L. A. HAWKINS.

BLOCK SIGNAL SYSTEM

APPLICATION FILED AUG. 7, 1909.

1,038,364.

Patented Sept. 10, 1912.

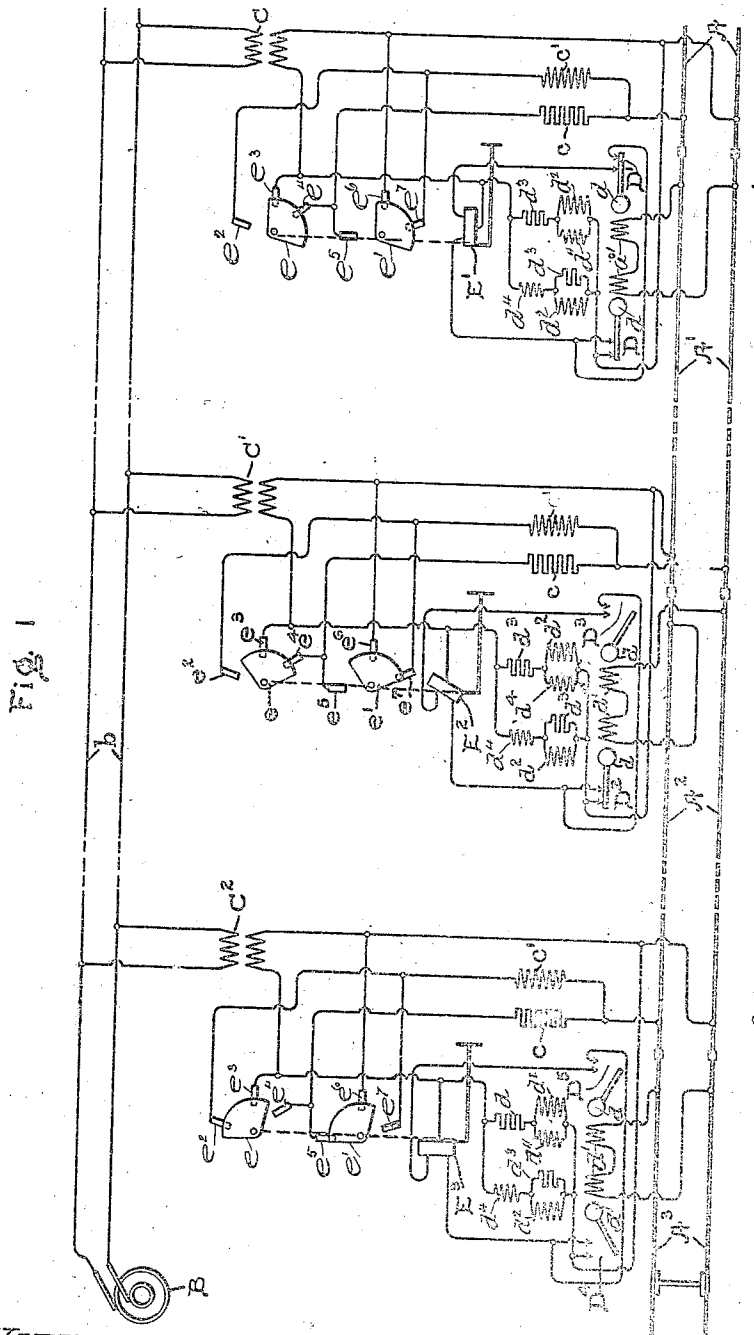

Fig. 1

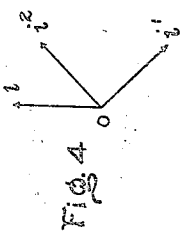

Fig. 4

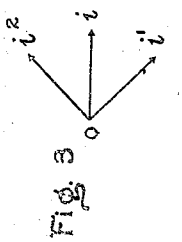

Fig. 3

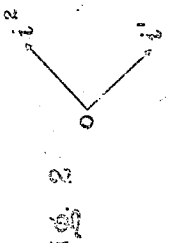

Fig. 2

WITNESSES:

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UNITED STATES PATENT OFFICE.

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.

1,038,364. Specification of Letters Patent. Patented Sept. 10, 1912.

Application filed August 7, 1909. Serial No. 511,664.

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 railways and consists of a modification of the system disclosed in my companion application, Serial No. 511,663, filed Aug. 7, 1909. In that application I disclosed a system in which the signals are arranged to give danger, caution and clear indications either by two 2 position arms or by one 3 position arm, and in which the control of the signals is obtained without line wires by an arrangement comprising a pair of track relays for each block controlling the caution and clear indications respectively, each having two coöperating windings, one connected to the track and the other supplied with alternating current independently of the track circuits, the currents in the latter windings of the two relays of each pair being different in phase, with means controlled by a train in one block for shifting the phase of the track current in the preceding block so as to energize first one and then both of the track relays of the preceding block. The principal advantages of that system, as compared with former wireless systems are, first, that track relays of the most efficient type are employed so that the current consumption is reduced to a minimum; second, that since the relay controlling the caution indication is not even momentarily deënergized when the phase of the track current is shifted to energize the relay controlling the clear indication, it is unnecessary to employ a quick acting switch for controlling the phase of the track current; and third, if the transformers of adjacent blocks are reversely connected a breaking down of the insulated joint between two adjacent block sections will always cause the relays adjacent to those joints to open their contacts so that the signal controlled by them will be put at stop, thus the false clear indications, which are possible in other wireless systems when joints break down, are impossible in this system.

In my companion application I illustrated and described a polyphase transmission system.

In some cases it is not convenient to employ a polyphase transmission, and the object of my present invention is to provide simple and reliable means for shifting the phase of the track current a sufficient amount when the system must be operated with a single phase transmission. In order to make the system positive and reliable, the phase of the track current should be shifted through nearly, if not quite, 90°. I have found that if a resistance and reactance are provided, each having an impedance approximately equl to that of the track circuit itself, and if in one position of the switch contacts controlling the track circuit the resistance be connected in series with the source of the track current and the reactance in shunt, and in another position the reactance be connected in series and the resistance in shunt, the phase of the track current will be shifted through practically 90° when the contacts move from one position to the other. The exact amount of impedance and reactance required will depend upon the power factor of the track circuit, but with such a power factor as is likely to be found in practice, the values above-mentioned are approximately correct.

By properly arranging the switch contacts the change from one set of connections to the other may be made without opening the circuit, so that the relay controlling the caution indication is not deënergized.

In its broadest aspect, my present invention is not limited to the particular relay arrangement of my companion application, but is particularly advantageous for use with that arrangement, since power is inevitably wasted in shifting the phase of the track current and since with the relay arrangement of my companion application, the amount of track current is small so that the amount of power wasted is correspondingly small.

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 Figs. 2 to 4 are explanatory vector diagrams.

In Fig. 1, A, A′ A^2 and A^3 represent the

rails of four blocks which are shown separated from each other by the customary insulating joints. B represents an alternating current generator supplying the line wires b from which current is derived for the signal circuits. C, C′ and C² represent transformers having their primaries connected to the line wires b and their secondaries supplying the track circuits A, A′ and A², respectively. c, c represent resistances, and c', c' reactances. D to D⁵ represent track relays. There are two of these relays per block or track section. These are shown diagrammatically as of the two phase induction type, each comprising a short-circuited member d actuating the relay contacts, a winding d' connected to the track, and a winding d^2 supplied with alternating current independently of the track circuit. The windings d^2 of each pair of relays are supplied with currents of different phase. This phase displacement between the currents may be obtained in the manner shown by placing a resistance d^3 in shunt to, and a reactance d^4 in series with, one winding d^2, and a reactance d^4 in shunt to, and a resistance d^3 in series with, the other winding d^2, or any other suitable arrangement for producing a 90° displacement between the currents in the windings d^2 may be employed. E′, E² and E³ represent signals for the blocks arranged to give three indications, danger, caution and clear. I have illustrated one-arm three-position signals, but it will be understood that my invention is equally applicable to two-arm two-position signals. e and e' represent contacts mounted on the signal shaft as indicated diagrammatically in dotted lines and e^2 to e^7 represent stationary contact fingers. These contacts and contact fingers control the phase of the current supplied to the track circuit by the secondary of the transformer by means of resistance c and reactance c'.

The usual contacts for controlling the signal mechanism, as well as the signal mechanism itself, are omitted from the drawing in order to avoid complication, since many suitable arrangements of mechanism and controlling contacts are well known in the art. It will be understood that the conductor led to the lower side of the blade is common to the circuits for caution and clear indications, the circuit extending directly from the upper side of the blade to the contacts of relay D, D², or D⁴ being that for the control of the caution indication, and the circuit extending directly to the contacts of relay D′, D³, or D⁴, that for the control of the clear indication. In accordance with usual practice, the circuit controlling the clear indication is controlled by the caution position relay (D, D² and D⁴) but it is understood that this arrangement of control is unnecessary in the normal working of the system and is employed only as a precaution to insure the signal moving to danger in case the contacts of the clear position relay should stick in the closed position.

When a train is in a block, as indicated in block A³, the track windings of both track relays D⁴ and D⁵ are deënergized, so that the relay contacts are open and the signal E³ stands at stop. The windings d^2 of the two relays are energized with currents differing in phase by approximately 90°, as indicated in Fig. 2, in which oi' indicates the phase of the current in the winding d^2 of relay D⁴ and oi^2 the phase of the current in the winding d^2 of relay D⁵. With the signal E³ at stop the contacts e and e' are in the positions shown, and it will be seen that the reactance c' is in series with the secondary of transformer C² while the resistance c is connected in shunt to the track circuit. These connections may be traced from the left-hand secondary terminal of transformer C², through contacts e^3, e, e^2, reactance c', to the upper rail of block A², while the shunt circuit extends from the upper rail to resistance c, contacts e^5 e' and e^6 to the right hand secondary terminal of transformer, C³, which is connected to the lower rail. The reactance being in series and the resistance in shunt to the track circuit the connections of the track circuit are similar to those of the winding d^2 of relay D², and if the power factor of the track circuit and of the winding d^2 were the same, the phase of the currents in the windings d' and d^2 of relay D² would be approximately in phase and the relay would consequently be without torque, if the resistance d^3 and reactance d^4 bore the same relation to the impedance of winding d^2 that the resistance c and the reactance c' bear to the impedance of the track circuit. But in practice the power factor of the track circuit and of the winding d^2 are not the same but may differ by as much as 45°. The track circuit is ordinarily of considerably higher power factor than the winding d^2, so that the track current is more advanced and does not lag in its phase so much as the current in the winding d^2. The conditions in the windings of relays D² and D³ may, consequently, be represented by the vector diagram, Fig. 3, in which oi' and oi^2 represent the currents in the windings d^2 of the relays D² and D³, as in Fig. 2, the same vectors represented the currents in the windings d^2 of the relays D⁴ and D⁵, while oi represents the phase of the track current, displaced approximately 45° from the currents in the other windings of the pair of relays but leading the current in winding d^2 of relay D² and lagging behind the current in the corresponding winding of relay D³. This

displacement of 45° is due to the difference in the power factors of the track circuit and of the windings d^2 of the relays, as explained above. If the relays are so wound or connected that they close their contacts when the current in the track winding leads that in the other, then relay D^2 will close its contacts, as shown, while relay D^3 will be held in open-circuited position both by gravity and by a reverse torque in the relay. Relay D^2 in closing its contacts closed the circuit from the right-hand secondary terminal of transformer C', through the relay contacts and through the signal mechanism to the left-hand secondary terminal of the transformer. The signal has accordingly moved from danger to caution position. In making this movement the signal shifts contacts e and e' to the position shown. The change in connections thereby produced may be understood by comparing the contacts of signal E^2 with the contacts of signal E^3. In moving from one position to the other, the first change in connections that occurs is opening the circuit of the resistance c at the finger e^5, so that the resistance which was connected in shunt to the track circuit is open-circuited. Next contact e engages contact e^4, so as to connect the resistance c in parallel with the reactance c'. Contact e then leaves contact e^2, open circuiting the reactance, and finally contact e' engages contact e^7 connecting the reactance in shunt to the track circuit. Thus the transformer C^2 has the reactance in series and the resistance in shunt, while the transformer C' has the resistance in series and the reactance in shunt, the change being made without opening the connections from the transformer to the track. The result of this change is to advance the phase of the current supplied by transformer C' to the track by about 90°, so that the conditions at relays D and D' are as shown in the diagram, Fig. 4, the track current oi being advanced 90°, as compared with its position in Fig. 3. The track current now leads the current in windings d^2 of both relays, so that both relays D and D' are energized. The relay D' closed a circuit which may be traced from the right-hand secondary terminal of transformer C, through contacts of relay D, contacts of relay D', and through the mechanism of signal E' to the left-hand transformer terminal, so that the signal E' has moved from caution to clear. During this movement the contacts e and e' of this signal have been moved to the position shown, but this movement of these contacts produces no change in the circuit connections.

It will be noted that during the intermediate connections established by the switch contacts, when the signal is moving from stop to caution so as to shift the phase of the track circuit from the position shown in Fig. 3 to that shown in Fig. 4, the track circuit is never opened and the phase of the current is advanced step by step, first in a direction to increase the phase displacement between the track current and that in the windings d^2 of relay D^2 and thus slightly to increase the relay torque, and then after this phase displacement has reached 90°, to reduce the relay torque again until the phase displacement of 135° is reached, which is the final condition shown in Fig. 4.

It will be noticed that the transformers of adjacent blocks are reversely connected to their track circuits. This relative reversal of connections has not been mentioned in the preceding description, since the track windings of the relays of the adjacent blocks are also relatively reversed, so that, so far as normal operation of the system is concerned the relative reversal is immaterial. The reversal becomes of importance when an insulated joint breaks down. In this event the current which flows through the broken down joint to the adjacent relays is reversed 180° in phase from the current which normally is supplied to the relays and, therefore, is always of a phase to create a reverse torque in the relay controlling the movement of the signal from danger to caution. Since the contact connections of the other relay are carried through this relay, the result is always to put the signal at stop regardless of its position prior to the breaking down of the joint and regardless of the positions of trains. Thus, the same advantage with respect to protection against broken joints is obtained in the present arrangement as is obtainable in the arrangement of my prior application.

I do not desire to limit myself to the particular arrangement of parts shown and described, 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, signals for the blocks adapted to indicate danger, caution, and clear, track circuits including sources of alternating current for the blocks, a pair of track relays for each block having windings included in the track circuit and controlling the caution and clear indications according as one or both relays are energized, a resistance and a reactance for each source, and connections including switch contacts controlled by a train in one block controlling the circuit of the source for the preceding block arranged in one position to connect the resistance in series and the reactance in shunt to said circuit and in another position to connect the reactance in series and the resistance in shunt to said

circuit, one of the track relays of said preceding block being responsive to current from said source with either of said connections and the other to current from said source with one connection only.

2. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear, track circuits including sources of alternating current for the blocks, a pair of track relays for each block controlling the caution and clear indications, according as one or both relays are energized, each of said relays having a winding included in the track circuit and a second coöperating winding supplied with alternating current independently of the track circuits, the currents supplied to said second windings differing in phase in the two relays of each pair, a resistance and a reactance for each source, and connections including switch contacts controlled by a train in one block controlling the circuit of the source for the preceding block arranged in one position to connect the resistance in series and the reactance in shunt to said circuit and in another position to connect the reactance in series and the resistance in shunt to said circuit.

3. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear, track circuits including sources of alternating current for the blocks, a pair of track relays for each block having windings included in the track circuit and controlling the caution and clear indications according as one or both relays are energized, a resistance and a reactance for each source, and connections including switch contacts controlled by a train in one block controlling the circuit of the source for the preceding block arranged in one position to connect the resistance in series and the reactance in shunt to said circuit and in another position to connect the reactance in series and the resistance in shunt to said circuit, the contacts which establish the series connections of the reactance being arranged to close before the contacts which break the series connection of the resistance open, one of the track relays of said preceding block being responsive to current from said source with either of said connections and the other to current from said source with one connection only.

4. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear track circuits including sources of alternating current for the blocks, a pair of track relays for each block controlling the caution and clear indications according as one or both relays are energized, each of said relays having a winding included in the track circuit and a second coöperating winding supplied with alternating current independently of the track circuits, the current supplied to said second windings differing in phase in the two relays of each pair, a resistance and a reactance for each source, and connections including switch contacts controlled by a train in one block controlling the circuit of the source for the preceding block arranged in one position to connect the resistance in series and the reactance in shunt to said circuit and in another position to connect the reactance in series and the resistance in shunt to said circuit, the contacts which establish the series connections of the reactance being arranged to close before the contacts which break the series connection of the resistance open.

5. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear, track circuits including sources of alternating current for the blocks, a pair of track relays for each block having windings included in the track circuits and controlling the caution and clear indications according as one or both relays are energized, a resistance and reactance for each source, and connections including switch contacts controlled by the movement of a signal from danger to caution controlling the circuit of the source for the preceding block arranged in one position to connect the resistance in series and the reactance in shunt to said circuit and in another position to connect the reactance in series and the resistance in shunt to said circuit, one of the track relays of the preceding block being responsive to current from said source with either of said connections and the other to current from said source with one connection only.

6. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear, track circuits including sources of alternating current for the blocks, a pair of track relays for each block controlling the caution and clear indications according as one or both relays are energized, each of said relays having a winding included in the track circuit and a second coöperating winding supplied with alternating current independently of the track circuits, the currents supplied to said second windings differing in phase in the two relays of each pair, a resistance and a reactance for each source, and connections including switch contacts controlled by the movement of a signal from danger to caution controlling the circuit of the source for the preceding block arranged in one position to connect the resistance in series and the reactance in shunt to said circuit and in another position to connect the reactance in series and the resistance in shunt to said circuit.

7. In a block signal system, signals for the blocks adapted to indicate danger, cau-

tion and clear, track circuits including sources of alternating current for the blocks, a pair of track relays for each block having windings included in the track circuit and controlling the caution and clear indications according as one or both relays are energized, a resistance and reactance for each source, and connections including switch contacts controlled by the movement of a signal from danger to caution controlling the circuit of the source for the preceding block arranged in one position to connect the resistance in series and the reactance in shunt to said circuit and in another position to connect the reactance in series and the resistance in shunt to said circuit, the contacts which establish the series connections of the reactance being arranged to close before the contacts which break the series connection of the resistance open, one of the track relays of the preceding block being responsive to current from said source with either of said connections and the other to current from said source with one connection only.

8. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear, track circuits for the blocks, a single phase transmission system extending along the roadway, a pair of track relays for each block controlling the caution and clear indications according as one or both relays are energized, each relay having two coöperating windings, one connected to the track circuit of the block and the other supplied from the transmission system independently of the track circuits, means for producing a difference of phase between the currents in the last-mentioned windings of each pair of relays, a transformer for each block having its primary supplied from said transmission system and its secondary connected to the track circuit of the block, and means controlled by a train in the block in advance for controlling the phase of the current supplied by said transformer to the track circuit.

9. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear, track circuits for the blocks, a single phase transmission system extending along the roadway, a pair of track relays for each block controlling the caution and clear indications according as one or both relays are energized, each relay having two coöperating windings, one connected to the track circuit of the block and the other supplied from the transmission system independently of the track circuits, means for producing a difference of phase between the currents in the last-mentioned windings of each pair of relays, a transformer for each block having its primary supplied from said transmission system and its secondary connected to the track circuit of the block, phase shifting means in circuit with said transformer, and connections including switch contacts controlled by a train in the block in advance in circuit with said transformer and said devices for controlling the phase of the current supplied by said transformer to the track circuit.

10. In a block signal system, signals for the blocks adapted to indicate danger, caution and clear, track circuits for the blocks, a single phase transmission system extending along the roadway, a pair of track relays for each block controlling the caution and clear indications according as one or both relays are energized, each relay having two coöperating windings, one connected to the track circuit of the block and the other supplied from the transmission system independently of the track circuits, means for producing a difference of phase between the circuits in the last-mentioned windings of each pair of relays, a transformer for each block having its primary supplied from said transmission system and its secondary connected to the track circuit of the block, phase shifting means in circuit with said transformer, and connections including switch contacts controlled by the signal next in advance operated upon the movement of said signal from danger to caution and arranged to vary the connections of said devices to vary the phase of the current supplied by said transformer to the track circuit.

11. In a railway signaling system, a track circuit, a source of alternating signaling current for the track circuit, a resistance and a reactance, means independent of the track circuit for connecting the resistance in series and the reactance in shunt with the track circuit and for connecting the reactance in series and the resistance in shunt with the track circuit; and two relays connected with the track circuit, one of which is responsive to current from the said source with either of said connections and the other of which is responsive to current from said source with one only of said connections.

12. In a railway signaling system, a track circuit, a source of alternating signaling current for the track circuit, a resistance and a reactance, means independent of the track circuit for connecting the resistance in series and the reactance in shunt with the track circuit, and for connecting the reactance in series and the resistance in shunt with the track circuit; and two relays each having a winding included in the track circuit and a second coöperating winding supplied with alternating signaling current independently of the track circuit, the currents supplied to said second windings differing in phase whereby one of the relays is responsive to current from the said source with either of said connections and the other relay is re-

sponsive to current from said source with one only of the said connections.

13. In a railway signaling system, a track circuit, a source of alternating signaling current, two relays each having a winding included in the track circuit and a second coöperating winding supplied with alternating signaling current independently of the track circuits; means for causing the currents supplied to the two said second windings to differ in phase, said means comprising a resistance in shunt to and a reactance in series with the second winding of one relay, and a reactance in shunt to and a resistance in series with the second winding of the other relay; and means for supplying currents of two different phases to the track circuit from the said source, one of the relays being responsive to track circuit current of either of said phases and the other relay being responsive to track circuit current of one only of said phases.

In witness whereof, I have hereunto set my hand this 5th day of August, 1909.

LAURENCE A. HAWKINS.

Witnesses:

BENJAMIN B. HULL,

EDWARD WILLIAMS.