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CONTROL FOR ELECTRIC MOTORS

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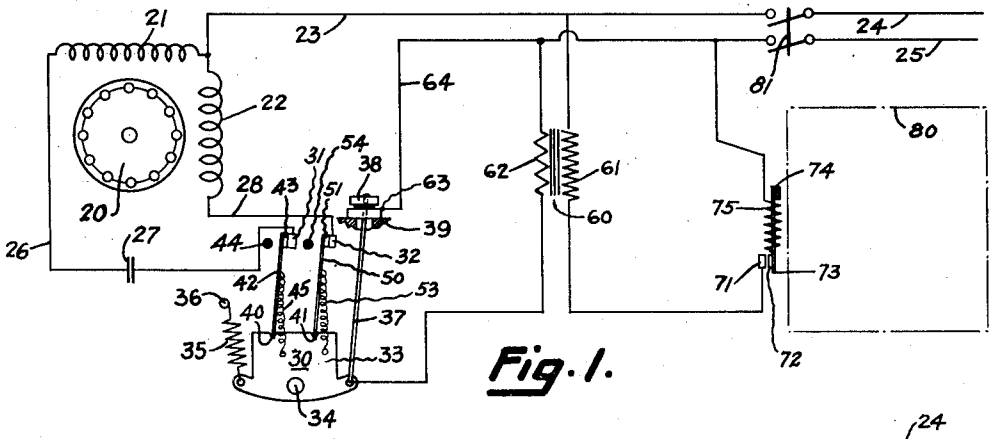


Fig. 1.

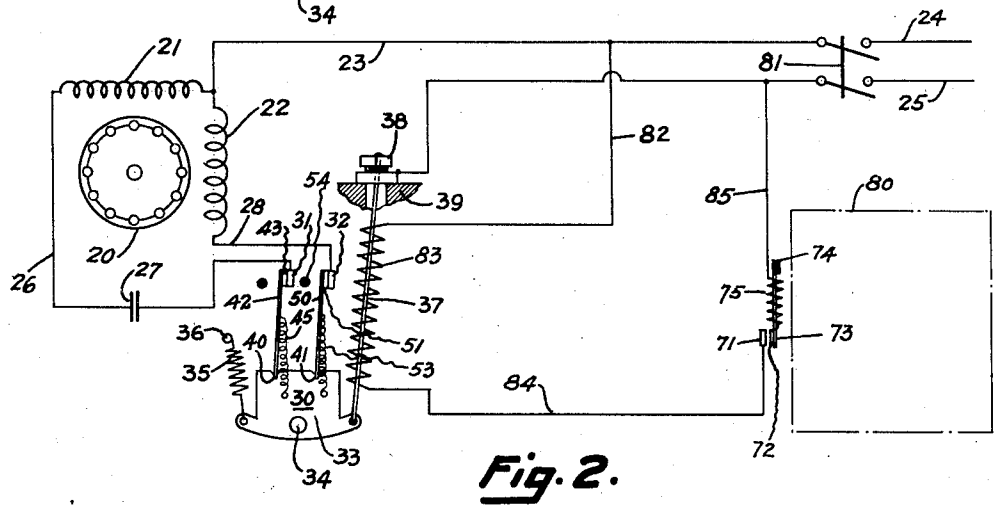


Fig. 2.

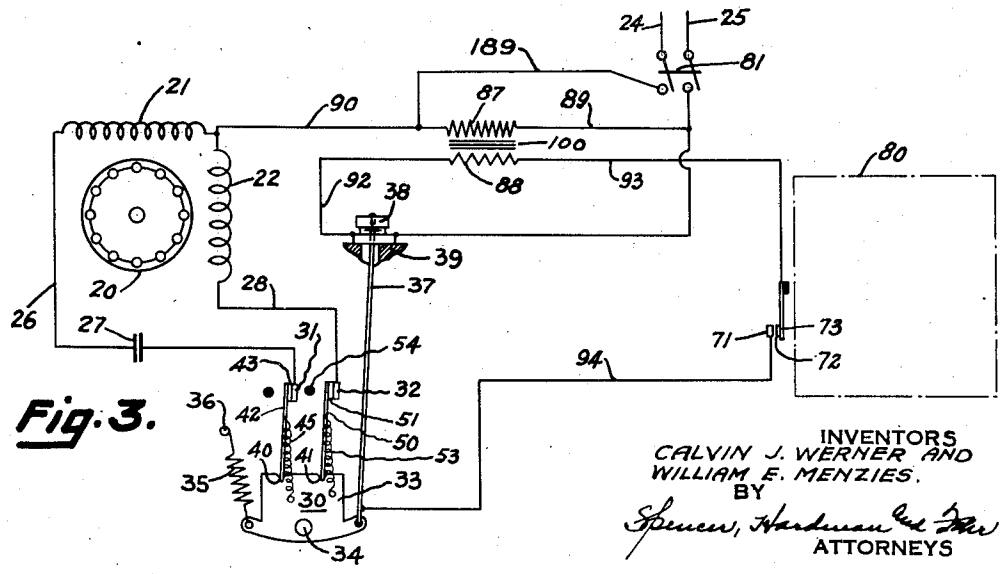


Fig. 3.

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CONTROL FOR ELECTRIC MOTORS

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The invention relates to improvements in electrical control devices particularly adapted for use with electric motors providing motive power for refrigeration or air conditioning apparatus.

It is among the objects of the present invention to provide a device of simple structure and design adapted to control the starting of an electric motor, protect it against damages by overload or abnormal running conditions and also to control operation of the motor in response to and in accordance with variations in temperature remote from said motor.

Simplicity of design and the required circuits are attained by providing a single control switch adapted to be rendered effective to control the motor in accordance with current conditions during the starting and running periods of said motor and also in accordance with variations in temperature remote from said motor.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, in which a preferred embodiment of the invention is clearly shown.

In the drawing:

Fig. 1 is a diagrammatic view illustrating the various elements of the device and their circuits, one of said elements being an electrical translating device in the form of a transformer, the lower voltage coil of which is directly connected across the thermal actuator of the switch.

Fig. 2 differs from Fig. 1 in the elimination of the transformer and the provision of a heater coil about the thermal member of the switch.

Fig. 3, like Fig. 1, illustrates the use of a transformer, however, in Fig. 3, the low voltage coil of the transformer is connected in circuit directly with the thermal element of the device.

Referring to the drawing, the numeral 20 designates the motor having a starting winding 21 and a running winding 22. An end of each winding 21 and 22 is connected through wire 23 with the main power supply line 24. The numeral 25 designates the other power supply line. A wire 26 connects the other end of the starting winding 21 with the stationary contact 31 of the thermal switch 30. A condenser 27 is shown in the line 26. The other end of the running winding 22 is connected by wire 28 with the stationary contact 32 of switch 30.

The thermo-electric switch 30 comprises a main body portion 33 pivotally carried by stud 34. A tension spring 35 is secured at one end to an extension of switch body 33, the other end of the spring being anchored to the stationary pin 36. Another extension of body 33 has one end of a thermal element 37 attached thereto, the opposite end of said thermal element being secured to the adjustable nut 38 carried by the stationary portion 39 of the switch. The switch body 33 has two notches 40 and 41. One end of the movable contact arm 42 seats in notch 40. A contact 43 is secured to said arm 42 adjacent its other free end and is adapted to engage stationary contact 31 as shown in Fig. 1, when contraction of thermal element 37 has rotated switch body 33 counter-clockwise a sufficient amount so as to bring notch 40 to the left of the axial line of spring 45. On the other hand is expansion of thermal element 37 permits spring 35 to rotate spring body 33 clockwise sufficiently, spring 45 will urge arm 42 toward contact 31.

A second arm 50 hingedly seats in notch 41 and has a contact 51 cooperating with stationary contact 32. A spring 53 is adapted to shift arm 50 between contact 32 and a stop pin 54 dependent upon movement of spring body 33.

An electric translating device in the form of a transformer 60 has one end of its primary coil 61 connected to the power supply line 24, the other end to a stationary contact 71. The secondary coil 62 has its one end connected to the thermal element as at 63 by wire 64, which wire also is connected to the power supply line 25. The other end of secondary coil 62 is connected to the end of thermal element 37 opposite the adjusting nut 38. Thus current from coil 62 must flow through the thermal element 37.

The means for controlling the flow of current through the primary winding 61 of the transformer comprises the stationary contact 71 adapted to be engaged by the contact 72 carried by the thermal member 73. One end of this thermal member 73 is anchored as at 74. A heater coil 75 is associated with the member 73, one end of said heater being electrically connected to said member 73, the other end to the power supply line 25. This controller element of the invention is placed in juxtaposition to or within the region where control of temperature is desired. In case the invention is used in connection with an electric motor for driving refrigeration apparatus, the controller including the thermal element 73 would preferably be placed adjacent the evaporator of the apparatus indicated by the dot-and-dash line 80 in Fig. 1. In this case said thermal element 73 would be initially stressed so that its contact 72 would just engage contact 71 at substantially 40° F. at the evaporator. A drop from this, what may be termed "reference tempera-

ture" causes the member 73 to flex so that its contact 72 is urged into engagement with contact 71 at an increased pressure, said pressure increasing as the temperature drops and thus increasing the interval of contact engagement. On the other hand, as the temperature rises above the "reference temperature" member 73 will flex to move contact 72 out of engagement with contact 71. Thus the greater the rise in temperature, the greater distance contact 72 will be moved from contact 71.

If, for instance, the electric motor, equipped with the present invention, is used to drive air conditioning apparatus, the regulator including the thermal member 73, is placed within the room or chamber in which the temperatures are to be controlled. Under these circumstances the member will be flexed initially so that its contact 72 will engage contact 71 at the desired "reference temperature," say at about 80° F. Variation in temperature from this reference temperature will affect the regulation in the manner aforedescribed.

The apparatus of Fig. 1 operates in the following manner:

When switch 30 is in the position as shown and power lines 24 and 25 are closed by switch 81, current will flow from power line 24 through wire 23 to both motor windings 21 and 22. Current flowing through the motor starting winding 21 will continue through wire 26, condenser 27 to the stationary contact 31 of switch 30, thence into contact 43, engaging contact 31, through arm or blade 42 into the body 33 of the switch, through thermal conductor or element 37 to the point 63 where wire 64 is electrically connected to said element 37. Wire 64 is connected to the other power supply line 25 by switch 81. This completes the circuit through the starting winding 21 of the motor.

The running winding circuit is completed as follows: from wire 23 through the running winding 22, wire 28, contacts 32 and 51, arm or blade 50 and thence back to the other power supply line through the switch body 33, thermal element or conductor 31, connection 63 and wire 64.

With both windings 21 and 22 so energized, motor 20 will start to operate. The first surge of current through the motor will be somewhat heavy and thus thermal element 37 carrying this surge of current will become heated, resulting in a predetermined expansion of said element. As element 37 expands, spring 35 becomes effective to rotate switch body 33 clockwise about its pivot pin 34. The contact arms or blades 42 and 50 are so arranged on the switch body 33 and relatively to their respective stop pins 44 and 54 and contacts 31 and 32 that as a result of a predetermined rotation clockwise of the switch body 33, contact arm or blade 42 will first be moved to disengage its contact 43 from the stationary contact 31. Further rotation of said body 33 clockwise will result in movement of contact arm 50 to disengage its contact 51 from contact 32. The element 37 is so designed that it will expand during the starting period of the motor, only sufficiently to permit spring 35 to rotate body 33 far enough to actuate contact arm 42 to circuit breaking position. Thus the starting circuit through winding 21 is broken. Current flowing through the thermal element 37 during the normal running of the motor is insufficient to heat up said element so that it will further expand and permit spring 35 to rotate the switch body 33 and actuate contact arm 50 to open circuit position. This takes place only when an abnormal running condition occurs or when the motor is overloaded or stalled at which time an abnormal flow through thermal element 37 results in increased heating and consequent expansion thereof. As the element 37 cools and consequently contracts, it will rotate the switch body counter-clockwise, resulting in a substantial simultaneous movement of arms 42 and 50 to their circuit closing positions. Thus it may be seen that switch 30 simultaneously closes the starting and running circuit contacts and successively opens them in accordance with the flow of current through the thermal element thereof.

This switch 30 of the present invention is adapted not only to control the starting and running of the motor, but it also provides protection for the motor under abnormal running conditions. Still another characteristic of the switch 30 is to control the motor in response to and in accordance with variations in temperature at the region designated by the dot-and-dash line 80. When the temperature at 80 is brought to and below the chosen reference temperature of 40° F., contact arm 73, as has been previously mentioned, will flex to urge its contact 72 into engagement with contact 71, thus completing the circuit from power line 24 through the primary winding 61 of the transformer, across contacts 71 and 72, member 73, heater coil 75 and back to the power supply line 25. This circuit will remain closed until the heater coil 75 radiates sufficient heat to overcome the effect of the lower ambient temperature and cause flexing of the thermal element to disengage its contact 72 from contact 71. Now thermal element 73 may cool off and again flex to close the circuit. It may clearly be seen that this operation of the thermal element 73 is repeated providing for intermittent closing of the primary circuit of the transformer. Naturally intermittent closing of the primary circuit causes the secondary circuit to provide intermittent current flow through the circuit which includes the thermal switch actuating element 37. When the closing intervals of contacts 71 and 72 are of sufficient duration due to lowering temperatures at the ambient region 80, secondary coil 62 will provide sufficient current flow through thermal element 37 to heat it, causing expansion thereof so that spring 35 may actuate the switch to open the motor circuits and thus cause cessation of motor operation.

When the temperature ambient to the control device comprising contacts 71 and 72 and thermal element 73 increases, said device will be affected to decrease the energy passing through the circuit including said device and thermoelectric element 37. When this energy level reaches the reset valve of switch 30, the switch will operate to close the motor circuits and again establish refrigeration.

The construction shown in Fig. 2 differs from that of Fig. 1 in that no transformer is used. Here the one power supply line 24 has a wire 82 leading from it to the one end of a heater coil 83 about thermal element 37, the other end of said coil having a wire 84 connecting it to the stationary contact 71. Thus each time contacts 71 and 72 are closed, current will flow from the power supply line 24 through wire 82 direct to and through the heater coil 83, wire 84, contacts 71 and 72, thermal element 73, heater coil 75 back to the other power supply line 25 via the wire 85. It will be understood, however, that thermal ele-

ment 37 is of such a nature that it will not be heated sufficiently to actuate contacts of switch 30 each time contacts 71 and 72 are closed to complete the circuit through heater coil 83. The engagement of contacts 71 and 72 must be of a predetermined interval to cause proper energization of the heater coil 83, so that it will radiate sufficient heat to effect the expansion of thermal element 37 and resultant switch operation.

In the Fig. 3 a modified form of the invention is illustrated. Here the transformer 100 has its primary winding 87 connected in circuit with the power supply line switch 81 by wires 89 and 188. The secondary, low voltage winding 88 of said transformer has one end connected through wire 92 to the adjusting nut 38 electrically engaging one end of the thermal element 37. The other end of the secondary winding 88 has a wire 93 connecting it with the thermal element 73 of the current regulator, which element carries a contact 72 cooperating with stationary contact 71. Wire 94 connects contact 71 with the end of thermal element 37 remote from the adjusting nut. In this instance the heater coil 75 about thermal element 73 is eliminated, the thermal element itself heating up and flexing due to the flow of current through it. The motor windings 21 and 22 are connected to one side of switch 81 through wires 90 and 189.

From the aforegoing description the device of the present invention comprises a single switch for controlling the circuits of the driving motor. This switch has one thermal element, affected by the current flow therethrough, to actuate the switch. Current flow during the starting period of the motor affects the thermal element to open only the starting winding. Abnormal current flow due to overload, stalling of the motor or abnormal motor requirements affects said thermal element to actuate the switch to break the running circuit of the motor. In addition to this, the device also has means providing an additional or separate current flow through the thermal element of the switch which affects said element to actuate the switch to control the motor circuits in accordance with and response to variations in temperature at a region remote from said motor.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a device of the character described, the combination with an electric motor having a starting and a running circuit, a switch adapted to control said circuits; energy translating means independent of the electric motor controlled by variations in temperature ambient thereto and remote from the motor; and means for actuating said switch, said means being rendered effective by current flow through both motor circuits and by the energy translating means.

2. In a device of the character described, the combination with an electric motor having starting and running circuits; a switch for controlling said circuits; means independent of and remote from the motor adapted to provide electrical impulses in accordance with temperature conditions ambient to said means; and an electro-thermal element for actuating said switch, said element being rendered effective by current flow through the motor circuits and also by the electrical impulses provided by the temperature controlled means.

3. In a device of the character described, the combination with an electric motor, an energy translating device; means remote from both the motor and the energy translating device for controlling the effectiveness of said device in accordance with variations in temperature ambient to said means; and a switch for controlling the motor, having means rendered effective to actuate said switch by either predetermined flows of current through the motor or the energy translating device.

4. Control apparatus for an electric motor having starting and running circuits; a switch in said circuits; thermo-electric means for actuating said switch in accordance with the flow of current through said circuits; means adapted separately to energize said thermo-electric means to actuate the switch; and a thermal circuit control device remote from the motor and unaffected thereby for regulating said energizing means in accordance with temperatures varying from a predetermined mean temperature.

5. Control apparatus for an electric motor having starting and running windings; a switch for opening and closing the circuits through both said windings; a temperature responsive actuator for said switch, in circuit with both said windings and rendered effective by variations in current flow through said windings; and means separate from the motor, for providing a flow of current to effect said temperature responsive actuator, said means comprising a temperature responsive make and break device remote from and independent of the motor adapted to control current flow in accordance with variations in temperature ambient thereto.

6. Control apparatus for an electric motor having starting and running windings; a switch having a thermal element in circuit with both windings of the motor and adapted in response to predetermined current flows therethrough to actuate the switch to control the starting circuit and to provide overload protection to the motor; and a separate circuit independent of and remote from the motor and including a thermal regulator connected to the thermal element and adapted to control said element in response to and accordance with variations in temperature ambient to said regulator.

7. Control apparatus for an electric motor having starting and running windings; a switch having a thermal element in circuit with both windings of the motor and adapted in response to predetermined current flows therethrough to actuate the switch to control the starting circuit and to provide overload for protection to the motor; and a separate circuit independent of the motor circuits for affecting said thermal element, said circuit including an electric regulator remote from the motor and comprising a thermal member and a heater coil, adapted to control said thermal element to actuate the switch in response to variations in temperature ambient thereto, the effect of said heater coil being a function of the difference between the reference temperature of said thermal member and the temperature ambient thereto.

8. Control apparatus for an electric motor having starting and running windings; a switch having a thermal element in circuit with both windings of the motor and adapted in response to predetermined current flows therethrough to actuate the switch to control the starting circuit and to provide overload protection to the motor; and a separate circuit independent of the

motor circuits adapted to effect operation of the switch by the thermal element, said circuit including a thermal member and a heating coil remote from the motor adapted in response to variations of temperature ambient thereto to provide recurrent electrical impulses in said separate circuit.

9. Control apparatus for an electric motor having starting and running circuits adapted to be connected to a source of electrical energy; a switch in said circuits; thermo-electric means for actuating said switch to control the motor in accordance with the flow of current through said circuits; a transformer having a primary and a secondary winding, one winding being connected to the thermo-electric means adapted to energize said means to actuate the switch; and a thermal switch remote from the motor and said means and in circuit with the other winding of the transformer and the source of electrical energy for controlling this circuit of the transformer to regulate its effect in accordance with varying temperatures ambient to said thermal switch.

10. Control apparatus for an electric motor having starting and running circuits adapted to be connected to a source of electrical energy; a switch in said circuits; thermo-electric means for actuating said switch to control the motor in accordance with current flow therethrough; a transformer having primary and secondary circuits, one of these circuits being connected to said means to energize it for effecting operation of said switch; and a thermal switch in the other transformer circuit, remote from the motor and independent thereof, said switch being responsive to a predetermined temperature ambient thereto to connect its transformer circuit with the source of electrical energy and in response to a predetermined, comparatively higher ambient temperature to effect deenergization of said transformer by opening the circuit.

11. Control apparatus for an electric motor having starting and running windings adapted to be connected to a source of electrical energy; a switch having a thermal element in circuit with both windings of the motor and adapted in response to predetermined current flows therethrough to actuate the switch to control the starting winding circuit and to provide overload protection to the motor; a transformer having primary and secondary windings, the secondary winding being connected with the thermal element and adapted to energize it for effecting actuation of the switch to stop the motor; and a temperature responsive switch remote from the motor and connected with the primary transformer winding and with the source of electrical energy, said temperature responsive switch acting in response to temperature variations ambient thereto to make or break the said primary transformer winding circuit.

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