No. 606,991. Patented July 5, 1898.

J. C. HENRY.

ELECTRIC RAILWAY.

(Application filed Apr. 25, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

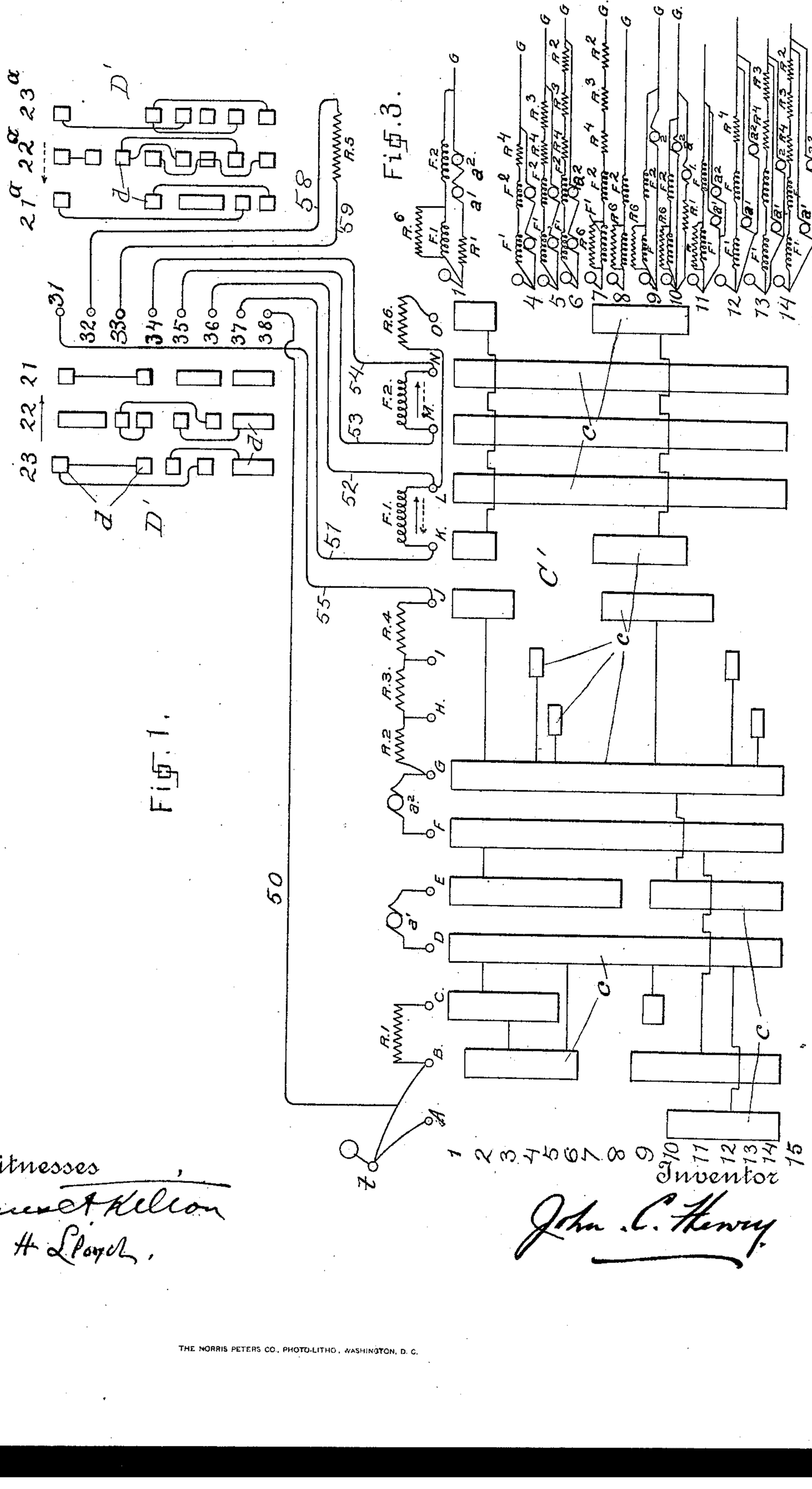

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Fig. 4.

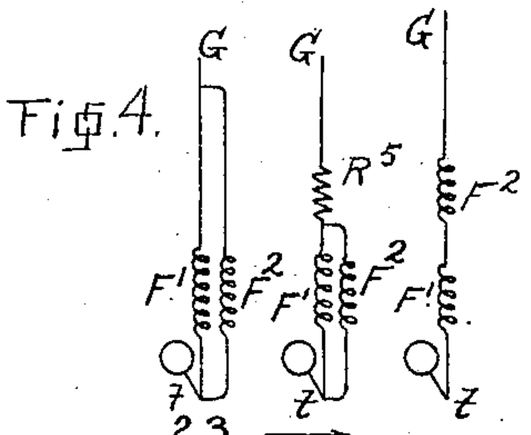


Fig. 5.

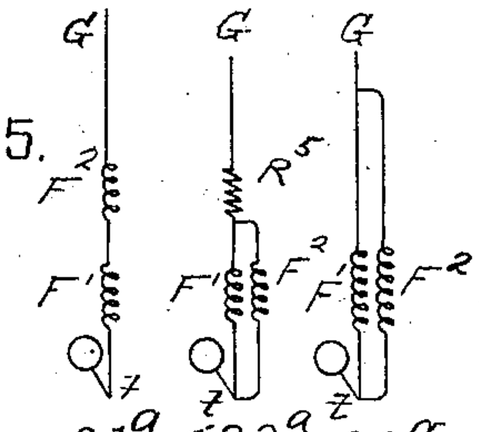


Fig. 2.

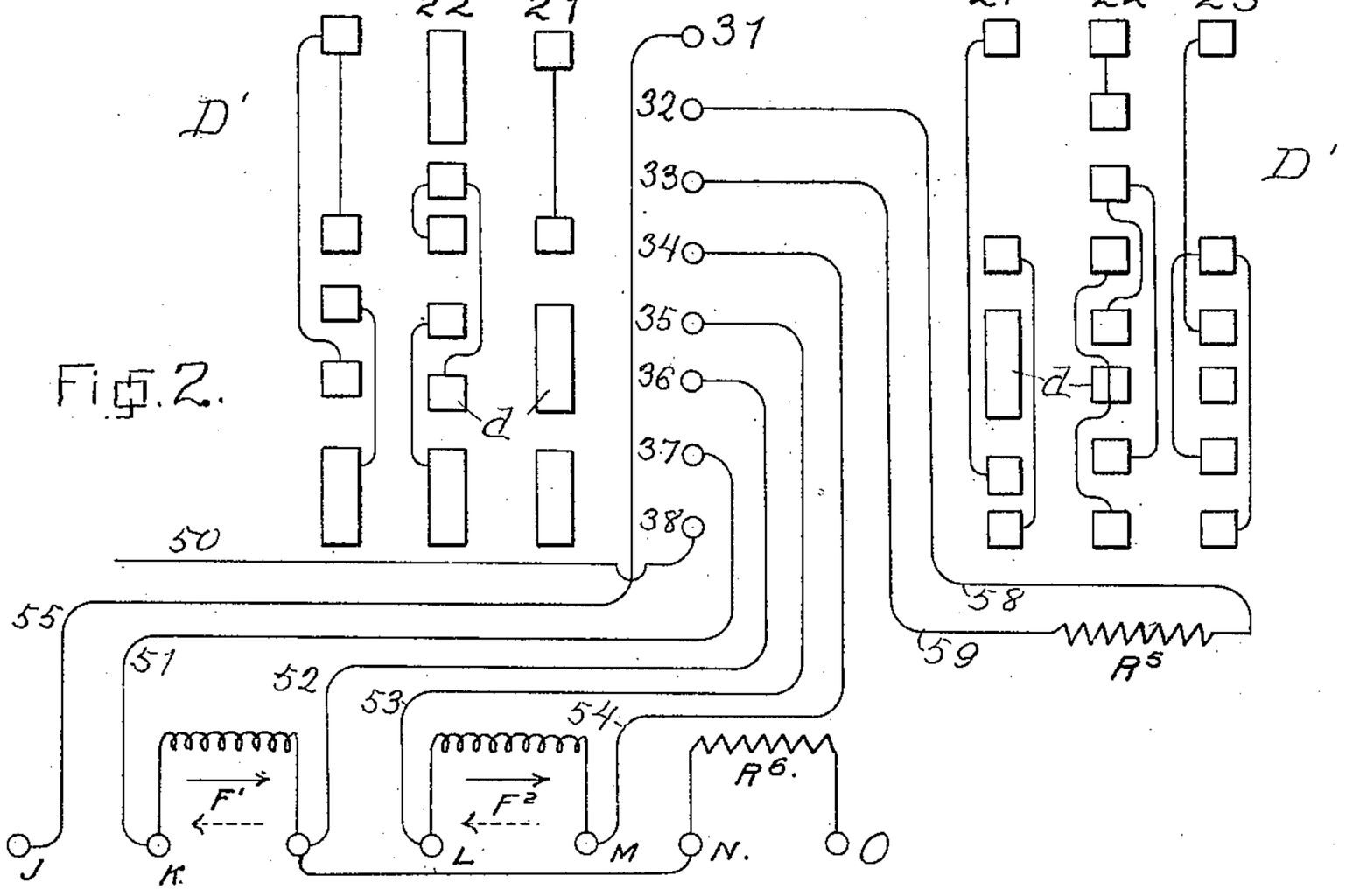


Fig. 6.

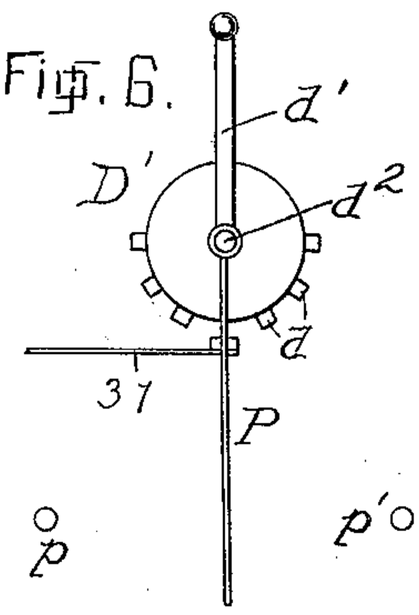


Fig. 7.

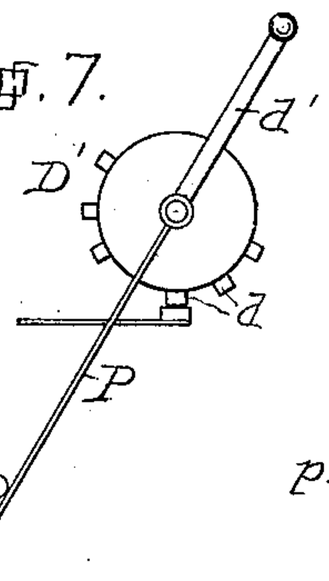


Fig. 8.

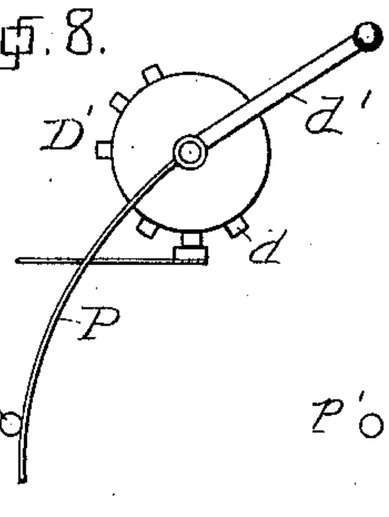
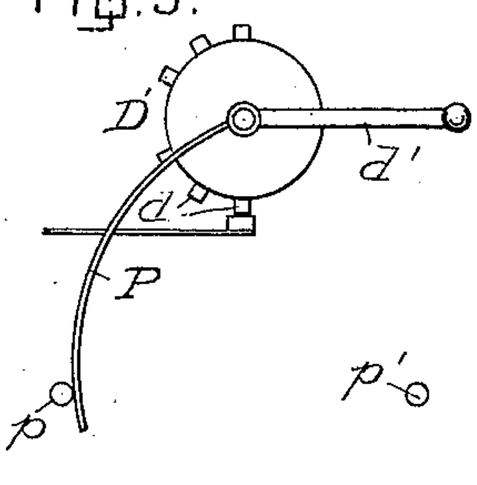


Fig. 9.



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UNITED STATES PATENT OFFICE.

JOHN C. HENRY, OF DENVER, COLORADO.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 606,991, dated July 5, 1898.

Application filed April 25, 1898. Serial No. 678,750. (No model.)

To all whom it may concern:

Be it known that I, JOHN C. HENRY, a citizen of the United States, residing at Denver, county of Arapahoe, State of Colorado, have invented certain new and useful Improvements in Electric Railways, of which the following is a specification.

This invention relates to improvements in electric railways; and its object is to provide means for changing the armatures of a two-motor car equipment from series to parallel relation without excessive changes or fluctuations of current strength, to provide means for throwing the armatures or electromotive devices temporarily out of action at any desired point or at more than one point in the operation of the controller, and to provide means for largely increasing the strength of the field-magnets in certain emergencies.

My invention is particularly intended for use in connection with a system wherein the armatures and field-magnets are energized by independent circuits—that is, are separately excited—although some of its features are not limited to such a system.

In changing the motors from series to parallel I arrange to break the armature-circuit at a time when the fields are weak and to connect them in parallel while the fields are strong, and in thus connecting them in parallel I prefer to connect them one at a time across the circuit and to use some means to check the current in the one which is connected later, as by inserting resistance in its circuit or by superenergizing its field-magnet. This last may be effected, in systems wherein the field-magnets are connected in series in an independent circuit, by shunting the other field-magnet with a resistance, so as to enable more current to flow to the non-shunted field-magnet. The armatures, however, may be connected to the circuit simultaneously through a resistance or resistances.

In some emergencies it is desirable to strongly increase the power of the field-magnets, so as to meet unusual conditions, as in pushing a disabled car up a short heavy grade or when an emergency stop is to be made. For this purpose I provide a switch independent of the controller whereby the field-magnets may be changed from series to parallel relation, thus largely increasing the field strength. In view of the desirability of bringing this switch into action in emergency stops I prefer to associate it with the usual reversing-switch. Means are preferably provided for making this change gradually by the insertion and withdrawal of resistances, and I also prefer to provide means for automatically returning the aforesaid switch to a position putting the field-magnets in series as soon as the handle is released.

With controllers now in use it is necessary when it is desired to break the circuit to move the controller back all of the way to the starting-point. In some cases, as in coasting down a grade, it may be desirable to break the circuit at an intermediate point of the controller or even at the highest-speed point, so that when connection is again established the motor may continue to operate under the same accelerating influences as before. I therefore arrange at any appropriate point in the controller—as, for example, between the series and parallel positions—to break the connections of the armature-circuit or the circuit of the electromotive devices, it being understood that this feature of my invention is applicable as well to the usual series-wound motors as to the separately-excited motors, to which it is herein applied. I may also arrange to similarly break the circuit of the electromotive devices at or about the highest-speed position of the controller.

In the accompanying drawings, which form a part of this specification, Figure 1 is a diagram showing the controller and the reversing-switch and field-magnet-circuit changer in development and their connections with the motors and operating-circuits. Fig. 2 is a similar diagram of the reversing-switch and field-magnet-circuit changer. Figs. 3, 4, and 5 are diagrams showing the circuit connections established by the controlling devices in the successive positions which are respectively in line with the several diagrams. Figs. 6 to 9 are top views of the reverser and field-magnet-circuit changer, showing different positions thereof, with special reference to the automatic return device for same.

The controller C′ comprises contacts *c*, which are mounted on a cylinder and operated in the usual manner to control the motor-circuits.

a' and a^2 are the armatures of two motors of a car equipment, and F' F^2 are the corresponding field-magnets.

A B C D E F G H I J K L M N O represent fixed terminals engaging with the contacts *c* of the controller and connected with the said armatures and field-magnets with resistances R' R^2 R^3 R^4 R^6 and with line connection or trolley *t* and ground connection G in the manner indicated.

D' represents the reverser and field-magnet-circuit changer, having movable contacts *d*, which may be mounted in the usual manner on a cylinder, as indicated in Fig. 6, and fixed contacts 31 32 33 34 35 36, which are connected to the field-magnets to line and to resistance R^5 in the manner indicated.

In the positions of the controller and reverser shown in Fig. 1 the circuits are all broken and there is no current flowing. By turning the reverser to the line of contact indicated at 21 in Figs. 1 and 2 the field-magnet circuit is closed. This circuit leads from line connection *t* through wire 50 to contact 38, through the reverser to contact 37, by wire 51 to field-magnet F', thence through wire 52 to contact 36, through the reverser to contact 35, through wire 53 to magnet F^2, and thence through wire 54 to contact 34, through the reverser to contact 31, and through wire 55 to contact J, whence connection exists through resistances R^4 R^5 R^2 to ground-contact G of the controller. If now the controller be turned to position 1, the resistances R^2 R^3 R^4 are short-circuited and at the same time the armature-circuit is closed from line connection *t*, wire 56, resistance R', contact C, through the controller to contact D, through armature a' to contact E, through the controller to contact F, and through armature a^2 to ground-contact G.

I prefer to simultaneously shunt one of the field-magnets, as F', by resistance R^6, connected to contacts L and O, engaging with interconnected contacts on the controller. This position of the controller is the normal starting position. To increase the acceleration, the controller is turned to position 2, which short-circuits resistance R' from the armature-circuit, and then to position 3, which breaks the shunt around the field-magnet F'. Positions 4, 5, and 6 successively insert resistances R^4 R^3 R^2 in the field-magnet circuit. The field-magnets are now extremely weak, giving a very high accelerative effect. The next change to position 7 breaks the armature-circuit and may, as shown, also close a shunt, including resistance R^6, around magnet F', as before. The next position 8 strongly increases the field magnetization by cutting out resistances R^4 R^3 R^2 from the field-magnet circuit directly across the supply-circuit—that is to say, between line and ground. In position 9 armature 2 is connected across the mains under the strong field F^2. Position 10 connects the other armature a', preferably inserting a resistance R' in its circuit, and position 11 cuts out this resistance. By these operations the circuit of the armatures is broken while the magnetic fields are weak and closed while such fields are strong, and this results in a graduation of the change from series to parallel, the inclusion of the resistance in the armature-circuit having a further effect in the same direction. The succeeding positions 12, 13, and 14 successively break the shunt around field-magnet F' and cut in increasing amounts of resistances in the field-magnet circuit, thus further accelerating the motors.

It will be noted that in positions 7 and 8 between the series and parallel positions the circuit through both the armatures is broken. The object of this was stated above, and for a similar reason a breaking position 15 may be provided after the last or maximum acceleration position. In this position 15 the circuit of all the armatures and field-magnets is broken. In either case, however, the circuit is broken in such a manner as to put the motor out of action and allow the car to run without either accelerating or retarding effect from the motors. My invention in this connection covers the breaking of the electromotive circuit of the car at a point or points other than the usual starting-point, irrespective of whether the circuit of the armature alone or of the whole motor is broken.

The reversing device D' was described as being turned to position 21, placing the field-magnets in series. Fig. 2 shows more clearly, in connection with Figs. 4 and 5, the operation of this field-magnet reverser and circuit-changer. Position 22 places the field-magnets F' F^2 in parallel with one another, the circuit from both of same to ground, however, including the resistance R^5, which is connected to contacts 32 33 by wires 58 59. The extreme position 23 of the reverser connects the field-magnets directly across between line and ground without extra resistance. The effect of these changes is to enormously increase the field magnetization, with the results above specified, this effect being rendered somewhat gradual by the intermediate resistance-step 22. For reversing the motors the controller is turned in the other direction and positions 21^a 22^a 23^a produce circuit conditions corresponding to 21 22 23, except that the direction of current through the field magnets is reversed.

Figs. 6 to 9 show the automatic return mechanism for the reverser. The handle *d'* of the reverser or the shaft d^2 thereof has a flat spring-arm P fixed thereto, and said arm is capable of engaging with pins *p p'*, placed at either side of the mean or central position of said arm, but sufficiently removed from it to enable the reverser to be turned freely from the central or "break" position, Fig. 6, to the first position in either side, as in Fig. 7, putting the field-magnets in series, which is the normal working position. In cases of emergency the reverser is turned farther to the position indicated in Figs. 8 and 9, these

positions putting the field-magnets in multiple, as above described, and as soon as the reverser passes the series position the spring-arm P comes into action, striking pin p or p' and being bent by the further rotation of the reverser, so that as soon as the reverser-handle is released the spring P in straightening will return the reverser to the series position, Fig. 7. This return action is indicated by the arrows in Fig. 2.

Having thus described my invention, the following is what I claim as new therein and desire to secure by Letters Patent:

1. The combination in an electromotive system for vehicle propulsion, of two motors having their armatures and field-magnets in separate circuits, a controller for controlling the operation of such motors, and a supplementary switch and connections arranged to connect said field-magnets in series or in parallel, substantially as and for the purpose set forth.

2. The combination in an electromotive system for vehicle propulsion, of two motors having their armatures and field-magnets in separate circuits, a controller for controlling the operation of such motors, and a supplementary switch and connections arranged to connect said field-magnets in series or in parallel, and to reverse the connections of said field-magnets.

3. The combination of an electromotive system for vehicle propulsion, of two motors having their armatures and field-magnets in separate circuits, a controller for controlling the operation of such motors, and a supplementary switch and connections arranged to connect said field-magnets in series or in parallel and to vary the resistance of the field-magnet circuit, when said magnets are in parallel substantially as and for the purpose set forth.

4. The combination with two electric motors having their field-magnets and armatures in separate circuits and a controller for regulating the field-magnets and armatures thereof, of a supplemental switch arranged to independently vary the resistance of said field-magnet circuit.

5. The combination with two electric motors having their armatures and field-magnets in separate circuits, of a controller for placing the armatures of such motors to the circuit in series or parallel relation, said controller comprising means for regulating the strength of said field-magnets and means for breaking the series armature connection and disconnecting the armatures from the circuit when the field-magnets are weak and connecting them in parallel when the field-magnets are strong.

6. The combination with two electric motors having their armatures and field-magnets in separate circuits, of a controller for connecting the armatures of such motors to the circuit in series or parallel relation, said controller comprising means for regulating the strength of said field-magnets and means for breaking the series armature connection when the field-magnets are weak and connecting them in parallel when the field-magnets are strong, such means being adapted to close the parallel connections of the two armatures successively.

7. The combination with two electric motors having their armatures and field-magnets in separate circuits, of a controller for placing the armatures of such motors in the circuit in series or parallel relation, said controller comprising means for regulating the strength of said field-magnets and means for breaking the series armature connection when the field-magnets are weak and connecting them in parallel when the field-magnets are strong, such means being adapted to close the parallel connections of the two armatures successively and to initially check the current in the armature inserted later, as by inserting resistance in its circuit.

8. The combination with two electric motors having their armatures and field-magnets in separate circuits, of a controller adapted to place the armatures of such motors in connection with the circuit in series or parallel relation, and to break the connection of both armatures at a point between the series and parallel positions.

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