No. 658,336.

Patented Sept. 25, 1900.

E. M. BENTLEY.

ELECTRIC RAILWAY.

(Application filed Aug. 5, 1896.)

(No Model.)

2 Sheets—Sheet 1.

Fig. 1.

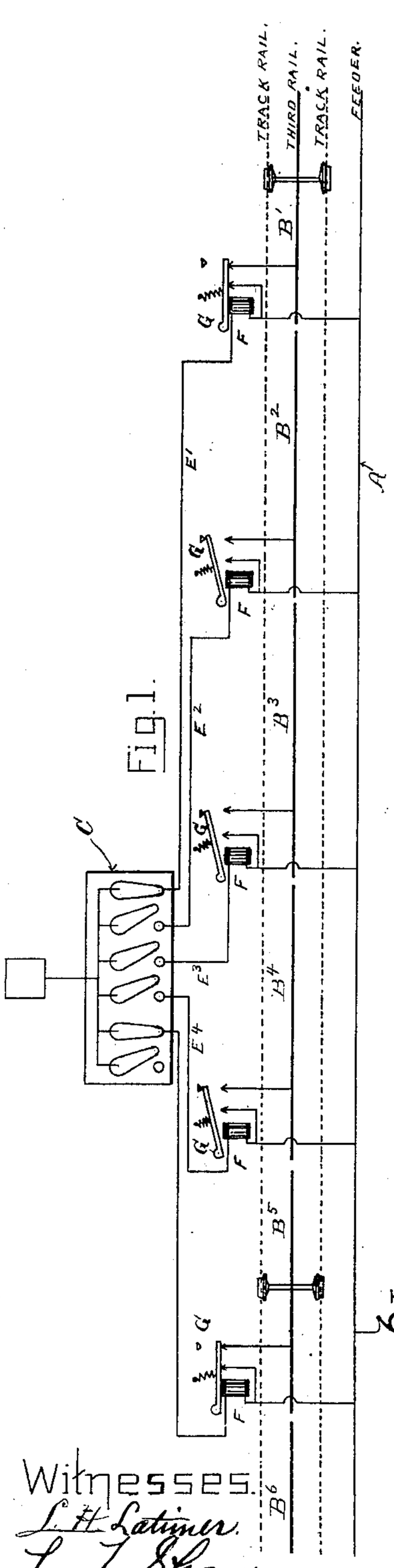


Fig. 2.

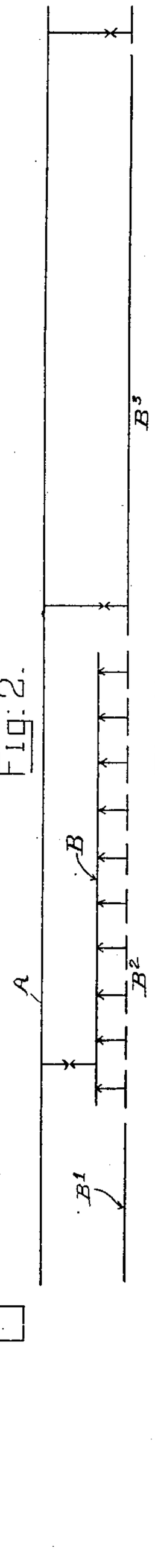
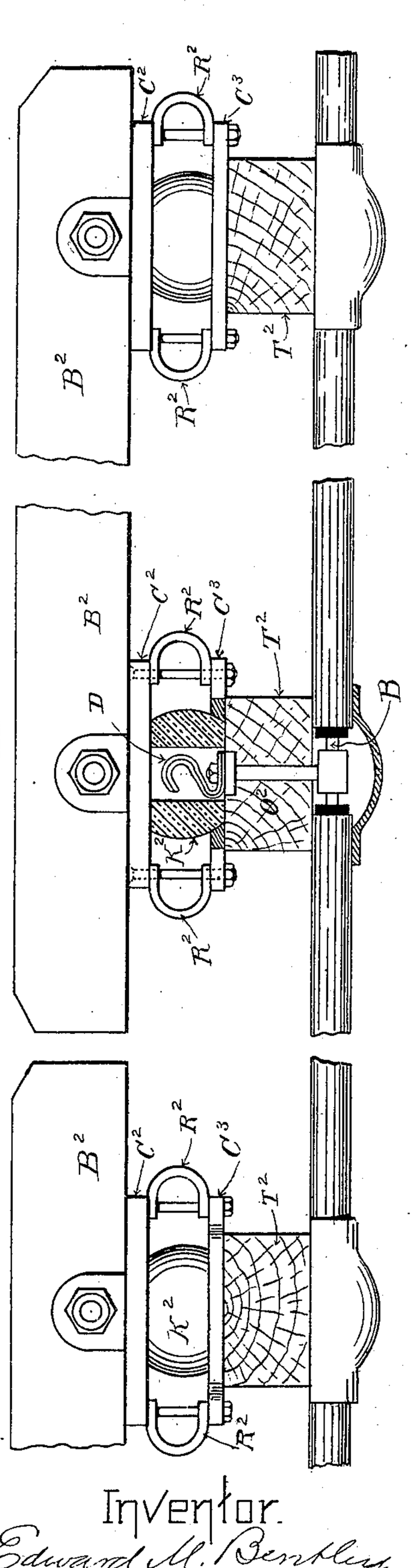


Fig. 5.



Witnesses.
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L. T. Shaw

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Fig. 3.

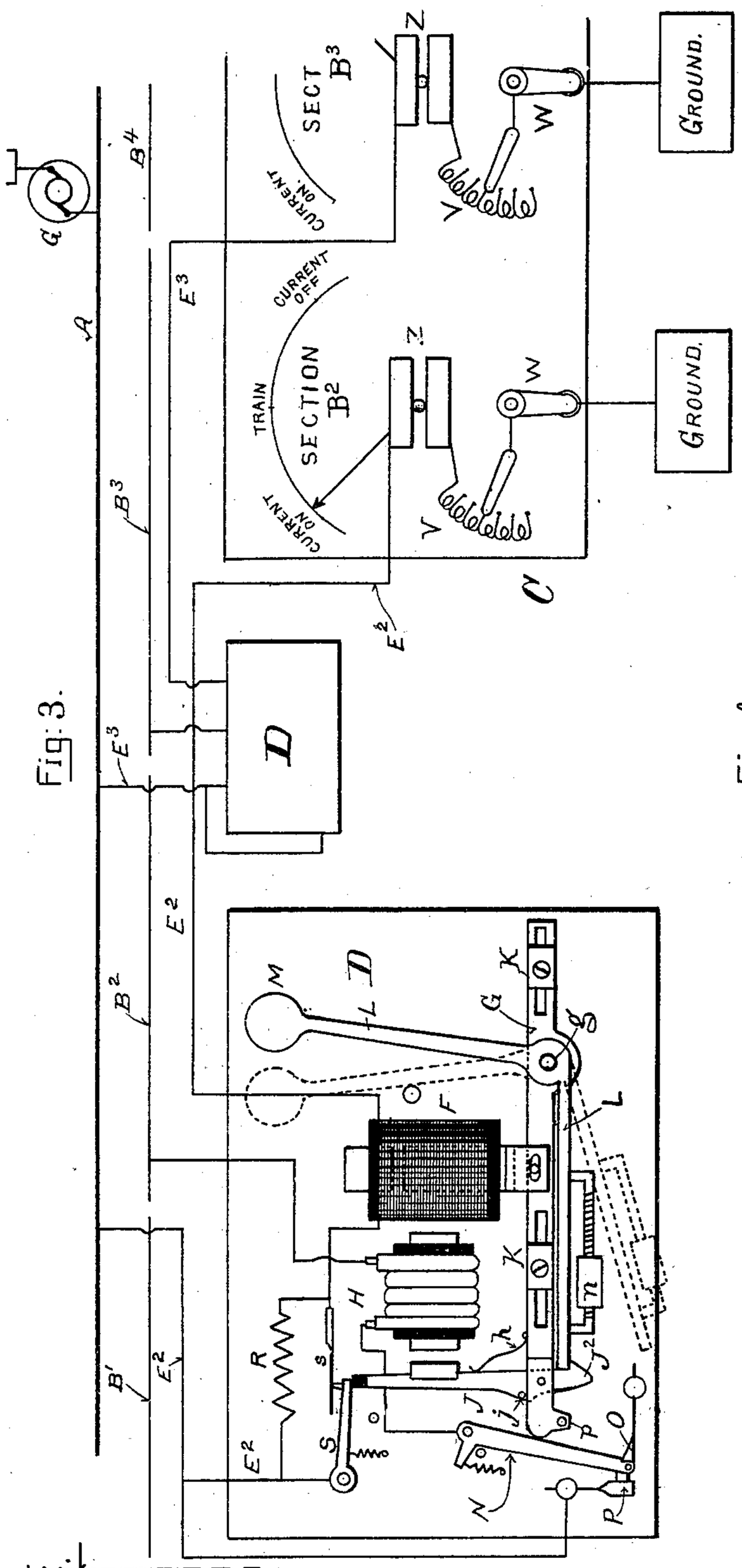
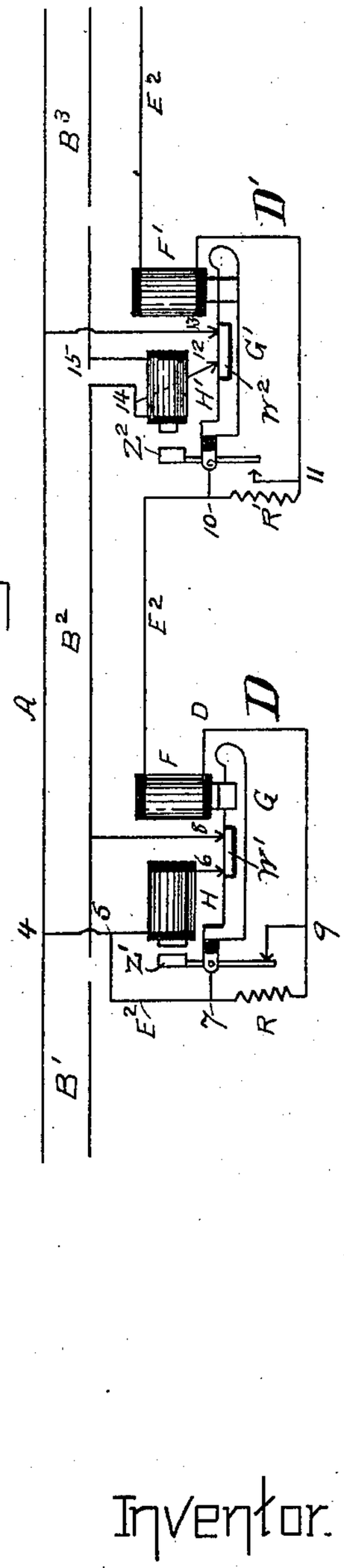


Fig. 4.



Witnesses.

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UNITED STATES PATENT OFFICE.

EDWARD M. BENTLEY, OF NEW YORK, N. Y.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 658,336, dated September 25, 1900.

Application filed August 5, 1896. Serial No. 601,710. (No model.)

To all whom it may concern:

Be it known that I, EDWARD M. BENTLEY, a citizen of the United States, residing at New York, in the State of New York, have invented certain new and useful Improvements in Electric Railways, of which the following is a specification.

My invention relates particularly to electric railways in which the line conductor extending along the railway takes the form of a third rail on the surface of the track, although the same arrangement may be applied to any electric railway having a line conductor.

My invention consists in dividing the line conductor with which the electric car is in immediate contact, and which may be called the "working conductor," into sections adapted to be connected temporarily with a well-insulated feeding-conductor and in placing the control of the connection between each section of working conductor and the feeder in the hands of a signalman or operator, so that he may even from a distant point connect or disconnect at pleasure any one of the number of sections comprising the division of the road under his control to or from the feeder. By such an arrangement the sections of working conductor will ordinarily be out of circuit and connected only as a train approaches in order to allow it to pass, being immediately thereafter disconnected and so remaining until the proper moment for the signalman to again throw it into circuit for the passage of another train. The signalman thus governs absolutely the movement of all the trains on the division under his control and, if necessary, may stop a train at any point by disconnecting the section of working conductor upon which the train is running at the time.

In connection with an electric railway embodying the foregoing principle certain signaling devices and other useful details of construction may be conveniently introduced. I have thus provided that so long as a section is disconnected a red or danger signal will be displayed to an approaching train, so that it will come to a stop before entering the cut-out section, and thus avoid being stalled. This danger-signal is changed to a white or safety signal as soon as the section is connected in circuit, thus notifying the train that it may proceed, while as soon as the train enters the section the signal is again thrown to "danger" to prevent a following train entering the same section. Moreover, I provide that the signalman will at once be notified whenever a train enters an active or live section and, if desired, also the time when it approaches the end of the section and requires to have the section ahead of it connected. By this means a block-signal system is provided and the signalman can observe at all times the progress of the train under his control. I lastly provide that over certain parts of the track the working conductor may be divided into short sections, which are automatically brought into circuit by the passing of the train, while this part of the working conductor is at the same time under the control of the signalman, like all other parts of the same conductor.

Referring to the accompanying drawings, Figure 1 is a diagram illustrating my invention. Fig. 2 illustrates the feature last described in the foregoing statement. Fig. 3 is a detailed illustration of the line apparatus and station apparatus. Fig. 4 represents an arrangement for indicating the presence of a train at the end of a section as well as at the beginning, and Fig. 5 represents a device for automatically connecting the subsections of a subdivided section of working conductor with its intermediate supply-conductor.

In the figures, A represents the main feeding-conductor extending along the railway-track and provided with current from the generator T.

B' B^2 B^3, &c., represent succeeding sections of working conductor with which in any well-known manner a moving car or train is maintained in electrical connection.

C represents a station for the signalman or operator, and as many sections of working conductor as desired may be placed under the control of one operator.

D, Fig. 3, represents the controlling and signaling apparatus provided at the beginning and also, if desired, at or near the end of each section of working conductor. Each apparatus D is provided with a separate wire running to the signalman's station, where it terminates in a switch which can be connected to ground at will, it being understood that the opposite or remote end of the wire

is connected to the feeder A, so as to receive a branch or shunt current therefrom whenever its station-terminal is connected to ground.

In the apparatus D, F, Fig. 3, is a shunt solenoid or magnet of fine wire permanently in circuit in the wire E^2.

G is a lever pivoted at *g* and operated by the magnet F^2. It is shown in the drawings as in its upper position, with the magnet F energized.

K K are adjustable counterbalance-weights on opposite ends of the lever G.

H is a coarse-wire magnet arranged to attract an armature-lever J, pivoted on the outer end of lever G. Lever J is normally pressed outward by spring *h*, but is prevented from moving too far by a stop *j*. At its lower end is a latch J^2, engaging one end of the elbow-lever L, which is pivoted to lever G on an axis concentric with the pivot of the latter. The lever L carries at the extremity of one arm a signal-disk M, while the extremity of the other arm engages, as aforesaid, with the latch J^2 of lever J. An adjustable weight *n* is provided on the lower arm of lever L. The signal-disk M in any well-known manner is made to give a white or safety signal in the position shown by full lines and to give a red or danger signal when in the position shown by dotted lines.

N is a circuit-closing lever connected to section B^2 by a wire passing through magnet H and operated by the cam-surface on the extremity of lever G, and when so operated its lower extremity comes into contact with spring-block P, which forms the opposite terminal of the normally-open circuit between feeder A and section B^2. It is shown in this position in the drawings, and it is there held by a spring-latch O, which when the lever G drops is struck by pin *p* on said lever G and depressed so as to release lever N, which flies back and breaks its connection with block P. The circuit between lever N and section B^2 includes, as stated above, the coarse-wire magnet H.

R is a resistance which may be shunted by the lever S coming into contact with the spring *s* whenever the said lever is forced upward by the tip of lever J. It is represented in the drawings as in its upper position, and this condition is maintained until the magnet H becomes energized and, drawing toward it the armature-lever J, which thus passes out from under the extremity of lever S, allows the latter to drop under the influence of its operating-spring and break its connection with the spring *s*. This, without breaking the circuit of line E^2, serves to transmit a signal upon the arrival of a train at section B^2 over line E^2 to the distant signalman's station, indicating to him the presence of a train at this point, as will be hereinafter described. These devices—to wit, the armature of magnet H and the means controlled thereby for so changing the current on line E^2 as to give an indication at the station—may be designated as a "signal-transmitting device," its function being to transmit a signal over wire E^2 for the purpose of advising the operator of the presence of a train on a section. In a similar manner, as will appear hereinafter, the signalman is notified of the arrival of the train at or near the opposite end of the section.

At station C the line E^2 first passes through a galvanometer Z, thence through an adjusting-resistance V, and thence through switch W to ground. The needle in galvanometer Z will assume the position indicated as "Current off" whenever the circuit of line E^2 is interrupted by the opening of switch W. When the current passing on line E^2 is at its maximum, the galvanometer-needle will assume the position "Current on." When, however, a smaller amount of current is passing, the needle will be at an intermediate position indicated by the word "Train." The galvanometer thus acts as a signal-receiving device responsive to the transmitted signals indicating the position of the train.

The operation of the above-described apparatus is as follows: Assuming that a train is approaching the end of section B′ and is about to enter upon section B^2, the signalman or operator at station C simply closes the controlling-switch W, completing a branch or shunt circuit from feeder A at the extremity of section B^2 through line E^2, resistance R, and magnet F to station C, where it passes through galvanometer V and switch W to ground. This energizes the magnet or solenoid F, which brings the parts into the position shown in the drawings—that is, the lever G is drawn up and throws the lever N into contact with block P, in which position it is locked by latch O, so that the section B^2 is brought into connection with feeder A by means of wire E^2, block P, lever N, and magnet H. At the same time the signal-disk M is turned to its safety position and the tip of armature-lever J in moving upward strikes the outer end of lever S and forces it into contact with spring *s*, thereby short-circuiting resistance R. At the central station C the galvanometer-needle is thrown to position "Current on." The parts are then as shown in Fig. 3 and in condition for the admission of a train to section B^2; but as soon as the train enters the section magnet H is energized and attracts its armature-lever J. This has two results: First, it releases lever L and allows disk M to turn to "danger," and, second, it opens the shunt around resistance R, so that the galvanometer-needle at the central station will fall back to a middle position, indicating that a train is on section B^2. As soon as the train passes off section B^2 the operator opens controlling-switch W and the parts of the apparatus come back to their normal condition, the lever G dropping down and the latch J^2 reëngaging with lower arm of lever L, ready for the next operation. I have shown a similar

apparatus D placed at the end of section B^3, although the details thereof are not shown, it being understood that it is just like the one before described, and in like manner a similar apparatus will be provided for each succeeding section and a separate wire therefrom will run to the station from which the sections are controlled. For instance, a station may be placed every four miles and may control four sections each a mile in length.

If desired, two devices D may be included in one line E and be placed at opposite ends of a section, so as to connect the section with the feeder at two points and at the same time indicate at the station the arrival of a train at or near the end of a section. In that event the devices will be alike, except that the signal-disk and lever will be unnecessary at the second device, and the magnet H in one case when energized will for transmitting a signal over line E to the operator open a shunt around resistance R in the manner above described and in the other case it will close such a shunt. The purpose of this last difference is to have one resistance R—namely, that at the end of the section—included in line E^2 when the apparatus is first set to connect the section with the feeder, while the arrival of a train on the section will energize magnet H at the first device only, and thereby throw its resistance R also into the circuit of line E, while upon its arrival at or near the end of the section it will energize magnet H of the second device E, which will operate to close a shunt around its resistance R, and thereby remove the latter from circuit. In this way the operator will receive exactly the same indications as are provided for in the above-described arrangement, wherein but one apparatus D was employed for each section.

In Fig. 4 I have illustrated diagrammatically an arrangement wherein an apparatus like apparatus D is placed at each end of a section, so that the operator by connecting to ground the controlling-wire for that section will close two branch circuits or connecting-lines between the said section and the feeder, one at the beginning of the section and the other near the end. At the same time the arrangement is such that the arrival of the train at the beginning of the section is indicated at the station and likewise the arrival of the train at the end of the section is similarly indicated. Referring to the drawings, B^2 is the conductor-section, which is thus provided with two controlling devices, one at each end, and E^2 is the controlling-wire for the section. One end of this controlling-wire is connected to the feeder A at 4 near the left-hand end of section B^2, and when there is no current on the wire a circuit may be traced from the feeder A to a branching point 5, where one part passes through a magnet H and teminates at a contact-point 6, which is normally open, but which when the armature G of magnet F is attracted becomes connected through the insulated metallic block W′ on the said armature to a similar contact-point 8 leading directly to section B^2. This portion of the circuit now being traced constitutes a normally-open branch circuit at the beginning of section B^2 between the feeder A and the said section, and the contact-block W′ on armature G constitutes a circuit-closer for completing the connection between feeder A and section B^2 through the described branch. The other portion passes by the wire E^2 at the left of magnet H downward to a second branching point 7, from which one portion passes through the resistance R and the other portion through the insulated armature Z′ of magnet H to a common junction-point 9, whence the line passes to magnet F and thence along parallel with section B^2 to the second controlling apparatus D′ at the farther end of the section. Upon reaching D′ there is another branching point 10, from which there are two routes—one through resistance R′ and the other by the armature Z^2 of magnet H′ to a junction-point 11, from which junction the line proceeds to magnet F′ and thence, leaving the apparatus D′, it proceeds to the station, where, in the manner already described, it passes through a galvanometer Z, an adjusting-resistance V, a switch W, and thence, if the said switch W is closed, to the ground. At apparatus D′ there is a second branch circuit between feeder A and section B^2 corresponding to the described branch circuit at apparatus D, and in like manner this second branch is provided with a circuit-closer consisting of an insulated metallic block W^2 on armature G′, which connects the two open terminals 12 and 13 of the said branch whenever the magnet F′ is energized and armature G′ is drawn up. The magnet H′ at this apparatus D′ is not included in the described branch connection between feeder A and section B^2, but it is included in a loop 14 from B^2, which bridges a break 15 in B^2 near the end of the section. If the wire E^2 be connected to ground at the station by the operator, a current will pass from feeder A over the route just described to the station and thence to ground. The effect of this will only be to energize magnets F and F′, one of which is at apparatus D and the other at apparatus D′. This will cause the two armatures G and G′ to be drawn up and close both of the described branch circuits between feeder A and section B^2, which are, as above stated, located one at apparatus D at the beginning and the other at apparatus D′ at the end of the said section B^2. The parts will remain in this condition until the arrival of a train at section B^2. The train upon arriving at B^2 will in the usual manner receive a current from B^2, which will be derived from the feeder A by means of the two branches above described; but while the magnet H in the first branch of apparatus D will be energized the magnet H′ of second apparatus D′ will not be

energized, because it is not included in the said branch circuit at D', nor will it be energized until the train arrives near the end of the section and passes over the break 15, that is bridged by the loop 14, containing the said magnet H', when the current passing from B^2 to the train must first pass over the loop-circuit and through magnet H'. The effect of the energizing of magnet H by the arrival of the train at the beginning of section B^2 is as follows: Previous to said arrival it will be observed that the resistance R at apparatus D is shunted by the by-path through the armature of the said magnet H; but at the second apparatus D' the corresponding resistance R' will not be shunted, so that but one of the two resistances R R' will be in circuit, and this one resistance is of such an amount as to check the current in controlling-wire E^2 to such an extent that the needle of galvanometer Z, included in said wire E^2 at the station, will stand at the position "current on." The energizing of magnet H, however, changes the described situation. It draws up its armature Z', and thereby breaks the shunt around resistance R, so that both of the resistances R and R' will then be in circuit. This causes the needle Z to fall back to the point marked "train," and the operator will then know that a train has arrived at section B^2. The parts will then remain in this condition until the train reaches the end of section B^2, when it will pass over the break bridged by the loop-circuit 14, including magnet H', so that this magnet will also be energized. The result of this will be that the armature of H' will be attracted, and thereby shunt the second resistance R', so as to leave only resistance R in the circuit of wire E^2. This will cause the galvanometer-needle at the station to return again to the position "current on," because the two resistances R and R' are supposed to be the same in amount, and the presence of either one alone in the circuit will give the same indication at the station, whether it be R or R'. Thus it will be apparent, as a general statement, that while a train is passing over section B^2 between the first apparatus D and the second apparatus D' both of the two resistances R and R' will be included in the circuit of E^2, while only one of the said resistances, either R or R', will be in circuit so long as the train is still on section B' or after it has passed the second apparatus D'. By means of this construction I am enabled to notify the operator of the arrival and also of the departure of a train at and from the said section B^2, while at the same time the said section is connected to the feeder during the presence of a train thereon by two branches and the line-resistance thereby reduced, since the train can receive current from both ends of the said section B^2 while it is passing over it.

In Fig. 2 I have shown one working-conductor section B^2 divided into subsections, which in any of the well-known ways may be automatically connected with the intermediate supply-conductor B as the train approaches and disconnected as the train recedes. In this case the conductor B, which forms an intermediary between section B^2 and feeder A, is treated exactly like section B^2 in Fig. 1 and just like the preceding section B' and succeeding section B^3, so that all of the subsections of B^2 may be simultaneously thrown out of circuit by the central-station operator.

The applicability of the above-described arrangement to a third-rail system of electric railways will be apparent. The third rail may be normally left out of circuit and only connected when a train is present, while at certain points, where it is undesirable to connect in circuit any long sections of conductor—as, for instance, at stations and in train-yards—the train itself will automatically connect the subsections of B^2 with the intermediate conductor B, while at the same time the signalman is able to exercise the same control over the train and over that part of the road upon which the train is running.

I have illustrated in Fig. 5 certain devices for automatically connecting the subsections of working conductor B^2 with the intermediate supply-conductor B. These are based upon the principle of supporting the short sections of the conductor-rail upon springs, which may be depressed by the weight of the locomotive applied thereto by a contact-wheel running upon the conductor and carrying a certain amount of the weight of the vehicle just like the car-wheel. Referring to the figure, T^2 is the ordinary railway-tie (shown in cross-section,) and on its upper surface rests a perforated plate C^3, upon which bear the curved springs R^2 R^2, upon which in turn bears a second plate C^2, bolted to the conductor-rail B^2 and supporting the same. Between the plates C^2 and C^3 is placed an ordinary rubber car-spring K^2, and within the hollow center thereof is a contact-spring D^3, attached to the upper end of a bolt O^2, which extends down through the tie T^2 and is connected at its lower end to the insulated and protected conductor B. The upper end of spring D^3 is normally out of contact with the under surface of the plate C^2; but when the heavy pressure of the locomotive comes on the conductor-rail B^2 it is slightly depressed, so that the plate C^2 comes into contact with the spring D^3 and the current is transmitted from the conductor B to the rail B^2. A spring-support of this kind will be provided at each end of the conducting-rail. Of course the springs R^2 R^2 will not be compressed by the pressure thereon of any vehicle of less weight than a locomotive or railway-car, and they will only be compressed by a vehicle of the latter kind when it is provided with a contact-wheel carrying a larger amount of weight.

I do not herein lay claim to the particular organization that is illustrated in Fig. 5, as the same is shown simply for the purpose of illustrating one of the many ways in which

short sections of working conductor may be automatically and temporarily connected with a well-insulated conductor. So far as my present invention is concerned any other devices for performing this same function may be employed, and I reserve for another application the specific devices illustrated in Fig. 5.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination in an electric railway of an exposed, sectional, working conductor normally disconnected from the circuit, an electrically-propelled vehicle on the railway provided with a traveling contact device adapted to pass over the sections of the said working conductor in succession and receive current therefrom, a feeding-conductor and an intermediate, manually-controlled circuit-closer operated from a distant point.

2. The combination in an electric railway of an exposed, sectional, working conductor normally disconnected from the circuit, an electrically-propelled vehicle on the railway provided with a traveling contact device adapted to connect with the sections of the said working conductor in succession and receive current therefrom, a feeding-conductor, a series of circuit-closers placed along the railway at the respective sections of working conductor and serving to connect the feeding-conductor with the said sections of working conductor respectively and a corresponding series of controlling devices for the said circuit-closers grouped at a common point.

3. The combination in an electric railway of an exposed, sectional, working conductor normally disconnected from the circuit, an electrically-propelled vehicle provided with a traveling contact device adapted to connect with the sections of the said working conductor in succession and to receive current therefrom, a feeding-conductor and an intermediate circuit-closing device consisting of contact-pieces connected with the two conductors respectively, an operating-magnet for said contact-pieces, a circuit extending to a distant point and a manual switch at said point controlling the said circuit.

4. The combination in an electric railway of an exposed, sectional, working conductor normally disconnected from the circuit, an electrically-propelled vehicle provided with a traveling contact device adapted to connect with the sections of the said working conductor in succession and receive current therefrom, a feeding-conductor, a series of circuit-closers along the railway serving to connect the feeding-conductor with the several sections of working conductors respectively, an operating-electromagnet for each circuit-closer, a circuit for each magnet and a series of manual controlling-switches for the several circuits placed at a common point.

5. The combination in an electric railway of a sectional working conductor normally disconnected from the circuit, a feeding-conductor, an intermediate circuit-closer and an operating-magnet for said circuit-closer included in a shunt-circuit from the said feeding-conductor and leading to a distant point where it is provided with a controlling-switch.

6. The combination in an electric railway of a sectional working conductor normally disconnected from the circuit, a feeding-conductor, a series of circuit-closers along the railway serving to connect the feeding-conductor with the several sections of working conductors respectively and a corresponding series of controlling devices for the said circuit-closers consisting each of an operating-electromagnet included in an individual shunt-circuit leading from the said feeding-conductor to a common controlling-point and there provided with a switch.

7. The combination in an electric railway of an exposed, sectional, working conductor normally disconnected from the circuit, an electrically-propelled vehicle provided with a traveling contact device adapted to connect with the sections of said working conductor in succession and receive current therefrom, a feeding-conductor, an intermediate manually-controlled circuit-closer operated from a distant point and a signaling device connected to the said circuit-closer so as to be manually controlled simultaneously therewith.

8. The combination in an electric railway of a section of working conductor, a feeding-conductor, an intermediate circuit-closer in a branch wire between the said conductors, a signaling device, a shunt-circuit magnet for operating the said circuit-closer and the said signaling device, and a magnet in series with said circuit-closer for restoring the said signaling device.

9. The combination in an electric railway of a section of working conductor, a feeding-conductor, an intermediate circuit-closer, a branch wire between the said conductors including the said circuit-closer, an operating-magnet for the said circuit-closer, a circuit for the said magnet extending to a distant point and there provided with a controlling-switch, signal-transmitting devices responding to the presence of a train on the said section of working conductor and corresponding signal-receiving devices at the aforesaid distant controlling-point.

10. The combination in an electric railway of a section of working conductor, a feeding-conductor, an intermediate circuit-closer, a branch wire between the said conductors including the said circuit-closer, a shunt-magnet for operating the circuit-closer, a circuit for said magnet extending to a distant point, an external resistance in said circuit, a series magnet operating shunting-contacts around the said resistance and indicating and controlling devices at the said distant point.

11. The combination in an electric railway of a section of working conductor, a feeding-conductor, two branch wires for connecting

the said conductors, and two intermediate circuit-closers in the respective branch wires, one located at the beginning and the other at or near the end of the section and a common controlling device for the two circuit-closers whereby they may be operated simultaneously from a distant point.

12. The combination in an electric railway of a section of working conductor, a feeding-conductor, two branch wires between the said conductors, one at the beginning and the other at or near the end of the section, two circuit-closers included respectively in the said branch wires, distinctive signal-transmitting devices responding to the arrival of a train at each of the circuit-closers respectively, and a circuit extending to a distant point and there provided with signal-receiving devices responding respectively to the distinctive signals transmitted as aforesaid on the arrival of the train at the two circuit-closers.

13. The combination in an electric railway of conductor A, conductor-section B^2, two branch wires connecting the said conductors, intermediate circuit-closing and signaling devices D and D′, one at the beginning and the other at the end of said conductor-section, a magnet H in the said device D included in one of the said branch wires, a resistance R controlled by the said magnet H, so as to be shunted when the said magnet is deënergized, a corresponding magnet H′ at the said signaling device D′ included in the other branch wire, a resistance R′ controlled by the said magnet H′ so as to be shunted when the said magnet is energized, a line-wire E^2 including both of the said resistances R and R′ and extending to the station, and signal and receiving devices in the said line E^2 at the station responsive to the variations of current in the said line E^2.

14. The combination in an electric railway of a feeding-conductor, a section of working conductor, a branch wire between the said conductors, an intermediate circuit-closer in said branch wire, a shunt-magnet for operating the said circuit-closer, a signal device normally connected to the armature of the shunt-magnet, and a magnet included in the circuit connecting the section of working conductor with the feeding-conductor and in series with the said circuit-closer and acting to release the signal device from its connection with the armature of the shunt-magnet.

15. The combination with levers G and L of a latch normally connecting the two, a magnet F for operating both levers while they are connected and a magnet H controlling the said latch whereby the said levers may be moved conjointly in one direction and moved separately in the opposite direction.

16. The combination in an electric railway of a conductor serving as a feeder, a sectional working conductor normally disconnected from said feeder and having one or more of its sections divided in the subsections, an electrically-propelled vehicle adapted to receive current from the said subsections successively, an intermediate supply-conductor adjoining the said subdivided sections and normally disconnected from the said feeder, manual circuit-closers between the feeder and each undivided section of working conductor and between the feeder and the said supply-conductor and automatic circuit-closers between the said supply-conductors and each subsection of the subdivided section of working conductor.

17. The combination of feeding-conductor A, intermediate supply-conductor B, subdivided section B^2, an electrically-propelled vehicle adapted to receive current from the subsections in succession, of working conductor, a manual circuit-closer between said conductors A and B and automatic circuit-closers between conductor B and each subsection of conductor B^2.

18. The combination in an electric railway of a conductor serving as a feeder, sections of working conductor normally disconnected from the feeder, circuit-closers acting temporarily and successively for connecting respectively the sections of working conductor to the feeder, a danger-signal at each section displayed normally while the section is disconnected and also when the section is occupied and a safety-signal displayed while the section is connected but not occupied.

19. The combination in an electric railway with conductor E^2 extending from the station to a remote point of the railway and connected with the feeding-conductor of the railway so as to receive a branch current therefrom, of a magnet therein, a section of working conductor, a circuit-closer between said section and feeding-conductor, signal-transmitting devices in said conductor E^2 at the remote point aforesaid and signal-receiving devices in said conductor E^2 at the station responsive to the said transmitting devices.

In witness whereof I have hereunto set my hand this 4th day of August, 1896.

EDWARD M. BENTLEY.

Witnesses:
L. T. SHAW,
E. L. SMITH.