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J. R. FINNEY.

PROPELLING CARS BY ELECTRICITY.

No. 285,353. Patented Sept. 18, 1883.

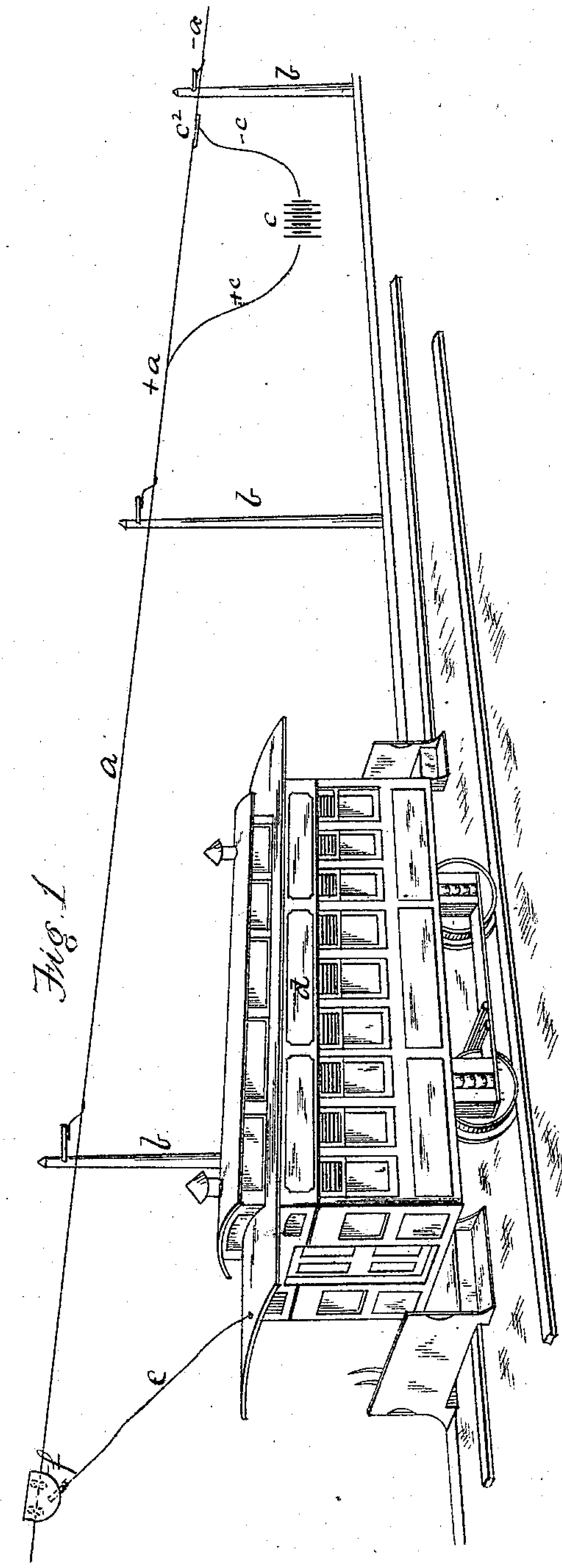

Fig. 1

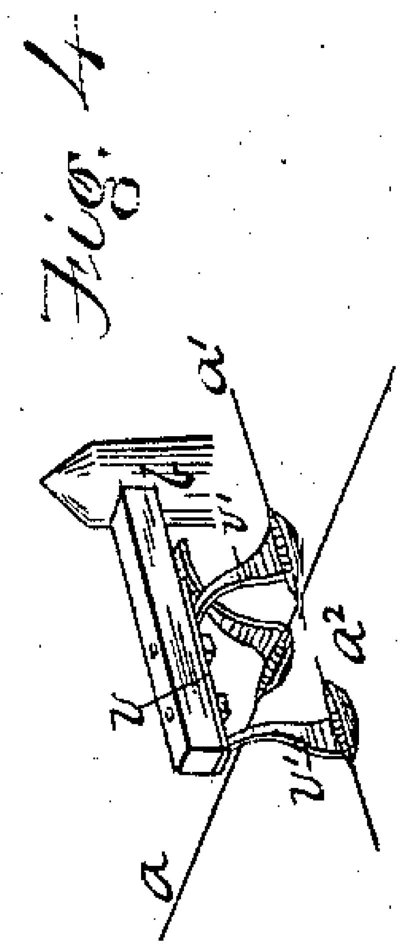

Fig. 4

Witnesses

J. W. Ritter Jr

H. B. Moulton.

Inventor

Joseph R. Finney

by his attys

Bakewell & Kerr

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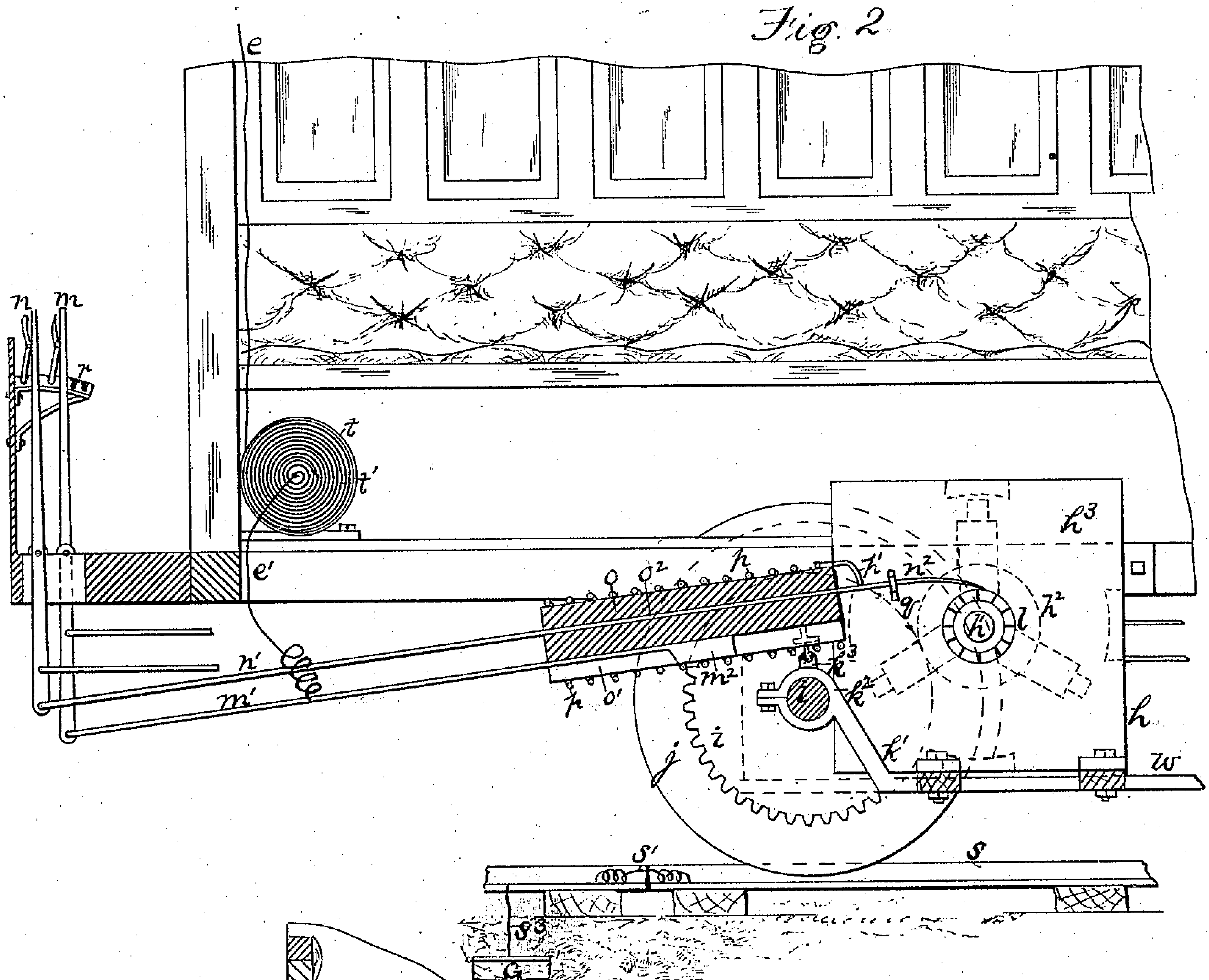
J. R. FINNEY.

PROPELLING CARS BY ELECTRICITY.

No. 285,353. Patented Sept. 18, 1883.

Fig. 2



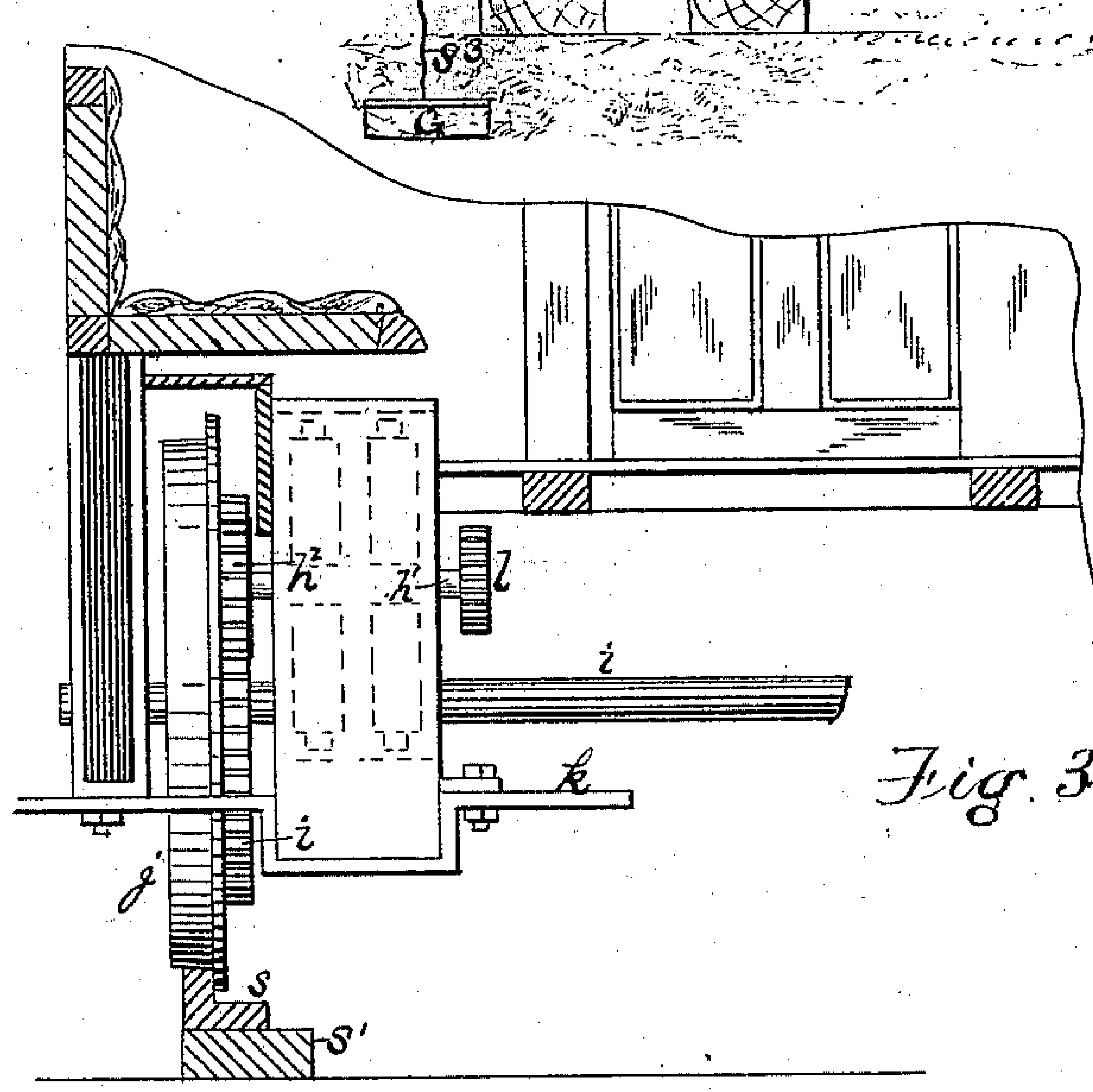


Fig. 3

Witnesses;

J. W. Ritter Jr.

H. B. Moulton

Inventor

Joseph R. Finney

by his attys

Bakewell & Kerr

N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.) 4 Sheets—Sheet 3.

J. R. FINNEY.

PROPELLING CARS BY ELECTRICITY.

No. 285,353. Patented Sept. 18, 1883.

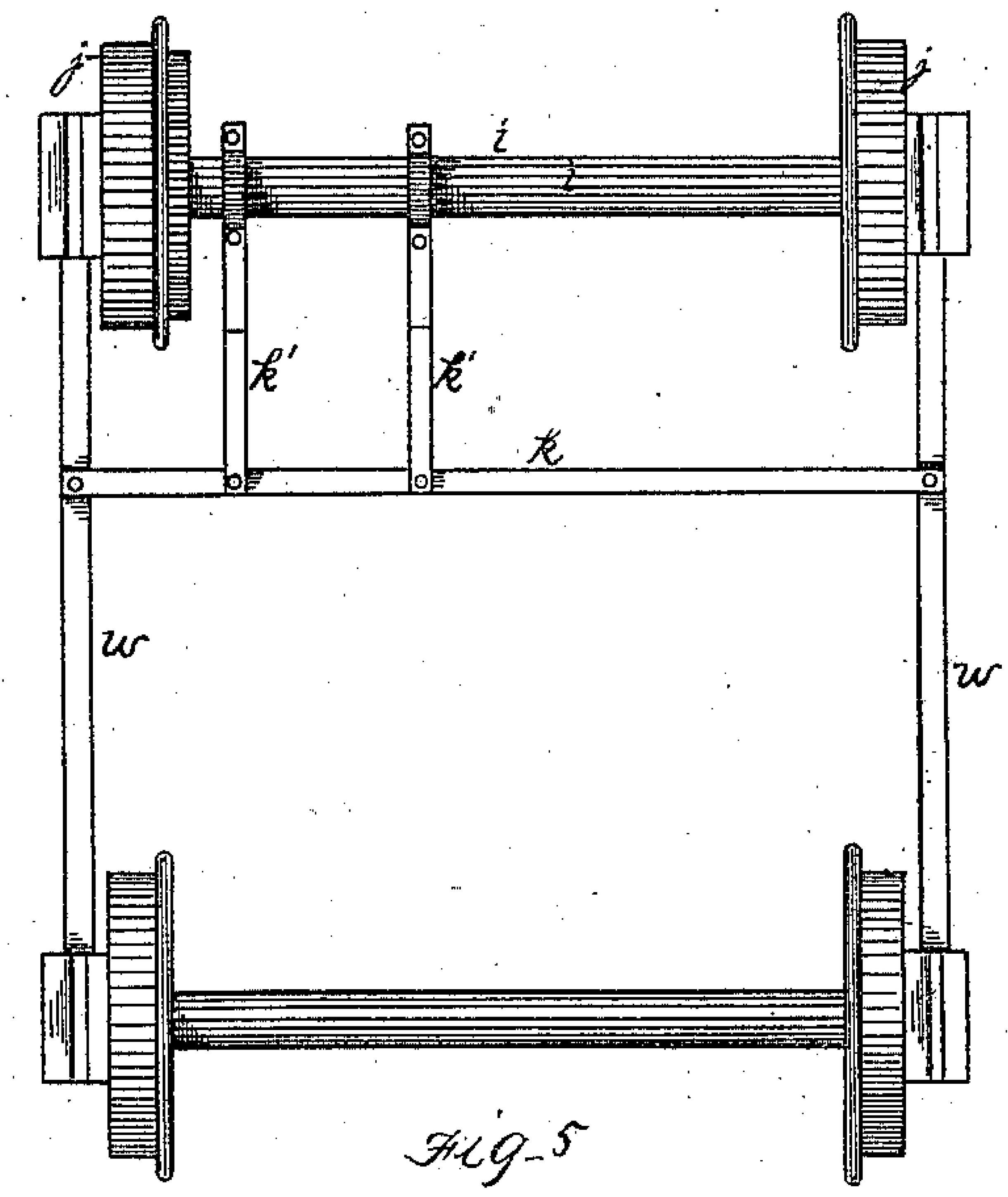


Fig. 5

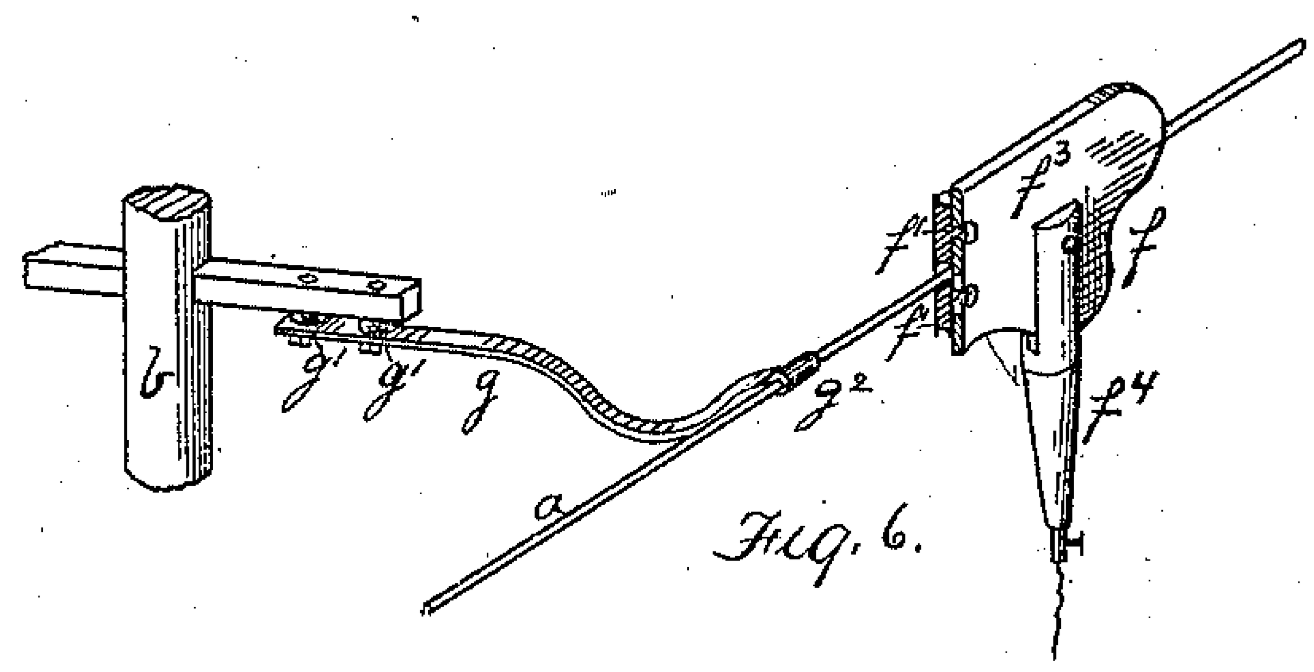


Fig. 6.

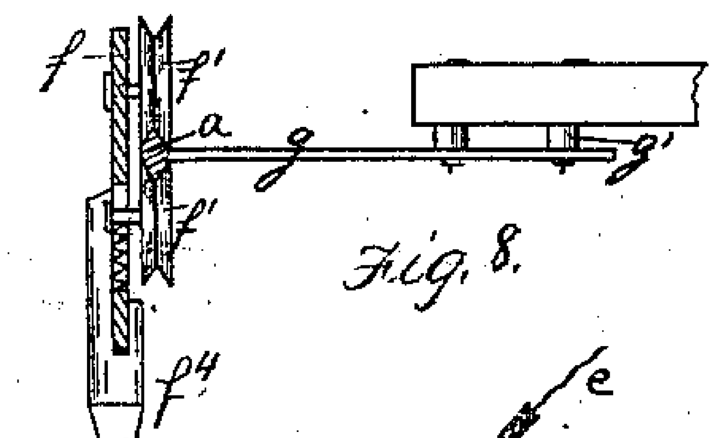


Fig. 8.

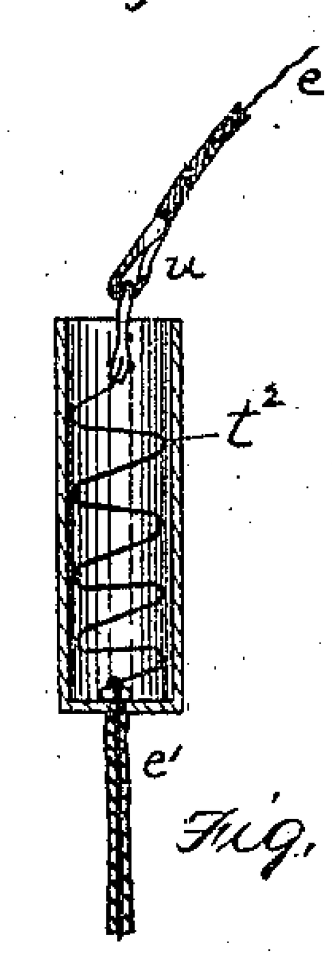


Fig. 10

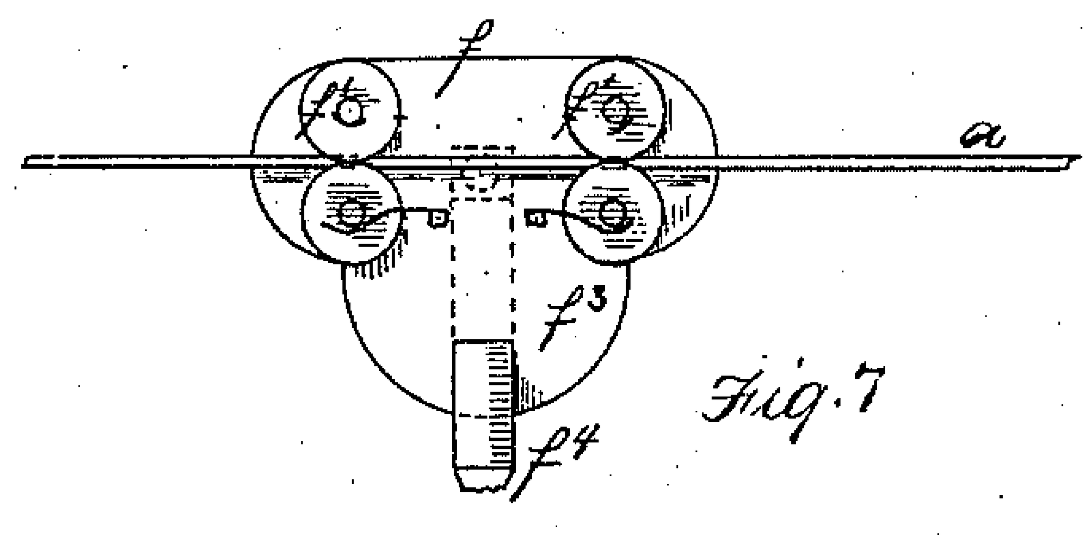


Fig. 7

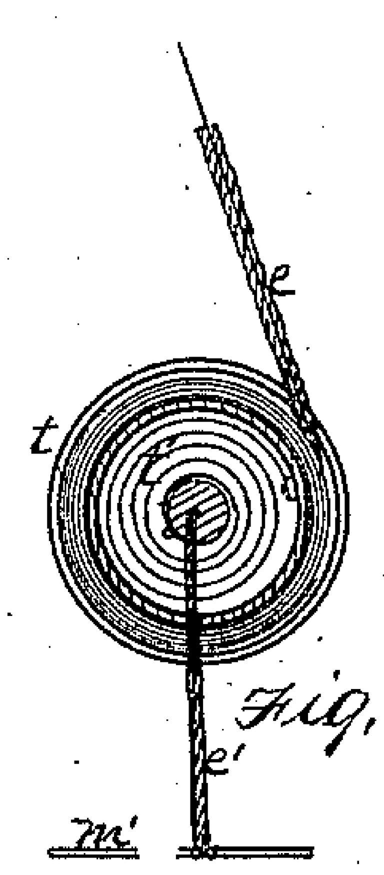


Fig. 9.

Witnesses.

R. C. Marshall

W. B. Corwin

Inventor

Joseph R. Finney
by his attys
Bakewell & Kerr

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J. R. FINNEY.

PROPELLING CARS BY ELECTRICITY.

No. 285,353. Patented Sept. 18, 1883.

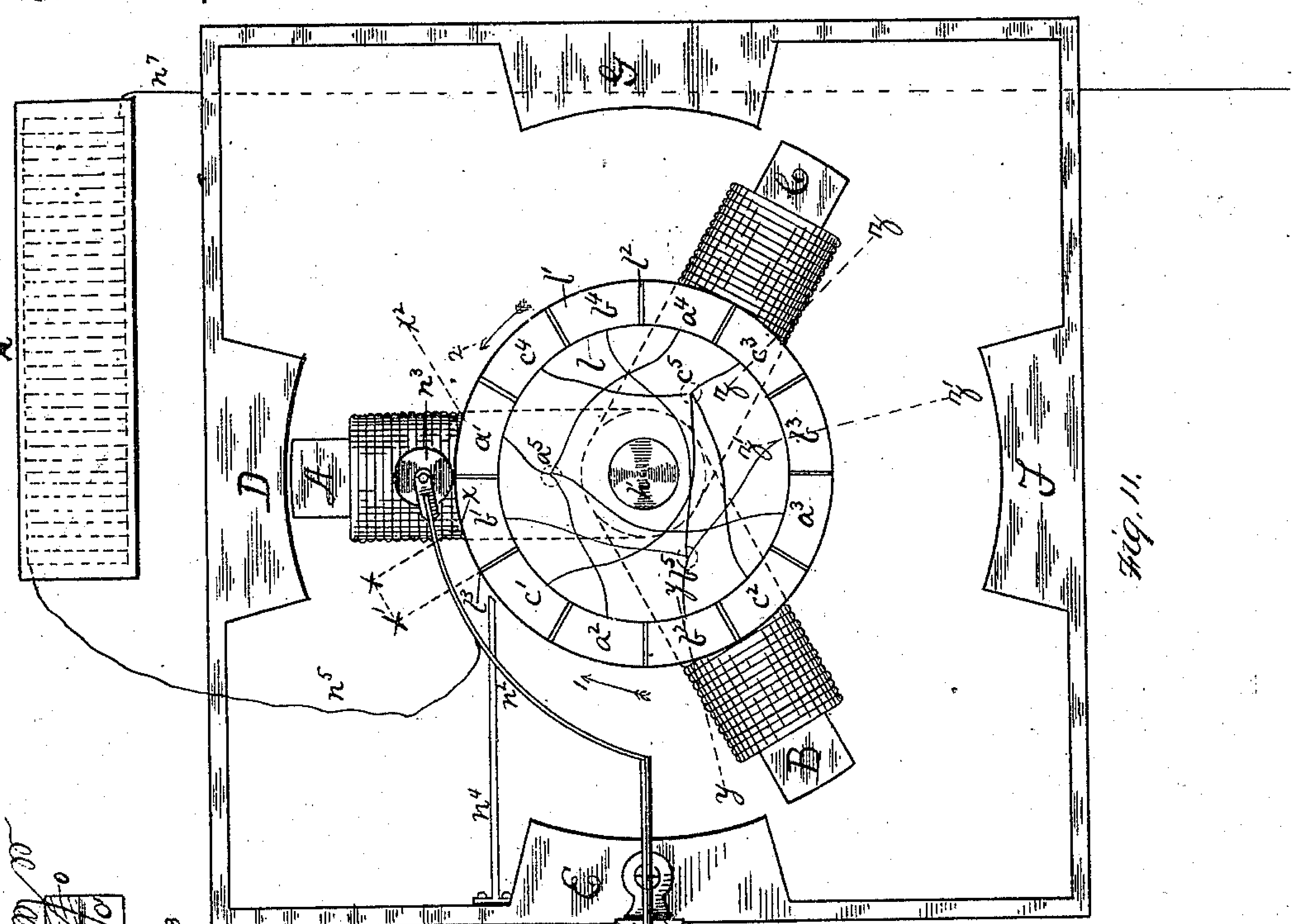
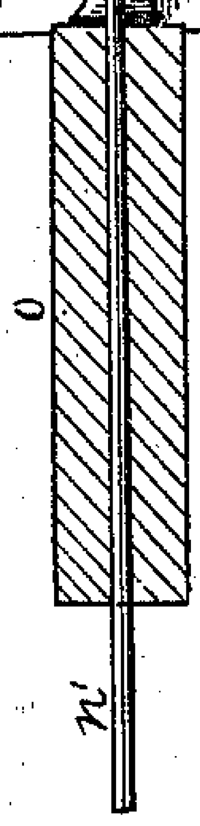


Fig. 11.



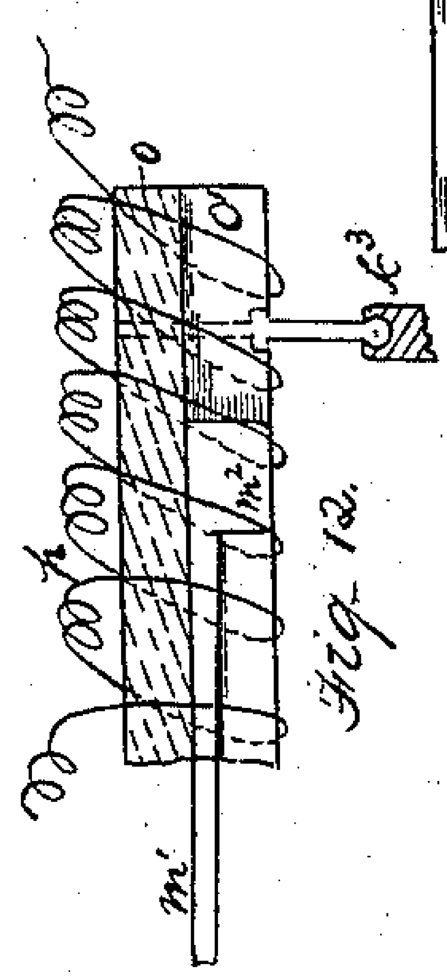


Fig. 12.

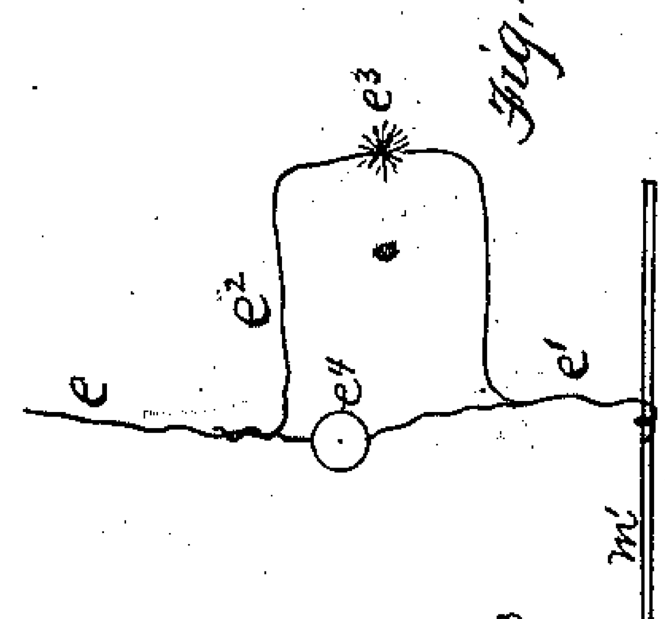
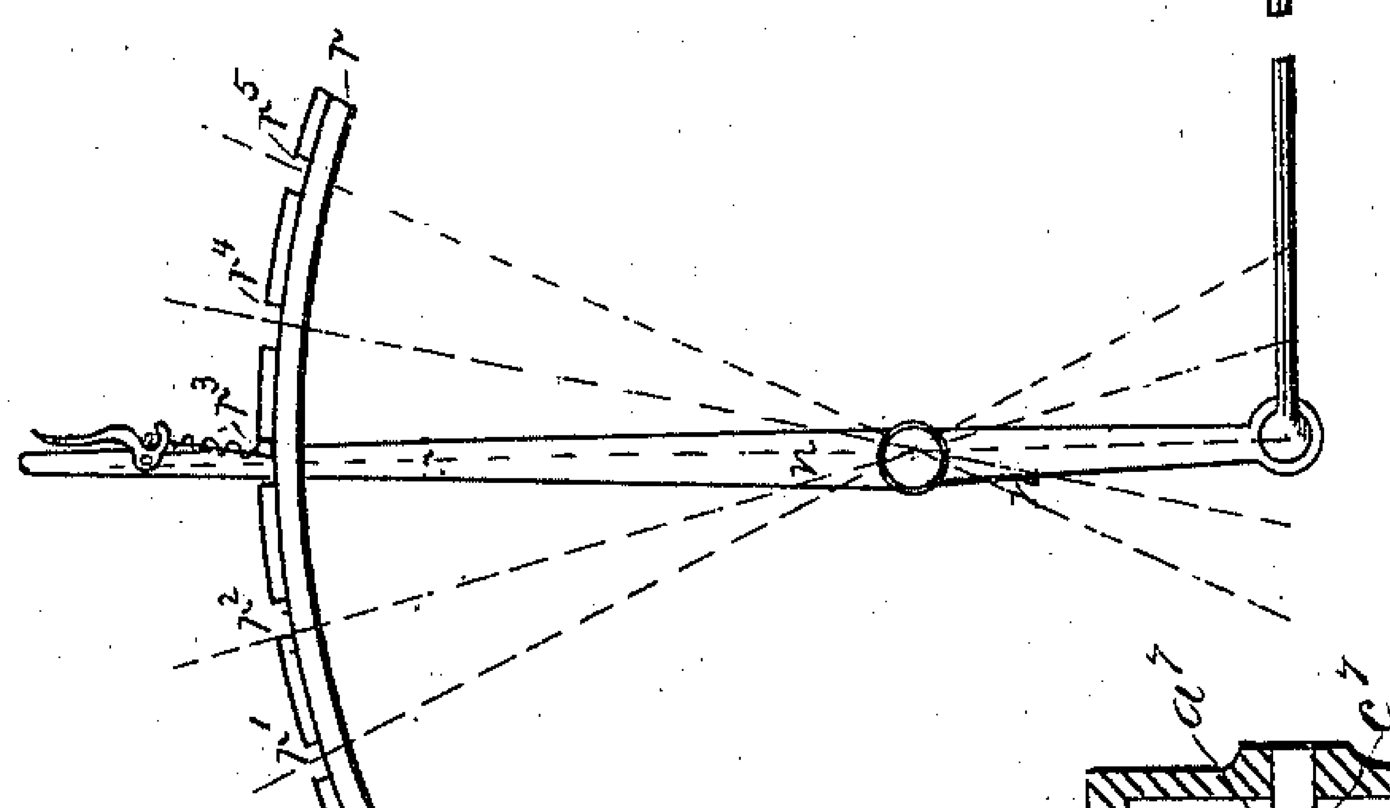


Fig. 14.



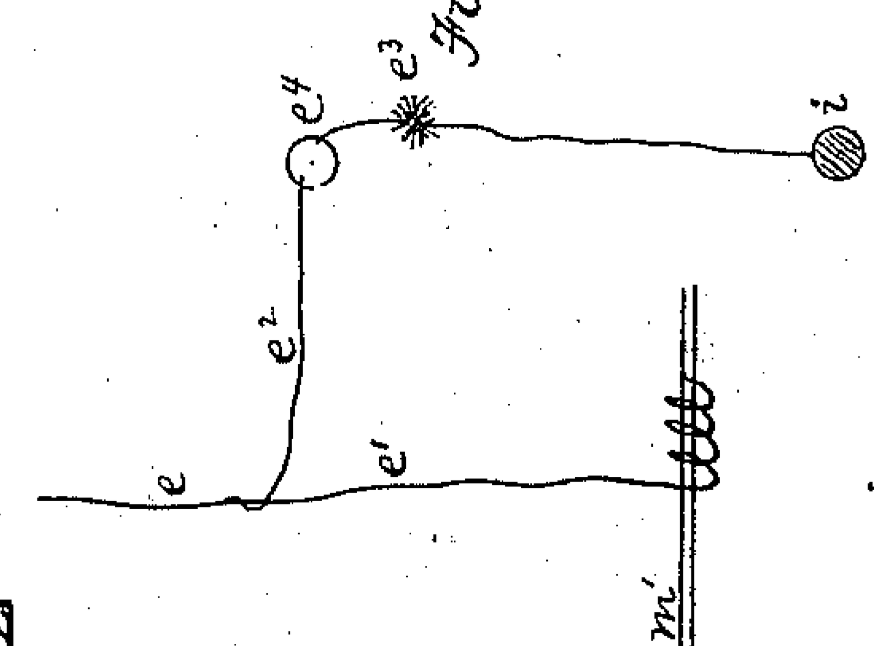


Fig. 13.

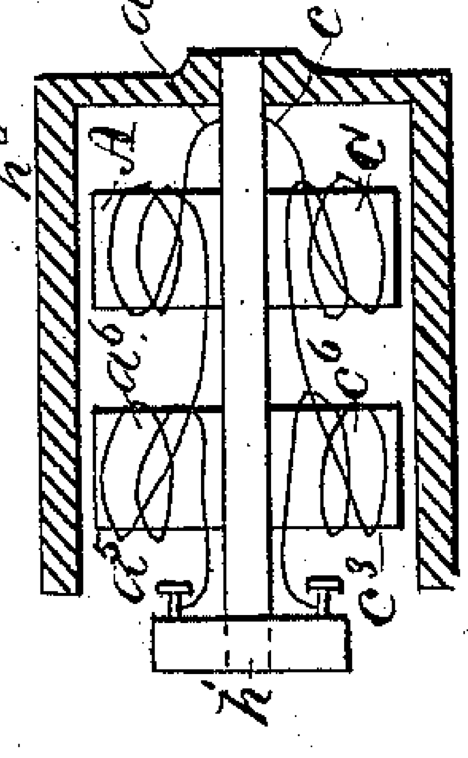


Fig. 15.

Witnesses

R. C. Wormshull

W. K. Dorwin

Inventor

Joseph R. Finney

by his attys

Bakewell & Kerr

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

JOSEPH R. FINNEY, OF PITTSBURG, ASSIGNOR TO HIMSELF AND THOMAS B. KERR, OF ALLEGHENY, PENNSYLVANIA.

PROPELLING CARS BY ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 285,353, dated September 18, 1883.

Application filed February 15, 1882. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH R. FINNEY, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Propelling Cars by Electricity; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the propulsion of railway-cars by means of an electric motor the axis of which is connected mechanically with the wheels, so as to turn the same, said motor being operated by electricity supplied thereto from a main wire or other conductor extending along the track by means of a branch wire or conductor connected to the car, having a traveling or moving contact with the said main conductor.

To enable others skilled in the art to make and use my invention, I will now describe it by reference to the accompanying drawings, in which—

Figure 1 is a perspective view of a street-car, illustrating the operation of my invention, the main conductor of electricity, the arrangement of the source of the current, and the branch conductor being also shown. Fig. 2 is a longitudinal vertical section of a part of the car, and shows the position of the motor, the reversing and brake appliances, and the attachment of the branch conductor to the car. Fig. 3 is a transverse vertical section of the car, showing the motor-sustaining and power-transmitting devices. Fig. 4 is a view of two main conductors crossing each other. Fig. 5 is a plan view of the motor-sustaining frame. Fig. 6 is a view of the bracket sustaining the main conductor, and shows the traveler of the branch conductor, partly in section. Fig. 7 is a side view of the traveler. Fig. 8 is a vertical section of the traveler, and shows another form of main conductor. Figs. 9 and 10 represent devices for taking up the slack of the branch conductor. Fig. 11 is a view of the commutator and of the brake and reversing appliances. Fig. 12 is a view of a modified form of resistance. Figs. 13 and 14 are diagrams showing how the cars may be lighted by electricity. Fig. 15 shows the connections between the binding-screws of the commutator and the coils of the magnet, and between the latter and the shaft.

Like letters of reference indicate like parts in each.

Along the side of or above the track, and as nearly as possible parallel thereto, I extend upon suitable poles, *b*, or other supports a strong wire or other shaped metallic conductor, *a*, one end of which is connected with a suitable machine or other stationary source, *c*, of electricity. The other pole of the producer is either grounded directly or extended out on poles, as shown in Fig. 1. In the latter case the current is grounded through other cars on the line. The current to operate the motor on the car *d* is conducted thereto by means of a single branch wire, *e*, which has a moving or traveling electrical contact with the main conductor, and extends to and is connected with the contact-regulator of the motor on the car. The moving contact is obtained by means of a traveler, *f*, (which is similar in construction to that described in Letters Patent No. 231,552, granted to me on August 24, 1880,) having one or two pairs of grooved metallic sheaves, f', with spring-bearings f^2, mounted on the plate f^3, for passing over the main conductor, and a pivoted socket, f^4, for the attachment of the branch wire *e*. The main conductor *a* is sustained on the poles *b* by brackets *g*, insulated from the poles or other support, as at g', and which, if desired, may be made of spring-steel to relieve the strain of the traveler when starting suddenly. At the end of the bracket *g* is an externally-smooth loop, g^2, which will receive the conductor *a*, but will afford little resistance to the passage of the traveler, which runs easily along the conductor, the sheaves parting slightly as they pass over a splice in the wire or over the loops g^2.

Mounted on the car is an electro-magnetic motor, *h*, of any known and suitable construction, the main shaft of which is mechanically connected with and drives one of the axles of the car. I prefer to use gearing, as it is more reliable than other connections and enables a better application of the power. This gearing consists, preferably, of a pinion, h^2, on the shaft h', and a gear-wheel, i', on the car-axle *i* or on the wheel j. The electromotor h is provided with a commutator, l, of the usual construction, it being a ring or collar on the shaft h', composed of segmental conductors l', insulated from each other by interposed layers of non-conducting material l^2.

The apparatus I use for governing the movements of the car is as follows: On the platform of the car are two pivoted levers, m and n. The lever m is pivotally connected to an iron rod, m', which terminates in a metallic block, m^2. The outer end of the rod m', with its metallic block m^2, extends into a longitudinal groove, o', in a wooden bar or other insulator, o, which is fastened to the frame k by a pivoted support, and extends to the motor-case h^3, opposite to the commutator l. The wooden bar o is surrounded by a coil of wire, p, which is insulated thereby from contact with the rods m' n', but not from the block m^2, which, being placed in the groove o', is in contact with one or more coils of the wire p. The branch wire e is connected to the rod m'. A hole, o^2, extends longitudinally through the bar o. The lever n is pivotally connected to an iron rod, n', which extends through the hole o^2 and through an insulated guide, q, placed on the end of the motor-case h^3, and terminates in a commutator-spring, n^2. The end p' of the wire p is placed in contact with the rod n' at the rear end of the bar o. The lever n is capable of several fixed positions. A rack, r, is provided on the platform, having five notches, r' r^2 r^3 r^4 r^5. The lever n can be placed in any one of the notches at pleasure. The commutator-spring n^2 can thereby be caused to assume five positions—two at either side of a vertical plane bisecting the center of the armature D in contact with the commutator, and the one entirely beyond and out of contact with the commutator. The first two positions will cause the car to go forward, the second two positions will cause the car to go backward, and the fifth will open the circuit and cause the car to come to a stop. I regulate the force of the current by means of the lever m. The coil p is a resistance. The greater the distance the current has to pass over it the less will be its force. The current passes from the branch e by the rod m', block m^2, wire p, and spring n^2 to the commutator.

Fig. 15 is a diagram which shows the electrical connections of the binding-screws a^5 b^5 c^5 with the coils of the magnets A B C, and of the latter with the shaft h'. In this view one of the magnets has been omitted for greater clearness of illustration. The wire a^6 extends from the binding-post a^5 around the cores of the magnet A, and is then connected to the shaft h' at a^7. The wire c^6 extends from the binding-post c^5 around the cores of the magnet C, and is fastened to the shaft h' at c^7. The connections of the magnet B are made in a similar manner. The shaft h' is in electrical connection with the metallic case h^3 at its bearings therein. The current passes from the commutator over the motor-coils to the shaft h', thence by case l^3 and metallic frame w to the car-axle i, and thence by the car-wheel j to the rails, thus making a ground or return current; or the current may pass from the motor-shaft through the gearing to the car-axle, and thence by the car-wheel to the rails. To insure a more perfect ground-connection, the rails being placed in wooden stringers s', the ends of adjoining rails may be connected by a wire, s^2, completing the circuit to the other pole of the generator; or, if desired, a ground-wire, s^3, may be used.

To provide for unequal distances between the track and the main conductor a, I make use of a device described in my said Patent No. 231,552, which consists of a hollow spool, t, the axle of which is metallic, and is set on insulated standards. Inside of the spool is a coiled spring, t'. The branch wire e is wound around the spool to allow for any variation of distance between the main conductor a and the car. The inner end of the wire e is connected with the metallic axle of the spool, and from one extremity of the axle a wire, e', which is merely the continuation of the wire e, extends to the rod m'. The coiled spring t' keeps the wire e always taut, but allows of its extension by unwinding it from the spool when the car is removed farther from the conductor a. Instead of the spring-spool t, I can use a strong spiral, waved, or similar spring, t^2, of sufficient extensibility to accommodate the unequal distances between the main conductor and the track. The branch wire e is covered with gutta-percha or other similar coating, so as to permit the attendants of the car to couple it to and uncouple it from the car with safety. It is provided with a snap or other similar coupling, u, so as to be easily detachable from the car at pleasure. This coupling may be made at the spool t. It is useful in changing the cars or shifting them to another track. In many cases double tracks are used, and it then will be desirable to have a main conductor a on each side of the way, and separate travelers for the same car when going in opposite directions. When a single track is used and cars are required to pass each other at switches, the branch conductors may be detached and transferred to the other car, and thus permit the cars to proceed without providing switches for the travelers to pass each other.

In case of two lines of track crossing each other at an angle, I have provided the following means of permitting the branch wire to pass the crossing main conductor without detachment: In Fig. 4 the main conductor a is continuous; but the crossing main conductor a' is cut, as at a^2, for the passage of the branch wire e. The conductor a is placed sufficiently above the line of a' to permit the passage under it of the traveler f on the conductor a' without interference. The ends of the divided conductor a' are electrically connected by the insulated plate v and brackets v' v'. The traveler used on the conductor a' has a long enough frame f^3 to enable it to bridge over the cut a^2 and pass it without falling through. The brackets v' v' support the cut ends of the conductor a'.

To provide for a constant and reliable power-connection between the motor-shaft h' and the axle or wheels of the car, I have placed the electromotor h on a frame-work or support, k, which rests upon the axle-bars w, instead of placing it on the body of the car, where it would be affected by the action of the springs of the car. In the latter case, the springing of the body of the car would tend to raise the teeth of the pinion h^2 either entirely out of those of the gear-wheel i' or to such an extent as to interfere seriously with the operation of the propelling devices. In case a belt or chain is used, instead of gearing, to transmit the power from the motor-shaft, the necessity of an invariable distance between the motor-shaft and the car-axle is equally apparent, as it is clear that for driving purposes such a belt must be taut, and that any increase or decrease of distance, caused by the action of the heavy car-body on the springs, would be destructive of the belt or of its ability to drive the car-axle.

The motor-supporting frame is composed of the cross-bar k, which extends between and rests upon the axle-bars w, and two or more angle-bars, k', one end of which rests upon the bar k and the other upon the axle i, being provided with bearings k^2. Extending up from the bearing k^2 is a standard, k^3, having a ball-and-socket or other pivotal joint at its upper end for supporting the insulating-bar o, which, being subjected by the attachment of the bars m n to the platform to the spring action of the car, requires to be pivoted so that the commutator-spring n^2 may always be in contact with the commutator.

I propose to place my source of power e at the middle of the line, or, in case the line is of sufficient length to require more than one source of power for its proper and economical operation, in the middle of a section of the same. Then, instead of connecting the negative pole of the machine or battery e directly to the ground, as is customary, I run the negative wire $-e$ out on poles b to one end of the line or section. At a point, c^2, between the junctions of the positive wire $+e$ and the negative wire $-e$ with the main conductor c, I place an insulator, which prevents the short-circuiting of the currents.

I will now explain how I regulate the speed and reverse the direction of the car. I have arranged the commutator spring or springs so that I am able not only to start, stop, and reverse the car, but also by the same mechanism by which I effect these operations to vary its speed without increasing or diminishing the current of electricity. To the clearer explanation of these devices and their operations, it is necessary to make a short explanation of the electrical connections of the commutator to the magnets of the motor.

Referring now to Fig. 11, the commutator l is composed of twelve segmental conductors, a' a^2 a^3 a^4, b' b^2 b^3 b^4, and c' c^2 c^3 c^4, which are insulated from each other and from the body of the commutator-wheel by a suitable non-conductor. These segments are electrically connected by suitable wires with the electro-magnets A B C of the motor. The wires from a' a^2 a^3 a^4 all lead to the contact-screw a^5, those from b' b^2 b^3 b^4 to b^5, and those from c', c^2, c^3, and c^4 to c^5. A single wire from the contact-screws a^5, b^5, and c^5 leads, respectively, to each of the magnets A B C, being connected to the coil of the same. The circuit being closed by putting the commutator-spring n^2 against one of the a segments, the current passes by its wire to the magnet A and causes its attraction by the nearest armature. This produces a rotation of the motor. The attraction of the magnet to the armature increases as it approaches it, and is greatest when the axles of the two coincide. At this point the turning of the commutator causes the spring to pass from the a segment to one of the b segments. The current then passes to the magnet B, which is then the nearest magnet to an armature, and acts through it in the manner just described in relation to magnet A. Now, it will be evident that if the commutator-spring is adjusted so as to leave the segments before the point of greatest power of attraction of the magnets is reached, and the current is thereby cut off from the magnets, the speed and power of the motor will be correspondingly diminished. It is by such an adjustment of the commutator-spring that I am enabled to increase or decrease the speed of the car without changing the force of the current supplied to the motor.

The commutator-spring n^2, provided with a friction-roller, n^3, is placed on the end of a sliding bar, n', which is operated by a pivoted lever, n, on the platform of the car. The lever n is fitted into a rack, r, having five notches, r' r^2 r^3 r^4 r^5. When the lever n is placed in the notch r^3, the contact of the spring n^2 is directly opposite to the middle of the armature D. As shown, Fig. 11, the lever is in the r^3 notch, and the circuit has just closed with the magnet B by the entering of the roller n^3 on the end of segment b'. The distance the magnet B has to move in order that its axis shall coincide with the axis of armature E', if taken on the same circle as the periphery of the commutator, is exactly equal to the length of segment b', and consequently the circuit will not be opened by the roller n^3 passing from the segment b' until the point of greatest attraction is reached and the current is utilized to its greatest extent. The notch r^3, then, is the one in which the lever n should rest to give the motor its greatest speed and power with a given current when turning in the direction of arrow 1. By shifting the lever to notch r', the roller n^3 is brought into contact with segment c^4, which closes the circuit with magnet C. The magnet C, being nearest to armature G, is attracted thereto and turns the motor in the direction of arrow 2, or the reverse of the first direction and at full power. The notch r', then, is the one in which the lever n should rest to reverse the motor. By shifting the lever n to the r^4 notch, the roller is brought into contact with the segment at such a point that it will pass over into the next segment before the magnet reaches the point of greatest attraction, and hence the motor will lose in power and velocity to the extent of such premature opening of the circuit. To illustrate, refer to Fig. 11 and take segment b' and magnet B, used in the first illustration. Placing the lever n in the notch r^4 brings the roller n^3 in contact with the commutator at the point x in the segment b'. This closes the circuit to the magnet B. The circuit will continue closed until the turning of the commutator brings the insulator l^3 to the roller n^3, and then it is opened and the current ceases to act on the magnet B. While the distance $x\ x'$ was covered by the roller n^3, the magnet B advanced to the broken line $y\ y$, the circuit opening before it had reached the point of greatest attraction. The circuit is closed to magnet C by the segment c' coming under the roller n^3, and will continue so closed while the roller passes the entire length of the segment c'. During this time the magnet C is being acted upon by the current, and its center will pass from broken line $z\ z$ to broken line $z'\ z'$. When the circuit is opened by the roller n^3 passing from segment c' to segment a^2, the point of greatest attraction has not been reached, and consequently there is a loss of power and velocity. This operation is repeated at the passing of every segment. The magnets are in circuit only when farthest from their armatures and at the points of least attraction. Thus the notch r^4 is to be used when it is desired to run forward slowly. The same operation is had when the lever is placed in the notch r^2, except that the direction of the rotation is reversed. Placing the lever n in the notch r^2 puts the roller n^3 in contact with the commutator at the point x^2. This causes the motor to run backward at reduced power and velocity. Putting the lever n in the notch r^5 causes the roller n^3 to be thrown out of contact with and away from the commutator and opens the circuit.

The devices just described require no skill on the part of the operator, as all he has to do is to move the lever n, and it may be safely left to the average car-driver. In case the power obtained at the notches r^2 and r^4 is insufficient to start the car, it may be done by placing the lever n for an instant in the notch r' or r^3, and then shifting it into the desired halfway notch r^2 or r^3. A further regulation of the speed and power of the car may be made by increasing the number of the intermediate notches and shifting the lever accordingly. In case the leak permitted to pass to the motor by the resistance p is not sufficient to propel the car uphill or when heavily laden, the amount of the current can be increased by reducing the resistance by moving the contact-block m^2 toward the motor. This will have the effect of reducing the amount of the current obtained by other cars on the line, there being a given quantity supplied to the main conductor; but this excess of current is not constant, because when the necessity is past, as when the ascent has been made or the load reduced, the attendant of the car, by increasing the resistance, reduces the leak to its normal volume.

In case it is desired to light the car by electricity, I do it, as shown in Fig. 13, by means of a leak-wire, e^4, which is electrically connected to the branch wire e, and runs thence to the axle i. A lamp, e^3, of any desired construction, is placed in the circuit, and adjustable resistance e^4 is placed either above or below the lamp to regulate the size of the leak.

In Fig. 14 I show the light e^3 arranged in a shunt, with a resistance, e^4, on the wire e, of sufficient power to deflect the required portion of the current to make the light. In like manner any desired number of lamps may be placed in the car or in the train. In the latter case the wire e' shall act as a main wire, and leak-wires e^2, containing the lights e^3 and a resistance, e^4, will be run off from it to ground or to a return-wire, as illustrated in Figs. 13 and 14.

The form of the resistance p may be varied at pleasure. In Fig. 12 I have shown a form which is more effective and desirable than that shown in Fig. 2.

If it is desired, in the operation of a train of cars, to have a separate motor to each car, it can be done by extending the wire e along through the train and running a branch or leak wire down from it to the motor in each car. Thus the current would be further divided.

To insure the certain withdrawal of the contact-roller n^3 from the commutator l, I have provided a stripper, n^4, which is a flat metallic conductor fastened to but insulated from the motor-case, and extending nearly to the commutator and just under the path of the roller n^3. Then when the roller n^3 is drawn back by the shifting of the lever n to notch r^5, it will encounter and leave the commutator upon the upper surface of the stripper n^4.

In order to store for utilization the electricity passing over the conductor e when the car is stopping, which electricity is in excess of the amount supplied to and not needed by other cars on the line, I extend a conductor, n^5, from the commutator-spring n^2 to an accumulator or secondary battery, n^6, of the ordinary construction, where it is stored. This battery has a ground-wire, n^7, which leads to the motor-frame w, and grounds the battery n^6 through the frame, axle i, and wheel j. When the contact-roller n^3 is restored to contact with the commutator l, the current in the battery n^6 flows back over the wire n^5 into the commutator and operates in connection with the current from the conductor e, the resistance of the motor being less than that of the battery n^6. When contact-roller n^3 is passing over the insulating-strips l^2 of the commutator, the current is diverted to the secondary battery over the wire n^5, so that the secondary battery is alternately receiving and discharging.

In Fig. 8 I have shown a main conductor a, of diamond-shaped bar or strip of metal, of sufficient stiffness to sustain the pull of the traveler in passing around curves or in making a semicircular turn at the end of the line or track, in order to pass onto the return-conductor. A main conductor of wire will not retain a circular shape, and hence a metallic rod of suitable shape is employed.

Heretofore, in electric railways, either an insulated rail or a wire arranged near the surface of the track has been employed as the main conductor. However well these may answer for elevated, underground, or inclosed railways, they are not adapted for use upon surface tracks crossing roads and streets, and for street-railways, because of the danger to life in crossing the conductors, and the difficulty of preserving the insulation in slushy and muddy streets. These objections, which practically destroy their utility, do not exist in my invention, in which the main conductor is placed overhead, so as not to interfere with street traffic and to render it impossible for accidents to arise. The cost of operating such a line will be less, as the insulation can be perfectly preserved, and leakage is impossible.

I do not herein claim the combination of a secondary battery with a motor and primary battery or generator, as I reserve the same for a separate application.

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

1. The combination, in an electric railway, of a battery or other generator of electricity, an overhead main conductor, a branch conductor connected to a car, and having a traveling contact with the main conductor, an electromotor mounted on the car and power-transmitting devices connecting the motor-shaft to the wheel or axle of the car, substantially as and for the purpose specified.

2. In combination with a car-motor operated by a leak or branch circuit from a main circuit, an adjustable resistance placed in said branch circuit and regulated by a lever or equivalent device placed on the platform or other accessible part of the car, substantially as and for the purposes described.

3. The combination of an electric generator, an overhead main conductor, a branch conductor having traveling contact with the main conductor, a resistance, a car, an electromotor mounted on the car, and power-transmitting devices which connect the motor-shaft with the wheel or axle of the car, substantially as as and for the purpose specified.

4. The combination, with a commutator, of a movable commutator-spring and a stripper to lift the commutator-spring from contact with the commutator, substantially as and for the purpose specified.

5. The combination of a continuous main conductor, having a traveling branch conductor, with a crossing main conductor cut to permit the passage of the said traveling conductor, and having an electrical connection between the cut ends around the first-named main conductor, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 19th day of January, A. D. 1882.

JOSEPH R. FINNEY.

Witnesses:
JOHN S. KENNEDY,
T. B. KERR.