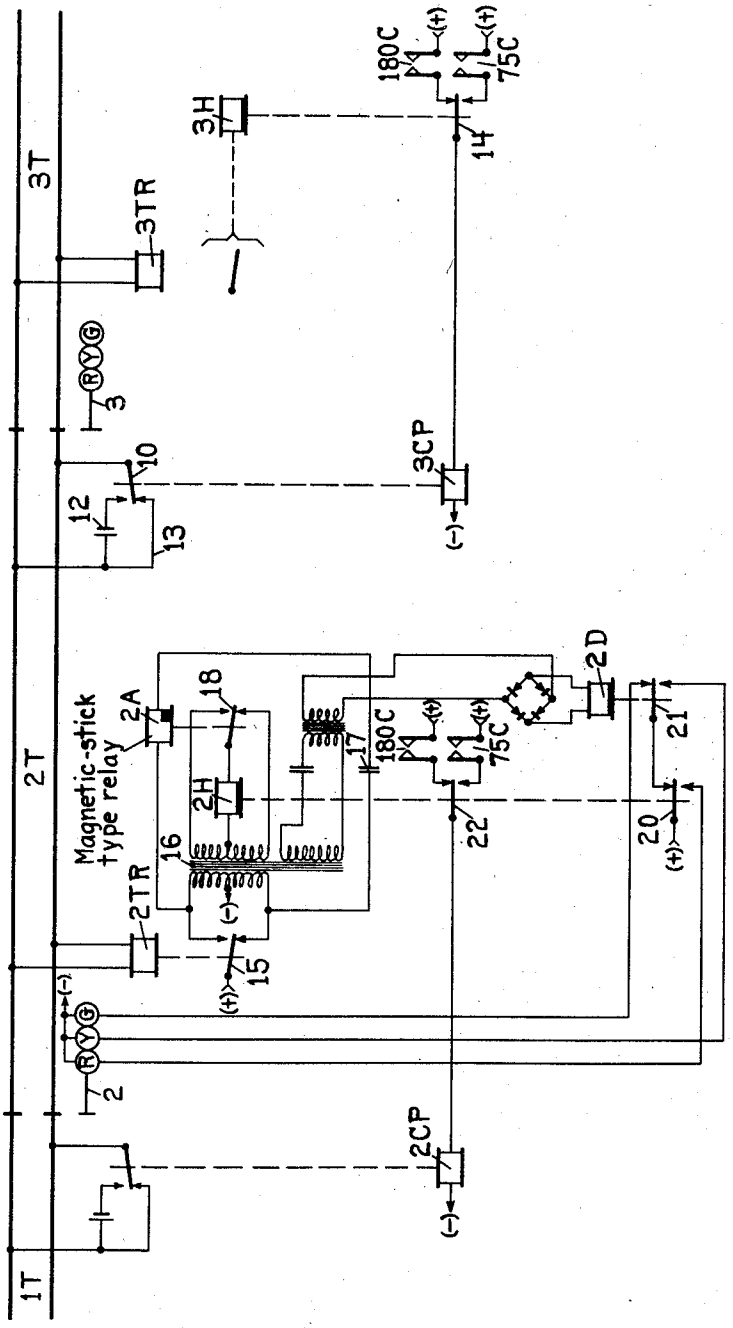
June 12, 1945. F. X. REES 2,378,325

CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed Aug. 31, 1943



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Patented June 12, 1945 2,378,325

UNITED STATES PATENT OFFICE

2,378,325

CODED TRACK CIRCUIT SIGNALING SYSTEM

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Application August 31, 1943, Serial No. 500,662

7 Claims. (Cl. 246—34)

The present invention relates to automatic block signaling systems for railroads using coded track circuits, and more particularly pertains to the improvement of decoding apparatus used in such signaling systems.

The usual block signaling system employing coded track circuits provides that impulses of current are successively applied to the exit end of any given track circuit section with spaced intervals between the impulses which have for convenience been termed "off" periods. These spaced impulses comprise a driven code which has distinctive rate of impulse application selected in accordance with traffic conditions of the adjoining track section in advance. At the entrance end of the coded track circuit section, a code following track relay is connected across the rails of the track circuit section to receive the driven code impulses and act upon suitable decoding apparatus which is distinctively conditioned in accordance with the rate of the driven code to thereby govern the indications of the associated signal in accordance with traffic conditions in advance of that signal without the use of any line wires.

In certain prior coded track circuit signaling systems, the decoding apparatus includes a decoding transformer having a primary winding which is energized in opposite directions alternately as the code following track relay is alternately picked up and dropped in response to driven code impulses. Energy impulses are thus induced in the secondary winding of this decoding transformer and are supplied to a slow-acting home relay through a rectifying contact of the track relay. Such an organization is simple and efficient for ordinary coded track circuit applications but it has the disadvantage that if the track relay fails to fully operate from one extreme position to the other alternately and just vibrates on a front or back contact, current may still be supplied to the decoding transformer in such a way as to cause the operation of the home relay in spite of the fact that the incomplete operation of the track relay may be due to circuit failures and stray currents, broken and vibrating wire connections, and the like.

In accordance with the present invention, it is proposed to provide decoding apparatus which requires the positive operation of the track relay contacts to their opposite positions alternately in order to act upon the slow-acting home relay in a manner to operate its contacts to energized positions. This is accomplished by providing a magnetic stick type relay controlled in multiple with the decoding transformer and through a condenser in such a way that the magnetic stick type relay operates its contacts to opposite positions alternately only if such operation is effected by the proper operation of the track relay contacts. Then, the secondary winding of the decoding transformer is connected to the slow-acting home relay through rectifying contacts of this magnetic stick type relay. Thus, the home relay is provided with successive uni-directional impulses of current only if the track relay completely responds to each driven code impulse; while in the event of improper operation of track relay contacts, such as the vibrating effect on the front or back contacts for example, the energy which may be transmitted through the decoding transformer will merely cause current to flow in alternate directions through the home relay without any contact response because the magnetic stick type relay can not operate its rectifying contact without being energized in opposite directions alternately. In this way, the present invention proposes to provide decoding apparatus which is immune to so-called vibrating connections and the like.

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

In describing the invention in detail, reference will be made to the accompanying drawing which shows the decoding apparatus of the present invention applied to a typical coded track circuit of an automatic block signaling system.

For the purpose of simplifying the illustration and facilitating the explanation, the various parts and circuits constituting the embodiment of the invention have been shown diagrammatically and certain conventional illustrations have been employed, the drawing having been made more with the purpose of making it easy to understand the principles and mode of operation than with the idea of illustrating the specific construction and arrangement of parts that would be employed in practice. Thus, the various relays and their contacts are illustrated in a conventionaal manner, and symbols are used to indicate connections to the terminals of batteries or other suitable sources of electric current instead of showing all of the wiring connections to these terminals.

The symbols (+) and (—) are employed to indicate the positive and negative terminals respectively of suitable batteries or other suitable sources of direct current; and the circuits with which these symbols are employed are assumed

to always have current flowing in the same direction, although it is to be understood that in some cases alternating current might be substituted for the direct current if desired, and in such cases the (+) and (—) are to be considered as indicating the relative instantaneous polarities of the alternating current.

With reference to the accompanying drawing, a stretch of track has been divided into track sections by suitable insulated joints of which the track section 2T has been shown completely and track sections 1T and 3T in part only. Color light type signals 2 and 3 are shown at the entrance ends of the track sections 2T and 3T respectively. These signals can of course be of any other suitable type desired.

At the exit end of the track section 2T, code transmitting apparatus has been shown as including a code transmitting relay 3CP which, when actuated to an operated position, connects a battery 12 across the track rails of the track section 2T through front contact 10 and when deenergized shunts these track rails through back contact 10 and a wire connection 13. This code transmitting relay 3CP has its contact 10 operated to opposite positions alternately due to the successive energizations of the relay 3CP in accordance with the 75 or the 180 code rate as selectively determined by the decoding apparatus associated with signal 3. This decoding apparatus at signal 3 has merely been indicated in block form as including a home relay 3H controlled by the code following track relay 3TR, but it is to be understood that this decoding apparatus will be the same as that shown associated with the signal 2.

When the relay 3H is picked up due to the reception of code impulses of either code rate from the signal in advance of signal 3, energy is intermittently supplied to the code transmitting relay 3CP through front contact 14 of relay 3H and the coding contacts 180C which are assumed to be operating at 180 impulses per minute. If a train is in the track section 3T so that the code following track relay 3TR is not operating due to the train shunt effect across the track rails, then the home relay 3H is deenergized and back contact 14 connects the transmitting relay 3CP to the coding contacts 75C which are assumed to be operating at 75 impulses per minute. These coding contacts 180C and 75C may be of any suitable type, that is, they may be motor driven, or may be code oscillators of the type disclosed for example in the prior application of O. S. Field, Ser. No. 369,862, filed December 12, 1940.

At the entrance to the track section 2T, the code following track relay 2TR normally operates in response to the driven code impulses received over the track rails to alternately connect positive energy (+) through front and back points of contact 15 to the opposite terminals of the decoding transformer 16 which has a center tap connected to negative energy (—). This operation of the contact 15 in effect pole changes the current in the transformer 16 upon each operation of such contact 15 to an opposite position. Also, when the contact 15 closes a front point, positive energy (+) is applied to the left-hand terminal of the magnetic stick type polarized relay 2A and as its right-hand terminal is connected through the condenser 17 and the lower portion of the primary of transformer 16 to (—), current flows through the relay 2A to charge the condenser 17 in one direction. This charging current is of sufficient quantity to cause the contacts of relay 2A to pick up to actuated positions. The contact 18 of the relay 2A remains in its actuated position due to its magnetic stick characteristics until the relay is energized in the opposite direction, which is the case when the contact 15 of the code following track relay 2TR makes its back point and charges the condenser 17 in the opposite direction allowing current to flow through the relay 2A in sufficient quantity to cause the contact 18 to assume a dropped-away position.

The decoding transformer 16 is of the usual type having a center-tapped primary winding so that the operation of contact 15 to either extreme position energizes one-half of the primary winding, while the charging current for the condenser 17 and relay 2A flows in the other half of the primary winding to the negative terminal (—) of the battery source. The energization of either half of the primary winding of transformer 16 of course produces a magnetic flux in the core of the transformer which acts to produce a potential across the other half of the primary winding. In other words, the transformer 16 acts as an auto-transformer and the potential thus produced in the other half of the primary winding adds to the potential supplied to the condenser 17 and relay 2A by the battery so as to provide the required charging current. However, it should be recognized that this charging current for the condenser 17 is relatively small compared to the regular current flow in the primary of the transformer 16 from the battery source. For example, the parts may be so constructed that the regular energizing current for the primary winding is in the order of 200 milliamperes, while the charging current for the condenser 17 and relay 2A may be in the order of 20 milliamperes.

The capacitance of the condenser 17 is so chosen as to compensate for the inductance of relay 2A and also in part for the inductance of the primary winding of the transformer so that the current flow in the relay 2A bears the proper phase relation to the voltage to operate the contact 18 of the relay at the desired time to give a proper rectifying action with a minimum of arcing at contact 18. It should also be noted that this circuit including the condenser 17 and relay 2A serves to suppress the arcing at contact 15.

Each time energy flows in an opposite direction through the primary winding of the decoding transformer 16, a current is induced in the secondary winding of such decoding transformer which current flows through the relay 2H in a direction depending upon the position of the contact 18. For convenience it is assumed that when front point 15 is closed the induced current in the secondary winding is of such a direction as to flow to the left through relay 2H with front contact 18 closed; and similarly when the back point 15 is closed the current flow induced in the secondary winding of the transformer 16 is in such a direction as to flow through the relay 2H in a left-hand direction with back contact 18 closed.

It is to be recognized that these magnetic stick type relays have permanent magnets included therein which polarizes them and causes the contacts thereof to remain in their last actuated positions. Also these relays are very quick-acting in their characteristics, so that the contact 18 assumes the proper position upon each reversal of current in transformer 16 at a time before the induced current in the secondary

winding of the transformer 16 assumes any appreciable value. This is for the reason that the value of capacitance of the condenser 17 may be so selected as to cause the proper phase relationship between the current and applied voltage to cause the contact 18 to operate at a time when the induced currents in the secondary of the transformer 16 are at zero. In this way the contact 18 can operate as a rectifying contact with a minimum of arcing at such contact.

When the code following track relay 2TR properly follows a driven code received over the track rails, the relay 2A repeats each impulse of such code so that uni-directional impulses are supplied to the relay 2H at a rate corresponding to the driven code then being received. This relay 2H has such slow-acting characteristics that it will pick up for the 75 or the 180 code rate and remain picked up so long as such code impulses are being received. However, if for some reason the code following track relay 2TR fails to properly operate and merely opens and closes its back contact (or its front contact) in what might be termed vibrating fashion, it will be seen that the same potential will be applied and reapplied to the circuit including the relay 2A and the condenser 17. The potential applied to this circuit builds up the charge on the condenser 17 and operates the relay 2A to the corresponding position, but regardless of the fact that the circuit is intermittently opened and the charge on the condenser leaks off through the shunt provided by the primary winding of the decoding transformer, such leaking of the charge is so slow that an operating value of current does not flow in the opposite direction through the relay 2A and its contacts remain in the same positions to which they were initially operated. Any impulse energy induced in the secondary winding of the transformer 16 due to such improper vibrating connections will flow in opposite directions through the relay 2H because the rectifying contact 18 is not being operated. The alternating direction of current flow produces a neutralizing effect on the relay 2H and its contacts remain deenergized.

In brief, under normal operation the contact 18 of relay 2A operates as a rectifying contact so that the relay 2H properly responds to the code repeated by the track relay 2TR; and since the time of response of contact 18 of relay 2A can be determined by the proper selection of capacitance of condenser 17, such rectifying action can be effected at maximum efficiency. However, upon any false or improper operation where the primary of the transformer is intermittently energized at one terminal or the other, but not both terminals alternately, (and assuming relay 2TR is not operated to opposite positions alternately), then the relay 2A does not operate to alternate positions, and the alternating current induced in the secondary of the transformer 16 is ineffective to operate the relay 2H because such relay is unresponsive to alternating current. For these reasons, the relay 2A is particularly advantageous in providing protection against accidental vibrating connections in the decoding circuit organization.

It is noted that the decoding transformer 16 has a lower secondary winding which is connected through a condenser and a tuning transformer as well as a full-wave rectifying unit to the relay 2D. This circuit organization is so tuned that the relay 2D receives actuating energy only during the reception of a driven code of the 180 code rate. The contacts of the relays 2H and 2D are so connected that when back contact 20 of relay 2H is closed the red lamp R of signal 2 is energized through an obvious circuit. This will be the case when a train is in the track section 2T shunting the track rails thereof so that the code following track relay 2TR does not receive energy.

When a driven code of the 75 code rate is being received by the track relay 2TR, the home relay 2H will be picked up and the distant relay 2D will be dropped away so that a circuit is closed for the yellow lamp Y through front contact 20 of relay 2H, back contact 21 of relay 2D, through the yellow lamp Y, to (—). This will be the case when a train occupies the track section 3T.

When a driven code of the 180 code rate is received, which means that both the track sections 2T and 3T are unoccupied, then a circuit is closed from (+), through front contact 20 of relay 2H, front contact 21 of relay 2D, green lamp G of signal, to (—).

With this circuit organization, it is seen that the erroneous operation of the track relay 2TR, that is such operation that its contact 15 fails to make complete front and back operations alternately, the relay 2H is deenergized and the signal 2 is held at stop. This is true even though the vibrating operation of a front or back point of the track relay 2TR might be at such a rate as to simulate a 180 code and cause the energization of the relay 2D. In other words, the circuit is so organized that the proper operation of the code following track relay 2TR must be effected in order to cause the decoding apparatus to clear the associated signal, thus providing a reliable and safe decoding apparatus for automatic block signal systems.

It will be seen that the track section 1T is provided with a code transmitting relay 2CP which is controlled by the relay 2H through contact 22 in a similar way as the relay 3CP is controlled by contact 14 of relay 3H'. In this way, the three indication signaling is provided.

Having described a coded track circuit automatic block signaling system employing decoding apparatus organized to protect against faulty operation of a code following track relay as one specific embodiment of the present invention, it is desired to be understood that the invention is shown in this connection with an automatic block signaling system for the purpose of facilitating its disclosure and that it can be applied to coded track circuit systems also governed by manual C. T. C. control and the like. And it is to be further understood that the specific embodiment of the invention may have various modifications, adaptations, and alterations made to the form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of present invention except as limited by the appended claims.

What I claim is:

1. In a coded track circuit signaling system, a section of track having driven code pulses of different selected rates applied at one end and decoding apparatus at the other end comprising, a code following track relay connected across the rails of said section, a decoding transformer having primary and secondary windings, circuit means governed by a contact of said code following track relay for alternately energizing said primary winding in opposite directions by alternate operations of said track relay, a magnetic stick type polarized relay and a condenser con-

nected in series across said primary winding to thereby energize said polarized relay in an opposite direction each time said primary winding is energized in an opposite direction, a slow-acting relay connected in series with a contact of said polarized relay to said secondary winding of said decoding transformer to thereby cause said slow-acting relay to be energized with uni-directional pulses of current only when said track relay is alternately operated to its opposite positions, and a signal governing the entrance of traffic into said section controlled in accordance with the energized and deenergized condition of said slow-acting relay.

2. In a coded track circuit automatic signaling system, a section of track having driven code pulses of different selected rates applied at one end and decoding apparatus at the other end comprising, a code following track relay connected across the track rails and having its contacts actuated to one position for each driven code impulse and actuated to the opposite position during each off period between impulses, a repeating relay of the polarized mag-stick type, circuit means controlled by said track relay to energize said repeater relay with opposite polarities alternately to operate it to its opposite positions alternately only upon the operation of said code following track relay to its opposite positions alternately, a slow releasing signal control relay, and circuit means for energizing said signal controlling relay with impulses of uni-directional current upon the operation of said code following track relay only provided said repeater relay is actuated to its opposite positions alternately.

3. In a coded track circuit for railroads decoding apparatus for a section of track having driven codes of selected rates applied thereto comprising, a code following track relay connected across the track rails for repeating each driven code pulse and assuming a normal deenergized position between the successive pulses, a repeating relay of the polarized mag-stick type, circuit means for causing said repeating relay to be actuated to opposite positions alternately only upon the actuation of the contacts of said code following track relay to its opposite positions alternately, a decoding transformer having a primary winding energized in opposite directions upon alternate operations of said code following track relay, and a signal controlling relay receiving impulse energy induced in the secondary winding of said decoding transformer as rectified through a contact of said repeating relay, whereby said signal control relay is picked up upon the reception of impulses of any selected code rate, but is dropped away in the absence of code reception and in the absence of the complete operation of said code following track relay from its normal deenergized position to its operated position alternately in succession to thereby protect against failures of circuit connections.

4. In a coded track circuit for railroads, a section of track having driven code pulses applied at one end, the successive pulses being separated by off periods, a decoding apparatus at the other end of the track section comprising, a code following relay of the two-position type having its contacts biased to one position, a repeating relay of the polarized two-position type having contacts that remain in their last actuated positions, circuit means for causing said repeating relay to assume opposite positions corresponding to the opposite positions of said track relay, said means including a condenser in series with said repeater relay and a leak for draining off the charge of said condenser at a relatively slow rate, a signal control relay of the slow-acting type, and circuit means for effectively energizing said signal control relay only providing said repeater relay is actuated to positions corresponding to the alternate positions assumed by said track relay.

5. In a decoding organization for coded track circuits, a code receiving relay having contacts operable to opposite positions alternately in response to a code, a two-position repeater relay of the stay-where-put type, circuit means for energizing said repeater relay to an opposite position each time said code receiving relay is operated to an opposite position, a decoding transformer having primary and secondary windings, circuit means controlled by the contacts of said code receiving relay for reversing the current flow in the primary winding of said transformer each time said code receiving relay is operated to an opposite position, a signal control relay, and circuit means governed by the contacts of said repeating relay for supplying uni-directional current from the secondary winding of said decoding transformer to said signal controlling relay, whereby currents induced in the secondary of said decoding transformer cannot operate said signal control relay without the operation of said repeating relay.

6. In a decoding organization for coded track circuits on railroads, a code receiving relay operable to opposite positions alternately in response to code pulses, a two-position polarized repeater relay of the magnetic stick type, circuit means including a condenser for energizing said repeater relay with an opposite polarity each time said code receiving relay is operated to an opposite position, a decoding transformer having primary and secondary windings, circuit means including contacts of said code receiving relay for reversibly connecting a source of current to the primary winding of said decoding transformer upon its operation to opposite positions, a slow acting signal control relay, and circuit means including contacts of said repeater relay for connecting the secondary winding of said transformer to said signal control relay to provide uni-directional current therein upon the successive reversals of the current in the primary winding of such transformer, whereby the capacitance of said condenser causes a proper phase relationship between the current and the voltage applied to said repeater relay so that its contacts operate during the absence of current flow in the windings of said signal control relay.

7. In a decoding organization for coded track circuits on railroads, a code receiving relay having contacts operated to opposite positions in response to the reception of code pulses, a decoding transformer having primary and secondary windings each having a mid tap, circuit means including contacts of said code receiving relay for connecting one terminal of a source of energy to the opposite terminals of said primary winding alternately and for connecting the other terminal of said source to said mid tap of such primary winding, whereby operation of said code receiving relay to opposite positions reversibly energizes said decoding transformer, a repeater relay of the two-position magnetic stick type, a condenser, circuit means connecting said repeater relay and said condenser in series across the opposite terminals of said primary winding of said

transformer, whereby charging current is supplied to said condenser to operate said repeating relay both by conduction from said source and inductively by said transformer, a signal control relay, and circuit means for connecting one terminal of said signal control relay to the mid tap of secondary winding and for connecting the other terminal of said signal control relay through a contact of said repeater relay to the opposite terminals of said secondary winding, whereby the operation of said code receiving relay effects the energization of said signal control relay with uni-directional current.

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