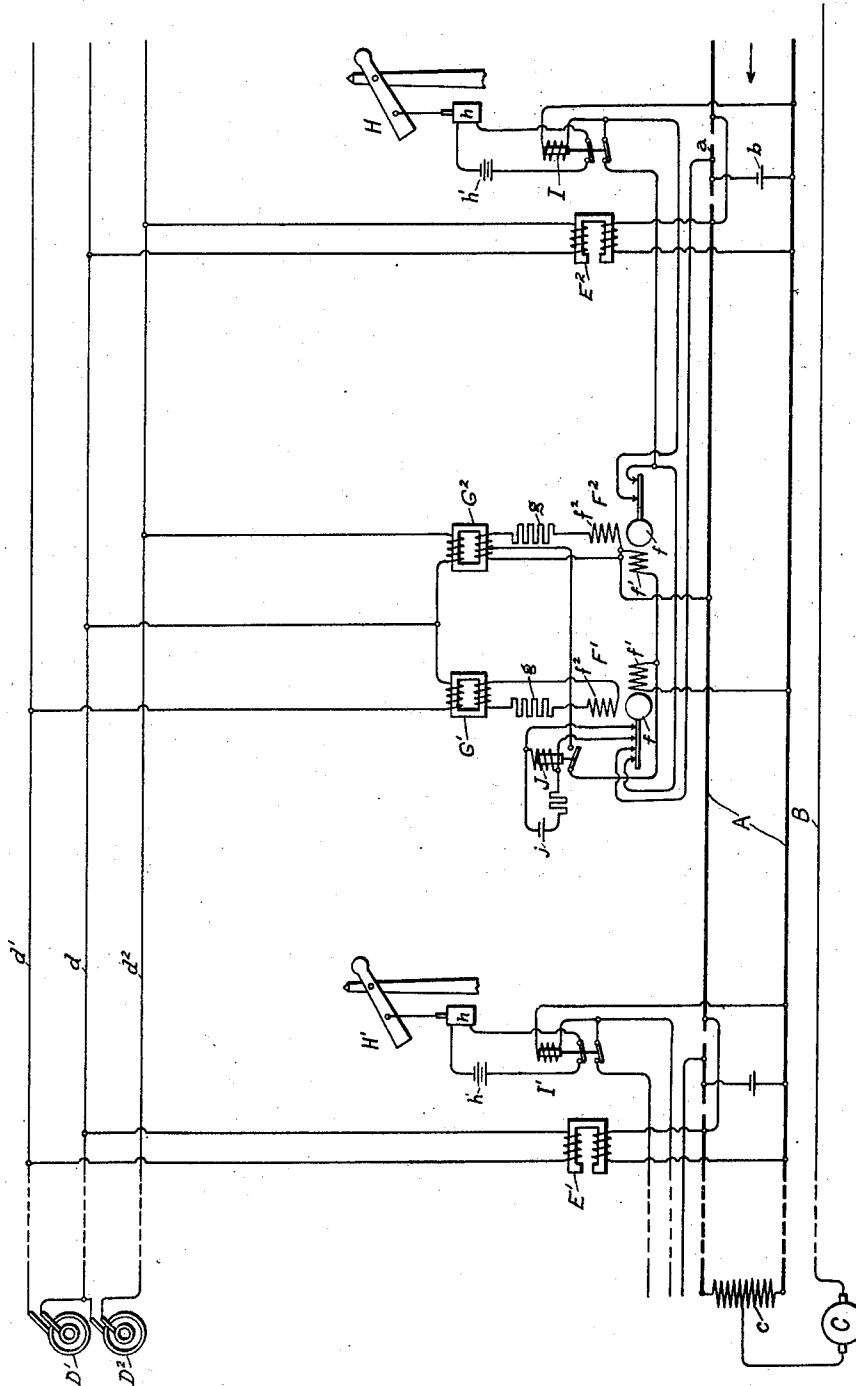


L. A. HAWKINS.
BLOCK SIGNAL SYSTEM.

APPLICATION FILED JUNE 10, 1907. RENEWED APR. 28, 1909.

937,738.

Patented Oct. 19, 1909.



WITNESSES:

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INVENTOR

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ATT'Y.

UNITED STATES PATENT OFFICE.

LAURENCE A. HAWKINS, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

BLOCK-SIGNAL SYSTEM.

937,738.

Specification of Letters Patent.

Patented Oct. 19, 1909.

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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, and consists in an improvement in the system described in my former application, Serial No. 329,347, filed August 6, 1906. In that former application I described a signal system in which both rails are conductively continuous for all currents, and sources of current are connected across the rails at the ends of the blocks, the currents from adjacent sources being of different frequency. Track relays are connected in pairs across the rails at points between the sources, each relay responding only to current of one frequency. The two relays jointly control a signal for the portion of the track between the sources, so that when either source is cut off from the relays by a train in the block the signal goes to danger. Since the rails in the system are continuous, an approaching train begins to lower the voltage supplied to the rails by the transformer at the entrance of the block before the train reaches that transformer, so that the relay responding to the current from that source drops its contact before the train reaches the transformer. In order to make the length of the block definite, or in other words, to make more or less definite the point reached by the train when the signal goes to danger, I took advantage in the system of my earlier application of the high impedance of an iron rail to alternating currents of high frequency. By using high frequency currents and transformers of fairly good regulation for the current sources, the system may be so arranged that the signal will not go to danger until the train is close to the transformer. In my former application, I suggested 250 and 300 cycles as suitable frequencies.

For railways having very long blocks, a high frequency signal current is disadvantageous, since it necessitates employing a high voltage for the signal current with consequent leakage.

My present invention consists in providing means for making the entrance end of

the block absolutely fixed, so that currents of low frequency may be used for the signal circuits, if desired. I accomplish this result by providing a magnet cooperating with the track relays to control the signal and arranged to be actuated only when a train reaches a fixed point. This magnet may control contacts shunting the contacts of the relay supplied from the transformer at the entrance of the block. With this arrangement, the relay supplied from that transformer may drop its contacts without putting the signal at danger. The signal remains at clear until the train reaches the fixed point.

With the arrangement above outlined, it will be seen that if a train approaches a signal of an occupied block, finds it at danger, and stops in front of the signal, its presence will prevent the track relay supplied from the transformer at the entrance end of the block from picking up its contacts when the block is again clear, and consequently will prevent the signal from clearing. While this is not always objectionable, since in automatic signal systems it is usually the rule for a train on finding a signal at danger to wait a certain length of time and then proceed at low speed through the block, I prefer to arrange the system so that the signal will clear at once when the train ahead leaves the block; and a second feature of my invention consists in the arrangement for doing this. I accomplish the desired result, as will be hereinafter explained, by controlling the relay supplied from the transformer at the entrance of the block by the relay responding to the current from the transformer at the exit end of the block. While this second feature of my invention is particularly advantageous for use in connection with the first feature, it may also be used to advantage in certain cases in the system described in my former application, without the use of the first feature. The reason for this is that it frequently is desirable to design the relay so that its torque, with its contacts closed, is greater than with its contacts open, in order to make the operation of the relay more positive. Even if the relay is not intentionally designed to secure this result, the relay may often possess this characteristic, due to its inertia and friction. Consequently, if the signal is placed at a point where the train shunts the

relay supplied from the transformer at the entrance end of the block sufficiently to make it drop its contacts, then if the relay contacts are once down, as would be the case with a train in the block, and if a second train stands at the signal waiting for it to clear, the relay will not pick up when the first train leaves the block. While this is not highly objectionable with the rule ordinarily in force, mentioned above, nevertheless a little time might occasionally be lost, which can be saved by supplying to the system what I have termed the second feature of my present invention.

My invention will best be understood by reference to the accompanying drawing, which shows diagrammatically a block signal system arranged in accordance with my invention.

In the drawing A represents the track rails, both of which are conductively continuous for all currents.

B represents the third rail, or other power-current conductor connected to one terminal of the power-generator C. The other terminal of this generator may be connected to the rails through a differential choke-coil *c*, so that the rails act as return conductor for the power-current.

D¹ and D² represent alternating current generators of different frequencies connected to the line-wires *d*, *d*¹ and *d*², line-wire *d* serving as common return for currents of both frequencies.

E¹ and E² represent transformers having their primaries connected to the line-wires, and their secondaries to the track. Adjacent transformers are connected to line-wires carrying currents of different frequencies.

F¹ and F² represent a pair of track relays approximately midway between the transformers E¹ and E². While current from both transformers passes through the track windings of the two relays, each relay is arranged to respond to current from only one of the transformers. Thus, relay F² may respond only to current from transformer E², and relay F¹ only to current from transformer E¹. In order to make the relays thus selective, they are supplied with two cooperating windings, one connected across the track, and the other supplied with current independently of the track. I have shown relays of the well known induction type, comprising a short-circuiting member *f* carrying the relay contacts, a primary winding *f*¹ connected across the track, the track windings of the two relays being shown connected in series, and a winding *f*² supplied independently of the track with current of the same frequency as, but of different phase from, that supplied by one of the transformers E¹ and E². For supplying the relay windings *f*², I have shown transformers G¹ and G² with their primaries

connected to the line-wires and their secondaries connected to the relay windings. Phase-controlling devices *g* may be employed to secure the necessary phase-difference between the currents in the two windings of the relay. This phase-difference should be approximately 90 degrees for maximum torque. The two relays F¹ and F² jointly control a signal H, the operating mechanism of which is indicated diagrammatically at *h* and its source of current at *h*¹.

The system, as thus far described, is the same as that disclosed in my former application, above referred to.

I represents a magnet, one terminal of which is connected to the lower rail A, and the other terminal of which is connected through the front contacts of relays F¹ and F² in series to a short insulated rail section *a*. A suitable source of either alternating or direct current, indicated by battery *b*, is connected between the lower rail A and the insulated rail section *a*. With relays F¹ and F² energized, as shown, the circuit of magnet I is closed, so that it holds up its contacts. The upper of these contacts closes the operating circuit of the signal H, holding it at clear, while the lower contact shunts the contacts of relay F². If a train approaches in the direction indicated by the arrow, it will begin to pull down the voltage supplied by the transformer E² to the track some time before it reaches this transformer, and when the voltage drops a predetermined amount, relay F² will drop its contacts. The distance between the train and the transformer, when this occurs, will depend on a number of factors,—principally on the frequency of the current, and consequently the impedance of the rails, and on the regulation of the transformer E². The point at which the train is when relay F² drops its contacts is immaterial in the present system, since these contacts are shunted by the lower contact of magnet I, so that the movement of relay F² to open circuit position produces no change in the circuit connections. The signal H remains at clear until the front wheels of the train reach the short insulated rail section *a*. At this instant magnet I is short-circuited and drops its contacts, thereby opening the actuating circuit of signal H and allowing signal H to go to danger. As the train passes off the insulated rail section, the magnet I does not again close its contacts, since its circuit is now open at the contacts of relay F², so that it cannot again close its contacts and clear the signal until relay F² returns to the position shown in the drawing. This cannot occur, however, as long as the train is between the transformer E² and the relay, and before the train reaches relay F² it will have shunted relay F¹ sufficiently to cause it to drop its contacts; there-

by producing a second break in the circuit of magnet I. Magnet I will not, consequently, again be energized, nor will signal H clear until the train has passed sufficiently beyond transformer E¹ for the voltage of this transformer to rise enough to cause relay F¹ to pick up its contacts. The use of the magnet I and the short insulated rail section thus makes the entrance point of the block absolutely definite; so that a low frequency may be employed, if desired, for the signal circuits. The short insulated rail section serves simply as a circuit-closing device actuated by the train, and any other suitable circuit-closing device adapted to be actuated by a passing train may be employed in place of this insulated rail section.

If a train should be near the center of the block, so that both relays F¹ and F² are de-energized, and if a second train, approaching and finding the signal at danger, should stop at the signal, and consequently close to transformer E², relay F² would not pick up its contacts when the first train left the block, were it not for the auxiliary contacts on relay F¹. Consequently the signal H would not clear, and the second train might be needlessly delayed. With the auxiliary contacts of relay F¹, however, the signal H will clear as soon as the first train leaves the block, regardless of the presence of the second train close to the secondary terminals of transformer E². These contacts are arranged to control a relay J, supplied from any suitable source *j*, and arranged when energized to supply to the track winding *f*¹ of the relay F² a current of the same frequency as that supplied to the track by transformer E². This current it taken from the secondary of transformer G², the phase-controlling device *g* being excluded from this circuit, so that the necessary phase-difference is secured between the currents in the windings *f*¹ and *f*² of relay F². With the armature of relay F¹ down, the relay J is energized, thereby energizing relay F² independently of the track. With the armature of relay F¹ up, relay J is short-circuited and inoperative.

The sequence of operations is as follows: A train entering the block causes relay F² to drop its contacts. As the train advances toward the relays, it reaches a point where relay F¹ drops its contacts, thereby energizing relay J and closing the auxiliary circuit for the track winding of relay F². As long as the train is close to the relays, the relay F² will not pick up its contacts, but as the train passes the relays and draws near to transformer E¹ relay F² will pick up its contact; and this will be true whether or not a second train has reached the signal H, since the relay F² is not now dependent on the transformer E² for its current. Therefore, as soon as the train passes transformer

E¹ sufficiently for relay F¹ to pick up its contacts, the circuit of magnet I will be closed, and signal H will be cleared. It will be understood that relay J and magnet I are properly designed so that when relay F¹ closes its contacts magnet I will close its contacts before relay J and relay F² have both had time to open their contacts.

While the use of contacts controlled by the magnet winding I to shunt the contacts of relay F² is a convenient arrangement for securing the coöperation of the magnet I with the track relays to control the signal, it is obvious that the same result may be secured in other ways. Consequently I do not desire to limit myself to the particular construction and arrangement of parts here shown, but aim in the appended claims to cover all modifications which are within the scope of my invention.

I do not in this application make any claim to a block signal system for railways having both rails conductively continuous for all currents, in which adjacent sources of current for the track circuits are of different character and the relays are selectively responsive to current of one character only, nor do I make any claim to a system for such railways having the relays arranged in pairs between adjacent sources, since these matters form the subject-matter of my prior application, Serial No. 329,347, above referred to.

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 the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between said sources, each responsive only to current of a certain character, a signal controlled by each pair of relays, and means for rendering the relay responsive to current from the source at the entrance to the block ineffective to operate the signal on the approach of a train until the train reaches a fixed point in the track.

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 the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between said sources, each responsive only to current of a certain character, a signal controlled by each pair of relays, contacts shunting contacts of the relay responsive to current from the source at the entrance to the block, and means for opening said shunting contacts when a train reaches a fixed point in the track.

3. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating currents connected across the rails at the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between said sources, each responsive only to current of a certain character, a signal controlled by each pair of relays, contacts shunting contacts of the relay responsive to current from the source at the entrance to the block, and a magnet normally holding said shunting contacts closed and arranged to be deenergized by a train at a fixed point in the track.

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 the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between said sources, each responsive only to current of a certain character, a signal controlled by each pair of relays, contacts shunting contacts of the relay responsive to current from the source at the entrance to the block, and a magnet normally holding said shunting contacts closed and arranged to be deenergized by a train at a fixed point in the track, the winding of said magnet being included in circuit with said shunting contacts.

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 the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between said sources, each responsive only to current of a certain character, a signal, a magnet controlling said signal having its winding in series with contacts of both relays, and means for preventing the deenergization of said magnet by an approaching train until the train reaches a fixed point in the track.

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 the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between said sources, each responsive only to current of a certain character, a signal, a magnet controlling said signal having its winding in series with contacts of both relays, contacts controlled by said magnet shunting contacts of the relay responding to current from the source at the entrance of the block, and connections whereby said

magnet is deenergized when a train reaches a fixed point in the track.

7. In a block signal system, the combination with a railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at the ends of the blocks, the currents from adjacent sources differing in character, signal controlling means connected across the rails at the point between said sources, a signal controlled thereby, a normally energized magnet cooperating with said means to control said signal, and connections whereby said magnet is deenergized only by a train at a fixed point in the track.

8. In combination with an electric railway having both rails conductively continuous for all currents, sources of current connected at intervals across the rails, the currents from adjacent sources differing in character from each other and from the power-current, track relays connected across the rails each responsive to current of one character only, block signals controlled by said relays, and means for definitely fixing the entrance points of the blocks.

9. In combination with an electric railway having both rails conductively continuous for all currents, two sources of current of different character connected across the rails a distance apart, a block signal for the portion of the track between said sources, signal-controlling means connected across the rails at a point between said sources and arranged to put said signal at danger upon a failure of current from either of said sources, and means for preventing said signal from being put to danger by an approaching train until the train reaches a fixed point in the track.

10. In combination with an electric railway having both rails conductively continuous for all currents, two sources of current of different character connected across the rails a distance apart, a normally-clear block signal for the portion of track between said sources, two relays connected across the rails at a point between said sources each responsive to current of one character only, and means cooperating with said relays to control the signal arranged to be actuated by a train at a fixed point on the track.

11. 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 the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between the said sources, each responsive to current from one of said sources only, a signal controlled by each pair of relays, and means controlled by the relay responsive to

current from the source at the exit-end of the block for controlling the relay responsive to current from the source at the entrance-end of the block.

5 12. 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 the ends of the blocks, the currents
10 from adjacent sources differing in character, relays connected across the rails in pairs between the said sources, each responsive to current from one of said sources only, a
15 signal controlled by each pair of relays, and means controlled by one of said relays for controlling the other.

13. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources
20 of alternating current connected across the rails at the ends of the blocks, the currents from adjacent sources differing in character, relays connected across the rails in pairs between the said sources, each responsive to
25 current from one of said sources only, a signal controlled by each pair of relays, and means controlled by one of said relays for supplying to the other relay independently of the track-circuit current of the character
30 to which it responds.

14. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources
35 of current of different character connected across the rails at the ends of the blocks, a signal, and a pair of relays jointly controlling said signal, each relay having two co-operating windings, one connected across the rails at a point between said sources, and
40 the other supplied with current independently of the track-circuits, one of said relays being provided with back contacts arranged and connected to supply to the track winding of the other relay independently of the
45 track-circuits a current corresponding in character to that supplied to the track by one of said sources.

15. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources
50 of alternating current connected across the rails at intervals, a pair of track relays supplied with current from the rails between two adjacent sources, each responding to
55 current from one adjacent source only, a signal near one of said sources guarding the portion of track between said sources and controlled by said pair of relays, and means actuated by a train approaching the source
60 near the signal for controlling the signal jointly with said pair of relays.

16. In a block signal system, in combination with a railway having both rails con-

ductively continuous for all currents, sources of alternating current connected across the
65 rails at intervals, a pair of track relays supplied with current from the rails between two adjacent sources, each responding to current from one adjacent source only, a signal near one of said sources guarding the
70 portion of track between said sources and controlled by said pair of relays, and means coöperating with said relays in the control of the signal for fixing the point reached by a car when the signal goes to danger.

17. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources
75 of alternating current connected across the rails at intervals, a pair of track relays supplied with current from the rails between two adjacent sources, each responding to current from one adjacent source only, a
80 signal near one of said sources guarding the portion of track between said sources and controlled by said pair of relays, contacts shunting the contacts of the relay responding to current from the source near the signal, and means for operating said contacts
85 arranged to be actuated by a train approaching said source.

18. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources
95 of alternating current connected across the rails at intervals, a pair of track relays supplied with current from rails between two adjacent sources, each responding to current from one adjacent source only, a signal near
100 one of said sources guarding the portion of track between said sources and controlled by said pair of relays, and a relay arranged to be actuated by a train approaching the source near the signal and controlling the
105 signal jointly with said pair of relays.

19. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources
110 of alternating current connected across the rails at intervals, a pair of track relays supplied with current from rails between two adjacent sources, each responding to current from one adjacent source only, a signal near
115 one of said sources guarding the portion of track between said sources and controlled by said pair of relays, and a relay arranged to be actuated by a train approaching the source near the signal and controlling the movement of the signal to danger.

In witness whereof, I have hereunto set
my hand this 7th day of June, 1907.

LAURENCE A. HAWKINS.

Witnesses:

BENJAMIN B. HULL,
MARGARET E. WOOLLEY.