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RAILWAY SIGNALING APPARATUS

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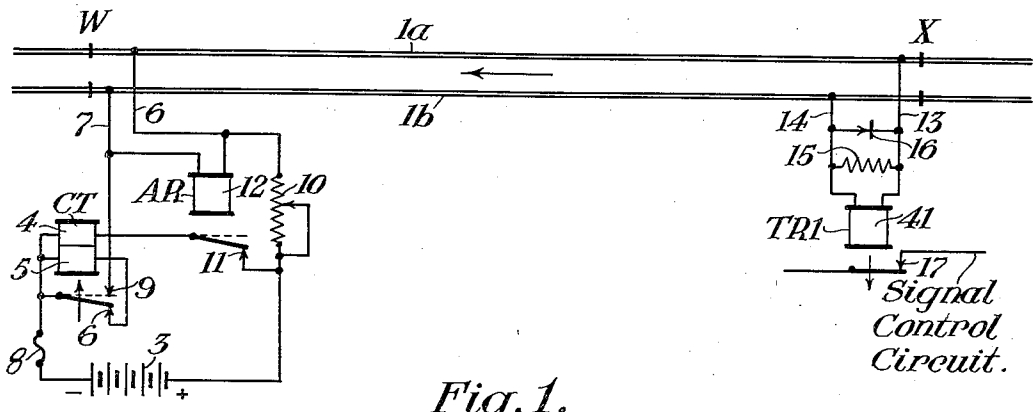

Fig. 1.

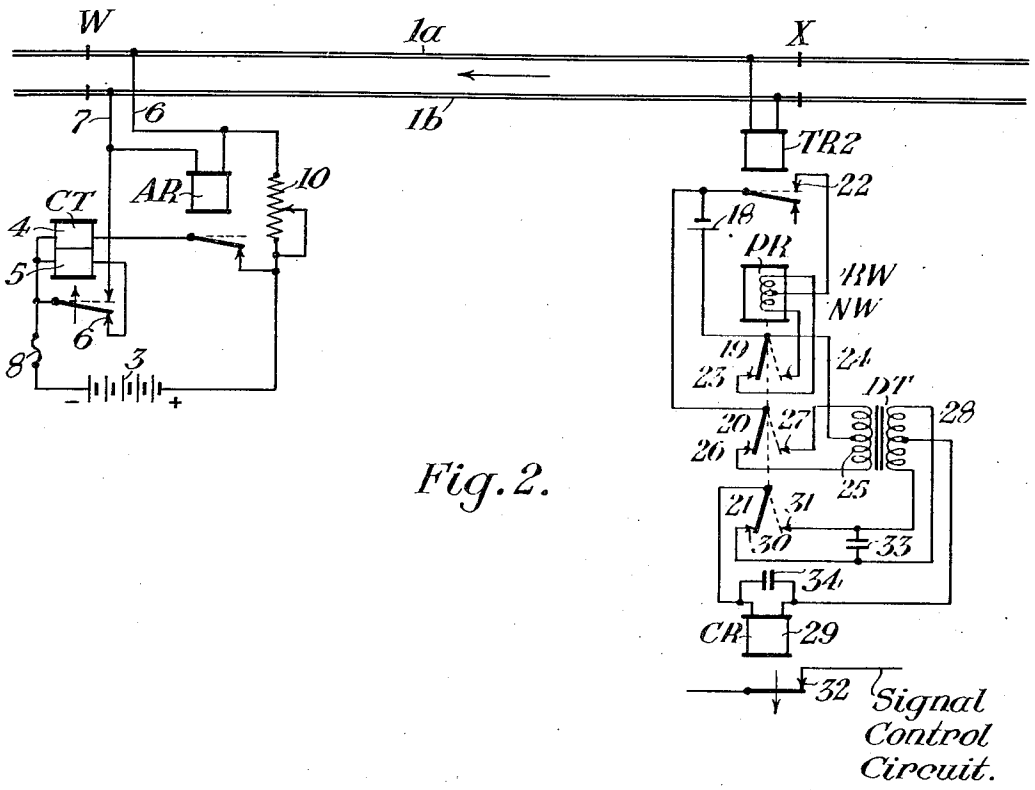

Fig. 2.

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RAILWAY SIGNALING APPARATUS

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11 Claims. (Cl. 246—34)

My invention relates to railway signaling apparatus, and more particularly to apparatus for railway track circuits.

A feature of my invention is the provision of novel and improved apparatus for supplying a track circuit with periodically interrupted or time spaced current impulses of relatively high voltage and short duration, and the duration of which is varied according to dry and wet ballast conditions so that a substantially uniform energization of the track relay is effected over a relatively wide range of ballast resistance. The high voltage of the current impulses is of aid to the shunting sensitivity of the track circuit because such voltage breaks down the rail film resistance. The short duration of such current impulses requires only a low energy output of the track battery or other current source. Another feature of my invention is the provision of novel and improved track relay means for a track circuit which is responsive to time spaced current impulses notwithstanding such impulses are badly distorted in wave form and which means also makes it possible to maintain a signal control relay energized from a low voltage source of control current. Other features and advantages of my invention will appear as the specification progresses.

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

In the accompanying drawings, Figs. 1 and 2 are diagrammatic views of two different forms of apparatus each of which embodies my invention. In each of the two views like reference characters designate similar parts.

Referring to Fig. 1, the reference characters *1a* and *1b* designate the track rails of a stretch of railway over which traffic normally moves in the direction indicated by an arrow and which rails are formed by the usual insulated rail joints with a track section W—X. The track section W—X is provided with a track circuit for signaling. This track circuit for section W—X comprises transmitting or coding means for supplying across the rails *1a* and *1b* at the exit end of the section periodically interrupted or time spaced current impulses, and a track relay connected across the rails at the entrance end of the section. The means for supplying time spaced current impulses may take different forms and as here shown it includes a track battery 3, a transmitting relay or coder CT, an auxiliary relay AR, a current limiting resistor 10, a protective device 8 and two track conductors 6 and 7 connected to the rails *1a* and *1b*, respectively. The track battery 3 preferably consists of several cells connected in series to produce a relatively high voltage, such as, for example, a ten volt storage battery.

The transmitting relay or coder CT is preferably of the neutral relay type having slow pick-up characteristics. In the form here shown the transmitting relay CT is provided with a top or operating winding 4 and a lower or retarding winding 5, the winding 5 being short circuited over a back contact 6 of the relay so that the relay is slow to pick up when the operating winding 4 is energized. The auxiliary relay AR is preferably a quick acting neutral relay.

The track battery 3 is connected across the rails *1a* and *1b* over the two conductors 6 and 7 and preferably in a manner so as to supply the track circuit with current of a predetermined polarity. To be explicit, the negative terminal of battery 3 is connected with conductor 7 over a protective device or fuse 8 and a front contact 9 of the transmitting relay CT, and the positive terminal of battery 3 is connected with conductor 6 over a current limiting resistor 10. The operating winding 4 of relay CT is connected across battery 3 over the back contact 11 of the auxiliary relay AR as will be readily understood by an inspection of Fig. 1. The winding 12 of the auxiliary relay AR is connected across the track rails by being connected directly with the conductors 6 and 7 which conductors possess an appreciable amount of ohmic resistance. It follows that when the front contact 9 of relay CT is closed and current is supplied from track battery 3 to the track circuit over conductors 6 and 7 the winding 12 of relay AR receives current in shunt with the track circuit. With relay AR energized and picked up opening back contact 11 the current to the operating winding 4 of relay CT is interrupted and relay CT is deenergized and immediately releases opening front contact 9 and removing current from the track circuit and also from the winding 12 of relay AR. Relay AR is now deenergized and releases closing back contact 11 to reenergize the operating winding 4 of the transmitting relay CT. It is apparent that relays CT and AR will have a cyclic operation, the cycle interval being determined largely by the slow pick-up period provided for the relay CT and relay CT being retained picked up a relatively short period of each cycle interval because of the relatively quick pick-up period of relay AR.

It is to be noted that the ballast resistance path between the track rails *1a* and *1b* forms a shunt path to the winding 12 of relay AR. Hence under dry ballast conditions and the rail to rail

ballast path of relatively high resistance so that the leakage current is low, the voltage drop at resistor 10 is low and substantially the full voltage of battery 3 is applied to winding 12 of relay AR and relay AR picks up correspondingly quick. Under wet ballast conditions and the rail to rail resistance path of relatively low resistance the increased flow of leakage current causes a relatively large voltage drop at resistor 10 and the voltage applied to the operating winding 12 of relay AR is correspondingly low, causing that relay to pick up correspondingly slow. Consequently, under dry ballast conditions the period the transmitting relay CT remains picked up is correspondingly short due to relay AR picking up quickly so that the duration of the current impulse supplied to the track circuit over front contact 9 of transmitting relay CT is correspondingly short. Under wet ballast conditions the period the transmitting relay CT remains picked up is correspondingly long due to relay AR picking up slowly so that the duration of the current impulse supplied to the track circuits is correspondingly long.

It is to be seen, therefore, that time spaced impulses of direct current of a predetermined polarity are supplied to the track circuit of section W—X, the impulses being of relatively high voltage and of short duration, the duration of the impulses being short compared with the interval between successive impulses and the duration of the impulses being automatically varied according to the ballast conditions.

It should be observed that contact 9 of the transmitting relay CT is preferably of the so-called safety type, that is, a contact adaptable of breaking a high voltage. It should also be observed that in the event of a circuit cross or ground and the transmitting relay CT fails in its operation with front contact 9 closed so that the magnitude of the current supplied from battery 3 is large, the fuse 8 would shortly melt and open this circuit removing all current from the track rails.

The track relay for the track circuit of section W—X is a direct current relay TR1, the operating winding 41 of which is connected across the rails 1*a* and 1*b* over conductors 13 and 14, respectively. A resistor 15 and a rectifier 16 are connected in multiple across the operating winding 41 of relay TR1 to give the relay quick pick-up and slow release characteristics.

When the section W—X is unoccupied, the short high voltage current impulses applied across the rails effectively energize and pick up the track relay TR1, the relay TR1 remaining picked up from one impulse to the next due to its slow release characteristic. The total energy available for energizing the relay TR1 is substantially uniform under both dry and wet ballast conditions since under dry ballast conditions the voltage of the impulses will be correspondingly high and the duration of each impulse will be correspondingly short, and under wet ballast conditions the voltage of the impulses will be correspondingly low and the duration of the impulses will be correspondingly long because of the action of the auxiliary relay AR as explained hereinbefore.

It is to be noted that since the track relay TR1 is slow releasing in character and is energized and retained picked up from one current impulse to the next the wave form of the individual impulses may be badly distorted because of track circuit conditions without causing an unfavorable operation of relay TR1.

When the track section W—X is occupied relays AR and CT are periodically operated, such operation being aided by the resistance possessed by conductors 6 and 7, and the relatively high voltage of the current impulses breaks down the rail film resistance and track relay TR1 is shunted, the track circuit for section W—X having a relatively high shunting sensitivity.

The track relay TR1 is used to control any desired signal control circuit of the usual form and as here shown the signal control circuit includes front contact 17 of relay TR1.

In Fig. 2, the track rails 1*a* and 1*b* of a stretch of railway are formed with a track section W—X having a track circuit the same as in Fig. 1. The means for supplying time spaced current impulses of relatively high voltage and short duration to the track circuit of section W—X of Fig. 2 is the same as in Fig. 1.

In Fig. 2, the track relay means includes a code following relay TR2 connected across the rails at the entrance end of the section W—X. Hence, when section W—X is unoccupied the track relay TR2 is effectively energized and picked up closing front contact 22 during the "on" period of each current impulse supplied to the track circuit of section W—X, and relay TR2 is deenergized and released during the "off" period of each current impulse, that is, during the interval between successive impulses. Since the duration of the current impulses is short compared with the duration between successive impulses the "on" period of the relay TR2 is short compared with the "off" period of the relay. The energy available, however, for picking up the track relay TR2 in response to each current impulse is substantially uniform over a relatively wide range of ballast resistance due to the operation of the auxiliary relay AR causing the individual impulses to be correspondingly short under dry ballast conditions and correspondingly long under wet ballast conditions. Such unequal and varied "on" and "off" periods in the operation of relay TR2 is immaterial to the operation of the apparatus governed by the relay TR2 as will shortly appear. When the track section W—X is occupied the track relay TR2 is shunted and is inactive, the track circuit for section W—X having a relatively high degree of shunting sensitivity due to the relatively high voltage of the current impulses.

The track relay means of Fig. 2 also includes a polar relay PR, a decoding transformer DT, a control relay CR and a low voltage control battery 18.

The polar relay PR is provided with a normal winding NW and a reverse winding RW, the arrangement being such that when normal winding NW is energized over a circuit to be shortly described the polar contact members 19, 20 and 21 of relay PR are operated to the normal or left-hand position as viewed in Fig. 2. When the reverse winding RW is energized by a circuit to be shortly described the polar contact members 19, 20 and 21 are operated to the reverse or right-hand position. Furthermore, the polar relay PR is characterized by the polar armature completing its stroke if energy is applied to either winding for a long enough interval to operate the polar armature away from its last position. In other words, when an impulse of current is supplied to winding NW or RW for an interval long enough to move the polar armature

of the relay from its last position, the polar armature moves to its other extreme position although the energizing current ceases.

A relay which may be made to operate in a manner just described is disclosed in the Letters Patent of the United States No. 1,790,671, granted February 3, 1931, to Branko Lazich for Electrical relays. In the instant application the polar relay PR is provided with two windings disposed for reversibly energizing the relay whereas in the patent the relay is shown provided with a single winding to which current is reversibly supplied, such equivalent arrangements of the windings of a polar relay being readily understood by those skilled in the art.

When relay TR2 is picked up closing front contact 22 current flows from battery 18 over front contact 22 of relay TR2, reverse winding RW of relay PR, normal polar contact 19—23 and back to battery 18, and relay PR is operated to move its contact members 19, 20 and 21 to the reverse or right-hand position. On the next current impulse of the track circuit and track relay TR2 is again picked up closing front contact 22, current flows from battery 18 over front contact 22, normal winding NW of relay PR, reverse polar contact 19—24 of relay PR and back to battery 18, and relay PR operates its contact members 19, 20 and 21 to the normal or left-hand position. It follows that the polar relay PR is operated to its reverse position in response to each odd impulse of the track circuit current and is operated to the normal position in response to each even impulse of the track circuit current. Furthermore, because of the operating characteristics of relay PR it is clear that the relay will be operated notwithstanding the "on" and "off" periods of the operation of the code following relay TR2 are unequal and are varied.

With polar relay PR thus operated current from battery 18 is alternately supplied over normal polar contact 20—26 and reverse polar contact 20—27 to the two portions of the primary winding 25 of transformer DT. Such alternate energization of the two portions of primary winding 25 induces an alternating electromotive force in the two portions of the secondary winding 28 of transformer DT and which electromotive force is rectified and applied to the winding 29 of control relay CR over normal polar contact 21—30 and reverse polar contact 21—31 with the result that rectified current flows in the winding 29 always in the same direction and relay CR is effectively energized and picked up closing front contact 32 interposed in a signal control circuit. Relay CR remains picked up closing front contact 32 as long as relay PR is operated since relay CR is provided with slow release characteristics. The ratio of the turns of the primary winding 25 to the turns of the secondary winding 28 of transformer DT is chosen so that relay CR is effectively energized from battery 18 when battery 18 is a single cell low voltage battery. The condensers 33 and 34 may be provided and connected as shown in Fig. 2 to suppress sparking at the contacts of the polar relay PR.

It is to be seen, therefore, that the signal control circuit including front contact 32 of relay CR is effectively governed from a low voltage control battery and in response to track circuit current impulses which are of relatively short duration compared with the duration between successive impulses, and which durations are varied in response to changes in ballast conditions, and notwithstanding the wave form of the current impulses may be badly distorted.

It should be observed that the windings NW and RW may be connected directly with the track rails of section W—X and the polar relay PR operated directly by the track circuit current impulses.

Although in both Figs. 1 and 2 the source of supply for the track circuit is shown as a battery 3 of the voltage of the order of 10 volts, it is to be understood that my invention is not limited to a battery of such voltage and connected with the polarity as shown in the drawing. Also an alternating current source may be used on the track circuit and relays CT and AR made alternating current relays of any of the several well-known types.

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 track section, a source of direct current, transmitting means operative to connect said source across the rails at one end of the section for supplying to said rails time spaced impulses of current, means connected across the rails at said one end of the section variably affected by wet and dry ballast conditions of the section to control the duration of each of said impulses of current, and a track relay connected across the rails at the other end of the section effectively energized by said impulses of current.

2. In combination, a track section, a source of direct current, transmitting means for periodically connecting said source across the rails at one end of said section to supply recurrent impulses of direct current to said rails, means connected with the rails responsive to changes in ballast conditions of said section to vary the duration of each of such current impulses to cause such impulses to be relatively short under dry ballast conditions and relatively long under wet ballast conditions, and a track relay connected across the rails at the other end of said section energized by said current impulses at substantially the same energy level for both dry and wet ballast conditions.

3. In combination, a track section, a source of direct current, a transmitting relay effective when energized to supply current from said source to the rails at one end of said section, an auxiliary relay connected across the rails at said one end of the section energized by said current supplied to the rails for picking up said auxiliary relay in an interval which is varied due to variations in the shunting action of dry and wet ballast conditions of the section, means including a back contact of said auxiliary relay to energize said transmitting relay to cause the current supplied to the rails to be relatively short current impulses under dry ballast conditions and relatively long current impulses under wet ballast conditions, and a track relay connected across the rails at the other end of said section energized by said current impulses at an energy level substantially the same for both dry and wet ballast conditions.

4. In combination, a track section, two conductors connected one with each rail at one end

of the section, a track battery, a transmitting relay, means including a front contact of said transmitting relay to connect said battery with said conductors to supply current to the rails of said section, an auxiliary relay having its winding connected with said conductors to pick up the auxiliary relay subsequent to the closing of said front contact of the transmitting relay in a time interval varied by the variations in the shunting action caused by dry and wet ballast resistances of the section, means including a back contact of said auxiliary relay to connect a winding of said transmitting relay across said battery to cause a cyclic operation of said relays with the period the transmitting relay is picked up and current supplied to the rails correspondingly short under dry ballast resistance and correspondingly long under wet ballast resistance, and a track relay connected across the rails at the other end of the section energized by current thus intermittently supplied to the rails at an energy level substantially the same for both dry and wet ballast resistances.

5. In combination, a track section, two conductors connected one with each rail at the exit end of said section, a track battery of relatively high voltage, a slow pick-up relay, an auxiliary relay, means including a front contact of said slow pick-up relay to connect said battery with said conductors to supply current to the rails of said section at a relatively high voltage, means to connect a winding of said auxiliary relay with said conductors for picking up the auxiliary relay subsequent to the closing of said front contact of the slow pick-up relay in a time interval dependent upon the shunting action of the ballast resistance of the section, means including a back contact of said auxiliary relay to connect a winding of said slow pick-up relay across said battery to provide a cyclic operation of said relays with the period the front contact of the slow pick-up relay is closed correspondingly short under dry ballast conditions and correspondingly long under wet ballast conditions, and a track relay connected across the rails at the entrance end of the section energized by the current impulses supplied to the rails when the section is unoccupied at substantially the same energy level irrespective of ballast conditions and said track relay effectively shunted when the section is occupied due to the high voltage of such current impulse breaking down the rail film resistance.

6. In combination, a track section, two conductors connected one with each rail at the exit end of said section, a track battery of the order of ten volts, a transmitting relay, an auxiliary relay, means including a front contact of said transmitting relay to connect said battery with said conductors to supply current to the rails of said section, means to connect a winding of said auxiliary relay with said conductors to pick up the auxiliary relay when said front contact of the transmitting relay is closed in a time interval varied due to the varied shunting action of the ballast resistance of the section, means including a back contact of said auxiliary relay to connect a winding of said transmitting relay across said battery to cause a cyclic operation of said relays with the period the transmitting relay is picked up each cycle and current supplied to the rails relatively short under dry ballast conditions and relatively long under wet ballast conditions, and a track relay connected across the rails at the entrance end of the section energized by said current impulses when the section is unoccupied at substantially the same energy level for both dry and wet ballast conditions and said relay shunted when the section is occupied with high sensitivity due to the ten volts of such current impulses breaking down the rail film resistance.

7. In combination, a track section, a track battery of the order of ten volts, a slow pick-up relay, a quick acting auxiliary relay, means including a back contact of said auxiliary relay to connect a winding of said slow pick-up relay across said battery to energize said slow pick-up relay, means including a front contact of said slow pick-up relay to connect a winding of said auxiliary relay across said battery to energize said auxiliary relay and cause a cyclic operation of said relays, other means including said front contact of the slow-pick-up relay to connect said battery across the rails at one end of the section to supply to the rails of said section recurrent impulses of direct current each of which has a peak voltage of the order of ten volts and a short duration due to the quick pick-up interval of said auxiliary relay, and a track relay connected across the rails at the other end of the section effectively energized by such current impulses when the section is unoccupied and effectively shunted when the section is occupied due to said peak voltage of said impulses breaking down the rail film resistance.

8. In combination, a track section, transmitting means including a source of direct current and a vibratory contact connected across the rails at one end of said section for supplying to the rails time spaced impulses of direct current, a polar relay having a normal and a reverse energizing winding and characterized by polar contact members which when moved away from one extreme position move to the other extreme position although the energizing current ceases, a first circuit including the reverse winding and a normal polar contact of said polar relay made effective to operate the polar relay in response to each odd numbered rail current impulse, a second circuit including the normal winding and a reverse polar contact of said polar relay made effective to operate the polar relay in response to each even numbered rail current impulse, whereby said polar relay is operated in step with said time spaced current impulse supplied to the rails, and a signal control circuit controlled by such operation of said polar relay.

9. In combination, a track section, transmitting means including a periodically operated contact and a source of direct current connected across the rails at one end of the section to supply to the rails time spaced impulses of direct current, a track relay connected across the rails at the other end of the section biased to one position and operated to a second position in response to each of said current impulses, another source of direct current, a polar relay having a normal and a reverse winding and characterized by polar contact members which when moved away from one extreme position move to the other extreme position although the energizing current ceases; a first circuit including said other source, a second position contact of said track relay, said reverse winding and a normal polar contact of said polar relay; a second circuit including said other source, a second position contact of said track relay, said normal winding and a reverse polar contact of the polar relay; a transformer, a signal control relay; means including said other source and a normal and a reverse polar contact of said polar relay

for alternately supplying current to two portions of the primary winding of said transformer, other means including a normal and a reverse polar contact of said polar relay to alternately connect two portions of the secondary winding of said transformer to said control relay to energize said control relay by current induced in said secondary winding, and a signal control circuit governed by said control relay.

10. In combination, a track section, transmitting means including a source of direct current and an operated contact connected across the rails at one end of said section to supply to the rails time spaced impulses of direct current, a track relay connected across the rails at the other end of said section biased to one position and operated to a second position in response to each of said current impudses, a polar relay having a normal and a reverse winding, another source of direct current; a first circuit including said other source, a second position contact of said track relay, said reverse winding and a normal polar contact of the polar relay; a second circuit including said other source, a second position contact of said track relay, said normal winding of the polar relay and a reverse polar contact of the polar relay; and a signal control circuit controlled by said polar relay.

11. In combination, a track section, a track battery of the order of ten volts, a slow pick-up relay, a quick acting relay, means including a back contact of said quick acting relay to connect a winding of said slow pick-up relay across said battery, means including a front contact of said slow pick-up relay to connect a winding of said quick acting relay across said battery to cause a cyclic operation of said relays with said slow pick-up relay picked up for a relatively short period of each cycle interval, means including a front contact of said slow pick-up relay to connect said battery across the rails at one end of the section to supply to the rails time spaced impulses of direct current of relatively short duration and of a voltage of the order of ten volts, and a track relay connected across the rails at the other end of the section effectively energized when said section is unoccupied by said current impulses with a small expenditure of energy by said battery and said track relay highly sensitive to the train shunt when the section is occupied due to the breaking down of the rail film by said voltage of the impulses.

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