No. 867,448. PATENTED OCT. 1, 1907.

L. H. THULLEN.

SIGNALING SYSTEM FOR RAILWAYS.

APPLICATION FILED JUNE 23, 1906.

3 SHEETS—SHEET 1.

Fig. 1.

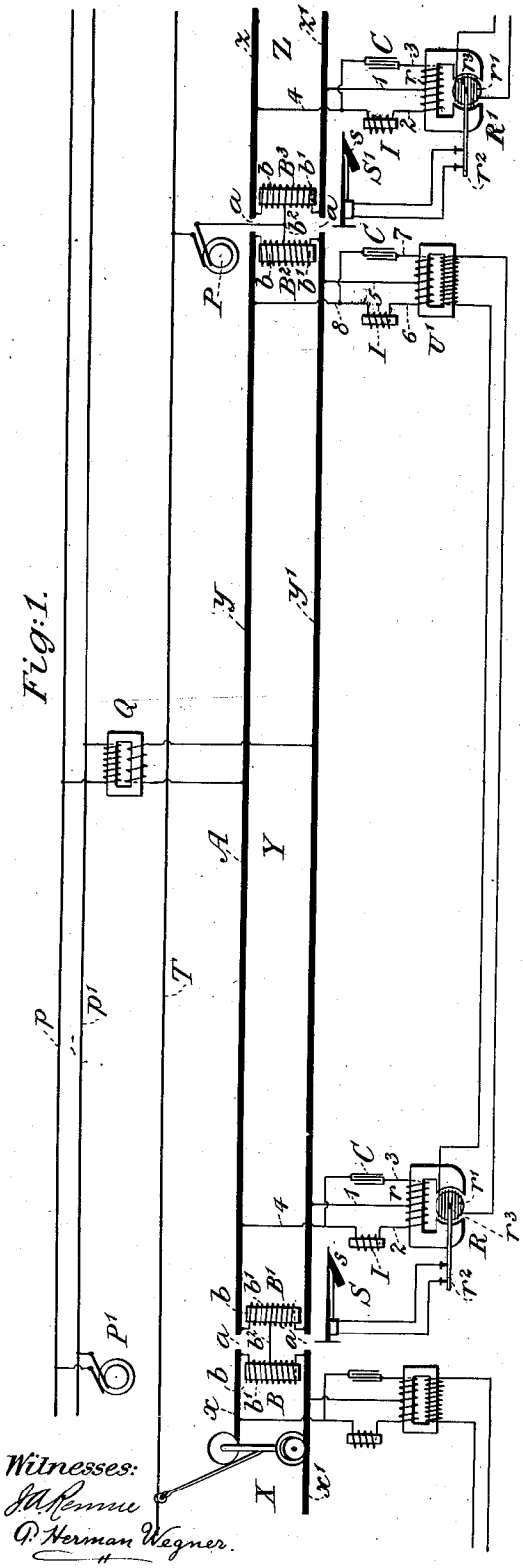
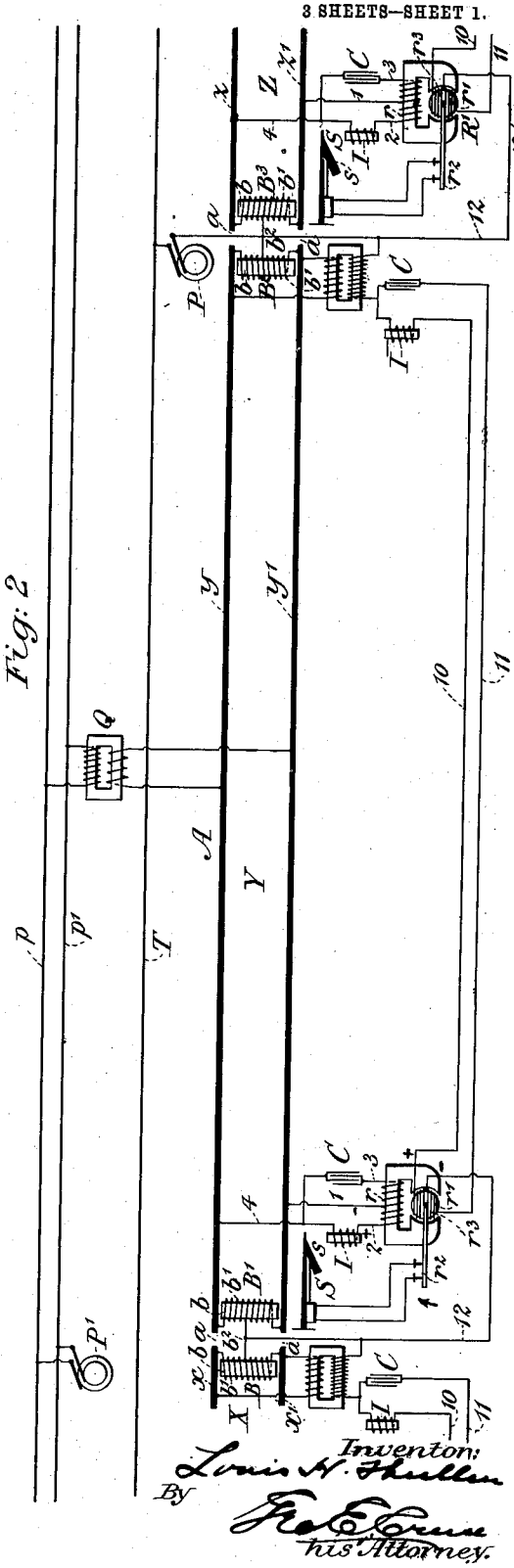


Fig. 2.



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3 SHEETS—SHEET 2.

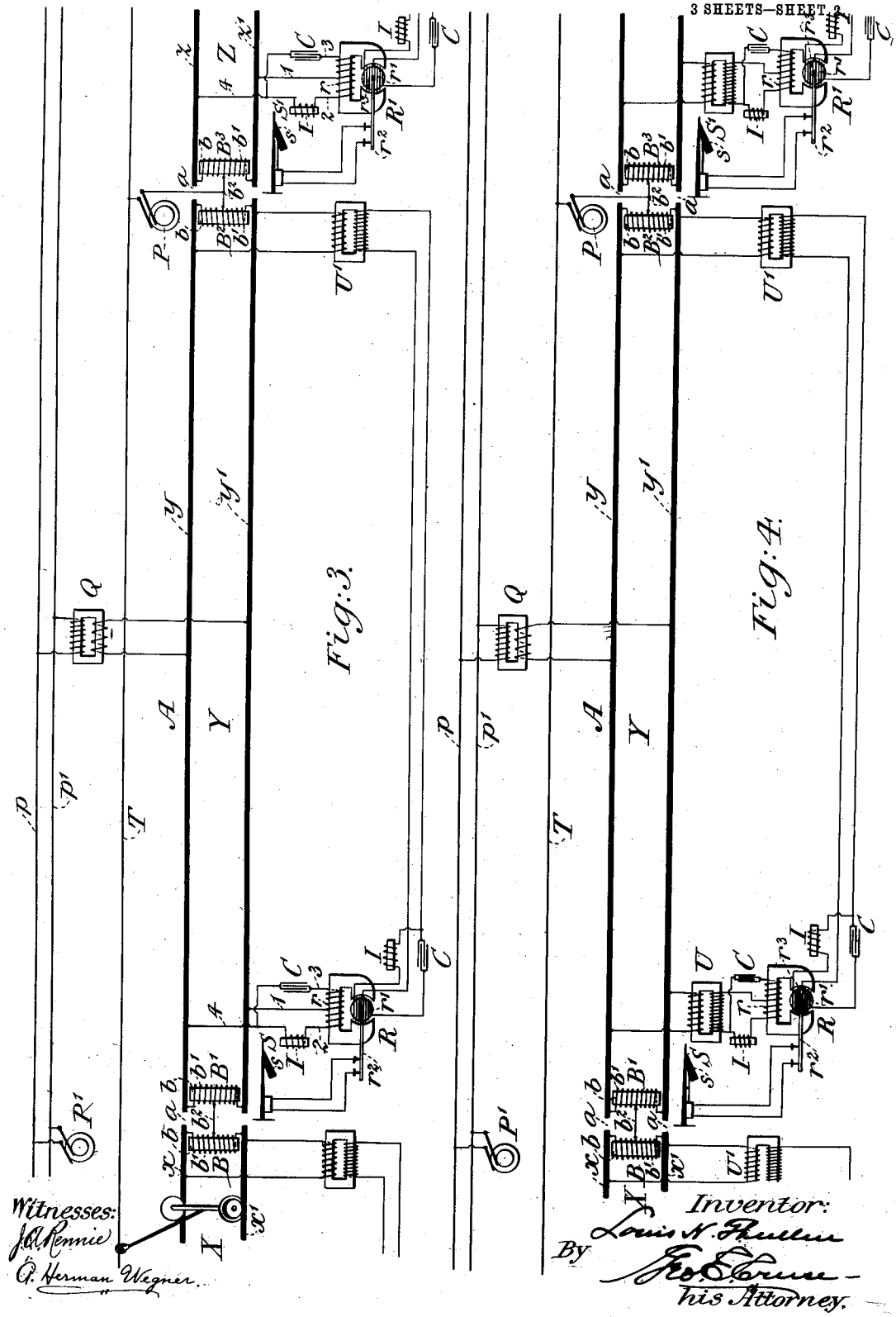

Fig. 3.

Fig. 4.

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3 SHEETS—SHEET 3.

Fig. 5.

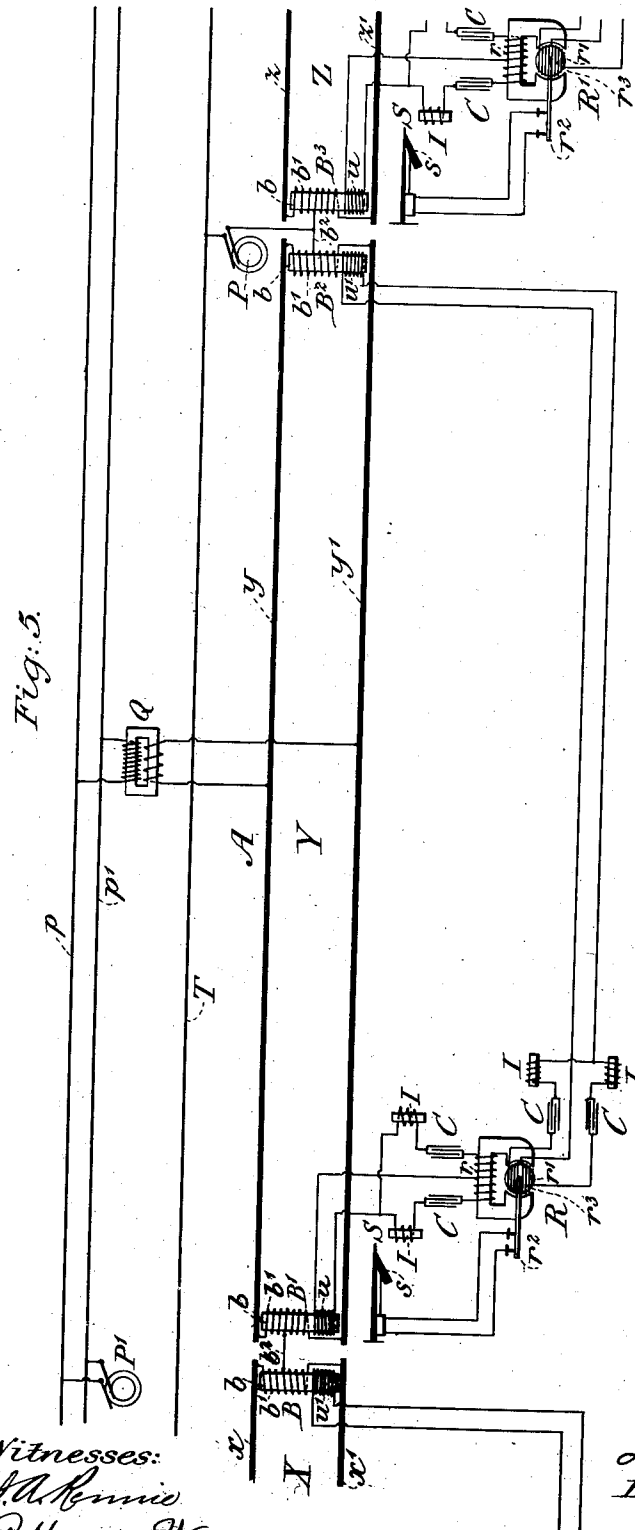
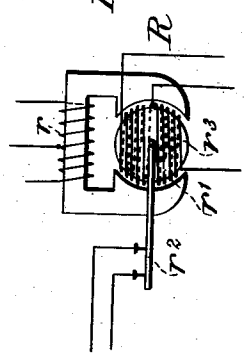


Fig. 6.



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UNITED STATES PATENT OFFICE.

LOUIS H. THULLEN, OF EDGEWOOD, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH AND SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

SIGNALING SYSTEM FOR RAILWAYS.

No. 867,448. Specification of Letters Patent. Patented Oct. 1, 1907.

Application filed June 23, 1906. Serial No. 322,987.

To all whom it may concern:

Be it known that I, LOUIS H. THULLEN, a citizen of the United States, residing at Edgewood, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Signaling Systems for Railways, of which the following is a specification.

My invention relates to signaling systems for railways and especially to railways, the track rails of which are included in and form part of the return path or conductor to the generator for the current employed for propelling motor cars along the railway.

I will describe a signaling system embodying my invention and then point out the novel features thereof in claims.

In the accompanying drawings Figure 1 is a diagrammatic view of a portion of an electric railway, the trackway of which is divided by insulation to form block sections, a transmission system for the car propulsion current and a signaling system applied to the railway and embodying my invention, and illustrating one form of relay. Figs. 2, 3, 4 and 5 are views similar to Fig. 1, but showing modified arrangements of apparatus employed in track circuits of the signaling system, and a modified form of relay. Fig. 6 is a detail diagrammatical view of the form of relay employed in Figs. 2 to 5.

Similar reference characters designate corresponding parts in all of the figures.

Referring now to the drawings, A designates a portion of a railway which is divided into sections, X, Y, Z, etc. These sections are generally termed "block or track sections" and I will hereinafter refer to them as "block sections." These block sections are formed by inserting insulation *a* in some form at determined points in one or both of the traffic rails, the one arrangement being the equivalent of the other so far as block sectioning is concerned, and both being well known in the art.

In the drawing I have shown insulation *a* inserted in both of the traffic rails.

x, x^1, designate the track rails of block section X, y, y^1, the track rails of block section Y, and so on.

P designates an alternating current generator, the current from which is used for propelling motor cars along the railway.

T designates a trolley or third rail connected with one pole of the power generator and extending along the railway in a usual and well known manner, and with which shoes or other contact devices carried by the cars make contact.

As the rails of the railway, one or both, are to form part of the return path or conductor for the alternating propulsion current employed for the motor cars and still contain insulation to form block sections, I make provision for conducting the propulsion current from the rails of one block section to the rails of the adjacent block section around the points of insulation. This I accomplish by means of inductive bonds, located at the insulated points, each of which inductive bonds comprises a core and a winding or windings surrounding the core. Each inductive bond is of such construction and arrangement as to afford a path of low ohmic resistance for the propulsion current, from the rails of one block section to the rails of another block section. A form of bond which I preferably employ is described and illustrated in my co-pending application filed February 27, 1906, Serial No. 303,155, and which is diagrammatically illustrated in my applications filed February 5, 1904, Serial Nos. 192,145 and 192,146. These inductive bonds, generally stated, each comprise a laminated iron core which may or may not have an open magnetic circuit and a winding of several turns. The ends of the winding are connected with the two rails of the block section, while a conductor extends from the middle of the winding and which conductor is arranged to be connected to the middle of the winding on an adjacent bond.

In the drawing I have diagrammatically illustrated the inductive bonds and their connections. B, B^1, B^2, B^3, etc. designate the inductive bonds. *b* designates the core thereof which may have either a closed or open magnetic circuit, depending upon conditions, and a winding b^1 surrounding a leg of the core. Instead of one winding b^1 there may be two windings each of the same number of ampere turns, electrically joined together at adjacent ends to form in effect one winding. In such case the point at which they are electrically joined is the middle point of the winding.

b^2 designates a conductor joining the middle points of two adjacent coils. This conductor as will be seen may be common to two adjacent coils. The rails, of course, will be connected to the generator in the usual and well known manner understood in this art. Thus it will be seen that the current taken from the feed conductor T and after passing through the car motors to the rails will flow through the rails and windings of the bonds.

It will be seen that the propulsion current in its passage through the winding of an inductive bond flows in at its ends and out at its middle point or in at its middle point and out at its ends in reverse or opposite directions, the result being that the core of the inductive bond is not appreciably magnetized by the propulsion current and that the propulsion current traversing the winding half in one direction and half in the other will therefore be non-inductive as far as the propulsion current is concerned, but will be inductive to the track current that traverses the wind-

ing in the same direction, so that the bond may be used as an impedance for alternating signaling currents used in the track circuits. This has been all set forth in my applications hereinbefore referred to, Serial Nos. 192,145 and 192,146.

The foregoing, it will be seen, is directed more particularly to the arrangement of the track in the return path or conductor of power circuit whereby the propulsion current flows along it yet it is divided into insulated sections to form the block or track sections of the signaling system. I will now proceed to describe the signaling system.

S, S^1, etc. designate railway signals for controlling the movements of cars or trains into and along the block sections. As shown, one railway signal is provided for each block section. Of course, other arrangements of railway signals may be used, according to the type of signaling system employed. The railway signals are preferably of any of the automatic types well known in the art. Each railway signal comprises a signal device s preferably in the form of a semaphore and an operating mechanism. The operating mechanism is employed to move the signal device from one position, generally its horizontal (danger) position to an inclined position, and hold it in such inclined position, when no car or train is in a block section. When a car or train enters a block section the signal device automatically moves to its danger position. This operation is well understood, and the movements of the signal device is automatically controlled by a car or train through relays which are included in track circuits forming part of the signal system. The track circuits and the apparatus used therein form an essential part of my invention.

Each block section is provided with a track circuit which, as usual, comprises a source of current, a relay and the rails of the block section or portions of them. I preferably employ an alternating current in each track circuit and of a frequency higher than that used for propulsion purposes.

The relay or translating device is constructed to respond to control its railway signal in its usual movements to the alternating signaling current of the track circuit, and the relay is protected by suitable apparatus or devices which act to prevent its being operated by the propulsion current to give a clear signal when a danger signal should be displayed.

P^1 designates a source of alternating signaling current, generating a current of a frequency higher than the frequency of the current generated by the generator P, which is comparatively low, say of 25 cycles.

p, p^1 designate mains or feeders extending from the generator P^1 along the line of railway.

Q designates a step-down transformer, one being provided for each block section and located preferably at about the middle of the track circuit of each block section. The primary windings of the transformers are preferably in multiple circuit with the mains p, p. The secondary of a transformer Q is connected with the track rails of the block section.

R, R^1, etc. designate the relays, one being provided for each block section. Each relay in its preferred form (see Fig. 6), comprises a field coil r inclosing a suitable core and an armature coil r^1 to which is connected an arm r^2 for opening and closing a circuit on a railway signal. The armature coil r^1 is suitably pivoted and moves about a stationary metallic core r^3 which is employed to reduce the magnetic reluctance of the field between the pole pieces of the core.

In the drawings I have shown the field coil of a relay energized from one end of the track circuit and the armature coil from the other ends of the track circuit. The windings of each relay are so connected either directly or intermediately with the track rails so that any current which will flow through the windings will either enter its ends and flow out at its middle point or flow into the windings at its middle point and out at its ends.

In the form of relay shown in Fig. 1 it is substantially the same as that illustrated in the other figures of the drawing, except that there is no conductor leading from the middle point of the armature coil.

In Figs. 1, 2 and 3 the field winding is shown as being directly connected with the track rails while in Figs. 4 and 5 it is connected with the secondary of a step-up transformer the primary of which is connected with the track rails. In Fig. 4 the transformer U is an independent device, while in Fig. 5 the winding b^1 of an inductive bond is employed as the primary and an additional winding u is placed on the core. In all of the figures of the drawings the armature winding is shown as being in circuit with the secondary winding of a step-up transformer.

In Figs. 1, 2, 3 and 4, the transformer is an independent device while in Fig. 5 the transformer is formed in part by the winding b^1 of an inductive bond with an additional winding u^1 placed on the core of the inductive bond. The purpose of using a step-up transformer in this connection is to impress a high E. M. F. on the relay with a comparatively small amount of current. To produce a turning movement of the armature coil relatively to the field in either direction current is required in both the field and armature coils, and the direction of flow of the current through either coil will determine the direction of movement of the armature coil. For instance, the direction of flow of current in the field may be reversed to cause reversed movements of the armature, provided the direction of flow of current through the armature is constant, or the direction of flow of current through the armature coil may be reversed to obtain reversed movements of the armature provided the direction of flow of current in the field coil is constant. If current is not flowing in one or the other of the two coils or is not flowing in both of the coils there will be a movement of the armature in one direction under the influence of gravity or a weight or spring.

The relative arrangement of the field and armature coils of a relay and their connections to the track rails of a block section of the railway are such that under normal conditions and with no car or train in the block section the alternating signaling current will flow in both coils and cause the armature to move to close a circuit on one or more railway signals. In the drawings the movement of the armature in this direction will cause a circuit on the railway signal for that block section to be closed. When a car or train enters a block section the signaling current is shunted by the wheels and axles of the car or train from one or both coils of the

relay, thereby permitting the armature coil to move or be moved to open the circuit on the railway signal and thus permit the railway signal to indicate that a car or train is in the block section. Should, for any reason, conditions arise when a car or train is in a block section, to cause the alternating car propulsion current to flow through either or both of the coils of the relay, its effect would not be to cause the armature to move to close the circuit on the railway signal, but on the contrary its effect would be to cause the armature to move in such direction so to open or hold open the circuit of the railway signal. Also, with no car or train in a block section, should conditions arise which would cause the alternating propulsion current to flow through either or both coils of the relay and of such a quantity that its magnetic effect in the relay is greater than the magnetic effect in the relay of the signaling current, its effect would be to have the armature move in such direction to open the circuit on the railway signal and thus have it give a danger indication. These operations of the relay are obtained by dividing one or both of the two coils of a relay and having one half of one or both coils normally energized by the alternating signaling current, using apparatus in the circuits of the two coils which in one case will permit a flow of the alternating signaling current and retard the flow of the alternating propulsion current. As the alternating propulsion current, except under unusual conditions will always flow through the track rails and inductive bonds, it will be seen at once that under the normal or usual conditions upon an electric railway, in effect only one half of one or both coils of a relay is used to produce one turning movement of the armature to control one or more railway signals along the railway, and when the unusual or abnormal conditions arise which might cause the alternating propulsion current to flow through a relay, then it is that the other half of one or both coils are employed and then only to cause the armature to move in such direction as to open or hold open the circuit on a railway signal or signals. This will now be specifically explained by reference to the drawings.

Referring now particularly to Figs. 1, 2 and 3, the middle point of the field coil r is shown as being connected by a conductor l with one rail of the track circuit of a block section, while the ends of the field coil are connected by conductors 2, 3, to a third conductor 4 with the other rail of the track cicuit. In one of the conductors 2, 3, a reactance or impedance I is inserted while in the other conductor a condenser C is inserted. As is well known in the art, an impedance is more effective in so far as the retarding of current flow is concerned with an alternating current of high frequency than with an alternating current of relatively higher frequency, while the reverse is true of a condenser or capacity. Thus it will be seen that in effect only one half of the field winding will be effectively energized by the signaling current of high frequency. As stated, there is normally no tendency for the alternating propulsion current to flow through the field coil of the relay. Yet should conditions arise in a block section which would cause a difference of potential of propulsion current to exist between the rails and thereby cause the alternating propulsion current to flow through one half of the field coil, its effect on the relay would be to cause a reverse movement of the armature. In Fig. 1 the middle point of the primary winding of the transformer U^1 is connected with one track rail through a conductor 5, while the ends of the primary winding are connected by conductors 6, 7, with a third conductor 8 to the other track rail. A condenser or capacity C is placed in one of the two conductors 6, 7, and an impedance or reactance I in the other. The secondary winding of the transformer U^1 is connected with the terminals of the armature winding of the relay. The condenser C and reactance I in the connections of the transformer U^1 with the track rails act in the same manner as the condenser C and reactance I in the connections of the field coil with the track rails. In Fig. 2 the primary of transformer U^1 is connected directly with the track rails. One terminal of the secondary winding is connected with two conductors 10, 11, one containing a reactance or impedance I and the other a condenser C and connected with the ends of the armature coil. The other terminal of the secondary of the transformer U^1 is connected with the conductor b^2 as is the middle point of the armature coil through a conductor 12. In Fig. 3 the same arrangement is shown as that illustrated in Fig. 2, except that the reactance and condenser are placed adjacent the relay and the secondary circuit of the transformer U^1 is not formed in part by the track rails. In Fig. 4 the same arrangement is illustrated as that shown in Fig. 3 with the exception that a transformer U is placed between the track rails and the field coil.

Fig. 5 illustrates substantially the same arrangement as that illustrated in Fig. 4 with the exception that the transformers U and U^1 are formed by placing an additional winding on the cores of adjacent inductive bonds. Also in the divided circuits of the field and armature coils of the relay a reactance I and condensers C are placed in series. The condensers and impedances in this arrangement are so proportioned that they are in resonance at the frequency of the propulsion current and therefore equal currents will flow through both halves of the field and armature winding, and the action of the propulsion current will be *nil*, while with another frequency, that is the frequency of the track current, the condenser and impedance will not be in resonance, hence the relay will be operated by this current. Of course, it will be understood that I do not limit myself to reactances and condensers for permitting the flow of an alternating current of one frequency and retarding the flow of an alternating current of a different frequency, and as any other apparatus which would accomplish the same result may be employed. Nor do I wish to be limited to the simultaneous use of a reactance and condenser and equivalent apparatus in the divided circuit, as either one may be dispensed with.

I do not wish to limit myself to the particular type of relay herein described and illustrated as it is evident that another form of relay could be used, such a relay operating on the principle of the expansion of metals by the passage of the current.

What I claim as my invention is:

1. In combination with an electric railway the track rails of which form part of the return path for the car propulsion current, a source of alternating current of one frequency for propelling the cars; and a signaling system for the railway which comprises track circuits each of which includes a source of alternating signaling current of a frequency different from the frequency of the propulsion cur-

rent, and a relay responsive thereto, said relay being arranged with coils which when energized by the alternating propulsion current act to move the armature of the relay to open or hold open a circuit on a railway signal.

2. In combination with an electric railway the track rails of which form part of the return path for the car propulsion current, a source of alternating current of one frequency for propelling the cars; and a signaling system for the railway which comprises track circuits each of which includes a source of alternating signaling current of a frequency different from the frequency of the propulsion current, and a relay responsive thereto, said relay being provided with a field coil and an armature coil.

3. In combination with an electric railway the track rails of which form part of the return path for the car propulsion current, a source of alternating current of one frequency for propelling the cars; and a signaling system for the railway which comprises track circuits each of which includes a source of alternating signaling current of a frequency different from the frequency of the propulsion current, and a relay responsive thereto, said relay having a divided field coil and means in circuit with one half of said coil which will permit the flow of alternating current of one frequency and retard the flow of an alternating current of a different frequency.

4. In combination with an electric railway the track rails of which form part of the return path for the car propulsion current, a source of alternating current of one frequency for propelling the cars; and a signaling system for the railway which comprises track circuits each of which includes a source of alternating signaling current of a frequency different from the frequency of the propulsion current, and a relay responsive thereto, said relay having a divided field coil and a divided armature coil and means in circuit with one half of each coil which will permit the flow of alternating current of one frequency and retard the flow of an alternating current of a different frequency.

5. In combination with an electric railway the track rails of which form a part of the return path for the car propulsion current; a source of alternating current of one frequency for propelling the cars; a signal system for the electric railway which comprises railway signals, block sections, and track circuits for the block sections each of which track circuits includes a source of alternating current of a frequency different from the frequency of the propulsion current and a relay; each of said relays being operative by the combined action of two coils of said relay, said coils being differentially wound and so connected that the relay will operate in one direction by the car propulsion current, and in the reverse direction by the track current.

6. In combination with an electric railway the track rails of which form part of the return path for the propulsion current; a source of alternating current of one frequency for propelling the cars; a signal system for the railway which comprises railway signals, block sections, and track circuits for the block sections each of which track circuits includes a source of alternating signal current of a frequency different from the frequency of the propulsion current, and a relay; said relay being operated by the combined action of two coils, said coils being differentially wound and so connected that the relay will operate in one direction by currents of one frequency and in the reverse direction by currents of another frequency.

7. In combination with an electric railway the track rails of which form part of the return path for the propulsion current; a source of alternating current of one frequency for propelling the cars; a signal system for the railway which comprises railway signals, block sections and track circuits for the block sections; each of which track circuits includes a source of alternating signal current of a frequency different from the frequency of the propulsion current and a relay; said relay being operated by the combined action of two coils, said coils being differentially wound and having inductance and capacity in series with the different coils so as to produce a movement of the relay in one direction by current of one frequency and in a reverse direction by current of another frequency.

8. In combination with an electric railway the track rails of which form part of the return path for the propulsion current; a source of alternating current of one frequency for propelling the cars; a signal system for the railway which comprises railway signals, block sections and track circuits for the block sections, each of which track circuits includes a source of alternating signal current of a frequency different from the frequency of the propulsion current and a relay, said relay being operated by the combined action of two coils, said coils being differentially wound and having inductance and capacity in series with the different halves of the coil so as to produce a movement in one direction by current of one frequency and in the reverse direction by current of another frequency.

9. In combination with an electric railway the track rails of which form part of the return path for the propulsion current; a source of alternating current of one frequency for propelling the cars; a signal system for the railway which comprises railway signals, block sections and track circuits for the block sections; each of which track circuits includes a source of alternating signal current of a frequency different from the frequency of the propulsion current and a relay, said relay being operated by the combined action of two coils, said coils being differentially wound and having inductance and capacity in series with either of the coils, so as to produce a movement of the armature in one direction by current of one frequency and in the reverse direction by current of a different frequency.

In testimony whereof I have signed my name to this specification in the presence of two subscribed witnesses.

LOUIS H. THULLEN.

Witnesses:
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A. D. VICOCK.