

Nov. 9, 1965

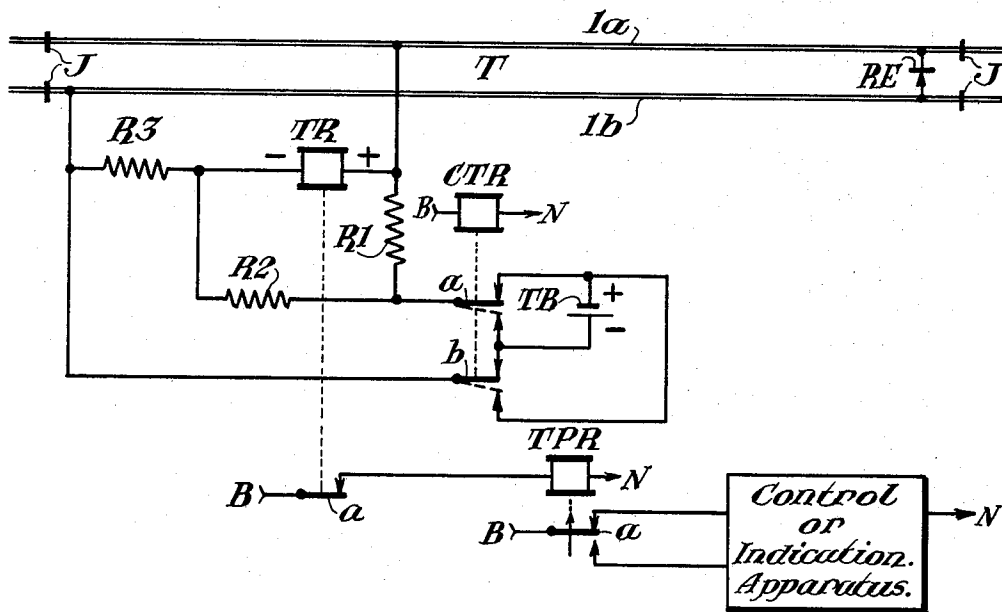
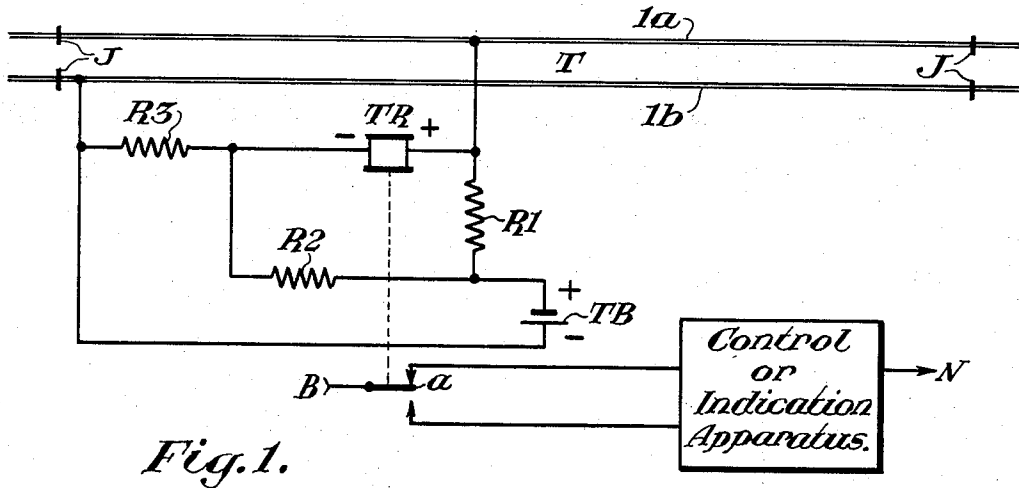
A. G. EHRLICH

3,217,158

RAILWAY TRACK CIRCUIT APPARATUS

Filed Nov. 29, 1961

2 Sheets-Sheet 1



INVENTOR.
Anthony G. Ehrlich.

BY

W. h. Stent.

HIS ATTORNEY

Nov. 9, 1965

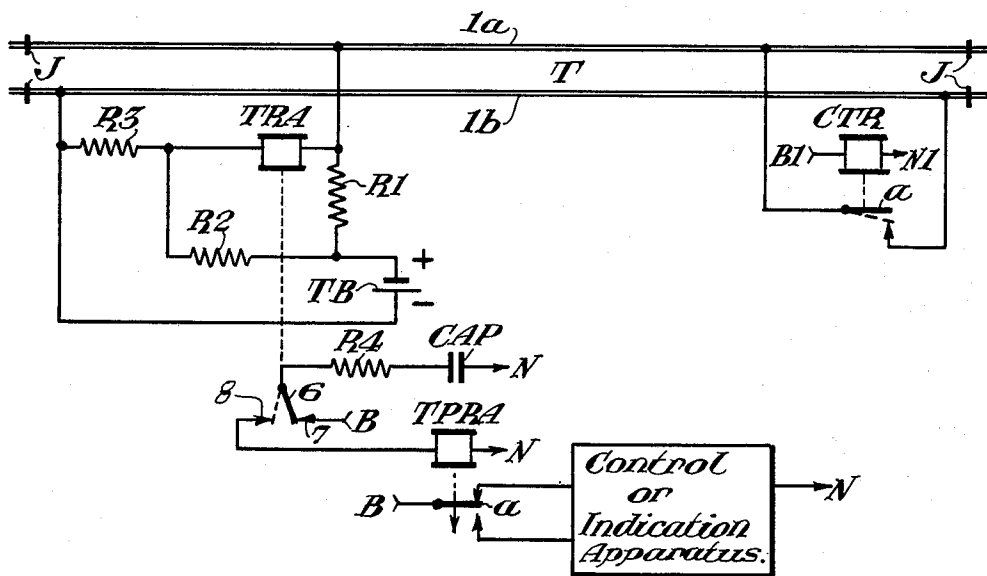
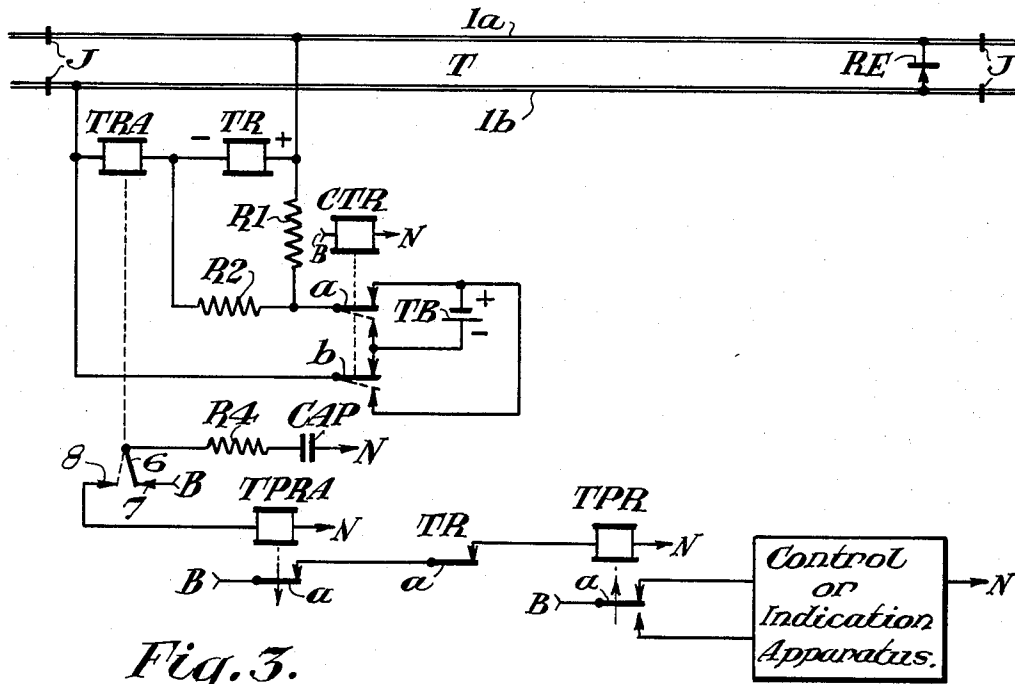
A. G. EHRLICH

3,217,158

RAILWAY TRACK CIRCUIT APPARATUS

Filed Nov. 29, 1961

2 Sheets-Sheet 2



INVENTOR.
Anthony G. Ehrlich.

BY

W. h. Stork

HIS ATTORNEY

1

2

3,217,158

RAILWAY TRACK CIRCUIT APPARATUS

Anthony G. Ehrlich, Pittsburgh, Pa., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

Filed Nov. 29, 1961, Ser. No. 155,614

8 Claims. (Cl. 246—34)

My invention relates to railway track circuit apparatus. More specifically my invention relates to a track circuit for detection of occupancy by a train of a section of railway track.

One object of my invention is to provide novel railway track circuit apparatus employing a track relay and in which such relay and the source of energy for operation thereof are both connected to the rails at the same end of a section of railway track.

Another object of my invention is to provide a track circuit such as that outlined above having improved shunting characteristics.

In accordance with my invention I provide apparatus including three resistive windings connecting a track relay and a source of direct current energy across the rails of a section of railway track at one end thereof, so that the relay is picked up by said source of energy when the track section is unoccupied and becomes released when the track section is occupied by a train.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

I shall describe a basic embodiment of my invention and three improved embodiments thereof, and shall then point out the novel features thereof in claims.

In the accompanying drawings, FIG. 1 is a diagrammatic view of the basic form of apparatus embodying my invention.

FIGS. 2, 3 and 4 each constitute a diagrammatic view showing first, second and third improved forms, respectively, of the apparatus shown in FIG. 1.

In each of the four views similar reference characters are used to designate similar parts.

Referring to FIG. 1, there is shown a section of railway track designated T and comprising track rails 1a and 1b separated from the rails of the adjoining track sections by insulated rail joints J. At one end of track section T a source of direct current track circuit energy shown as a battery TB has its positive pole or terminal (+) connected to rail 1a through a resistor or resistive winding R1 and its negative pole or terminal (—) connected directly to rail 1b.

A relay TR, preferably of the magnetically biased type, has its positive terminal (+) connected to the end of resistor R1 which is connected to rail 1a and such terminal is, therefore, also connected directly to rail 1a of track section T. The negative terminal (—) of the relay is connected through a resistive winding or resistor R2 to the positive terminal of battery TB, and also through a resistive winding or resistor R3 to the negative terminal of the battery and, therefore, to rail 1b of track section T. As stated above, relay TR is preferably but need not necessarily be of the magnetically biased type, that is, a relay having an armature which is biased to a first position magnetically and which is activated to a second position only when the operating flux due to the energization of the windings of the relay is of a particular polarity. As shown in the drawing, relay TR becomes picked up only when the positive terminal (+) of the relay is connected to the positive terminal of a direct current source and the negative terminal (—) of the relay is connected to the negative terminal of such source. When energy of opposite polarity is supplied across the winding of relay TR, the magnetic bias of the relay aids

the relay to become released. Such biased relays are well known in the art and relay TR may, for example, be similar to that shown and described in Letters Patent of the United States No. 2,728,880, issued December 27, 1955, to Harry E. Ashworth for Electrical Relays and assigned to the assignee of the present application.

It should be pointed out that several of the relays shown in the drawings are slow acting, that is, slow to release or slow to pick up. The windings of these relays are shown in the drawings in the usual manner by a geometric rectangle representing the windings, but the contacts of such relays have an arrow drawn through the movable parts thereof with the head of the arrow pointed in the direction in which the relays are slow acting. This will be readily apparent from a brief glance at the drawings.

It should also be pointed out that the contacts of the relays are not in all instances located directly below the geometric rectangles representing the control windings of the relays but, where the contacts of the relays are not so located, the reference character designating the relay controlling such contacts is disposed on the drawing directly above the contacts.

In each of the figures of the drawings a source of direct current energy, such as a battery of proper voltage and capacity, is provided at the relay end of track section T for operation of the apparatus other than the track circuit apparatus itself. In FIG. 4 an additional source of direct current energy is provided at the end of track section T opposite the track relay end of such track section. For purposes of simplicity these sources are not shown in the drawings but the positive and negative terminals of the direct current source at the track relay end of track section T are designated B and N, respectively, and the positive and negative terminals of the additional source in FIG. 4 are designated B1 and N1, respectively.

Relay TR actuates control or indication apparatus as shown in the drawings, the circuit for actuating such apparatus extending from terminal B of the direct current source over the front or back points of contact a of relay TR and through the control or indication apparatus to battery terminal N. The control or indication apparatus is, therefore, actuated in accordance with the picked-up or released condition of relay TR as is readily apparent.

In order that the hereinafter described operation of the apparatus of my invention will be fully understood, it should be pointed out that resistive windings or resistors R1, R2 and R3 should be chosen with consideration to the resistance of the control winding or windings of relay TR, the resistance of a typical train shunt in track section T, the ballast resistance and rail resistance of such track section, the resistance of the conductors connecting the battery TB and relay TR to the rails of the track section, and the voltage of track battery TB. While the selection of the resistive windings R1, R2 and R3 is purely a question of engineering technique, the resistance values of such windings may be obtained from the following equation wherein (referring to FIG. 1 of the drawings):

E=electromotive force supplied by battery TB, in volts.

I=the current through relay TR in the direction from the positive terminal (+) to the negative terminal (—) of the relay, in amperes.

R=resistance of the winding or windings of relay TR, in ohms.

R1=resistance of resistive winding R1, in ohms.

R2=resistance of resistive winding R2 in ohms.

R3=resistance of resistive winding R3, in ohms.

S=the sum of the resistance of the conductors connecting battery TB and relay TR to the track rails, the resistance of the rails of the track section and the resist-

ance of a train shunt across the rails of the track section, in ohms. (For purposes of simplification the track ballast is assumed to be dry and, therefore, has an infinite resistance and need not be considered in calculating S).

$$I = \frac{E \left(R_2 - \frac{R_1 R_3}{S} \right)}{\left(1 + \frac{R_1}{S} \right) (R_2 R_3 + R R_2 + R R_3) + R_1 (R_2 + R_3)}$$

For proper operation of the apparatus the following two conditions must be met:

(1) When no train shunt is present in track section T ($S = \infty$) and with minimum battery voltage ($E_{\min}$) available, relay TR must receive working current (I_w).

(2) With a train shunt present in track section T and with maximum battery voltage ($E_{\max}$) available, relay TR must receive at most minimum release current (I_{mr}).

From (1) above:

$$\begin{aligned} I_w &= \frac{E_{\min} R_2}{R_2 R_3 + R R_2 + R R_3 + R_1 (R_2 + R_3)} \\ &= \frac{E_{\min} R_2}{(R_2 + R_3) (R_1 + R) + R_2 R_3} \\ &= \frac{E_{\min}}{\left(1 + \frac{R_3}{R_2} \right) (R_1 + R) + R_3} \end{aligned}$$

From (2) above:

$$I_{mr} = \frac{E_{\max} \left(R_2 - \frac{R_1 R_3}{S} \right)}{\left(1 + \frac{R_1}{S} \right) (R_2 R_3 + R R_2 + R R_3) + R_1 (R_2 + R_3)}$$

In a given application, that is, for a known battery and relay, the quantities $E_{\min}$, $E_{\max}$, I_w , I_{mr} and R will be known. There then remain the quantities R_1 , R_2 , R_3 and S as unknowns. Two of these may be given arbitrary values, and the remaining two may be determined by the two preceding equations.

In a preferred adaptation of the apparatus of my invention the resistances of the windings of resistors R_1 , R_2 and R_3 may be, but need not necessarily be, of equal value. In such a case the two preceding equations may be reduced to:

$$\begin{aligned} I_w &= \frac{E_{\min}}{3R_1 + 2R} \\ I_{mr} &= \frac{\left(1 - \frac{R_1}{S} \right) E_{\max}}{\left(1 + \frac{R_1}{S} \right) (R_1 + 2R) + 2R_1} \end{aligned}$$

Assuming that track battery TB consists of 1 cell of lead storage battery ($E_{\max} = 2.3$ volts and the battery is maintained to have $E_{\min} = 2$ volts), and that relay TR has a winding resistance of 0.5 ohm, I_w of the relay $= 0.320$ ampere and I_r of the relay $= 0.217$ ampere; then from the above equations:

$$\begin{aligned} 0.320 &= \frac{2}{3R_1 + 1} \\ 0.217 &= \frac{\left(1 - \frac{R_1}{S} \right) 2.3}{\left(1 + \frac{R_1}{S} \right) (R_1 + 1) + 2R_1} \end{aligned}$$

Solving these two equations for R_1 and S :

$R_1 = 1.75$ ohms and $S = 5.37$ ohms.

If then windings R_1 , R_2 and R_3 each have a resistance of 1.75 ohms, relay TR will release when the value of S is 5.37 ohms or less. It will be assumed that track section T is a 5,000-foot track section having infinite ballast resistance and a rail resistance of 0.03 ohm per 1000 feet of track, and that the conductors connecting track battery TB and relay TR to rails of the track sec-

tion have a total resistance of 0.15 ohm. Under these conditions it will be apparent that a train shunt having a resistance of 5.07 ohms (5.37 ohms minus 0.3 ohm) or less will cause track relay TR to release. A train shunt having a resistance of 1.45 ohms (1.75 ohms minus 0.3 ohm) or less will cause a reversal of current through the winding or windings of relay TR. It should be pointed out that in calculating the operation of a track circuit the resistance of a typical train shunt is usually considered to be 0.06 ohm.

Referring further to FIG. 1 of the drawings, the apparatus therein shown operates, in general terms, as described below.

When track section T is unoccupied, energy from the positive terminal of battery TB flows through resistor R_1 to the positive terminal of relay TR and through the control windings of the relay to the negative terminal thereof. Energy from the positive terminal of battery TB also flows through resistor R_2 to the negative terminal of relay TR. From the negative terminal of relay TR the energy flows through resistor R_3 to the negative terminal of battery TB. Relay TR is thus normally energized or picked up when track section T is unoccupied.

When track section T becomes shunted by the wheels and axle or axles of a train entering the track section and such shunt is of sufficiently low resistance, energy from the positive terminal of battery TB flows through resistor R_2 , through the control windings of relay TR in a direction from the negative terminal of the relay to its positive terminal, rail 1a, through the wheels and axles of the train to rail 1b and thence to the negative terminal of battery TB. Thus relay TR is actuated to its released position by the reversal of the direction of the direct current energy through its control windings.

Having thus described the operation of the basic form of apparatus embodying my invention, I will describe the apparatus of the modifications shown in FIGS. 2, 3, and 4.

In FIG. 2 there is shown a coding relay CTR commonly termed a code transmitter or code generator relay, contacts a and b of which are employed in the connections from the poles or terminals of battery TB to intermittently pole-change, at the code rate of relay CTR, the energy from the battery to relay TR and rails 1a and 1b of track section T. The control winding of relay CTR is connected across the terminals B and N of the energy source at the track relay location and contacts a and b of relay CTR are constantly alternatively opening and closing their front and back contact points at the selected coding rate of relay CTR. Code transmitter relays such as relay CTR are well known in the art.

A slow pickup repeater relay TPR is employed to repeat the action of front contact a of relay TR, relay TPR being controlled over an obvious circuit including said front contact a of relay TR. A contact a of relay TPR is used in the control circuits for the control or indication apparatus in place of contact a of relay TR in FIG. 1.

A half-wave rectifier RE is connected across rails 1a and 1b of track section T, at the end thereof opposite the connections of relay TR to such rails, with the low resistance direction of the rectifier being from rail 1b towards rail 1a. When relay CTR closes the front points of its contacts a and b , as shown in FIG. 2 of the drawings, energy from battery TB flows from the positive pole or terminal thereof over the front point of contact a of relay CTR through resistor R_1 and the control windings of relay TR, and also through resistor R_2 as previously described for FIG. 1, and from the negative terminal of relay TR through resistor R_3 and over the front point of contact b of relay CTR to the negative pole or terminal of battery TB. Energy is prevented from flowing over the rails of track section T at this time by rectifier RE. When relay CTR pole-changes the connections to battery TB, energy from the positive terminal of that battery flows over the back point of contact b of relay CTR,

5

rail 1b rectifier RE in its low resistance direction, rail 1a, through the winding of relay TR and resistor R2, and also through resistor R1, and over the back point of contact a of relay CTR to the negative terminal of battery TB. Thus relay TR is maintained energized or picked up when contacts a and b of relay CTR are in either of their two possible positions, and track section T is not occupied by a train.

When a train enters track section T, the wheels and axle or axles of the train shunt rails 1a and 1b. During the periods when relay CTR has its front contact points closed, energy from battery TB flows from the positive pole or terminal TB over the front point of contact a, resistor R2, the negative terminal of relay TR and through the control windings of that relay to the positive terminal thereof, rail 1a through the wheels and axles of the train, rail 1b and thence over the front point of contact b of relay CTR to the negative terminal or pole of battery TB. Relay TR is, therefore, actuated to its release position when relay CTR has its front contact points closed and track section T is occupied by a train. When relay CTR closes the back points of its contacts a and b, energy from battery TB flows over the back point of contact b of relay CTR, rail 1b, the wheels and axles of the train, rail 1a, through the winding of relay TR from the positive terminal to the negative terminal thereof, resistor R2, and over the back point of contact a of relay CTR to the negative terminal of battery TB. Relay TR thus becomes picked up at this time. It is apparent that relay TR follows the code generating action of relay CTR when track section T is occupied by a train.

When front contact a of relay TR opens during the above discussed code following operation of that relay, slow pickup relay TPR releases and remains released during such code following operation of relay TR. Contact a of relay TPR actuates the control or indication apparatus as is obvious. It should be pointed out that the pickup delay time of relay TPR must be sufficiently long that the relay will not become picked up during the periods of the code following operation of relay TR that relay TR has its front contact a closed.

Referring to FIG. 3 of the drawings, the organization of the apparatus is identical to that of FIG. 2 except that the winding of an additional relay TRA is substituted for resistor R3 in the circuit from the negative terminal of relay TR. Relay TRA is a code following relay and may be of the type commonly known as a magnetic stick relay. For the purposes of this description relay TRA may be considered but need not necessarily be similar to the relay shown and described in Letters Patent of the United States No. 2,695,346 issued November 23, 1954, to William A. Robison for Electric Relay and assigned to the assignee of the present application.

Magnetic stick relays, such as relay TRA, have an armature and contacts controlled thereby which are actuated to first and second positions according to the polarity of the energy supplied across the control windings of each respective relay. When the control windings of such a relay are deenergized the contacts of the relay remain in the position to which they were last actuated by the polarity of the energy supplied across the control windings of the relay. As shown in FIG. 3, relay TRA has a movable contact point 6 which is actuated to closed positions against fixed contact points 7 or 8 according to the polarity of the energy supplied to the control windings of the relay.

A capacitor CAP and a resistor R4 are employed in the embodiment of apparatus shown in FIG. 3 in the well known capacitor code detection scheme. While I have shown the apparatus as employing the capacitor code detection scheme, it is to be understood that any of the other well known code detection systems may be used in place of the capacitor code detection system.

A slow release repeater relay TPRA is used in the capacitor code detection system in the usual manner and is provided with a pickup circuit which extends from the left

6

hand terminal of capacitor CAP, resistor R4, employed for the protection of arcing on contact 6 of relay TRA, movable contact 6 of relay TRA, fixed contact point 8 of relay TRA, and through the winding of relay TPRA to terminal N of the energy source. Capacitor CAP is provided with a charging circuit which extends from battery terminal B over contact 6 closed in the right hand position thereof against fixed contact point 7, resistor R4, the left hand terminal of capacitor CAP and through the capacitor to battery terminal N. Thus capacitor CAP is charged whenever contact 6 of relay TRA is closed against fixed contact point 7 and is discharged through the winding of relay TPRA whenever contact 6 closes against fixed contact point 8 of relay TRA in the code following operation of the relay to be hereinafter described. Relay TPRA is made sufficiently slow to release that it will bridge the open contact time of contact 6 of relay TRA in the code following operation of relay TRA.

Relay TPR in FIG. 3 is a slow pickup relay similar to relay TPR in FIG. 2 and is provided with a control circuit which extends from terminal B of the source of energy over front contact a of relay TPRA, front contact a of relay TR and through the winding of relay TPR to battery terminal N. Contact a of relay TPR controls the control or indication apparatus in a manner similar to that discussed for FIG. 2.

In the organization of apparatus shown in FIG. 3, relay TR operates in a manner identical to that described for relay TR in FIG. 2, that is, when track section T is unoccupied relay TR is maintained picked up and when track section T becomes occupied relay TR follows the coding operation of relay CTR thereby releasing slow pickup relay TPR. The purpose for employing relay TRA is to provide protection if relay CTR becomes stalled and therefore ceases to generate code, or in the event of a broken rail in track section T. Such protection is not always provided in the apparatus of FIG. 2. For example, referring again to FIG. 2, if relay CTR stalls and keeps its front contact points steadily closed, relay TR will become released, as it did previously, when a train enters track section T. However, a broken rail in track section T would not be detected if relay CTR stalls with its front contact points closed, since the apparatus is then operating identically to that described for FIG. 1. Further, if relay CTR in FIG. 2 stalls with its back contact points steadily closed relay TR will not release upon a train entering track section T since the train shunt at that time has the same effect as rectifier RE, that is, shunts the rails of track section T. A broken rail in track section T will be detected, however, if relay CTR stalls with its back contact points closed, since a broken rail will, at that time, interrupt the flow of energy to relay TR in the direction from the positive terminal to the negative terminal of relay TR.

Returning to FIG. 3, when track section T is unoccupied by a train, relay TRA follows the coding action of relay CTR. That is, when relay CTR closes the front points of its contacts a and b as shown in the drawing, energy from the positive terminal of battery TB flows over the front point of contact a of relay CTR and over the circuits previously discussed to the right hand terminal of relay TRA, and through the windings of relay TRA and over the front point of contact b of relay CTR to the negative terminal of battery TB. Relay TRA is actuated by this polarity of current to close contact 6 against fixed contact point 7. When relay CTR closes the back points of its contacts a and b in its coding operation, energy from the positive terminal of battery TB flows over the back point of contact b of relay CTR, the left hand terminal of relay TRA, through the control windings of relay TRA to the right hand terminal of that relay, resistor R2 and over the back point of contact a of relay CTR to the negative terminal of battery TB. Relay TRA is thus actuated at this time to close contact 6 against fixed contact point 8.

The code following operation of relay TRA, as de-

scribed above, energizes relay TPRA which in conjunction with front contact *a* of relay TR energizes relay TPR. If code generator relay CTR stalls, the energy supplied across the control windings of relay TRA becomes steady in one direction or the other depending on whether relay CTR stalled with its front contact or its back contact points closed. Thus relay TRA will cease its code following action and relay TPRA will become released to open the control circuit for relay TPR, which in turn releases and actuates the control or indication apparatus. It is, therefore, apparent that the organization of apparatus of FIG. 3 provides the same protection as that of FIG. 2 and also the additional protection against the stalling of code transmitter relay CTR.

FIG. 4 of the drawings shows another modification of the apparatus of my invention. In this modification magnetic stick relay TRA replaces the relay TR of FIG. 3 and code transmitter relay CTR is employed at the other end of the track section to intermittently shunt the rails of the track section at that end. Battery TB is steadily connected across the winding of relay TRA in a manner identical to that in which such battery is connected across the winding of relay TR in FIG. 1. Contact 6 of relay TRA is employed in a capacitor code detection scheme as in FIG. 3, and contact *a* of relay TPRA alone actuates the control or indication apparatus.

The control winding of relay CTR is connected across the terminals B1 and N1 of the source of energy at the end of track section T opposite from the track relay end of such section, and contact *a* of relay CTR is intermittently shunting the rails of track section T at such opposite end of the track section at the selected code rate of relay CTR. When contact *a* of relay CTR is open, as shown in the drawings, energy from the positive terminal of battery TB flows through resistor R1 and the winding of relay TRA, as well as through resistor R2, and through resistor R3 to the negative terminal of battery TB. Relay TRA is thereby actuated to cause the relay contact 6 to close against fixed contact point 7. Capacitor CAP is charged at this time as in FIG. 3. When contact *a* of relay CTR closes, energy from the positive terminal of battery TB flows through resistor R2 and through the winding of relay TRA in the opposite direction to that described above, over rail 1*a*, contact *a* of relay CTR, rail 1*b* and thence to the negative terminal of battery TB. Relay TRA is actuated at this time to cause contact 6 of that relay to close against fixed contact point 8. The charge in capacitor CAP discharges through the winding of relay TPRA at this time and relay TPRA is thus maintained picked up by the code following operation of relay TRA.

It is apparent that when a train enters track section T and shunts the rails thereof the code following operation of relay TRA ceases and relay TPRA subsequently releases to actuate the control or indication apparatus. If relay CTR stalls with its contact *a* either open or closed, or if a broken rail should occur in track section T, relay TRA will cease its code following operation and relay TPRA will be released in the same manner as if a train entered track section T.

While the apparatus of FIG. 4 is shown as employing a code following relay of the magnetic stick type, it will be understood that any type of code following relay can be employed for relay TRA and the apparatus will operate in the manner described.

While I have shown and described only four forms of apparatus embodying my invention, it should be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. A track circuit for a section of railway track comprising, in combination, first, second and third resistive windings connected in that order in series with each

other across the rails of said track section; a source of direct current energy having one of its poles connected to the connections between said first and second resistive windings and the other of its poles connected to the connection from the third resistive winding to one of the rails of said track section at a first end thereof, a magnetically biased relay having its positive terminal connected to the connection from the first resistive winding to the other of the rails of the track section at said first end thereof and its negative terminal connected to the connection between said second and third resistive windings, a coding relay, means controlled by said coding relay for intermittently pole changing the connections to the poles of said energy source, a half-wave rectifier connected across the rails of said track section at the end thereof opposite said first end in such manner that the low resistance direction of the rectifier is from said one rail to said other rail, a slow acting relay, an energizing circuit for said slow acting relay including a front contact of said biased relay, and indication circuits controlled by a contact of said slow acting relay.

2. A track circuit for a section of railway track comprising, in combination; first, second and third resistive windings connected in that order in series with each other across the rails of said track section; a source of direct current energy having one of its poles connected to the connections between said first and second resistive windings and the other of its poles connected to the connection from the third resistive winding to one of the rails of said track section at one end thereof, a magnetically biased relay having its positive terminal connected to the connection from the first resistive winding to the other of the rails of the track section at said one end thereof and its negative terminal connected to the connection between said second and third resistive windings, a coding relay, means controlled by said coding relay for intermittently pole changing the connections to the poles of said energy source, a half-wave rectifier connected with its low resistance direction from said one rail to said other rail at the end of the track section opposite said one end, and indication means controlled by a contact of said biased relay.

3. A track circuit for a section of railway track comprising, in combination; first, second and third resistive windings; a source of direct current energy, a biased relay, a first circuit connecting the positive terminal of said relay to a first end of said first winding and to one of the rails of said track section at one end thereof, a second circuit connecting one of the poles of said energy source to a first end of said third winding and to the other of the rails of said track section at said one end thereof, a third circuit connecting the negative terminal of said relay to the first end of said second winding and the second end of said third winding, a fourth circuit connecting the other of the poles of said energy source to the second ends of said first and second windings, a half-wave rectifier connected across the rails of said track section at the end thereof opposite said one end and with the low resistance direction of the rectifier being from said other rail towards said one rail, a coding relay, means controlled by said coding relay for intermittently pole changing the connections to the poles of said energy source, a slow acting relay, an energizing circuit for said slow acting relay including a front contact of said biased relay, and indication circuits controlled by a contact of said slow acting relay.

4. A track circuit for a section of railway track comprising, in combination; first, second and third resistive windings; a source of direct current energy, a magnetically biased relay, a first circuit connecting the positive terminal of said relay to a first end of said first winding and to one of the rails of said track section at a first end thereof, a second circuit connecting one of the poles of said energy source to a first end of said third winding and to the other of the rails of said track section

at said first end thereof, a third circuit connecting the negative terminal of said relay to the first end of said second winding and the second end of said third winding, a fourth circuit connecting the other of the poles of said energy source to the second ends of said first and second windings, a half-wave rectifier connected across the rails of said track section at the end thereof opposite said first end and with the low resistance direction of the rectifier being from said other rail towards said one rail, a coding relay, means controlled by said coding relay for intermittently pole changing the connections to the poles of said energy source, and indication means controlled by a contact of said biased relay.

5. A track circuit for a section of railway track comprising, in combination; first, second and third resistive windings connected in that order in series with each other across the rails of said track section at a first end thereof, said third winding being the control winding of a magnetic stick relay; a source of direct current energy having one of its poles connected to the connection between said first and second resistive windings and the other of its poles connected to the connection from the third resistive winding to one of the rails of said track section, a biased relay having its positive terminal connected to the connection from the first resistive winding to the other of the rails of the track section and its negative terminal connected to the connection between said second and third resistive windings, a coding relay, means controlled by said coding relay for periodically pole changing the connections to the poles of said energy source at the code rate of said coding relay, a half-wave rectifier connected across the rails of said track section at the end thereof opposite said first end with the low resistance direction of the rectifier being from said one rail towards said other rail, a slow release decoding relay, decoding means including a contact of said magnetic stick relay for periodically energizing said decoding relay, a slow pickup relay, a control circuit comprising front contacts of said decoding relay and said biased relay for energizing said slow pickup relay, and indication circuits controlled by a contact of said slow pickup relay.

6. A track circuit for a section of railway track comprising, in combination; first, second and third resistive windings, said third winding being the control winding of a magnetic stick relay; a source of direct current energy, a magnetically biased relay, a first circuit connecting the positive terminal of said biased relay to a first end of said first winding and to one of the rails of said track section at a first end thereof, a second circuit connecting one of the poles of said energy source to a first end of said third winding and to the other of the rails of said track section at said first end thereof, a third circuit connecting the negative terminal of said biased relay to the first end of said second winding and the second end of said third winding, a fourth circuit connecting the other of the poles of said energy source to the second ends of said first and second windings, a coding relay, means controlled by said coding relay for periodically pole changing the connections to the poles of said energy source, a half-wave rectifier connected with its high resist-

ance direction from said one rail to said other rail of the track section at the end thereof opposite said first end, a slow release decoding relay, indication apparatus decoding means controlled by a contact of said magnetic stick relay for energizing said decoding relay, means controlled by front contacts of said decoding relay and said biased relay for controlling said indication apparatus.

7. A track circuit for a section of railway track comprising, in combination; first, second and third resistive windings connected in that order in series with each other across the rails of said track section at one end thereof, a source of direct current energy having one of its poles connected to the connections between said first and second resistive windings and the other of its poles connected to the connection from the third resistive windings to one of the rails of said track section at said one end thereof, a first relay having its positive terminal connected to the connection from the first resistive winding to the other of the rails of the track section at said one end thereof and its negative terminal connected to the connection between said second and third resistive windings, a coding relay, a circuit including a contact of said coding relay connected across the rails of said track section at the end thereof opposite said one end, and code detection means controlled by a contact of said first relay.

8. A track circuit for a section of railway track comprising, in combination; first, second and third resistive windings; a source of direct current energy, a code following relay, a first circuit connecting the positive terminal of said relay to a first end of said first winding and to one of the rails of said track section at a first end thereof, a second circuit connecting one of the poles of said energy source to a first end of said third winding and to the other of the rails of said track section at said first end thereof, a third circuit connecting the negative terminal of said relay to the first end of said second winding and the second end of said third winding, a fourth circuit connecting the other of the poles of said energy source to the second ends of said first and second windings, a code generating relay, means controlled by a contact of said code generating relay for intermittently shunting the rails of said track section at the second end thereof, code detection apparatus, and means controlled by a contact of said code following relay for actuating said code detection apparatus.

References Cited by the Examiner

UNITED STATES PATENTS

1,790,526	1/31	Young	-----	246—41
1,914,958	6/33	O'Hagan.		
2,095,684	10/37	Witmer et al.	-----	246—34
2,654,081	9/53	Staples.		

FOREIGN PATENTS

25,340	19/07	Great Britain.
487,276	6/29	Germany.

ARTHUR L. LA POINT, *Primary Examiner*.

JAMES S. SHANK, *Examiner*.