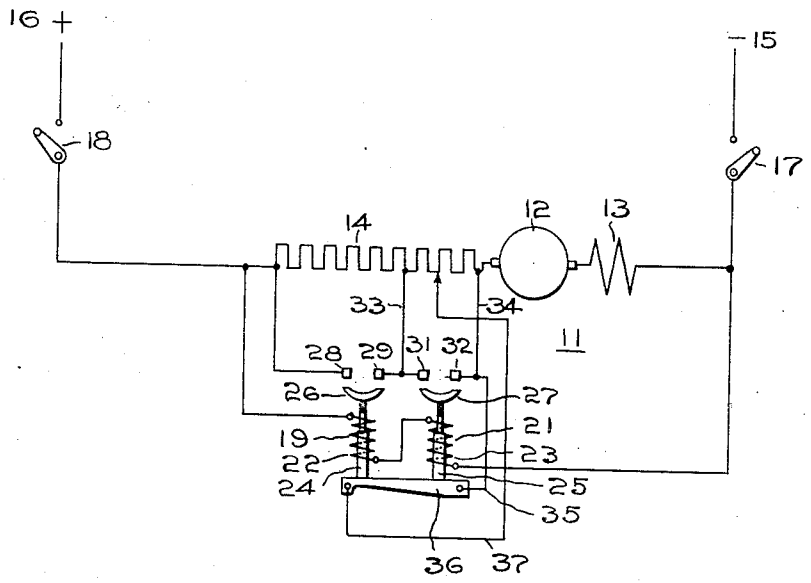
July 3, 1928.

1,675,396

H. E. WHITE

THERMAL RELAY

Filed May 4, 1925



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Patented July 3, 1928. 1,675,396

UNITED STATES PATENT OFFICE.

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THERMAL RELAY.

Application filed May 4, 1925. Serial No. 27,720.

My invention relates to motor starting devices and particularly to thermally controlled motor starters.

One object of my invention is to provide a relatively simple and compact thermally-controlled means for automatically starting a motor, that shall comprise relatively few parts.

In practicing my invention, I provide a plurality of magnetic contactors and a single magnetically-reversible, current traversed member co-operating with the core members of the contactors to normally hold them in their inoperative positions.

The single figure of the drawing is a schematic diagram of connections and of a device embodying my invention.

An electric motor 11 comprises an armature 12 and a field-magnet winding 13 and is here illustrated as a direct-current, series-wound motor, although the device embodying my invention is not limited in its use to this particular type of motor, but may be used with any motor requiring a starting rheostat.

A starting rheostat 14 is connected in series-circuit relation to the motor 11 and the two members are connected to two supply circuit conductors 15 and 16. Manually operable switches 17 and 18 are provided to permit of de-energizing or energizing the motor circuit. While I have illustrated the two manually operable switches as separate single-pole switches, they may be combined in any desired form, usually employed in the art.

Means for effecting the automatic short-circuiting of the starting resistor 14 in predetermined steps, comprises a pair of electromagnetic contactors or switches 19 and 21, respectively embodying actuating coils 22 and 23, and movable core members 24 and 25 of magnetic material, such as iron or steel. Contact bridging members 26 and 27 are operatively connected to the respective core members 24 and 25 and insulated therefrom in the usual manner and are adapted to co-operate with pairs of spaced contact members 28 and 29, 31 and 32, respectively. The contact member 28 is connected to that terminal of the resistor 14 connected to the conductor 16, and the two contact terminals 29 and 31 are connected together and to an intermediate point of the starting resistor 14 by a conductor 33. The terminal 32 is connected to the other terminal of the resistor 14 by a conductor 34, which end of the resistor is electrically connected to one terminal of the motor armature 12.

The terminal 32 is connected, through a conductor 35, to one end of a fixed magnetically reversible member 36 that has a varying area of cross-section from one end thereof toward the other end thereof, substantially in the manner illustrated in the drawing. The other end of the member 36 is connected through a conductor 37 to an intermediate point of the resistor 14 and provision is made in the resistor 14 for a plurality of taps in order to permit of varying the point of connection of the conductor 37.

The member 36 comprises a metal alloy having the characteristic that, when normally cool, it is magnetic, if heated to a temperature of a predetermined value it becomes non-magnetic, and if cooled to a temperature slightly below this value, it again becomes magnetic. Because of this reversible characteristic, relative to its magnetic properties when subjected to heat, the member 36 may be designated a magnetically reversible member.

The actuating coils 22 and 23 of the two electromagnetic contactors are connected in series-circuit relation to each other and to the supply circuit conductors 16 and 15, respectively, or to the outer terminals of the starting resistor and of the motor, respectively.

The operation of the device embodying my invention is substantially as follows: upon closing the energizing switches 17 and 18, a current will traverse the motor armature, the field-magnet winding and the starting resistor, that is initially in direct accordance with the voltage of the circuit and inversely in proportion to the resistance of the circuit constituted thereby. As the motor armature increases in speed, it will develop counter-electromotive force and reduce the current in a manner well known in the art.

As soon as the switches 17 and 18 are closed, a current will traverse the two actuating coils 22 and 23, the value of which will be in accordance with the voltage of the circuit and the resistance of the two coils. The two coils thus energized will tend to move the core members 24 and 25 upwardly but such action will be prevented by reason of the fact that the lower ends of the core

members are indirect operative engagement with the upper surface of the elongated member 36, which, as stated above, is normally magnetic. The pull caused by the actuating coils 22 and 23 is of such value that disengagement of the core member 24 and 25 cannot be effected under the normal conditions.

The member 36 is connected in shunt circuit relation to a portion of the resistor 14 and will, therefore, be traversed by a current that is in accordance with the current traversing the resistor and the motor, and further in accordance with the amount of the starting resistor to which it is connected in parallel circuit relation. After a predetermined length of time, which depends upon the current traversing the same, the temperature of the member 36 will be increased to such a value that it ceases to be magnetic. It is evident that the portion of the member 36 having the smaller area of cross-section will become non-magnetic sooner than the other portions thereof that are of relatively larger area of cross-section because the current density is greater therein.

A member of a nickel-steel alloy has the required properties hereinbefore described, of becoming non-magnetic at a higher temperature and by suitable proportioning of the amount of nickel and of steel, it is possible to cause this loss of magnetic properties to take place at a relatively low temperature, such as say 150° F. When this change occurs at the left hand end of the member 36, the core member 24 is actuated upwardly by the pull of the coil 22 and the bridging member 26 engages the fixed contact members 28 and 29 and effects a short circuit of that portion of the starting resistor 14 connected between these points.

Since current is still traversing the member 36, the portions thereof of larger cross-sectional area will be heated to such temperature as will result in a loss of its magnetic property. When this occurs, the core member 25 will be caused to move upwardly under the influence of the coil 23 and the remaining portion of the starting resistor electrically connected between the fixed contact members 31 and 32 will be short circuited.

As the actuating coils 22 and 23 are continually energized, the core members 22 and 23 will be maintained in their upper positions, wherein the bridging members 26 and 27 operatively engage the respective pairs of contact members 28 and 29, and 31 and 32, irrespective of the fact that the member 36 is no longer traversed by a current and that, upon cooling, it again is magnetic. Should the device and the actuating coils 22 and 23 become de-energized for any reason, as by opening of either or both of the switches 17 or 18, or by reason of a no-voltage condition occuring on the line, the core members 22 and 23 will again drop downwardly so that their lower ends will engage the member 36 and the hereinbefore described method of operation will again be effected to automatically start the motor and bring it up to normal speed when connected across the line.

While I have illustrated two electromagnetic contactors only, I do not desire to be limited thereto, as it is evident that any desired number of such contactors may be employed and it is only necessary to provide a proper length of the magnetically-reversible, current-traversed member 36 to co-operate with the desired number of electromagnetic contactors.

It may be noted also that by varying the point of contact of the conductor 37 to or with the resistor 14, it is possible to vary the length of time required between the operation of the respective contactors to short circuit portions of the starting resistor. If a larger amount of the starting resistor is connected in shunt circuit relation with the ends of the member 36, it is evident that the member 36 will be traversed by a larger current and that it will heat up more quickly and permit the hereinbefore described operation of the individual contactors to take place sooner.

Various modifications and changes may be made without departing from the spirit and scope of the invention, and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art.

I claim as my invention:

1. A thermally-controlled motor starter comprising a current-traversed magnetically-reversible member, and a plurality of electro-magnetic switches operated in predetermined sequence thereby.

2. A thermally-controlled motor starter comprising a single current-traversed magnetically-reversible member, and a plurality of electromagnetic switches, each comprising a winding and a magnetic core that is initially in operative engagement with said magnetically-reversible member and disengaged therefrom in predetermined sequence upon heating of said member.

3. In a thermally-controlled motor starter, a plurality of electromagnetic switches, each comprising an energizing winding and a magnetic core member actuable thereby, and a current-traversed magnetically-reversible member for normally holding said core members against the action of said energizing winding and for releasing the same in predetermined sequence.

4. In a thermally-controlled motor starter, a plurality of actuating coils, a plurality of cooperating movable magnetizable members,

and a current-traversed magnetically reversible member for normally restraining said movable members against movement by the actuating coils and for causing said movable members to be actuated in predetermined sequence upon heating of said member.

5. In a thermally-controlled starting device for a motor having a resistor operatively associated therewith, a plurality of actuating coils, a plurality of cooperating movable magnetizable members, and a current-traversed magnetically-reversible member connected in shunt circuit relation to said resistor and effective to normally restrain the movable members against movement by the actuating coils and to cause movement thereof in predetermined sequence to short-circuit said resistor upon heating of said magnetically-reversible member.

6. In a starting device for a motor having a resistor operatively associated therewith, the combination with a plurality of electromagnets having movable core members associated therewith, of a single member that loses its magnetism at a predetermined temperature for normally holding the core members in inoperative positions, means for permitting a current to traverse said single member that is in accordance with the current traversing said resistor, said single member being so shaped that it will permit the core members to be moved in predetermined sequence only.

7. In a thermally-controlled motor starter, a plurality of actuating coils, a plurality of movable core members associated therewith, a single, elongated, magnetically-reversible member of varying area of lateral cross-section and means for permitting said magnetically-reversible member to be traversed by a current that is in accordance with the current traversing said motor, to be heated thereby and permit movement of said core members in predetermined sequence.

8. The combination with a motor and a starting resistor therefor, of means for shunting said resistor, a normally magnetized thermal element for restraining said shunting means, said element being heated by current traversing said resistor, whereby said element becomes de-magnetized.

9. The combination with a motor and a starting resistor therefor, of a switch for shunting said resistor, and a magnetized member for restraining said switch, said member being heated and de-magnetized in accordance with current traversing said resistor.

10. The combination with a motor and a starting resistor therefor, of means for progressively shunting said resistor out of the motor circuit comprising a plurality of electromagnet switches, and a magnetic member, heated in accordance with the current flowing in said motor during the period when the resistor is in circuit therewith, adapted to release said switches in sequence.

In testimony whereof, I have hereunto subscribed my name this 29th day of April, 1925.

HAROLD E. WHITE.