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ELECTRIC SIGNALING SYSTEM.

APPLICATION FILED SEPT. 2, 1908.

919,996.

Patented Apr. 27, 1909.

3 SHEETS—SHEET 1.

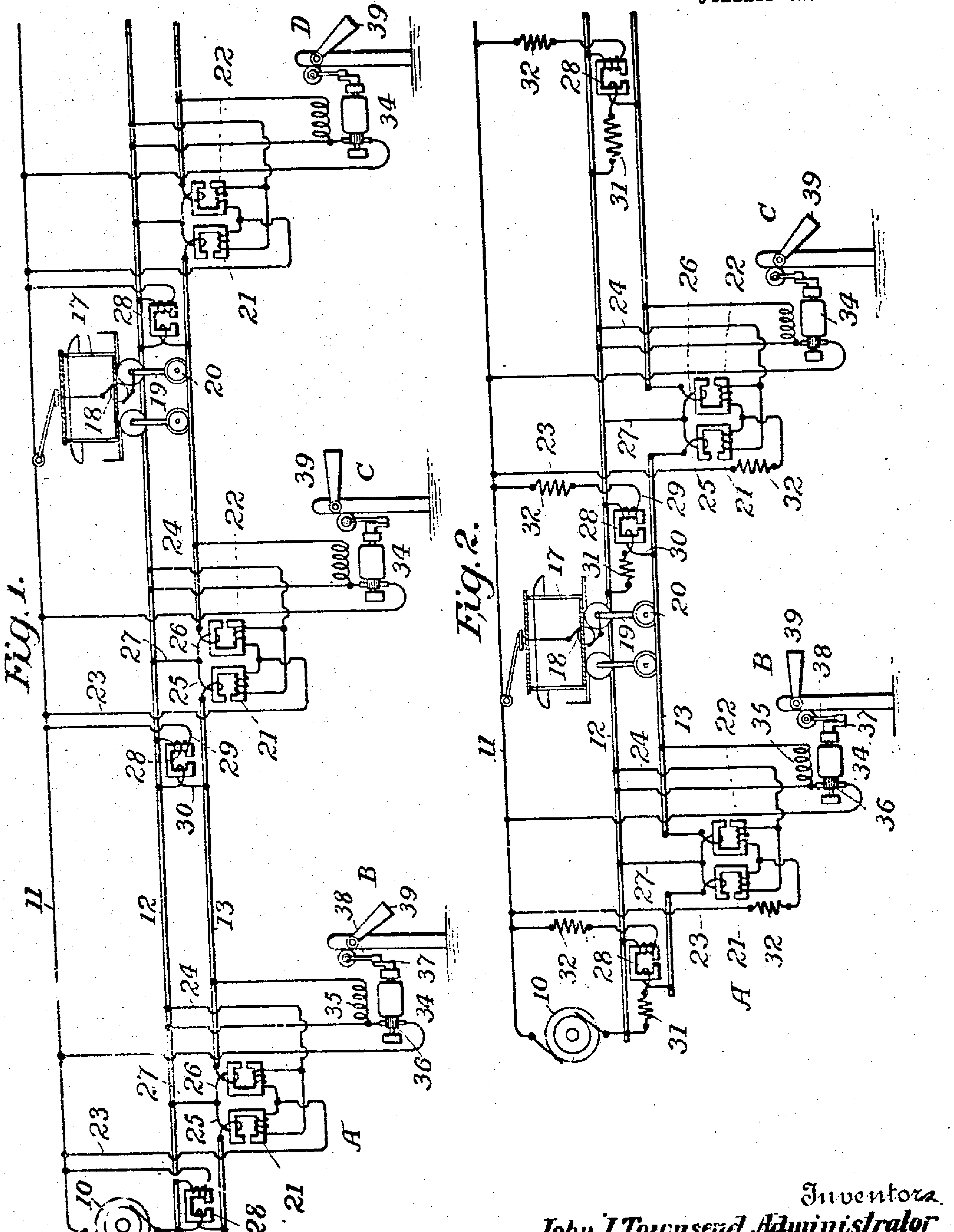

Fig. 1.

Fig. 2.

Witnesses

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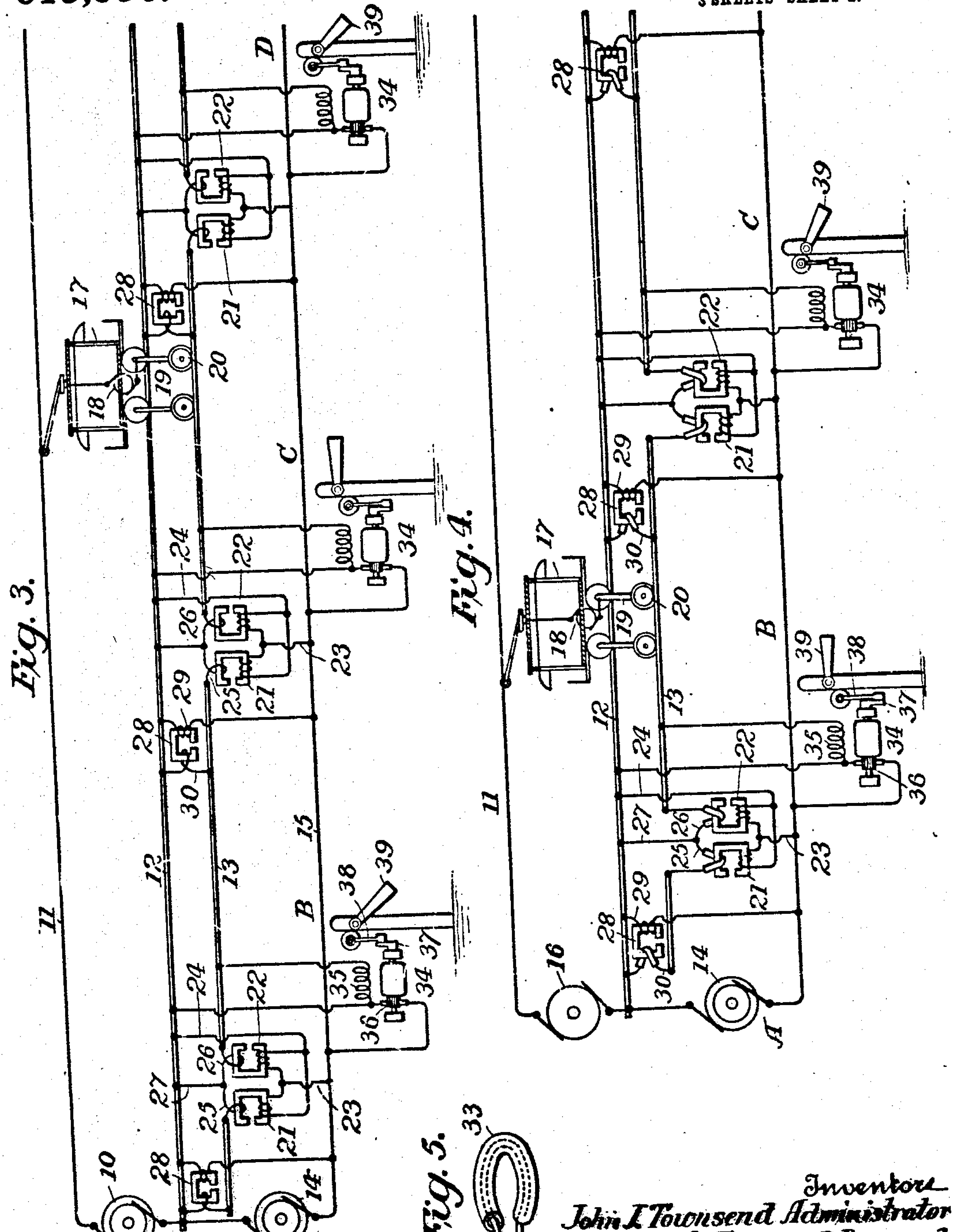


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3 SHEETS—SHEET 3.

*Fig. 6*

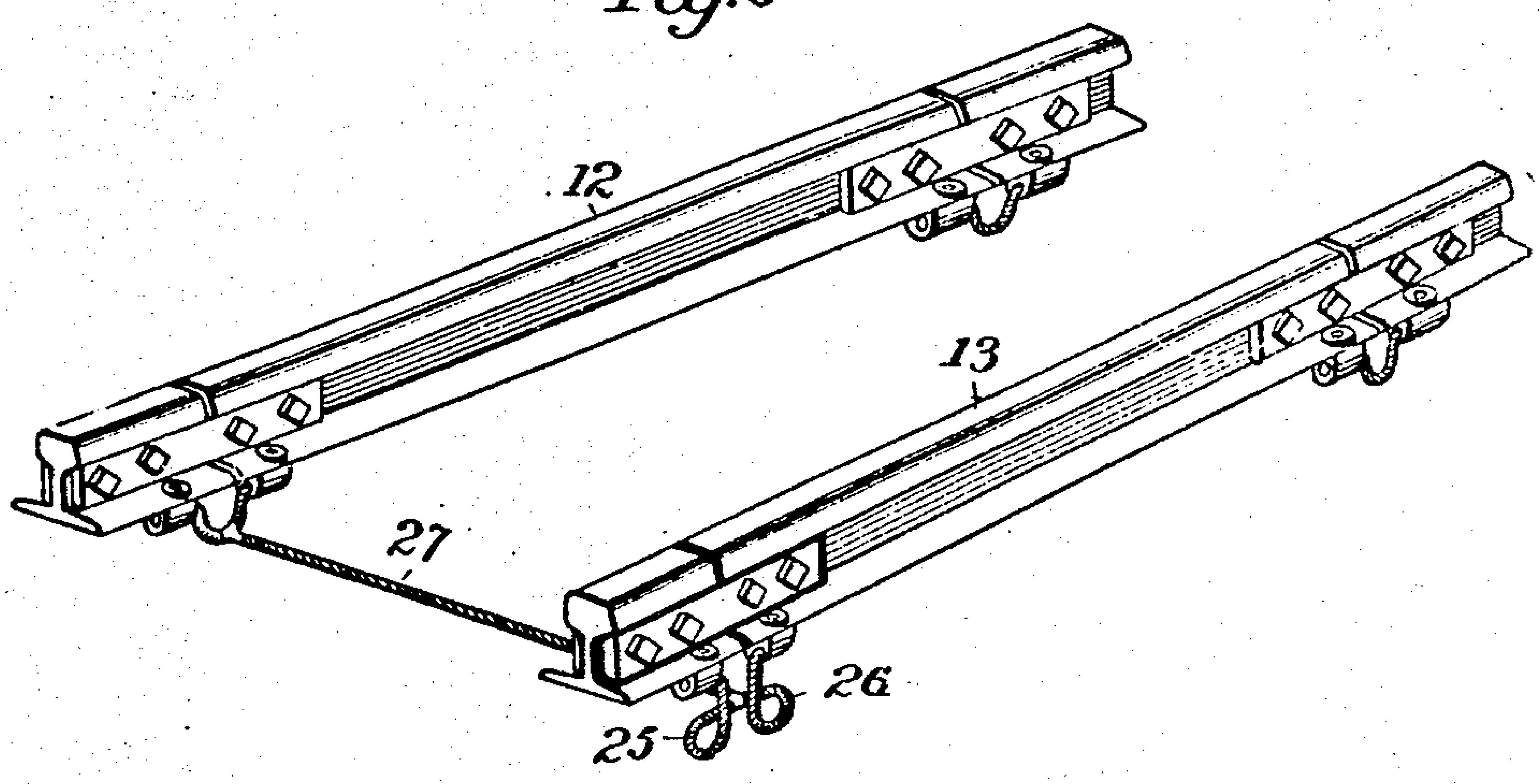



*Fig. 7.*

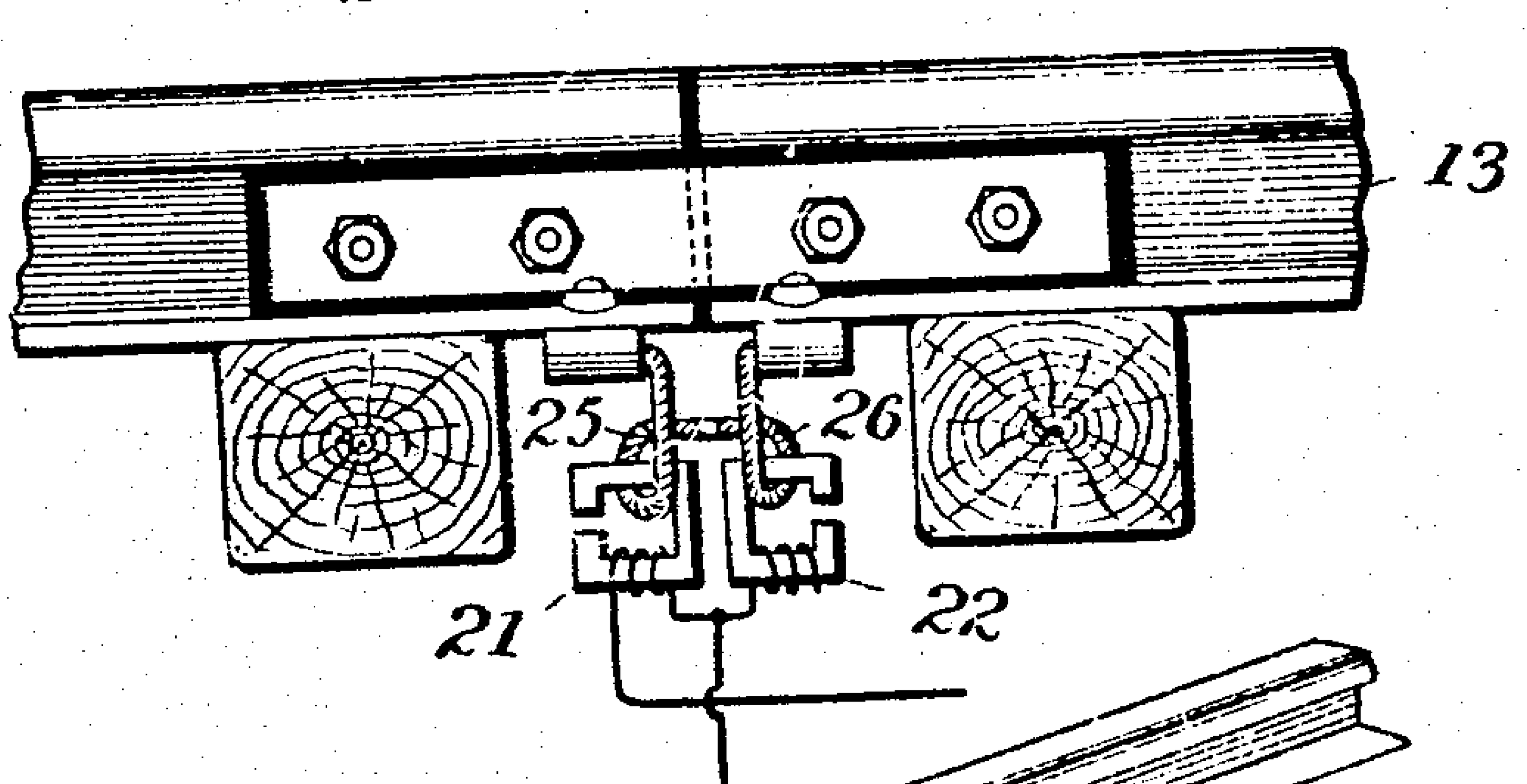



*Fig. 8.*

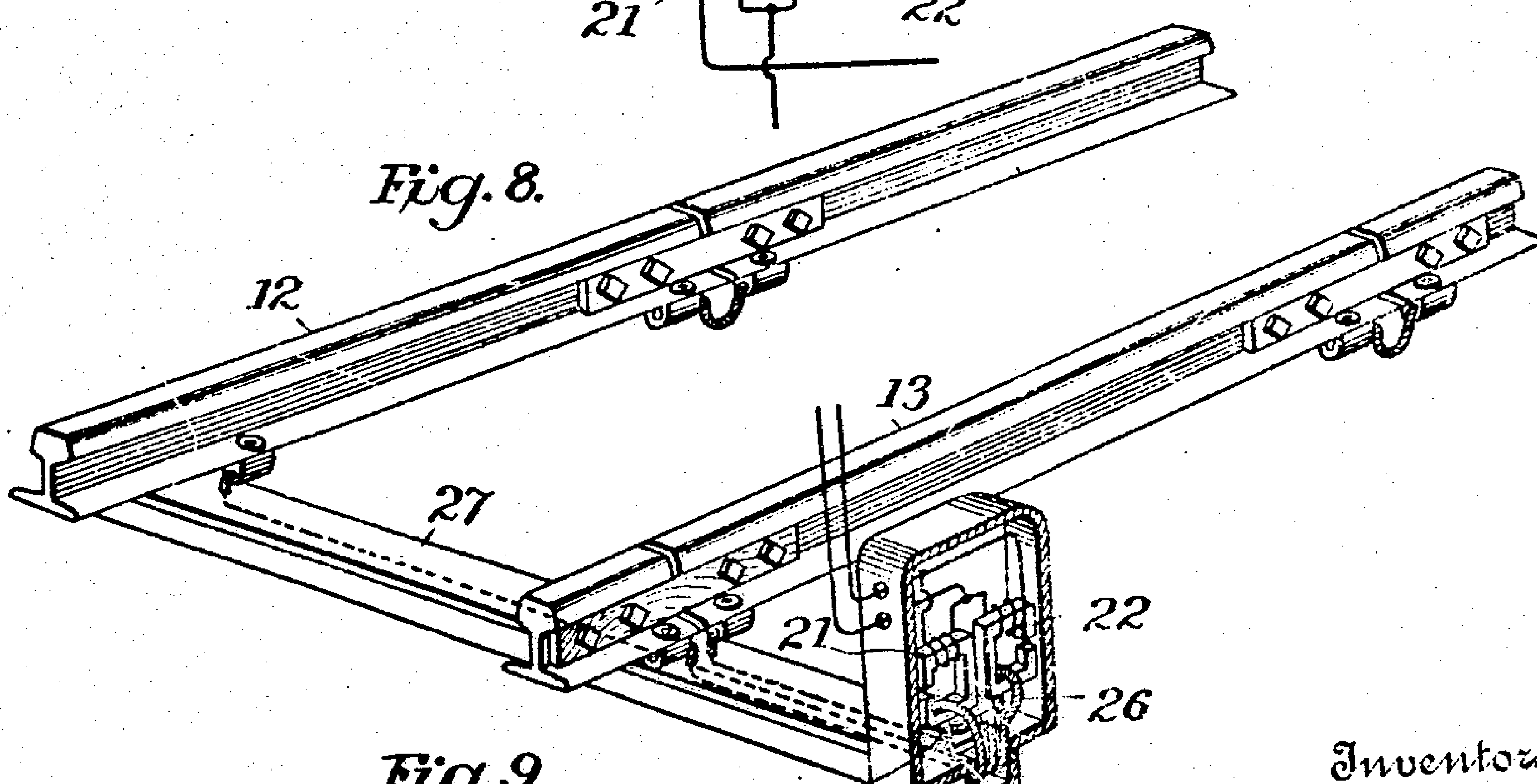
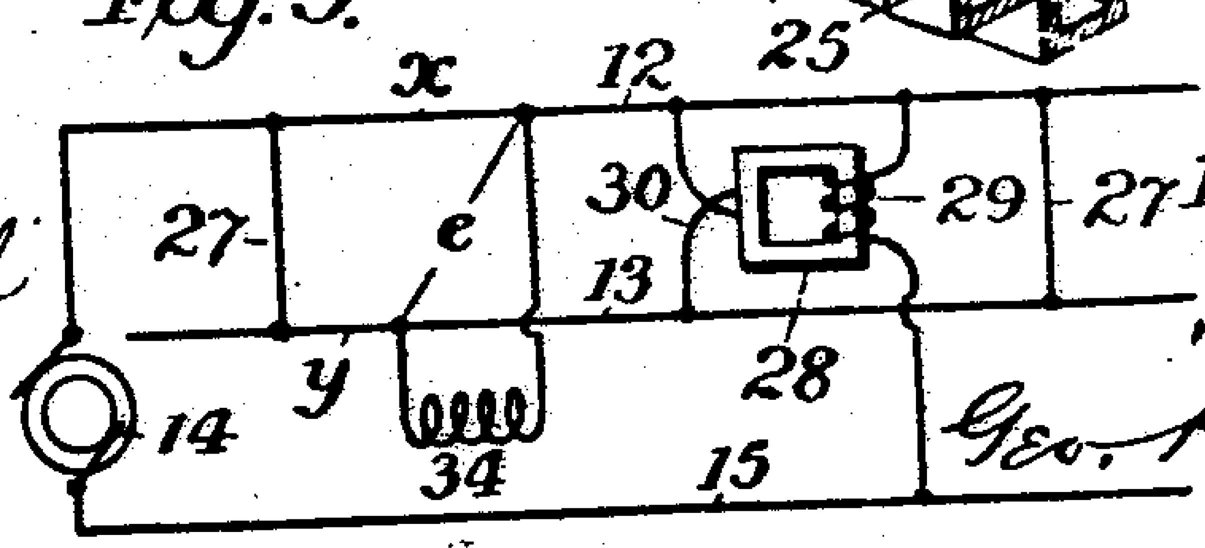



*Fig. 9.*

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# UNITED STATES PATENT OFFICE.

SAMUEL M. YOUNG, OF NEW YORK, N. Y., AND JOHN J. TOWNSEND, ADMINISTRATOR OF FITZHUGH TOWNSEND, DECEASED; SAID YOUNG AND SAID FITZHUGH TOWNSEND (BEFORE DEATH) ASSIGNORS TO SAID YOUNG.

## ELECTRIC SIGNALING SYSTEM.

No. 919,996. Specification of Letters Patent. Patented April 27, 1909.

Original application filed November 21, 1903, Serial No. 182,079. Divided and this application filed September 2, 1908. Serial No. 451,454.

*To all whom it may concern:*

Be it known that SAMUEL M. YOUNG, a citizen of the United States, residing at New York city, county and State of New York, jointly invented with FITZHUGH TOWNSEND, deceased, late of New York city, county and State of New York, during his lifetime, certain new and useful Improvements in Electric Signaling Systems, of which the following is a specification.

The invention relates to an automatic block signaling system for electric railways, and is a division of prior application, Serial No. 182,079, filed November 21, 1903.

In prior applications filed in the name of Samuel Marsh Young, Serial No. 144,548, February 21, 1903; Serial No. 154,275, April 25, 1903; Serial No. 160,086, June 4, 1903, there is described a system of automatic block signaling for electric railways embodying two sources of current differing in character, outgoing feeder-conductors leading therefrom, a trackway formed of two rails, divided into a series of sections, means for creating a difference of potential between the rails of each section, a signaling device in each section normally energized by such difference of potential and held thereby in the "clear" position and deënergized to move to the "danger" position and be maintained in such position when a car moves into a section, and means introduced between separated ends of one rail of each section for introducing localized impedance between adjacent sections which will offer opposition to the passage of the current employed to actuate the signaling devices in said sections, but which will permit both rails of all of the sections to serve as continuous conductors for the power current.

Our present invention, while it may be said to embody the general principle of operation set forth in the above-mentioned applications, differs therefrom in the following particulars: First: Instead of using two sources of electrical energy-generating currents differing in character we may use a single source of electrical energy or different sources of electrical energy of the same character, but differing in phase or frequency. Second: Instead of creating the required difference of potential between the opposite rails of each section by means of a single transformer having its primary connected across the source of energy and its secondary across the rails, we create the required potential in a block by means of two transformers, which have their primaries connected in parallel across the source of energy and their secondaries wound in opposition and connected in parallel across the rails. For purposes of economy we prefer to use an ordinary conductive bond as the secondaries of these transformers. A pair of transformers are located at each end of a section, with their secondaries connected in series across the divided ends of one rail of adjacent sections. The parallel connection of the transformer secondaries across the rails is effected by connecting the block-segregating cross-bond from a point intermediate the conductor constituting the combined conductive bond and the transformer secondaries, to the opposite rail. We may also make use of another transformer in each block having its primary connected across the source of energy and its secondary across the rails.

Among the advantages of the present arrangement of parts may be mentioned: (*a*) The number of sources of energy or currents used may be decreased; (*b*) the electrical individuality of the sections so far as relates to the current used to operate the signaling devices is more distinct; (*c*) the amperage of the current transmitted to the rails for operating the signals in each section may be largely increased without correspondingly increasing the difference of potential between the rails; (*d*) the use of localized impedance is done away with, each of the rails being bonded with ordinary conductive bonds so that they shall be of equal conductivity for all currents.

The accompanying diagrams will serve to illustrate our invention.

Figure 1 is a diagram showing the general arrangement of the system where one source of alternating current is employed. Fig. 2 is a corresponding diagram showing the same general arrangement with the addition of resistance in the circuits of the current-transforming devices. Fig. 3 is a diagram showing the general arrangement of the system where two sources of alternating-current energy are employed. Fig.

4 is a similar diagram showing the general arrangement of the system where one source of direct current and one source of alternating current are employed. Fig. 5 is an enlarged view of a portion of the rail-bond used in the construction shown in Fig. 4. Figs. 6, 7 and 8 are enlarged detail views showing the manner in which the combined conductive bond and transformer secondaries, and the cross-bond may be arranged in the track. Fig. 9 is a diagram to illustrate the effect of the cross-bond in determining the block sections.

Referring to the diagrams, in Figs. 1 and 3 the trackway is shown as divided into four sections A B C D, in Figs. 2 and 4 into three sections A B C. Manifestly, the number of sections will depend upon the length of road, the length of each section may be such as desired.

10 indicates an alternating generator connected in Figs. 1, 2, and 3 across the feeder-conductor 11 and two track-rails 12, 13. In Figs. 1 and 2 the generator 10 is assumed to be of sufficient capacity to operate the car motors and the signaling devices and in Fig. 3 to operate the car-motors. In Figs. 3 and 4, a second alternating generator 14 is shown connected across the feeder-conductor 15 and the track-rails 12, 13. The generator 14 is assumed to be of sufficient capacity to operate the signaling devices. In the construction shown in Fig. 3, the generators 10, 14, while both alternating generators, may have their currents differentiated either as to phase or frequency—as, for instance, one generator may deliver a current of twenty-five cycles and the other one hundred or more cycles. It will be understood by electricians without further description that a phase or the phases of one current may be used to operate the car-motors and a phase or the phases of the other current to actuate the signaling devices, or a current of one frequency to operate the car-motors and that of the other frequency to operate the signaling devices and that there will be no intermingling of such currents, or, in other words, that each current will perform its office irrespective of the other and irrespective of the fact that both are impressed upon the two rails of the system.

16, Fig. 4, indicates a direct-current generator connected across the feeder-conductor 11 and the two rails 12, 13.

17 indicates a car carrying a motor 18, one terminal of which is connected to the axle 19, on the ends of which are the wheels 20.

In the constructions shown in Figs. 1 and 2, the alternating current from the generator 10 actuates the car-motors, creates the difference of potential between the rails, and actuates the signaling devices. In the construction shown in Fig. 3, the generator 10 actuates the car-motors and the generator 14 creates the difference of potential between the rails and actuates the signaling devices. In the construction shown in Fig. 4 the direct-current generator actuates the car-motors and the alternating-current generator 14 creates the difference of potential between the rails and actuates the signaling devices. The electrical individuality of the sections A B C D of the trackway is obtained in the manner which we will now proceed to describe.

In the former application referred to, a reactance-bond was interposed between the ends of the rail 13 of adjacent sections, and, further, a reactance cross-bond was used. The effect of using the reactance-bond between the ends of the rail 13 was to introduce between adjacent sections of the rail 13, a localized impedance, thus adjacent the impedance of the rail 13 as a whole, and determining the length of block sections by reason of the increased impedance to the signaling current—as, for instance, from A to B—while permitting the passage of the power current used to operate the car-motors. This arrangement in practice proved to be satisfactory because the artificial reactance added to the rail impedance determined accurately the limit of the block sections, causing the E. M. F. of the signaling current in the section bounded thereby to drop suddenly, so that a signaling device connected beyond the artificial reactance would not be susceptible to the energy impressed by the signaling transformer. Moreover, the artificial or localized reactance is not susceptible to weather conditions as is the impedance of the rails. There are, however, certain objections to the use of artificial reactances due to the cost of installation and the increase to the total impedance of the rails constituting the return-path of the currents to the generator or generators.

In the present case, the rail 13 is bonded at the ends of the block sections with a conductor having the same carrying capacity as a corresponding length of rail, like the ordinary bond. This conductor or bond is utilized to form the secondaries 25, 26, of two transformers 21, 22, whose primaries are connected in parallel across the feeder-conductor 11 and one rail 12, Figs. 1 and 2, or, as shown in Figs. 3 and 4, in parallel across the feeder-conductor 15 and the rail 12. This bond connected to the ends of the adjacent sections of rail 13 makes a minimum of one turn around each of the transformer cores 21, 22, to serve as the secondaries 25, 26, these turns being wound in opposite directions as shown. The object of using a single turn around each of the transformer cores is to avoid the impedance effect which would be caused by a plurality of turns, especially where the power-current is an alternating current. In cases where the power-current is a direct current the number of turns may be increased. The arrangement shown also reduces to a minimum the magnetization of the cores of the transformers 21, 22, by the power-current used to operate the car-motors. A conductor bond 27 connects a central point between the secondaries 25, 26, with the rail 13, and closes the track circuits of the adjacent block sections. It will be observed that by means of the cross-bond 27, the secondaries are connected in parallel across the rails, 12, 13, and in series between abutting rail ends 13. A third transformer 28 is also employed in each section, having its primary 29 connected across, in Figs. 1 and 2, the feeder-conductor 11 and the rail 12, or, in Figs. 3 and 4, across the feeder-conductor 15 and the rail 12, and its secondary 30 across the rails 12, 13.

It will be seen from the above that there are three transformers in each section,—*i. e.*, in section B, for instance, the transformer 22 at the left, transformer 21 at the right, and transformer 28 in the section,—and that the difference of potential between the rails 12, 13, is derived from the secondaries of these transformers, and, further, that the transformers 21, 22, whether located adjacent at the end of a section or separated by the length of a section, are wound to oppose each other. It thus appears that there will be a resultant current which will energize the signal-operating device in the absence of a train in a block section and that this resultant signal-operating current will be short-circuited to deënergize the signal-operating device when a train is present in a block. The relative effect of the electromotive forces of the several transformer secondaries will depend upon the impedance of the rails, lengths of the sections, relative strengths, polarities, etc. of these impressed electromotive forces, which it will be within the province of engineers to vary under any particular conditions.

As above pointed out, the electromotive forces impressed by the transformers 21, 22, upon the two portions of a bond constituting the secondaries 25, 26, are substantially equal and opposite. Inasmuch as the cross-bond 27 is connected to an intermediate point between the secondaries 25, 26, the electromotive forces of the transformers 21, 22, combine with that of the secondary 30 of transformer 28 to form a resultant electromotive force. If, however, there should be a break in the cross-bond 27, or it should become disconnected, the electromotive force of the transformers 21, 22, is removed from across the rails, and the resultant electromotive force in adjacent blocks will be changed to cause the signal to go to "danger." Furthermore, since the transformer secondaries 25, 26, are in opposition between the abutting rail ends, they will present no counter-electromotive force to the passage of the energy from the transformer 28.

From the above description, it will now be clear that the cross-bond 27, aided by the reactance of the rails, and by the reversal of polarities of the transformers feeding adjacent blocks, limits the influence of the transformers and divides the rails into block sections.

It will be appreciated that by utilizing the bond connecting abutting rail ends to serve also the function of secondaries of the transformers 21, 22, a large economy is effected, and by means of the connection with the cross-bond 27, an additional element of safety is effected in case of a broken or disconnected cross-bond. The manner in which these connections may be arranged in practice is indicated in the detail views, Figs. 6, 7, and 8.

That the use of transformers 21, 22, increases the safety of the system may be seen from a consideration of the diagram shown in Fig. 9, showing how the transformers 21, 22, may be dispensed with, together with the attendant disadvantages. By reference to this figure it will be observed that if a cross-bond 27 should break, the difference of potential still exists across the rails and the signal relay 34 would continue to be energized, whereas when the electromotive forces from the transformers 21, 22, are present, the resultant electromotive force, in case of a break in the cross-bond, will cause the signal to go to danger. Without the use of transformers 21, 22, as shown in diagram Fig. 9, if a cross bond 27 should break there would be a tendency for the energy fed to one block by transformer 28, to influence the signaling devices of adjacent blocks, unless the frequencies of the signaling currents are increased and these are alternated in alternate blocks, which entails an increase in the cost of installation.

If desired and in order to prevent absolute short-circuiting of the secondaries of the transformers 21, 22, 28, resistance 31 may be introduced in such secondaries, as shown in Fig. 2, and a similar resistance 32 may, if desired, be introduced in the primaries. Instead of using such resistance in the secondaries we may use the arrangement shown in Figs. 4 and 5. In this arrangement a sleeve of iron 33 is placed over the secondaries 25, 26, 30. Magnetic whirls are set up in this sleeve concentrically to the secondary winding, thereby producing a counter electromotive force, which causes a drop in the voltage and prevents a dead short-circuit. The sleeve therefore acts as an impedance, the effect being the same as putting a resistance or reactance in the primary or secondary windings.

It now remains to describe the signaling device employed in each section. This may be constructed in a variety of ways. Preferably we prefer to use an electromotor 34. The field magnets 35 of this motor are connected across the rails 12, 13, and its armature 36 across in Figs. 1 and 2, the feeder-conductor 11 and the rail 12, and in Figs. 3 and 4, the feeder-conductor 15 and the rail 12, whereby the device will only respond to the frequency which energizes both field and armature and will not be responsive to a difference of potential of a different frequency or frequencies that may exist across the rails; and it will also be evident to engineers that a more perfect block segregation would be obtained, especially in the case of a broken cross-bond connection, if the signaling frequencies or phases are multiplied and current of a different character is fed to adjacent blocks. The counterweighted semaphore-arm 39 may be connected through a link 38 to a crank or eccentric 37 on the shaft of the motor armature. Connected to the armature of this motor is a crank 37, which is connected through a link 38 to a counterweighted semaphore-arm 39.

The operation of the system is as follows: Normally—that is, when no car is on a section—a difference of potential is created between the rails 12, 13, which excites the field-magnets 35 of the motor 34, and as the armature 36 of the motor of that section is also excited by a current of the same frequency, a turning movement results, which pushes the semaphore arm to the "clear" position shown in sections B, D, of Figs. 1 and 3, and C in Figs. 2 and 4. The connections of the signaling motors 34 are shown a certain distance from the cross-bonds 27, so that there shall be a drop of potential between the motor terminals depending upon the reactance or impedance of the length of rail between the said terminals and bond 27, together with that of the bond. This is evident from the diagram Fig. 9, from which it will be seen that if there were no reactance in the shunt path including the rail lengths $x$, $y$, and the bond 27, there would be no difference of potential $e$, across the terminals of the motor 34. When a car moves into a block, the wheels 20 and axle 19 short-circuit the signaling current in that block, thereby destroying the difference of potential between the rails and, in effect, short-circuiting the field-magnets 35 of the motor 34. At this time the counterweight on the end of the semaphore-arm acts and brings the arm to the "danger" position shown in section C of Figs. 1 and 3 and section B of Figs. 2 and 4.

In this specification we have used the expression "differing in character" as referring to the currents transmitted from the generators 10, 14, 14, 16,—that is, currents differing in phase, currents differing in frequency, or one alternating and the other direct,—as differentiated from the expression "differing in strength" as applied to two currents.

Having thus described our invention, we claim:—

1. In combination with an electric railway having both rails conductively continuous for all currents, a plurality of sources of high frequency alternating current connected at intervals across the rails, means for dividing the rails into block sections, signaling devices for controlling the signals connected across the rails at points intermediate adjacent sources, and signals controlled by said signaling devices.

2. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, means for dividing the rails into block sections, signaling devices for controlling the signals connected in shunt to a short portion of the signal circuit, and signals controlled by said signaling devices.

3. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, means for dividing the rails into block sections, signaling devices for controlling the signals, each having two coöperating windings, one connected in shunt to a short portion of the signal circuit and the other supplied with alternating current independently of the track circuit, and signals controlled by said signaling devices.

4. In a block signal system, in combination with an electric railway having rails conductively continuous for all currents, a source of alternating current connected across the rails, an impedance connected across the rails at a distance from the transformer, a signaling device for controlling the signals connected in shunt to a short portion of the signal circuit between the source and the impedance, and a signal controlled by the signaling device.

5. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, a source of alternating current connected across the rails, an impedance connected across the rails at a distance from the transformer, means for dividing the track rails into block sections, a signaling device having two coöperating windings, one connected in shunt to a short portion of the signal circuit between the source and the impedance and the other supplied with

alternating current independently of the track circuit.

6. In block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current, connected across the rails at intervals, impedances connected across the rails at points between said sources, signaling devices for controlling the signals connected in shunt to short lengths of rails and adjacent to said impedances, and signals controlled by said signaling devices.

7. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, impedances connected across the rails at points between said sources, signaling devices for controlling the signals each having two cooperating windings, one connected in shunt to a short length of rail adjacent to an impedance and the other supplied with alternating current independently of the track circuits, and signals controlled by said signaling devices.

8. In combination with a railway the trackway of which is divided by insulation to form block sections and serves as part of the return path for the propulsion current, for the cars traveling along the railway, of an alternating current generator for supplying the car propulsion current, a track circuit for each block section, alternating current supplied to each track circuit from the said generator but of a different phase from that of the alternating propulsion current, and an alternating current signaling device for each track circuit operable by different phases of alternating current, one of which phases is supplied from the track circuit.

9. In combination with a railway the trackway of which is divided by insulation to form block sections and serves as part of the return path for the propulsion current for the cars traveling along the railway, of an alternating generator for supplying the car propulsion current, a track circuit for each block section, alternating current supplied to each track circuit from the said generator but of a different phase from that of the alternating propulsion current, and an alternating current signaling device for each track circuit operable by different phases of alternating current one of which phases is supplied from the track circuit and another from the alternating current generator.

10. In combination with an electric railway the trackway of which is divided by insulations to form block sections and serve as part of the return path for the propulsion current for the cars traversing along the railway, of an alternating current generator for supplying the car propulsion current, a track circuit for each block section, alternating current supplied to each track circuit, from said generator, but of a different phase from that of the alternating propulsion current, and an alternating current signaling device for each track circuit operable by different phases of alternating current, one of which is supplied from the track circuit, another of which is supplied from the alternating current generator, and means for regulating the phase in one of the coils.

11. In a signaling system, a trackway in which the rails are electrically continuous and divided into block sections by crossbonds.

12. In a signaling system, a trackway the rails of which are electrically continuous and divided into a series of closed track circuits through the instrumentality of crossbonds.

13. In a signaling system, a trackway, the rails of which are electrically continuous, a series of crossbonds dividing the rails into block sections, means for impressing an alternating current in each track circuit and means normally energized by said impressed current and adapted to control a signal or signals.

14. In a signaling system, a trackway comprising rail sections, conductive bonds between the ends of the rail sections whereby both rails are electrically continuous for all currents, conductive bonds connected across the trackway at points along its length, whereby the trackway is divided into block sections and the signaling current confined to the block sections, means for impressing signaling current upon the block sections, and means normally energized by said impressed current and adapted to control a signal or signals.

15. In a signaling system, a source of energy, a feeder conductor connected to one terminal of the source of energy, a trackway connected to the opposite terminal of the source of energy, the trackway comprising sectional rails, conductive bonds interposed between the ends of the rails, and conductive bonds connecting the opposite rails at different points in their length; means for impressing a signaling current within the block limits included between each pair of conductive crossbonds, and means normally energized by said impressed current to control a signal or signals.

16. A signaling system comprising a source of alternating current energy, a feeder conductor arranged along the trackway and connected to one terminal of the source of energy, a trackway divided into block sections by conductive crossbonds, and connected to the other terminal of the source of energy, transformers having their primaries connected across one rail and the feeder con-

ductor, and their secondaries connected across both rails; and signaling devices controlled by the currents derived from the secondaries of such transformers.

17. A signaling system in which the trackway consists of a series of sectional rails connected by conductive bonds, and is divided into block sections by conductive bonds, whereby the power current will flow along both rails as return paths to the power generator, and the signaling current impressed upon a block section confined to the limits of such block section.

In testimony whereof we affix our signatures in the presence of two witnesses.

SAMUEL M. YOUNG,
JOHN J. TOWNSEND,
*Administrator of the estate of Fitzhugh Townsend.*

Witnesses as to S. M. Young:
JOHN L. LYTTLE,
OSCAR G. STEVENS.

Witnesses as to J. J. Townsend:
OSCAR G. STEVENS,
JAMES B. LUDLOW.