

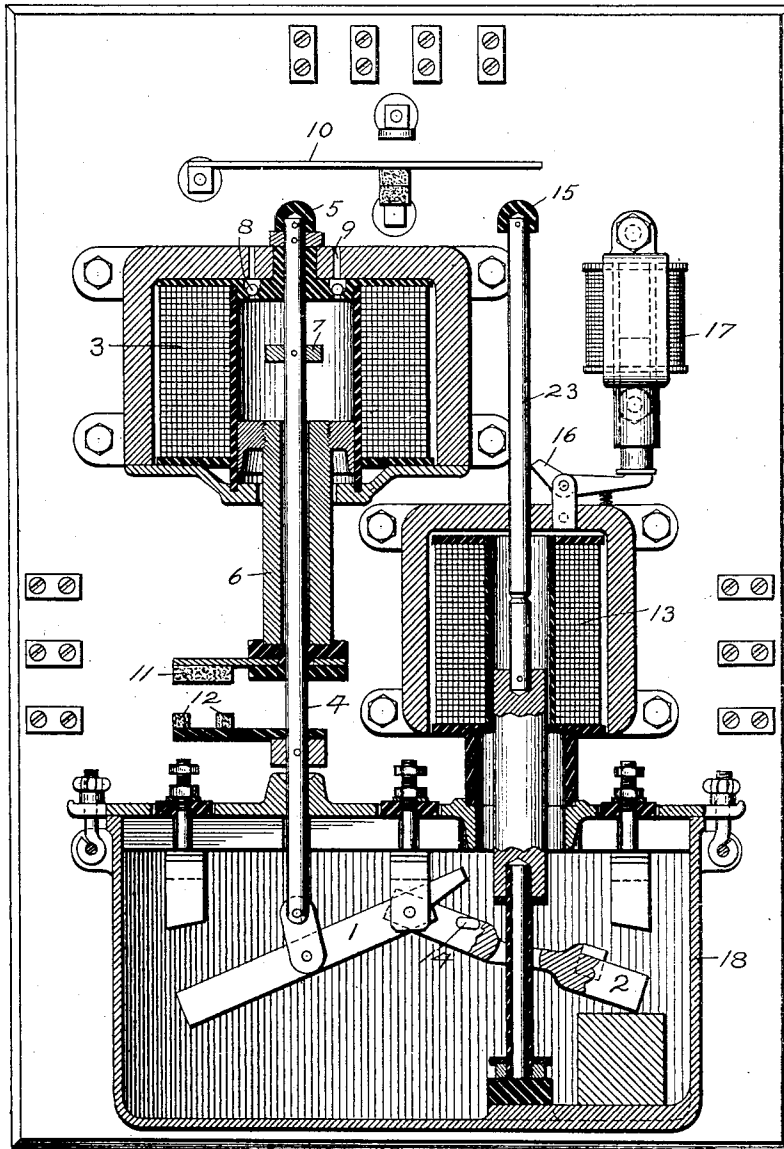
C. D. KNIGHT.
STARTING SWITCH FOR ELECTRIC MOTORS.
APPLICATION FILED DEC. 1, 1905.

1,031,650.

Patented July 2, 1912.

2 SHEETS-SHEET 1.

Fig. 1.



WITNESSES.
W. Ray Taylor.
Helen W. Ford

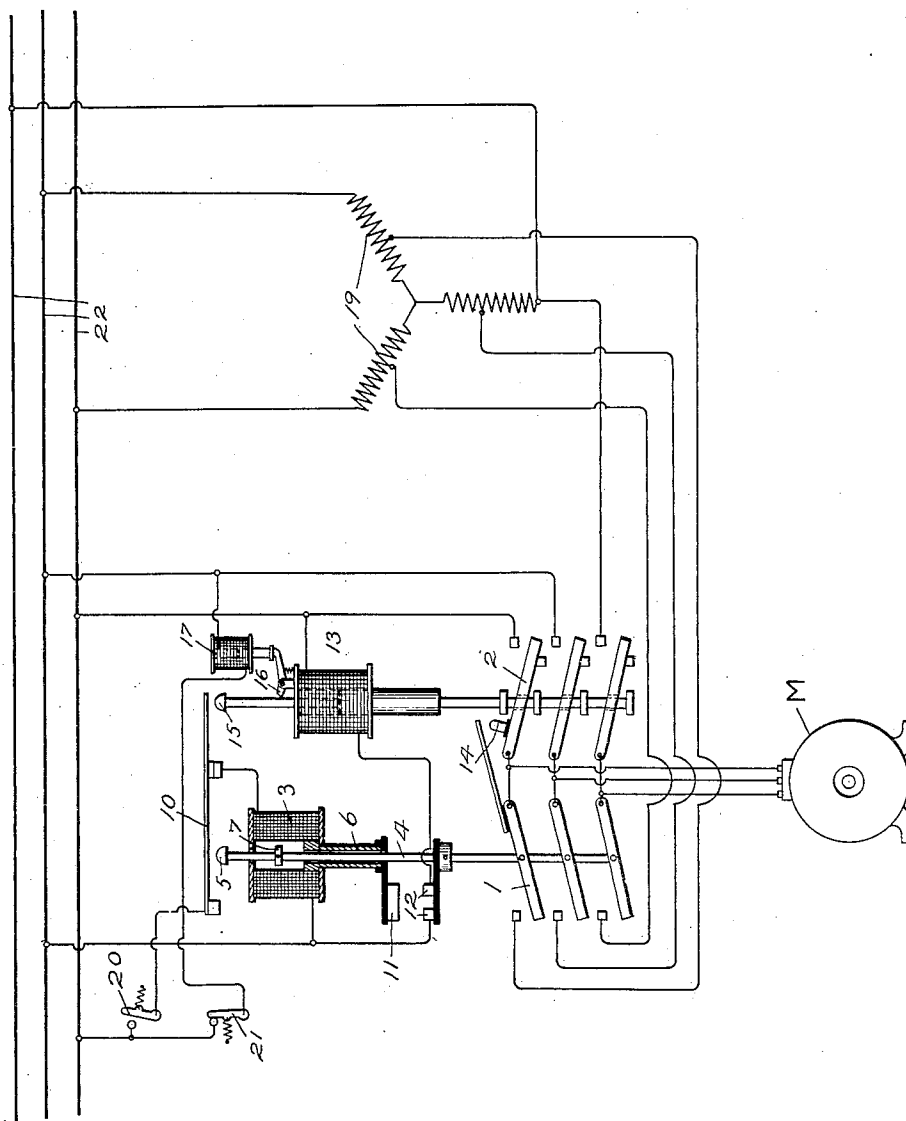
INVENTOR.
CHARLES D. KNIGHT.
by *Albert Davis*
Att'y.

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 2 SHEETS-SHEET 2.

Fig. 2.



WITNESSES.
W. Ray Taylor.
Helen Oxford

INVENTOR.
 CHARLES D. KNIGHT.
 by *Albion S. Davis*
 Att'y.

UNITED STATES PATENT OFFICE.

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

STARTING-SWITCH FOR ELECTRIC MOTORS.

1,031,650.

Specification of Letters Patent.

Patented July 2, 1912.

Application filed December 1, 1905. Serial No. 289,774.

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 Starting-Switches for Electric Motors, of which the following is a specification.

My invention relates to starting switches for electric motors, and is particularly adapted for use with alternating-current motors of the type which are controlled by connecting them to a source of low voltage for starting and then increasing the impressed voltage for running. But my invention is not limited to this particular type of motor.

The object of my invention is to provide a simple, efficient and reliable automatic starter for electric motors, by means of which motors may be controlled from a distance either manually or by automatic switching devices, such as pressure governors, float switches, etc.

My invention in one aspect consists in the combination with an electric motor, of two switches for establishing respectively starting and running connection, operating magnets for the switches, and means controlled by the operating magnet of the starting switch for energizing the operating magnet of the running switch at a predetermined interval after the first magnet is energized.

In another aspect my invention consists in the combination with an electric motor, of two switches adapted to establish respectively starting and running connections, a control system comprising automatic operating means for said switches adapted to close the starting switch, and then to close the running switch and open the starting switch after a predetermined interval, and means for deenergizing the operating means when the running switch is closed.

In still another aspect my invention consists in the combination of an alternating current motor and an alternating current supply circuit of a transformer and a plurality of automatically operated switches

for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit.

My invention further comprises a number of other features, which will best be understood by reference to the accompanying drawings, in which—

Figure 1 shows a front elevation, partly in cross-section, of an automatic motor starting switch in accordance with my invention; and Fig. 2 is a diagram showing the circuit connections.

Referring first to Fig. 1, 1 and 2 represent two knife-blade switches adapted to establish respectively the proper connections for starting and for running. The switch 1 is operated by the magnet 3 through a rod 4 which is connected to the switch, and which, when the switch is opened, hold the switch in the position shown by means of a button 5 at the upper end of the rod engaging the top of the magnet. 6 represents the core of the magnet which, when drawn up, engages and lifts the collar 7 on the rod 4, thereby closing the switch 1. When the rod 4 is thus raised the button 5 on the upper end of the rod engages the switch contact 10 in circuit with the magnet 3. The upper end of the core 6 is formed as a piston moving within the bore of the magnet 3, and by means of the passages 9 and the ball valves 8, a dash-pot construction is provided which permits the free upward movement of the core while retarding its downward movement. The core 6 carries a contact 11, which in certain positions of the rod and core, as will hereinafter be explained, engages the contacts 12 carried by the rod 4. The running switch 2 is operated by a magnet 13, and is provided with a lug 14 adapted to engage switch 1 when switch 2 is closed and to force switch 1 open. The two switches are thus mechanically interlocked. The core of magnet 13 is connected to the switch 2 by a lost-motion connection, as shown. This lost-motion connection enables the core of magnet 13 to impart a hammer-blow to the switch

2 in closing, so as to close switch 2 and open switch 1 with a quick action. The core of magnet 13 carries a spindle 23 at the top of which is a button 15 which, like the button 5, is adapted to engage the contact 10. 16 is a spring-actuated latch controlled by a no-voltage release magnet 17. When the magnet 17 is energized and the magnet 13 draws up its core the latch 16 is forced by its spring into engagement with a notch on the spindle 23 carried by the core of magnet 13, so as to hold the core in its raised position.

Now, referring to Fig. 2, the circuit connections and mode of operation will be explained. M represents an electric motor which in this figure is indicated as a three-phase induction motor and which is connected by switches 1 and 2 either to intermediate points on the winding of the compensator or other voltage controlling device 19, or directly to the line-wires 22. 20 and 21 represent two switch contacts in the control circuit, one of which is normally open and the other normally closed. Although these contacts are indicated as simple manually operated switches, it will be understood that my automatic starter may be used with any well known type of automatic switch, such as fluid-pressure governor, float-switch, time-switch, etc.

The operation of the starter is as follows: If the switch 20 is closed momentarily, a circuit is completed from a line-wire 22 through switch 20, through switch-contact 10, and magnet 3, to a second line-wire. Magnet 3 consequently draws up its core 6 and when this core strikes the collar 7 on the rod 4 it closes switch 1 with a quick movement. At the same time the button 5 on the top of rod 4 engages the switch contact 10, raising it and breaking the circuit of magnet 3. The core 6 consequently begins to fall. Switch 1 remains closed, however, since the connection between this switch and the core is such as to permit the return movement of the core without moving the switch, and since the switch is of the ordinary knife-blade type, the friction of the contacts is sufficient to hold it closed. Core 6 moves downward slowly, since its return movement is retarded by the dash-pot construction that has been heretofore explained. By the closing of switch 1 motor M has been connected to intermediate points on the winding of the compensator 19, and has consequently started. By the time the motor is up to speed the core 6 has again reached its lowest position, and in this position the contact 11 carried by the core now engages the contacts 12 carried by the rod 4, since these contacts have been raised by the closing of switch 1. A circuit is thereby closed from a line-wire 22 through contacts 12 and 11, magnet 13 to a

second line-wire. Magnet 13 consequently draws up switch 2 with a quick movement, owing to the lost-motion construction heretofore explained, at the same time opening switch 1 by the engagement of the projection 14 therewith. Rod 4 is consequently drawn down again to the position shown in Fig. 2, and this movement has two results. In the first place, button 5 at the upper end of the rod is drawn away from contact 10, but this produces no effect, since button 15 has been raised into engagement with contact 10 so as to hold it open. Also the contacts 12 are drawn away from contact 11, thereby breaking the circuit of magnet 13. The core of magnet 13 does not fall, however, since it is engaged by the latch 16, the no-voltage release magnets 17 being energized so as to draw up its core. By the closing of switch 2 and the opening of switch 1 motor M is connected directly to the line and thus receives the full-line voltage for running. It will be seen that when running connections are thus established, both operating magnets are cut out of circuit. The no-voltage release magnet 17 alone is energized, and thus this may be made comparatively small, very little energy is wasted while the motor is running. The motor continues to run until the voltage release-magnet 17 is deenergized either by a failure of the line-voltage or upon opening the switch 21 in circuit with the no-voltage release magnet. By means of this switch the motor may be stopped whenever it is desired to do so. When the no-voltage release-magnet 17 is deenergized its core falls, forcing the latch 16 out of engagement with the notch in the spindle 23, allowing the core of magnet 13 to fall. Owing to the lost-motion between this core and switch 2 the core strikes the switch a hammer-blow, driving it open with a quick movement, thereby breaking the motor circuit and bringing the motor to rest. At the same time contact 10 is allowed to fall, so that all parts are restored to starting position.

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

1. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor and means for deenergizing the same when the starting switch is closed, a switch for establishing running connections, an operating magnet therefor, and means controlled by the first magnet for energizing the second magnet at a predetermined interval after the first magnet is deenergized.

2. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, means controlled by the first magnet and independent

of the current for energizing the second magnet at a predetermined interval after the first magnet is energized, and means for opening the starting switch when said second magnet is energized.

3. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, means controlled by the first magnet for energizing the second magnet at a predetermined interval after the first magnet is energized, and a mechanical interlock between said switches.

4. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, means for deenergizing the same when the starting switch is closed, a switch for establishing running connections, an operating magnet therefor, a control circuit including the first magnet, and means for automatically energizing the second magnet a predetermined time after the control circuit is closed.

5. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, a control circuit including the first magnet, means independent of the current for automatically energizing the second magnet a predetermined time after the control circuit is closed, and means for opening the starting switch when said second magnet is energized.

6. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, a mechanical interlock between said switches, a control circuit including the first magnet, and means for automatically energizing the second magnet a predetermined time after the control circuit is closed.

7. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, a control circuit including the first magnet, means independent of the current for automatically energizing the second magnet a predetermined time after the control circuit is closed, means for automatically deenergizing the second magnet when the running switch is closed, and a no-voltage release magnet controlling said running switch.

8. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, means independent of the current and controlled by the

first magnet for energizing the second magnet at a predetermined interval after the first magnet is energized, means for automatically deenergizing the second magnet when the running switch is closed, and a no-voltage release magnet controlling said running switch.

9. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a control system comprising automatic operating means for said switches adapted to close the starting switch and then to close the running switch and open the starting switch after a predetermined interval, means for deenergizing said operating means when the running switch is closed, and a no-voltage release magnet controlling said running switch.

10. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a mechanical interlock between said switches, a control system comprising automatic operating means for said switches adapted to close first the starting and then the running switch after a predetermined interval, means for deenergizing said operating means when the running switch is closed, and a no-voltage release magnet controlling said running switch.

11. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a mechanical interlock between said switches, and a control system comprising automatic operating means for said switches adapted to close first the starting switch and then the running switch after a predetermined interval.

12. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, an operating magnet for the starting switch, means for deenergizing said magnet when said starting switch is closed, means for retarding the return movement of the core of said magnet, and means controlled by the movement of said core for closing the running switch and opening the starting switch.

13. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a magnet having its core operatively connected to the starting switch, the connections between said core and said switch being adapted to permit the return movement of said core without moving said switch, means for breaking the circuit of said magnet when the starting switch is closed, means for retarding the return movement of the core, and means controlled by the movement of the core for closing the running switch.

14. In combination with an electric motor, two switches adapted to establish re-

spectively starting and running connections, a magnet having its core operatively connected to the starting switch, the connections between said core and said switch being adapted to permit the return movement of said core without moving said switch, means for breaking the circuit of said magnet when the starting switch is closed, means for retarding the return movement of the core, and means controlled by the movement of the core for closing the running switch and opening the starting switch.

15. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a magnet having its core operatively connected to the starting switch, the connections between said core and said switch being adapted to permit the return movement of said core without moving said switch, means for breaking the circuit of said magnet when the starting switch is closed, means for retarding the return movement of the core, means controlled by the movement of the core for closing the running switch, and a mechanical interlock between the starting and running switches.

16. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a magnet having its core operatively connected to the starting switch, the connections between said core and said switch being adapted to permit the return movement of said core without moving said switch, means for deenergizing said magnet when the starting switch is closed, means for retarding the return movement of the core, a magnet controlled by the movement of the core for closing the running switch, means for deenergizing said magnet when the running switch is closed, and a no-voltage release magnet controlling said running switch.

17. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a magnet having its core operatively connected to the starting switch, the connections between said core and said switch being adapted to permit the return movement of said core without moving said switch, means for deenergizing said magnet when the starting switch is closed, means for retarding the return movement of the core, a magnet controlled by the movement of the core for closing the running switch and opening the starting switch, means for deenergizing said magnet when the running switch is closed, and a no-voltage release magnet controlling the running switch.

18. In combination, a knife-blade switch, an operating magnet therefor, connections between said switch and the core of said magnet adapted to close said switch when

said magnet is energized and to permit the return movement of said core without moving said switch, means for deenergizing said magnet when said switch is closed, means for retarding the return movement of said core, and means controlled by the movement of said core for opening said switch.

19. In combination, a knife-blade switch, an operating magnet therefor, a lost-motion connection between the magnet core and said switch, means for deenergizing said magnet when said switch is closed, means for retarding the return movement of said core, and means controlled by the movement of said core for opening said switch.

20. In combination with an electric motor, a knife-blade switch in the motor circuit, an operating magnet therefor, a lost-motion connection between the magnet core and said switch, means for deenergizing said magnet when said switch is closed, and a no-voltage release magnet adapted to restrain said core.

21. In combination, two knife-blade switches, independent operating magnets for said switches, lost-motion connections between each switch and the core of its operating magnet, and an interlock between said switches.

22. In combination, two knife-blade switches, independent operating magnets for said switches, lost-motion connections between each switch and the core of its operating magnet, an interlock between said switches, and means for deenergizing each magnet when the switch operated thereby is closed.

23. In combination, two knife-blade switches, independent operating magnets for said switches, lost-motion connections between each switch and the core of its operating magnet, an interlock between said switches, means for deenergizing each magnet when the switch operated thereby is closed, and a no-voltage release magnet controlling the core of one of said operating magnets.

24. In combination with an electric motor, two knife-blade switches adapted to establish respectively starting and running connections, independent operating magnets for said switches, an interlock between said switches, a control system adapted to energize the magnet for the starting switch and then the magnet for the running switch after a predetermined interval, and means for deenergizing the magnet of the starting switch when said switch is closed.

25. In combination with an electric motor, two knife-blade switches adapted to establish respectively starting and running connections, independent operating magnets for said switches, an interlock between said switches, a control system adapted to energize the magnet for the starting switch and

then the magnet for the running switch after a predetermined interval, means for deenergizing each magnet when the switch operated thereby is closed, and a no-voltage release magnet controlling the running switch.

26. In combination, a knife-blade switch, an operating magnet therefor, a lost-motion connection between the magnet core and said switch, means for deenergizing said magnet when said switch is closed, a latch adapted to engage said core, and a magnet controlling said latch.

27. In combination, a knife-blade switch, an operating magnet therefor, a lost-motion connection between the magnet core and said switch, means for deenergizing said magnet when said switch is closed, a latch adapted to engage said core, a magnet controlling said latch, and a switch in circuit with said latch-controlling magnet.

28. In combination with an electric motor, a knife-blade switch in the motor circuit, an operating magnet therefor, a lost-motion connection between the magnet core and said switch, means for deenergizing said magnet when said switch is closed, a no-voltage release magnet adapted to restrain said core, and a switch in circuit with said no-voltage release magnet.

29. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, means controlled by the first magnet for energizing the second magnet at a predetermined interval after the first magnet is energized, means for automatically deenergizing the second magnet when the running switch is closed, a no-voltage release magnet controlling said running switch, and a switch in circuit with said no-voltage release magnet.

30. In combination with an electric motor, a switch adapted to establish starting connections, an operating magnet therefor, a switch for establishing running connections, an operating magnet therefor, a control circuit comprising the first magnet, means for automatically energizing the second magnet a predetermined time after the control circuit is closed, means for automatically deenergizing the second magnet when the running switch is closed, a no-voltage release magnet controlling said running switch, and a switch in circuit with said no-voltage release magnet.

31. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a control system comprising automatic operating means for said switches adapted to close the starting switch and then to close the running switch and open the starting switch after a predetermined interval, means

for deenergizing said operating means when

the running switch is closed, a no-voltage release magnet controlling said running switch, and a switch in circuit with said no-voltage release magnet.

32. In combination with an electric motor, two switches adapted to establish respectively starting and running connections, a mechanical interlock between said switches, a control system comprising automatic operating means for said switches adapted to close first the starting switch and then the running switch after a predetermined interval, means for deenergizing said operating means when the running switch is closed, a no-voltage release magnet controlling said running switch, and a switch in circuit with said no-voltage release magnet.

33. In combination with an alternating-current motor, a voltage controlling device, two switches adapted to connect said motor in different relations to said device for starting and for running respectively, operating magnets for said switches, and means controlled by the operating magnet of the starting switch for energizing the operating magnet of the running switch at a predetermined interval after the first magnet is energized.

34. In combination with an alternating-current motor, a voltage controlling device, two switches adapted to connect said motor in different relations to said device for starting and for running respectively, operating magnets for said switches, a control circuit comprising the operating magnet for the starting switch, and means for automatically energizing the operating magnet of the running switch a predetermined time after the control circuit is closed.

35. In combination with an alternating-current motor, a voltage controlling device, two switches adapted to connect said motor in different relations to said device for starting and for running, a control system comprising automatic operating means for said switches adapted to close the starting switch and then to close the running switch and open the starting switch after a predetermined interval, and means for deenergizing said operating means when the running switch is closed.

36. In combination with an alternating-current motor, a voltage controlling device, two switches adapted to connect said motor in different relations to said device for starting and for running, a control system comprising automatic operating means for said switches adapted to close the starting switch and then to close the running switch and open the starting switch after a predetermined interval, means for deenergizing said operating means when the running switch is closed, and a no-voltage release magnet controlling the running switch.

37. The combination of an electric motor,

a switch adapted to establish starting connections, operating means therefor, a switch for establishing running connections, operating means therefor, and means controlled by the first operating means for energizing the second operating means at a predetermined interval after the first operating means is energized.

38. The combination of an electric motor, a switch adapted to establish starting connections, operating means therefor, a switch for establishing running connections, operating means therefor, means controlled by the first operating means for energizing the second operating means at a predetermined interval after the first operating means is energized, and means for opening the starting switch when the second operating means is energized.

39. The combination of an electric motor, a switch adapted to establish starting connections, operating means therefor, a switch for establishing running connections, operating means therefor, means controlled by the first operating means for energizing the second operating means at a predetermined interval after the first operating means is energized, and a mechanical interlock between said switches.

40. The combination of an electric motor, two switches adapted to establish starting and running connections respectively, a control system comprising operating means for said switches, and means controlled by the operating means for the starting switch for energizing the operating means for the running switch at a predetermined interval after the operating means for the starting switch is energized.

41. In combination, an induction-motor, a supply-circuit, a transformer, a plurality of automatically-operated switches for first connecting the motor to the supply-circuit through the transformer and then connecting the motor directly to the supply-circuit.

42. In combination, an alternating-current electric motor, an alternating-current-supply circuit, a transformer, a plurality of separately-actuated switches for first connecting the motor to the supply-circuit through the transformer and then connecting the motor directly to the supply-circuit.

43. In combination, an alternating-current motor, an alternating-current-supply circuit, a transformer, a plurality of automatically-operated switches for first connecting the motor to the supply-circuit through the transformer and then connecting the motor directly to the supply-circuit.

44. A main motor controller, comprising a plurality of separately-actuated contacts, a master controlling device for said main motor-controller, a source of current-supply, an electric motor, a transformer, and connec-

tions whereby when the master-controller is in one position the contacts are actuated to connect the motor to the source of supply by means of the transformer and when in another position the contacts are actuated to connect the motor directly to the source of supply.

45. A motor, a source of current-supply, a master-controller, transformer-windings, and means controlled by the master-controller for connecting the motor and source of supply through the transformer-windings in one position of the master-controller and for connecting the motor and the source of supply directly in another position of the master-controller.

46. An electric motor, a source of current-supply, transformer-windings, an automatically-operated master-controller, a main motor-controller controlled by the master-controller and adapted to connect the motor and the source of supply through the transformer-windings in one position of the master-controller and to connect them directly in another position of the master-controller.

47. In an electric motor, a source of current-supply, transformer-windings, an automatically-operated master-controller, a main motor controller consisting of a plurality of separately-actuated contacts and controlled by the master-controller, these contacts being adapted to connect the motor and the source of supply through the transformer-windings in one position of the master-controller and to connect the motor and the source of supply directly in another position of the master-controller.

48. In combination, an electric motor, a supply-circuit, an autotransformer, and a plurality of separately-actuated contacts for first connecting the motor to the supply-circuit through the autotransformer and then connecting the motor directly to the supply-circuit.

49. In combination with an alternating current motor, a voltage controlling device, two switches adapted to connect said motor in different relations to said device for starting and for running, and a control system for said switches comprising means automatically operating to close the starting switch and then to close the running switch and open the starting switch after a predetermined interval.

50. The combination with a motor, of a compensator, a compensator switch for connecting the motor thereto, a running switch for connecting the motor directly to the line, and a time relay device adapted after a predetermined interval of time to cause said compensator switch to be actuated to disconnect the motor from the compensator and cause said running switch to be actuated to connect the motor directly to the line.

51. The combination with a motor, of a compensator, a compensator switch for connecting said motor with the compensator, a running switch for connecting the motor directly to the line, a time relay device for causing said compensator switch to be opened after a predetermined period and for causing said running switch to be closed, and means for preventing said switches from being closed at the same time. 10

In witness whereof, I have hereunto set my hand this 29th day of November, 1905.

CHARLES D. KNIGHT.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.