

937,440.

Patented Oct. 19, 1909.
2 SHEETS—SHEET 1.

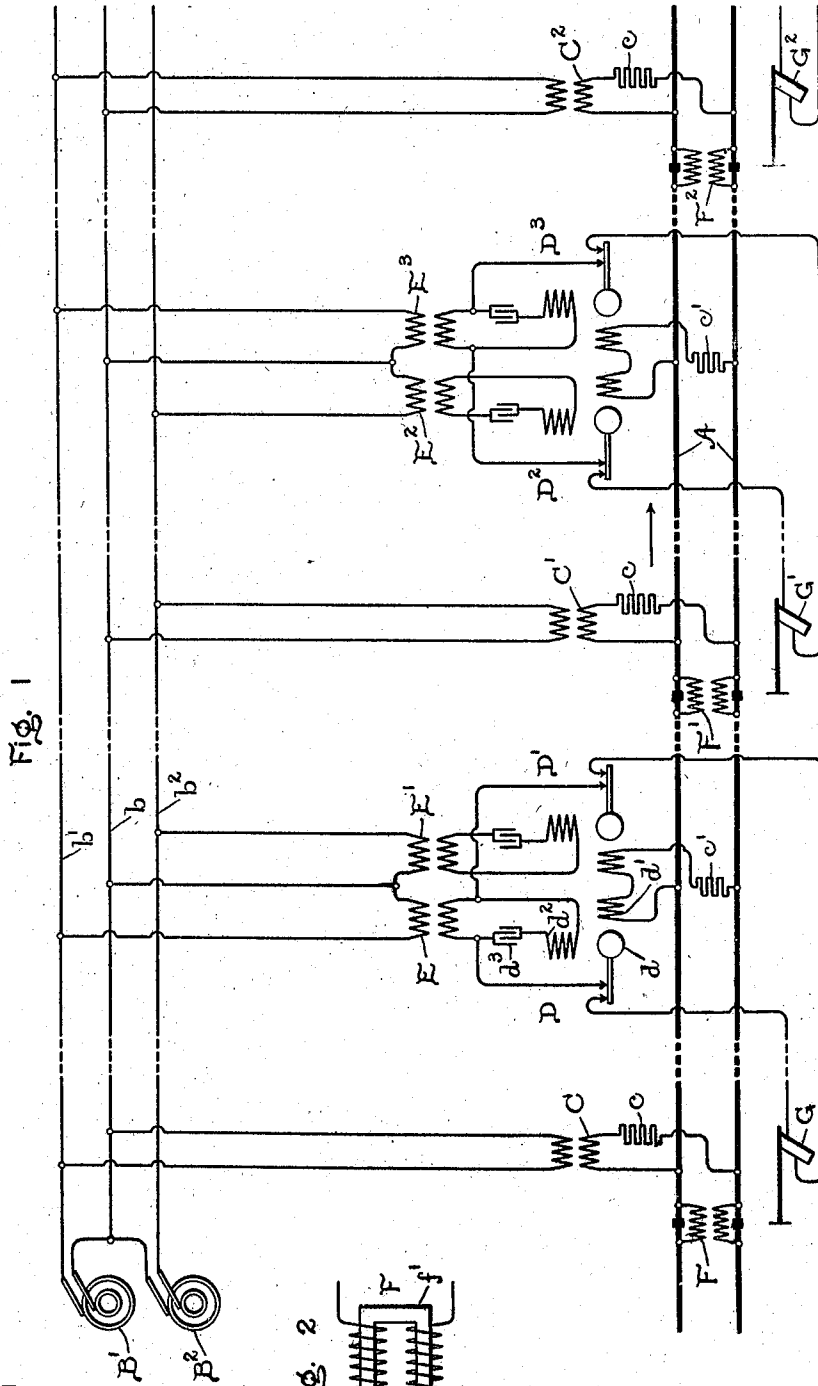


Fig. 1

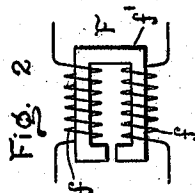


Fig. 2

WITNESSES:
Lester H. Bulmer
J. Ellis Elen.

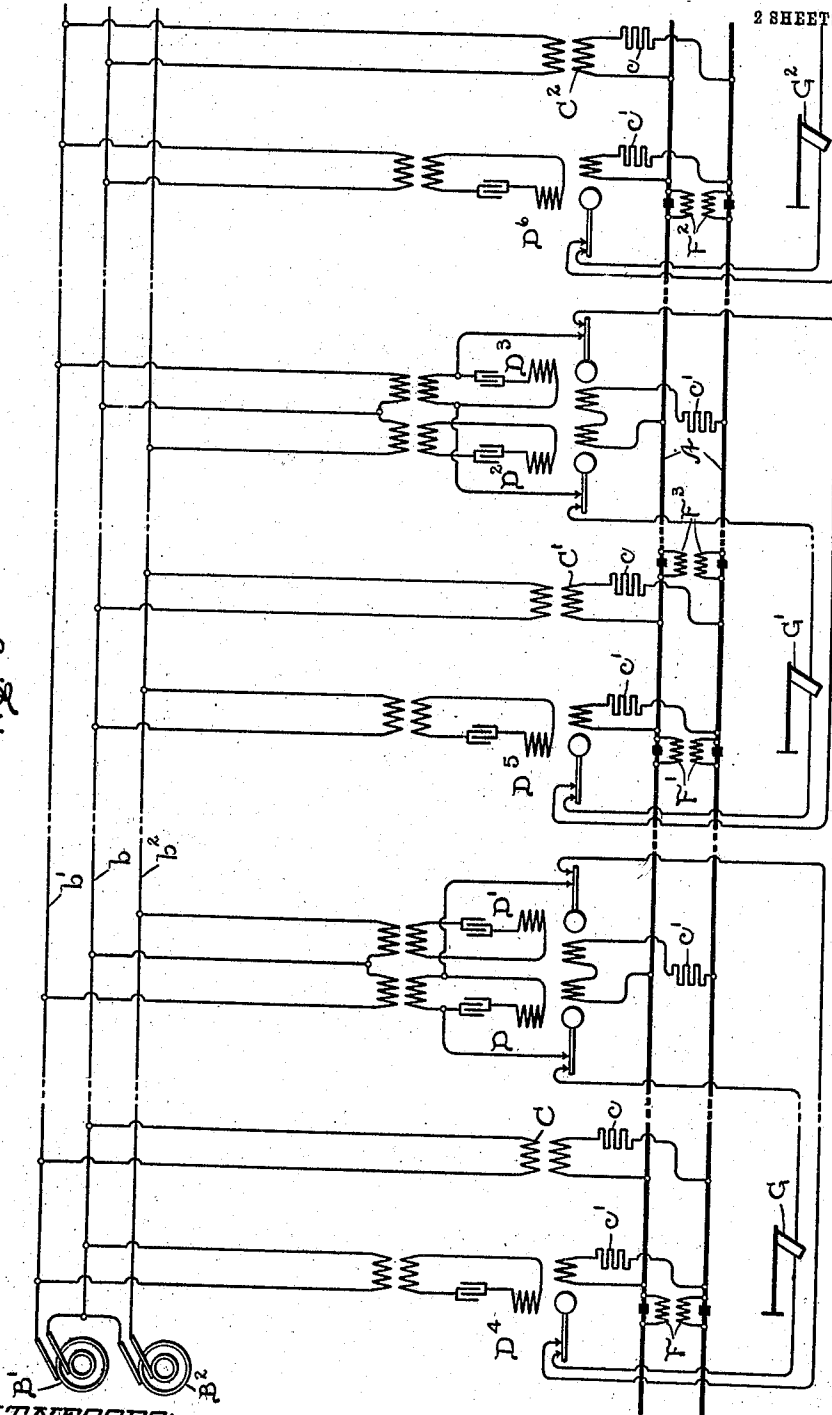
INVENTOR
LAURENCE A. HAWKINS.
BY *Albert J. Davis*
ATTY

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2 SHEETS—SHEET 2.

FIG. 3



WITNESSES:

Lester H. Fulmer.

J. Ellis Egan.

INVENTOR
 LAURENCE A. HAWKINS
 BY *Alfred S. Davis*
 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.

937,440.

Specification of Letters Patent.

Patented Oct. 19, 1909.

Application filed April 23, 1909. Serial No. 491,707.

To all whom it may concern:

Be it known that I, LAURENCE A. HAWKINS, a citizen of the United States, residing at Schenectady, in the 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 alternating current signal systems for electric railways, and its object is to provide a continuous-rail system having the same advantage with respect to exactly defining the entering points of the block as the inductive bond system.

Two types of systems adapted for use on electric railways have been proposed heretofore. In one of these the blocks are divided from each other by insulated joints, as in steam-road practice, and reactances or inductive bonds are used to transmit the power-current from one block to the next, so as to permit the rails to serve as return for the power-current, while confining the signal current of each block to its own track circuits. The other type of system may be applied to the standard electric railway having both rails conductively continuous for all currents. The blocks are not separated from each other by insulated joints, but other means are used for dividing the blocks from each other, as, for instance, by employing currents of different frequency for adjacent block sections, so that the current from one block flowing into the next block cannot affect the relays of said next block. Such a system is disclosed in my prior application, Serial No. 329,347, filed August 6, 1906.

The continuous rail system has the advantage of avoiding the cost of the inductive bonds which, if the power current is large, are exceedingly expensive, and also of offering a better return for the power current. It does not, however, define the entering points of the blocks with the exactness of the inductive bond system with its insulated joints. Ordinarily, this is of no importance, since, as pointed out in my prior application, by placing the signals adjacent to the transformers which supply the alternating current to the track, and by using transformers of good regulation, the maximum variation in the entering point of the block can be confined to a comparatively few feet. In certain cases, however, as, for instance, at

the approach to interlocking, cross-overs, etc., it is desirable that the entering point of the block should be exactly fixed. By my present invention I am enabled to obtain this result wherever it is required, while preserving to a large extent the advantages of the continuous-rail system.

The system of my present invention, while employing insulated joints and reactances, is a true continuous-rail system, since the joints and reactances do not confine the signal currents in any way; but, on the contrary, the signal currents can, and must, flow past the joints through the reactances in the normal operation of the system, so that the rails remain throughout their length conductively continuous for all currents. The reactances are made exceedingly small, having an impedance which need not be greater than that of 100 or 200 feet of rail; so that the addition of the joints and reactances to the track circuits simply have the effect of increasing the length of the track circuits by 100 or 200 feet, or less. Since the reactances do not serve at all to confine the signal currents, other means for separating the block sections, such as the use of currents of different frequencies in adjacent track circuits, must be used. Since the reactances are so small, their cost is very much less than the cost of the inductive bonds in the inductive bond system, but because of the special arrangement and location of the reactances in accordance with my invention, they serve to define the entering points of the blocks as effectively as reactances large enough to confine the signaling currents.

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; Fig. 2 shows diagrammatically a suitable construction for the reactance; and Fig. 3 shows my invention applied to a modified form of system.

In Fig. 1, A represents the rails of an electric railway which are conductively continuous for all currents throughout their length. B¹ and B² represent alternating current generators of different frequencies for supplying current to the signal circuits. I have indicated a three-wire transmission system b¹, b and b² the wire b serving as

common return for both frequencies. C , C^1 and C^2 represent transformers having their secondaries connected across the rails at intervals and their primaries connected to the transmission wires. Adjacent transformers are connected to transmission circuits of different frequencies. Resistances c are placed in series with the secondaries of the transformers to limit the flow of current when the transformer is short-circuited by a car and also to prevent saturation by an unbalanced flow of power current. D , D^1 , D^2 and D^3 represent relays which are connected in pairs across the rails between adjacent sources. The relays are shown diagrammatically as of the well-known induction type, comprising a short-circuited secondary d carrying the relay contacts, a winding d^1 connected to the rails, and a second winding d^2 supplied independently of the rail circuits with current of a phase displaced from that in the track winding d^1 . I have indicated transformers E to E^3 for supplying the second windings of the relays. Phase controlling devices, such as condensers d^3 , may be employed, if necessary, to produce a phase displacement between the currents in the two relay windings. Resistances c^1 may be placed in series with the track windings of the relays to prevent saturation by unbalanced power current. Adjacent to, and in advance of, each source is the reactance F , having its windings inserted in the rails. Signals G , G^1 and G^2 are placed at the reactances, and each signal is controlled by the pair of relays next beyond the adjacent transformer,—that is, signal G is controlled by relays D and D^1 . If the reactances F , F^1 and F^2 were removed, the arrangement of the system would be identical with that disclosed in my prior application, Serial No. 329,347, above referred to. A car approaching the transformer C (the direction of traffic being as shown by the arrow) would gradually reduce the voltage supplied by this transformer to the track until when the car had reached a point near the transformer, the track voltage would be too low to maintain the relay D energized, so that that relay would open its contacts allowing signal G to go to stop position. The point reached by the car when the signal went to stop would vary slightly with different weather conditions. This variation, which can be made very small if the transformers have good regulation, can be entirely eliminated by the use of the reactance F . For instance, if, under extreme weather conditions, the relay D were shunted with a car 50 feet and 100 feet, respectively from the transformer, then the maximum variation in the shunting point would be 50 feet. If the reactance F is placed 50 feet, or a little less, from transformer C , and the reactance of each of its windings is made equivalent to

the impedance of a little more than 50 feet of rail, then the signal G will always go to stop the instant the front wheels of the car pass the reactance, because, before the car reaches the insulated joints spanned by the reactance, there is between it and the transformer an impedance equal to slightly more than that of 200 feet of rail, which, under the conditions assumed, is sufficient to prevent the relay D from shunting between all extremes of weather conditions, while the instant the front wheels have passed the insulated joints, the modification between the car and the transformer is less than that of 100 feet of rail, which, under the conditions assumed, is small enough to insure the shunting of relay D under all extremes of weather conditions.

It would, of course, be possible to place the reactance F at the secondary terminals of transformer C , but by placing it in advance of the transformer by a distance slightly less than the minimum shunting distance, the impedance of the rails between the transformers and reactances is utilized so that the reactance may be smaller. If the ratio between minimum and maximum shunting distances is two to one, as in the case assumed above, the reactances so placed need be only slightly more than half as large as would be necessary if they were placed at the transformer terminals. The reason that the reactance may be of so small an amount is that the only time it performs any useful function in the system is when a car is approaching it and is close to the transformer. At this time the transformer is delivering an abnormally large current, which flows through the reactance and the wheels and axles of the car, and this abnormally large current produces in the reactance a sufficient voltage drop for maintaining the relay D energized, although the reactance itself is very small, since the voltage drop is the product of the current and the impedance of the reactance. When no car is approaching a reactance, the reactance has no function. The current from transformer C^1 flows through the reactance F^1 to energize relay D^1 precisely as though the reactance were absent. The only effect of the reactance with the block clear is to add an impedance to the track circuit between transformer and relay equivalent to lengthening the track circuit 50 or 100 feet, that is, increasing its length, if the blocks are a mile long, by two to four per cent.

While it is not necessary that the reactance should have two windings, the two-winding arrangement is preferable, since both these windings may then be placed on a common core, and the power current in the two windings produces opposing effects, so that the only tendency to saturation by the power current is due to an unbalancing of the flow

in opposite rails. Fig. 2 shows diagrammatically the arrangement of the two windings f of the reactance F on a common core f^1 , which is provided with an air gap to prevent saturation by unbalanced power current.

In a prior application, Serial No. 482,637, filed March 11, 1909, I have disclosed a modification of the system of my earlier application, which modification consists in the addition of a third relay for each block; the third relay being placed near to and in advance of the transformer at the entrance of the block. The purpose of this modification is to decrease the amount of current required for a given frequency, or to permit a decrease in the frequency with the same current consumption. Other things being equal, the variation in the shunting point of the relay is almost exactly proportional to its distance from the transformer which supplies it, so that by providing an extra relay near the transformer for fixing the entering point of the block the transformer may have a lower voltage and poorer regulation than in the earlier form of the system, or the frequency employed in the signal circuits may be reduced.

In Fig. 3 I have shown my present invention applied to the form of system disclosed in application, Serial No. 482,637. The relay D^4 is placed near to and in advance of the transformer C , and relays D^5 and D^6 are similarly placed with respect to transformers C^1 and C^2 , respectively. The signals are placed near the relays D^4 , D^5 and D^6 , and each signal is controlled by its adjacent relay jointly with the pair of relays next beyond the adjacent transformer,—that is, signal G , for instance, is controlled by relays D^4 , D and D^1 . When my invention is applied to this modification of a system, the reactance F is placed at, or within the minimum shunting distance of, the track connections of relay D^4 , and acts to define exactly the shunting point of the relay D^4 precisely as in Fig. 1 it acts to define exactly the shunting point of the relay D . Comparing the arrangement of Fig. 3 with that of Fig. 1, that of Fig. 3 requires an extra relay, but the size of the reactance may be even less than in the arrangement of Fig. 1.

Referring again to Fig. 1, it will be seen that signal G goes to stop when a car passes reactance F , and that signal G^1 goes to stop when the car passes reactance F^1 . Signal G does not, however, clear when signal G^1 goes to stop, but remains at stop until the car has passed transformer C^1 a sufficient distance for the voltage of that transformer to rise enough to cause relay D^1 to close its contacts. There is thus an overlap in the system, the amount of which is not exactly fixed, but which will vary somewhat with weather conditions. This overlap simply means so much

additional protection, and the slight variation in its amount is ordinarily wholly immaterial. If, however, it is desired to fix definitely the point reached by the car when a signal clears, this can be accomplished by inserting a reactance just beyond a transformer. This is shown in Fig. 3, in which the reactance F^3 is inserted in the rails just beyond the transformer C^1 , so as definitely to fix the point reached by a car when signal G clears. In order to make the reactance F^3 as small as possible, it should be placed at the distance from transformer D^1 corresponding to the minimum distance at which under extreme weather conditions relay D^1 would close its contacts, were the reactance not present.

My invention is applicable to other types of systems than that shown, and may be applied in various combinations. Accordingly, 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 spirit and 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 combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, each supplying current to track circuits on both sides of it, a pair of track relays between adjacent sources supplied with current from the rails and each responding to current from one adjacent source only, a reactance having a winding inserted in a rail adjacent to and in advance of a source, and a signal placed near said reactance and controlled by the pair of relays next beyond said source.

2. In combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, each supplying current to track circuits on both sides of it, a pair of track relays between adjacent sources supplied with current from the rails and each responding to current from one adjacent source only, a reactance comprising two windings on one core inserted respectively in opposite rails adjacent to and in advance of a source, and

a signal placed near said reactance and controlled by the pair of relays next beyond said source.

3. In combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, each supplying current to track circuits on both sides of it, a pair of track relays between adjacent sources supplied with current from the rails and each responding to current from one adjacent source only, a reactance inserted in the rails adjacent to and in advance of a source, a relay connected across the rails between said reactance and said source, and a signal placed near said reactance and controlled jointly by the last-mentioned relay and the pair of relays next beyond said source.

4. In combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, each supplying current to track circuits on both sides of it, a pair of track relays between adjacent sources supplied with current from the rails and each responding to current from one adjacent source only, a reactance comprising two windings on one core inserted respectively in opposite rails adjacent to and in advance of a source, a relay connected across the rails between said reactance and said source, and a signal placed near said reactance and controlled jointly by the last-mentioned relay and the pair of relays next beyond said source.

5. In combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, each supplying current to track circuits on both sides of it and the currents from adjacent sources differing in character, track relays connected across the rails in pairs between adjacent sources, each relay being responsive only to current of the character supplied to the rails by one adjacent source, signals placed near said sources each controlled by the pair of relays next beyond the adjacent source, and a reactance having a winding inserted in a rail near a source whereby the passage of a car over said reactance produces a sudden variation of voltage in the track circuit on the other side of said source.

6. In combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, each supplying current to track circuits on both sides of it and the currents from adjacent sources differing in character, track relays connected across the rails in pairs between adjacent sources, each relay being responsive only to current of the character supplied to the rails by one adjacent source, signals placed near said sources each controlled by the pair of relays next beyond the adjacent source, and a reactance comprising two windings on one core inserted respectively in opposite rails adjacent to a source whereby the passage of a car over said reactance produces a sudden variation of voltage in the track circuit on the other side of said source.

7. In a block signal system, in combination with the signals and control circuits therefor, a source of alternating current connected across the rails, a track relay at a distance from said source energized by current therefrom supplied through the rails, a reactance having a winding inserted in the track circuit at a point between the source and the relay, and a second relay connected across the rails near the reactance between the reactance and the source and energized with current from said source, the contacts of the two relays being connected in different control circuits.

8. In a block signal system, in combination with the signals and control circuits therefor, a source of alternating current connected across the rails, a track relay at a distance from the source energized by current therefrom supplied through the rails, a reactance having two windings on a single core inserted respectively in opposite rails at a point between the source and the relay, and a second relay connected across the rails near the reactance between the reactance and the source and energized with current from said source, the contacts of the two relays being connected in different control circuits.

In witness whereof, I have hereunto set my hand this 22nd day of April, 1909.

LAURENCE A. HAWKINS.

Witnesses:

BENJAMIN B. HULL,
HELEN ORFORD.