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No. 810,687. PATENTED JAN. 23, 1906.

F. TOWNSEND.

SYSTEM OF AUTOMATIC SIGNALING FOR ELECTRIC RAILWAYS.

APPLICATION FILED NOV. 10, 1905.

3 SHEETS—SHEET 1.

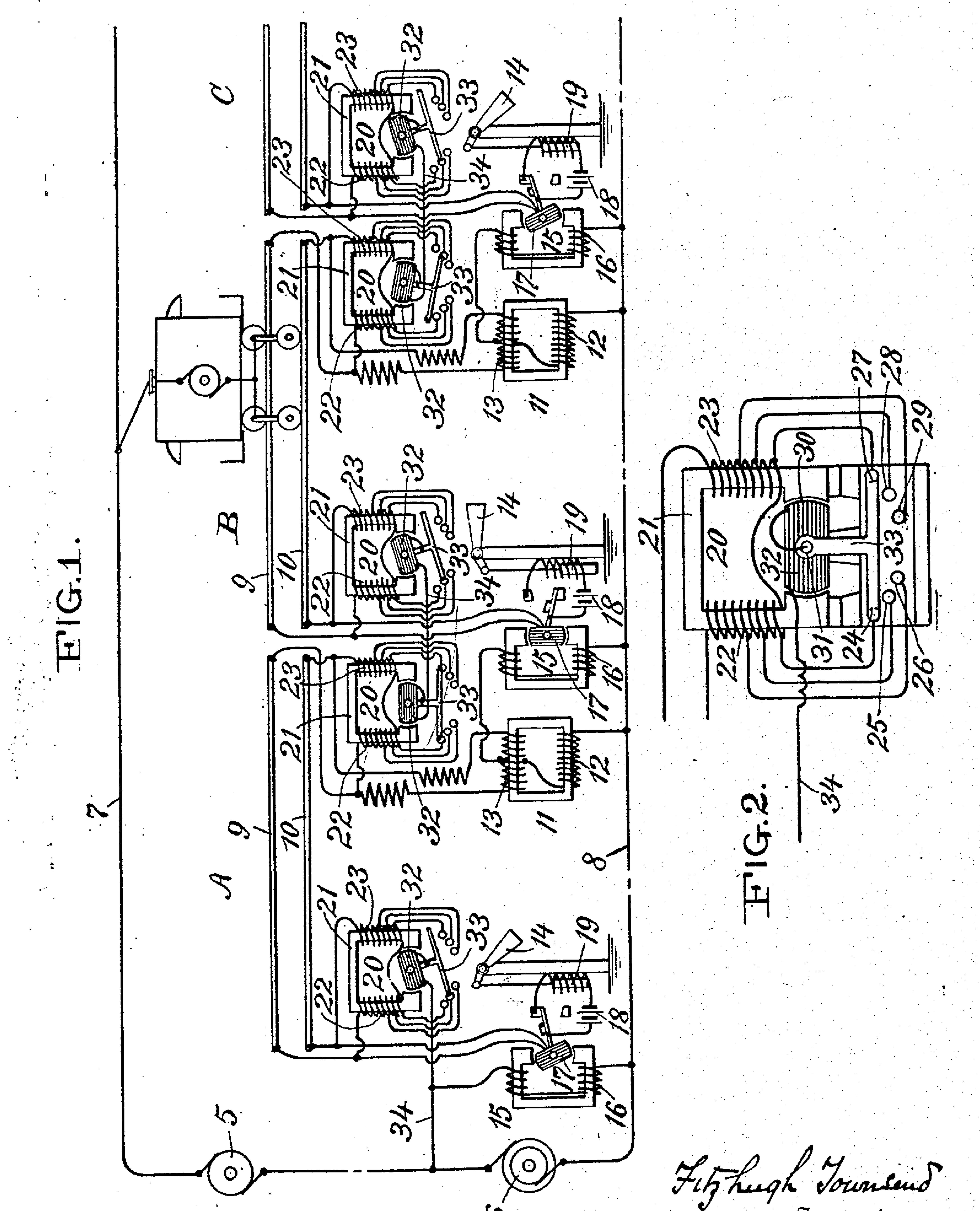

FIG. 1.

FIG. 2.

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Inventor

By his Attorney Geo. H. Benjamin

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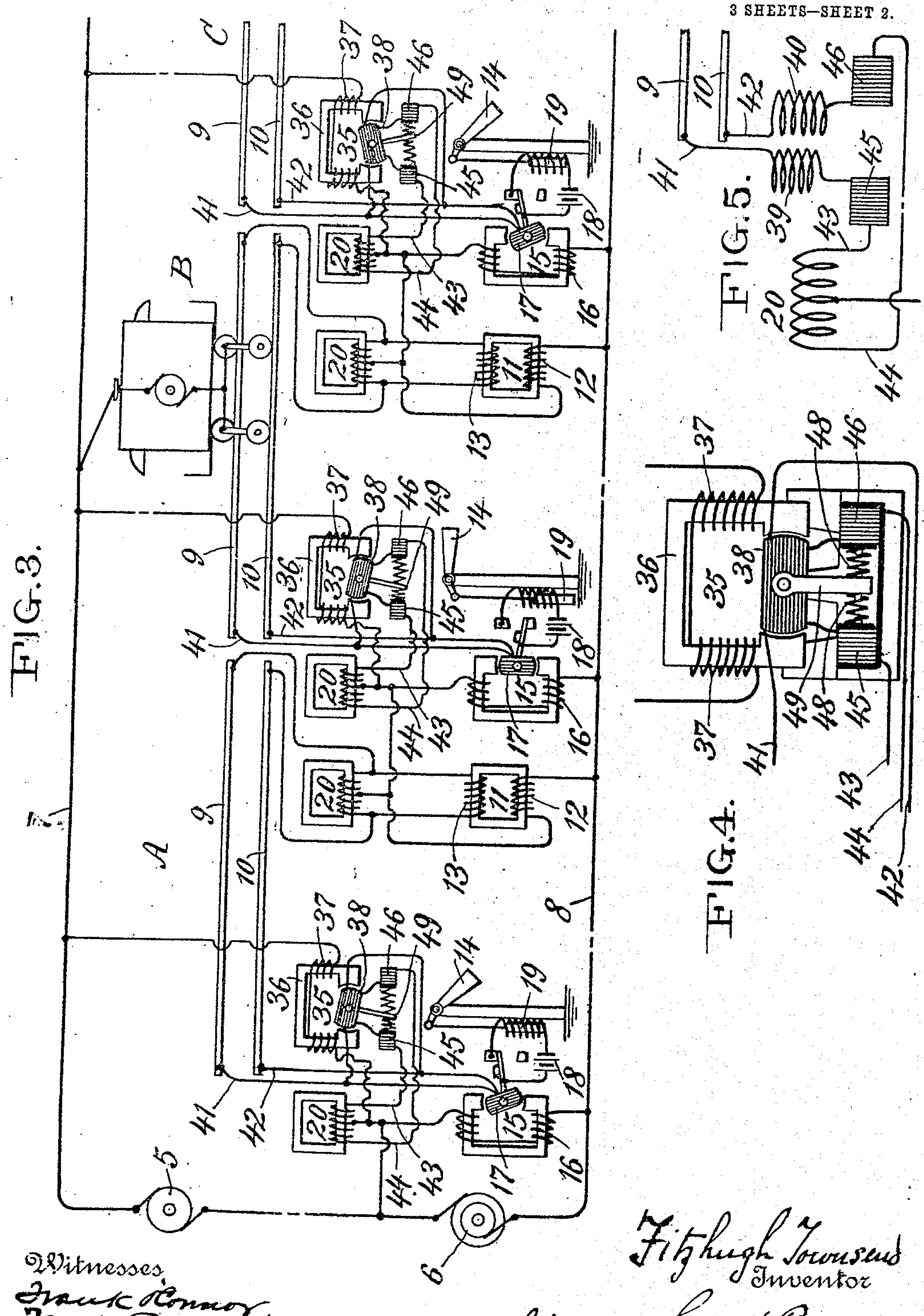

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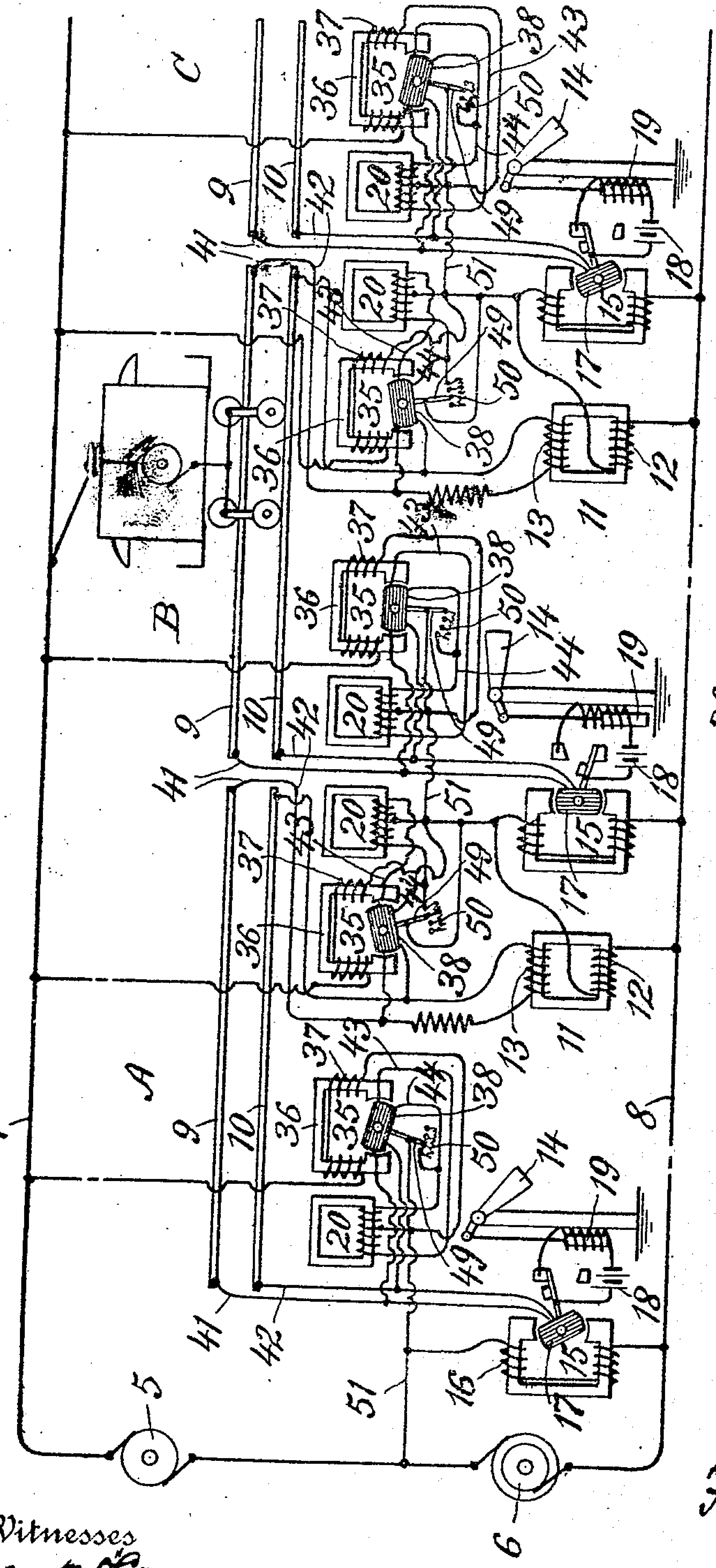

FIG. 6.

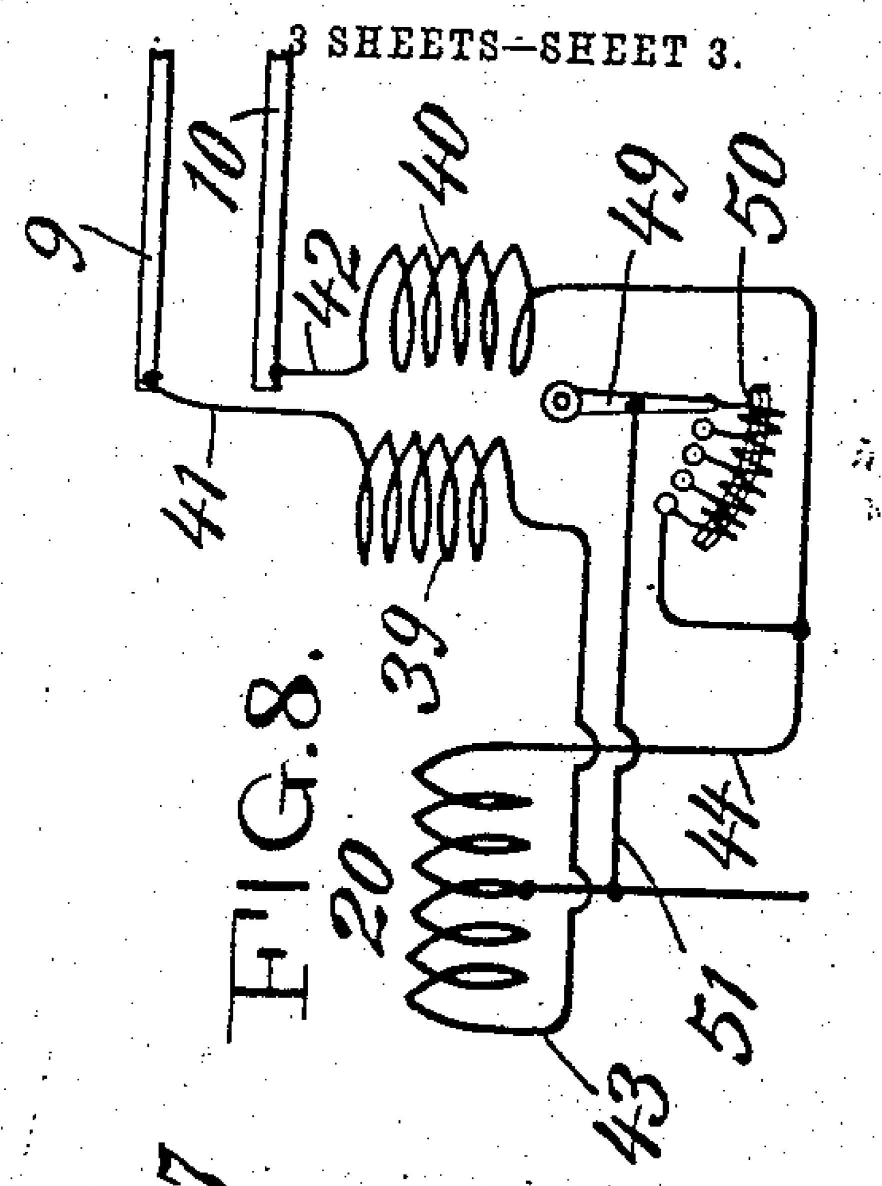

FIG. 8.

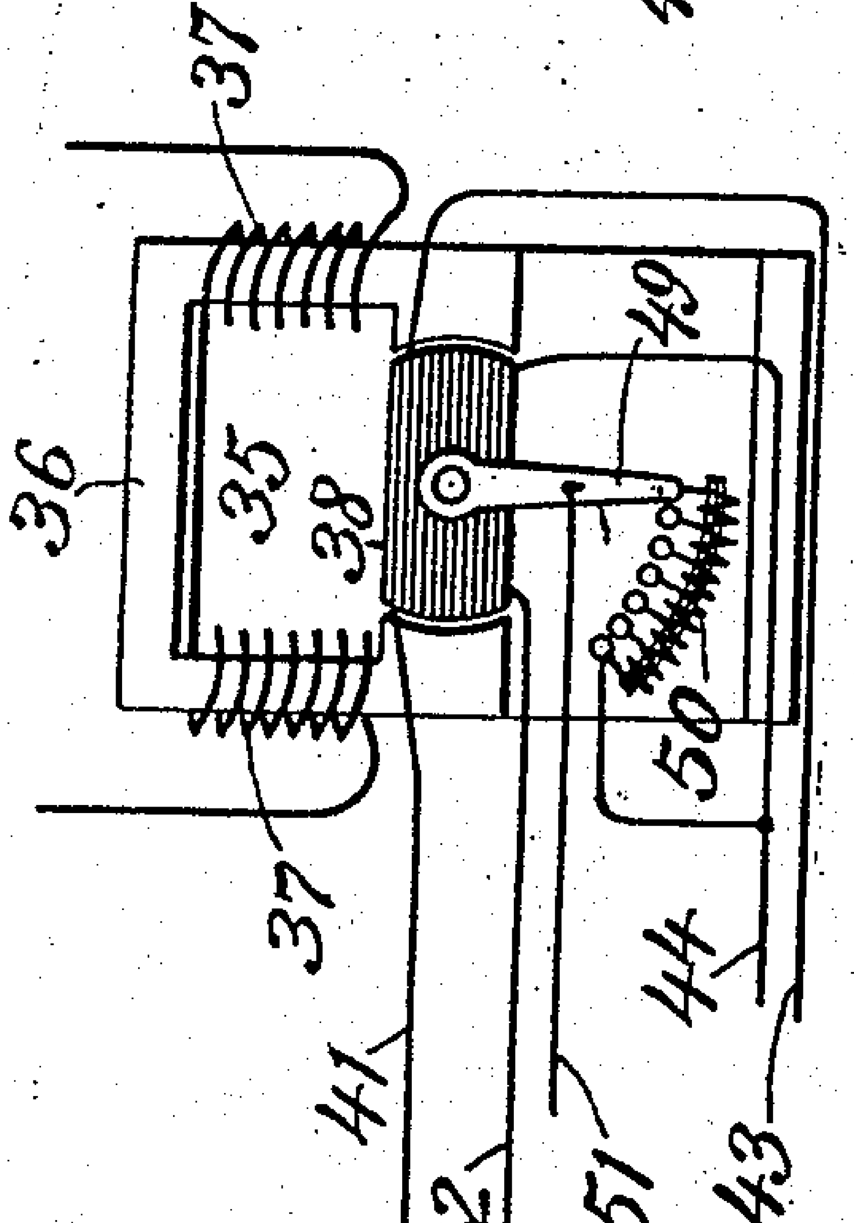

FIG. 7.

Witnesses
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UNITED STATES PATENT OFFICE.

FITZHUGH TOWNSEND, OF NEW YORK, N. Y., ASSIGNOR TO GENERAL RAILWAY SIGNAL COMPANY, A CORPORATION OF NEW YORK.

SYSTEM OF AUTOMATIC SIGNALING FOR ELECTRIC RAILWAYS.

No. 810,687. Specification of Letters Patent. Patented Jan. 23, 1906.

Application filed November 10, 1905. Serial No. 286,741.

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 and State of New York, have invented a System of Automatic Signaling for Electric Railways, of which the following is a specificaton.

This invention relates to a system of automatic block-signaling for electric railways of the type comprising a source of power-current, a source of signaling-current, a trackway divided into block-sections, means for setting up an alternating difference of potential between the rails of a block-section, means which will freely permit the passage of the power-current from block-section to block-section, but prevent the alternating difference of potential between the rails of a block-section from affecting the signaling devices in adjacent block-sections, a signaling device in each block section, and means controlled by the movements of the cars which will control the movements of the signaling devices. In such a system it is usual to arrange the reactance bonds so that the power-current of the two traffic-rails produces counteracting or opposing magnetomotive forces. In practice it has been found necessary to make these bonds of large size in order to provide for the possible inequality in the amounts of power-current carried by each traffic-rail. The inequality of the current in the traffic-rails tends to magnetize unequally the cores of the bonds, thus affecting their reactive influence and giving rise to other objectionable features known to signal engineers.

The object of my invention, therefore, is the provision of means in a block system for reducing the resultant magnetomotive force of the power-currents carried by the two traffic-rails to zero in the inductance bonds.

The accompanying diagrams will serve to illustrate my invention.

Figure 1 is a diagram illustrating a system of automatic signaling for electric railways, with means for varying the turns in the inductance bonds in a manner proportionately to the degree of inequality of the currents carried by the traffic-rails, thus reducing the resultant magnetomotive force to zero in the coils. Fig. 2 is a detail view of the inductance bonds employed in the arrangement shown in Fig. 1. Fig. 3 is a diagram similar to Fig. 1 with means for equalizing the power-current between the rails, such means consisting of inductance bonds having coils in the path of the power-current with means for changing the effective resistance of one or the other of said coils, and thus altering the relative resistance of the return-paths through the rails. Fig. 4 is a detail view of the inductance bond employed in the arrangement shown in Fig. 3. Fig. 5 is a view in diagram thereof. Fig. 6 is a diagram similar to Fig. 1 with means for equalizing the opposing magnetomotive forces due to the power-currents in the inductance bonds, said means being adapted to shunt more or less of the power-current around a portion of the winding of the inductance bond, depending upon the degree of inequality in the power-currents carried by the traffic-rails. Fig. 7 is a detail view of the inductance bond employed in the arrangement in Fig. 6, and Fig. 8 is a view in diagram thereof.

The three arrangements shown illustrate the different means for carrying my invention into effect. I wish it understood I do not limit myself in any wise to such specific arrangements, as others may be employed without requiring more than the use of well-known electrical principles and devices.

Referring to the diagrams, 5 indicates a source of power-current; 6, a source of signaling-current; 7, power-feeder; 8, signaling-feeder; 9 10, track-rails. These rails are divided into block-sections A B C. Situated in each block-section is a transformer 11, having its primary 12 energized from the source of signaling-current 6 and its secondary 13 connected across the track-rails. The purpose of these transformers is to excite an alternating difference of potential between the track-rails of each block-section. Situated also in each block-section is a signal 14, a relay 15, having its field 16 connected across the source of signaling-current 6 and its armature 17 across the track-rails 9 10, and this armature adapted to control a local circuit 18, which when closed energizes a solenoid 19 to control signal 14.

The features of construction so far as described present no point of novelty and when used in connection with suitable reactance bonds interpos d between the rails of the respective block-sections constitute a system of automatic block-signaling for electric railways—such, for instance as is generically described in United States Letters Patent No. 757,537, granted to S. M. Young April 19, 1904. The system described in such patent, as well as in subsequent patents, makes use of a reactance bond having no moving part. In the present case I employ a reactance bond with a moving part, as in Fig. 1, which has for its purpose to relatively vary the effective length of the coils on the bond, or a device to be used in connection with the bond to vary the relative effective resistance of the coils on the bonds, as in Fig. 3, or shunt one coil of a bond, as in Fig. 7.

Referring to Figs. 1 and 2, 20 indicates reactance bonds. These bonds each consist of an iron core 21, on which are wound two coils 22 23. These coils are in series and are connected across the track-rails 9 10. Each coil at definite points in its length is connected to contact-plates 24 25 26 for the coil 22, 27 28 29 for the coil 23, and an armature 30, pivoted to oscillate on axis 31 and provided with a coil 32. One end of this coil is connected to a T-shaped contact-arm 33 and the other end through conductor 34 to the coil 32 of the next adjacent reactance bond 20—*i. e.*, in the next block-section, or, as shown in block-section A, to the sources of current.

The operation of the system shown in Fig. 1 is as follows: The power-current starts from generator 5, thence by feeder 7 to the car in block B, thence by rails 9 10 to the reactance bond 20 at the left-hand end of the block, thence through the coils 22 23, which are wound in such manner that there will be no magnetization of the core 21 if the currents in the rails are equal, thence to contact 25, contact-arm 33, coil 32, thence by conductor 34 to coil 32 on armature 30 of bond 20 in block A to contact-arm 33, (of this bond,) through coils 22 23, (of this bond,) rails 9 10 to bond at left-hand end of the block A, thence following the same path as first described to generator 5. Should the current in rail 9, for instance, exceed that in rail 10, the core 21 will be magnetized. This condition will cause the armature 30 to turn, and this rotation will move the contact-arm 33 to a position to diminish the number of active turns of the coil 22. This is the condition indicated by the bonds at the left-hand end of blocks A, B, and C, while the position at the right-hand end of block B indicates the reverse and the position at the right-hand end of block A an equalized current. The signaling-current starts from generator 6, excites the transformers 11, which excite a difference of potential between the rails 9 10. It will be observed that by reason of the direction of the windings of coils 22 23 of the bonds 20 the core 21 is not saturated by the power-current and that consequently these coils set up a reactance which chokes back the alternating signaling-current, thus maintaining an alternating difference of potential between the traffic-rails. This reactance also prevents such alternating difference of potential in one block-section from affecting the relay apparatus of an adjacent block-section. It will be observed in regard to Fig. 1, as well as Figs. 3 and 6, that the reactance bonds of adjacent sections have their coils connected at their centers, so that the power-current flowing along the rails 9 10 will not magnetize the cores 21 of the bonds. The alternating difference of potential between the rails 9 10 causes a current to flow through the coil of armature 17 of the relay 15, and a current of the same phase and frequency from the signaling-generator 6 flows through the field 16 of the relay, thereby normally causing a turning movement of the armature, which carries it into the position shown in A and C. This action closes the local circuit 18 and carries the signals 14 to the "clear" position shown in blocks A and C. When a car moves into a block, the armature 17 of the relay in said block is short-circuited, the local circuit 18 is broken and the signal carried to the "danger" position, as shown in block B.

It will be seen from the above description that the action of the bond 20 is to reduce the opposing magnetomotive forces due to the power-currents in coils 22 and 23 to equality, so that no magnetic flux is produced in the core 21 by said power-currents. This action is entirely independent of the condition of the block-section so far as regards the signaling-current—that is, it is immaterial whether or not the blocks are occupied by the cars.

Referring to Figs. 3, 4, and 5, the bonds 20 are shown mechanically separated from the equalizing device 35. The equalizing device here used consists of a core 36, on which are coils 37, wound in series and connected across the source of power-current, also a pivoted armature 38, on which are two coils 39 40. 41 43 represent the terminals of one coil, 42 44 the terminals of the other coil. The terminals 41 42 are connected at the rails 9 10 and the terminals 43 44 to the opposite ends of the coil on bond 20. 45 is a resistance interposed in series with coil 39, and 46 a similar resistance in series with coil 40. The resistances 45 46 may be made of contact-plates placed one against the other and held in position by means of springs 48. The armature 38 is provided with an arm 49, which tends when moved in one direction or the other to press one or the other of the series of contact-plates into close relation. The action of the equalizing device 35 in this case is to reduce the magnitude of the power-currents in the traffic-rails to equality, so that there is no necessity of an alteration in the winding of the coils 20. This equalization of the power-currents is accomplished by means of variable resistances inserted in series with the traffic-rails. In the drawings I have shown contact-plates. It will be obvious to engineers, however, that other arrangements of resistance could be employed with equal success. It is obvious from the connections described for the equalizing device that if the currents in the two traffic-rails of a block are equal no turning moment will be exerted by the armature 38, the coils 39 and 40 being differentially wound. Should, however, the rail 9 of block A be carrying more current than the rail 10, the armature 38 will turn and through the arm 49 press the blocks or plates 46 into close relation, thus diminishing the resistance to the current carried by rail 10 and at the same time releasing the pressure acting upon plates 45, thereby increasing the resistance in rail 9 and equalizing the currents between the rails.

Referring to Figs. 6, 7, and 8, in these figures, in which the general arrangement of the system is substantially similar to that shown in Fig. 3, the equalizing device 35 has a core 36 and two coils 37, connected in series across the source of power-current, also an armature 38, having two coils 39 40. Coil 39 is connected in series with rail 9 and coil 40 in series with rail 10. One terminal 41 of coil 39 is connected to rail 9, and the other terminal 43 is connected to one terminal of the reactance bond 20. One terminal 42 of coil 40 is connected to rail 10, and the other terminal 44 is connected to the opposite terminal of the reactance bond 20. These coils are wound so that they act differentially, and if the currents carried by them are equal no turning moment of the armature 38 will be developed. The armature 38 carries a contact-arm 49, which moves over a rheostat 50. The end of the rheostat is connected to the terminal end 44 of the coil 40, and connected to the contact-arm 49 is a conductor 51, which is connected to the central point of the coil on the bond 20. It will therefore be seen that if the current in the rails 9 10 is the same the position of the contact-arm 49 would be that shown at the left-hand end of block B. If the current in either of these rails is increased or decreased relative to the other, the armature 38 will be moved and more or less of the resistance of the rheostat will be thrown into a shunt around one-half of the coil on transformer bond 20. Thus both halves of the bond may carry the same current. If necessary, the shunted half of the bond may be given a few turns more than the unshunted half. The resistance used here should be an inductance resistance. When the current in rail 10 of block A, for instance, exceeds that in rail 9, the armature 38 will turn in such a way as to diminish the resistance which shunts half of the coil of the bond 20. Thus the actual windings on one-half of the bonds will not carry any more current than before. In this way the saturation of the bond is prevented.

The generic principle here involved is the automatic control of the magnetizing influence of the power-current transmitted through the two sides of the reactance bond. If the power-currents traversing the two sides of the bond are equal, the coil of the bond, owing to its construction, will not be magnetized, and consequently the bond will properly perform its function as a reactance device to prevent the flow of an alternating current through it. If, however, the power-current flowing through the two sides of the bond is not the same, the side through which the greater power-current flows will be magnetized, which will affect the reactance bond. Generically, therefore, my invention seeks to control the influence of the power-current upon the bond, and I claim to be the first to describe any practical means for effecting such control.

Having thus described my invention, I claim—

1. The combination with a signaling system of the type described provided with cross-bonds for the return conductors or rails, of means whereby the power-current will be equalized in the return-conductors to the source of power-current.

2. The combination with a signaling system of the type described, of automatic means whereby the power-current will be equalized in the return-conductors to the source of power-current.

3. The combination with a signaling system of the type described, of means for automatically varying the resistance of the return-paths for the power-current in inverse proportion and in accordance with the power-current in said paths.

4. The combination with a signaling system of the type described, of means for automatically altering the relative resistance of the return-paths for the power-current, and in proportion to the power-current in said paths.

5. The combination with a signaling system of the type described, provided with cross-bonds for the return conductors or rails, of means whereby the power-current will be equalized between the traffic-rails as return-conductors.

6. The combination with a signaling system of the type described, of means for automatically equalizing the power-current between the traffic-rails as return-conductors.

7. The combination with a signaling system of the type described, of reactance bonds, and means for altering the relative resistance of the paths for the power-current through said bonds.

8. The combination with a signaling system of the type described, of reactance bonds, and means for automatically altering the relative resistance of the paths for the power-current through said bonds.

9. The combination with a signaling system of the type described, of reactance bonds including in their structure means for automatically altering the relative resistance of the paths for the power-current through said bonds.

10. The combination with a signaling system of the type described, of reactance bonds having a fixed member with a coil in each path for the return power-current and a movable member adapted to vary the relative resistance of such paths.

11. The combination with a signaling system of the type described, of reactance bonds having a fixed member in the path of the power-current, and a movable member adapted to vary the length of the coil of the member in the path of the power-current.

12. The combination with a signaling system of the type described, of means energized by the power for varying the relative resistance of the return-paths for the power-current and in accordance with the power-current flowing in said paths.

13. The combination with a signaling system of the type described, of a reactance-bond-equalizing device comprising a core having coils thereon in the path of the power-current and wound in opposite directions so as not to magnetize the core, an armature energized by the power-current, and means controlled by the armature whereby the relative resistance of the paths for the power-current through said bond may be varied, and without affecting the reactance of the bond to an alternating current.

14. The combination with a signaling system of the type described, of an inductance bond comprising a core having coils thereon in the path of the power-current, and wound in opposite directions, so as not to magnetize said core, an armature energized by the power-current, and means controlled by the armature whereby the magnetomotive forces of the power-currents in said bond may be varied, and without affecting the reactance of the bond to an alternating current.

15. The combination with a signaling system of the type described, of means energized by the power-current for varying the relative power-current magnetomotive forces, in accordance with the inequality of the power-currents flowing in the traffic-rails.

16. An automatic system of block-signaling, embodying means whereby the return propulsion-currents are automatically equalized between the traffic-rails.

17. An automatic system of block-signaling, embodying means for automatically segregating the alternating signaling-current between the respective blocks of the trackway and for equalizing the power-current between the rails of the railway as return-conductors.

18. An automatic system of block-signaling, embodying means whereby the magnetomotive forces of the power-currents in the inductance bonds are automatically equalized.

19. A signaling system of the type described, comprising traffic-rails of variable relative resistance, inductance bonds wound with wire, adapted to transmit the power-current, and automatic means of magnetomotive-force control, combined with said reactance bonds.

20. A system of block-signaling of the type described, comprising traffic-rails of variable relative resistance, inductance bonds connected to said rails, and a power-current of zero-resultant magnetomotive force, transmitted through said bonds.

21. In a system of automatic signaling of the type described, traffic-rails of varying relative resistance, inductance bonds adapted to transmit the power-current, automatic means energized by the power-current, adapted to reduce the resultant magnetomotive force of the power-current in the bond to zero.

22. In a system of automatic signaling for railways, traffic-rails carrying varying power-currents and means of automatic magneto-force control as to the power-current actuated by the difference in the currents carried by said rails.

23. In a system of automatic signaling, the combination of traffic-rails carrying the power-current, a block-segregating means, transmitting said power-current, and comprising a fixed member, and a movable member actuated by the difference in the currents carried by the traffic-rails, and means of magnetomotive-force control of the power-current combined with said segregating means.

24. In a system of automatic signaling, a block-segregating device comprising an iron core, an automatic means for maintaining zero-unidirectional magnetization in said core and a magneto-force-regulating device combined with it, actuated by the power-current.

25. In a system of automatic signaling, the combination with the traffic-rails of reactance bonds, and means whereby the magnetizing effect of the power-current, separately transmitted over said rails as a return and through the bond, will be equalized within the bond and thereby produce no magnetization of the bond, thus presenting return-paths for the power-current to the source of energy.

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

FITZHUGH TOWNSEND.

Witnesses:
W. H. PUMPHREY,
FRANK O'CONNOR.