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(54) Delayed action thermal relay with double bimetal.

(57) The subject of the invention is a delayed-action thermal relay especially suitable for starting motors for refrigerator compressors and the like comprising a housing molded of plastic material with a first, a second, and a third electric terminal molded into the housing, a first U-shaped bimetallic strip inserted between the first and third electrical terminals and carrying in intermediate position at the base portion of the U-shape a contact element cooperating in normally closed condition with a corresponding contact element carried by a second bimetallic strip connected to the second electrical terminal. There is provided on said respective bimetallic strips associated permanent magnet and armature means which tend to keep said bimetallic strips and hence the contact elements provided on the strips electrically engaged in a closed circuit position.

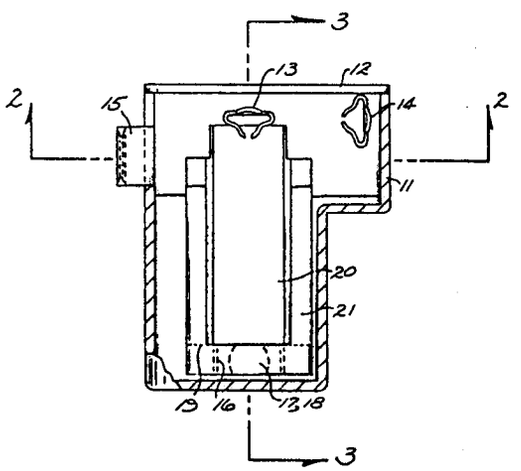

Fig.1.

EP 0 223 599 A2

Description

DELAYED ACTION THERMAL RELAY WITH DOUBLE BIMETAL

Background of the Invention

The present invention relates to a bimetallic relay. with normally closed contacts, particularly suitable for use as a starting relay for single-phase induction motors, of the kind used in compressors for refrigerators and the like. More particularly the invention concerns a fast release relay, with double bimetal, relatively insensitive to the variations of ambient temperature.

As is known, a single-phase induction or asynchronous motor requires special devices for overcoming the obstacle of starting, especially under load, in order then to go into normal running operation. That problem of starting has been resolved with various devices, one of which provides the use of a supplementary winding, more particularly called a starting winding, which is deenergized or excluded from use in the motor after the motor is started. To obtain this result, one uses a relay connected in series with the starting winding with normally closed contacts which open after a certain delay. At present, many different relays are used for this application, all comprising a certain delay function, for which reason they are called delayed relays or delay relays, generally coming under two basic types:

- electromechanical or gravity relays; and
- thermal relays with PTC (positive temperature coefficient) resistive heaters.

Brief Summary of the Invention

The general object of the present invention is to make a relay which has the advantages of both above-mentioned types but without having their respective limitations. Besides the fact of being able to have the normally closed contacts, so as to make possible their use with motors of the PSC (Permanent Start Capacitor) type, the other characteristics to be realized in the relay of the present invention are the following:

- low energy consumption;
- maximum independence of the operating characteristics from variations of the ambient temperature;
- reasonably short reset times;
- high reliability, in the range of millions of cycles;
- resistance to vibrations;
- small number of parts, all of fully established technologies, to hold down the manufacturing costs; and
- guarantee of reliable operation in any position independent of gravity.

These objects set forth above and the advantageous structural and functional characteristics mentioned before are realized in the present invention which, in its preferred form of realization, consists of a delayed action thermal relay comprising a housing molded of plastic material with a first, a second, and a third electrical terminal already inserted and preferably molded into the plastic housing material, a first U-shaped bimetallic strip extending between the first and third electric terminal and carrying in an intermediate position at the base of the U-shape a contact element, and another contact element which is carried by a second bimetallic strip connected to the second electrical terminal. There is provided on said bimetallic strips associated permanent magnet means and an armature respectively which tend to keep said bimetallic strips together and hence the contact elements provided on them electrically engaged in a closed circuit position.

Although the invention is described as consisting of a relay for the above indicated application, it must of course be understood that the staring of single-phase induction motors, of which the motors of refrigerator compressors and the like are examples, do not exhaust the possibilities of application of such relays, which in fact can be used whenever two electric users must be fed, one of which must subsequently be excluded from the power supply with a certain delay.

The two bimetallic strips are disposed so that their temperature increase brings about deformation of the strips in equal directions. This makes operation of the device independent of the ambient temperature.

From the structural point of view, the bimetallic strips are of a simple type, not preformed and a low strength, so that, also assisted by the presence of the magnetic means, they are able to bring about a snap opening of the contacts so as to obtain a distance between them of the order of several millimeters.

Description of the Drawings

Other objects and advantages of the present invention will become evident to those expert in the field from the following detailed description and from the attached drawings, in which the preferred form of realization is shown in an illustrative and non-restrictive sense.

In the drawings:

Figure I shows a top view, with the housing partially in section, of the device of the present invention;

Figure 2 shows a section view along line 2-2 of Fig. I;

Figure 3 shows a section view along line 3-3 of Fig. I; and

Figure 4 represents schematically the circuit in which the device of the present invention is inserted and of which it forms a part.

Description of Preferred Embodiments

Referring now to the drawings, it is seen that the relay comprises a housing II one end of which is closed with a housing cover part I2 molded of plastic material in which three electric terminals I3, I4 and I5 are already mounted, preferably by being molded into the plastic material of the housing cover part, for connection with an external circuit. The details of

this connection will be clarified below in reference to Figure 4.

At the terminal I3 is connected a bimetallic strip 20 by welding or the like, and between the terminals I4 and I5 another bimetallic strip 2I is similarly connected. The first strip 20 is a simple linear elongated form, for example rectangular, while the second bimetallic strip 2I is U-shaped and has its legs 2Ia, 2Ib secured to terminals I4 and I5 respectively.

The bimetallic strip 20 carries at its free end, that is, the distal end with respect to the terminal I3, a small permanent magnet I6 which cooperates functionally with an armature I9 integral with the other bimetallic strip 2I, fastened to the bow or base zone of the U-shaped strip 2I, which is the distal zone with respect to the two terminals I4 and I5. The two bimetallic strips 20 and 2I also carry respectively two contact elements I7 and I8 which are urged to remain electrically engaged in a closed circuit position by the force of attraction exerted by the functional cooperation between the permanent magnet I6 and the armature I9.

With a construction thus realized and with reference to the wiring diagram of Figure 4, the operation of the device is as follows:

It is seen in Figure 4 that the terminal I5 is connected to one or two power source or network terminals while the terminals I3 and I4 are connected to the other network terminal across two respective motor windings - a start winding of the motor which must be cut off after the start up of the motor, and the main winding of the motor used for a normal running operation of the motor. Upon start up of the motor, the starting current I_S, owing to the normally closed state of the contacts I7, I8, flows through the terminal I3 and the bimetallic strip 20, which is dimensioned and provided with selected electrical resistance properties so that the temperature increase in the strip 20 due to the Joule effect of the start winding current circulating therein is relatively small, so that strip 20 tends to remain substantially in its initial position relative to strip 2I even when traversed by the current. The current I_M of the main or normal run winding of the motor passes through the terminal I4 and into the first arm 2Ia of the U-shaped bimetallic strip 2I. In the second arm 2Ib of the strip 2I, therefor, a current $I_S + I_M$ flows. The bimetallic strip 2I is dimensioned and provided with selected electrical resistance properties so that the heating of strip 2I caused by said currents urges it to deflect in a direction opposed to the attraction of the permanent magnet I6 to a relatively greater extent than the strip 20 so that the magnetic attraction force is overcome. At that point the bimetallic strips 20 and 2I move apart with a snap action, abruptly opening the contacts I7 and I8. The starting winding is thus cut off from the power supply.

When running, the current I_M of the motor is such as to maintain the bimetallic strip 2I at a temperature, and hence at a deformation, sufficient for the contacts I7 and I8 to remain open and thereby the starting winding remains disconnected.

When the power supply to the motor is interrupted, current no longer circulates in the bimetallic strip 2I, so that it cools off and again engages against the bimetallic strip 20 until the force of attraction of the permanent magnet I6 becomes predominant again, bringing the contact I7 and I8 into (normally) closed or reset position. Thereby the auxiliary or starting winding is again connected.

The self-heating due to the Joule effect of the currents flowing in the bimetals is such that this relay has a relatively low consumption and typically absorbs a power less than I/I0 of a Watt in a refrigerator compressor motor application for example.

As already mentioned, the snap opening of the contacts is ensured by the presence of the permanent magnet I6, so that no particular forming of the bimetallic strips needs to be provided, which can therefore work under conditions of extremely low stress, thus guaranteeing a required long fatigue life. The bimetallic strips have thermal response characteristics such that, when the contacts are engaged in close circuit position, the strips tend to be deformed in a similar manner in response to ambient temperature changes to retain the contacts in closed circuit position independent of such ambient temperature changes.

The above explained principle of opening of the contacts is such that, with appropriate dimensioning and provision of electrical resistance properties in the parts, the distance between the open contacts can be of the order of several millimeters, thus giving assurance against the priming of electric arcs and against accidental closing of the contacts because of vibrations. This is very important from the viewpoint of meeting the national and international standard requirements.

In the foregoing the preferred form of realization of the present invention has been described, but it is understood that the experts in the field can make changes and variants in the structural details without thereby going outside the scope of the present invention.

Claims

I. Delayed action thermal relay comprising a housing molded of plastic material with a first, a second, and a third electrical terminal mounted thereon, characterized in that the relay comprises a first bimetallic strip inserted between the first and the third electrical terminal and carries in position intermediate the first and third electrical terminals a contact element cooperating in normally closed condition with a corresponding contact element carried by the second bimetallic strip which is connected to the second electrical terminal, there being provided on said bimetallic strips respective associated permanent magnet means and armature means which tend to maintain said bimetallic strips together with the contact elements provided thereon electrically engaged in a closed circuit position, the bimetal strips being provided with selected proportions and electrical resistance properties relative to each

other so that directing a selected current between the first electrical terminal and the second and third electrical terminals is adapted to separate the contacts against the bias of said permanent magnet means after a selected delayed period.

2. Delayed action thermal relay according to claim 1, further characterized in that said first bimetallic strip is U-shaped and is connected to the first and third electrical terminal at the ends of two legs of the U-shape.

3. Delayed action thermal relay according to claim 1, further characterized in that the second bimetallic strip is of elongated form and is connected by one of its ends to said second terminal.

4. Delayed action thermal relay according to claim 1, further characterized in that said contact elements and said permanent magnet means and armature means are provided on said bimetallic strips at distal ends thereof relative to the electrical terminals.

5. Delayed action thermal relay according to claim 1, further characterized in that said bimetallic strips are free of preforming and of relatively low strength.

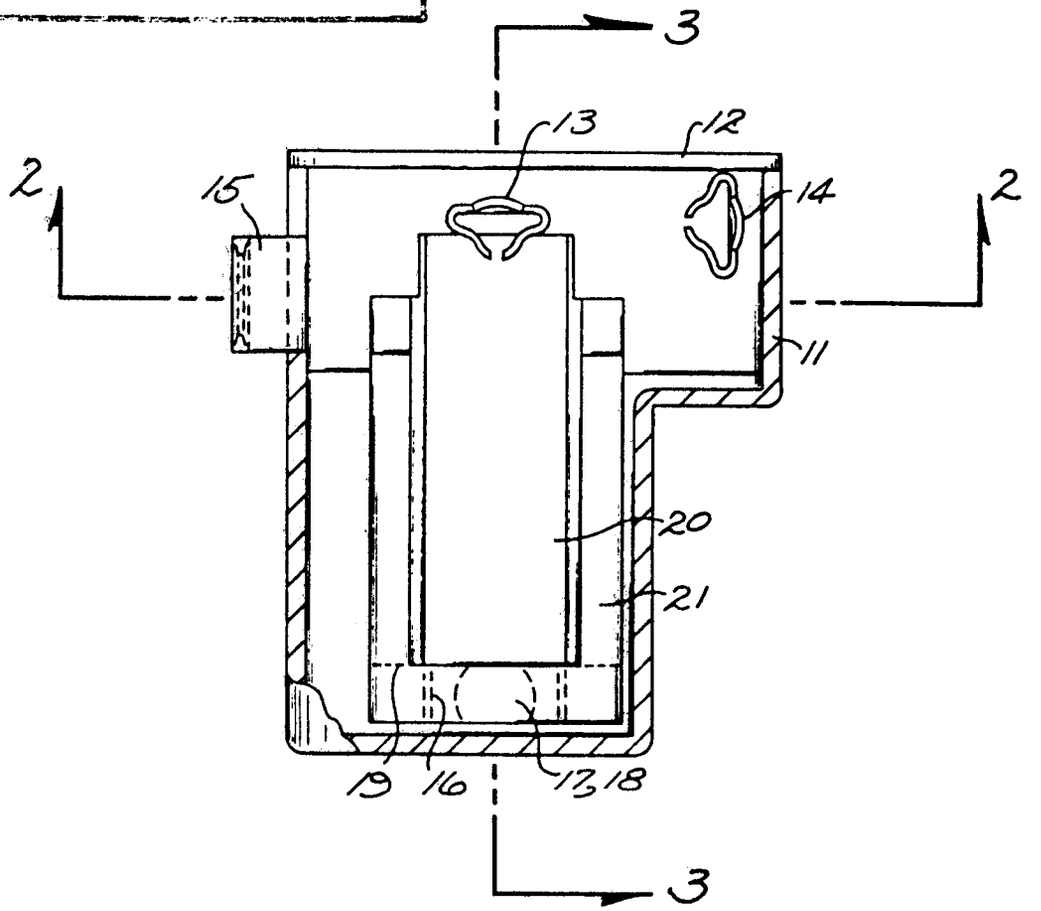

Fig. 1.

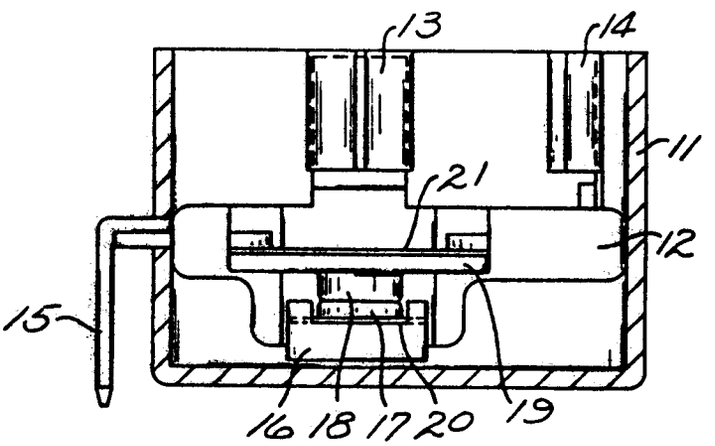

Fig. 2.

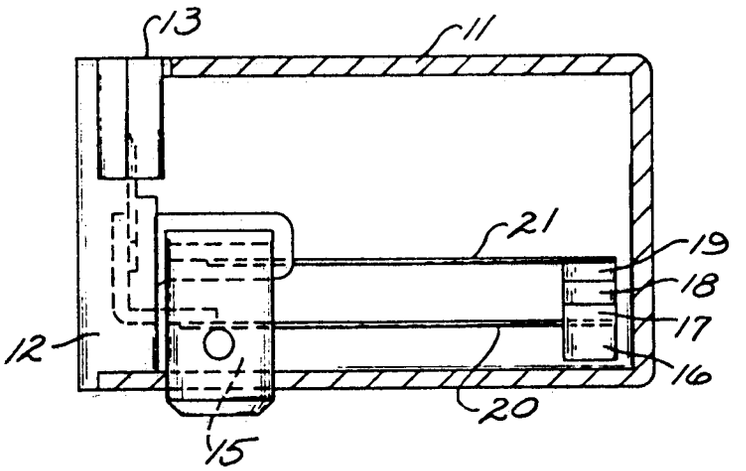

Fig. 3.

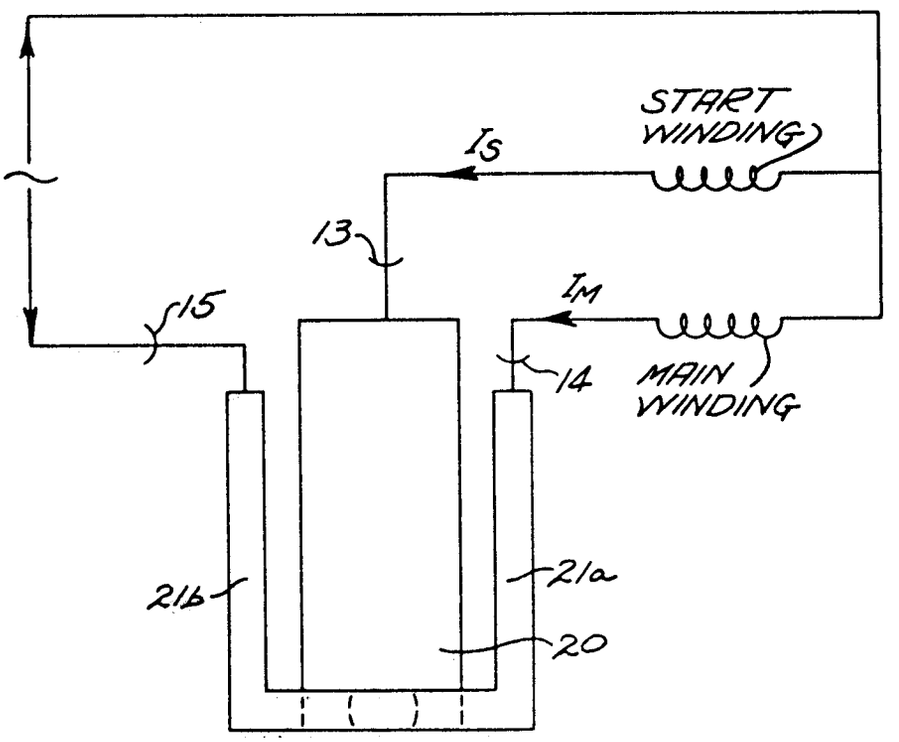

Fig. 4.