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PATENT SPECIFICATION

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(54) SUPPORT

(71) We, MABUCHI MOTOR KABUSHIKI KAISHA (MABUCHI MOTOR CO., LTD.), a Japanese body corporate of No. 14-11, Tateishi 3-chome, Katsushika-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to supports and more particularly to means adapted to support a bearing with a part-spherical external surface. As will become apparent from the description which follows, such support means are particularly useful for supporting a bearing at one axial end of a rotor shaft of an electric motor.

In accordance with the present invention, we provide means adapted to support a bearing with a part-spherical external surface, which support means comprises an inner bearing housing cylinder separated from a circumlocated external support by an annular groove, the cylinder being solid with the external support at one of its axial ends, and being open at its other axial end for receiving the bearing, the inner surface of the cylinder being formed with a part-spherical surface for accommodating the external surface of the bearing and with a plurality of inwardly extending projections for restraining the bearing from being withdrawn through the said other axial end, a plurality of webs dividing the annular groove and interconnecting the outer surface of the cylinder and the confronting inner surface of the external support, and all of the cylinder, the external support and the webs being integrally formed of a synthetic resin.

The invention also extends to a motor comprising: a stator providing a permanent magnetic field; a rotor positioned for free rotation within the stator; a motor case enclosing both the stator and the rotor; and bearing means for supporting a shaft of the rotor at one axial end of the motor case, the bearing means comprising a bearing having a part-spherical external surface and an inner cylindrical surface for supporting the rotor

shaft therewithin, and the bearing being supported within a support means as defined in the preceding paragraph, the said external support being formed in or connected to the motor case at one axial end thereof.

The invention is hereinafter more particularly described by way of example only with reference to the accompanying drawings, in which:—

Fig. 1a shows a plan view of a previously proposed motor case cover;

Fig. 1b is a scrap sectional view taken along the line B—B';

Fig. 2a is a plan view of an alternative form of bearing support previously proposed and usable in the motor case cover of Fig. 1a;

Fig. 2b is a scrap sectional view taken along the line C—C' in Fig. 2a;

Fig. 3a is a plan view generally similar to Fig. 2a of a further example of previously proposed bearing support;

Fig. 3b is a sectional view taken along the line D—D' in Fig. 3a;

Fig. 4 is a view generally similar to Fig. 1a showing a motor case cover provided with an embodiment of bearing support constructed in accordance with the present invention;

Fig. 5 shows a side elevational view to a somewhat enlarged scale of a bearing for which the bearing support of Fig. 4 is adapted;

Fig. 6 is an enlarged sectional view taken along the line E—E' in Fig. 4; and

Fig. 7 is a plan view of the bearing support of Figs. 4 and 6 to an enlarged scale showing the elastic deformation with the bearing in position.

Before describing in detail a preferred embodiment of bearing support means in accordance with the present invention, we believe it would be helpful to briefly describe three previously proposed bearing support means with reference to Figs. 1a to 3b.

The motor case cover shown in Fig. 1a in plan has a fitting pin 1, a mount 2 and brush gear 3 of the metal spring type. In the centre of the motor case cover is a bearing support means defining a central hollow 4 provided with a plurality of inwardly directed projections 5, the hollow 4 being adapted to

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accommodate a bearing 6 having a part-spherical external surface and the projections 5 being provided in an effort to restrain the bearing 6 from being removed from the hollow 4. The bearing 6 can nutate to ensure its self-alignment with the bearing hollow 4.

The previously proposed bearing support means described hereinabove suffers from certain disadvantages, so we have found. Firstly, press-fitting of the bearing 6 into the hollow 4 is not easy. The hollow 4, the projections 5 and the bearing 6 itself must be made extremely precisely because after press-fitting of the bearing, it is retained only by elasticity of the projections 5. Lack of precision in the dimensions of these parts may cause difficulty or failure in press-fitting of the bearing 6 into the bearing hollow 4 or in the retention of the bearing 6 by the projections 5 whilst still allowing it to nutate.

In the arrangement of Figs. 2a and 2b, which has also been previously proposed, the bearing 6 is received within an inner divided bearing sleeve or cylinder 7, which sleeve or cylinder 7 extends from a plastics base S. The bearing 6 is held in position by end portions of the divided sleeve 7. We have found that this arrangement also suffers from disadvantages in that the different portions of the divided sleeve 7 may not have the same strength in which case the bearing 6 may be mis-aligned since it is held in its correct position only by the resiliency of the divided sleeve or cylinder 7.

Figs. 3a and 3b illustrate a further previously proposed arrangement in which a plurality of inwardly directed positioning pieces 8 supplement an inner divided sleeve or cylinder 9 and serve to ensure that the bearing 6 is properly positioned. We have found the arrangement of Figs. 3a and 3b disadvantageous in that complicated moulds are required for moulding plastics material into the form illustrated. Poor efficiency and production results in practice.

In Figs. 4 to 7 which show, by way of example, a preferred embodiment of support means constructed according to the invention, the parts numbered 1 to 4 correspond to those similarly identified in Fig. 1a. The motor case cover is made, for example, by moulding polyacetal resin. The support means is integrally moulded at its centre and includes an inner housing bearing cylinder 10 provided about its rim at one axial end with a plurality of projections 11 (here: three) for restraining the spherical bearing from being withdrawn from the cylinder. A similar number of webs 12 bridge or connect the outer surface of the cylinder 10 and an opposing wall of the motor case from which it is separated by an annular groove 13. Each of the webs 12 extends at an angle to the respective radius from the cylinder 10. The inner surface of the cylinder 10 has a part-spherical portion

as shown. The cylinder 10 is made to have a comparatively thin wall. For a motor case cover having a diameter of approximately 30mm, the thickness t (Fig. 7) of the external end of the cylinder 10 should be 0.5mm or less so that it has sufficient elasticity to be deformed or expanded as shown.

As bearing 14 shown in Fig. 5 is press-fitted into the part-spherical bearing seat 4 within the cylinder 10, the open end of the cylinder 10 is expanded and the bearing 14 is received therewithin. When the bearing is fully seated, the open end of the cylinder 10 contracts and the retaining projections 11 hold the bearing 14 tight to prevent it from slipping out. However, the bearing 14 is still permitted to nutate for self-alignment.

Fig. 7 shows the bearing 14 press-fitted and retained in the cylinder 10. As will be seen from the figure, the annular cylinder 10 is slightly deformed towards a triangular shape, indicating that the bearing 14 is securely fastened and retained by the retaining projections 11. Although the cylinder 10 has a relatively thin wall, if ever its wall should lack strength or precision in a small extent, the bearing 14 will nevertheless be accurately positioned by virtue of the three webs 12.

The webs are positioned at an angle to the respective radii for the following reason. Supposing that the webs 12 did extend along radii and the cylinder 10 smaller than the correct size, the bearing 14 would then be fastened too tight by the retaining projections 11 to allow its free rotational and directional movements. By having the webs 12 extend at an angle to the respective radii, the junction of each web 12 with the cylinder 10 can be expanded outwardly to a small extent and consequently the bearing 14 can be maintained in a properly fastened state.

As will be clear from the above description, the spherical bearing can be properly positioned and retained in the described bearing housing cylinder even if the manufactured cylinder should have dimensions deviating from and smaller than the prescribed standard by a certain tolerance. The described support means can be formed by far simple moulds than the complicated moulds required for the support means shown in Fig. 3 whilst possessing almost all the functions of the support means of Fig. 3. Consequently, as compared with the Fig. 3 arrangement we can now increase production efficiency and decrease production cost.

WHAT WE CLAIM IS:—

1. Means adapted to support a bearing with a part-spherical external surface, which support means comprises an inner bearing housing cylinder separated from a circum-located external support by an annular groove, the cylinder being solid with the external support at one of its axial ends, and being

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accommodate a bearing 6 having a part-spherical external surface and the projections 5 being provided in an effort to restrain the bearing 6 from being removed from the hollow 4. The bearing 6 can nutate to ensure its self-alignment with the bearing hollow 4.

The previously proposed bearing support means described hereinabove suffers from certain disadvantages, so we have found. Firstly, press-fitting of the bearing 6 into the hollow 4 is not easy. The hollow 4, the projections 5 and the bearing 6 itself must be made extremely precisely because after press-fitting of the bearing, it is retained only by elasticity of the projections 5. Lack of precision in the dimensions of these parts may cause difficulty or failure in press-fitting of the bearing 6 into the bearing hollow 4 or in the retention of the bearing 6 by the projections 5 whilst still allowing it to nutate.

In the arrangement of Figs. 2a and 2b, which has also been previously proposed, the bearing 6 is received within an inner divided bearing sleeve or cylinder 7, which sleeve or cylinder 7 extends from a plastics base S. The bearing 6 is held in position by end portions of the divided sleeve 7. We have found that this arrangement also suffers from disadvantages in that the different portions of the divided sleeve 7 may not have the same strength in which case the bearing 6 may be mis-aligned since it is held in its correct position only by the resiliency of the divided sleeve or cylinder 7.

Figs. 3a and 3b illustrate a further previously proposed arrangement in which a plurality of inwardly directed positioning pieces 8 supplement an inner divided sleeve or cylinder 9 and serve to ensure that the bearing 6 is properly positioned. We have found the arrangement of Figs. 3a and 3b disadvantageous in that complicated moulds are required for moulding plastics material into the form illustrated. Poor efficiency and production results in practice.

In Figs. 4 to 7 which show, by way of example, a preferred embodiment of support means constructed according to the invention, the parts numbered 1 to 4 correspond to those similarly identified in Fig. 1a. The motor case cover is made, for example, by moulding polyacetal resin. The support means is integrally moulded at its centre and includes an inner housing bearing cylinder 10 provided about its rim at one axial end with a plurality of projections 11 (here: three) for restraining the spherical bearing from being withdrawn from the cylinder. A similar number of webs 12 bridge or connect the outer surface of the cylinder 10 and an opposing wall of the motor case from which it is separated by an annular groove 13. Each of the webs 12 extends at an angle to the respective radius from the cylinder 10. The inner surface of the cylinder 10 has a part-spherical portion

as shown. The cylinder 10 is made to have a comparatively thin wall. For a motor case cover having a diameter of approximately 30mm, the thickness t (Fig. 7) of the external end of the cylinder 10 should be 0.5mm or less so that it has sufficient elasticity to be deformed or expanded as shown.

As bearing 14 shown in Fig. 5 is press-fitted into the part-spherical bearing seat 4 within the cylinder 10, the open end of the cylinder 10 is expanded and the bearing 14 is received therewithin. When the bearing is fully seated, the open end of the cylinder 10 contracts and the retaining projections 11 hold the bearing 14 tight to prevent it from slipping out. However, the bearing 14 is still permitted to nutate for self-alignment.

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The webs are positioned at an angle to the respective radii for the following reason. Supposing that the webs 12 did extend along radii and the cylinder 10 smaller than the correct size, the bearing 14 would then be fastened too tight by the retaining projections 11 to allow its free rotational and directional movements. By having the webs 12 extend at an angle to the respective radii, the junction of each web 12 with the cylinder 10 can be expanded outwardly to a small extent and consequently the bearing 14 can be maintained in a properly fastened state.

As will be clear from the above description, the spherical bearing can be properly positioned and retained in the described bearing housing cylinder even if the manufactured cylinder should have dimensions deviating from and smaller than the prescribed standard by a certain tolerance. The described support means can be formed by far simple moulds than the complicated moulds required for the support means shown in Fig. 3 whilst possessing almost all the functions of the support means of Fig. 3. Consequently, as compared with the Fig. 3 arrangement we can now increase production efficiency and decrease production cost.

WHAT WE CLAIM IS:—

1. Means adapted to support a bearing with a part-spherical external surface, which support means comprises an inner bearing housing cylinder separated from a circum-located external support by an annular groove, the cylinder being solid with the external support at one of its axial ends, and being



- open at its other axial end for receiving the bearing, the inner surface of the cylinder being formed with a part-spherical surface for accommodating the external surface of the bearing and with a plurality of inwardly extending projections for restraining the bearing from being withdrawn through the said other axial end, a plurality of webs dividing the annular groove and interconnecting the outer surface of the cylinder and the confronting inner surface of the external support, and all of the cylinder, the external support and the webs being integrally formed of a synthetic resin.
- 5 2. A support according to Claim 1, wherein said projections are located at spaced intervals about the rim of the cylinder at its said other axial end; and wherein the webs are connected to the outer surface of the cylinder approximately mid-way between the locations of respective projections.
- 10 3. A support according to Claim 2 in which both the projections and the webs are three in number and are approximately equally spaced.
- 15 4. A support according to any preceding claim, wherein each web extends from the cylinder to the external support at an angle to the respective radius.
- 20 5. A support according to any preceding claim, in which the thickness of the cylinder is such that in operation it is elastically deformed.
- 25 6. Means adapted to support a bearing with a part-spherical external surface, which support means is substantially as hereinbefore described with reference to and as shown in Figures 4, 6 and 7 of the accompanying drawings.
- 30 7. A motor comprising: a stator providing a permanent magnetic field; a rotor positioned for free rotation within the stator; a motor case enclosing both the stator and the rotor; and bearing means for supporting a shaft of the rotor at one axial end of the motor case, the bearing means comprising a bearing having a part-spherical external surface and an inner cylindrical surface for supporting the rotor shaft therewithin, the bearing being supported within a support means according to any preceding claim, the said external support being formed in or connected to the motor case at one axial end thereof.
- 35 8. A motor substantially as hereinbefore described with reference to and as shown in Figures 4 to 7 of the accompanying drawings.
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