C. D. KNIGHT.

CONTROLLING DEVICE FOR ELECTRIC MOTORS.

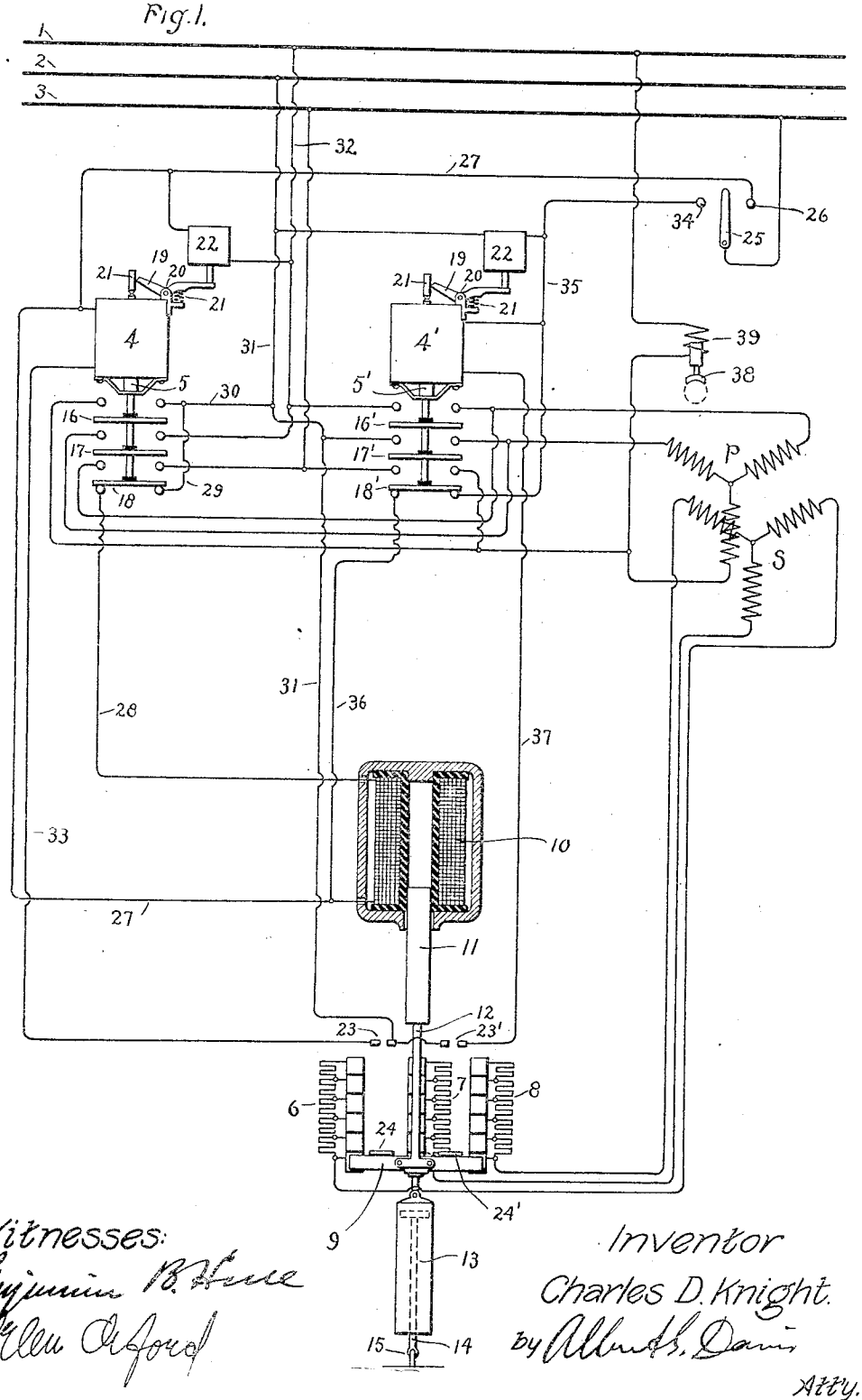
APPLICATION FILED FEB. 21, 1907.

930,603.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

Fig. 1.



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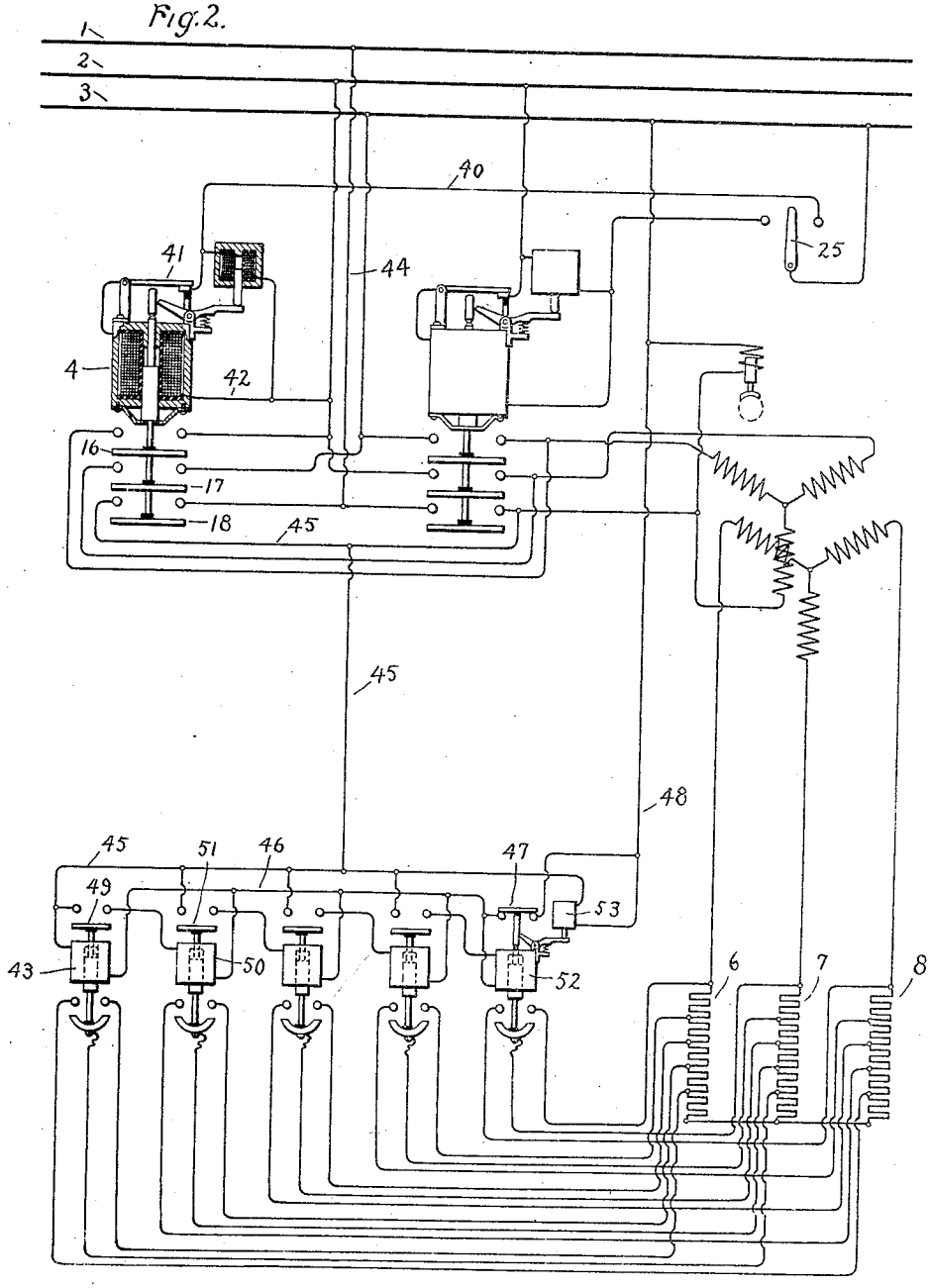
2 SHEETS—SHEET 2.

Fig. 2.



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UNITED STATES PATENT OFFICE.

CHARLES D. KNIGHT, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CONTROLLING DEVICE FOR ELECTRIC MOTORS.

No. 930,603. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed February 21, 1907. Serial No. 358,531.

To all whom it may concern:

Be it known that I, CHARLES D. KNIGHT, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Controlling Devices for Electric Motors, of which the following is a specification.

This invention relates to means for controlling electric motor circuits and has for its object the provision of a device whereby an electric motor may be started and brought up to running speed in a reliable, safe and efficient manner.

My invention relates more specifically to the starting of alternating current motors of the induction type.

In the starting of induction motors of the slip-ring type it is essential that the secondary circuit be closed through the necessary resistance before the closing of the primary circuit. It is also desirable that means be provided for cutting the resistance out of the secondary circuit in a convenient manner. In carrying out my invention therefore I provide in connection with automatic means for cutting the resistance out of the secondary circuit, electrical connections whereby the primary circuit cannot be closed until the secondary circuit is closed through the entire resistance, and whereby the automatic mechanism begins to cut resistance out of the secondary circuit as soon as the primary circuit is closed.

In the accompanying drawings, in which I have shown my invention embodied in two different forms, Figure 1 is a view of my device controlling a three-phase induction motor, and Fig. 2 is a similar view of a modified form of my invention, in which contactors are used for automatically cutting out the resistance from the secondary circuit, controlling the same type of motor.

Referring to Fig. 1 of the drawings, P is the primary and S is the secondary of an induction motor of the slip-ring type, and 1, 2 and 3 are the three-phase mains from which the motor is operated. The primary circuit is closed by means of solenoid switches 4 4′ having cores 5 5′, respectively, the former for operating the motor in one direction of rotation and the latter for reversing it. Connected in series with the windings of the secondary are three resistances 6, 7 and 8 controlled by a resistance-varying arm or element 9, which simultaneously engages the contacts of the three resistances. This controlling arm 9 is operated by a solenoid 10 acting upon a core 11 connected to the element 9 by a rod 12. To the lower end of the rod is connected a dash-pot 13, the barrel of which is pivoted to the under side of arm 9 while the piston 14 is pivoted at 15. The arm 9 is normally down in the position shown, having a bias to this position by virtue of its weight or by any other desired agency. The dash-pot is designed to permit the arm 9 to move upward freely but operates to retard it upon its return. When the arm 9 is down the resistances 6, 7 and 8 are short-circuited while, when it is in the upper position, the resistances are all in circuit.

The two solenoid switches 4 and 4′, which control the primary circuit, are identical in construction and operation and consist simply of solenoids, each having a core carrying three bridging contacts 16, 17 and 18, and 16′, 17′ and 18′, respectively. When the solenoids are energized, these contacts are raised and bridge the corresponding contacts to close the three phases of the primary circuit. Bridging contacts 18 and 18′, when in their lower position, complete the circuit of the solenoid 10, and when moved up, break the same. The contacts are held in the raised position by means of latches 19 pivoted at 20 arranged to engage extensions 21 of the cores 5 5′ of the solenoids to latch the same in a raised position. The latches are held in by means of solenoids 22 which are connected in circuit so as to be energized upon the closing of the main switch and act against the tension of their springs 21 to hold the latches in an operative position. The circuits of solenoids 4 and 4′ are completed through contacts 23 and 23′, which are bridged by means of contacts 24 and 24′ on the arm, when the latter is in its raised position. A switch 25 is arranged to close the circuit through either one of the solenoids 4 or 4′, depending upon the direction of rotation desired.

The arrangement of circuits and mode of operation is as follows: When the switch 25 is closed on the contact stud 26, current will pass from the main 3 through switch 25, conductor 27, solenoid 10, conductor 28, bridging contact 18, conductors 29, 30 and 31, back to line at main 2. At the same time the

solenoid 22 is energized between the mains 1 and 3 from conductor 27 to conductor 32. The solenoid 10 being energized, the controlling arm 9 is raised until it reaches the upper position where the circuits of the solenoids 4 and 4′ are closed by the contacts 24 and 24′ bridging contacts 23 and 23′. In this position all of the resistances 6, 7 and 8 are in the secondary circuit. As soon as the contacts 23 are bridged, the solenoid 4 is energized, current passing therethrough as follows: from conductor 27 through solenoid 4, conductor 33, contacts 23 and conductor 31, back to line at main 2. The solenoid being energized, it closes the three phases of the primary circuit at contacts 16, 17 and 18. The latter contact as it rises opens the circuit of the solenoid 10 whereupon the core 11 is released. The arm 9 thereupon drops and is retarded by the dash-pot 13. As the arm drops, the motor speeds up and when the lowest position is reached the motor is running at full speed. If the switch arm 25 is moved on to the stud 34, the direction of rotation of the motor will be reversed but the operation will be the same. Current will then pass from switch through conductor 35, bridge 18′, conductor 36, solenoid 10, thence back to line as before through conductor 28. The solenoid 4′ is energized from conductor 35 to conductor 37, contacts 23′ and conductor 31, back to line at main 2. In order to stop the motor quickly as is sometimes desired, especially where the motor is used to operate a hoist or an elevator, I provide a brake 38 controlled by solenoid 39. As soon as the primary circuit is closed, the solenoid 39 is energized and the brake withdrawn from the motor. Upon failure of voltage, solenoids 22 are deënergized to open the primary circuit.

In Fig. 2 I have shown a similar arrangement, the only difference being that instead of using a single controlling element operating to vary the secondary resistance, I provide a series of contactors, each one of which as it operates cuts out a section of resistance. When the switch 25 is closed the solenoid 4 is immediately energized from main 3 through switch 25, conductor 40, switch 41, solenoid 4 and back to main 2 through conductor 42. This operates as before to close the three phases of the primary circuit, all of the resistances 6, 7 and 8 being in the meantime in the secondary circuit. In this case the circuit of the solenoid 4 is opened by the opening of switch 41 after the primary circuits are closed. When the lower contact 18 closes its circuit the solenoid 43 of the first contactor is energized as follows: from main 1 through conductor 44, bridging contact 18, conductor 45, solenoid 43, conductor 46, bridging contact 47 and back to line at main 3 through conductor 48. This solenoid pulls up one contactor to cut out one section of resistance, and at the same time closes a circuit through bridging contact 49 of solenoid 50. This solenoid in turn operates its contactor to cut out another section of resistance, and at the same time by means of its bridging contact 51 closes the circuit of the next succeeding solenoid and so on. When the last solenoid 52 is reached, the resistance is short-circuited and the circuits of all of the other solenoids are opened at contact 47. The contactor of solenoid 52 is held in a raised position by latch mechanism 53, such as is described in connection with Fig. 1. The arrangement shown in Fig. 2 may be used where the currents are heavy, and the operation will be substantially the same as that described with reference to Fig. 1.

I have shown my invention in connection with a particular form of motor, *i. e.*, a three-phase induction motor of the slip-ring type, but it should be understood that my invention is not limited to this particular application except in so far as it is limited to the claims annexed hereto.

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

1. The combination with an alternating current motor, of means for controlling the same comprising an electromagnetic switch for varying the resistance in the secondary circuit and an electromagnetic switch arranged to be automatically energized to close the primary circuit when the resistance varying switch is moved to a predetermined position.

2. The combination with an alternating current motor, of means for controlling the same comprising a resistance normally excluded from the secondary circuit, an electromagnetic switch for including the resistance in said circuit and an electromagnetic switch arranged to be automatically energized to close the primary circuit when said resistance is included.

3. The combination with an alternating current motor, of means for controlling the same comprising an electrically-controlled switch for closing the primary circuit, an impedance for the secondary circuit, and a varying mechanism therefor arranged to control the circuit of said switch.

4. The combination with an alternating current motor, of means for controlling the same in opposite directions of rotation comprising electromagnetic primary circuit closing switches one for each direction, an impedance for the secondary circuit, and electromagnetic means arranged to control the circuit of said switches for including said impedance in the secondary circuit.

5. The combination with an alternating current motor, of means for controlling the same comprising an electromagnetic switch for closing the primary circuit, an impedance for the secondary circuit, and an automat-

ically operated varying mechanism therefor arranged to control the circuit of the primary circuit-closer.

6. The combination with an alternating current motor, of means for controlling the same comprising an electrically controlled switch for the primary circuit, an impedance for the secondary circuit, electromagnetic varying mechanism therefor controlled by said switch, and connections whereby said varying mechanism controls the circuit of the switch.

7. The combination with an alternating current motor, of means for controlling the same in opposite directions comprising an electromagnetic switch for varying the resistance in the secondary circuit and electromagnetic switches, one for each direction of rotation, arranged to be automatically energized to close the primary circuit when the resistance varying switch is moved to a predetermined position.

8. The combination with an alternating current motor, of means for controlling the same in opposite directions comprising a resistance normally excluded from the secondary circuit, electromagnetic switches one for each direction of rotation for including the resistance in said circuit and an electromagnetic switch arranged to be automatically energized to close the circuit when said resistance is excluded.

9. The combination with an alternating current motor, of means for controlling the same comprising automatic means for closing the primary circuit, a variable impedance for the secondary circuit, a controlling element therefor having a bias toward the low-impedance position, an electromagnetic device for moving said element to a high-impedance position, and means controlled by the primary circuit-closer for deënergizing the electromagnetic device to release the controlling element.

10. The combination with an alternating current motor, of means for controlling the same comprising an electromagnetic switch for the primary circuit, a variable impedance for the secondary circuit, a controlling element therefor having a bias toward the low-impedance position, an electromagnetic device for moving said element to a high-impedance position, and connections whereby the circuit of the primary circuit is closed when said element reaches a predetermined position.

11. The combination with an alternating current motor, of means for controlling the same comprising an electromagnetic switch for the primary circuit, a variable impedance for the secondary circuit, a controlling element therefor having a bias toward the low-impedance position, an electromagnetic device the circuit of which is controlled by said switch for moving said element to a high-impedance position, and connections whereby the circuit of the primary switch is closed when said element reaches a predetermined position.

12. The combination with an alternating current motor, of means for controlling the same comprising an electromagnetic switch for the primary circuit, a variable impedance for the secondary circuit, a controlling element therefor having a bias toward a minimum impedance position, an electromagnetic device the circuit of which is controlled by said switch for moving said element to a maximum impedance position, and connections whereby the circuit of the primary switch is closed when said element reaches the latter position.

13. The combination with an alternating current motor, of means for controlling the same in opposite directions of rotation comprising electrically-controlled switches for the primary circuit one for each direction, an impedance for the secondary circuit, electromagnetic varying means therefor controlled by either of said switches, and connections whereby said varying mechanism controls the circuits of the switches.

14. The combination with an alternating current motor, of means for controlling the same in opposite directions of rotation comprising electromagnetic switches one for each direction, a variable impedance for the secondary circuit, a controlling element therefor having a bias toward a minimum impedance position, an electromagnetic device the circuit of which is controlled by either of said switches for moving said element to a maximum impedance position, and connections whereby the circuits of the primary switches are closed when said element reaches the latter position.

In witness whereof, I have hereunto set my hand this 19th day of February, 1907.

CHARLES D. KNIGHT.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.