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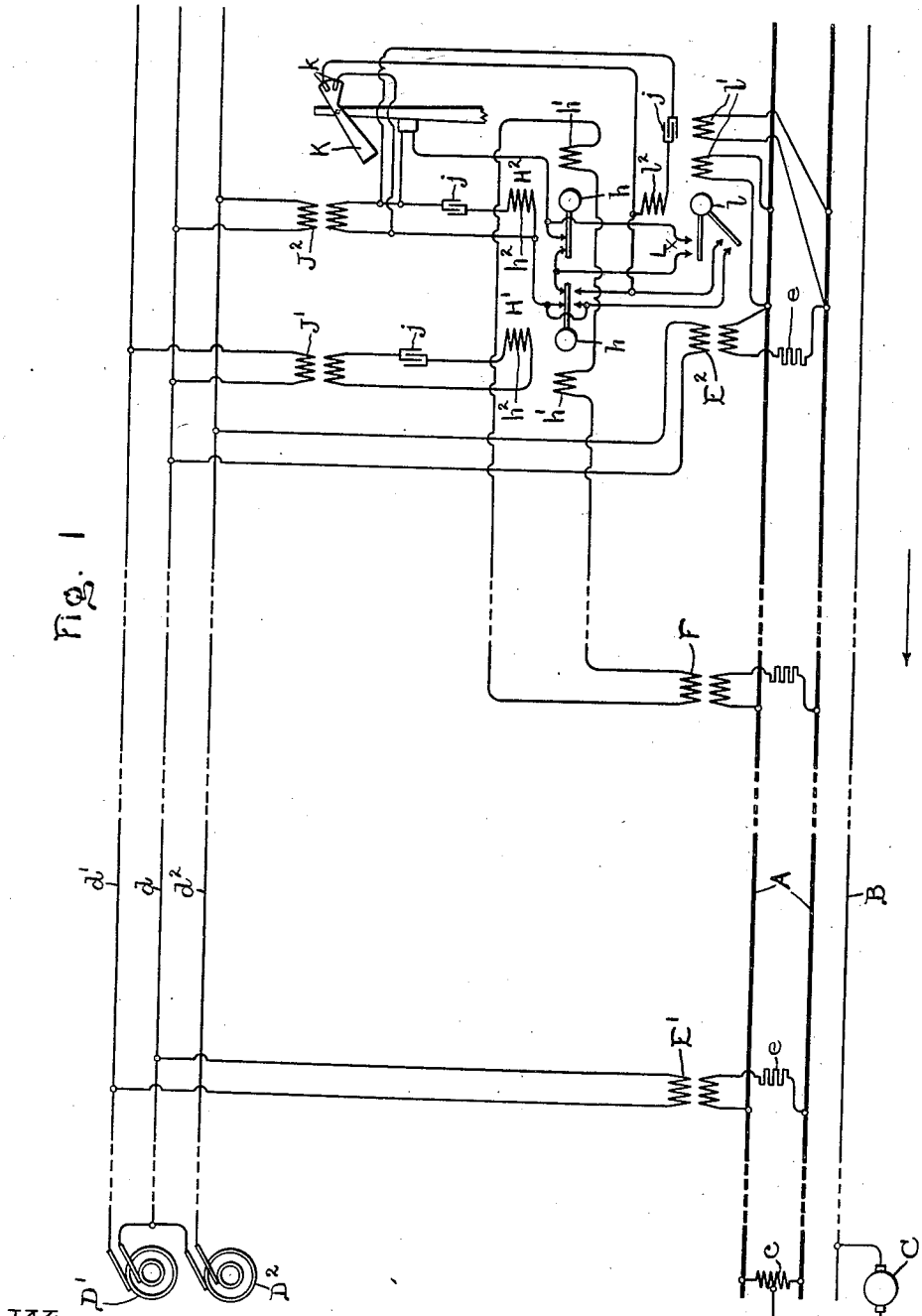
BLOCK SIGNAL SYSTEM.

APPLICATION FILED JULY 22, 1908. RENEWED OCT. 11, 1910.

1,094,894. Patented Apr. 28, 1914.

2 SHEETS—SHEET 1.

Fig. 1



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BLOCK SIGNAL SYSTEM.

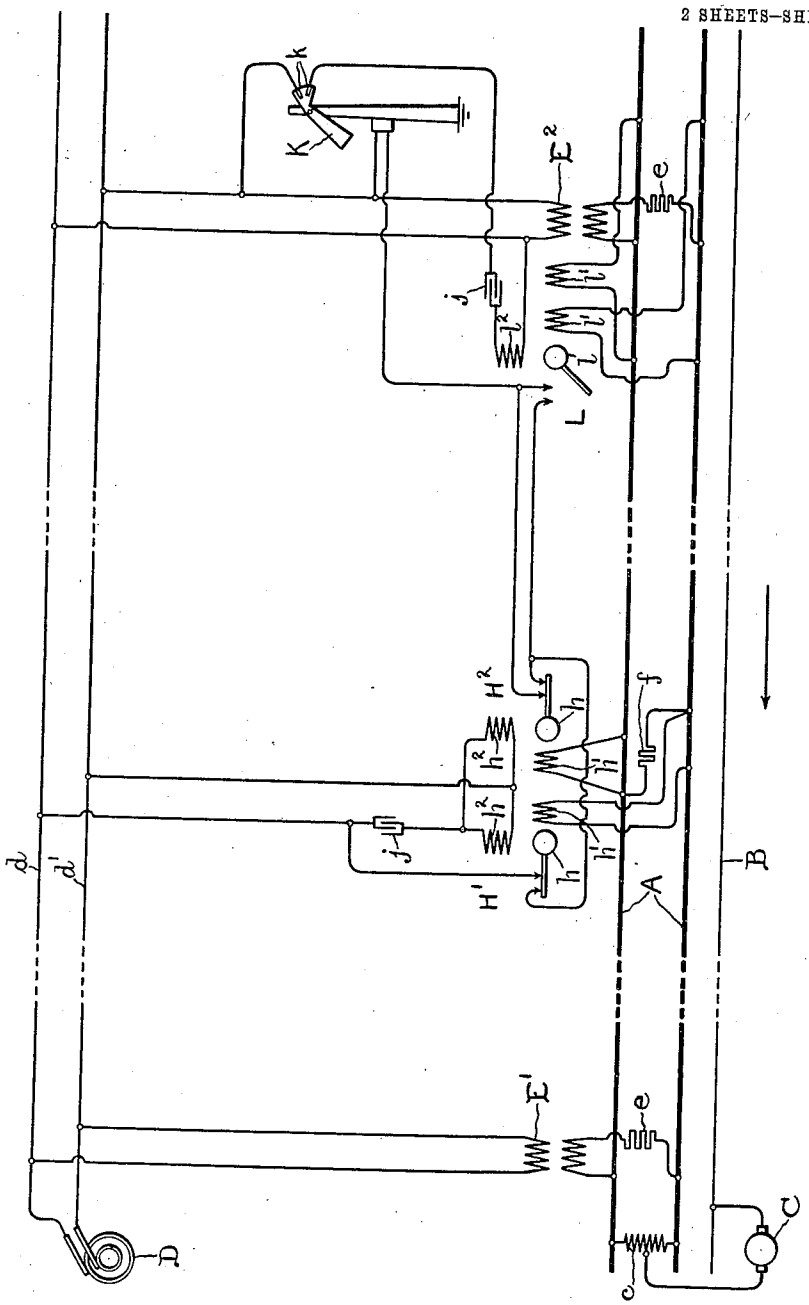
APPLICATION FILED JULY 22, 1908. RENEWED OCT. 11, 1910.

1,094,894.

Patented Apr. 28, 1914.

2 SHEETS—SHEET 2.

Fig. 2



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LAURENCE A. HAWKINS, OF SCHENECTADY, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE UNION SWITCH AND SIGNAL COMPANY, A CORPORATION OF PENNSYLVANIA.

BLOCK-SIGNAL SYSTEM.

1,094,894. Specification of Letters Patent. Patented Apr. 28, 1914.

Application filed July 22, 1908, Serial No. 444,744. Renewed October 11, 1910. Serial No. 586,558.

To all whom it may concern:

Be it known that I, LAURENCE A. HAWKINS, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Block-Signal Systems, of which the following is a specification.

My invention relates to block signal systems for electric railways, in which the rails are continuous for all currents, comprising sources of alternating current connected across the rails at intervals, and a pair of relays supplied with current from the tracks between each two adjacent sources, each relay responding to current from one adjacent source only. In such a system, a block or block section may extend from one source to the next, or from one pair of relays to the next, according as a pair of relays are connected to control the same or different signals. One such system, in which the block extends from one source to the next, is described in my former application, No. 329,347, filed August 6, 1906. In such a system a train approaching a source of current at the entrance to a block, reduces its voltage and gradually deënergizes the relay supplied from that source. The point at which the relay drops its contact and causes the signal to go to danger is consequently not absolutely fixed. While it can be fixed sufficiently closely for all practical purposes by employing transformers of good regulation, and using a high frequency signal current, so that the impedance of the rails to the signal current is high, it is sometimes advantageous to provide other means for fixing the point at which the signal goes to danger. This may be done either to fix the point more definitely than would otherwise be the case, or to save power, since when such means are employed the transformer need not have good regulation, and consequently the current delivered by the transformer, when a train is standing across its secondary terminals, is not high. One arrangement for definitely fixing the point at which the signal goes to danger is described in my former application, Serial No. 378,243, filed June 10, 1907. In the system disclosed in that application I employed a short insulated rail section.

The purpose of my present invention is to provide auxiliary means for defining the entrance-point to the block without introducing any insulated joints into the rails. I accomplish this by providing a relay having a winding connected in shunt to a short length of rail near the transformer at the entrance to the block, and arranged to control the signal jointly with the other track relays in such manner as to render ineffective to control the signal that relay of the pair of relays of the block which responds to the current from the source at the entrance of the block.

My invention will best be understood by reference to the accompanying drawings, in which—

Figure 1 shows diagrammatically a block signal system arranged in accordance with my invention; and Fig. 2 shows my invention applied to a differently arranged signal system of the same general character.

In Fig. 1, A represents the track rails, which may be made conductively continuous for all currents throughout their length. B represents a third-rail, or other supply conductor, and C the generator of the power-current, which has one terminal connected to the third-rail B, and the other to the track-rails A through the differential choke-coil *c*. The power-generator C may deliver either direct or alternating current. D^1 D^2 represent alternating-current generators for supplying the signal current. The currents delivered by these generators differ from each other in frequency, and, if the power-current is alternating, they differ in frequency from that current. *d*, d^1 and d^2 represent transmission wires supplied with current from the generators D^1 and D^2. A three-wire transmission system is shown with the wire *d* serving as common return for both frequencies. E^1 and E^2 represent transformers having their primaries supplied with current from the generators D^1 and D^2, respectively, through the line-wires, and the secondaries connected across the track-rails at a distance apart, which, in the drawing, corresponds to the length of a block. Impedances *e* may be inserted in series with the transformer secondaries to prevent saturation of the secondaries by the power-current and to limit the short-circuit current with a train standing on the track at the transformer. F represents a transformer having its primary connected across the rails between the sup-

ply transformers E^1 and E^2. H^1 and H^2 represent a pair of relays, which are shown as of the well-known two-phase induction type, each comprising a short-circuited secondary member h carrying the relay contacts and two coöperating windings for producing the torque in the secondary member. The windings h^1 of the two relays are both connected to the secondary of the transformer F, and are consequently supplied with current from the track between the two transformers E^1 and E^2. The other relay windings h^2 are connected to different line-wires through step-down transformers J^1 and J^2, respectively, so that they are supplied with currents of different frequency. Thus, although the windings h^1 of both relays are normally traversed by current supplied to the track by both transformers E^1 and E^2, the relay H^1 responds only to current from transformer E^1, and the relay H^2 only to current from transformer E^2. Any suitable means, such as condensers j, may be employed for producing a proper phase relation between the currents of windings h^1 and h^2 of each relay. K represents a signal guarding the portion of track between the transformers E^1 and E^2, the direction of traffic being as indicated by the arrow. L represents a third relay, which may also be of the two-phase induction type. This relay has two track windings, l^1, which are connected in shunt to short lengths of rail opposite each other and adjacent to transformer E^2, while the winding l^2 is supplied independently of the track circuit with current of the same frequency as that delivered by transformer E^2. The voltage impressed on windings l^1 is that due to the voltage drop in the rail lengths shunted by them, which voltage, because of the "skin effect" produced by the alternating signal current is much higher than would be produced by direct current of the same amount. As long as a block is clear, both relays H^1 and H^2 are energized, as shown, their front contacts completing the circuit for the operating mechanism of signal K, so that signal K stands at clear. Relay L is normally deenergized, since the normal current that flows from the secondary of transformer E^2 through the track to the right of the transformer, is insufficient in amount to produce enough current in the track windings l^1 to give the relay enough torque to hold its contacts closed.

Now, if a train is approaching the block, that is approaching transformer E^2 from the right, it draws an increasing current from this transformer, and at the same time reduces the voltage supplied to the track by this transformer. Relay H^1, which responds only to current from transformer E^1, is not affected, but relay H^2 has its torque gradually reduced, as the train comes near the block, and when the train is a certain distance away from transformer E^2, relay H^2 will open its contacts. This would put signal K at danger, if it were not for the relay L. Before relay H^2 opens its contact, the increased current drawn from transformer E^2 by the approaching train increases the drop of potential in the rails immediately to the right of this transformer, so as to increase the current in the track winding l^1 of the relay L. This increase is sufficient to cause relay L to close its contacts, and its upper front contacts short-circuit the contacts of relay H^2. Thus, although, relay H^2 opens its contacts, signal K is not thrown to danger until the train passes over the short lengths of rail spanned by the track windings l^1 of relay L. When the train reaches transformer E^2, relay L is wholly deënergized and drops its contacts, thereby causing signal K to go to danger. The circuit of the winding l^2 of relay L passes through contacts k on the signal, so arranged that when the signal has gone to danger, the circuit of this winding is opened. The purpose of this arrangement is to avoid the possibility, when a train has passed transformer E^2 some distance, but has not reached transformer F, so that relay H^1 is still energized; of a second train approaching transformer E^2 and drawing sufficient current from the transformer to energize relay windings l^1, thereby causing relay L to shunt the contact of relay H^2 and clear the signal. Since the winding l^2 runs through contacts k on the signal its circuit is open when the signal is at danger, relay L can only serve to prevent the signal from being thrown to danger by relay H^2, when the signal is at clear; but cannot cause the signal to clear if it is once at danger and relay H^2 is open. The opening of relay H^1 will always throw the signal K to danger, regardless of the condition of relay L, so that a train approaching the block cannot prevent the signal from being thrown to danger by a train backing into the block at the other end.

In addition to the contacts shunting the contacts of relay H^2, relay L has a second pair of front contacts connected in parallel with back contacts on relay H^1. This arrangement is not absolutely essential, but has the following advantage. If these contacts were not employed, and if the block were already occupied by a train so that a second train, approaching the block and finding signal K at danger, waited for it to clear, then when the first train ran out of the block, allowing relay H^1 to close its contacts, the signal K would not clear, because the second train would be close enough to transformer E^2 to prevent relay H^2 from picking up, while the winding l^2 of relay L would be opened at contacts k, so that relay L

would not pick up its contacts. The second train would thus be unnecessarily delayed. This is not a serious matter, since in automatic block signal systems it is ordinarily the rule for a train, on finding a signal at danger, to wait a certain length of time and then proceed through the block under control. The additional contacts, above mentioned, however, avoid unnecessary delay. The first train, as long as it is in the last half of the block, holds relay H^1 deënergized, so that the back contacts of this relay are closed. These back contacts are in shunt to the contacts k on the signal, as well as to the lower front contacts of relay L, so that with relay H^1 deënergized, winding l^2 of relay L is energized. Therefore, if a train is waiting at the signal for it to clear, relay L will be energized before the train ahead leaves the block. Consequently relay L shunts the front contacts of relay H^2, so that when relay H^1 picks up its contacts as the train ahead leaves the block, the circuit of the operating mechanism of signal K is closed, and this signal clears. The opening of the back contacts of relay H^1, when this relay picks up, does not deënergize relay winding l^2, since the lower front contacts or relay L are in shunt to the back contacts of relay H^1, so that when relay L is energized, it remains energized as long as a train is standing near transformer E^2, and to the right of the terminals of windings l^1. Thus, by the use of these auxiliary contacts, the signal K is caused to clear as soon as the first train passes out of the block, but would be immediately returned to danger, if the first train should again back into the block.

My invention is not limited to systems in which the adjacent sources of current are of different frequency, or of different character; but is applicable to any system in which the sources of current are connected across the rails at intervals, and pairs of relays are supplied from the track between two adjacent sources, each relay responding only to current from one source. While in Fig. 1, in order to render each relay responsive to current from one source only, the adjacent sources are caused to supply currents of different character, in Fig. 2, each relay is rendered responsive to current from one source only by its connection to the track. This connection is such that normally no current flows through the track winding of the relay, except that from one adjacent source, and any current that does flow through the track winding of the relay from the other adjacent source cannot actuate the relay, because it is of the wrong phase.

In Fig. 2, the adjacent transformers E^1 and E^2 are supplied from the same generator D. In place of the transformer F of Fig. 1, a low impedance f is connected across the rails, and the track winding h^1 of relays H^1 and H^2 are connected in shunt to short lengths of rails on opposite sides of the impedance f. This impedance may be connected diagonally across the rails, as shown, so as to cause the track connections of relays H^1 and H^2 to overlap, as described in my former application, Serial No. 435,861, filed June 1, 1908. With this arrangement of the relays, they are more conveniently placed at the middle of the block, instead of near the signal, as in Fig. 1, in which figure the relays are placed near the signal simply to reduce the number of wires to the smallest amount. The relay L, as before, has its contacts connected in shunt to the contacts of relay H^2, so that when the relay L is energized, relay H^2 is rendered ineffective to put the signal at danger. As before, the relay winding l^2 has its circuit carried through contacts k on the signal, for reasons above pointed out. The other set of contacts on relay L shown in Fig. 1 in shunt to back contacts of relay H^1 are omitted in Fig. 2, in order to simplify the wiring. As has been pointed out, the addition of these contacts is not essential. The connection of the track winding l^1, of relay L, is somewhat different in Fig. 2 from that of Fig. 1. Instead of being connected in shunt to short rail-lengths lying wholly to the right of transformer E^2, they are connected in shunt to short rail-lengths lying equally on opposite sides of the transformer. Thus, normally, there is no current flowing through the windings l^1, but a train approaching transformer E^2 from the right produces a flow of current through these relay windings because the voltage drop in the rails to the right of the transformer is then greater than that to the left. Either connection of the relay windings l^1 may be used with either the system of Fig. 1 or that of Fig. 2, the arrangement of Fig. 1 giving a somewhat greater maximum torque to the relay L, while that of Fig. 2 gives a wider range of torque if the transformer E^2 is of poor regulation, so that the current does not increase very greatly when a train approaches, and furthermore gives the relay a back torque to force it open very positively when the train passes to the left of transformer E^2.

I do not desire to limit myself to the particular connections and arrangement of parts here shown, but aim in the appended claims to cover all modifications which are within the scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing

in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, and a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal, the said portion of rail being of such length that the relay is normally deënergized but responds to the increased current flow in the rail produced by an approaching train, said relay being arranged when energized to render ineffective to control the signal that relay of said pair which responds to the current from said source near the signal.

2. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, and a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal, of such length that said relay is normally deënergized but responds to the increased current-flow in the rails produced by an approaching train, which relay when energized renders ineffective to control the signal that relay of said pair which responds to the current from said source near the signal.

3. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track relays between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, and a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal, of such length that said relay is normally deënergized but responds to the increased current-flow in the rails produced by an approaching train, said relay having front contacts connected in parallel with front contacts of that relay of said pair which responds to the current from said source near the signal.

4. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, and a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal and jointly with said pair of relays controlling said signal, the said portion of rail being of such length that the relay is normally deënergized but responds to the increased current flow in the rail produced by an approaching train.

5. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal and jointly with said pair of relays controlling said signal, the said portion of rail being of such length that the relay is normally deënergized but responds to the increased current flow in the rail produced by an approaching train, and contacts controlled by said signal controlling a circuit of the last-mentioned relay.

6. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal and jointly with said pair of relays controlling said signal, the said portion of rail being of such length that the relay is normally deënergized but responds to the increased current flow in the rail produced by an approaching train, and means controlled by said signal for rendering the last-mentioned relay inoperative.

7. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal and jointly with said pair of relays controlling said signal, the said portion of rail being of such length that the relay is normally deënergized but responds to

the increased current flow in the rail produced by an approaching train, and contacts controlled by said signal in circuit with a circuit of the last-mentioned relay and arranged to open said circuit when the signal is at danger.

8. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal and jointly with said pair of relays controlling said signal, the said portion of rail being of such length that the relay is normally deënergized but responds to the increased current flow in the rail produced by an approaching train, and contacts controlled by said signal in circuit with a winding of said relay and arranged to deenergize said winding when the signal is at danger.

9. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, adjacent sources differing in character, a pair of relays supplied with current from the track between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources controlled by the pair of relays, a relay having a winding connected in shunt to a portion of rail near the source adjacent to the signal, the said portion of rail being of such length that the relay is normally deënergized but responds to the increased current flow in the rail produced by an approaching train, and means controlled by said signal for rendering the last-mentioned relay inoperative, that relay of said pair which responds to current from the source not adjacent to the signal having back contacts connected in shunt to the contacts controlled by the signal.

10. In combination, a stretch of railway track, a source of signaling current connected with the rails thereof, a relay supplied with current from the rails, a signal controlled by said relay, a second relay having a winding connected in shunt to a portion of rail adjacent said source the difference of potential between opposite ends of said portion due to the normal flow of current through said portion being of such an amount that the relay is normally deënergized but that the relay responds to the current-flow in the rails due to an approaching train, and means controlled by said second relay when energized for rendering the first-mentioned relay ineffective to control said signal.

11. In combination, a stretch of railway track, a source of signaling current connected with the rails thereof, a relay having a winding connected in shunt to a portion of rail extending to the rear from the connection of said source, said portion of rail being of such length that the relay is normally deënergized but responds to the current-flow due to an approaching train, and a signal controlled by said relay.

12. In a railway signaling system, in combination with the rails of a railway, a source of current connected across the rails, a relay having one winding connected in shunt with a portion of rail adjacent the source, the portion being of such length that the relay is normally deënergized but responds to the current-flow in the said rail due to an approaching train, and a signal controlled by the relay.

13. In combination, a stretch of railway track, a source of current connected across the rails of said stretch, a relay having a winding connected in shunt to a portion of rail adjacent said source, the difference of potential between opposite ends of said portion due to the normal flow of current being such that the relay is normally deënergized, but the difference of potential between opposite ends of said portion due to an approaching train being such that the relay is then energized, and a signal controlled by said relay.

In witness whereof, I have hereunto set my hand this 20th day of July, 1908.

LAURENCE A. HAWKINS.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."