assume its deenergized condition after each off-code pulse before the transmitter relay CP can be energized to give the next on period for the transmitted code.

The decoding apparatus and means for transmitting the off-code pulses at the other end of the track section may be of any suitable arrangement in accordance with regular practice. As illustrated, an impulse relay IMP of the two-position biased polar type is arranged to act, when deenergized and its contact finger 10 is moved to the left, to connect the code following track relay CFTR across the track rails, and when energized to connect the battery 11 for the off-code pulse across the track rails. The contact finger 12 of the code following track relay CFTR energizes alternately the two halves of the primary of a decoding transformer 13 having a mid-tap in accordance with the usual practice, and one secondary of this transformer is connected through rectifying contacts 14 on this track relay CFTR to a relay 1H, which is energized so long as the code following track relay is coded regardless of its code rate. Another secondary of the decoding transformer is arranged to energize a circuit including a condenser 29 and tuned for the higher code rate of 180 for impulsing the primary of the transformer 16, the secondary of which is connected through a full-wave rectifier 17 to a relay 1D for indicating that a code of the 180 rate is being transmitted. The relays 1H and 1D are assumed to control the green, yellow, and red indications of the signal 1 in the usual manner.

The decoding transformer 13 is also provided with an impulse winding 18 for energizing the impulse relay IMP when the code following track relay CFTR is deenergized at the end of an on period of the driven code. This impulse winding 18 is so wound and connected to the winding of the relay IMP that the momentary voltage induced therein when the relay CFTR drops causes current to flow through relay IMP in a direction to move its contact finger 10 from the biased position, while the voltage induced in the impulse winding when the relay CFTR picks up merely holds the relay IMP in its biased position to the left. If, as illustrated in Fig. 1, it is desired to control the inverse code independently of the occupancy of the track section, the circuit for the impulse relay IMP includes a contact 19 of the relay Y.

The operation of the relays in the transmission of a driven and an inverse code is the same as in the conventional coded track circuit equipped for off-code transmission. Briefly stated, when the code oscillator C180, for example, closes its contacts for the on period, the transmitter relay CP is energized to connect the battery 5 across the track rails and pick up the code following track relay CFTR. This reverses the energization of the primary of the decoding transformer 13 to provide energizing pulses for the relays 1H and 1D. When the code oscillator opens its contact and relay CP drops, the battery 5 is disconnected and the off-code track relay OCTR is connected across the track rails; and when the code following track relay CFTR releases, the impulse relay IMP is momentarily energized in a direction to connect the battery 11 to the rails to create an off-code pulse to energize the relay OCTR, this energization being only momentary so that relay OCTR assumes its deenergized biased condition before or at the time the code oscillator again closes its contacts for the next on period.

Assume now that there is an extraneous or stray potential across the track rails due to ground currents or leakage from some source, and that this stray potential is of the proper polarity and of sufficient intensity to energize the off-code track relay OCTR. Under these conditions, when the transmitter relay CP is deenergized and the relay OCTR is connected across the track rails, it is effectively energized by this stray potential and is maintained effectively energized, so that the circuit for energizing the transmitter relay CP is broken at the contact finger 8 of the track relay OCTR, thereby preventing any further operation of the transmitter relay. This not only prevents the intermittent disconnection and connection of the off-code track relay OCTR to the track rails by the transmitter relay CP and the possibility of it being improperly operated by the stray potential, but also stops the transmission of the driven code to put to stop signal 1, thus calling attention to the fact that abnormal conditions exist. Such cessation of code transmission occurs as soon as the stray potential appears across the track rails, regardless of whether or not off-code pulses then exist, and the apparatus is likewise automatically restored to normal operation of the track circuit as soon as the stray potential disappears. Also, the protective feature is effective regardless of the point of application of the stray potential along the track rails, the resistance of the ballast or the bonding, or the relative intensity of stray potential as compared with the voltage of the track battery, the determining factor for cessation of code transmission being simply that there is a stray current present capable of energizing the off-code track relay and causing false self-coding operation.

Since the transmitter relay CP in this embodiment of the invention illustrated in Fig. 1 cannot be energized with the oscillator contacts closed, unless and until the off-code track relay OCTR has released, it can be readily appreciated that prolongation of the off-code pulse tends to artificially prolong the off periods of the driven code and shorten the on periods. It is ordinarily desirable, however, for satisfactory and efficient decoding operation, particularly for the higher code rates, to have the code following track relay or its repeater operate its contacts at uniform intervals; and it is contemplated that quick-acting relays will be used and the system otherwise so organized that the off-code pulse will fit in the normal off periods of the driven code, with a reasonable margin to take care of variations in ballast resistance and battery voltage. In this connection, various expedients may be employed to control the duration of the off-code pulse, and also prolong artificially the controlling effect produced by a very short off-code pulse.

The specific embodiment of the invention has been illustrated and described in connection with a single coded track circuit adapted for use in various types of railway signalling systems in which it is desirable to provide a safe inverse or off code in addition to a driven code. As already indicated, the off-code protective check afforded by this invention is particularly useful where the off code is relied upon for safety, and is cut off prior to the entrance of a train into the corresponding track section; and as a typical or illustrative example of such an application of this invention, there is illustrated in Fig. 2 in a simplified and diagrammatic manner one organization of circuits utilizing the principles of this invention in connection with approach locking control.

In the arrangement illustrated in Fig. 2, it is assumed that a home signal 1 of an interlocking or centralized traffic control system governs train movement over a power-operated switch or switches indicated conventionally at 25, and that the distant signal 2 and other automatic block signals (not shown) in the rear are controlled by coded track circuits, an inverse or off code being employed to provide approach locking control for the switch. The particular organization of apparatus and circuits governing the power operation of the switch or switches and the indications of the home signal 1 by the supervisory manual control of an operator in accordance with recognized practice, is not material to the present invention; and to facilitate an understanding of the principles and mode of operation of such a system, a simplified arrangement of parts and circuits has been illustrated. The home signal 1 is manually controlled by movement of a signal lever GL to energize or deenergize a signal control relay GZ to close a contact 26, having an operative connection to the signal control circuits for signal 1, so that this signal may be cleared, subject to such track circuit control as is customary, to give a high speed or restricted speed indication dependent upon the position of the switch. The signal control relay GZ also operates a contact 27 to control the code rate and cause the distant signal 2 to indicate caution or clear in accordance with the indication of the home signal 1. A switch machine SM of the well

known and typical construction is assumed to have its operation controlled by a polar relay WZ of the magnetic stick type, which may be energized with one polarity or the other by the movement of a switch lever WL, provided an approach locking relay ALS is energized to close its front contact 26 included in the circuit for relay WZ.

In accordance with the conventional practice for approach locking control, when the relay GZ is energized to clear the home signal 1, it opens its back contact 30 to deenergize the circuits for the approach locking relay ALS readily traced on the drawings; and this relay ALS releases its armature to open at its contact 28 the circuit for the switch control WZ and prevent any operation of the switch machine. While the home signal 1 is at stop and back contact 30 of relay GZ is closed, the relay ALS is maintained energized by a stick circuit through its front contact 31 readily traced on the drawings, in spite of the deenergization of the approach relay 2—OCH and opening of its front contact 32 by an approaching train, so that the switch may be operated. If the home signal 1, having once been cleared, is manually put to stop by the operator preparatory to changing the route, and if there is no train within the approach locking limits so that relay 2—OCH is energized to close its front contact 32, the approach locking relay ALS may be energized by its pick-up circuit and the switch operated. If, however, there is a train present within the approach locking limits and relay 2—OCH is deenergized opening contact 32, the approach locking relay ALS is not re-energized by putting the signal 1 to stop, and the switch is locked and cannot be operated in front of the approaching train. In accordance with the usual practice, suitable provision (not illustrated) may be made to permit the emergency release of the approach locking by a time element device or equivalent, so that after the approaching train has had time to stop in obedience to the restrictive signal indications, the switch may be unlocked and operated.

Considering now the use of the inverse or off code for control in approach locking, the limits for the approach locking control usually include a track circuit section in the rear of the distant signal 2, the normal direction of traffic being from left to right. Instead of using a line circuit to deenergize an approach relay adjacent the switch when either one or both of the track sections T2 or T3 is occupied, it is contemplated that an inverse or off code in these track sections will be employed to indicate by the deenergization of the off-code responsive relay 2—OCH the presence of an approaching train in either of these track sections. The track section T3 may extend through the block to the next signal in the rear of signal 2, or may include only a portion of this block, but in either case, it is provided with a code following relay and an impulse relay (not shown) at its entrance end in the same way as at the entrance end of the track section T2. Each of these track sections is provided with an off-code track relay OCTR arranged to maintain a slow-release decoding relay OCH energized so long as this track relay is coding. In the particular arrangement illustrated in this Fig. 2 when the contact finger 34 of the relay OCTR is in the biased deenergized position, the primary of a transformer 35 is energized; and when this contact finger 34 assumes the operated position, a secondary of this transformer 35 is connected to the relay OCH. In this way, each time the track relay is energized an impulse is delivered to the relay OCH, and so long as the track relay is intermittently energized and deenergized, this relay OCH is maintained energized.

The intended operation when an inverse or off code is used for approach locking in this manner is that the presence of a train in the track section T3 shunts out the inverse code pulses in this track section and causes relay 3—OCH to release and open contact 56, which in turn stops the transmission of off-code pulses in the track section T2, thereby releasing 2—OCH and manifesting the presence of an approaching train in the approach locking limits.

Assume, however, that there should be a stray potential on the track rails of section T2 capable of energizing the track relay 2—OCTR, it can be seen that, without the check or protective feature provided by contact 57 of this invention, this track relay 2—OCTR might be falsely self-coded by this stray current and maintain relay 2—OCH energized, in spite of the fact that the off-code pulses had been cut off by the presence of the train in the track section T3 opening contact 56.

In this connection, it is intended that the polarity of the track batteries and the operating polarity of the track relays will be so selected as to afford the protection against broken-down insulated rail joints characteristic of the coded track circuit; and with one combination of polarities, a stray potential capable of effectively energizing the off-code track relay OCTR will also tend to energize the code following track relay CFTR, so that the presence of a stray current capable of causing unsafe false self-coding of the off-code track relay will also tend to prevent the reception of the driven code by locking up the code following track relay CFTR, thereby putting the distant signal 2 to stop. This may be said to be a supplemental protection against improper operation by stray currents, since an approaching train would receive a stop indication at signal 2, if a stray current exists, and hence would be proceeding at a restricted speed making it permissible to release the approach locking. Such protection is marginal, however, because with low ballast resistance or poor bonding, a stray potential near the exit end of the track section T2 may be of sufficient intensity to operate the off-code track relay 2—OCTR without locking up the code following track relay 2—CFTR.

It is noted that the relays 2CP and 3CP are shown as neutral type relays in this Fig. 2, but they may be polar relays as in Fig. 1.

There are a number of modifications and adaptations that may be made in the particular arrangement and construction of the parts and circuits to carry out the principles of this invention; and a number of modifications are illustrated in Figs. 3 and 4.

Generally speaking, it is desirable to use a minimum number of contact fingers on a track relay responding to driven or off-code pulses for satisfactory and efficient operation, particularly with long track circuits and poor ballast; and at the same time, it is expedient to employ a decoding transformer for controlling the energization of the relay OCH.

In the modification illustrated in Fig. 3, the contact finger 40 of the off-code track relay OCTR in the deenergized biased position supplies current to the energizing circuit for the transmitter relay CP in accordance with the principle of protection

characteristic of this invention. This same contact finger 40 energizes and deenergizes the primary of a transformer 41 as the track relay is intermittently operated; and the secondary of this transformer, in which impulse voltages are thus induced, first in one direction and then in the other, supplies uni-directional energizing current for the code-responsive relay OCH through a full-wave rectifier 42 of the usual type and construction.

Fig. 4 illustrates another modification in which the off-code track relay OCTR operates a repeater OCTP which controls the decoding transformer and rectifying contacts for governing the relay OCH, leaving free a back contact 40 of the track relay for performing the checking function characteristic of this invention.

Various other modifications and adaptations not illustrated or described may be made in the construction and arrangement of parts and circuits illustrated without departing from the invention; and it is to be understood that the specific embodiments and modifications of the invention illustrated are merely typical and illustrative of the principles and mode of operation of the invention.

What I claim is:

1. In a coded track circuit for railroads comprising, a source of current and an off-code track relay associated with the exit end of a track circuit section, driven code transmitting means operating to connect said source of current across the track rails intermittently to provide driven code pulses of a selected code rate separated by off intervals and to connect said off-code track relay across the track rails during each off interval, means including a code following track relay associated with the other end of the track circuit section for transmitting a momentary off-code pulse during each off interval of the driven code and thereby energize said off-code track relay, code responsive means including a slow release relay maintained energized in response to the intermittent operation of said track relay by off-code pulses but becoming deenergized if said off-code track relay ceases operation, and means for causing said driven code transmitting means to cease operation if said off-code track relay is energized by a sustained potential across the track rails and hence fails to release near the end of an off interval between driven code pulses, whereby said driven code transmitting means cannot cause false operation of said off-code track relay when a sustained potential is present across the track rails.

2. In a track circuit of the coded type for railway signaling systems operable to transmit an inverse code in one direction during the off intervals of a driven code transmitted in the opposite direction comprising, an off-code track relay, a transmitter operating intermittently to transmit driven code pulses and to connect said track relay across the track rails during each off interval between the driven code pulses, and means for preventing said intermittent operation of said transmitter while said off-code track relay is energized, whereby transmission of both the driven code and the off code is automatically stopped whenever said off-code track relay is maintained energized by a stray potential across the track rails.

3. In a coded track circuit for railroads operable to transmit off-code current pulses in one direction during each off interval of a driven code transmitted in the opposite direction comprising, an off-code track relay responsive to the off-code pulses, a transmitter relay intermittently energized to transmit a driven code and to connect said off-code track relay across the track rails during each off period of the driven code, and an energizing circuit for said transmitter relay including a back contact of said track relay, whereby operation of said transmitter relay is automatically stopped if said track relay is energized by a stray potential across the track rails.

4. In a coded track circuit of the character described comprising, a self-propelled code transmitter, means operated by said transmitter for alternately connecting a source of current and a two-position biased polar off-code track relay across the track rails at one end of a track section, and means for preventing said alternate operation of said transmitter while said track relay is energized, whereby the presence of a stray potential on the track rails of a polarity and intensity sufficient to effectively energize said track relay automatically stops coding operation of said track circuit.

5. In a coded track circuit system of traffic control comprising, a signal at an entrance end of a track section, a transmitter for alternately connecting a source of current and an off-code track relay across the track rails at the exit end of said section at any selected one of a plurality of code rates, means for applying across the track rails at the entrance end of said section an off-code current pulse during each of the off periods of the driven code for energizing said off-code track relay, decoding means associated with said signal for governing its indications in accordance with the rate of driven code transmitted, and means for automatically stopping operation of said transmitter and causing said signal to indicate stop whenever said off-code track relay is maintained energized by a sustained current on the track rails.

6. In a system of traffic control for railroads employing a plurality of coded track circuits each operable to transmit an inverse code in one direction during the off intervals of a driven code in the opposite direction, said system comprising, means responsive to the presence of a train in one section for stopping the transmission of the inverse code in an adjoining section in advance, decoding means for detecting the inverse code in said adjoining section and including an off-code track relay connected across the track rails during the off periods of the transmitted code, said de-coding means being responsive only to the continued intermittent operation of said track relay, and means for automatically rendering said decoding means ineffective whenever said off-code track relay is energized by a sustained potential on the track rails.

7. In a system of traffic control for railroads comprising, a plurality of adjoining track circuit sections each equipped with a coded track circuit operable to transmit an inverse code pulse in one direction during each off interval between driven code pulses of a selected code rate transmitted in the opposite direction, an inverse code track relay for each section intermittently connected across its track rails to be energized by the inverse code pulses, code responsive means controlled by each inverse code track relay and maintained energized only if the corresponding inverse code track relay is operated intermittently, means for automatically preventing transmission of

driven code pulses in a track section while the inverse code track relay for that track section is energized, and means for stopping the transmission of inverse code pulses in a track circuit section when the code responsive means of an adjoining section is deenergized.

8. In a system of approach locking for power-operated track switches comprising, a home signal and a distant signal governing train movement toward a switch, a section of track between said signals equipped with a coded track circuit operable to apply a momentary off-code pulse across the track rails at the entrance end of said section during each off interval between the pulses of a driven code of a selected code rate applied to the exit end of said track section for governing the indications of said distant signal, an off-code track relay, means for intermittently connecting said off-code track relay across the track rails at the exit end of said track section during the off interval of the driven code, means responsive to the presence of a train in a track section in the rear of the distant signal for stopping the transmission of off-code pulses in said adjoining track section, an approach locking stick relay acting when deenergized to prevent operation of the track switch, an energizing circuit for said approach locking stick relay, code responsive means maintained energized only by the intermittent operation of said off-code track relay for controlling said energizing circuit, and means for rendering said code responsive means ineffective if said off-code track relay is maintained energized by a sustained potential across the track rails of said track section after cessation of an off-code pulse, whereby said code responsive means may not be improperly energized by an extraneous stray current and permit energization of the approach locking stick relay even though a train approaching the distant signal has cut off the off-code pulses.

9. In a coded track circuit of the character described, a source of track circuit current, an off-code track relay, a transmitter relay acting to connect across the track rails at one end of a track section said source of current and said off-code track relay alternately as said transmitter relay is energized and deenergized respectively, power-actuated coding contacts, an energizing circuit for said transmitter relay including said coding contacts and a back contact of said off-code track relay closed when that relay is deenergized, a decoding transformer having the energization of its primary controlled by operation of said off-code track relay, and a code responsive relay connected to the secondary of said transformer and temporarily energized by the impulse voltages produced by said transformer as said off-code track relay is intermittently operated.

10. In a coded track circuit for railroads comprising, a source of current and a track relay associated with one end of a track section, a transmitter relay acting when energized and deenergized to connect alternately said source of current and said track relay respectively across the track rails of said track section, decoding means maintained energized only by the repeated operations of said track relay, power operated coding contacts intermittently opened and closed at a selected code rate, and an energizing circuit for said transmitter relay including in series said coding contacts and a back contact of said track relay.

11. In a system of approach locking for power operated track switches, a home signal governing traffic over the power operated track switch and at least two approach track sections leading to said switch, said track section nearest said switch having a distant signal governing the entrance of traffic thereto, coded track circuit apparatus associated with each of said track sections for providing a driven code applied to the rails at the exit end of the section and also providing for the transmission of an inverse code by applying momentary pulses across the rails at the entrance end of the section between the impulses of any driven code, said apparatus providing that the driven code of said near section has a rate in accordance with the indication of said home signal, and providing that the driven code in said distant section has a rate in accordance with traffic conditions in said near section, and said apparatus also providing that the inverse code in said near section shall be dependent upon the presence of an inverse code in said distant section; approach code responsive means adjacent said track switch including a track relay responsive to the inverse code pulses and a home relay maintained energized only upon the continued reception of an inverse code by said track relay, said means also acting to prevent transmission of said driven code if said track relay remains steadily energized, manually operable means for governing the indications of said home signal, an approach locking stick relay preventing power operation of said track switch when it is deenergized, means effective to deenergize said approach locking stick relay when said home signal is controlled to indicate clear, and a pick-up circuit for said approach locking stick relay closed only when said home relay is energized, whereby the presence of a train in either said near or said distant section is effective to govern the pick-up of said approach locking stick relay.

12. In a coded track circuit for railroads of the type having code pulses transmitted in both directions, a transmitting and receiving means at one end of the track circuit comprising a source of current, a track relay, a transmitter relay effective when energized and deenergized to alternately connect said source of current and said track relay across said track circuit, coding contacts opened and closed with a predetermined periodicity, an energizing circuit for said transmitter relay including said coding contacts and a contact closed only when said track relay is deenergized, and decoding means controlled by the intermittent operation of said track relay, whereby said transmitter relay is rendered ineffective to transmit a code pulse while said track relay is energized.

13. In a coded track circuit for railroads, the combination with a track circuit section, driven code transmitting means for applying across the track rails at the exit end of said section driven code pulses at any selected one of a plurality of different code rates, said driven code pulses being separated by off periods, means including a code following track relay connected across the track rails at the opposite end of said section for decoding said driven code, means responsive to the operation of said code following track relay for at times applying at said opposite end of said section an off-code current pulse during a portion of each of the off periods of the driven codes, an off-code track relay at said exit end of said section intermittently energized by said off-code pulses, decoding means including a slow-acting

relay, circuit means for normally maintaining said decoding means effective to energize said slow-acting relay during continued intermittent normal operation of said off-code track relay by said off-code pulses, and contact means acting on said driven code transmitting means to render said means ineffective whenever said off-code track relay is subjected to a steady stray potential across the track rails, whereby said code following track relay ceases operation and thereby prevents the application of off-code current pulses during the presence of a steady stray potential across the track rails.

14. In a coded track circuit for railroads, the combination with a track section, a source of current, an off-code track relay, code transmitting means for intermittently connecting said source of current and said track relay alternately across the track rails of said track section at one end to provide driven code pulses separated by off intervals, means associated with the other end of said track section for applying to the track rails off-code pulses of limited duration during the off intervals between said driven code pulses, code responsive means energized only in response to the intermittent operation of said track relay by off-code pulses, and means for preventing operation of said code transmitting means and the disconnection of said track relay from the rails of said track section by said code transmitting means if said track relay is energized by a sustained potential across the track rails, whereby the presence of a sustained potential across the track rails results in the deenergization of said code responsive means.

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