No. 705,241. Patented July 22, 1902.

J. C. HENRY, Dec'd.

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ELECTRIC CONTROLLER.

(Application filed Apr. 1, 1901.)

(No Model.)

Fig. 2

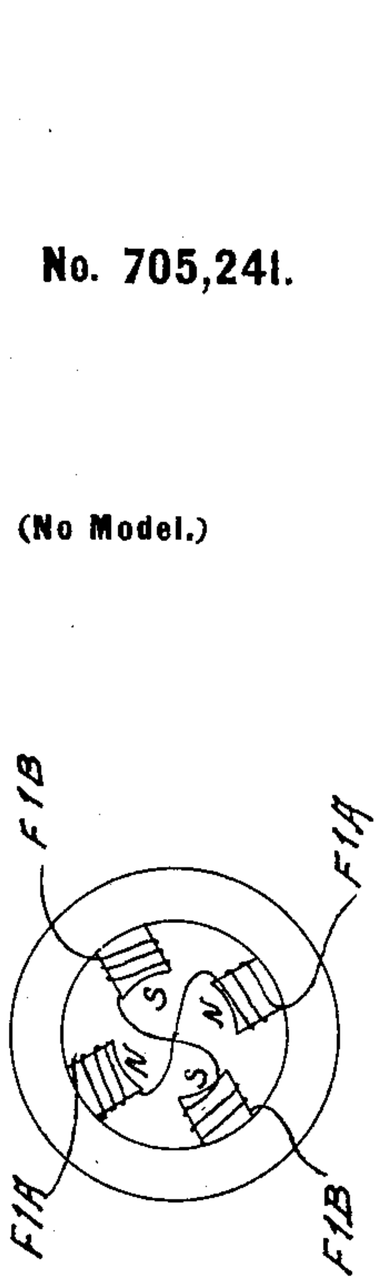

Fig. 1

WITNESSES:

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JOHN C. HENRY, OF DENVER, COLORADO; SUSIE A. HENRY, EXECUTRIX OF SAID JOHN C. HENRY, DECEASED, ASSIGNOR TO STANLEY ELECTRIC MANUFACTURING COMPANY, A CORPORATION OF NEW JERSEY.

ELECTRIC CONTROLLER.

SPECIFICATION forming part of Letters Patent No. 705,241, dated July 22, 1902.

Application filed April 1, 1901. Serial No. 53,999. (No model.)

To all whom it may concern:

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

This invention relates to improvements in controllers of the series-multiple class, and is an improvement on the form described in my application, Serial No. 740,282, filed December 18, 1899.

The main improvement consists in an arrangement whereby the motors may be varied in speed when connected either in series or parallel relation and all changes may be made without the use of dead resistance.

In the drawings, Figure 1 represents a development of the controller; Fig. 2, a diagram of the preferred form of motor; and Figs. 3 to 16, inclusive, are diagrams showing the course of the current through the various motor parts when the switch is shifted to comply with different requirements.

In the first running position, Fig. 5, it will be noticed that the current passes from trolley to ground through all of the field-magnets and armatures in series, while in the last running position, Fig. 16, the current passes through the fields and armatures in parallel. The main features of the invention are the provision of means for thus changing the connections and bringing in a great variety of speed changes without using artificial resistance. When it is desired to decrease the resistance of the motor, as by changing the independent motor-field wires from series to parallel, the circuits are changed within the controller, as shown in the diagrams Figs. 6, 7, and 8.

Fig. 2 represents the form of field-magnet preferred. It will be observed that when one of the fields is cut out, as in Figs. 6 and 7, the polarity of the field-magnets remains unchanged. The cores which do not have current circulating around them become consequent poles, and owing to the decrease of resistance in the field-circuit the current becomes more dense and partially makes up for the loss in turns in the cut-out coils—in effect, the motor will speed up slightly, owing to a weakening of the total fields.

In the development the course of the current through the various members may be traced as shown in the diagram opposite the corresponding dotted line. In Fig. 3 the trolley connection is open, while in Fig. 4 the connection between the two motors is open at finger L. The first running position is shown in diagram 5. Current enters from trolley to contact 1, thence by wire to contact 2, to field 1 A, to finger F, contacts 8 and 7 and finger E through field F 1 B, thence through armature 1 to finger L and contact 21, thence by wire to contact 4, through field F 2 A to finger I, contacts 13 and 11, finger H to field F 2 B through armature No. 2 to the ground.

Figs. 6, 7, and 8 show the changing over of the individual motor-field coils from series to parallel for each motor to decrease the resistance.

The connection of the second running position is shown in diagram 8. Here the current enters from trolley, thence to contacts 2 and 3 by fingers B and C, from where it divides, that from contact 2 passing through F 1 A to contacts 9 and 10, through finger F to armature 1, where it is joined by the other part of the current from contact 3, finger C, field F 1 B, also to armature 1, after passing through armature 1 to fingers J and L, to contacts 17, 13, and 11, finger H, through field F 2 B and through contacts 21½, 21, and 4 to field F 2 A, and from both these fields through armature 2 to the ground. The leaving side of field F 2 A is connected by contacts 14 and 18 to the armature 2.

In next position, Fig. 9, one field-magnet of motor No. 2 is cut out, and then in position 10 it is again connected, but in reverse connection, the object being to neutralize the magnetism in the fields preparatory to short-circuiting the armature. Then in position 11 it is again cut out, leaving the armature in connection with only one field-magnet during the short-circuiting position 12.

It will be understood that positions 11 to 14 are transitionary only and that position 11 does not last sufficient length of time for the field-magnet to become reënergized to any

substantial extent, such large magnets requiring an appreciable time for magnetization. If preferred, however, step 11 may be omitted and the controller pass right from step 10 to position 12.

In running position 3, Fig. 10, the course of the current is the same as in running position 2, except that the field F 2 A has been disconnected and then reversely connected. The current from armature 1, finger J, contacts 17 and 15 passes through field F 2 A backward, thence by contacts 5, 4, 21, and 19 to armature 2.

In next position, Fig. 13, motor No. 2 is removed from the circuit.

In next position, Fig. 14, the single motor No. 1 is speeded up by placing one section of the fields of the idle motor No. 2 in parallel with the fields of the first motor. The result is that the fields of the first motor are weakened. At the same time a section of those of the idle motor are independently excited preparatory to connecting the second motor to the circuit. An abnormal rush of current is thus avoided. When connecting the second armature to the circuit, its current is held back by having to receive its supply through the high-resistance single field-coil, as also by revolving under the independently-excited field. This combination is followed by that shown in diagram 16, where a double effect is produced—*i. e.*, by establishing a cross connection between the armatures. It relieves the field of motor No. 1 of its shunt, thereby increasing its voltage and decreasing its current-supply. At the same time it decreases the voltage and increases the current-supply to motor No. 2, so that a current balance is established between the machines.

In running position 4, Fig. 15, the current enters by contacts 2, 3, and 6 and divides between fingers B, C, and D, that through finger B passing through field F 1 A, finger F, contacts 9 and 10, to armature 1. The current from finger C passes through field F 1 B to armature 1, and the current from finger D passes through field F 2 A, finger I, contacts 16 and 10 to armature 1, from armature 1 to finger L, contacts 22 and 23 to ground. Current also passes from trolley through contacts 1, 2, 3, 6, and 12 to finger H, to field F 2 B, thence by armature 2 to ground.

In the fifth running position, Fig. 16, the connections are the same as in the fourth, except that by contacts 20, 16, and 10 and fingers K and G a cross connection is established between the armatures.

In order to limit the field losses, it may be stated that smaller wire than is ordinarily employed in series motor-fields is used. In the starting position the small wire is particularly advantageous, as it not only cuts down the current by its inherent high resistance, but it also opposes the initial current by the self-induction effects. It is well known that iron magnetizes and demagnetizes slower with fine-wire than with coarse-wire winding. The self-induction creates a back pressure which resists the initial current and acts as a substitute for the artificial resistance ordinarily employed on starting cars.

In the claims I refer to both of the field-coils, which are shown always connected together, in the singular sense—that is, as a "field-coil" or as the "sections of field-coils."

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

1. The combination with an electric motor having a plurality of pairs of poles with magnetizing-coils connected in series, of a switch arranged to cut out a pair of said coils, thereby increasing the current through the other coils and changing the motor from an ordinary multipolar machine to a consequent-pole machine.

2. The combination with an electric motor having a plurality of pairs of poles with magnetizing-coils connected in series, of a switch having contacts and connections adapted and arranged to cut out a pair of said coils, thereby increasing the current through the other coils and then changing the field-coils from series to parallel relation.

3. The combination with a pair of electric motors having a plurality of pairs of poles with magnetizing-coils, of a switch having contacts and connections adapted and arranged to cut out a pair of the magnet-coils, reconnecting the coils in reverse manner to demagnetize the field, then short-circuiting the said motor and removing it from the circuit.

4. The combination with a motor having a plurality of pairs of poles with magnetizing-coils thereon, of a controller having contacts and connections adapted, in one position of the controller, to interrupt the circuit on one pair of said coils, allowing the corresponding pole series to act as consequent poles.

5. The combination with a motor having a plurality of pairs of field-magnet poles with magnetizing-coils thereon, of a controller having contacts and connections adapted and arranged in different positions of the controller to place the said field-magnet coils in series and in parallel relation, and in an intermediate position to interrupt the circuit on one pair of coils, allowing the corresponding pole-pieces to act as consequent poles.

6. The combination with an electric motor, of a controller having contacts and connections adapted and arranged to reverse a field-magnet coil of said motor and in a subsequent position, to place the said motor on short circuit.

7. The combination with an electric motor having a plurality of field-magnetizing coils, of a controller having contacts and connections adapted and arranged to reverse a part of the field-coils and to subsequently short-circuit the armature through another part of the field-coils.

8. In a series-parallel controller, a switch

arranged to disconnect one of the motors from the circuit and to speed up the other motor by connecting a section of the fields of the idle motor in parallel with those of the other motor.

9. The combination with a plurality of motors, one at least of which has a plurality of field-coils, of a switch having contacts and connections adapted and arranged to disconnect one of the motors from the circuit and to speed up the other motor by connecting a part of the field-coils of the idle motor in parallel with those of the other motor.

10. In a series-parallel controller, a switch arranged to disconnect one of the motors from the circuit, and to excite a section of the field-coils of said idle motor, and then to connect the armature and balance of the field-coils of said motor to the line in parallel with the other motor.

11. In a series-parallel controller, a switch having contacts and connections adapted and arranged to disconnect one of the motors from the circuit and to then connect the idle motor to the circuit in parallel insteps substantially as follows, first connecting one section of the field-coils of said motor in parallel with the field-coils of the active motor, next connecting the balance of the field-coils and the armature of the idle motor, in parallel with the other motor, and finally establishing a cross connection between all of the field-coils and armatures.

12. The combination with a pair of electric motors, of a controller having contacts and connections adapted and arranged to disconnect one of the motors from the circuit, and to excite a section of the field-coils of said idle motor, and then to connect the armature and balance of the field-coils of said motor in parallel with the other motor.

In testimony whereof I have hereunto set my hand and seal, this 7th day of March, A.D. 1901, in the presence of two witnesses.

JOHN C. HENRY. [L. S.]

Witnesses:

D. CARL HENRY,

CARLE WHITEHEAD.