F. TOWNSEND.

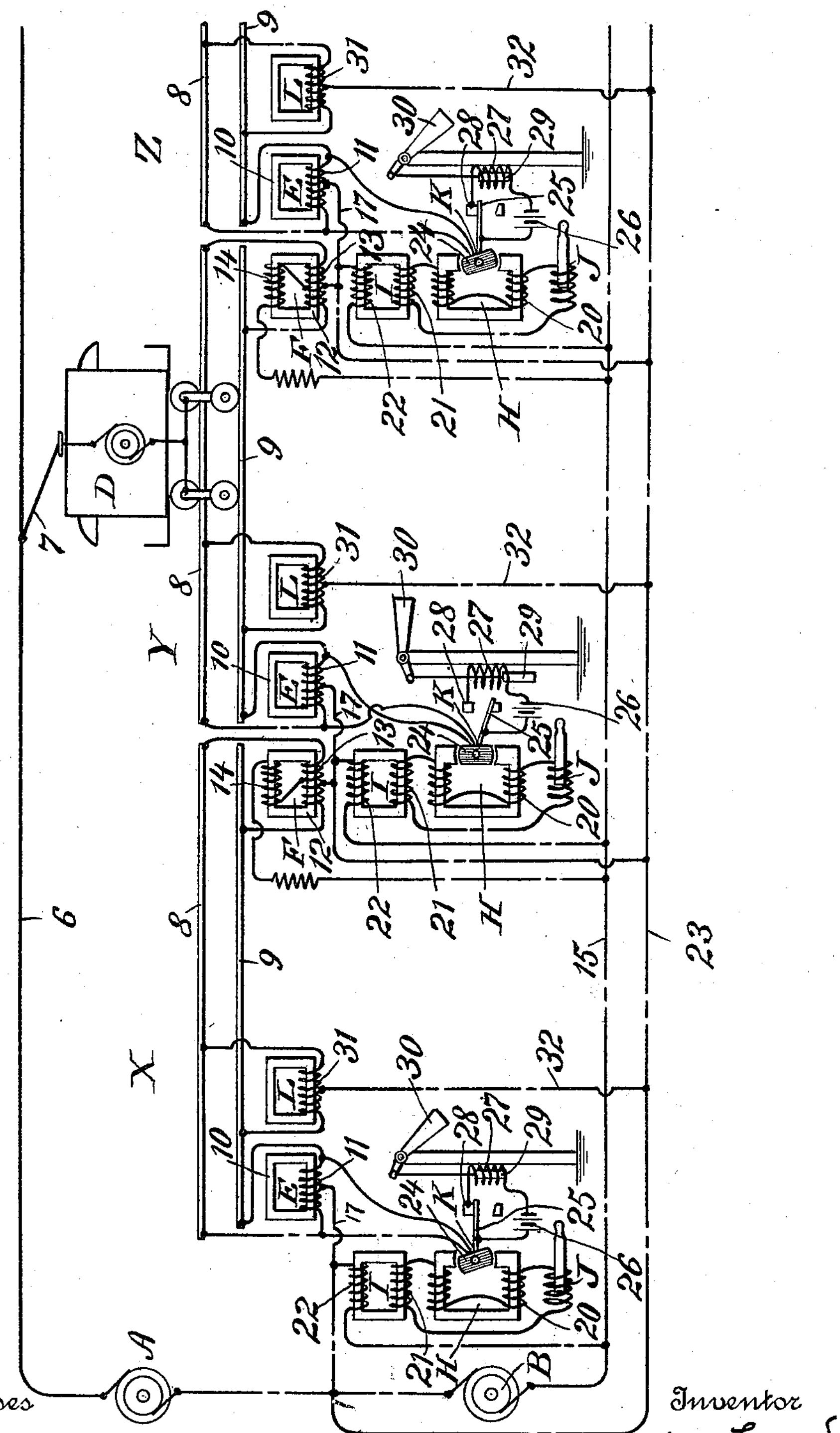
SYSTEM OF AUTOMATIC BLOCK SIGNALING.

APPLICATION FILED JUNE 16, 1904.

1,130,353. Patented Mar. 2, 1915.

3 SHEETS—SHEET 1.

FIG. 1.



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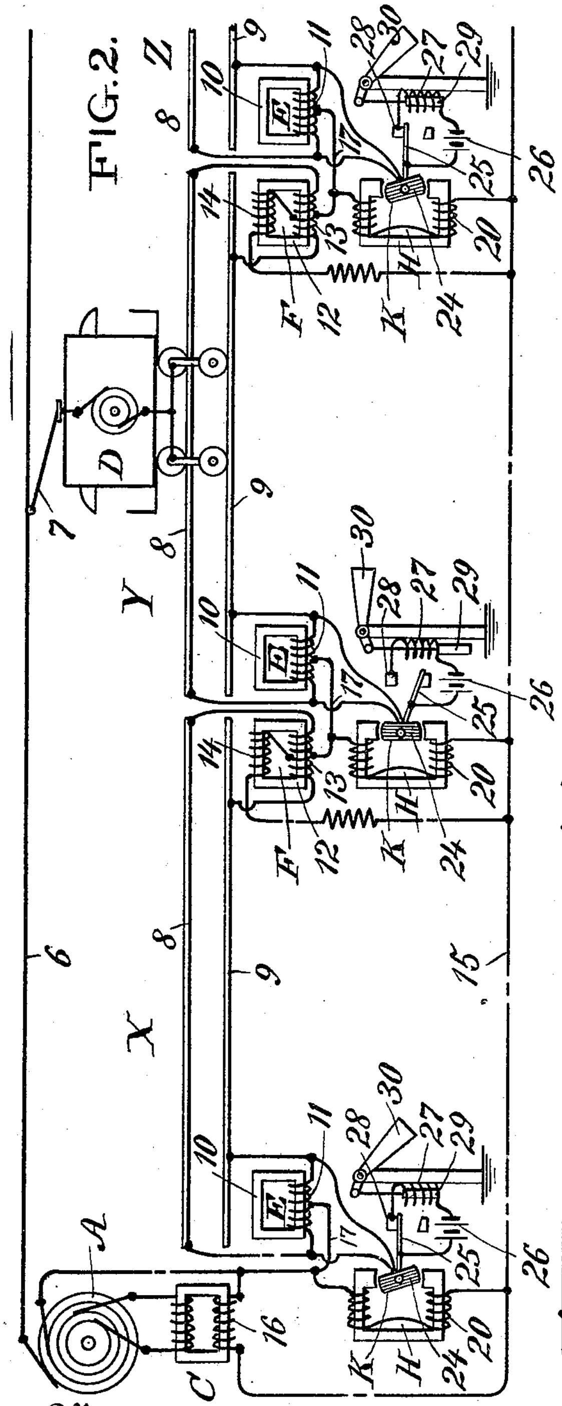

FIG. 2.

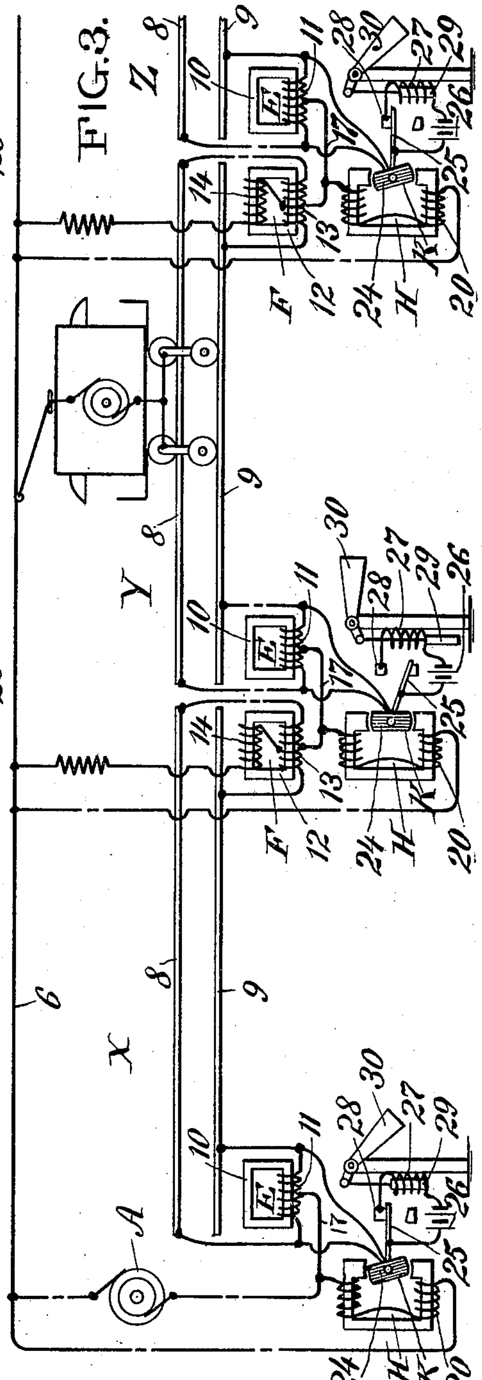

FIG. 3.

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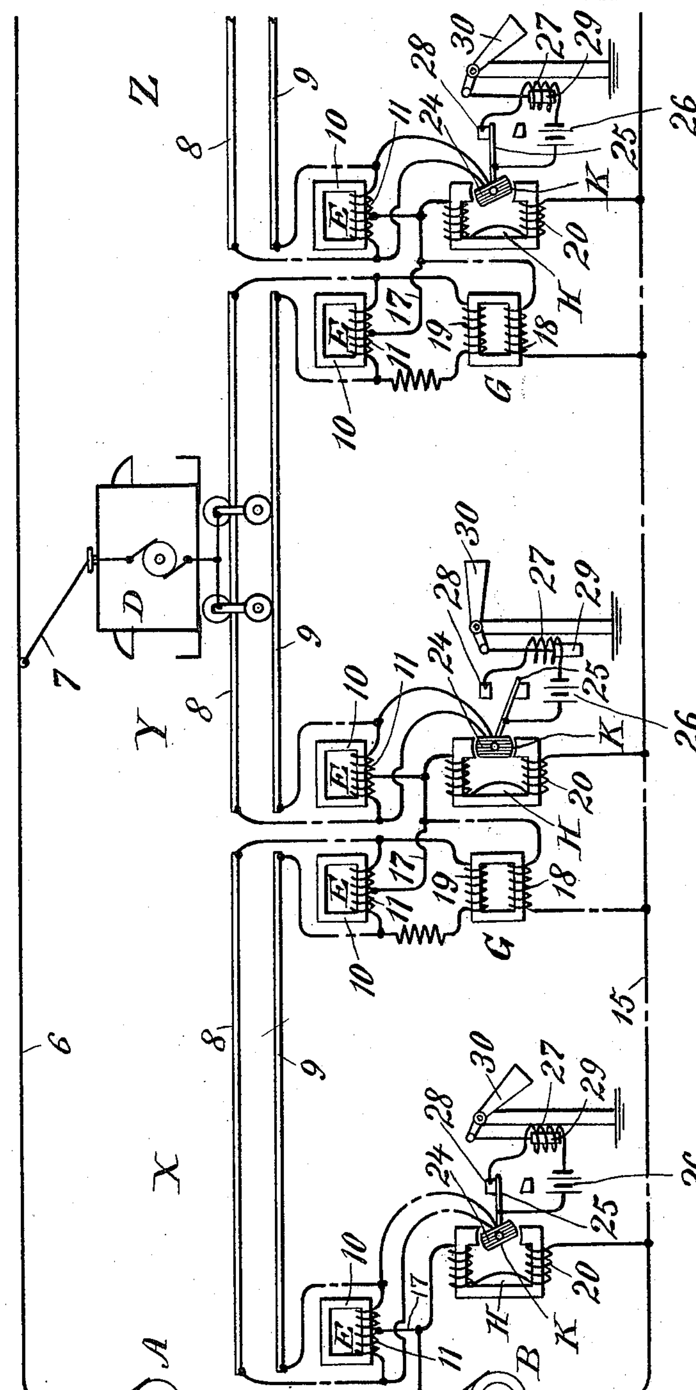
3 SHEETS—SHEET 3.

FIG. 4.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF AUTOMATIC BLOCK-SIGNALING.

1,130,353. Specification of Letters Patent. **Patented Mar. 2, 1915.**

Application filed June 16, 1904. Serial No. 212,798.

To all whom it may concern:

Be it known that I, Fitzhugh Townsend, a citizen of the United States, residing at New York city, county of New York, State of New York, have invented a System of Automatic Block-Signaling for Electric Railways, of which the following is a specification.

My invention relates to a system where the operation of the signals is controlled by the motion of a motor vehicle into and out of a block and while in the block. In the practical operations of such a system several requirements must be fulfilled in order that the normal conditions of operation of the railway shall not be interfered with; *i. e.*, the traffic rails must be segregated into block sections, the power current which operates the motor vehicle must flow along the traffic rails from one block section to the next without being impeded, the traffic rails should have an equal conductivity and should both serve as return conductors for the power current, and means should be provided to increase the conductivity of the return circuit when desired, by what is technically known as "return" or "negative feeders."

Systems of automatic block signaling have heretofore been proposed which in a measure complied with one or more of the above stated requirements. In one of such systems, the traffic rails have been divided into block sections by means of insulating joints, and in order to facilitate the return of the power current, such joints have been bridged by reactance coils. Such system, however, does not give a complete use of the divided rail as a conductor for the power current. Where such system has been applied to a direct current railway, the reactance coils interposed between the ends of the sections of the divided rail materially increase the ohmic resistance of the divided rail relative to that of the continuous rail, with the result, that the major portion of the power current is diverted to the continuous rail. Consequently, instead of having two rails of equal resistance, as a return for the power current as in ordinary railways, the conductivity of the two rails, divided and continuous, is equal only to approximately that of one rail and a fraction. Where such system is applied to an alternating current railway the disadvantage mentioned is found to be greatly increased, by the fact that the reactance coils oppose a counter-electromotive force of self-induction, as well as ohmic resistance to the power current, with the result that the current carried by the divided rail is still further diminished relative to that carried by the continuous rail.

In the system which I have designed, both traffic rails are divided into block sections by insulation interposed between the ends of the rails. In order to allow the power current to return along the traffic rails and pass from one block section to the next, I interpose what I term "bonding-coils" between the rails at the points of division between the blocks and in such manner that the power current flows through each bonding coil (in at both ends and out at the middle point of the coil) in such manner as to produce no magnetization of the core on which the coil is wound. The advantages secured by the arrangement of the bond-coils as employed by me, are: Owing to the small amount of iron and copper required to form the bond, such bonds are cheap in construction. The drop in volts due to the passage of the power current through the bonding-coils is greatly diminished. In the case of an alternating current railway, (where the power current produces no magnetization in the bonding-coils at any time), no counter-electro-motive force of self-induction will impede the power current in its passage along the traffic rails from one block section to the next. My improved system is applicable to roads operated either by direct or alternating current.

In order to control the signaling devices, an alternating current is employed, (irrespective of whether the power current is a direct or an alternating current,) which is preferably fed into each block section at the end of the block at which the car normally leaves the block; (this current I shall denote in this specification as the "signaling current"). The signaling current produces a difference of potential between the traffic rails, which difference of potential is adapted to normally, that is, when a block is not occupied by a motor vehicle, energize a relay device connected across the traffic rails, preferably at the end of the block section at which the car normally enters the block. This relay device normally acts to close a local circuit in such a way that the signaling device employed will indicate a clear signal. The presence of the motor vehicle in a block section, through the wheels and axles of the car, or any suitable contact device, serves to short circuit the relay device; or in other words, shunt the difference of potential around the relay device, thus deenergizing the relay and causing the signaling device to indicate a danger signal. The relay employed may be of any suitable type. I prefer, however, to use a relay which will be selective in character, and such as will only be actuated by an electro-motive force across the rails, having the particular frequency and phase of the signaling current employed.

I have shown in this specification a particular form of relay. I, however, make no claim in this application for such relay, as the same has been made the subject of a separate application Serial No. 212,298, filed June 13th, 1904.

The signaling current employed, may be derived from any suitable source. In the drawings I have shown three different methods of obtaining signaling current; that is, the signaling current may be obtained from an independent generator, Figures 1 and 4, from the generator which furnishes the power current, (the power current being of one phase and the signaling current of another phase), Fig. 2, and from the same generator which furnishes the power current, but as a segregated current, Fig. 3.

The accompanying drawings will serve to illustrate my invention, in which—

Fig. 1 is a diagram illustrating my improved system as applied to an alternating current railway, with two generators, one for the power current and one for the signaling current. Fig. 2 shows my system as applied to an alternating current railway, with a single generator employing one phase for the power current and one phase for the signaling current. Fig. 3 shows my system as applied to an alternating current railway with a single generator, with the signaling current segregated from the power current. Fig. 4 shows my system applied to a direct current railway, with a direct current generator for the power current and an alternating generator for the signaling current.

Referring to the drawings: A indicates the generator for the power current. In Figs. 1 and 3, this generator is an alternating current generator of the single phase type; in Fig. 2, an alternating current generator of the two phase type, and in Fig. 4 a direct current generator. I wish it understood that the power current may be derived from any suitable source of electricity, as is the case with ordinary electric railways, that is, the current may be an alternating current of single phase or polyphase, a direct current, or a pulsating current.

B, Figs. 1 and 4, indicates the generator for the signaling current. In Figs. 2 and 3, the signaling current is derived from the generator A, which furnishes the power current. In Fig. 2, the signaling current is taken off from a different set of collector rings of the generator A from that of the power current and differs in phase from the power current, and which current is used to excite the primary 5 of a transformer C. In Fig. 3, the signaling current is a segregated current from the power current delivered from generator A, as will be described. I wish it understood that the signaling current may be derived from any suitable source of electricity, and that such current be different in frequency or phase from the power current. I prefer that the frequency of the signaling current be greater than that of the power current, for instance, the power current may be 25 cycles and the signaling current 60 cycles. The phases of the power and signaling current may be displaced at any angle, preferably 90 degrees.

6 indicates the outgoing feeder contact conductor; D motor vehicle; 7, traveling contact; 8, 9, traffic rails. The traffic rails are shown as divided into three blocks or sections X, Y, Z; the corresponding rails of respective sections being insulated from each each other or otherwise separated. The feeder contact conductor 6 and the rails 8, 9 are connected to the terminals of the power generator A and form a power circuit.

In order to connect the traffic rails 8, 9 of the blocks X, Y, Z, together, and thus furnish two return paths for the power current to the generator A, and which paths shall be of equal resistance, I make use of the bond E, which consists of an iron core 10, on which is wound a coil of copper wire 11, which coil is connected across the rails 8, 9, at the left hand end of each block. Also the bond transformer F, which consists of the core 12, on which is wound the copper wire coils 13, 14. The coil 13 is connected, like the coil 11, across the traffic rails 8, 9, but at the opposite end of each block. The coil 14 is connected, one end to the center of the coil 13, and the other end to a conductor 15. The conductor 15 is connected at one end to the source of the signaling current, that is, in Figs. 1 and 4, to one terminal of the generator B; in Fig. 2 to one terminal of the secondary 16 of transformer C; in Fig. 3 to the feeder contact conductor 6, which takes the place of the conductor 15.

The coil 14 forms the primary coil of the bond transformer F, and as it is connected across the terminals of the signaling current, serves to excite the coil 13, which coil forms a double purpose, *i. e.*, that of a bond and that of a secondary of the transformer F. The current from each coil delivered to the traffic rails 8, 9, creates a difference of potential between these traffic rails, which current is used, as will hereafter be described, to operate a relay when a motor car is not in a block, but which current is short-circuited when a motor car moves into a block. The coils 11, 13 of bond E and bond transformer F, are connected together at their middle point, by means of a conductor 17.

The operation of the bond E and bond transformer F, so far as relates to its function as a bond, will now be understood: The power current from a rail 8 flows through the left hand half of the coil 11 to conductor 17, while the current from rail 9 flows through the right hand half of the coil 11 to conductor 17. As the direction of the flow of these two currents is opposite no magnetization of the core 10 of bond E will take place. The currents which have joined in the conductor 17 are delivered to the center of the coil 13 on bond transformer F, divide and flow through opposite halves of the coil 13, respectively to the rails 8 and 9 of the next section, for instance X, and as they flow in opposite directions do not magnetize the core 12. The coils 11, 13, therefore do not offer any considerable resistance to the power current flowing to the generator through the traffic rails 8 and 9. It will be observed, however, that the coils 11 and 13 are connected across the rails 8, 9; consequently, the current due to the difference of potential excited in the rails 8, 9, by the coil 13 acting as secondary of the bond transformer F and tending to flow through coil 11 of bond E in one direction, is met by the reactance effect of the coil 11, which practically resists the flow of such current and thereby tends to maintain the potential of the signaling current across the rails 8, 9. The conductor 17, it will be observed, at the left hand end of the block X, is connected in Figs. 1 and 4, to the generators A, B, in Fig. 2, to the generator A and one terminal of the coil 16 of the transformer C, in Fig. 3, to the generator A. The conductor 17, it will be observed, also forms a common return for both the power and the signaling current employed in all of the figures. Instead of using a bond E and transformer F, as shown in Figs. 1, 2, 3, I may use two bonds of similar construction, as shown in Fig. 4, and excite the difference of potential across the rails 8, 9, by means of an independent transformer G, having its primary 18 connected across the conductors 15 and 17, and its secondary 19 across the traffic rails 8 and 9.

Referring now to the relay device: The relay device may have its field coil 20, connected directly across the source of signaling current, as shown in Figs. 2, 3 and 4, or across the terminals of the secondary coil 21 of a transformer I, the primary 22 of which is connected across the conductor 15 and a conductor 23; one terminal of the primary is also connected to the conductor 17. Located in the field coil 20 of the relay H, is a device J, Fig. 1, through which an inductive resistance may be interposed in the field circuit of the relay.

K indicates the armature of the relay, which consists of a coil of wire 24, whose plane in its normal position is parallel with the field of force between the pole pieces of the relay. The terminals of this coil are connected across the rails 8, 9. Carried by this armature is an arm 25.

26 indicates a local circuit, in which is a solenoid core 27. One end of the local circuit is fastened to the arm 25 and the other end to a contact plate 28.

29 indicates an armature located in the solenoid 27, and connected to the short arm of the semaphore 30.

In certain localities, as for instance, upon elevated roads, it is useful to decrease the resistance of the return path for the power current, and for this purpose I provide the additional connecting feeder bonds L, which are constructed in all respects like the bonds E and have their coil 31 connected across the rails 8, 9, and connected at its central point through a conductor 32 to the conductor 23, which conductor may, for instance, be the structure of an elevated road, or other good conducting path.

The operation of my improved system is as follows:—The signaling current derived from the generator B, or from one phase of the generator A, but segregated from the power current, Fig. 3, excites, through the transformer bonds F, Figs. 1, 2, 3, or supplemental transformer G, Fig. 4, a difference of potential between the rails 8, 9. Such signaling current also excites the field coil 20 of the relay H, either directly, as shown in Figs. 2, 3, 4, or through the instrumentality of a transformer I, as shown in Fig. 1. The voltage across the rails 8, 9, excites a current in the coil 24.

Remembering now that the signaling current exciting the field coil 20 of the relay H corresponds in phase with the current exciting the coil 24 of the armature I, a turning movement of the armature I will take place, which turning movement will cause the arm 25 to make contact with the plate 28 and close the local circuit 26, thereby causing the solenoid 27 to attract its armature 29 and carry the signal to the clear position, *i. e.*, to the position shown in blocks X and Z. The semaphore arm will be maintained in this position so long as a voltage exists across the rails 8, 9. Should this voltage be destroyed by any means, as for instance, by malicious interference or otherwise, the semaphore arm will automatically go to danger. Or, in the normal operation of the road, a car entering a block, in which case the wheels of the car and axles will short circuit the armature I of the relay. Or, in other words, prevent the current due to the difference of potential between the rails 8, 9 from flowing through said armature, with the result that the armature will return to its normal position and open the local circuit, thereby allowing the semaphore arm to drop by gravity to the danger position.

In order to provide against the danger of a current from an energy transformer of one section affecting the relay in a contiguous section, which would be the case if the insulation between two adjacent sections were broken down, as for instance, the sections X, Y, the connections of the primary 14 of the energy transformer in section X are reversed relative to those of the energy transformer of section Y, thereby making the polarity of the traffic rails in section X always opposite to that of the polarity of section Y. At the same time the connection of the terminals leading to the armature 24 of sections X and Y are correspondingly reversed.

In the various diagrams I have shown the rails included in the primary circuit of the transformers. Manifestly, and to insure greater safety, I may excite the transformers which create a difference of potential across the rails by means of entirely independent conductors.

I wish it understood that I do not limit myself to the particular arrangement of circuits indicated in the accompanying diagrams, as it will be obvious to electricians, that many changes may be made without in anywise departing from the intent of my invention. Nor do I limit myself to the particular construction of bond or bond transformer, or relay, shown, as many changes may be made therein, without involving any radical change in the operation of the system.

What I wish to have understood is—that I claim to be the first to have described and illustrated a system of automatic block signaling for electric railways where the conductivity of the traffic rails is practically the same, and will be maintained the same as in an ordinary electric railway, and which conductivity is not effected by having impressed thereon in the direction of the flow of the power current or across the rails, an alternating current for signaling purposes.

Having thus described my invention, I claim:—

1. A system of automatic block signaling for electric railways, embodying two rails divided into sections by insulated joints, bonds arranged to bridge said joints, said bonds each having a core and a coil thereon, said coil connected across the traffic rails, and two adjacent bonds connected together at their centers, and a second coil on one of said bonds connected across a source of alternating current.

2. A system of automatic block signaling for electric railways, embodying two rails divided into sections by insulated joints, bonds constructed and connected as described, arranged to bridge said joints, means for exciting a difference of potential between the rails of each section, supplemental bonds constructed as described and connected across the rails in each section, and a return auxiliary conductor connected to the central point of the coil in each supplemental bond.

3. In a system of automatic block signaling for electric railways, the combination of a series of blocks or sections, relays responsive to currents of one frequency and phase controlled by the blocks or sections, signals controlled by said relays, transformers energizing the sections with current of this particular frequency, the connections of the transformers in adjacent blocks being reversed through 180 electrical degrees so that this phase of the current in adjacent blocks is different and each relay being connected to pick up in response to the phase impressed by the transformer of its block.

4. In a system of automatic block signaling for electric railways, the combination of a trackway divided into block sections, a coil connected across the trackway, an independent return conductor for the power current, and a conductor connecting the central point of the coil with the return conductor.

5. In a system of automatic block signaling for electric railways, the combination with a track having both rails divided into sections of a power current and a signaling current of different characteristics flowing in both rails of a track divided into sections, the signaling current supplied to each section by a transformer, the primary current of this transformer flowing into the middle

point of the winding of the secondary and returning to the generator through both rails equally, the secondary of the transformer connected across the track and carrying the full power current.

6. In a system of automatic block signaling for electric railways and in combination with the traffic rails each divided into block sections by insulated joints, a reactance transformer bond comprising a core, a coil thereon, a conductor leading from the middle point of the coil, and a second coil thereon having an inductive relation to the first mentioned coil.

7. In a system of automatic block signaling for railways and in combination with the traffic rails each divided into block sections by insulated joints, reactance transformer bonds each bond comprising a core, a coil thereon connected across the trackway, a conductor leading from the middle point of the coil, and a second coil thereon wound in inductive relation to the first mentioned coil and adapted to be connected across the source of signaling energy.

8. In a signaling system for railways, the combination with a plurality of track circuits, each of which includes an inductive device comprising an iron core and a winding which is electrically connected with both track rails of the track circuit, and an additional winding on each inductive device which is in circuit with a source of alternating current.

9. In a signaling system for railways, the combination with a plurality of track circuits, each of which includes an inductive device comprising an iron core and a winding which is electrically connected with both track rails of the track circuit; an electrical connection between the winding of one inductive device and the winding of an inductive device in an adjacent track circuit such that propulsion current in the track rails will flow in opposite directions through the windings of one inductive device to the connection, and from the connection in opposite directions through the winding of the adjacent inductive device; and an additional winding on an inductive device in each track circuit which is in circuit with a source of alternating current.

10. In a signaling system for electric railways a source of alternating signaling current, a plurality of track circuits each of which includes an inductive device comprising a core and a winding which is connected with the rails of the track circuit and a second inductive device, an electrical connection between adjacent inductive devices, and a second winding on one of said inductive devices in each block traversed by an alternating signaling current which induces a secondary current in the first named winding thereon.

11. In a signaling system, the combination of a closed track circuit, a source of alternating current supply of high frequency for said track circuit, an impedance coil in circuit with the closed track circuit affording a path for any or all current other than the current of high frequency that may be in said track circuit, and a circuit connected with the terminals of the impedance coil which circuit comprises a translating device operable only by alternating current of high frequency, and a source of alternating current of lower frequency for the motive power.

12. In a signaling system, the combination of a closed track circuit, a source of alternating current supply for said track circuit of a high frequency, an impedance coil in circuit with the closed track circuit, and a circuit connected with the terminals of the impedance coil which circuit comprises a translating device operable only by the alternating current of high frequency, and a source of alternating current of lower frequency for the motive power.

13. In a signaling system, the combination with a closed track circuit which includes a transformer coil and a translating device responsive only to alternating current of one frequency, a source of alternating current of the frequency to which the translating device will respond, and means for affording a path through said closed track circuit of low resistance to alternating currents of a different frequency and to direct currents.

14. In a signaling system for electric railways, a trackway having both rails divided into block sections and which serves as a return for alternating propulsion current, a source of alternating propulsion current, a series of track circuits formed in part by the trackway, a source of alternating signaling current for each track circuit, a relay for each track circuit responsive to the alternating signaling current, and impedance coils connected across the trackway.

15. In an electric railway signaling system, in which the running rails are used as part of the return for the propulsion current, the combination of a supplementary return conductor for the propulsion current, a plurality of track circuits, two or more inductive cross bonds for each track circuit, means for electrically connecting two cross bonds in adjacent track circuits to each other, and means for electrically connecting any such pair of cross bonds to the supplementary return conductor.

16. In a signaling system for railways, the combination with a plurality of track circuits, each of which includes an inductive device comprising an iron core and a winding which is electrically connected with both track rails of the track circuit; an elec-

trical connection between the winding of one inductive device and the winding of an inductive device in an adjacent track circuit such that propulsion current in the track rails will flow in opposite directions through the winding of one inductive device to the connection, and from the connection in opposite directions through the windings of the adjacent inductive device; and an additional winding on an inductive device in each track circuit which is in circuit with a source of alternating current.

In testimony whereof, I affix my signature, in the presence of two witnesses.

FITZHUGH TOWNSEND.

Witnesses:

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Frank O'Connor.

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