L. H. THULLEN.

SIGNALING SYSTEM FOR RAILWAYS.

APPLICATION FILED JULY 5, 1906.

1,043,170.

Patented Nov. 5, 1912.

2 SHEETS—SHEET 1.

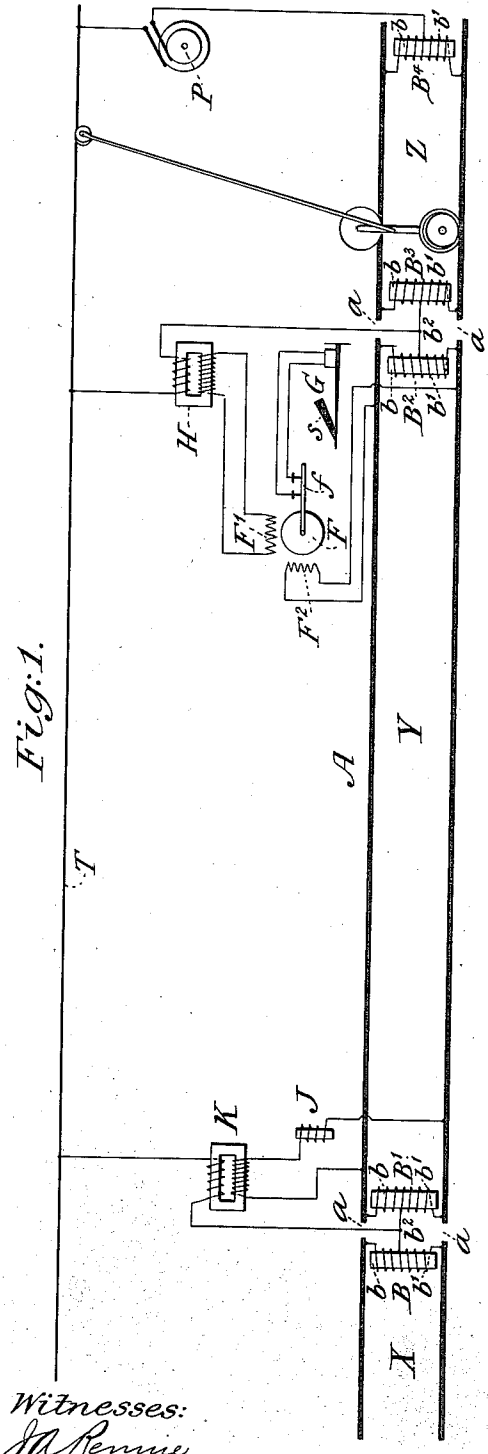

Fig. 1.

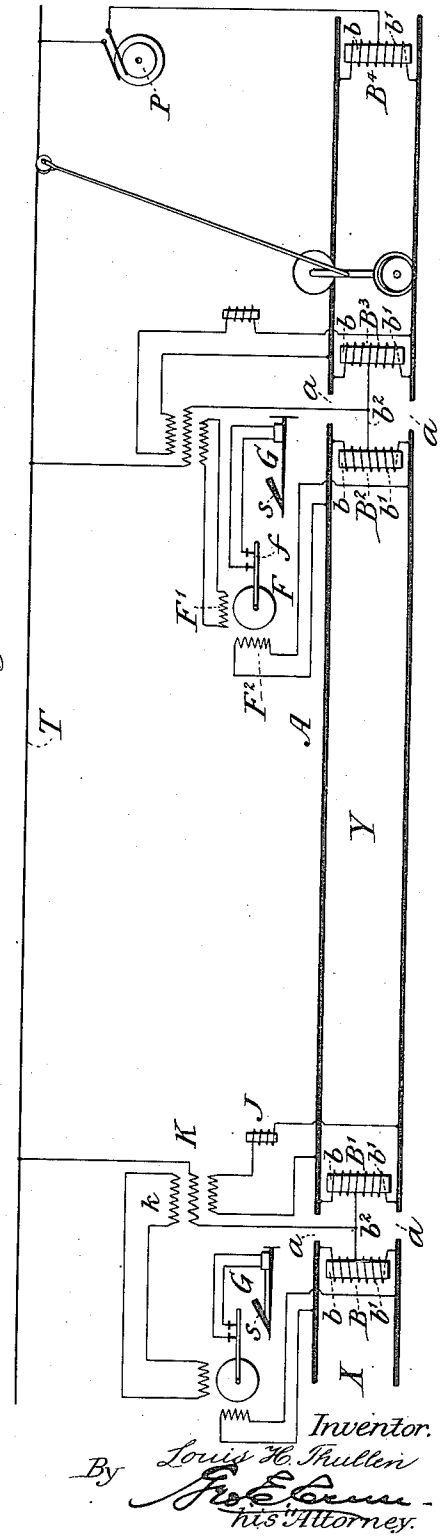

Fig. 2.

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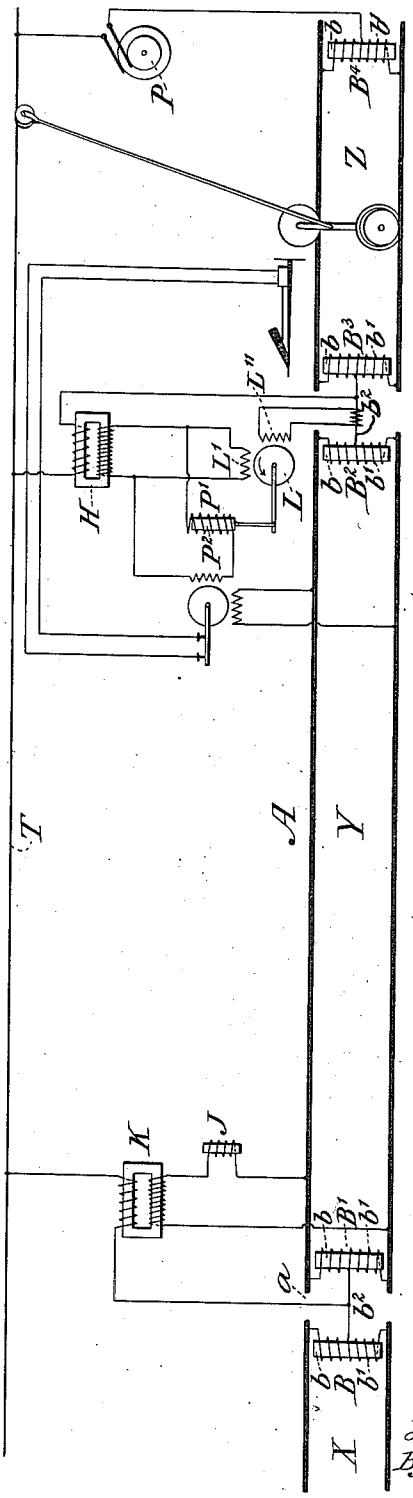

Fig: 3.

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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.

1,043,170. Specification of Letters Patent. Patented Nov. 5, 1912.

Application filed July 5, 1906. Serial No. 324,731.

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 diagrammatical view of a portion of an electric railway, the trackway of which is divided into block sections, a transmission system for the car propulsion current, and a signaling system embodying my invention. Figs. 2 and 3 are views similar to Fig. 1, but showing modifications of the signaling system.

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 in 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.

P designates an alternating current generator 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 contact devices carried by the motor cars make contact.

As the rails of the railway, one or both, are to form part of the return path or conductor for the propulsion current and still contain insulation to form block sections, I make provision for conducting such current from the rails of one block section to the rails of an adjacent block section around the points of insulation. This I accomplish by means of inductive bonds, located at the insulated points which inductive bonds each comprise a core and a winding or windings surrounding the core. The inductive bonds are 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 application filed February 5, 1904, Serial No. 192,146. These 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 point of the winding on an adjacent inductive bond. In the drawing I have diagrammatically illustrated the bonds and their connections, B, B^1, B^2, B^3, etc., designate the 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. 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 winding of the bonds back to the generator.

It will be seen that the propulsion current in its passage through the windings of the inductive bonds flows in at their ends and out at its middle point or in at its middle point and out at its ends in reverse or op-

posite directions, the result being that the core is not appreciably magnetized, so that the inductive bonds may be used as impedances for alternating signaling currents used in the track circuits. This has been all set forth in my application hereinbefore referred to, Serial No. 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. The signaling system which I employ is of the automatic type, that is, the railway signals governing the passage of cars or trains along the railway are automatically controlled by the cars or trains as they travel along the railway.

The several block sections of the railway are each provided with a closed track circuit, which as is well known, comprises a source of current, the opposite lines of rails of the block section and a relay. I employ an alternating current in the track circuit, the frequency of which is the same as the frequency of the alternating car propulsion current, but of a different phase. The relay which I employ is of that type of motor which is operable by alternating currents differing in phase. Such types of motors are well known and will not be herein specifically illustrated or described.

Referring now particularly to Fig. 1 of the drawings, K designates transformers, one being provided for each block section. The primary of each transformer K is in multiple circuit with the feed wire T and track rails, and the secondary is connected with the track rails of its block section. Included in this secondary is a reactance J or other device which acts to produce a delay of phase of the signaling current. F designates a relay in the form of a motor, which operates with alternating currents of different phases or two different phases of the same alternating current. I have illustrated two coils F^1, F^2, one of which F^2 is connected with the track rails of the block section for which the relay is provided, while the other coil F^1 is in circuit with the secondary of a transformer H, the primary of which is in multiple circuit with the conductor T and the track rails. The armature *f* moves in one direction under the influence of the currents in the coils F^1, F^2, to close a circuit on a railway signal G, and when current is short circuited from one of the coils, for example when a car or train is in the block section, the armature moves or is moved in a reverse direction to open the circuit of the railway signal. The armature has a limited movement in each direction and any desired means for accomplishing this may be provided. A railway signal G is provided for each block section and may be any of the well known automatic types, that is, the type of railway signal employing a signal device *s* and an operating mechanism for moving it from one position to another. When no car or train is in a block section the signal device is held in such position by the operating mechanism and when a car or train is in a block section the signal device is moved (by gravity) to a position to indicate that a car or train is in the block section. Of course, when the car or train moves out of the block section the operating mechanism moves the signal device to its position which indicates that the block section is clear.

Referring now to Fig. 2, this figure illustrates the same form of the invention as that illustrated in Fig. 1 with the exception that the transformer H is dispensed with, and an additional winding *k* is placed on each transformer K which is in circuit with one of the coils of the relay F, or a coil of the relay may be in circuit with one of the two windings of the transformer K.

Referring now to Fig. 3, this figure illustrates the same form of invention as that illustrated in Fig. 1 with the exception that a device for regulating the phase of one of the relay coils is employed. It is well known that the power factor of the alternating current operating a car or train is a variable quantity, the power factor varying through a wide range. The varying power factor is due to the fact that the alternating current propelling the car or train is out of phase with its E. M. F., and the angle of phase varies according as the load and speed of the car or train varies. As the phase of the alternating current furnished by the secondary of the transformer H is determined only by its own circuit and so would be constant, it is apparent that the propulsion current, if sufficiently out of phase with its E. M. F. might operate the relay F, if a difference of potential between rails, due to the power current, should occur for any reason. To overcome this, I have included in the circuit of coil F^1 of the relay a phase angle changing device P^1, here shown as being in the form of a variable reactance. The variation in reactance is obtained by means of inserting or withdrawing from the coil the laminated iron core P^2. The movement of the core P^2 is under the control of a motor device which is also operable by alternating currents of different phase. L designates such a device. One of its coils L^1 is in circuit with the secondary of the transformer H, while its other coil L'' is in series circuit with the track rails of two adjacent block sections. It is apparent that a difference of phase in the two coils L^1 and L'' of the motor L will rotate the armature. The rotating of the armature causes the iron core P^2

to move into and out of the winding P^1, thereby increasing or diminishing the reactance in this circuit and increasing or decreasing also the angle of lag. It is the object of this invention to so proportion the parts that the change in the angle of lag in the coil F^1 of the relay will be in proportion to the angle of lag between the E. M. F. and the propulsion current. As the current in the coil L^1 is determined only by the transformer, and the current in the coil L'' is the propulsion current, any difference of phase angle between these two currents will cause a rotation of the armature of the motor L, to move the core P^2 in the coil P, thereby increasing the lag of the current in the coil F^1. The angle of lag between the E. M. F. and the propulsion current will not usually exceed about 45 degrees and the angle of lag between the E. M. F. and the track current may be made nearly 90 degrees. It is therefore apparent that even if sufficient reactance is inserted in the current traversing the winding F^1 of the relay F so as to cause the angle of lag in the current traversing this circuit to be the same as the propulsion current, about 45 degrees, there will still be a sufficient angle of lag between the alternating track current and the alternating current traversing coil F^1 to operate the relay F. With this arrangement of apparatus I therefore cause the current traversing the coil F^1 of the relay to be automatically controlled so that it has the same phase as the propulsion current, therefore the relay cannot be operated by the combined action of the current in the coil F^1 and the propulsion current which might flow through the coil F^2, while at the same time I obtain sufficient angle between the current traversing the coil F^1 of the relay and the signaling current to operate this relay.

What I claim as my invention and desire to secure by Letters Patent, is:

1. In combination with an electric railway, the trackway of which is divided by insulations to form block sections and serves as part of the return path for the propulsion current for the cars traveling along the railway, an alternating current generator for supplying the car propulsion current, means for conducting the propulsion current from the track rails of each block section to the track rails of the adjacent block sections, a track circuit for each block section, alternating current supplied to each track circuit from the said generator, but of a different phase from that of the alternating propulsion current, an alternating current relay for each track circuit operable by a plurality of alternating currents of different phases, one of which is supplied from the track circuit, another of which is supplied from the alternating current generator, and means controlled by variations in the phase of the return propulsion current flowing along the track rails for varying the phase of the last-mentioned current in the relay.

2. In combination with an electric railway the trackway of which is divided by insulations to form block sections and serves as part of the return path for the propulsion current for the cars traveling along the railway, an alternating current generator for supplying the car propulsion current, means for conducting the propulsion current from the track rails of each block section to the track rails of the adjacent block sections, a track circuit for each block section, alternating current supplied to each track circuit from said generator but of a different phase from that of the alternating propulsion current, an alternating current relay for each track circuit operable by a plurality of alternating currents of different phases, one of which is supplied from the track circuit, another of which is supplied from the alternating current generator, and a means whereby the phase angle of the last mentioned current in the relay is controlled by the variation in the phase of the return propulsion current in the rails of the trackway.

3. In combination with an electric railway the trackway of which is divided by insulations to form block sections and serves as part of the return path for the propulsion current for the cars traveling along the railway, an alternating current generator for supplying the car propulsion current, means for conducting the propulsion current from the track rails of each block section to the track rails of the adjacent block sections, a track circuit for each block section, alternating current supplied to each track circuit from said generator but of a different phase from that of the alternating propulsion current, an alternating current relay for each track circuit operable by a plurality of alternating currents of different phases, one of which phases is supplied from the track circuit, another of which phases is supplied from the alternating current generator, and a means whereby the angle of lag of the last mentioned current in the relay is maintained the same as the angle of lag of the return propulsion current in the track rails for the corresponding block section.

4. In combination with an electric railway the trackway of which is divided by insulations to form block sections and serves as part of the return path for the propulsion current for the cars traveling along the railway, an alternating current generator for supplying the car propulsion current, means for conducting the propulsion current from the track rails of each block sec-

tion to the track rails of the adjacent block sections, a track circuit for each block section, alternating current supplied to each track circuit from said generator but of a different phase from that of the alternating propulsion current, an alternating current relay for each track circuit operable by a plurality of alternating currents of different phases, one of which phases is supplied from the track circuit, another of which phases is supplied from the alternating current generator, and a means whereby the angle of lag of the last mentioned current in the relay is maintained the same as the angle of lag between the return propulsion current in the track rails and the voltage for the corresponding block section.

5. In combination with an electric railway the trackway of which is divided by insulations to form block sections and serves as part of the return path for the propulsion current for the cars traveling along the railway, an alternating current generator for supplying the car propulsion current, means for conducting the propulsion current from the track rails of each block section to the track rails of the adjacent block sections, a track circuit for each block section, alternating current supplied to each track circuit from said generator but of a different phase from that of the alternating propulsion current, an alternating current relay for each track circuit operable by a plurality of alternating currents of different phases, one of which is supplied from the track circuit, another of which is supplied from the alternating current generator, and means controlled by variations of the phase of the return propulsion current in the track rails of a block section for varying the phase of the last mentioned current in the relay.

6. In a signaling system for an electric railway the track rails of which are included in the circuit of the propulsion current, track sections formed by insulations in the track rails, a source of alternating propulsion current, means for conducting the propulsion current from track section to track section around the insulations, a track circuit for each track section, means for supplying each track circuit with current from the said source but differing in phase from the voltage of said source, a relay for each track circuit operable by a plurality of alternating currents differing in phase one of which currents is supplied from the track circuit and another of which currents is supplied from the said source independently of the track circuit, and means controlled by variations in the phase of the propulsion current in the track rails for varying the phase of the last-mentioned current in the relay, and railway signals controlled by the relays.

7. In a signaling system for an electric railway the track rails of which are included in the circuit of the propulsion current, track sections formed by insulations in the track rails, a source of alternating propulsion current, means for conducting the propulsion current from track section to track section around the insulations, a track circuit for each track section, means for supplying each track circuit with current from the said source but differing in phase from the voltage of said source, a relay for each track circuit operable by a plurality of alternating currents differing in phase one of which currents is supplied from the track circuit and another of which currents is supplied from the said source independently of the track circuit, and means controlled by the propulsion current in the track rails for maintaining the lag of the last-mentioned relay current the same as the lag of the propulsion current behind the voltage of the said source, and railway signals controlled by the relays.

8. In a signaling system for an electric railway the track rails of which are included in the circuit of the propulsion current, a source of alternating propulsion current, a track circuit, means for supplying to said track circuit alternating current from said source but differing in phase from the voltage of the source, a relay operable by a plurality of alternating currents differing in phase one of which currents is supplied from the track circuit and another of which is supplied from the source independently of the track circuit, and means controlled by the propulsion current in the track rails for varying the phase of the last-named relay current relative to the voltage of the said source in accordance with variations of the phase of the propulsion current in the rails relative to the voltage of the said source, and a railway signal controlled by the relay.

9. In a signaling system for an electric railway the track rails of which are included in the circuit of the propulsion current, a source of alternating propulsion current, a track circuit, means for supplying to said track circuit alternating current from said source but differing in phase from the voltage of the source, a relay comprising two windings one of which is energized from the track circuit and the other of which is energized from the source of propulsion current independently of the track circuit, and means controlled by the propulsion current in the track rails for varying the phase of the last-mentioned current in the relay in accordance with variations in the phase of the propulsion current relative to the voltage, and a railway signal controlled by the relay.

10. In a signaling system for an electric railway the track rails of which are included in the circuit of the propulsion current, a

source of alternating propulsion current, a track circuit, means for supplying to said track circuit alternating current from said source but differing in phase from the voltage of the source, a relay operable by a plurality of alternating currents differing in phase one of which currents is supplied from the track circuit and another of which is supplied from the source independently of the track circuit, an adjustable impedance included in the circuit of the last-named relay current, and a motor device for the control of said impedance comprising two windings one of which is energized by the propulsion current flowing in the track rails and the other of which is energized from the said source of current independently of the propulsion current in the track rails, and a railway signal controlled by the relay.

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

LOUIS H. THULLEN.

Witnesses:

GEO. E. CRUSE,

W. L. MCDANIEL.