C. D. KNIGHT.

AUTOMATIC MOTOR STARTER.

APPLICATION FILED JUNE 10, 1907. RENEWED APR. 3, 1909.

1,003,915.

Patented Sept. 19, 1911.

3 SHEETS—SHEET 1.

Fig. 1.

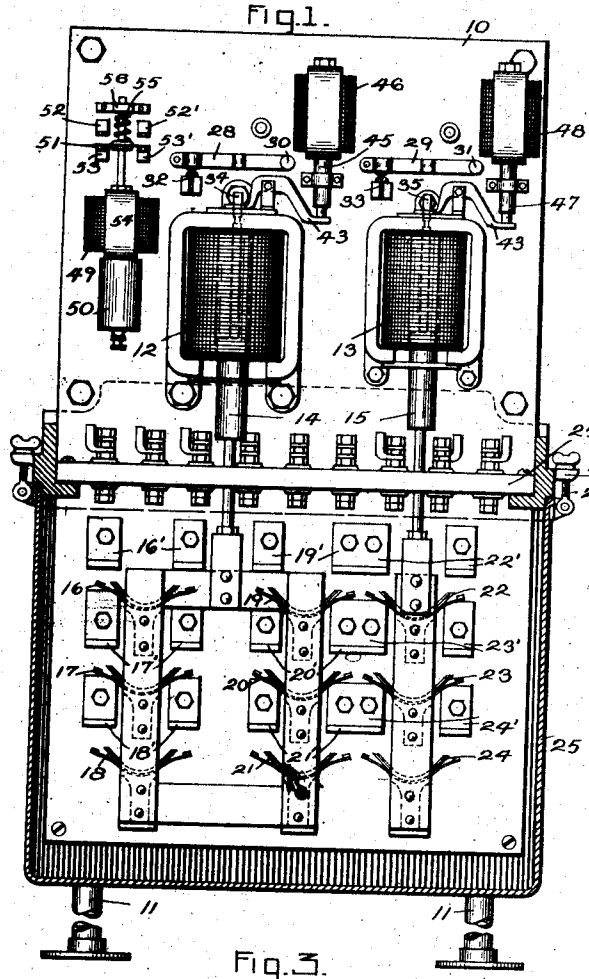


Fig. 2.

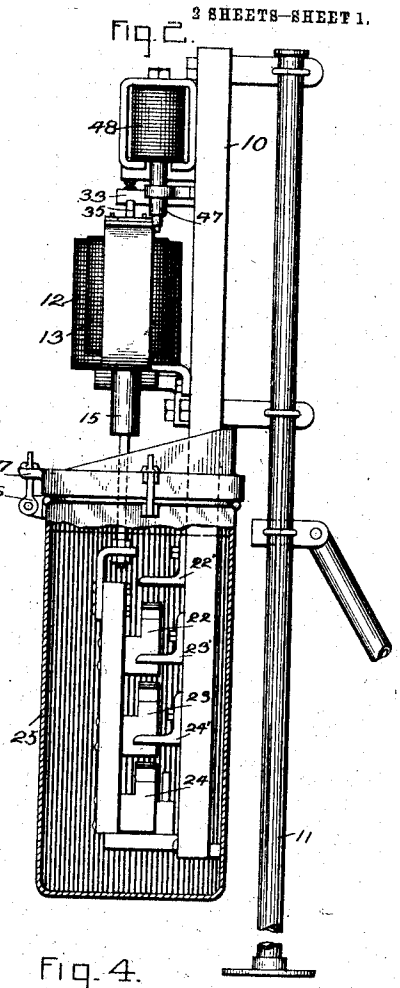


Fig. 3.

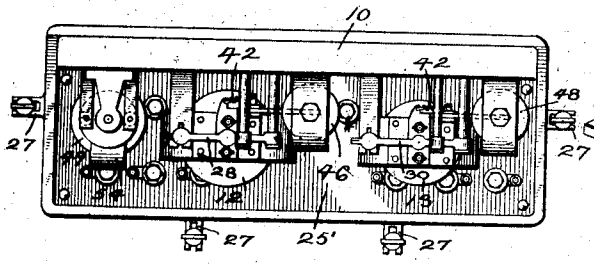
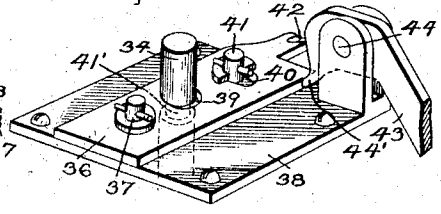


Fig. 4.



WITNESSES

W. Ray Taylor.

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INVENTOR

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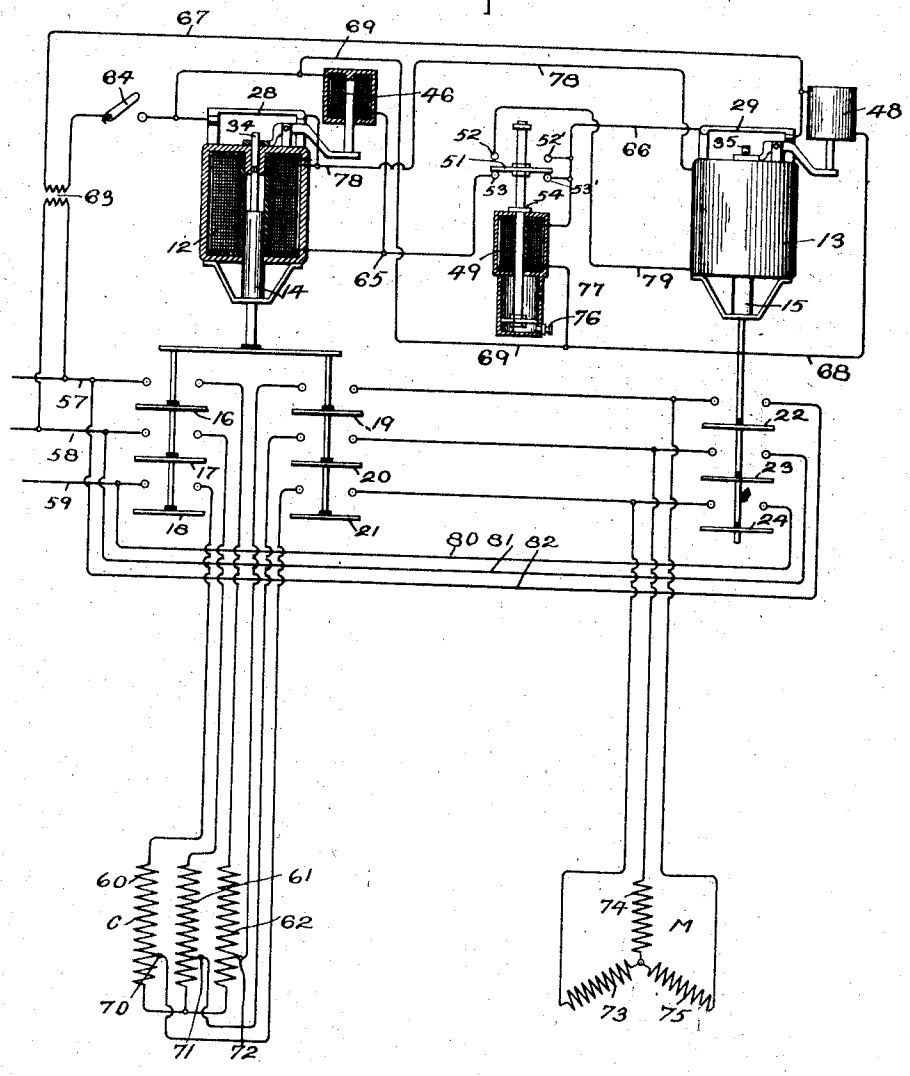
2 SHEETS—SHEET 2.

Fig. 5.



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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

AUTOMATIC MOTOR-STARTER.

1,003,915. Specification of Letters Patent. Patented Sept. 19, 1911.

Application filed June 10, 1907, Serial No. 378,255. Renewed April 3, 1909. Serial No. 487,789.

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 Automatic Motor-Starters, 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 type which are controlled by connecting them to a source of low voltage for starting and then increasing the impressed voltage for running.

One of the objects of my invention therefore is to provide a simple and efficient automatic starter for alternating current circuits by means of which motors may be controlled from a distance either manually or by automatic switching devices, such as pressure governors, float switches and the like.

In carrying out my invention I provide in connection with a transformer, a plurality of switches arranged to first connect the source of current with the motor through the transformer and then connect the motor directly to the source of current.

More specifically I provide two solenoid switches which are so arranged as to deënergize the solenoids when the switch is in operative position.

In order to hold the switch in operative position after the solenoid is deënergized, I provide latch mechanisms which are electrically controlled. I also provide an automatically operated master controller equipped with retarding means. This master controller is so arranged that at the end of a definite interval it releases the locking device of the first solenoid and simultaneously energizes the second solenoid thereby cutting out the transformer, and connecting the motor directly to the line.

My invention will be more clearly comprehended by a reference to the accompanying drawings in which I have shown my invention embodied in concrete mechanism for purposes of illustration.

In these drawings, Figure 1 is a front elevation of my complete device; Fig. 2 is a side elevation of the same, the oil tank being partially broken away to show the switches; Fig. 3 is a plan view of the device; Fig. 4 is a detail of the latching mechanism; and Fig. 5 is a diagram of the circuits.

Referring to the drawings, I shall first describe the mechanical features of my device and shall then proceed to describe the operation and circuiting.

Referring therefore to Figs. 1 to 4, 10 is an insulating panel of slate or soapstone, supported in a vertical position by the standards 11, on the front of which my switching mechanism is mounted. The switching mechanism proper consists of two solenoid switches 12 and 13 having cores 14 and 15 respectively. The core 14 has secured to its lower end a frame-work for supporting six laminated brushes 16, 17, 18, 19, 20 and 21 each adapted to bridge a pair of corresponding contacts 16′, 17′, 18′, 19′, 20′, and 21′ when the core is in a raised position. Secured to the lower end of the core 15 is a frame-work for supporting a similar set of three brushes 22, 23 and 24 likewise adapted to bridge corresponding contacts 22′, 23′ and 24′ when the core is in its raised position. A tank 25 adapted to be filled with oil is secured to the contact board 25′, which projects from the panel, by means of pivoted bolts 26. These bolts fit into slotted bars 27 so that the tank can be easily lowered or removed. Above each of the solenoids 12 and 13 are switch arms 28 and 29 pivoted respectively at 30 and 31 having at their free ends carbon contacts engaging with fixed carbon contacts 32 and 33. These switch arms are arranged directly over the cores 14 and 15 and are adapted to be engaged by projecting rods 34 and 35 on the ends of the cores. The carbon contacts 32 and 33 are thus separated as the cores 14 and 15 are drawn into their respective solenoids. The switches 28 and 29 open the circuits of their corresponding solenoids and in order to maintain the cores of the solenoids in a raised position after the solenoids are deënergized, I provide a latching mechanism, the details of which are shown in Fig. 4. The locking or latching devices of both solenoids are the same and consist of a latch 36 pivoted at 37 to the

plate 38 on the upper end of the solenoid. The latch is provided with a perforation 39 adapted to admit the rod 34 and also a slot 40 coöperating with a pin 41 in the plate 38 to limit the movement of the latch. The rod 34 is provided wih a groove 41′ arranged to be engaged by the latch 36 and hold the rod 34 in a raised position. The spring 42 attracts the latch into the groove as shown in Fig. 4. A lever 43 pivoted at 44 to a bracket on plate 38 coöperates with the latch. This lever has a lip 44′ at one end to engage the latch and at its opposite end extends in a horizontal direction so as to be engaged by core 45 of magnet 46. A similar core 47 controlled by solenoid 48 acts upon the rod 35 of core 15. It will be seen that when the magnets 46 and 48 are deënergized, the cores are down and exert pressure upon their corresponding levers 43. This forces the latch against the tension of the spring 42 so that the rod will pass freely through the perforation 39. When, however, the cores 45 and 47 are raised, the springs 42 exert a tension upon the latch so that the rod 34 is raised until the groove 41 reaches the latch 36, and the latter enters the groove locking the same in place. When the core drops upon the lever 43, the latch 36 is forced over and releases the rod 34, allowing the core 14 to drop therefore causing the switches secured thereto to drop. A solenoid 49 is mounted upon the panel adjacent to the solenoid 12 and is provided with a core, the lower end of which has a piston (see Fig. 5) operating in a barrel 50 so as to constitute a dash-pot. The upper end of the core passes loosely through contactor 51 adapted to move between the contacts 52, 52′, and 53, 53′. A collar 54 on the rod engages the contactor and forces it to bridge contacts 52, 52′, and a spring 55 between the contactor and bearing block 56 forces the contactor into engagement with the contacts 53, 53′.

The arrangement of circuits and the mode of operation are as follows: I have shown my device in use on a three-phase circuit, of which 57, 58 and 59 are the main or supply conductors. M is a three-phase motor and C is the starting compensator or autotransformer having three branches 60, 61 and 62, one for each phase. A control circuit is tapped off from the conductors 57 and 58 and a step-down transformer 63 reduces the potential to the desired point for control purposes. The switch 64 may be operated manually or in any desired manner, as for instance by a float switch or the like. When the switch 64 is closed, four solenoids 12, 46, 48 and 49 are simultaneously energized. The control current passes from switch 64 through solenoid 46 and also in parallel through the solenoid 12 to the point 65, current to the solenoid 12 passing through the switch arm 28. Current then passes across contactor 51 through conductor 66, switch arm 29, conductor 67 and back to the transformer. Current also passes through solenoid 49 from switch 64 to conductor 69 and thence through conductor 66, switch arm 29 and conductor 67.

The circuit of the solenoid 48 is independently completed as follows: from switch 64, conductor 69, solenoid 48 and conductor 67. The circuit of solenoid 48 therefore can only be opened and closed at the switch 64. The solenoid 12 being energized draws up its core and closes the switches 16, 17, 18, 19, 20 and 21 which connect the main conductors 57, 58 and 59 to one end of the transformer sections 62, 61 and 60 respectively and also taps 70, 71 and 72 with the three phases 73, 74 and 75 of the motor. The taps of the transformer are so arranged as to give the desired starting potential to the motor, and may be adjusted as desired. When the core 14 rises, the rod 34 at its upper end engages the switch arm 28 and opens the circuit of solenoid 12. Solenoid 46, however, is energized and by raising its core allows the latch 36 to engage the groove 41 in the rod 34 and hold the core in a raised position. Solenoid 49 also being energized attracts its core but this core is retarded by the dash-pot which may have its speed regulated by the valve 76. The piston moves upward slowly until it reaches the perforations 77, when the dash-pot is suddenly released and the core moves upward quickly. The collar 54 strikes the contactor 51 and moves it quickly upward so as to bridge the contacts 52, 52′, and break the circuit at 53, 53′. When the contactor leaves the contacts 53, 53′ the solenoid 46 is deënergized and the core 14 thereupon drops cutting off the compensator C. The circuit of solenoid 13, however, is immediately closed through contacts 52, 52′, the circuit now being as follows: from switch 64 to arm 28, conductor 78, solenoid 13, conductor 79, contactor 51, switch arm 29 and conductor 67. The core 15 is thereupon drawn up and the circuit is closed from the main conductors 57, 58 and 59 directly to the motor through brushes 22, 23 and 24, and conductors 80, 81 and 82 respectively. When the core 15 rises the circuit of the solenoid 13 is opened but the core is prevented from dropping by the latching mechanism since the solenoid 48 is all of the time energized. This solenoid 48 operates as a no-voltage magnet and upon failure of voltage will release the core 15 and open the circuit. The same thing will happen if the circuit is opened at switch 64. It should be noted that when the switch 29 is opened the circuit of the solenoid 49 is likewise opened and the core drops back quickly, the dash-pot not operating on the return movement. While the motor then is

running under normal conditions solenoid 48 is the only coil energized, the energizing circuit of the others being opened at switch 29.

It will be seen that I have provided a very simple and efficient method of starting alternating current motors by simply operating a control switch, the arrangement being such that only a no-voltage magnet is energized while the motor is in operation.

Various modifications will of course suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

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

1. A starter for electric motors comprising a transformer, a plurality of magnetically-operated switches for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit, and electrically-controlled means for mechanically locking said switches in operative position.

2. A starter for electric motors comprising a transformer, a plurality of magnetically-operated switches for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit, a master controller for the switches, and electrically-controlled means for mechanically locking said switches in operative position.

3. A starter for electric motors comprising a transformer, a plurality of magnetically-operated switches for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit, an electrically-controlled device for mechanically locking one of said switches in operative position, and a master controller for said switches and said locking device.

4. A starter for electric motors comprising a transformer, a magnetically-operated switch for connecting the supply circuit to the transformer and the transformer to the motor, a second magnetically-operated switch for connecting the supply circuit directly to the motor, and electrically-controlled means for locking said switches in operative position.

5. A starter for electric motors comprising a transformer, a plurality of solenoid switches for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit, means for deënergizing said solenoids when the switches are moved to the operative position, and electrically-controlled means for locking said switches in said position.

6. A starter for electric motors comprising a transformer, a plurality of solenoid switches for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit, means for deënergizing said solenoid when the switches are moved to the operative position, means for locking said switches in said position, and a master controller for said solenoids.

7. A starter for electric motors comprising a transformer, a plurality of solenoid switches for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit, means for deënergizing said solenoids when the switches are moved to the operative position, means for locking one of said switches in said position, and a master controller for said solenoids and said locking device.

8. A starter for electric motors comprising a transformer, a solenoid switch for connecting the motor to the supply circuit through the transformer, means for deënergizing said solenoid when the switch is moved to the operative position, means for locking said switch in said position, a second solenoid switch for connecting the motor directly to the supply circuit, and a master controller arranged to release the said locking device and simultaneously energize said second solenoid.

9. A starter for electric motors comprising a transformer, a solenoid switch for connecting the supply circuit to the transformer and the transformer to the motor, means for deënergizing said solenoid when the switch is moved to the operative position, electrically-controlled means for locking said switch in said position, a second solenoid switch for connecting the motor directly to the supply circuit, and a master controller arranged to release the said locking device and simultaneously energize said second solenoid.

10. A starter for electric motors comprising a transformer, a solenoid switch for connecting the supply circuit to the transformer and the transformer to the motor, means for deënergizing said solenoid when the switch is moved to the operative position, electrically-controlled means for locking said switch in said position, a second solenoid switch for connecting the motor directly to the supply circuit, means for deënergizing said second solenoid when the switch is moved to the operative position, an electrically-controlled locking device for said second switch, and a master controller arranged to release said first locking device and simultaneously energize said second solenoid.

11. A starter for electric motors comprising an impedance, a plurality of solenoid switches for first connecting the motor to the supply circuit through the impedance and then connecting the motor directly to

the supply circuit, independent electrically controlled means for locking each switch in operative position, and means for deënergizing each solenoid as its switch is moved to operative position.

12. A starter for electric motors comprising a transformer, a plurality of magnetically-operated switches for first connecting the motor to the supply circuit through the transformer and then connecting the motor directly to the supply circuit, and electrically-controlled means for mechanically locking said switches in operative position.

In witness whereof, I have hereunto set my hand this 8th day of June, 1907.

CHARLES D. KNIGHT.

Witnesses:

BENJAMIN B. HULL,

MARGARET E. WOOLLEY.