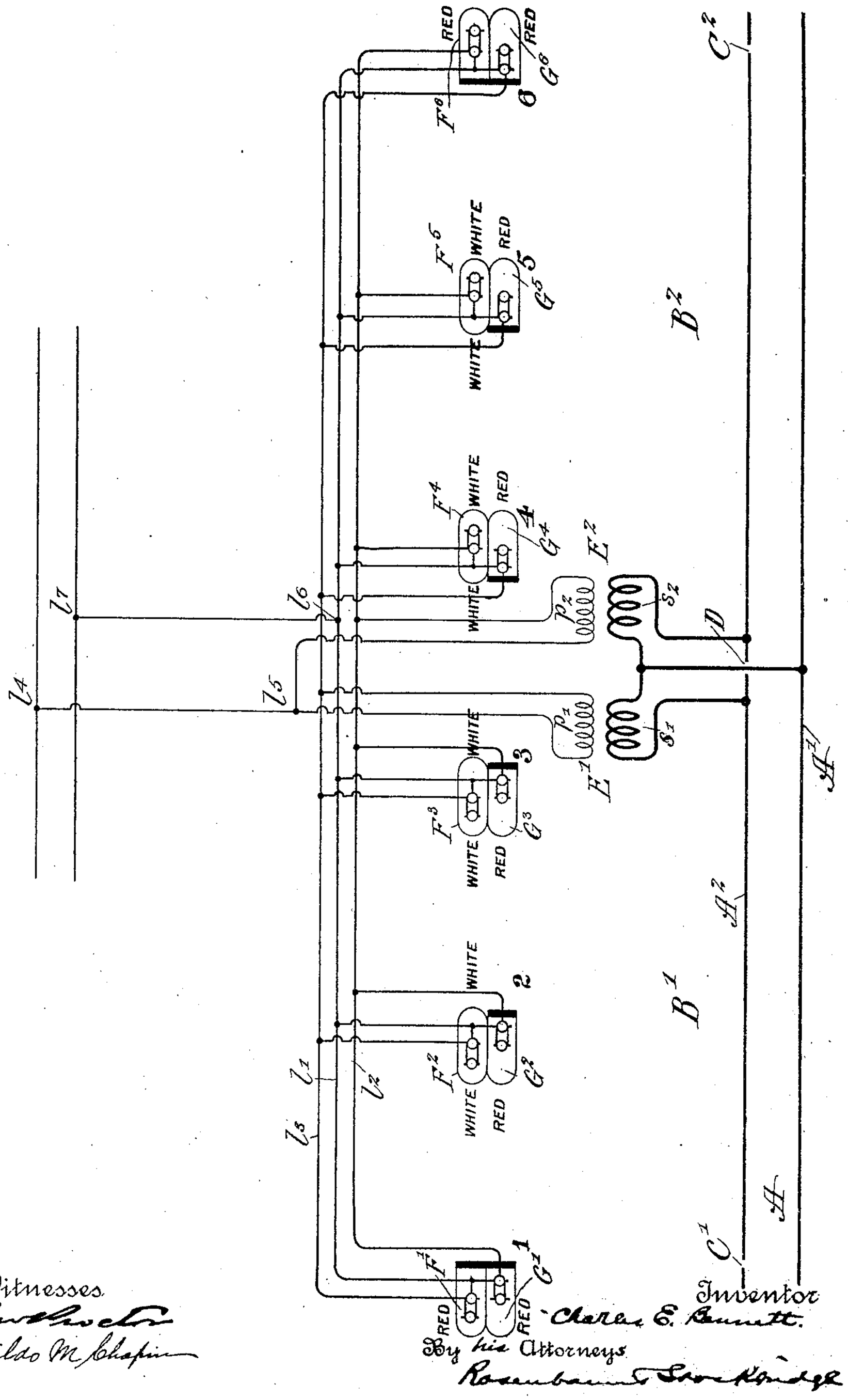
No. 803,539. PATENTED NOV. 7, 1905.

C. E. BENNETT.

BLOCK SIGNAL SYSTEM.

APPLICATION FILED JUNE 10, 1905.



Witnesses
Chas. Swoboda
Waldo M. Chapin

Inventor
Clarence E. Bennett.
By his Attorneys
Rosenbaum & Stone Kridge

UNITED STATES PATENT OFFICE.

CHARLES E. BENNETT, OF NEW YORK, N. Y.

BLOCK-SIGNAL SYSTEM.

No. 803,539. Specification of Letters Patent. Patented Nov. 7, 1905.

Application filed June 10, 1905. Serial No. 264,675.

To all whom it may concern:

Be it known that I, CHARLES E. BENNETT, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Block-Signal Systems, of which the following is a full, clear, and exact description.

My invention relates to block-signal systems for railways.

By the ordinary block-signal systems lamps are displayed or semaphores operated by the movement of the trains within the different blocks; but it is believed that relay-magnets for closing the different operating-circuits are almost universally employed. A perfect block-signal system should make use of the usual track-rails and should require these to be charged to only a low-potential difference in order to avoid excessive leakage through the indifferent insulation afforded by the ties. On the other hand, the lamps or semaphore-signals should be operated by a current of fairly high voltage, so that their operation may be absolutely positive and the potential drop over line-wires negligible. Various methods have been proposed to make these results possible; but, so far as I am aware, they have involved the use of relays, contactors, circuit-breakers, or similar devices. The use of relays, contactors, circuit-breakers, and all such devices is highly objectionable in a block-signal system. All such devices are liable to fail at any moment by reason of particles of dust which may lodge between the contacts. Moreover, the delicate parts are often necessarily exposed to damp and unfavorable conditions in subways and roadbeds and frequently get out of order and require the services of an expert to restore them to operation. A further disadvantage of such devices is the danger to human life which arises from any mechanism liable to fail in a block-signal system.

It is the purpose of my invention to secure all the essential and desirable features of a block-signal system, making use of the ordinary tracks and charging them to low potential, and to have the lamps or semaphore-signals in a high-potential circuit, and, in addition to all these desirable features, to absolutely eliminate relays, contactors, circuit-breakers, and all such appliances of every form.

A further object of the invention is to secure a system which shall be applicable to any road, either steam or electric, which shall be of maximum simplicity, and certain in operation.

A further object is to secure a system by which an indication may be given in case any breakage or burn-out should occur to damage the apparatus.

A further purpose is to provide an apparatus which can be repaired by any track-hand without requiring the services of an expert in case of failure thereof.

My invention consists in the construction, combination, location, and arrangement of parts and apparatus, as will be later more fully described, as shown in the accompanying drawing, and finally particularly pointed out in the appended claims.

The drawing illustrates in diagrammatic representation, a portion of a track having a signal system embodying the principles of my invention applied thereto.

In its broad aspects my invention contemplates the use of a transformer whose secondary circuit includes portions of the track-rails and whose primary circuit includes the lamps or other display apparatus. Each transformer is energized from any convenient source of alternating current and should be of the "step-down" variety, the low-potential windings being included in the track-rail circuits.

Referring now to the drawing and to the various reference-signs appearing thereon, of which the same signs indicate like parts wherever they occur, A denotes a portion of a single-track railway of any sort divided into successive sections or blocks. Each block comprises two distinct and separate "subdivisions," or "subsections," as I shall term them, and in the drawing I have illustrated one complete block having two subsections B' and B^2. One of the rails, which I have designated as A', is preferably continuous throughout its length, although this is not essential, and this rail may constitute a ground connection throughout the line. The other rail A^2 is provided with insulated joints C' and C^2 and D, which divide it according to the blocks, and the subsections, respectively, E' and E^2 designate separate transformers having primary windings p' and p^2 and secondary windings s' and s^2. These transformers are separately included in circuits which include the different track-subsections and also the lamps or other indicators, as will be later more particularly described.

At points along the track I provide a plu-

rality of signal devices, (designated as 1, 2, 3, 4, 5, and 6 in the drawing.) Any number of these signal devices may be used and at any required interval or space; but I prefer to employ ordinary incandescent lamps, which shall be displayed in various signal-boxes having colored glass or lenses therein, so that a light of proper color may be displayed under any given conditions. In the embodiment of my invention illustrated in the drawing I have employed three signals for each subsection, and each signal comprises two indicator-boxes with lenses and colored glass on one or both sides in the manner which is clearly illustrated in the figure—that is to say, signal No. 1 comprises two boxes, both of which are adapted to show a red light in a left-hand direction only. Signal No. 2 has two boxes, one of which shows a red light in a left-hand direction, while the other of which may show a white light in either direction. Section 3 is similar to section 2, and sections 4, 5, and 6 correspond to sections 1, 2, and 3, except that their relative position is reversed. Within each of the boxes is the signal device, which preferably constitutes an ordinary incandescent lamp or a pair of such lamps in multiple, so that one of them may burn out without causing the signal to fail. I will now describe the manner in which the lamps or indicators are connected in the various circuits, so as to perform the features of my invention.

F′ and G′ designate the separate indicators of signal No. 1, which I will hereinafter refer to as a "lamp" in each case, it being understood that in practice I prefer to form two lamps in multiple in the box and wish to include within my invention electrically-operated shutters, semaphores, and electrically-operated signals of every other description. F^2 and G^2 indicate the lamps in section No. 2, of which F^2 shows white in both directions and G^2 red in only a left-hand direction. In like manner the lamps of the successive signals are correspondingly designated. In the form of my invention shown lamps G′, G^2, and G^3 are included in the same circuit, all being connected in multiple therein, and the same multiple circuit includes lamps F^4, F^5, and F^6 of the other subsection. l' and l^2 indicate the line-wires which constitute the mains for this multiple circuit. The lamps F′, F^2, and F^3 lie in another multiple circuit, which also includes lamps G^4, G^5, and G^6. The line-wires which include this multiple circuit are designated as l^3 and l' on the drawing, it being understood that l' constitutes a common return-wire. It is obvious that separate return-wires could be used or l' could be made the neutral wire of a three-wire system. These features are immaterial for the purposes of my invention, it being merely essential that non-corresponding lamps in the different subsections be connected into the same multiple circuits. Each of these multiple circuits is placed in the series with one of the primary coils p' and p^2 of the transformers E′ and E^2. The connections of these circuits can be readily traced on the drawing as follows: Starting from the alternating-current main l^4, the circuit is led to l^5, where it divides, part going through primary p' and part going through primary p^2 into the line-wires l^3 and l^2; from thence it passes through the lamps of the circuits above stated and returns through common return-wire l' to point l^6, where it returns to the alternating-current main l^7.

The general arrangement of an apparatus adapted to carry the method of my invention into operation having now been described, I will particularly set forth the successive steps, acts, and processes of operation which constitute my said method.

An alternating current of any desired voltage, but preferably of about two hundred volts, is impressed in the mains l^4 and l^7, which extend throughout the entire railroad. Separate generators for the different blocks could of course be used; but I prefer to employ continuous mains impressed with a constant-voltage alternating current. The alternating current is led into a group of lamps G′, G^2, and G^3 of one subsection and another non-corresponding group of lamps F^4, F^5, and F^6 of the other subsection, all arranged in multiple, and from thence it passes into primary p^2 of transformer E^2, and from thence back to the alternating-current main. In like manner current is constantly passing through sections F′, F^2, and F^3, G^4, G^5, and G^6, and primary p' of transformer E′. The secondaries s' and s^2 of the transformers are thereby impressed with a certain electromotive force, and this electromotive force is led to the rails A^2 of the subsections B′ B^2, so that they are maintained at an alternating difference of potential from the rail A′.

The transformers E′ and E^2 may be wound for any desired potential relations, which would depend largely on the actual conditions which might arise in practice; but I have found a practical ratio to be a step-down of ten to one from the primary to the secondary, so that while the mains l^4 and l^7 are maintained at two hundred volts the track-rails are maintained at a difference of potential of substantially twenty volts alternating current. The ordinary track-rail is a sufficiently good conductor to carry a heavy current at twenty volts, so that the potential is maintained throughout the section in spite of considerable leakage through the ground and ties. Under normal conditions when no trains are passing the leakage is relatively unimportant and there is practically no load on either of the transformers E′ and E^2.

The actions in the transformer-primaries under no-load conditions will now be briefly considered in order that the operation of my invention may be properly understood. It

will be understood by those skilled in the art that when a transformer is operating under no-load conditions no current passes in the secondary and the transformer acts exactly like a choke-coil or "kicker," merely interposing a very heavy inductive resistance across its terminals. The effect of this inductive resistance is twofold. As is well known, it causes the current to lag considerably behind the impressed electromotive force, so that at times the current is in a contrary direction to the impressed electromotive force and work is being given back to the mains. In this way although a certain current passes through the primary coil of the transformer it is what is known as a "Wattlass current," since work is first done by the main circuit and then returned to the main circuit, so that the summation or integral of the work is *nil* in theory at any rate and is very low in practice. The heating effect of the Wattlass current is, however, identical with that of any electrical current, and accordingly the phenomenon of the extinguishment of the lamps in the method of my invention, when no load is being taken off of the transformers, must not be confused with the Wattlass-current phenomenon. The extinguishment of the lamps is due to a different phenomenon of transformers under no-load conditions which will now be explained.

As above stated, the effect of a transformer under no-load conditions in a circuit is to merely impose inductive resistance. This causes the current to lag considerably behind the impressed electromotive force, and such current generates a counter electromotive force in the primary winding due to the phenomenon of self-induction, as will be understood by those skilled in the art. The effect of the counter electromotive force is to oppose the impressed electromotive force, so that the resultant electromotive force is to cut down, and the actual current very much reduced. It is incidentally true that this is a Wattlass current, so far as the alternating mains are concerned; but this feature is not important in the present case. On account of the opposing action of the counter electromotive force, as above described, the current through the transformer-primaries under no-load conditions is cut down, and since all of the signals lie in circuits which include said primaries the effective current through the lamps is proportionately diminished, and in practice it is diminished to such an extent that the lamps are wholly extinguished and cease to display any signal.

The conditions will now be considered when trains are passing on the track, and I will first consider a single train coming from left to right, and subsequently I will consider the condition when the single track is employed for trains in both directions. A train coming from left to right passes onto the subsection B′ and immediately short-circuits the rails A^2 and A′ through all the axles of the cars. The immediate effect of this is to throw a load upon the transformer E′, the secondary s' of which is now virtually short-circuited. The effect of imposing a load on the transformer is to neutralize the counter electromotive force or self-induction of the primary winding, and as this becomes cut down the entire impressed electromotive force of two hundred volts from the alternating-current mains l^4 l^7 becomes effective to send current through the primary winding p', so that the current therein is very much increased. This current, however, is obliged to pass through the following multiple circuit of lamps, which all become at once illuminated: Lamps F′, F^2, and F^3 become illuminated on subsection B′, and lamps G^4, G^5, and G^6 become illuminated on said section B^2. Referring to the drawing, it will be seen that this results in signal No. 1 showing red, No. 2 white, and No. 3 white in the direction of the approaching train. Nos. 4, 5, and 6 all show red in the opposite direction. Accordingly the engineer on said train sees nothing in front of him but white lights throughout the series, which indicates that the track is clear and further shows that the apparatus is in working order. Under these circumstances the engineer progresses and finally passes onto subsection B^2. This at once imposes a load on transformer E^2 and causes white signals to be displayed in sections 4 and 5 ahead of the approaching train, at the same time keeping a red signal displayed in section No. 1, which prevents any second train from entering the block while the first train is at any point therein. The red lamp is also constantly displayed at section No. 6 to prevent any train from the opposite direction entering the block. Accordingly perfect protection is realized for a single train within the block at all times, and at the same time the white display-lamps keep the engineer constantly notified that the apparatus is in proper working order. A condition might arise in practice, however, upon a single-track railway where two trains from opposite directions entered the two corresponding subsections B′ and B^2 of a block at the same instant. This might happen by reason of the fact that as the trains entered the block, no signals of any sort being lighted, which is the normal condition of the apparatus, both engineers would simultaneously enter, lighting up all of the white lamps F^2, F^3, F^4, and F^5, which is the signal for both of the engineers to proceed at full speed. A collision in this case is, however, avoided by the following signals which are displayed: The train on subsection B′ shows a red light in signal 1, a white light in signal 2 and also in signal 3 and also shows a red light in sections 4 and 5. This forms the danger indication for the approaching train on section B^2. In

like manner the train on section B^2 shows a red light in sections 2 and 3, which is the danger-signal for the approaching train on section B'. In this way the trains are notified of the danger in spite of the fact of their running by the signal-lamps 1 and 6, due to their simultaneous entrance on the block.

Should my apparatus fail to operate at any time, it can only be by reason of the burn-out of the signal-lamps, since these are the only parts which are liable to failure in my system. In the practice of my invention I employ ordinary incandescent lamps for the signals, so that in order to restore the apparatus to working order it is merely necessary to plug in new lamps, which can be done by any one. The method of having two lamps in multiple in each signal-box insures that a signal will be given in spite of a burn-out in any single lamp.

While I have particularly described my method of block-signaling as applied to single-track systems in which trains enter the blocks from opposite directions, it is equally adaptable to the ordinary two-track installations, and in this case the method of "subsections" above described may or may not be used. It is of course apparent that with a two-track railway the blocks on each track may be simply constructed to correspond with any one of the subsections above described. It is also apparent that each signal may comprise a single box, of red or white, as the case may be, instead of two boxes in separate circuits. It is also not important to use lamps, since any form of signal or indicating device may be substituted therefor, and it will be understood that any desired number or disposition of them can be made to suit the conditions which arise in practice. I do not, therefore, desire to be limited or restricted to the particular method or to the particular features of construction which I have described.

What I claim is—

1. In a block-signal system, a signal, a circuit having means for displaying said signal when the current varies therein, a step-down transformer having its primary in said circuit, and means actuated by a passing train for closing the secondary circuit of said transformer.

2. In a block-signal system, a circuit including a display-signal and the primary of a step-down transformer, and a circuit including the secondary of said transformer adapted to be closed by a passing train.

3. In a block-signal system, a circuit including the primary of a transformer and display-signals in series with said transformer and in multiple arc with one another, and a separate circuit including the secondary of said transformer adapted to be closed by a passing train.

4. In a block-signal system, a transformer having a step-down ratio of substantially ten to one, a signal device included in series with the primary of said transformer, and a circuit including the secondary of the transformer arranged to be closed by a passing train.

5. A block-signal system comprising a track divided into sections, each section being subdivided into a pair of subsections, a pair of transformers in each block having their terminals connected to the rails of the subsections, and two sets of display-signals including signals in both subsections in each set, included in circuits through the primaries of said tranformers.

6. A block-signal system comprising insulated track-sections, and transformers having their secondaries in circuits which include the rails of said track-sections, and a circuit including two signal devices at the respective ends of a block-section in circuit with the primary of its transformer.

7. A block-signal system comprising a track divided into a plurality of insulated sections, a step-down transformer connected to charge the rails of a section with a comparatively low alternating potential difference, and signals included in circuit with the high-potential primary of the said transformer.

8. A block-signal system comprising a track having insulated sections, a step-down transformer connected to impress a low alternating potential difference between the rails of a section, and a signal included in the primary of said transformer.

9. In a block-signal system, a track having insulated blocks or sections each divided into a plurality of subsections, a pair of transformers connected to maintain each of said subsections at a low alternating potential difference, a set of signals disposed along the entire section and included in the primary of one transformer, and a second set of signals also disposed along the entire section included in the primary of the other transformer.

10. In a block-signal system, an insulated track-section, a step-down transformer connected to impress a low alternating potential difference between the rails of said section, a plurality of signals arranged in multiple with one another and in series with the primary of said transformer, some of said signals displaying danger and some safety indications.

11. In a block-signal system, a block-section having a danger-signal at each end each included in the primary of a separate transformer, subsections within the block or section, and connections from the transformers to the subsections whereby the secondary of the transformer for either signal is short-circuited by a train entering the other end of the block.

12. In a block-signal system, an insulated track-section, a signal arranged at each end of said track-section and included in the primary circuits of separate transformers, a plurality of additional signals disposed along the track-

section and divided into two groups or sets also included in series with the primaries of said transformers, and means actuated by a passing train for short-circuiting the secondaries of said transformers.

13. In a block-signal system, means for displaying signals at both ends of a track-section operated by an alternating current, a step-down transformer having its primary winding in series with said alternating-current circuit, and means actuated by a passing train for short-circuiting the secondary winding.

14. In a block-signal system, means operated by an alternating current for displaying a signal at each end of a track-section, a step-down transformer having its primary winding in series with the circuit including said means, and means operable by a train entering the block for closing the circuit through the secondary of said transformer.

In witness whereof I subscribe my signature in the presence of two witnesses.

CHARLES E. BENNETT.

Witnesses:

FRANK S. OBER,

WALDO M. CHAPIN.