

MOLDED MOTOR WITH BUILT-IN THERMAL PROTECTOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a molded motor with a winding molded using a synthetic resin molding material which has electrical insulation properties.

Description of the Related Art

Hitherto, as disclosed in Japanese Utility Model No. 5-2553 (H02K3/44), for example, the motors extensively used for the fans of household air conditioners or the like frequently have stator cores and coils, namely, stator windings, which are integrally molded using thermosetting resin as a molding material which has electrical insulation properties (this type of a motor will be hereinafter referred to as "a molded motor").

There is a danger that overcurrent flowing through the coils of such molded motors generates abnormal heat, leading to burning or a fire. For this reason, this type of a molded motor is provided with a thermal protector which is shown as a thermal element in the said Utility Model.

The thermal protector has a bimetallic contact sealed in a bottomed tubular square resin case. The resin case normally measures approximately 3.9 mm by 15.5 mm by 7.3 mm and 0.9 mm thick.

The thermal protector is installed either by integrally molding it in a molding material of the molded motor or by inserting it a preformed recession from the rear at the time of molding as in the said Utility Model. Thus, if the winding should generate abnormal heat, then the bimetal senses the abnormal heat and causes the supply of electric currents to be cut off so as to protect the motor.

The conventional thermal protector, however, uses a resin case molded using a polybutylene terephthalate material; therefore, molding the thermal protector integrally in the molding material poses a problem in that the resin case is deformed because of the temperature and pressure to which it is subjected during the molding process, with a resultant disturbed operating point of the bimetal contact.

More specifically, the temperature at which the heat deformation of polybutylene terephthalate material begins, even when it is reinforced with glass fiber, is +200 degrees centigrade under a pressure of 18.6 kg/cm^2 . The same material with no reinforcement begins to exhibit heat deformation at +60 degrees centigrade under the same condition. The molding temperature and pressure applied to an unsaturated polyester resin molding material used for the molded motor are + 160 degrees centigrade and 70 kg/cm^2 , respectively. The molding temperature and pressure would easily deform the resin case.

For the reason stated above, the conventional molding involves a complicated process wherein a steel cover is placed over the thermal protector before putting the thermal protector on the windings of the stator and molding them.

The method in which the thermal protector is inserted in the preformed spot from behind as disclosed in the Utility Model mentioned above also presents a problem of slow heat conduction because no direct contact with the windings can be made, resulting in delayed protection due to an increased time lag before the thermal protector is put in operation after abnormal heat generation occurs. To avoid the problem, an attempt has been made to set a lower operating point of the bimetal; however, this has posed a new problem in that malfunction frequently takes place.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been made with a view toward solving the problems with the prior art stated above and it is an object of the present invention to provide a molded motor which is capable of achieving easier assembly and also of enabling accurate protective operation by a thermal protector.

To this end, according to the present invention, there is provided a molded motor which has a stator core, a stator winding mounted on the stator core, a rotor which rotates when subjected to a magnetic field generated by the stator winding, and which is formed by molding at least a part of the stator winding with a synthetic resin molding material; the molded motor being constructed by a thermal protector which is composed of a bottomed tubular synthetic resin case and a bimetal contact sealed in the case and which opens or closes at a predetermined temperature, and a connection for controlling the supply of electric currents to the stator winding via the bimetal contact of the thermal protector; wherein the synthetic resin molding material brings the synthetic resin case of the thermal protector in contact with a coil end of the stator winding, keeps the synthetic resin case and the molding material in close contact, and has the connection embedded therein.

The connection is a wiring pattern formed on a printed circuit board embedded in the molding material. The bimetal contact of the thermal protector and the stator winding are connected through the wiring pattern.

According to the present invention, the thermal protector is molded integrally with the synthetic resin case kept in contact with the coil end of the stator winding and the molding material in close contact with the

surface of the resin case, enabling significantly easier installation of the thermal protector and easier assembly of a molded motor. The present invention also improves the heat transfer between the thermal protector and the stator winding; therefore, quick protective operation can be achieved.

In the molded motor according to the present invention, the synthetic resin case of the thermal protector is molded using a resin material, the heat deformation temperature of which under the pressure applied during molding is higher than the molding temperature.

Further, the synthetic resin case of the thermal protector is molded using a resin material which exhibits no or an extremely small amount of deformation at the molding temperature and under the molding pressure during the molding process.

Furthermore, the synthetic resin case of the thermal protector is molded using polyphenylene sulfide resin, the heat deformation temperature of which is +260 degrees centigrade or higher under the pressure of 18.6 kg/cm².

With such an arrangement, the deformation of the synthetic resin case of the thermal protector can be controlled to zero or to an extremely small amount; therefore, malfunction can be prevented, thus ensuring accurate protective operation.

In addition to the features described above, the stator winding of the molded motor in accordance with the present invention uses the stator winding for a toroidal type motor; the resin case of the thermal protector is in contact with the coil end of the stator winding.

Moreover, the stator winding is a split-phase winding, a salient-pole winding, or the stator winding of a shaded-pole motor; the resin case of the thermal protector is in contact with the coil end of the stator winding.

According to the present invention, the resin case of the thermal protector can be made smaller and thinner, making the resin case ideally used for protecting the stator winding of a toroidal type motor which is especially suited for achieving a smaller motor.

The molded motor in accordance with the present invention incorporates a thermal protector which is made by heating the polyphenylene sulfide resin, which has the heat deformation temperature of +260 degrees centigrade or above under the pressure of 18.6 kg/cm^2 and a flow length of 120 mm at a temperature of +320 degrees centigrade and under a pressure of 1000 kg/cm^2 at a temperature of +290 to +310 degrees centigrade to melt it, then injecting the melt in a predetermined metal mold, the temperature of which is controlled to +150 degrees centigrade under an injection pressure of 50 to 70 kgf/cm^2 . After the injection, the injected melt is cooled to form a bottomed tubular resin case, then a bimetal contact is inserted in the resin case and sealed with a lead wire led out.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal side view of a molded motor in accordance with the present invention;

Fig. 2 is a longitudinal side view of a stator of the molded motor in accordance with the present invention;

Fig. 3 is a rear view of the stator shown in Fig. 2;

Fig. 4 is a front view of the stator shown in Fig. 2;

Fig. 5 is a top cross-sectional view of the molded motor in accordance with the present invention;

Fig. 6 is a top view of a stator core of the molded motor in accordance with the present invention;

Fig. 7 is a top cross-sectional view of a thermal protector built in the molded motor in accordance with the present invention;

Fig. 8 is a cross-sectional view taken on line A-A of the thermal protector shown in Fig. 7;

Fig. 9 is an electrical circuit diagram of the molded motor in accordance with the present invention;

Fig. 10 is a longitudinal cross-sectional view of a metal mold for the thermal protector shown in Fig. 7; and

Fig. 11 is a longitudinal cross-sectional view of the metal mold illustrative of the manufacturing process of the molded motor in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described in detail with reference to the accompanying drawings. Fig. 1 is a longitudinal side view of a molded motor M (single-phase induction motor) in accordance with the present invention. As shown in Fig. 1, the molded motor M has a stator A, a rotor B, and a rotary shaft C. A coil 3, which is a stator winding, is toroidally wound around yokes 1c and 2c which have teeth 1b and 2b, respectively, of an iron core 1 via an insulator 2. A premixed molding material composed of unsaturated polyester, which serves as an electrically insulating synthetic resin, is charged from outside to mold a frame 4.

As shown in Fig. 6, the rotor core 1 is obtained by providing the semicircular, toroidal iron cores 1a and 2a, which are comprised of a plurality of semicircular, toroidal electromagnetic steel plates with lugs 5 clamped by crimping, with the insulator 2, which is shaped like a

semicircular toroid, and the coil 3, then by butting them against each other and gluing them together with the molding material to form the toroid.

Semicircular, toroidal printed circuit boards 12A and 12B on which driving circuit components such as a Hall element (or Hall IC) H and a thermal protector S are mounted are installed on the insulator 2 of the stator A which is constituted by the stator core 1, the insulator 2, and the coil 3. The insulator 2 has pins 38 for retaining the printed circuit boards; the printed circuit boards 12A and 12B are mounted onto the insulator 2 by positioning retaining holes 40 made in the printed circuit boards 12A and 12B onto the retaining pins 38. This enables the printed circuit boards 12A and 12B to be retained on the insulator 2 and also the two iron cores 1a and 2a of the stator core 1 to be annularly connected by the printed circuit boards 12A and 12B. The printed circuit boards 12A and 12B are installed on the coil end side of the stator A so that they do not touch coil 3.

The stator core 1 with the coil 3 attached is integrally molded using the molding material and solidified to make the stator A. At this time, the printed circuit boards 12A and 12B are embedded in the molding. The thermal protector S, which is connected to the printed circuit board 12A, is in contact with the coil 3 on the coil end side of the stator A and molded as one piece using the molding material.

The printed circuit boards 12A and 12B have a plurality of wiring patterns between a terminal 13 (of only the printed circuit board 12A) to which a power supply is connected and a plurality of connections 24 to which the coil 3 is connected as it will be discussed later. For a four-pole motor, for example, wiring patterns D, E, F, G, and N for connection are provided as shown in Fig. 5. The thermal protector S is connected to a

part of the wiring patterns so that it is connected to the coil 3 via the wiring patterns as it will be discussed later.

If no printed circuit board is provided, then the thermal protector S is directly connected to a connecting portion at the terminal of the coil 3, which portion does not have the coil function.

The printed circuit boards 12A and 12B have the plurality of connections 24 which project on the outer and inner circumferences thereof.

The connections 24 are shaped to flare outward; wiring patterns 25 which extend from the wiring patterns D, E, F, G, and N to the surfaces of the connections 24 are also flared similarly to the connections 24. Lead wires 26 of the coil 3 are wrapped around and soldered to the connections 24 which include the wiring patterns.

The printed circuit boards 12A and 12B have contacting sections 28 for retaining pins 27 of the printed circuit boards 12A and 12B, the contacting sections 28 being positioned to evade the wiring patterns. Attached to the printed circuit board 12A are lead wires 15 through which power is supplied and which are connected to the terminal 13; the lead wires 15 are clamped by a synthetic resin bushing 16 which is fixed to the lead wire 15 to protect the lead wires against heat or pressure generated during molding or to improve their adhesion with resin.

In Fig. 1, the frame 4 is provided with a bearing housing 6 which is molded integrally with the frame 4 on one side thereof in the axial direction. A bracket 9, which has been made by drawing, is provided on the other side of the frame 4 in the axial direction. The bracket 9 is fixed to the frame 4 by a screw 10; a bearing 11 and a bearing 7 fitted inside support the rotor B which has the rotor winding.

The thermal protector S according to the invention will now be

described with reference to Fig. 7 and Fig. 8. The thermal protector S is constituted primarily by a bimetal 53 and a moving contact 51 attached to an arm 54 made of a conductive material, a plate 55 made of a conductive material and a fixed contact 52 attached thereto, lead wires 59 and 60 connected to the arm 54 and the plate 55, respectively, insulating members 56 and 57 made of polyphenylene sulfide resin, and an epoxy sealing material 58 which are all placed in a bottomed tubular square resin case 50.

The resin case 50 measures 3.9 mm by 15.5 mm by 7.3 mm and 0.9 mm thick; it is molded using polyphenylene sulfide resin.

The heat deformation temperature of the polyphenylene sulfide is +260 degrees centigrade or higher under a pressure of 18.6 kg/cm^2 and the flow length thereof is 120 mm at a temperature of +320 degrees centigrade and under a pressure of 1000 kg/cm^2 .

As shown in Fig. 10, to mold the resin case 50, a core 63 is inserted between an upper die 61 and a lower die 62, then the polyphenylene sulfide resin, which has been melted in a cylinder 67, is injected through an inlet 64 into the cavity formed between the upper die 61 and the lower die 62 via a nozzle 66. At this time, in the foregoing part of the cylinder 67, a polyphenylene sulfide pellet is predried at +140 degrees centigrade for three hours. The temperature of the hopper side of the cylinder 67 is controlled to +290 to +300 degrees centigrade, that of the nozzle side of the cylinder 67 is controlled to +310 degrees centigrade, and that of the nozzle 66 is controlled to +310 to +320 degrees centigrade. The temperatures of the upper die 61, the lower die 62, and the core 63 are controlled to +150 degrees centigrade; the injection pressure is controlled to 50 to 70 kgf/cm^2 .

As mentioned above, the flow length of the polyphenylene sulfide is

120 mm at the temperature of +320 degrees centigrade and under the pressure of 1000 kg/cm^2 ; accurate molding can be achieved by controlling the temperatures and pressure as stated above and by evenly injecting the melted resin material into the mold.

After the injection, the upper die 61, the lower die 62, and the core 63 are cooled. When the polyphenylene sulfide solidifies, the resin case 50 is taken out of the mold. Then, the arm 54, the bimetal 53 and moving contact 51, the plate 55 and the fixed contact 52, the insulating members 56 and 57, and the lead wires 59 and 60 connected to the arm 54 and the plate 55, respectively, are inserted in the resin case 50 and sealed using the sealing material 58, with the lead wires 59 and 60 pulled out. This completes the thermal protector S.

The polyphenylene sulfide is frequently a filler such as glass fiber; it may produce a small amount of a corrosive gas during molding. Hence, a material which has both wear resistance and corrosion resistance must be used for the mold.

In the case of the molded motor M, as shown in Fig. 11, the toroidal insulator 2 is attached, the stator core 1 provided with the coil 3 and the printed circuit boards 12A and 12B is set in the mold constituted by an upper die 29 and a lower die 30, then a molding material composed of unsaturated polyester is injected through two inlets 31 to mold the stator A.

The molding temperature at that time is +160 degrees centigrade and the pressure is 70 kg/cm^2 . When injecting the synthetic resin, the retaining pins 27 jut out from the upper die 29 to form holes 28A in the rear surface of the frame 4 as shown in Fig. 3 and come in contact with the contacting sections 28 of the printed circuit boards 12A and 12B to position and hold in place the printed circuit boards 12A and 12B. This prevents

the printed circuit boards 12A and 12B from being dislocated or deformed and enables the printed circuit boards 12A and 12B to be solidified together with the stator A in the predetermined positions.

The molding material solidifies, closely adhering to the surface of the resin case 50 of the thermal protector S. The resin case 50 is composed of the polyphenylene sulfide, which has the higher heat deformation temperature than the conventional polybutylene terephthalate as described above; therefore, the deformation of the resin case 50 can be controlled to zero or an extremely small amount even when it is molded with the molding material at the temperature and under the pressure stated above. Hence, the distortion problem of the thermal protector S itself can be solved; and malfunction of the thermal protector S can be prevented. This has been proven by an experiment wherein a molded stator A was inserted in an oven; the bimetal 53 used for the experiment had an operating temperature of +130 degrees centigrade and a resetting temperature of +90 degrees centigrade. A steel cover or the like for protecting the thermal protector during molding is no longer necessary, resulting in a remarkably simplified mounting work involved in the molding process.

Fig. 9 shows the electrical circuit diagram of the molded motor M, wherein 3M and 3A respectively denote a primary winding and an auxiliary winding constituting the coil 3, which is the stator winding, and they are connected to a commercial AC power supply AC via the thermal protector S in accordance with the present invention and a triac 63. The gate of the triac 63 is controlled by a controller 64 to which the output of the Hall element H for detecting the number of revolutions is connected. A capacitor 62 is connected in series to the auxiliary winding 3A.

The operation in the configuration stated above will be described. It

is assumed that the moving contact 51 of the thermal protector S is in contact with the fixed contact 52 as shown in Fig. 8 in normal state. The moment the triac 63 is triggered by the controller 64, electric currents flow into the primary winding 3M and the auxiliary winding 3A, causing a rotator B to begin rotating. The controller 64 controls the conducting timing of the triac 63 in accordance with the output of the Hall element H so as to control the number of revolutions of the molded motor M.

If an overcurrent should flow into the coil 3, namely, 3M and 3A, due to the rotator B locking or the like, with resultant generation of abnormal heat, the bimetal 53 is put in operation to drive the arm 54, thereby separating the moving contact 51 from the fixed contact 52 which were in contact in Fig. 8. This cuts off the supply of electric currents to the coil 3 and stops the revolution of the molded motor M. In this case also, the thermal protector S is in contact with the coil 3 to ensure good heat conductivity, which enables accurate operation of the bimetal 53.

The embodiment employs the induction motor; however, it may also be applied to a DC motor. Likewise, the coil 3 of the stator A in the embodiment is toroidal type; however, it is not limited thereto and it may alternatively be the split-phase winding, the salient-pole winding, or the shaded-pole type.

Thus, according to the present invention, the resin case can be molded with the molding material while it is kept in contact with the windings to fabricate the thermal protector; and the molding material is in close contact with the surface of the resin case. This makes it possible to significantly simplify the installation of the thermal protector and also to permit easier assembly of molded electric equipment. Moreover, the heat transfer between the thermal protector and the windings can also be improved,

allowing quicker protective operation to be achieved.

Further, the deformation of the resin case of the thermal protector can be controlled to zero or an extremely small amount even when the resin case is exposed to the molding temperature and the molding pressure. This feature prevents malfunction of the thermal protector and enables accurate protective operation of thereof.

Especially because the resin case of the thermal protector can be made smaller and thinner, it is best suited for protecting the stator winding of a toroidal type motor which can be made smaller.



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REPLACED

WHAT IS CLAIMED IS:

1. A molded motor which has a stator core, a stator winding mounted on said stator core, a rotor which rotates when subjected to a magnetic field generated by said stator winding, and which is formed by molding at least a part of said stator winding with a synthetic resin molding material, said molded motor comprising:

a thermal protector composed of a bottomed tubular synthetic resin case and a bimetal contact which is sealed in said case and which opens or closes at a predetermined temperature; and

a connection for controlling the supply of electric currents to said stator winding via said bimetal contact of said thermal protector;

wherein said synthetic resin molding material brings said synthetic resin case of said thermal protector in contact with a coil end of said stator winding, keeps said synthetic resin case and said molding material in close contact, and has said connection embedded therein.

2. A molded motor according to Claim 1, wherein said connection is a wiring pattern formed on a printed circuit board embedded in said molding material and said bimetal contact of said thermal protector and said stator winding are connected through said wiring pattern.

3. A molded motor according to Claim 1, wherein a case of said thermal protector is molded using a resin material, the heat deformation temperature under a molding pressure of which is higher than the molding temperature.

4. A molded motor according to Claim 1, wherein the case of said

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thermal protector is molded using a resin material which exhibits no deformation or an extremely small amount of deformation when it is exposed to a molding temperature and pressure at the time of molding.

5. A molded motor according to Claim 4, wherein the case of said thermal protector is molded using a polyphenylene sulfide resin, the heat deformation temperature of which is +260 degrees centigrade or above under a pressure of 18.6 kg/cm^2 .

6. A molded motor according to Claim 1, Claim 2, Claim 3, Claim 4, or Claim 5, wherein said stator winding is a stator winding of a toroidal type motor and the case of said thermal protector is in contact with a coil end of said stator winding.

7. A molded motor according to Claim 1, Claim 2, Claim 3, Claim 4, or Claim 5, wherein said stator winding is a split-phase winding, a salient-pole winding, or a shaded-pole motor stator winding, wherein the case of said thermal protector is in contact with a coil end of said stator winding.

8. A molded motor comprising a thermal protector which is fabricated by:

heating a polyphenylene sulfide resin, which has a heat deformation temperature of +260 degrees centigrade or above under a pressure of 18.6 kg/cm^2 and a flow length of 120 mm at a temperature of +320 degrees centigrade under a pressure of 1000 kg/cm^2 , at a temperature of +290 to +310 degrees centigrade to melt it;



injecting the melt in a predetermined metal mold, the temperature of which is controlled to +150 degrees centigrade, under an injection pressure of 50 to 70 kgf/cm² ;

cooling the injected melt to form a bottomed tubular case;

inserting a bimetal contact in said case; and

sealing said case with a lead wire pulled out.