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[21] Appl. No. 887,875
[22] Filed Dec. 24, 1969
[45] Patented Aug. 31, 1971
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[54] HERMETIC MOTOR PROTECTOR
5 Claims, 8 Drawing Figs.
[52] U.S. Cl. 337/104,
337/89, 337/107
[51] Int. Cl. H01h 37/54,
H01h 61/04
[50] Field of Search..... 337/89,
102, 104, 107, 112

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ABSTRACT: A hermetically sealed device for protecting the start and main windings of a motor has a pair of posts extending through a header plate in insulated relation to each other and to the plate. A first heater extends from one post to support a thermostatic member which carries a movable contact to engage a fixed contact carried by the other post, the first heater extending in heat transfer relation to the thermostatic member. A second heater embodying a relatively wide and thin strip of electrical resistance heater material has a U-shaped configuration and is embossed along the legs of said configuration to make the heater more rigid, the heater being connected between the first heater and said plate to dispose the second heater with its wide surfaces in generally parallel, heat transfer relation to the thermostatic member.

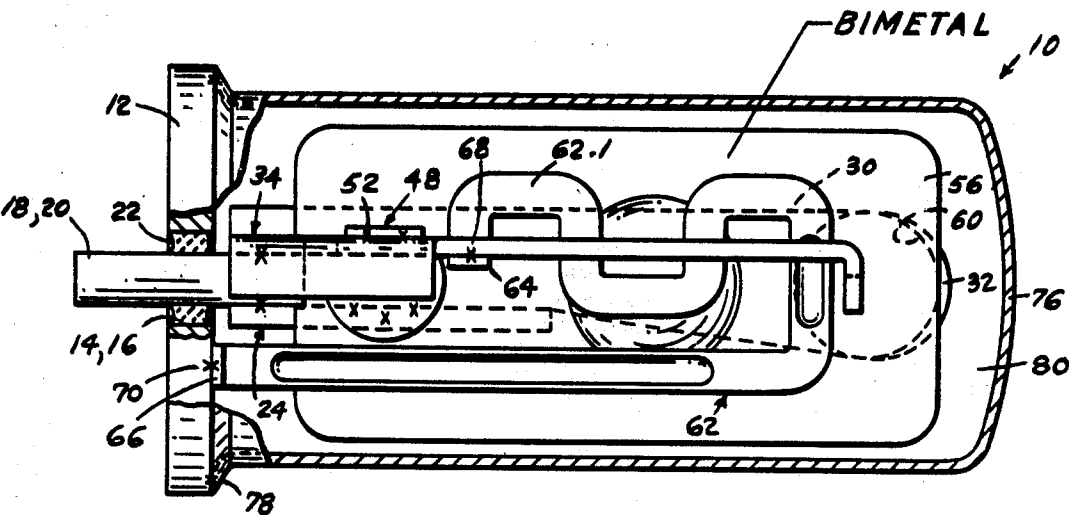


Fig. 1.

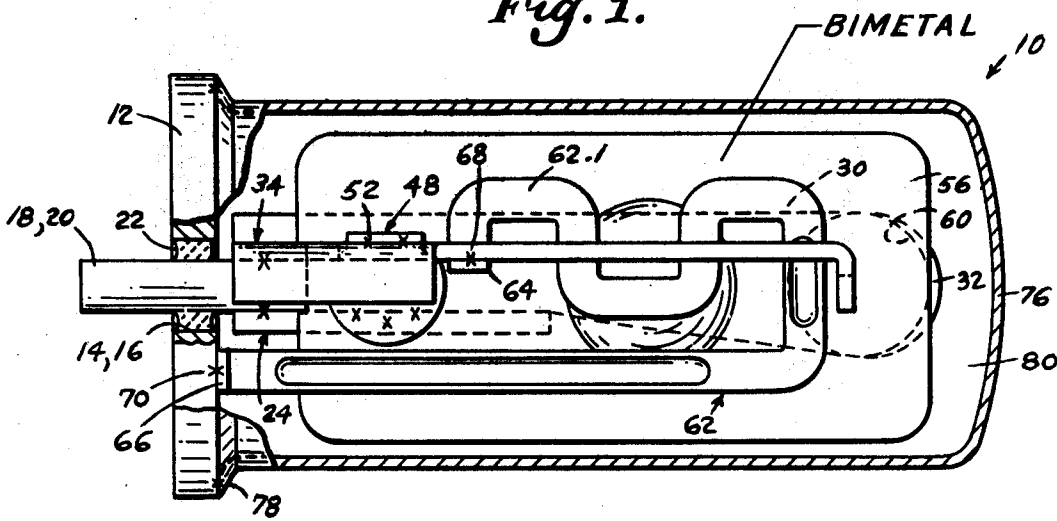


Fig. 2.

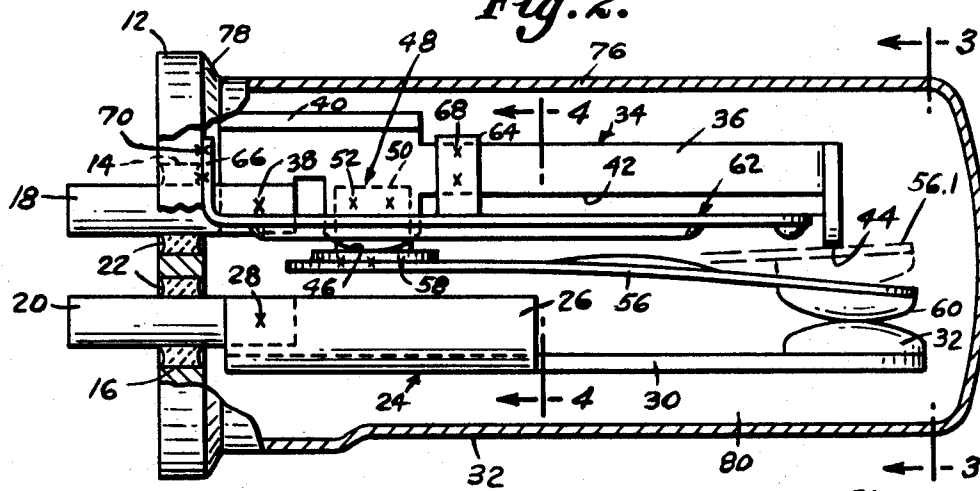


Fig. 3.

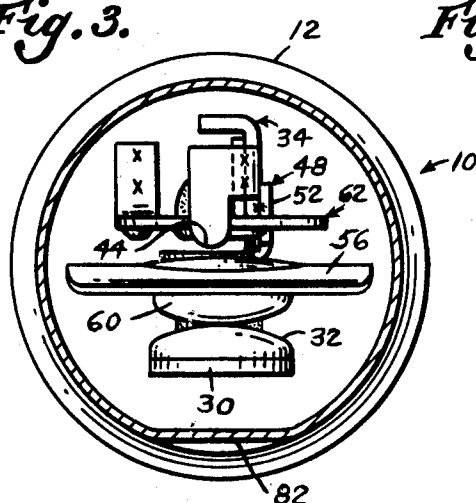
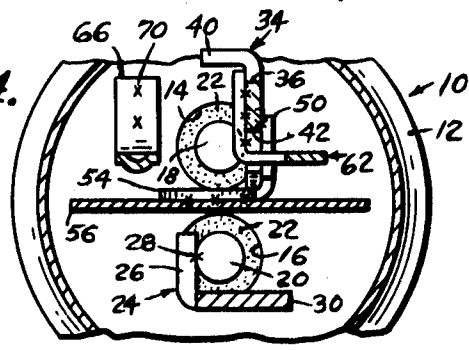


Fig. 4.



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Fig. 5.

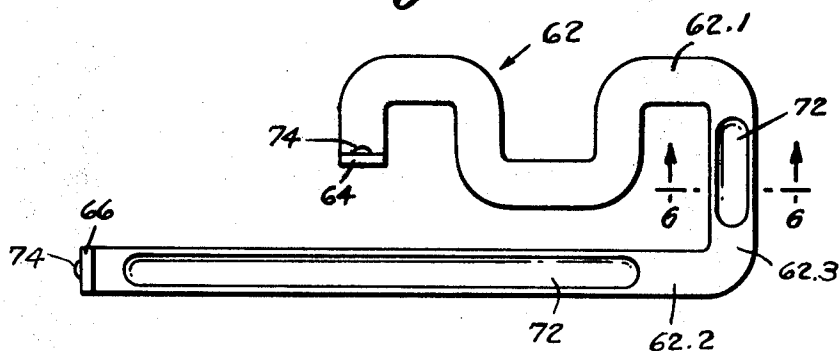


Fig. 6.

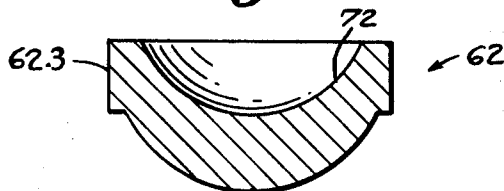


Fig. 7.

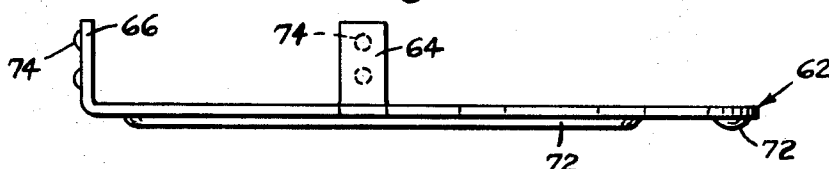
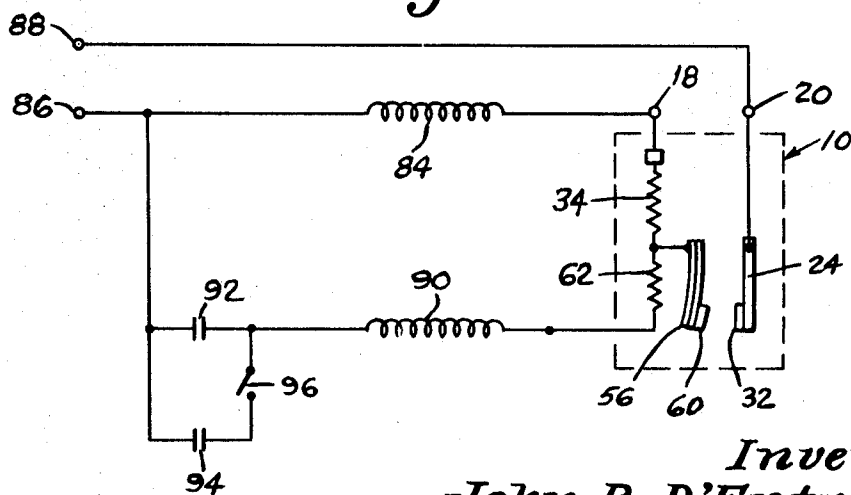


Fig. 8.



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HERMETIC MOTOR PROTECTOR

Hermetically sealed motor protectors for use in protecting air-conditioner compressor motors and the like conventionally embody compact, rugged and hermetically sealed constructions in which a heater element, a thermostatic disc and a pair of electrical contacts are arranged in series to be connected in the main winding circuit of a compressor motor for protecting the main motor winding against overheating. At least one such prior art construction comprises a welded assembly in which all welds formed in the protector assembly after location of the protector components in the protector assembly are made without altering the critical locations of the components in the assembly. However, such conventional hermetically sealed motor protectors do not provide suitable means for protecting the start winding of the compressor motor against overheating in certain abnormal situations which can occur. For example, the start winding of the compressor motor can become overheated if welded relay contacts in the motor circuit permits the start capacitor to remain in the circuit, if the start capacitor is short circuited, or if a loss of gas condition occurs in the air-conditioner served by the motor protector.

It is an object of this invention to provide a novel and improved hermetically sealed motor protector; to provide such a protector which is especially adapted for protecting air-conditioner compressor motors; to provide such a protector which is adapted to protect a motor against overheating of either the start or main windings of the motor; to provide such a motor protector which is particularly adapted to protect the start winding of an air-conditioner compressor motor against loss of gas conditions and against conditions which permit the start capacitor in the motor circuit to remain in the circuit; to provide such a protector which incorporates a novel and advantageous start-winding heater; to provide such a protector which utilizes an advantageous welded construction; and to provide such a motor protector which is of simple, inexpensive, compact, accurate and rugged construction.

Other objects, advantages and details of the motor protector of this invention appear in the following detailed description of preferred embodiments of the invention, the detailed description referring to the drawings in which:

FIG. 1 is a section view along the longitudinal axis of the motor protector of this invention;

FIG. 2 is a section view similar to FIG. 1 illustrating the motor protector of FIG. 1 rotated 90° on its longitudinal axis;

FIG. 3 is a section view along line 3—3 of FIG. 2;

FIG. 4 is a partial section view along line 4—4 of FIG. 2;

FIG. 5 is a plan view of the novel start-winding heater utilized in the motor protector of FIG. 1;

FIG. 6 is a section view along line 6—6 of FIG. 5;

FIG. 7 is a side elevation view of the heater of FIG. 5; and

FIG. 8 is a schematic diagram illustrating use of the motor protector of FIG. 1 in a motor circuit.

Referring to the drawings, 10 in FIGS. 1-4 indicates the novel and improved motor protector of this invention which is shown to include a generally disc-shaped header plate or member 12 having a pair of apertures 14 and 16 and having a pair of terminal posts 18 and 20 secured in the respective plate apertures in generally parallel relation to each other by means of a sealant material 22. The header plate and terminal posts are preferably formed of a rigid, electrically conductive material such as steel or the like. The posts are mounted in sealed, electrically insulated relation to the header plate and to each other by use of a glass sealant material 22 or other conventional electrically insulating material. As the terminal posts are mounted in the header plate in the described manner by any well-known technique, sealing of the terminal posts and the header plate is not further described herein.

As shown, the motor protector 10 further includes a rigid electrically conductive contact arm 24 formed of steel or the like, the arm including one flange portion 26 which is welded

to one side of the terminal post 20 as indicated at 28 in FIGS. 1 and 2 and including an angularly disposed flange portion 30 which extends in cantilever relation from the post 20 in a plane generally parallel to the axis of the terminal post 20. A fixed contact 32, preferably formed of material of high electrical conductivity such as silver, is welded or otherwise secured to the distal end of the extending portion of the contact arm as shown.

The motor protector 10 further includes a heater element or member 34 having one flange portion 36 welded to the terminal post 18 as indicated at 38 and having a second flange 40 providing the heater element with a desired degree of rigidity, the flange 36 extending in cantilever relation from the post 18 so that an edge 42 of the extending flange faces the contact arm 24. The heater element preferably includes a stop or end portion 44 which terminates in a plane lying parallel to the axes of the terminal posts 18 and 20. The heater element also preferably has a rounded surface 46 formed on the edge 42 of the flange 36 as shown in FIG. 2. The heater element is formed of any one of a variety of materials of selected electrical conductivity so that the element is adapted to generate a predetermined amount of heat in response to selected flow of electrical current through the element. For example, the heater element is preferably formed of rigid cold-rolled steel to provide the element with selected electrical heating characteristics. Alternately, heater elements of other rigid metals or the like are used for providing the heater with different electrical heating properties within the scope of this invention.

In addition, the motor protector 10 includes an electrically conductive, angle-shaped support 48 of cold-rolled steel or the like which has one flange 50 welded to the heater element flange 36 as indicated at 52 in FIG. 2 and another flange 54 welded to an edge of an electrically conductive, resilient, thermally responsive snap-acting disc or member 56 as indicated at 58 in FIGS. 1 and 2. A movable contact 60, preferably formed of the same material as the fixed contact 32, is welded or otherwise secured to an edge of the thermally responsive member oppositely of the support 48. As illustrated, the flange portion 50 of the support extends away from the thermally responsive member at substantially a right angle to the general plane of the member. The welding of the support 48 to the heater 34 disposes the thermally responsive member 56 in selected heat transfer relation to the heater element and locates the member 56 extending in cantilever relation from the heater so that the movable contact 60 engages and disengages the fixed contact 32 in response to snap-acting movement of the member 56. That is, the member 56 is normally located as illustrated in solid lines in FIG. 2 so that the member resiliently holds the movable contact in engagement with the fixed contact to close a first motor protector circuit from the terminal post 18 through the heater 34, support 48, snap-acting member 56, contacts 60 and 32, and contact arm 24 to the terminal post 20.

The motor protector 10 further includes a second heater element 62 which, as shown particularly in FIGS. 1 and 5, has a generally U-shaped configuration. The heater 62 is preferably formed as a stamping from a sheet of high electrical resistance material such as an 80 percent nickel, 20 percent chromium alloy so that the heater has a relatively wide and thin striplike character of generally rectangular cross-sectional configuration. The heater 62 has one leg portion 62.1 in the form of a series of crenellations defining a tortuous path to increase the circuit length constituted by the heater leg. The other heater leg portion 62.2 is preferably relatively straight as shown. At each end of the heater element 62, flanges 64 and 66 are formed, the flange 64 being welded to the first heater 34 adjacent to the support 48 as indicated at 68 and the other heater flange 66 being welded to the header plate 12 as indicated at 70. Preferably, as shown, the general plane of the heater 62 is close to and generally parallel to the general plane of the thermostatic disc 56, the heater 62 preferably being located between the heater 34 and the disc 56. In the preferred construction of the heater 62, the long, straight leg

62.2 of the heater and the bottom portion 62.3 of the U-shape defined by the heater are embossed as indicated at 72 in FIGS. 1 and 5 so that, at these locations, the heater 62 has a channel-like configuration as shown particularly in FIG. 6. As will be understood by reference to FIGS. 5 and 7, the embossments indicated at 72 as well as weld projections 74 formed by smaller embossments in the heater flanges 64 and 66 are readily formed in the sheet of heater material.

In this arrangement, the heater element 62 extends in closely spaced, heat transfer relation to the thermostatic disc 56 and defines a second motor protector circuit from the header plate 12, through the heater 62, a small portion of the heater 34, the support 48, snap-acting member 56, contacts 60 and 32, and contact arm 24 to the terminal post 20.

A cup-shaped body 76 formed of steel or other rigid material has its rim welded in electrically conductive relation to the header plate 12 as indicated at 78 to form a device chamber 80, this weld serving to seal the device chamber so that the motor protector 10 is completely sealed and pressure resistant. Preferably, the body has a flat portion 82 shown in FIGS. 2 and 3 for use in locating the device 10 when mounting the device in a motor circuit.

Operation of the motor protector 10 is illustrated in FIG. 8. That is, the first motor protector circuit described above is interposed in series with a main motor winding 84 between a line 86 and a common terminal 88. The second motor protector circuit described above is then interposed in series with a start motor winding 90 between the line and common terminals. The usual running capacitor 92 connected in series with the start winding and in parallel with the start capacitor 94 and relay 96 are also shown in FIG. 8. In this arrangement, with the contacts 60 and 32 engaged, current flowing in the main motor winding flows through the first motor protector circuit through the heater 34. In normal operation, the heater 34 does not generate sufficient heat to cause snap-acting movement of the thermally responsive disc 56 so that the first motor protector circuit remains closed. However, when abnormal current such as would tend to overheat the main motor winding flows through the main winding, the increased current in the heater 34 and in the disc 56 in the first motor protector circuit generates sufficient heat to move the disc 56 with snap action to the position indicated by dotted lines 56.1 in FIG. 2, thereby to disengage the contacts 60 and 32 as shown in FIG. 8. In this open circuit position, the snap-acting disc 56 resiliently engages stop portion 44 of the heater 34 for limiting travel of the disc away from the fixed contact and for preventing undesirable movement of the disc in response to vibration and the like. In this way the first motor protector circuit serves to protect the main motor winding.

In accordance with this invention, the motor protector 10 also serves to protect the start winding 90 under conditions which tend to overheat the start winding. That is, when current is initially directed through the start winding with the contacts 60 and 32 engaged, the initial start winding current is high as controlled by the start and run capacitors 94 and 92. After the start winding has completed its primary function, the relay 96 normally opens to reduce the start winding current. In this normal operation, the current in the second motor-protecting circuit flowing through the heater 62 does not generate sufficient heat to cause snap-acting movement of the thermally responsive disc 56. However, if the relay 96 fails to open because of welding of the relay contacts or the like or if the start capacitor 94 should be short circuited so that the start winding current becomes excessively high or continues at a high rate for an excessive period of time, the additional current flow in the heater 62 generates sufficient heat to cause snap-acting movement of the disc 56 to open the contacts 60 and 32 for protecting the start winding against overheating. This arrangement also serves to protect the start winding against overheating which may result from excessive winding current caused by other abnormal correlations such as the loss of freon gas in the compressor of the air-conditioner being served by the motor protector 10.

In this regard it will be understood that significant overheating of the start winding can occur very rapidly in some of the abnormal situations above described so that the motor protector 10 must be adapted to open the protector circuits very rapidly upon the occurrence of these abnormal situations. The motor protector 10 is particularly adapted to achieve such rapid thermal response in that the heater element 62 is relatively wide and thin and has its wide surfaces disposed in facing relation to the thermally responsive disc 56, whereby the heater rapidly generates heat and rapidly radiates this heat to the disc 56. The close spacing of the heater to the disc also permits transfer of heat to the disc by conduction of heat through the atmosphere between the heater and disc. The U-shaped configuration of the heater 62 permits the heater to be heated to a high temperature without causing sagging of the heater to result from thermal expansion of the heater material. The U-shaped heater shape, particularly with the crenellations in the heater leg 62.1, provides a very long heater circuit which covers a substantial surface of the thermally responsive disc 56. The embossing of the straight leg 62.2 and bottom of the U-shaped heater at 72 provides considerable strength and rigidity in the heater so that, even when substantially heat softened, the heater can be positioned very close to the disc 56 without risk of sagging into contact with the disc.

The motor protector 10 of this invention is also characterized by a compact, inexpensive, yet accurate, welded construction. That is, in making the protector 10, the terminal posts 18 and 20 are mounted and sealed, insulated relation within the header plate apertures in conventional manner as shown. The heater element 34 is then located with the flange 36 engaged with the post 18 with the edge 42 of the heater facing as shown and with the stop 44 of the heater disposed in a plane properly spaced from the planes of the terminal post axes as indicated in FIG. 2. The heater element is then welded to the post 18 as indicated at 38. The thermally responsive disc 56, which comprises two or more layers of metal of different coefficients of thermal expansion bonded together, preferably has the contact 60 and the support 48 welded to the disc material before the disc material is dished to provide its snap-acting properties. The disc material is then deformed in conventional manner to provide the noted dished portion so that the disc forms a snap-acting member of selected thermal response characteristics. The disc 56 with its attached support and contact is then located with the flange 50 of the support engaging the flange 36 of the heater 34 and with the movable contact 60 aligned with and located in a plane at a selected distance from the stop 44 of the heater 34. In attaching the disc to the heater in this way, the support flange 50 is conveniently engaged with the rounded surface 46 of the heater element and is moved against the rounded surface to aid in locating the contact 60 in the desired relationship to the heater stop 44. The flange 50 of the support 48 is then welded to the flange 36 of the heater 34 as indicated at 52.

The fixed contact 32 is welded to the contact arm 24 and the flange 26 of the contact arm is engaged with the terminal post 20 as shown in FIG. 2. The contact arm is then adjusted to locate the contact 32 in selected relationship to the movable contact 60 and the engaging portions of the contact arm and terminal post 20 are welded together as indicated at 28. The heater 62 is then positioned with the desired spacing relative to the disc 56 and with the flanges 64 and 66 of the heater engaged with the heater 34 and the header plate 12 respectively. The flanges of the heater 62 are then welded to the heater 34 and the header plate as indicated at 68 and 70. Finally, the cup-shaped body 76 is welded to the header plate 12 around the rim of the body as indicated at 78.

In this construction, the welds utilized in locating the header 34, the disc 56, the contact arm 24 and the heater 62 are all disposed to provide an accurate motor protector construction. For example, the heater 34 is readily located to position the stop 44 in a selected plane. The weld 38 which then secures the heater 34 in this position is readily made without altering the position of the stop 44 in its selected plane. That is, any

collapse of the material of the heater 36 or of the terminal post 18 in the area of the weld 38 does not alter the position of the stop 44 in the desired plane. When the snap-acting disc 56 is to be mounted, the critical positional feature to be considered is the provision of the appropriate spacing between the heater element stop 44 and the movable contact 60 carried by the disc 56. In the motor protector 10, the disc contact 60 is provided with its appropriate spacing from the stop 44 and the disc support 48 is welded to the heater 34. Any collapse of the heater or support material in the area of the welds 52 does not alter the spacing between the movable contact 60 and the stop 44. Similarly, the contact 32 is readily positioned in the desired relationship with the contact 60 and formation of the weld 28 which serves to fixedly locate the contact 32 does not alter the position of the contact 32 relative to the contact 60. Finally, the heater 62 is readily positioned in the desired spaced relationship to the disc 56 and making of the welds 68 and 70 which serve to hold the heater in this desired positional relationship does not result in any alteration in the spacing between the heater 62 and disc 56. In this way, the motor protector 10 is economically constructed to display precisely predetermined thermal response properties. The device is rugged and inexpensive, is hermetically sealed and pressure resistant, is vibration resistant so that the device does not tend to open or close a circuit inadvertently even when exposed to substantial vibrational forces, is particularly suited for use in a freon atmosphere or to protect air-conditioner compressor motors, and is adapted to protect such motors against overheating under abnormal conditions which effect either the main or start windings of the motor.

It should be understood that although particular embodiments of the motor protector of this invention have been described by way of illustration, this invention includes all modifications and equivalents thereof which fall within the scope of the appended claims.

1. A motor protector comprising an electrically conductive header plate, a pair of terminal posts extending through said plate in spaced, electrically insulated relation to the plate and to each other, a rigid electrically conductive contact arm secured in electrically conductive relation to one of said posts to extend in cantilever relation therefrom, said arm carrying fixed contact means at the distal end of said arm, a first, rigid, electrical resistance heater secured in electrically conductive relation to the other of said posts to extend in cantilever relation therefrom in generally parallel relation to said arm, an electrically conductive thermally responsive snap-acting member having a movable contact secured to one end thereof and having a support secured to an opposite end of said member, said support having a portion extending out of the general plane of said member secured to a portion of said first heater for disposing said member in selected heat transfer relation to said first heater so that said movable contact engages and disengages said fixed contact to close and open a circuit in response to snap-acting movement of said member, and a relatively wide and thin striplike electrical resistance element defining a second heater of generally U-shaped configuration having one end thereof secured to said plate and having its opposite end secured to said portion of said first heater for supporting said second heater in selected heat

transfer relation to said thermally responsive member.

2. A motor protector as set forth in claim 1 wherein said U-shaped heater has bottom and leg portions disposed in a plane and wherein said relatively wide dimension of said striplike element extends in said plane, said U-shaped heater being disposed with said plane thereof generally parallel to the plane of said thermally responsive member.

3. A motor protector as set forth in claim 2 having portions of said striplike heater element embossed to provide said portions with a channellike cross-sectional configuration.

4. A motor protector as set forth in claim 2 wherein one of said legs of said U-shaped heater is substantially straight and has an embossed portion extending therealong providing said heater with selected rigidity, the other of said legs defining a tortuous path having a general direction parallel to said one leg providing said heater with a substantial effective length.

5. A hermetically sealed motor protector comprising an electrically conductive header plate, a pair of terminal posts extending through said plate in sealed relation to said plate and in spaced, electrically insulated relation to said plate and to each other, a rigid electrically conductive contact arm having two angularly disposed flanges and having one of said flanges welded to one of said terminal posts so that said other flange extends away from said plate in cantilever relation from said terminal post, said arm carrying a fixed contact in a first selected plane at the distal end of said arm, a first rigid electrical resistance heater element having two angularly disposed flanges and having one of said flanges welded to the other of said posts so that a flange of said heater element extends in cantilever relation from said other post in generally parallel relation to said arm for disposing a distal portion of said extending flange in a second selected plane, an electrically conductive thermally responsive snap-acting member having a movable contact secured to one end thereof, a support having two angularly disposed flanges and having one of said flanges secured in electrically conductive relation to an opposite end of said member so that the other of said support flanges extends out of the general plane of said member, said other support flange being welded to a second portion of said extending flange of said first heater for disposing said thermally responsive member in selected heat transfer relation to said first heater and for disposing said one end of said member so that said movable contact engages and disengages said fixed contact and so that said one member end disengages and engages said distal portion of said first heater to close and open a circuit in response to snap-acting movement of said member, a relatively wide and thin striplike electrical resistance element defining a second heater of generally U-shaped configuration having a bottom portion and two leg portions disposed in a plane and having said relatively wide dimension of said striplike element extending in said heater plane, said U-shaped heater having flanges at said leg ends welded to said plate and to said second portion of said first heater respectively for supporting said second heater in selected heat transfer relation to said member, said welds being arranged so that a line normal to the plane of each of said welds lies substantially parallel to said first and second selected planes, and a cup-shaped body having its rim secured in sealed relation to said plate for enclosing said heaters, arm, contacts, support and member.