Aug. 12, 1952 C. W. FAILOR 2,607,002

CODED SIGNALING APPARATUS

Filed June 20, 1946 2 SHEETS—SHEET 1

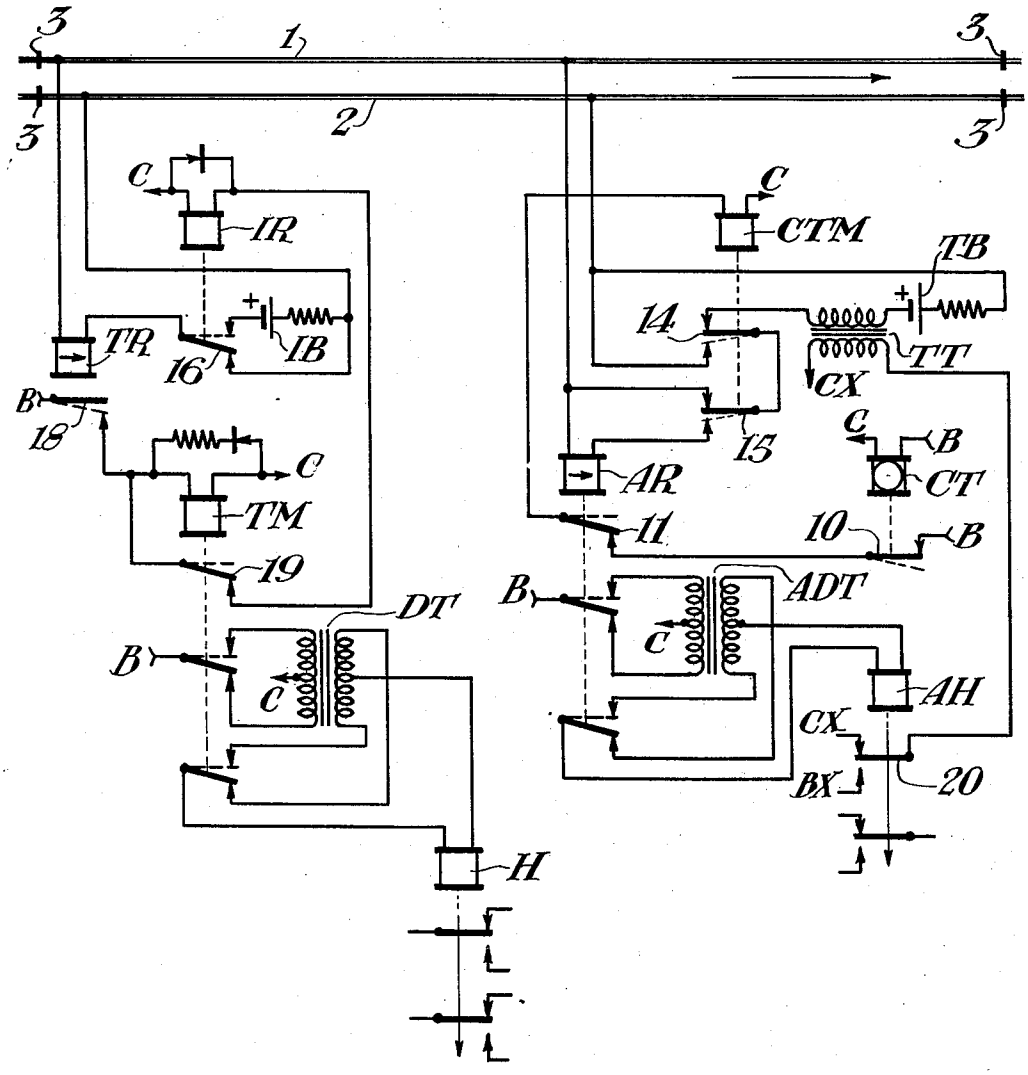


Fig. 1.

INVENTOR
Charles W. Failor.
BY
HIS ATTORNEY

Aug. 12, 1952 C. W. FAILOR 2,607,002

CODED SIGNALING APPARATUS

Filed June 20, 1946 2 SHEETS—SHEET 2

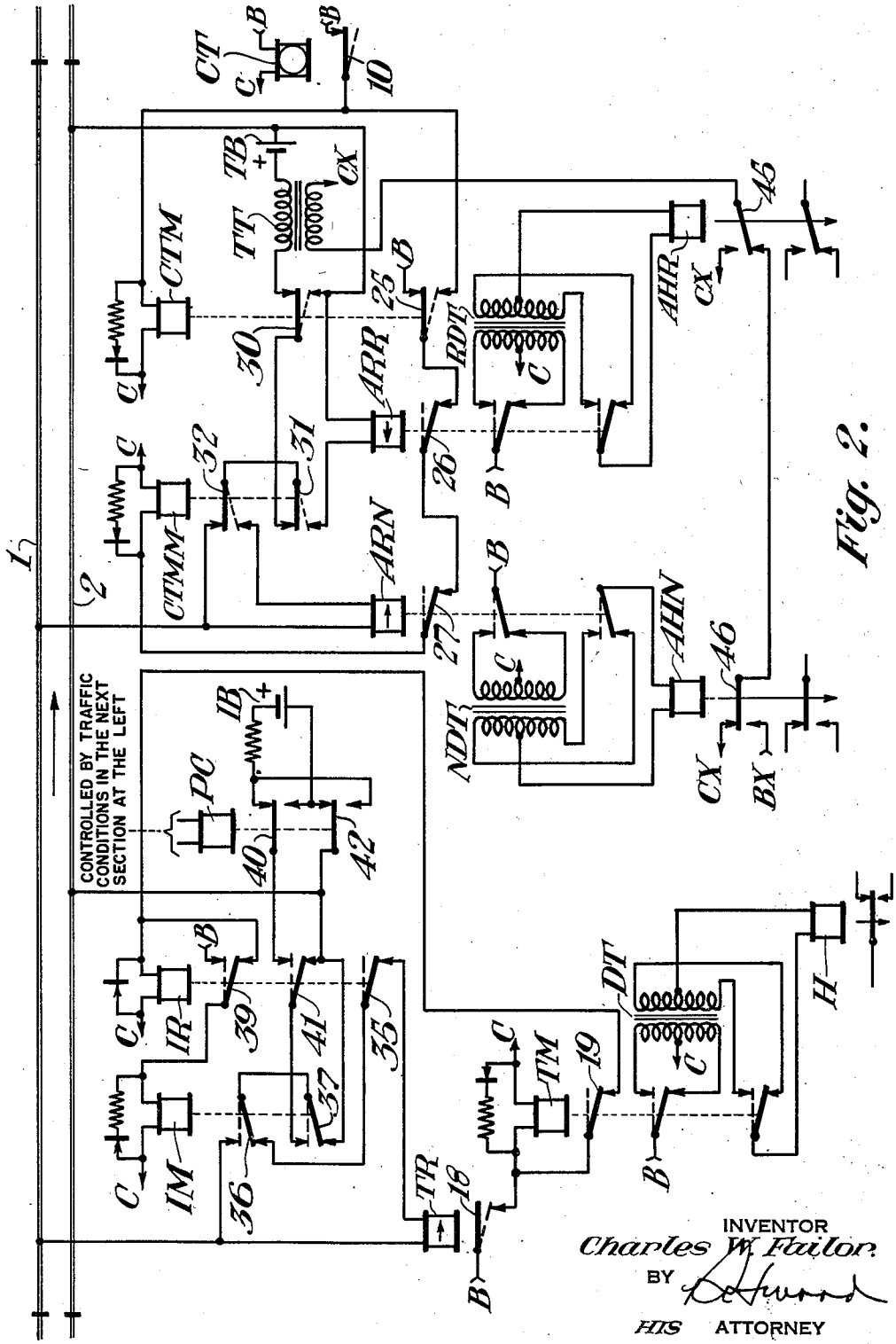


Fig. 2.

INVENTOR
Charles W. Failor
BY
HIS ATTORNEY

Patented Aug. 12, 1952

2,607,002

UNITED STATES PATENT OFFICE

2,607,002

CODED SIGNALING APPARATUS

Charles W. Failor, Forest Hills, Pa., assignor to Westinghouse Air Brake Company, a corporation of Pennsylvania

Application June 20, 1946, Serial No. 678,026

6 Claims. (Cl. 246—38)

1

My invention relates to coded railway signaling apparatus and particularly to improved means for preventing improper supply of energy to a code following relay.

In some types of coded signaling systems, as for example, a coded track circuit signaling system, a transmitting relay is located at one end of a pair of conductors and has contacts which are operated between two positions in one of which they connect the winding of a code following relay across the conductors and in the other of which they connect a source of energy across the conductors.

The contacts of the transmitting relay are normally adjusted so that on movement of the relay movable contacts between their two positions, the circuits established in one position of the relay contacts are interrupted before the circuits established in the other position of the relay contacts are established.

If the transmitter relay contacts are out of adjustment, the circuits controlled in both positions of the relay contacts may be established simultaneously during movement of the relay contacts between their two positions and energy from the source may be supplied through the transmitter relay contacts to the winding of the code following relay and may pick up its contacts, while the supply of energy from the source to the winding of the code following relay may be interrupted when the contacts of the transmitter relay complete their movement. If energy is supplied from the source to the winding of the code following relay over the transmitter relay contacts, the contacts of the code following relay will pick up and release and will cause energization of the code detecting relay governed thereby even though coded energy is not being supplied over the conductors to the code following relay.

An object of this invention is to provide improved means governed by the contacts of a transmitting relay for alternately connecting a source of energy and the winding of a code following relay across a pair of conductors, this means being arranged to eliminate the possibility that energy from the source will be supplied to the code following relay in the event the contacts of the transmitter relay are defective or out of adjustment.

A further object of the invention is to provide improved means of the type described which employs two movable contacts of the transmitting relay which are connected together permanently and which control circuits arranged so that overlapping of the fixed contacts associated with one

2

of the movable contacts short-circuits the track battery and overlapping of the fixed contacts associated with the other one of the movable contacts short-circuits the code following relay.

Another object of the invention is to provide improved means of the type described which employs two movable contacts of the transmitting relay which are connected together permanently and which control circuits arranged so that in one position of the transmitting relay contacts a code following relay is connected across the track rails and so that in the other position of the transmitting relay a source of energy is connected across the track rails independently of the winding of the code following relay.

A further object of the invention is to provide improved means of the type described which employs a first transmitting relay which has contacts movable between a first and a second position and governs a second transmitting relay to cause its contacts to occupy corresponding positions, and having circuits including two movable contacts of the second transmitting relay which are connected permanently together and are effective in one position to connect a code following relay across the track rails and effective in the other position provided a contact of the first transmitting relay is in the corresponding position to connect a source of energy across the track rails independently of the winding of the code following relay.

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

I shall describe two forms of coded signaling apparatus embodying my invention and shall then point out the novel features thereof in claims.

In practicing my invention I provide a transmitting relay together with means for recurrently moving the relay contacts between their two positions. Two movable contacts of this relay are permanently connected in series and when both movable contacts are in one position establish a circuit to connect a code following relay across the rails of a track section, while when both movable contacts are in their other position they establish a circuit independent of the winding of the code following relay to connect a source of energy across the track rails. These circuits are arranged so that, if one movable contact simultaneously engages both of the associated stationary contacts, the winding of the code following relay will be short-circuited and so that, if the other movable contact simultaneously engages

both of its associated stationary contacts, the source of energy is short-circuited to thereby prevent improper supply of energy from the source to the code following relay in the event that either of the contacts of the transmitting relay is defective.

In a modification, the transmitting relay is governed by an associated transmitting relay which also controls the circuit for connecting the source of energy across the track rails so that a short time interval is provided between the instant of interruption of the supply of energy from the source and the instant at which the circuit for connecting the code following relay across the track rails is completed.

In the drawings, Fig. 1 is a diagram of a section of railway track equipped with coded track circuit apparatus embodying this invention, and

Fig. 2 is a diagram of a section of railway track equipped with a modified form of coded track circuit apparatus embodying my invention.

Similarly reference characters refer to similar elements in each of the two views.

Referring to Fig. 1 of the drawings, there is shown therein a section of railroad track through which traffic normally moves in the direction indicated by the arrow, that is, from left to right. The locomotives which are operated in this track stretch are equipped with cab signal apparatus responsive to flow of coded alternating current energy in the track rails. The construction and operation of the locomotive cab signal apparatus is not a part of this invention and this equipment may be arranged as shown in Letters Patent of the United States No. 1,986,679, issued January 1, 1935 to Lloyd V. Lewis for Railway Traffic Controlling Apparatus.

The track rails 1 and 2 of the track section shown in the drawings are separated from the rails of the adjoining sections by insulated joints 3. A code following track relay TR is connected across the section rails at the left-hand or entrance end of the section and is operated by coded energy supplied over the section rails from the right-hand or exit end of the section. The track relay TR controls a repeater relay TM, and it also controls an impulse relay IR which causes impulses of feed back energy to be supplied to the rails at the entrance end of the stretch.

An approach relay AR is located at the exit end of the section and the winding of this relay is connected across the section rails when the contacts of the transmitter relay CTM are released.

As shown, the track section is vacant and relay AR is released so energy is supplied over front contact 10 of a continuously operating code transmitter CT and back contact 11 of relay AR to the transmitter relay CTM and its contacts are picked up. The energy which is supplied to relay CTM is supplied from a suitable local source, such as a storage battery, not shown, the terminals of which are designated B and C in the drawings.

As the contacts of relay CTM are picked up, the track battery TB is connected across the section rails over the circuit which is traced from the positive terminal of the battery through the secondary winding of the track transformer TT, and over front contacts 14 and 15 of relay CTM in series to track rail 1, while the negative terminal of the battery is connected directly to track rail 2. At this time, as the contacts of relay CTM are picked up, the circuit of the winding of relay AR is open at contact 15 of relay CTM so the relay AR remains released and its contact 11 maintains the circuit of the relay CTM.

The energy supplied from battery TB to the section rails feeds over the track rails and over back contact 16 of relay IR to the winding of the track relay TR and picks up its contact to interrupt the circuits of relays TM and IR so that they are released.

After a short time interval contact 10 of code transmitter CT interrupts the circuit of the relay CTM and its contacts release to interrupt the circuit traced above for connecting the track battery and the secondary winding of the track transformer across the track rails while the winding of relay AR is connected across the track rails over the circuit which is traced from track rail 1 through the winding of relay AR, and back contacts 15 and 14 of relay CTM in series to track rail 2.

When the supply of energy from battery TB to the section rails is cut off, the track relay TR releases and energy is supplied over its back contact 18 to relay TM, and prior to picking up of relay TM, is supplied to relay IR over the branch circuit which includes back contact 19 of relay TM. The energy supplied to relay IR prior to picking up of relay TM picks up the contact of relay IR, while the relay IR is snubbed by a rectifier so that the relay contact remains picked up for a short time interval subsequent to interruption of the relay circuit. When relay IR picks up, energy is supplied from the impulse battery IB through the winding of track relay TR in the wrong direction to pick up the relay contact.

The track relay TR and the approach relay AR are of the polar biased neutral type, the contacts of which pick up when and only when energy flows through the relay winding in a selected direction as indicated by the arrow on the relay. As explained in Letters Patent of the United States No. 2,286,002, issued June 9, 1942 to Frank H. Nicholson for Railway Signaling System, this arrangement for supplying energy from battery IB through the winding of relay TR protects this relay against improper energization in the event the front and back contacts of relay IR overlap, and also protects the relay TR against operation by energy inductively discharged from the track circuit on interruption of the circuit of the battery IB.

When relay IR picks up and connects battery IB across the section rails, energy from the battery is supplied over the section rails and over back contacts 14 and 15 of relay CTM to the winding of relay AR and picks up the contacts of the relay AR. On release of relay IR, the supply of energy from the battery IB to the relay AR is cut off and relay AR releases and closes its back contact 11 in the circuit of relay CTM so that energy is supplied to relay CTM during the next closed period of contact 10 of the code transmitter CT.

The contact 10 of the code transmitter CT continuously operates between its two positions at a predetermined rate, such as 75 or 180 times a minute so it is closed shortly after release of relay AR. Accordingly, energy is supplied to relay CTM and its contacts pick up to interrupt the circuit of relay AR and connect the track battery and the secondary winding of the track transformer TT across the section rails with the result that energy from the battery feeds to the track relay TR and picks up its contact 18. When the track relay TR picks up, the supply of energy to relay TM is interrupted and its contacts re-

lease. A resistance is connected across the terminals of the winding of relay TM and, on interruption of the supply of energy to the relay winding, delays release of the relay contacts slightly to compensate for the delay in picking up of the relay contacts on the supply of energy to the relay winding and thereby substantially equalizes the picked-up and released periods of the contacts of the relay TM.

After a short interval, contact 10 of the code transmitter CT interrupts the circuit of the relay CTM and its contacts release to cut off the supply of energy from battery TB to relay TR and the contact of relay TR releases to establish the circuits of relays TM and IR so that the contact of relay IR picks up to cause an impulse of energy to be supplied from battery IB to the relay AR.

As long as the section is vacant, the equipment continues to operate as described and as a result of movement of the contacts of relay TM energy is supplied through the decoding transformer DT to the relay H and its contacts are picked up. The relay H may be employed for any suitable purpose, such as to control a signal, not shown, for governing movement of traffic in the stretch. Likewise, movement of the contacts of the relay AR causes energy to be supplied through the decoding transformer ADT to relay AH and its contacts are picked up with the result that its contact 20 short-circuits the primary winding of the track transformer TT. The relay AH is provided with other contacts which control circuits which may be employed for any appropriate purpose.

When a train enters the section, the track rails are shunted and energy supplied from battery TB ceases to operate relay TR and it remains released so relay TM is steadily picked up while relay IR remains released and does not supply energy from battery IB to the section rails. Accordingly, relay AR remains released and its contact 11 maintains the circuit of relay CTM and relay CTM continues to be operated by the code transmitter CT.

When relay TM is steadily picked up, energy is no longer supplied through the decoding transformer DT to relay H and its contacts release. Similarly, when relay AR remains released, energy is not supplied through transformer ADT to relay AH and its contacts release so that contact 20 establishes the circuit for supplying alternating current energy to the primary winding of track transformer TT from a source the terminals of which are designated BX and CX. Accordingly, during the pick-up periods of the relay CTM, alternating current energy is supplied from the secondary winding of the track transformer TT to the section rails and operates the locomotive cab signal equipment.

When the section is vacated, energy supplied from battery TB to the section rails again operates the track relay TR while relay IR again operates to supply energy from battery IB to the relay AR. As a result of operation of relay TR the relay H picks up, and as a result of operation of relay AR the relay AH picks up to interrupt the supply of energy to the primary winding of transformer TT and to short-circuit this winding.

This equipment is arranged so that if the contacts of relay CTM are out of adjustment with the result that either of the movable contacts 14 and 15 engages its front and its back points of contact simultaneously, energy will not be supplied from battery TB or from the track transformer TT to the relay AR.

If contact 14 engages its front and back points of contact simultaneously, the track battery and the secondary winding of the transformer TT are short-circuited over the circuit which is traced from the positive terminal of the battery through the transformer secondary winding, and thence to the negative terminal of the battery through front and back points of contact of contact 14, which are assumed to overlap or engage. As the battery and transformer are short-circuited, energy will not be supplied to relay AR regardless of the position of contact 15, and there is no danger that the contacts of relay AR will be picked up and released because of the supply of energy to the relay winding from the battery TB or the transformer TT.

If contact 15 engages its front and back points of contact simultaneously, the winding of relay AR is short-circuited through the contact 15, as is obvious from the drawing, and the relay AR will not be operated by energy supplied from battery TB or the transformer TT.

If the contacts 14 and 15 are out of adjustment so that front contact 14 and back contact 15 engage simultaneously, energy may be supplied from the battery TB and the transformer TT through the winding of relay AR to the track rails. However, the energy supplied from the battery flows through the winding of relay AR in the wrong direction to pick up the relay contacts. The alternating current energy supplied from transformer TT to the winding of relay AR is of relatively high frequency, and the contacts of relay AR may not operate rapidly enough to respond to this energy, but if they do, the rate of operation of the contacts is so high that too little energy is supplied through the decoding transformer ADT to relay AH to pick up the relay contacts or to maintain them packed up. Accordingly, relay AH is released under these conditions.

If the contacts 14 and 15 are out of adjustment so that back contact 14 and front contact 15 engage simultaneously, the back rails 1 and 2 are short-circuited and the relay AR is certain to remain released.

The circuit of the relay AR is arranged so that energy inductively discharged from the track circuit on interruption of the circuit of the track battery will not pick up the contacts of the relay AR. When the contacts of relay CTM are picked up, the battery TB is connected across the track rails with the positive terminal of the battery connected to track rail 1 so that energy flows from the battery to track rail 1, thence to track rail 2 and the negative terminal of the battery through the winding of track relay TR, or through the wheels and axles of a vehicle if the section is occupied. Because of the inductance of the track circuit, an impulse of energy is induced in the track circuit when the supply of energy from the battery to the track rails is interrupted by opening of front contacts 14 and 15 of relay CTM, and, on closing of back contacts 14 and 15 of relay CTM, this energy is supplied to the winding of relay AR. The energy supplied at this time flows in the same direction as that supplied from the battery, and therefore flows from track rail 1 to track rail 2, over back contacts 14 and 15 of relay CTM and through the winding of relay AR from right to left to track rail 1. This impulse of energy, therefore, flows through the winding of relay AR in the wrong direction to pick up the relay contacts so there is no possibility that the relay contacts will be

improperly picked up by the energy inductively discharged from the track circuit.

As a result of the supply of energy from the track battery TB to the track rails, a charge may be built up in the track ballast so that the ballast and the track rails together in effect form a storage battery from which energy may be supplied to the winding of the relay AR when the relay winding is connected across the track rails. However, the voltage of the energy supplied from this source to the relay AR is relatively low and although this energy flows through the winding of relay AR in the proper direction to pick up the contacts of relay AR, insufficient energy flows through the winding of relay AR to pick up the relay contacts, and the relay contacts will not be picked up improperly by energy supplied from this source.

It will be seen, therefore, that the track battery and track transformer and the relay AR are alternately connected across the section rails by contacts of the transmitter relay CTM, but that the connections governed by the contacts of the relay CTM are arranged so that, in the event the contacts of relay CTM are out of adjustment, there is no possibility that the relay AR will be operated by energy from the battery TB or the transformer TT so as to improperly energize the relay AR. Similarly, the various parts of the track circuit are arranged so that the contacts of relay AR will not be improperly picked up by energy inductively discharged from the track circuit or by energy stored in the track circuit. Accordingly, the relay AH is certain to remain released unless the relay AR is being operated by coded energy supplied over the section rails and the relay AH, therefore, reliably indicates whether the section is occupied or not.

The arrangement provided by this invention is also adapted for use in track sections where feed-back energy of both polarities is employed and Fig. 2 is a diagram showing this modification. The apparatus of Fig. 2 is generally similar to that shown in Fig. 1 but differs therefrom in that two code following approach relays are provided at the exit end of the section. These relays are designated ARN and ARR and are of the biased polar type, like relay TR, but are arranged so that they respond to feed-back energy of opposite polarities. In addition, a repeater relay CTMM is provided for the transmitter relay CTM to provide an open circuit interval following interruption of the circuit of the track battery TB and thus prevent operation of either of the approach relays by energy inductively discharged from the track circuit.

At the entrance end of the section, a pole changing relay PC governs the polarity of the energy supplied from the battery IB to the track rails, while a repeater relay IM is provided for the impulse relay IR to provide an open circuit interval following interruption of the circuit of the battery IB and thus prevent operation of the track relay by energy inductively discharged from the track circuit. The relay PC may be controlled in any suitable manner, not shown, as, for example, by traffic conditions in the section to the left of the section shown.

The apparatus of Fig. 2 is shown in the condition which it assumes when the track stretch is vacant and an impulse of energy is being supplied from the track battery to the track relay. At this time contact 10 of the code transmitter CT is closed and supplies energy to the transmitter relay CTM and its contacts are picked up with the result that energy is supplied over its front contact 25, back contact 26 of relay ARR, and back contact 27 of relay ARN to relay CTMM and its contacts are picked up. As relays CTM and CTMM are picked up, the track battery TB and track transformer TT are connected across the track rails over the circuit which is traced from the positive terminal of the battery through the secondary winding of transformer TT, over front contact 30 of relay CTM, and front contacts 31 and 32 of relay CTMM in series to track rail 1, while the negative terminal of the battery is connected directly to track rail 2.

The energy supplied from battery TB to the track rails is supplied to the winding of track relay TR over the circuit which is traced from track rail 1 through the track relay winding from left to right, back contact 35 of relay IR, and back contacts 36 and 37 of relay IM in series to track rail 2. The energy supplied to the track relay TR picks up its contact 18 to interrupt the circuit of relay TM and of relays IR and IM and these relays are released.

After a short time interval the contact 10 of code transmitter CT opens and opens the circuit of relay CTM and its contacts release so that contact 25 interrupts the circuit of relay CTMM while contact 30 interrupts the circuit of the battery TB and of the track transformer TT. The relay CTM is snubbed by a rectifier and resistance so release of the relay contacts is delayed slightly after interruption of the circuit of the relay winding to compensate for the pick-up time of the relay and thus equalize the picked-up and released times of the relay contacts. The relay CTMM is also snubbed by a rectifier and a resistor so the contacts of this relay do not release for a short period after the supply of energy to the relay winding is interrupted by release of contact 25 of relay CTM.

In the period between release of relays CTM and CTMM the track rails are short-circuited over the circuit which is traced from track rail 1 over front contacts 32 and 31 of relay CTMM in series and back contact 30 of relay CTM to track rail 2. This short-circuiting of the track rails discharges energy stored in the track ballast and also dissipates the energy impulse induced in the track circuit on interruption of the circuit of the track battery and prevents this energy impulse from being supplied to the relays ARN and ARR. Where only one approach relay is employed, as in Fig. 1, the equipment can be arranged so that the impulse of energy inductively discharged from the track circuit is of the wrong polarity to operate the approach relay, but where two approach relays, which are responsive to energy of opposite polarities are employed, this method of protecting the approach relays cannot be employed and the time interval provided by the relay CTMM is provided for this purpose.

When the supply of energy from battery TB is cut off, the track relay TR releases and energy is supplied over its back contact 18 to relay TM, and is also supplied over back contact 19 of relay TM to relay IR, and, in addition, over back contact 39 of relay IR to relay IM. The supply of energy to relays IR and IM is cut off as soon as relay TM picks up but the apparatus is arranged so the relays IR and IM will be picked up by the energy supplied thereto prior to picking up of relay TM. After relay IR picks up, energy is supplied to relay IM over the front contact 39 of relay IR so the relay IM will remain picked up as long as relay IR is picked up. The relay

IR is snubbed by a rectifier so its contacts remain picked up for a short time subsequent to interruption of the supply of energy to the relay winding, while the relay IM is snubbed by a rectifier and resistance to keep its contacts picked up for a short period after release of relay IR and consequent interruption of the supply of energy to the winding of relay IM.

When relays IR and IM are both picked up, the battery IB is connected across the track rails so as to supply energy of normal or reverse polarity according as the contacts of relay PC are picked up or released. As shown, the contacts of relay PC are picked up and when relays IR and IM are both picked up, the positive terminal of battery IB is connected over front contact **40** of relay PC, front contact **41** of relay IR and front contacts **37** and **36** of relay IM in series to track rail **1**, while the negative terminal of the battery is connected over front contact **42** of relay PC to track rail **2**. The energy supplied from battery IB to the track rails is supplied to relays ARN and ARR in series over the circuit which is traced from track rail **1** through the winding of relay ARN from left to right, over back contacts **32** and **31** of relay CTMM in series, and through the winding of relay ARR from left to right to track rail **2**.

The energy supplied from battery IB when relay PC is picked up is of the polarity effective to pick up the contacts of relay ARN but not relay ARR. When relay ARN picks up, its contact **27** interrupts the circuit of relay CTMM to insure that relay CTMM remains released and maintains the circuit of the relays ARN and ARR. As relay CTMM cannot pick up when relay ARN or relay ARR is picked up there is no possibility that relay ARN or ARR, when picked up, will be released as a result of picking up of relay CTMM. Accordingly, if foreign current is present and picks up one of the relays ARN or ARR, the relay will be steadily picked up and will not cause energy to be supplied through the associated decoding transformer, as would occur if the relay were recurrently released because of picking up of relay CTMM. The relays ARN and ARR, therefore, will not operate as code following relays if foreign current is present and the relays AHN and AHR will both be released.

When relay ARN or ARR is picked up, the circuit of the relay CTM is not affected and it continues to be operated by the code transmitter CT. However, picking up of relay CTM does not affect the circuit of the relays ARN and ARR, and picking up of relay CTM with relay CTMM released does not result in the supply of energy from the track battery TB or the track transformer to the section rails.

Returning to the equipment at the entrance end of the section, the relay IR releases after a short interval and its contact **41** interrupts the circuit of battery IB and its contact **39** interrupts the circuit of relay IM, but the snub for relay IM delays release of its contacts for a short interval. After release of relay IR, but before release of relay IM, the track rails are short-circuited over the circuit which is traced from track rail **1** over front contacts **36** and **37** of relay IM in series and back contact **41** of relay IR to track rail **2**. The short-circuiting of the track rails discharges energy stored in the track ballast and it dissipates the impulse of energy inductively discharged from the track circuit on interruption of the supply of the circuit of battery IB and thus prevents picking up of the contact of relay TR by this energy. Where the energy supplied from battery IB to the section rails is always of the same polarity, the arrangement shown in Fig. 1 may be employed to prevent picking up of the track relay by energy inductively discharged from the track circuit, but where the energy supplied from battery IB is at times of one polarity and at other times of the other polarity, the arrangement shown in Fig. 2 must be employed.

The relay IM releases shortly after relay IR and interrupts the circuit traced above for short-circuiting the track rails and establishes the previously traced circuit for connecting the track relay TR across the track rails.

When the supply of energy from battery IB is cut off, the relay ARN releases and its back contact **27** is closed to permit energy to be supplied to relay CTMM.

On subsequent closing of contact **10** of the code transmitter CT, energy is supplied to relay CTM, and prior to picking up of relay CTM, is also supplied to relay CTMM over back contact **25** of relay CTM so that relay CTMM will pick up concurrently with relay CTM. When relay CTM picks up, its contact **25** establishes a circuit for energizing relay CTMM to keep it picked up as long as relay CTM is picked up. When relays CTM and CTMM are picked up, energy is again supplied from the battery TB over the section rails to relay TR and its contact **18** is picked up to release relay TM, while the equipment thereafter operates as previously described.

As a result of operation of relay TM energy is supplied through the decoding transformer DT to the relay H and its contacts are picked up. Similarly, as a result of operation of relay ARN energy is supplied through the transformer NDT to relay AHN and its contacts are picked up with the result that the primary winding of transformer TT is short-circuited over the circuit which includes back contact **45** of relay AHR and front contact **46** of relay AHN.

On the approach of a train the contacts of relay PC may be released by means not shown, thereby changing the polarity of the energy supplied from battery IB. After release of relay PC the positive terminal of battery IB is connected over back contact **42** of relay PC to track rail **2**, while during the picked-up periods of relays IR and IM the negative terminal of the battery is connected over back contact **40** of relay PC, front contact **41** of relay IR, and front contacts **37** and **36** of relay IM in series to track rail **1**. The energy supplied from battery IB at this time flows from rail **2** through the winding of relay ARR from right to left, over back contacts **31** and **32** of relay CTMM in series, and through the winding of relay ARN from right to left to track rail **1**. This energy, therefore, is effective to operate relay ARR but not relay ARN, and as a result the relay AHR is picked up while relay AHN releases. After relay AHR picks up, the primary winding of transformer TT is short-circuited over front contact **45** of relay AHR, while the operation of the equipment is otherwise unchanged.

When the train enters the track section shown, the track relay TR is shunted and remains released and establishes the circuit of the relay TM so that its contacts are steadily picked up and energy is no longer supplied to relay H and it releases while contact **19** of relay TM interrupts the circuits of the relays IR and IM and they remain released so that energy is no longer supplied from battery IB to the section rails and

relays ARN and ARR both remain released. Accordingly, relay AHR releases and relay AHN remains released and energy is supplied over back contact 46 of relay AHN and back contact 45 of relay AHR to the primary winding of track transformer TT so that during subsequent picked-up periods of the relays CTM and CTMM alternating current energy is supplied from the transformer secondary winding to the track rails to operate the cab signal apparatus on the locomotive in the track section.

When the section is vacated, energy from battery TB again feeds to track relay TR and picks up its contact 18 and relay TM releases so that on subsequent release of relay TR energy is supplied over back contact 19 of relay TM to relays IR and IM and they pick up to supply energy from battery IB to the section rails. This energy picks up one or the other of the relays ARN or ARR, depending on the polarity of the energy, with the result that one of the relays AHN or AHR picks up to cut off the supply of energy to transformer TT and to short-circuit the transformer primary winding. Similarly, as a result of operation of the track relay TR the relay H picks up and the equipment is again substantially in the condition in which it is shown in the drawings.

This equipment is arranged so that defects in the contacts of relays CTM and CTMM, or abnormal operation of these contacts, cannot result in objectionable supply of energy from the battery TB or the transformer TT to the relays ARN and ARR, or in picking up of either of the relays ARN or ARR by the energy inductively discharged from the track circuit on interruption of the circuit of the track battery.

If the front and back points of contact of movable contact 30 of relay CTM engage simultaneously, the track battery TB and the primary winding of the track transformer TT are short-circuited and energy will not be supplied to the relays ARN and ARR even if the contacts of relay CTMM are released.

If front contact 30 of relay CTM is closed and contacts 31 and 32 of relay CTMM are released, energy cannot be supplied from the battery TB and the transformer TT to the relays ARN and ARR since the circuit of the battery and transformer is open at front contact 31 of relay CTMM.

If movable contact 31 of relay CTMM engages its front and back contacts simultaneously, a circuit will be established from battery TB and transformer TT through the winding of relay ARR during the picked-up periods of contact 30 of relay CTM. At such times energy may be supplied from the positive terminal of the battery TB through the secondary winding of transformer TT, over front contact 30 of relay CTM, through front and back points of contact of contact 31 of relay CTMM, which are assumed to engage simultaneously, and through the winding of relay ARR from left to right to the negative terminal of the battery. The energy supplied from the battery to the winding of relay ARR flows through the relay winding in the wrong direction to pick up the relay contacts so they remain released and this supply of energy to relay ARR cannot produce an objectionable result. If energy is supplied from transformer TT to relay ARR over the circuit traced above, the relay contacts, if they operate at all, will operate so rapidly that insufficiently energy will be supplied through the transformer RDT to relay AHR to pick up its contacts.

Under the conditions stated, namely, when the front and back contacts of contact 31 engage simultaneously, if back contact 32 is closed, energy may be supplied from battery TB and transformer TT through the winding of relay ARN to the track circuit. This will also be true if the contacts of relay CTMM are out of adjustment so that front contact 31 and back contact 32 engage simultaneously. At such times the positive terminal of the battery TB is connected through the secondary winding of transformer TT, over front contact 30 of relay CTM, front contact 31 and back contact 32 of relay CTMM, and through the winding of relay ARN from right to left to track rail 1, while the negative terminal of the battery is connected to track rail 2. The energy supplied from the battery through the winding of relay ARN flows through the relay winding in the wrong direction to pick up the relay contacts and there is no danger that relay ARN will be operated improperly. As explained above, energy from the transformer TT may be supplied through the winding of relay ARN but cannot cause energization of relay AHN.

If the front and back points of contact of movable contact 32 engage simultaneously, the winding of relay ARN will be short-circuited and energy will not be supplied through this winding regardless of the position of contact 31 of relay CTMM or contact 30 of relay CTM. Accordingly, the contacts of relay ARN remain released and will not cause improper energization of relay AHN.

If front contact 32 and back contact 31 of relay CTMM engage simultaneously, the relay ARR will be connected across the track rails, but the circuit of the battery TB and of the transformer TT is open at front contact 31 of relay CTMM and energy will not be supplied from the battery or the transformer to either the relay ARR or the track circuit and relay ARR remains released, while the circuit of the winding of relay ARN is open at back contact 32 of relay CTMM and relay ARN remains released.

The equipment at the exit end of the section is also arranged so that the impulse of energy induced in the track circuit on interruption of the circuit of the battery TB will not be supplied to relay ARN or ARR and will not operate their contacts. Energy is supplied from battery TB to the track rails only when relays CTM and CTMM are both picked up, and when relay CTM is picked up its contact 25 establishes a circuit for relay CTMM so that the contacts of relay CTMM remain picked up as long as relay CTM is picked up. On interruption of the circuit of the relay CTM by contact 10 of the code transmitter CT the contacts of relay CTM release with the result that contact 30 interrupts the circuit of battery TB and contact 25 interrupts the circuit of the relay CTMM, but because of the rectifier and resistance snub connected across the terminals of the winding of relay CTMM, the contacts of relay CTMM remain picked up for a short interval subsequent to release of relay CTM. When the circuit of battery TB is interrupted by opening of front contact 30 of relay CTM, the flow of energy in the track circuit ceases and an impulse of energy is induced in the track circuit. When contact 30 of relay CTM engages its back contact, the contacts of relay

CTMM are still picked up and the track rails are short-circuited so the energy inductively discharged from the track circuit will be dissipated through this connection between the track rails before the relay CTMM releases to interrupt this connection and connect the relays ARN and ARR across the track rails.

The equipment at the entrance end of the section is arranged so that defects or misadjustments in the contacts of relays IR and IM cannot result in improper supply of energy to relay TR. If movable contact 41 of relay IR engages its front and its back points of contact simultaneously, the battery IB will be short-circuited and energy will not be supplied from the battery to either the track relay or the track circuit and the contact of the track relay will remain released and maintain the circuit of the relay TM so that relay H remains released.

If front contact 41 and back contact 35 of relay IR are closed simultaneously, energy will not be supplied from battery IB to relay TR as the circuit of relay TR is open at back contact 36 of relay IM, if the contacts of relay IM are picked up, or at front contact 37, if the contacts of relay IM are released.

If movable contact 37 of relay IM engages its front and back points of contact simultaneously, the battery IB will be short-circuited when contact 41 of relay IR is picked up and energy will not be supplied from the battery IB to the relay TR regardless of the position of contact 36 of relay IM or contact 35 of relay IR.

Similarly, if movable contact 36 of relay IM engages its front and back points of contact simultaneously, the winding of relay TR will be short-circuited if back contact 35 of relay IR is closed to establish the circuit of this winding. As the winding of the track relay is short-circuited the relay contact is certain to remain released.

As was explained in detail above, the relays IR and IM cooperate to prevent energization of relay TR by the impulse of energy inductively discharged from the track circuit on interruption of the circuit of the battery IB.

Although I have herein shown and described only two forms of apparatus embodying my invention, it is 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 first and a second conductor extending between two spaced locations, and apparatus at one of said locations, at least, for alternately supplying coded energy to said conductors and for receiving coded energy from said conductors comprising a transmitter relay having a first and a second movable contact which are connected directly together and are moved periodically between a first and a second position substantially in synchronism, a code following relay having one terminal of its winding connected permanently to said first conductor and having a contact biased to a first position and movable to a second position when and only when energy is received from said conductors which flows through the relay winding in the positive to negative direction from said first conductor to said second conductor, a source of direct current energy having its negative terminal permanently connected to said second conductor, said transmitter relay first movable contact being effective according as it is in its first or its second position to connect said transmitter relay second movable contact to said second conductor or to the positive terminal of said source of direct current, said transmitter relay second movable contact being effective according as it is in its first or its second position to connect said transmitter relay first movable contact to the other terminal of the winding of said code following relay or to said first conductor, and a detector relay responsive to the periodic movement of the contact of said code following relay between its two positions.

2. In a coded signaling system, in combination, a first and a second conductor extending between a first and a second location, a first code following relay at said first location responsive to direct current impulses received over said conductors, a first source of direct current at said first location for supplying impulses to said conductors during the intervals between the received impulses, said first source having its positive terminal connected to the first conductor, a second code following relay having one terminal connected permanently to said first conductor and a second source of direct current having one terminal connected permanently to said second conductor, both at said second location, a transmitter relay at said second location having a first and a second movable contact which are electrically connected together permanently and are moved periodically between a first and a second position substantially in synchronism, a circuit including both of said transmitter relay contacts in series for connecting the winding of said second code following relay across said conductors when both of said transmitter relay contacts are in their first position, a circuit including both of said transmitter relay contacts in series for connecting said second source of direct current across said conductors with the positive terminal of said second source connected to said first conductor when both of said transmitter relay contacts are in their second position, said second code following relay having a contact biased to a first position and movable therefrom to a second position when and only when current flows in the positive to negative direction through the relay winding from the terminal which is connected to said first conductor to the terminal which is connected to said second conductor, and a code detecting relay responsive to code following operation of said second code following relay.

3. In a coded track circuit signaling system, in combination, a section of railway track having a pair of track rails, and apparatus for alternately supplying coded energy to said track rails and for receiving coded energy from said track rails, comprising a first transmitter relay having contacts which are moved between a first and a second position, a second transmitter relay having a first and a second movable contact which are electrically connected together and are movable periodically between a first and a second position substantially in synchronism, circuit means governed by said first transmitter relay for operating the second transmitter relay to cause its contacts to occupy their first or their second position according as the contacts of the first transmitter relay occupy their first or their second position, said first movable contact being effective according as it is in its first or its second position to connect said second movable contact to one of said track rails directly or through the winding

of a first code following relay which is responsive to energy of one polarity only, said second movable contact being effective according as it is in its second or its first position to connect said first movable contact to the other of said track rails through the winding of a second code following relay or through a source of energy provided a contact of said first transmitter relay is in its first position.

4. In a coded track circuit signaling system, in combination, a section of railway track having a pair of track rails, and apparatus for alternately supplying coded energy of a given relative polarity to said track rails and for receiving coded energy of either of two polarities from the track rails, comprising a first transmitter relay having contacts which are moved between a first and a second position, a second transmitter relay having a first and a second movable contact which are electrically connected together and are movable periodically between a first and a second position substantially in synchronism, circuit means governed by said first transmitter relay for operating the second transmitter relay to cause its contacts to occupy their first or their second position according as the contacts of the first transmitter relay occupy their first or their second position, said first movable contact being effective according as it is in its first or its second position to connect said second movable contact to one of said track rails directly or through the winding of a first code following relay which is responsive to energy of one polarity only, said second movable contact being effective according as it is in its second or its first position to connect said first movable contact to the other of said track rails through the winding of a second code following relay or through a source of energy provided a contact of said first transmitter relay is in its first position, said code following relays each having contacts biased to a released position and movable therefrom to a picked-up position when and only when energy flows through the relay winding in a selected direction, the circuits for connecting said code following relays and said source across the track rails being arranged so that these relays respond to opposite polarities of energy supplied over the track circuits and so that the energy supplied from said source to the track rails is of the same polarity as that which is effective to pick up the contacts of said second code following relay.

5. In a coded track circuit signaling system, in combination, a section of railway track having a pair of track rails, and apparatus for alternately supplying coded energy to said track rails and for receiving coded energy from said track rails, comprising a first transmitter relay having contacts which are moved between a first and a second position, a second transmitter relay having a first and a second movable contact which are electrically connected together and are movable periodically between a first and a second position substantially in synchronism, circuit means governed by said first transmitter relay for operating the second transmitter relay to cause its contacts to occupy their first or their second position according as the contacts of the first transmitter relay occupy their first or their second position, said first movable contact being effective according as it is in its first or its second position to connect said second movable contact to one of said track rails directly or through the winding of a code following relay, said second movable contact being effective when in its first position to connect said first movable contact to the other of said track rails through a source of energy provided a contact of said first transmitter relay is in its first position and being effective when in its second position to establish a connection between said first movable contact and said other track rail irrespective of the position of the contacts of said first transmitter relay.

6. In a coded track circuit signaling system, in combination, a section of railway track having a pair of track rails, and apparatus for alternately supplying coded energy to said conductors and for receiving coded energy from said conductors, comprising a first transmitter relay having contacts which are moved between a first and a second position, a second transmitter relay having a first and a second movable contact which are electrically connected together and are movable periodically between a first and a second position substantially in synchronism, circuit means governed by said first transmitter relay for operating the second transmitter relay to cause its contacts to occupy their first or their second position according as the contacts of the first transmitter relay occupy their first or their second position, a code following relay having the first terminal of its winding connected to one of said track rails, said first movable contact being effective according as it is in its first or its second position to connect said second movable contact to said one track rail or to the second terminal of the winding of said code following relay, said second movable contact being effective when in its first position to connect said first movable contact to the other of said track rails through a source of energy provided a contact of said first transmitter relay is in its first position, said second movable contact being effective when in its second position to establish a connection from said first movable contact to said other track rail irrespective of the position of the contacts of said first transmitter relay.

CHARLES W. FAILOR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,286,002	Nicholson	June 9, 1942
2,352,743	Staples et al.	July 4, 1944
2,389,982	Jerome	Nov. 27, 1945