No. 675,038. Patented May 28, 1901.

P. FARNSWORTH.

ELECTRIC RAILWAY.

(Application filed May 31, 1900.)

(No Model.) 3 Sheets—Sheet 1.

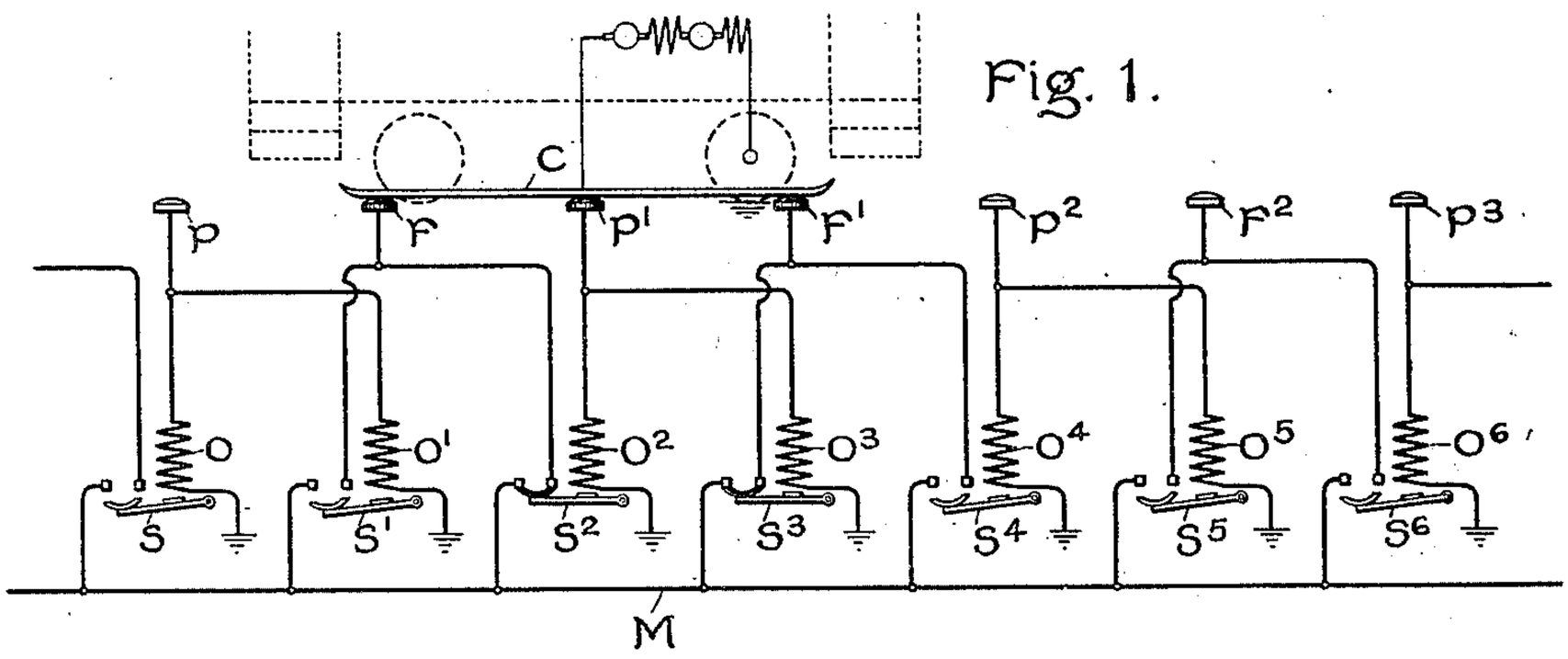


Fig. 1.

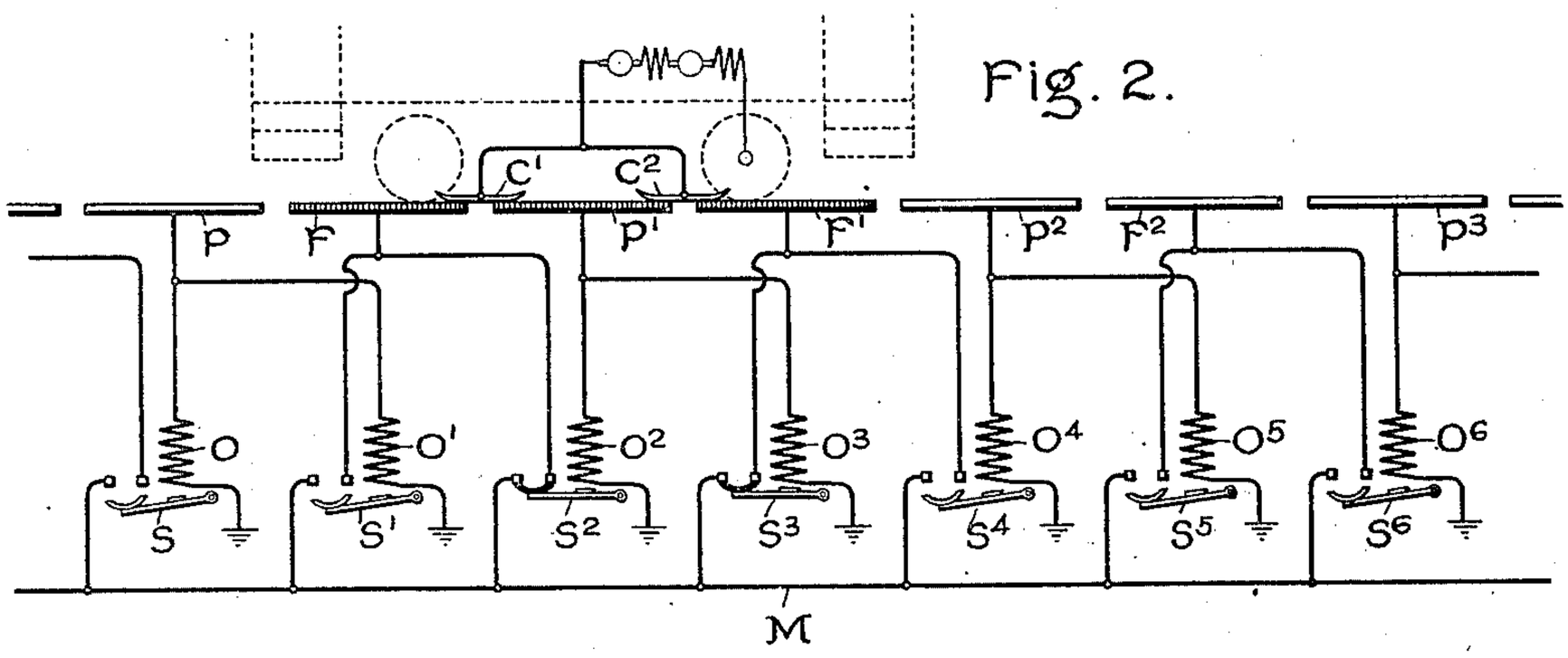


Fig. 2.

Witnesses:

Lewis E. Abell.

Benjamin B. Hull.

Inventor:

Philip Farnsworth.

No. 675,038. Patented May 28, 1901.

P. FARNSWORTH.

ELECTRIC RAILWAY.

(Application filed May 31, 1900.)

3 Sheets—Sheet 2.

(No Model.)

Fig. 3.

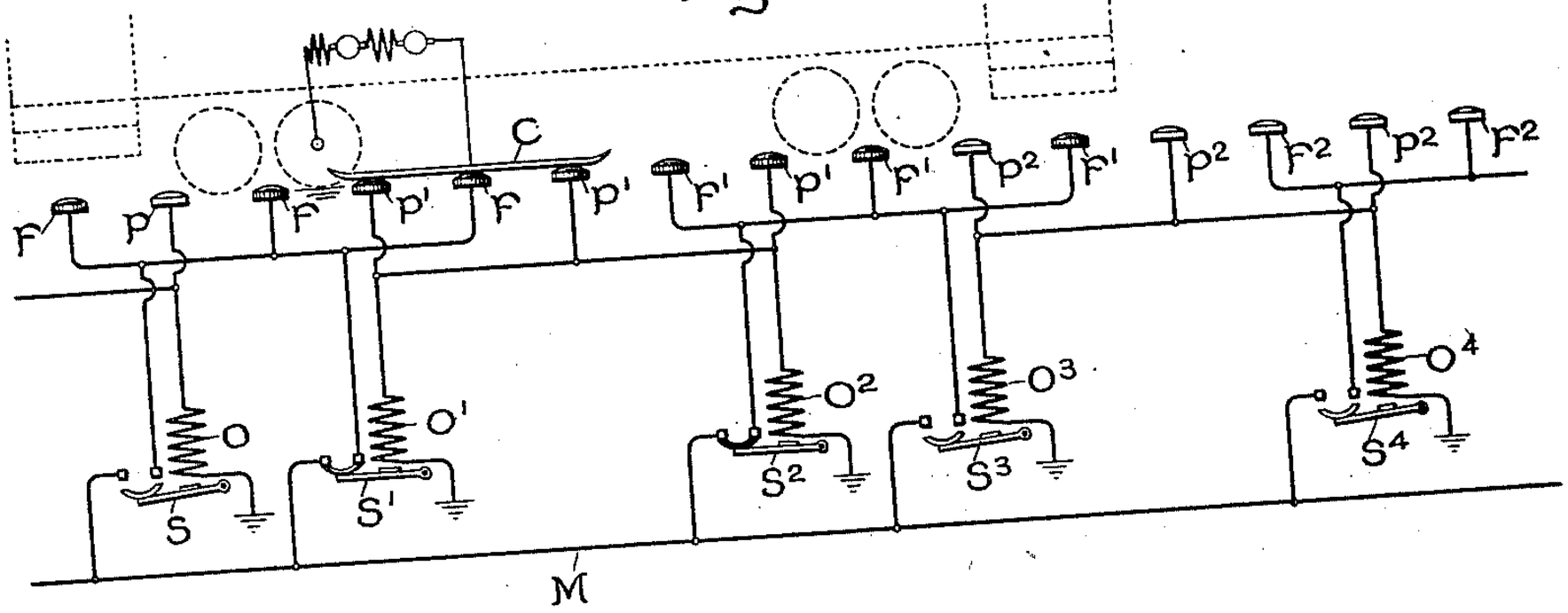
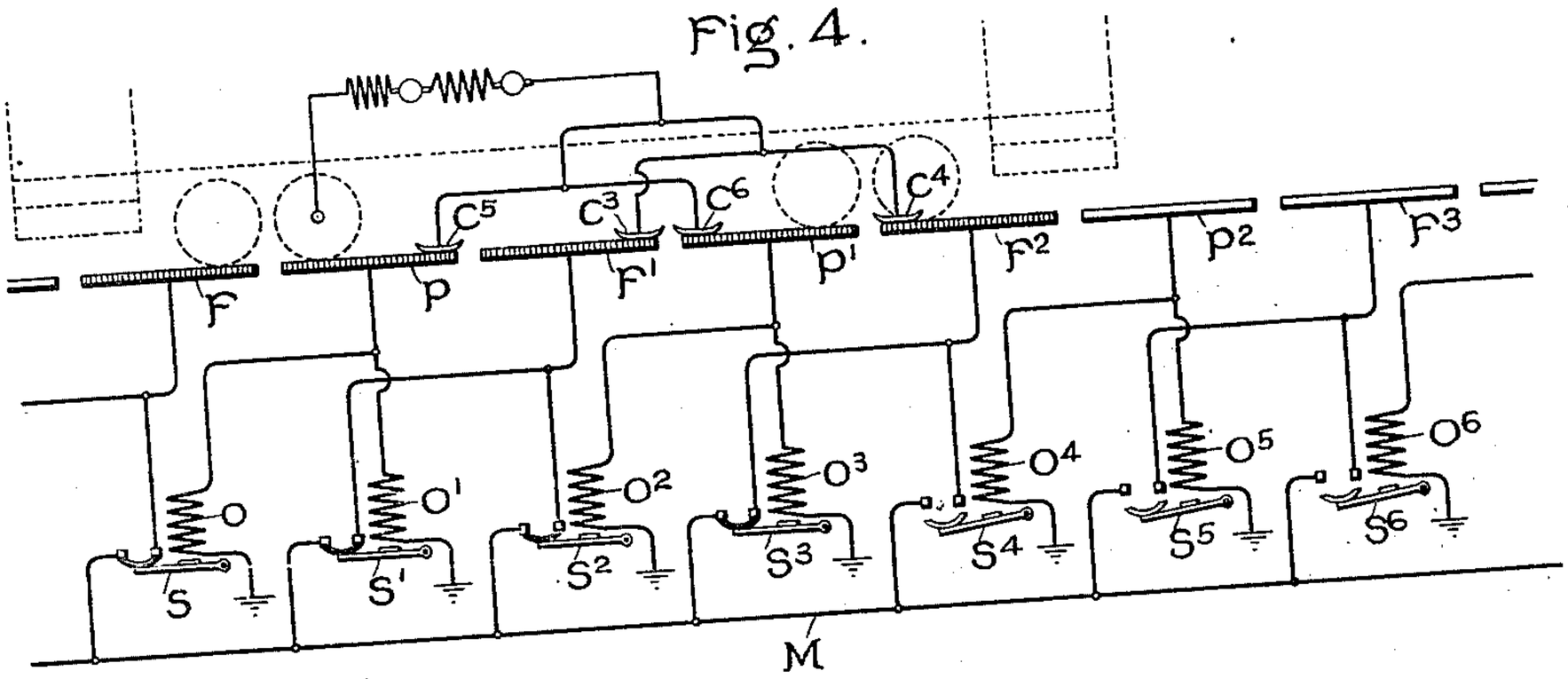


Fig. 4.



Witnesses.

Lewis E. Abell.

Benjamin B. Hull.

Inventor.

Philip Farnsworth.

No. 675,038. Patented May 28, 1901.

P. FARNSWORTH.

ELECTRIC RAILWAY.

(Application filed May 31, 1900.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 5.

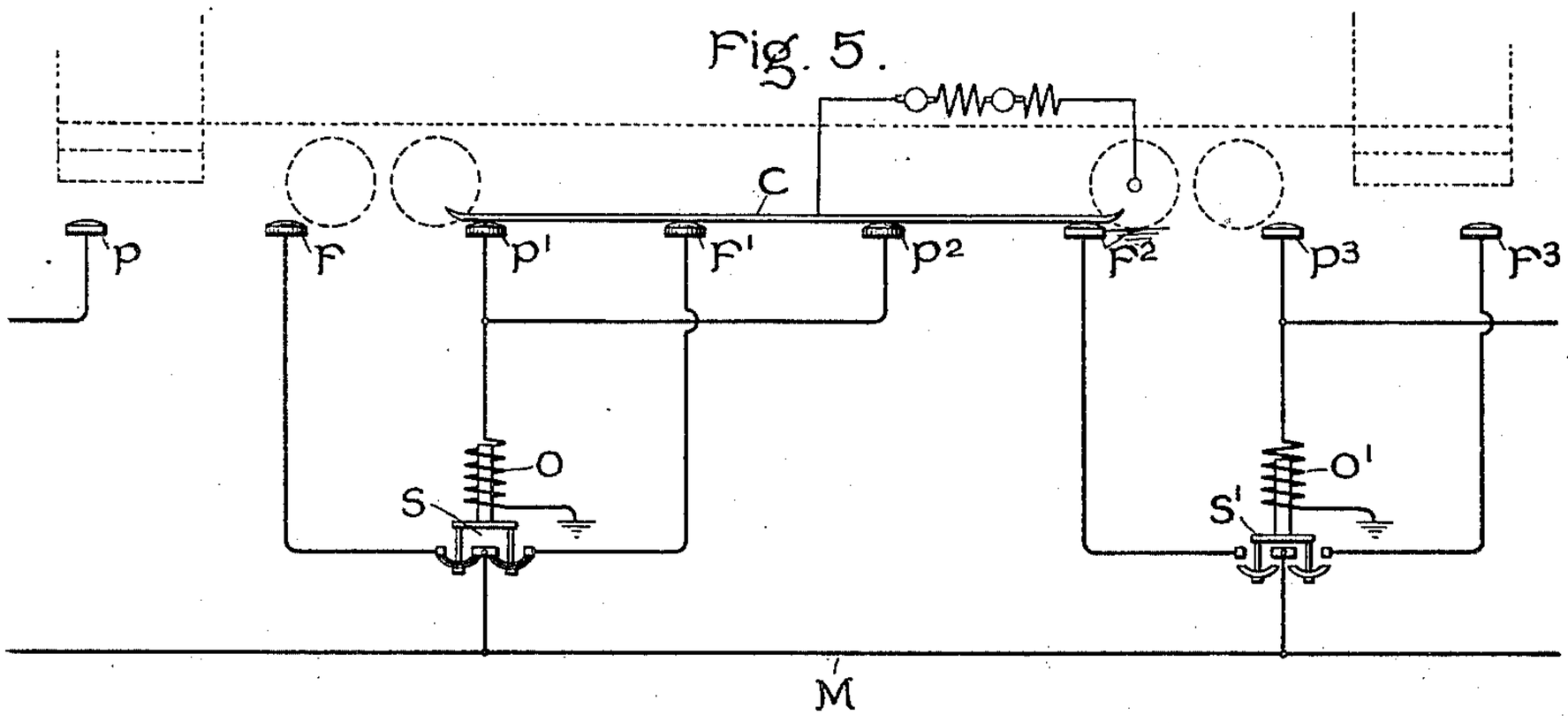
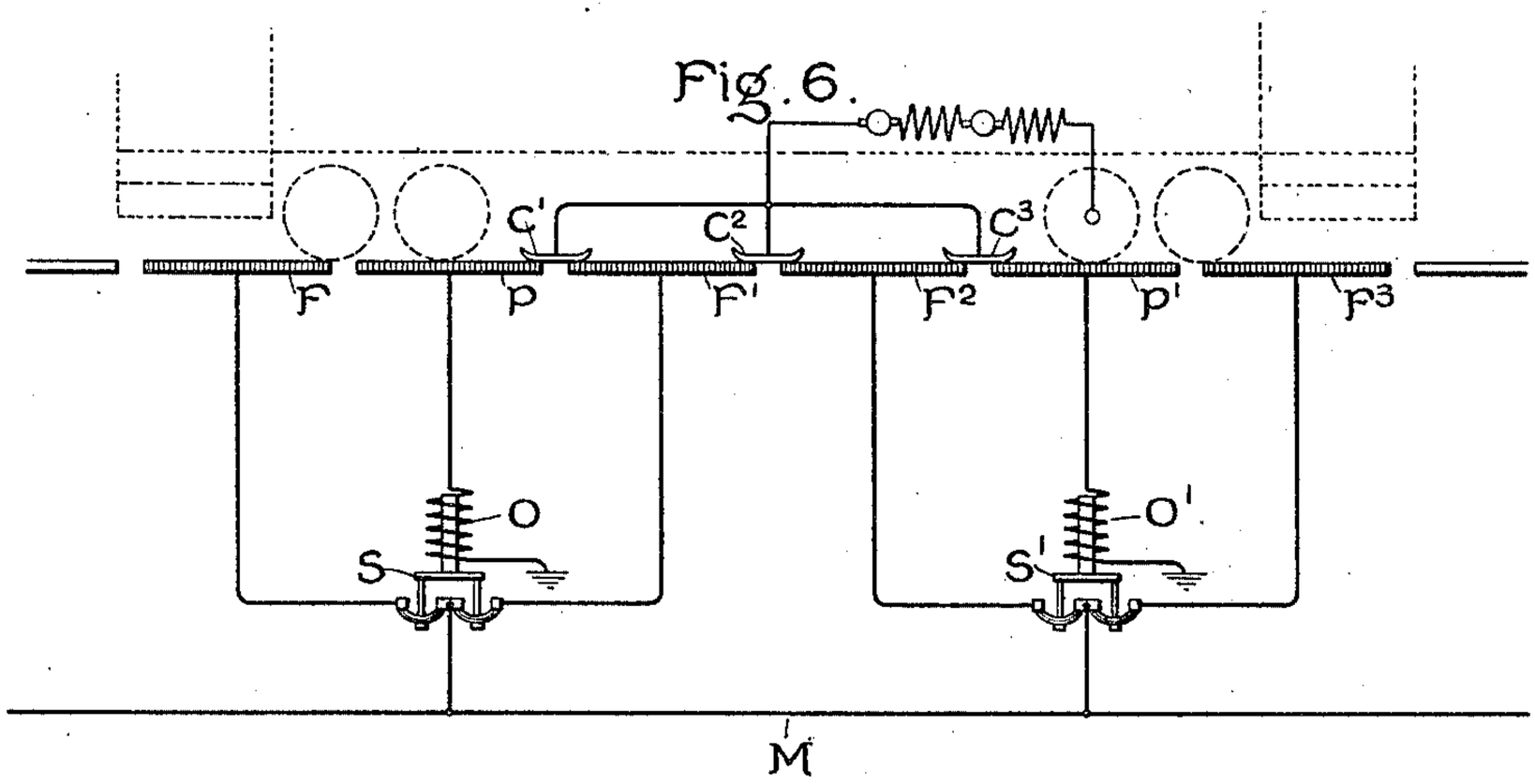


Fig. 6.



Witnesses:
Louis D. Abell.
Benjamin B. Hicks.

Inventor:
Philip Farnsworth.

UNITED STATES PATENT OFFICE.

PHILIP FARNSWORTH, OF SCHENECTADY, NEW YORK, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 675,038, dated May 28, 1901.

Application filed May 31, 1900. Serial No. 18,503. (No model.)

To all whom it may concern:

Be it known that I, PHILIP FARNSWORTH, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Railways, (Case No. 1,709,) of which the following is a specification.

This invention relates to electric railways; and its object is to provide a cheap safe commercial road which is very simple in construction.

Inasmuch as the objections to series coils or combinations of series and shunt coils for controlling the switches which connect the feeder with the sectional service-conductor of safety systems have proved to be so great that it has been found impracticable to use them in such systems, an object of this invention is to provide a railway wherein the only switch-coils are in shunts to ground around the car-motors from conductor-sections which are engaged by the collector carried by the car.

A further advantage resulting from this invention is that only a single sectional service-conductor is used, whereas in most of the previous commercial systems an auxiliary sectional conductor has been utilized for the operation of the shunt switch-coils, as in the patent to Crehore, No. 536,828. Thus ensues a saving of fifty per cent. in the cost of service-conductor studs or rails, and since the insulating structure for the auxiliary rail in sectional third-rail systems is dispensed with, as well as the rail itself, there results a saving of more than twenty-five per cent. in the total cost of service and track rails.

A further advantage consists in the fact that whether the invention is applied to a spot or stud system or to a third-rail system it is generally necessary that only three of the studs or rails be bridged by the collector.

Furthermore, the invention can be applied in such manner that a smaller number of the shunt-coils need be used, which is of great advantage, as the cost of these coils and their switches is not small. The invention is also much more simple than previous similar systems and provides a greater number of feeder-sections relative to the number of pick-up sections and permits the use of a shorter collector, which is of great importance in street-car work.

In general it may be said that the system possesses great flexibility in adaptation to varying conditions, and many other advantageous results will flow from its application to different types of railways.

According to custom, a battery will be provided on each car or train to start the latter from a dead section, the track-rails will generally constitute the ground or return, and the collector is electrically connected with the motors on the car.

Figure 1 is a diagrammatic illustration of a stud system, showing a collector of nearly the length of the car. Fig. 2 is a similar view showing the applicability of the invention to a railway, such as an elevated road, upon which trains of cars are run and wherein the studs of Fig. 1 are replaced by sections of rail, and the collector, instead of being a long shoe, is composed of two interconnected shoes, each of which bridges two adjacent sections. Fig. 3 is a similar view illustrating the flexibility of the system and showing an increased number of studs with the same number of switches. Fig. 4 is a similar view further illustrating the applicability of the invention to railroads where long cars or trains are used and the fact that the form of the collector may be varied for different conditions without exceeding the limits of the invention. Fig. 5 is a similar view illustrating an embodiment of the invention which has a reduced number of switches, and Fig. 6 is a similar view illustrating the application of the arrangement shown in Fig. 5 to a third-rail system. Throughout the drawings the energized sections are shaded.

The invention will be most readily understood by reference to the particular embodiment shown in Fig. 1. The sections P, which are connected to ground through the two coils O, alternate with the sections F, which are connected to the feeder or main M through two consecutive switches S. Suitable resistances will be inserted between the pick-up studs and the coils, according to custom, to prevent too great a flow of current. It may be assumed that the collector C, shown in engagement with the feeder-sections F and F′ and with the pick-up section P′, is being carried to the right by the car. After it has left the section F the motors will receive current through the section F′ alone. Then the

collector engages with the pick-up section P^2, whereby current is shunted around the car-motors from the section F′ through the collector and the coils O^4 and O^5 to ground, thus closing the switches S^4 and S^5 and making section F^2 alive. Immediately thereafter the collector leaves the pick-up section P′, thereby opening the switches S^2 and S^3; but although the section F′ is thus disconnected from the feeder at the switch S^3 it continues to be energized through the switch S^4, which has already been closed, as described. The collector then engages with the feeder-section F^2, which has already become energized by the closing of switch S^5, as described, and the collector again receives current in parallel from two sections, which are in this case sections F′ and F^2.

Assuming that the controller of the car has been reversed and that the car is started in the opposite direction to that last described, the collector will first leave the feeder-section F^2, thus receiving current through the section F′ alone, which is connected with the feeder by the switch S^4, which is closed while the shoe is in engagement with the pick-up section P^2. The collector then engages with the pick-up section P′, thereby closing the switches S^3 and S^2, current being shunted around the car-motors to ground from the section F′. Immediately thereafter the collector leaves the pick-up section P^2, whereby the switch S^4 is opened. The feeder-section F′ remains energized, however, owing to its connection with the closed switch S^3. The collector then engages with the feeder-section F, which is energized by its connection with the closed switch S^2, and the collector is again in the position shown and receiving current from the feeder-sections F and F′ in parallel, the switches S^2 and S^3 being held closed by the currents shunted from the sections F and F′ toward the center of the collector to the section P′ and the coils O^2 and O^3 to ground.

A careful observation of Fig. 1 will make it clear that the system would be operative in each direction with only one coil connected to a pick-up section if a collector bridging four sections instead of three were used; but, even so, with the high speeds attained in modern practice the collector might be carried from a power-section before it had energized the next power-section, and hence it is necessary to employ two coils connected with each pick-up section for controlling the power-sections adjacent to the pick-up section in order to provide ample time allowance in each direction. In Fig. 5 is shown an application wherein sufficient time allowance is obtained by a single coil by means of a longer collector.

The operation of the application illustrated in Fig. 2 is substantially the same as that just described. The studs are replaced by short lengths of rail, and two interconnected collectors C′ and C^2 are provided. Although short rail-sections and a single car are shown, this figure illustrates the applicability to railways over which long trains are run. The rail-sections may be of the standard sixty-foot length, and the collectors C′ and C^2 may be located at the proper part of the train and connected by a train-wire. In connection with this figure it may be remarked, with respect also to the other figures, that it is not necessary that the sections of the service-conductor be arranged in a straight line. As convenience or necessity may dictate they may be located in any suitable positions with respect to each other, as the pick-up sections in one row interrupted by long spaces and the feeder-sections in another row also interrupted by long spaces. In such a case the collectors would be arranged in echelon. Such an irregular arrangement might be necessary in certain cases to prevent short circuits by leakage from the feeder-sections to the pick-up sections. In the position shown the shoe C′ engages the feeder-section F and the pick-up section P′ and the shoe C^2 engages the pick-up section P′ and the feeder-section F′, so that the motors are receiving current from the feeder-sections F and F′ in parallel, and current is shunted from each shoe through the pick-up section P′ and the coils O^2 and O^3 to ground to hold the switches S^2 and S^3 closed, whereby the feeder-sections F and F′ are energized. Assuming that the car is moving to the right, the shoe C′ leaves the feeder-section F, the shoe C^2 leaves the pick-up section P′, and the motors receive current through the feeder-section F′ and shoe C^2 alone. Current is shunted from the car-circuit through the shoe C′ to keep the switches S^2 and S^3 closed. Then the shoe C^2 engages the pick-up section P^2, thereby shunting current from the car-circuit to close the switches S^4 and S^5 by passing to ground through the coils O^4 and O^5. Thus the feeder-section F′ is caused to remain energized after the shoe C′ has left the pick-up section P′, and the feeder-section F^2 is energized in advance of the shoe C^2, which is about to engage it. The motors will now be receiving current from the shoe C′ alone, and current will be shunted through the shoe C^2 and section P^2. In the next position the motors will receive current through the feeder-sections F′ and F^2 in parallel. Assuming that the controller is reversed and the car driven in the opposite direction to that last described, the shoe C^2 leaves the feeder-section F^2, the shoe C′ leaves the pick-up section P^2, and the motors receive current from the feeder-section F′ alone, current being shunted from the car-circuit to ground through the shoe C^2 and section P^2 to hold the switch S^4 closed. The shoe C′ next engages the pick-up section P′, whereby current is shunted to ground through the coils O^2 and O^3 to close the switches S^2 and S^3, so that the feeder-section F′ remains energized after the shoe C^2 has left the pick-up section P^2, and the feeder-section F is energized in advance of the shoe C′, which is about to engage it. Finally, the

shoe C′ engages the feeder-section F, the shoe C^2 engages the pick-up section P′, and the collector is in the position shown.

In Fig. 3 is shown an application of the invention wherein the studs or sections are arranged alternately; but the feeder studs and sections are connected together in sets, as are the pick-up sections. If in this application the studs are arranged more closely together than before, a shorter collector may be used, whereas if the sections are not located more closely together than before a smaller number of switches is required. In an application such as this shown in Fig. 3 and also in other cases where several sections are alive at one time the arrangement should be such that at no time should live sections be exposed beyond either end of the car or train. The operation of the application illustrated in Fig. 3, being similar to that of applications previously described, may easily be studied out by tracing the circuits as the car progresses.

In Fig. 4 is shown an application of the invention which illustrates another of the varied collecting devices which may be used with the invention. The particular arrangement herein shown is well adapted for trainwork, the various shoes being arranged at the proper parts of the train and connected together by train-wires. The switches and connections are similar to those hitherto described, and the operation is substantially the same. In the position shown the motors are receiving current from the feeder-sections F′ and F^2 in parallel through the shoes C^3 and C^4, and current is being shunted from the conductor which connects shoes C^3 and C^4 with the motors through the shoes C^5 and C^6 and pick-up sections P and P′, respectively, to maintain the switches S, S′, S^2, and S^3 closed. As the car progresses to the right the shoe C^5 leaves the pick-up section P, whereby the switches S and S′ are opened. Then the motors receive current through the shoes C^5 and C^4 from the sections F and F′, current being shunted from the car-circuit through the shoes C^3 and C^6 and the section P′ to keep the switches S^2 and S^3 closed. When the shoe C^4 engages with the pick-up section P^2 to close the switch S^5 and energize the feeder-section F^3 in advance of the shoe C^4, the motors receive current through the shoes C^3 and C^6 from the section F^2, current being shunted from the car-circuit through the shoes C^5 and C^4 to hold the switches S^2, S^3, S^4, and S^5 closed. The shoe C^4 next engages the previously-energized section F^3, the shoe C^5 being on the feeder-section F^2 and current being shunted from the car-circuit through the shoes C^3 and C^6 and the section P^2 to hold the switches S^4 and S^5 closed. The operation in the opposite direction is similar.

In Fig. 5 is shown another manner of causing one of the sections connected with a shunt-coil to control preceding and succeeding sections which are connected with the feeder. Instead of two ground-shunts from the pick-up sections a single coil controls the switch connections of both the preceding and succeeding feeder-sections, whereby a considerably smaller number of switches is required. The collector C in the position shown in Fig. 5 is taking current from the section F′ and shunting through the coil O to hold the switch S closed. As the car proceeds to the right the switch S is held closed by current shunted from the car-circuit through the section P^2 after the collector has left the section P′. The collector engages the section P^3, closing the switch S′ and energizing the section F^2 before it leaves the section F′. When the collector engages the section F^3, it takes current from the sections F^2 and F^3 in parallel, and it leaves the pick-up section P^2, whereby the switch S is opened before it engages the pick-up section succeeding the section F^3. The operation in the opposite direction is similar. This arrangement, wherein the sections F and F′ are maintained alive by the engagement of the collector C with the section P^2, is especially applicable to roads where a leading motor-car draws a trailer or smoking-car, which would cover the sections F and F′ until the collector left the section P^2. The arrangement would be operative in both directions, with the collector bridging only three sections, if a section be inserted between sections P and F and connected with the section P′.

In Fig. 6 is shown an application to a third-rail system of the arrangement shown in Fig. 5. If the rails be only of the standard sixty-foot lengths, it is obvious that there is only one switch for each one hundred and eighty feet of road-bed. With short sections of rail this arrangement would be advantageous for street systems, since only one section is alive behind the collector. In fact, were the rail-sections of Fig. 6 replaced with studs there would result an excellent arrangement for single-car street traffic with a slight increase over the number of switches in the arrangement of Fig. 6. In the position of the collector shown all the sections illustrated are alive, the motors receiving current from the shoes C′, C^2, and C^3 in parallel with the sections F′ and F^2, current being shunted from the car-circuit through the shoes C′ and C^3 to the sections P and P′ to hold the switches S and S′ closed. As the car proceeds to the right the shoe C′ leaves the section P, the switch S opens, and the sections F and F′ are disconnected from the feeder. The shoe C^2 now supplies current to the motor and to the shunt from the car-circuit around the shoe C^3 to keep the switch S′ closed, whereby sections F^2 and F^3 are connected with the feeder. During this time the shoe C′ is traveling over the dead section F′. In the next position of the collector the shoes C′ and C^3 take current from the sections F^2 and F^3 in parallel

and current is shunted around the car from both the shoes through the center shoe C^2 to keep the switch S′ closed. The operation in the opposite direction is similar.

I might show other forms which my invention may take without exceeding the scope thereof; but I believe that sufficient has been described, in connection with the appended claims, to define the limits of the invention.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, individual alternating successive sections of which are connected by parallel branches to the feeder and return respectively, a switch for each of said feeder branches, a coil in each of said return branches, and a collector carried by the car whereby current passes from a previously-energized section, and in shunt to the car-circuit through the two coils in the parallel branches to return from one of said sections, to close the switches which connect both adjacent sections with the feeder.

2. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, connections between each alternate section thereof and the feeder, connections including switch-coils from each intermediate section to return, and a collector, which, when it engages with one of the sections connected to the return causes current to be shunted from the car-circuit through the switch-coils in the return connections, whereby both sections adjacent to said return-sections are connected with the feeder.

3. In an electric railway, the combination with the feeder, of normally-dead sectional service-conductor sections, including electromagnetically-operated switches between alternate sections thereof and the feeder; connections in shunt around the car-motors, and including switch-coils, from the intermediate sections to return, each coil operating a switch which connects one section with the feeder; and a single collector adapted to engage all the sections and connected to one side of the car-motors, whereby each section connected to return controls the connections of a plurality of sections connected with the feeder.

4. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, connections between sets of interconnected sections thereof and the feeder, a switch for the feeder connections for each set, and a connection in shunt around the car-motors and including a magnet-coil, from a section intermediate the sections of a set to the return.

5. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, connections between sets of alternate sections throughout the length of the conductor and the feeder, switches for said connections, and connections in shunt around the car-motors and including switch-coils, from the intermediate sections to the return.

6. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, connections between sets of interconnected alternate sections and the feeder, switches for said connections, and connections including switch-coils from sets of intermediate interconnected sections to the return.

7. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, certain sections of which have electromagnetically-controlled connections with the feeder, and certain other sections of which have return-shunts around the car-motors which include magnet-coils, whereby each of the latter sections controls the feeder connections of the immediately-preceding section and immediately-succeeding section.

8. In an electric railway the combination with the feeder, of a normally-dead sectional service-conductor, certain sections of which have electromagnetically-controlled connections with the feeder, certain other sections of which have return-shunts around the car-motors which include magnet-coils, and a collector carried by the car whereby when the collector engages with only one section connected to return, two or more successive sections having feeder connections are energized.

9. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, parallel electromagnetically-controlled connections from each of certain sections to the feeder, and return-shunts from other sections around the car-motors, which shunts include the magnet-coils.

10. In an electric railway, the combination with the feeder, of a single normally-dead sectional service-conductor, the sections of which are all located in alinement, electromagnetically-controlled connections between certain sections and the feeder, and magnet-coils connected with other sections in shunt to the car-motors, whereby each of the latter sections controls the feeder connections of preceding and succeeding sections.

11. In an electric railway, the combination with the feeder, of a single normally-dead sectional service-conductor, the sections of which are all located in alinement, electromagnetically-controlled connections between certain sections and the feeder, and return-shunts around the car-motors from other sections, which shunts include magnet-coils, whereby each of the latter sections controls the feeder connections of preceding and succeeding sections.

12. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, a plurality of interconnected sections of which conductor are adapted to be connected with the feeder, and other sections of which have a return-shunt around

the car-motors, which includes a magnet-coil for connecting said interconnected sections with the feeder.

13. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, a plurality of interconnected sections of which conductor are adapted to be connected with the feeder, and a plurality of interconnected sections of which are connected in shunt to return around the car-motors, which shunt includes a magnet-coil for connecting said first-mentioned sections with the feeder.

14. In an electric railway, the combination with the feeder, of a normally-dead sectional service-conductor, a plurality of interconnected sections of which conductor are adapted to be connected with the feeder, and a plurality of interconnected sections of which have a return-shunt including a magnet-coil for connecting said first-mentioned sections with the feeder, each section connected with the feeder being located between two sections connected to return, and vice versa.

15. In an electric railway, the combination with the feeder, of a collector carried by the car, a single normally-dead sectional conductor, and switches for connecting the latter with the former, each of certain conductor-sections being connected to a plurality of switches, each switch being connected to a plurality of such sections, and the remaining sections being connected to shunts around the car-motors to return, whereby when such a shunt is closed by the engagement of the collector with both a section connected to the feeder and a section in the shunt, a switch is closed to connect a plurality of feeder-sections with the feeder.

16. In an electric railway, the combination with the feeder, of power-conductor sections, connections between said sections and the feeder, electromagnetic switches in said connections, switch-energizing conductor-sections located in alinement with the power-conductor sections and connected to return through the coils of the switch-magnets, and a plurality of collector-shoes comprising the car collecting device, which are arranged in tandem, to engage the line of power and switch energizing conductor-sections, and which are all connected with one side of the car-motor circuit, whereby a portion of the current flowing to the motor is shunted to return through the switch-coils, to connect the power-conductor sections with the feeder.

17. An electric-railway system, which has a single sectional conductor made up of feeder-sections and switch-energizing sections arranged alternately in alinement, switches for connecting the feeder-sections with the feeder, two connections from each feeder-section to two successive switches, two connections in shunt to the motor-circuit from each switch-energizing section to the return, and a coil in each of said latter connections, which two coils control two successive switches, one of which switches is connected to the feeder-section which is located in one direction with respect to the switch-energizing section to which the coils are connected, the other of which switches is connected to the feeder-section which is located in the other direction with respect to said switch-energizing section.

18. An electric-railway system, which has a single sectional conductor made up of feeder-sections and switch-energizing sections alternately arranged in alinement, switches which connect the feeder-sections with the feeder, and return connections in shunt to the car-motors from each switch-energizing section, which connections contain coils for actuating said switches.

19. A sectional conductor for electric railways, which comprises sections each connected in shunt to the car-motors to two electromagnets which control feeder-switches, and which comprises also sections each connected to two switches controlled by said electromagnets, each of the latter sections being located between two of the first sections, and all said sections being located in single line.

20. A contact system for electric railways, which comprises a single line of conductor-sections connected alternately, one to the feeder through two switches and the other through two switch-coils in shunt to the car-motors to the return.

21. In an electric-railway system, the combination with the feeder, of a single line of conductor-sections, switches for connecting certain of the latter with the former, coils in shunt to the car-motors for actuating the switches, said conductor-sections being connected alternately, one to two switches and the other to two coils, and a collector carried by the car, connected to the car-motors, and adapted to connect three of said sections.

22. An electric-railway system, which comprises a feeder or main and a single line of feeder and energizing-conductor sections, a car-collector which engages with all said sections and connects each energizing-section in a shunt from a feeder-section around the car-motors to return as the car proceeds, and suitable electrical connections whereby each energizing-section controls the supply of current to a plurality of feeder-sections.

23. An electric-railway system, which comprises a feeder or main and a single line of feeder and energizing-conductor sections, a car-collector which engages all said sections and connects each energizing-section in a shunt from a feeder-section, around the car-motors to return as the car proceeds, and suitable electrical connections whereby each energizing-section controls the supply of current to a feeder-section on each side of it.

In witness whereof I have hereunto set my hand this 28th day of May, 1900.

PHILIP FARNSWORTH.

Witnesses:

BENJAMIN B. HULL,

MAUD R. MAY.