May 4, 1937. W. P. PLACE 2,079,525

RAILWAY TRACK CIRCUIT APPARATUS

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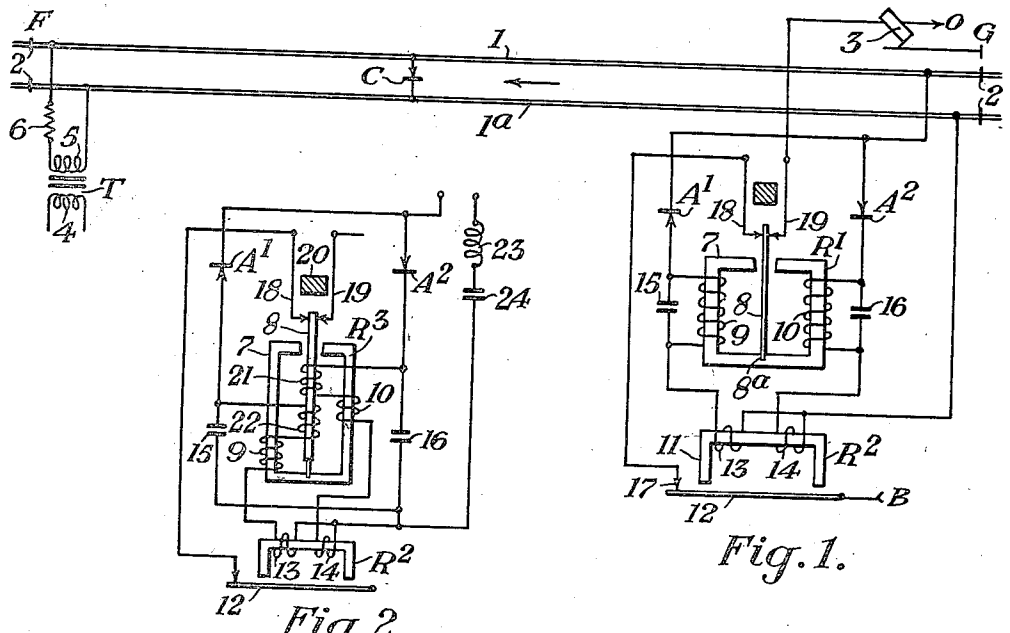

Fig. 1.

Fig. 2.

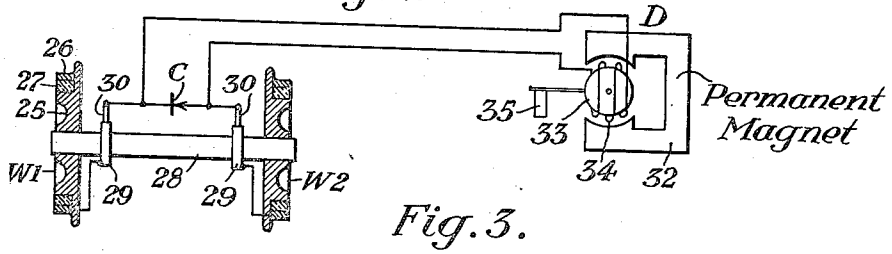

Fig. 3.

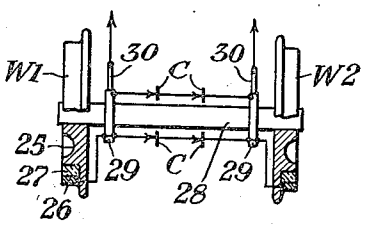

Fig. 4.

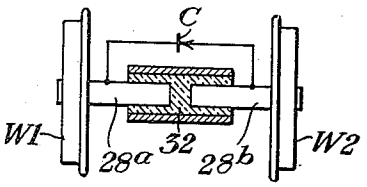

Fig. 5.

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RAILWAY TRACK CIRCUIT APPARATUS

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16 Claims. (Cl. 246—34)

My invention relates to railway track circuit apparatus of the type involving a source of current and a relay each connected across the rails of a section of track. One feature of my invention is the provision of means for improving the sensitiveness and reliability of the operation of apparatus of this character.

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

In the accompanying drawing, Fig. 1 is a diagrammatic view showing one form of trackway apparatus embodying my invention. Fig. 2 is a view showing a modification of a portion of the apparatus shown in Fig. 1 and also embodying my invention. Fig. 3 is a view showing one form of car-carried apparatus which may be used in cooperation with the trackway apparatus shown in Fig. 1. Figs. 4 and 5 are views showing modifications of the car-carried apparatus shown in Fig. 3 and also embodying my invention.

Similar reference characters refer to similar parts in each of the views.

Referring first to Fig. 1, the reference characters 1 and 1a designate the rails of a stretch of track along which traffic normally moves in the direction indicated by the arrow. These rails are divided by insulated joints 2 to form a section of track F—G, and traffic through this section is governed by a wayside signal 3. Located at the left-hand end of section F—G is a transformer T, the secondary 5 of which is connected across the rails through a current-limiting impedance 6. The primary 4 of transformer T is connected with a source of alternating current which is not shown in the drawing, but the frequency of which is preferably of the order of 60 cycles and the wave form of which is symmetrical.

Located at the right-hand end of section F—G are two relays R^1 and R^2. Relay R^1 comprises a U-shaped core 7, and an armature 8 pivotally mounted at the point 8a and capable of movement toward either pole of the core 7. This armature controls a contact 18—19 which is closed when the armature is in its middle position, but which opens when the armature is drawn toward either pole of the core 7. The opening of contact 18—19 results from one or the other member of this contact striking the fixed stop shown in section above the armature 8 and designated by the reference character 20 in Fig. 2. Core 7 is provided with two windings 9 and 10, which when energized, tend to pull the armature 8 in opposite directions, so that if winding 9 alone is energized, the armature 8 will be swung to the left from its middle position, whereas if winding 10 alone is energized, armature 8 will be swung to the right from its middle position.

Relay R^2 is a conventional relay having a U-shaped core 11 and a cooperating armature 12. The core 11 is provided with two windings 13 and 14 which are so connected that they aid each other in creating magnetic flux in the core 11.

Winding 13 is connected across the track rails 1 and 1a through winding 9 and a rectifier A^1. Winding 14 of relay R^2 is similarly connected across the rails by a circuit which includes winding 10 and a second rectifier A^2. Condensers 15 and 16 are connected across the terminals of windings 9 and 10, respectively, in order to smooth the current flowing in these windings. Rectifiers A^1 and A^2 are oppositely poled, so that the positive half of each wave of alternating current will flow through winding 10 but will not flow through winding 9, whereas the negative half of each wave will flow through winding 9 but not through winding 10.

The inertia of armature 8 is such that when windings 9 and 10 are alternately energized by the negative and positive half waves of alternating current of the frequency supplied by transformer T, contact 18—19 remains closed.

Signal 3 is controlled by a circuit which passes from terminal B of a suitable source of current, through contact 12—17 of relay R^2, contact 18—19 of relay R^1, and the operating mechanism of signal 3 to terminal O of the same source of current. It follows that signal 3 will indicate stop when either contact 12—17 or contact 18—19 is open, and will also, of course, indicate stop when both of these contacts are open.

The reference character C designates a rectifier which is carried on a car, and which is so arranged that its two terminals are always in contact with the two track rails respectively. As shown in Fig. 3, the wheels W^1, W^2 of the car are of the type involving a metallic tread 26, which is spaced from the hub 25 by a cushion 27 of insulating material. In this case two collector rings 29 are mounted on and insulated from the axle 28, and these rings are connected with the metallic treads 26 of the two wheels W^1 and W^2, respectively. The rectifier C is connected with two brushes 30, which are in contact with the two collector rings 29, respectively, and so it follows that the terminals of rectifier C are connected with the two treads 26 and so with the two track rails 1 and 1a.

The operation of the apparatus shown in Fig. 1, is as follows: When the track section F—G is unoccupied, an alternating difference of potential exists across the rails at the right-hand end, and the wave form of this difference of potential is symmetrical, that is, the average value of the current flowing during the positive half-cycle is equal to the average value of the current which flows during the negative half-cycle. During the positive half of each wave, current will flow through the rectifier A^2, winding **10** and winding **14**, whereas during the negative half of each wave, current will flow through the winding **13**, winding **9** and rectifier A^1. It follows that the contacts of both relays R^1 and R^2 are closed, so that signal **3** will be energized to give an indication that the section F—G is unoccupied.

I will now assume that a car equipped with the apparatus shown in Fig. 3 enters section F—G. The rectifier C will then shunt the positive half of each wave away from the relays R^1 and R^2 but will not disturb the negative half of each wave. The result of this will be that windings **10** and **14** will receive less current than before, whereas the current in windings **9** and **13** will not be materially disturbed. Armature **8** will, therefore, be drawn to the left, and so will open contact **18—19**, with the result that the signal **3** will change to the stop indication. Relay R^2 may or may not release, depending on the amount of reduction in the value of the current in its winding **14**.

From the above it will be apparent that the effect of rectifier C on the current received from the rails by relays R^1 and R^2 is to distort the wave form of this current in such a manner that the positive half-cycles are materially decreased or substantially disappear. Since relay R^1 is selectively responsive according as the wave form of the current is symmetrical or is distorted in the above manner, it may properly be said that relay R^1 responds to the wave form of the current received from the rails. By "wave form" is meant the manner in which the current ordinate varies during a half-cycle so as to produce a given average current value for the half-cycle which value differs from that of the succeeding half-cycle. Obviously, variations in wave form which do not result in a change in the ratio of the average current values for the half-cycles will not cause an unbalance of relay R^1.

Referring now to Fig. 2, the apparatus shown in this view is the same as that shown in Fig. 1, except that the relay which is responsive to wave form, and which is here designated R^3, is polarized to increase the sensitivity of this relay in its response to a change of the wave form of the alternating current received from the track rails. Windings **9** and **10** are connected so that their magnetomotive forces aid each other in magnetizing the core **7**, whereas windings **21** and **22**, which surround the armature **8**, are connected so that they oppose each other. When the wave form is symmetrical, there is no magnetomotive force applied to the armature, but when the wave form becomes unsymmetrical in that the positive and negative half-cycles are unequal with respect to the average value of the current, one of the windings **21** or **22** will become weaker than the other, and the armature **8** will then move to open contact **18—19**. One of the circuits across the track rails with the apparatus shown in Fig. 2, includes, in series, rectifier A^2, and windings **21**, **10** and **14**. The other circuit includes rectifier A^1 and windings **22**, **9** and **13**. The operation of the apparatus shown in Fig. 2 will be obvious from the foregoing description of the operation of the apparatus shown in Fig. 1. Windings **9** and **10** could, if desired, be omitted and a permanent magnet could then be substituted for the magnetizable core **7** or the armature **8** could be made the permanent magnet.

As shown in Fig. 2, a reactor **23** and a condenser **24** are included in series in both of the paths across the track rails. These elements constitute a wave filter to exclude from the relays R^2 and R^3 any alternating current of a frequency other than that to which these relays are intended to respond. This wave filter may be used, for example, when alternating propulsion current of a frequency different from the signaling current is employed.

As shown in Fig. 4, a plurality of rectifiers C are connected across the rails, and these rectifiers are mounted to revolve with the wheels and axle. That is to say, two rectifiers in series are connected directly with the two collector rings **29** and are mounted on the axle **28**, and to avoid a failure due to a breakdown of such rectifiers, two additional rectifiers are likewise connected in series and mounted in the same manner.

As shown in Fig. 5, the wheels are of the conventional type, that is, they are solid metal, and in this case the axle may be formed of two sections 28^a and 28^b, which are insulated from each other by insulating material **32**. The rectifier C is connected across the two axle sections 28^a and 28^b.

When rubber tired cars are used, and in other cases if desired, the car-carried shunt across the rails may be provided by shoes in contact with the rails, the shoes being connected by an electro-conductive path which includes a rectifier.

The conventional track circuit depends for its operation upon the fact that the current through the track relay is reduced by the shunt which is formed by the wheels and axles of a car or train. Owing to the extreme variation in the impedance between the track rails caused by variations in the weather and in other conditions, the shunt created by the car or train must be very good, that is, its resistance must be very low, so that the wayside equipment is able to detect the differences between a train and a wet roadbed. In accordance with my invention, I have provided an additional factor which does not change with the weather or the condition of the track, but which can be changed by the presence of a train, the result being that a relatively small change can easily be detected. This factor is the wave form of the alternating current which reaches the track relays. Even though the impedance between the track rails changes enormously, there is no reason for believing that it is unsymmetrical. In other words, whatever the impedance between the rails happens to be, if an alternating voltage is impressed across the rails the impedance offered to the positive half cycle is the same as the impedance offered to the negative half cycle, and so the wave form at the relay end will be symmetrical unless an unsymmetrical impedance is purposely introduced. I have introduced such an impedance by shunting the track rails through the rectifier C, and I have provided wayside equipment capable of responding to an unsymmetrical wave form and to that alone. That is to say, relay R^1 will open its contact in response to an unsymmetrical wave form but will keep its contact closed when the wave form is symmetrical. Relay

R^2 will, of course, open its contact whenever the voltage across the rails drops below a predetermined point. Since the distortion of the wave form need not be very great, the shunt across the track rails need not have a very low resistance. For example, a relay such as R^3 can be designed to respond to a 5% unbalance of the current flowing in its windings. If the resistance between the rails happens to be 2 ohms, calculation will show that a shunt having a resistance of 38 ohms in its low resistance direction will give the necessary 5% unbalance to open the contact of the relay R^3. The rectifier C itself will, of course, have a very low resistance in the forward direction, and, consequently, most of the 38 ohms may be contact resistance between rails and wheels.

Apparatus embodying my invention can be said to respond to a change in an intrinsic characteristic of the current, wave form being such an intrinsic characteristic. It will be understood, however, that by modifying an intrinsic characteristic of the current, I mean some change in the current which does not necessarily affect the actual quantity or amount of the current which is received from the rails by the wayside device.

Although I have herein shown and described only a few 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 with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, means on said car for shunting one half of each wave but not the other of such alternating current, and apparatus connected across said rails and selectively responsive to such alternating current and to the pulsating current which remains when said car occupies the section.

2. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, means on said car for modifying an intrinsic characteristic of the alternating current flowing from said source in the rails of a portion of said track section, a signal controlling circuit associated with said section, and apparatus connected across the rails of said portion of the track section and effective to close said signaling circuit when energized by said alternating current but not when energized by such modified current.

3. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, means on said car for shunting one half of each wave but not the other of such alternating current, a signal controlling circuit associated with said section, and apparatus connected across the rails of said section and effective to close said circuit in response to such alternating current but not in response to the pulsating current which results when said car occupies the section.

4. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, a relay having two windings each connected across the rails of said section, two oppositely poled rectifiers included in series with said two windings respectively, an armature subjected to opposing forces by the fluxes due to currents in said two windings respectively, a contact operated by said armature and closed when such opposing forces are substantially balanced but open when the armature moves in response to unbalancing of such forces, signaling means for said section controlled by said contact, and means on said car for shunting one-half of each wave but not the other of such alternating current away from said windings.

5. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, a relay having two windings each connected across the rails of said section, two oppositely poled rectifiers included in series with said two windings respectively, a polarized armature subjected to opposing forces by the fluxes due to currents in said two windings respectively, a contact operated by said armature and closed when such opposing forces are substantially balanced but open when the armature moves in response to unbalancing of such forces, signaling means for said section controlled by said contact, and means on said car for shunting one half of each wave but not the other of such alternating current away from said windings.

6. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, a relay having two windings and an armature subjected to opposing forces by the fluxes due to currents in said two windings, a second relay having two windings and an armature subjected to forces in the same direction by the fluxes due to currents in its associated windings, a circuit connected across the rails of said section including one winding of each relay in series, another circuit connected across said rails and including the other windings of said relays in series, two oppositely poled rectifiers included in said two circuits respectively, means on said car for shunting one half of each wave but not the other of said alternating current from said windings, and signaling means for said section controlled jointly by said two armatures.

7. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, a relay having two windings and an armature subjected to opposing forces by the fluxes due to currents in said two windings, a contact operated by said armature and closed when the opposing forces on the armature are substantially equal but open when the armature moves in response to an unbalancing of said forces, a second relay having two windings and an armature subjected to forces in the same direction by the fluxes due to currents in such windings, a contact operated by the armature of said second relay and closed or open according as the energy supplied to the associated winding is above or below a given value, a circuit connected across the rails of said section including one winding of each relay in series, another circuit connected across said rails and including the other windings of said relays in series, two oppositely poled rectifiers included in said two circuits respectively, means on said car for shunting one half of each wave but not the other of said alternating current from said windings, and signaling means for said section controlled by said two contacts in series.

8. In combination with a section of railway

track and a car for travel thereon, a source of alternating current connected across the rails of said section, a relay having two windings each connected across the rails of said section, two oppositely poled rectifiers included in series with said two windings respectively, an armature subjected to opposing forces by the fluxes due to currents in said windings, respectively, signaling means for said section controlled by said armature, and means on said car for shunting one half of each wave but not the other of said alternating current away from said windings.

9. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, a rectifier carried by said car and connected across the track rails, and signaling means for said section receiving current from the rails and selectively responsive to the alternating current as supplied by said source and to the current of modified wave form due to the action of said rectifier when said car occupies said section.

10. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, means on said car for modifying the wave form of current, a device in the trackway responsive to current of such modified wave form but not to current symmetrical in wave form, a second device in the trackway responsive to the difference of potential across said rails but not to the wave form of such potential, and signaling means controlled jointly by said two devices.

11. In combination with a section of railway track and a car for travel thereon, a source of alternating current connected across the rails of said section, a wayside control device receiving current from the rails of said section, means on said car for modifying the wave form of the current received by said device, said device being designed to assume one or another condition according as it receives alternating current or current of said modified wave form respectively, and signaling apparatus controlled by said device.

12. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a wayside control device supplied with current from the rails of said section, means effective when a car enters said section for modifying the wave form of the current supplied to said device, said device being designed to assume one or another condition according as it is supplied with alternating current or current of said modified wave form respectively, and signaling apparatus controlled by said device.

13. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a wayside control device supplied with current from the rails of said section, means including a rectifier and effective when said section is occupied by a car for modifying the wave form of the current supplied to said device, said device being designed to assume one or another condition according as it is supplied with alternating current or current of said modified wave form respectively, and signaling apparatus controlled by said device.

14. In combination, a section of railway track, a source of alternating current connected across the rails of said section, wayside signaling apparatus receiving current from the rails of said section and selectively responsive to the wave form of the current received thereby, and means effective when a car enters said section for modifying the wave form of the current received by said apparatus to thereby cause a response of said apparatus.

15. In combination, a section of railway track and a car for travel thereon, a source of current connected across the rails of said section, means on said car for modifying an intrinsic characteristic of the current flowing from said source in a portion of said track section, a signal controlling circuit associated with said section, and apparatus connected across the rails of said portion of the track section and effective to close said signaling circuit when energized by current from said source but not when energized by such modified current.

16. In combination, a section of railway track, a source of current connected across the rails of said section, signaling apparatus connected across the rails of said section and selectively responsive according as a given intrinsic characteristic of the rail current received thereby is or is not modified, and means effective when said section becomes occupied by a rail car for modifying said given intrinsic characteristic of said rail current to cause a response of said apparatus.

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