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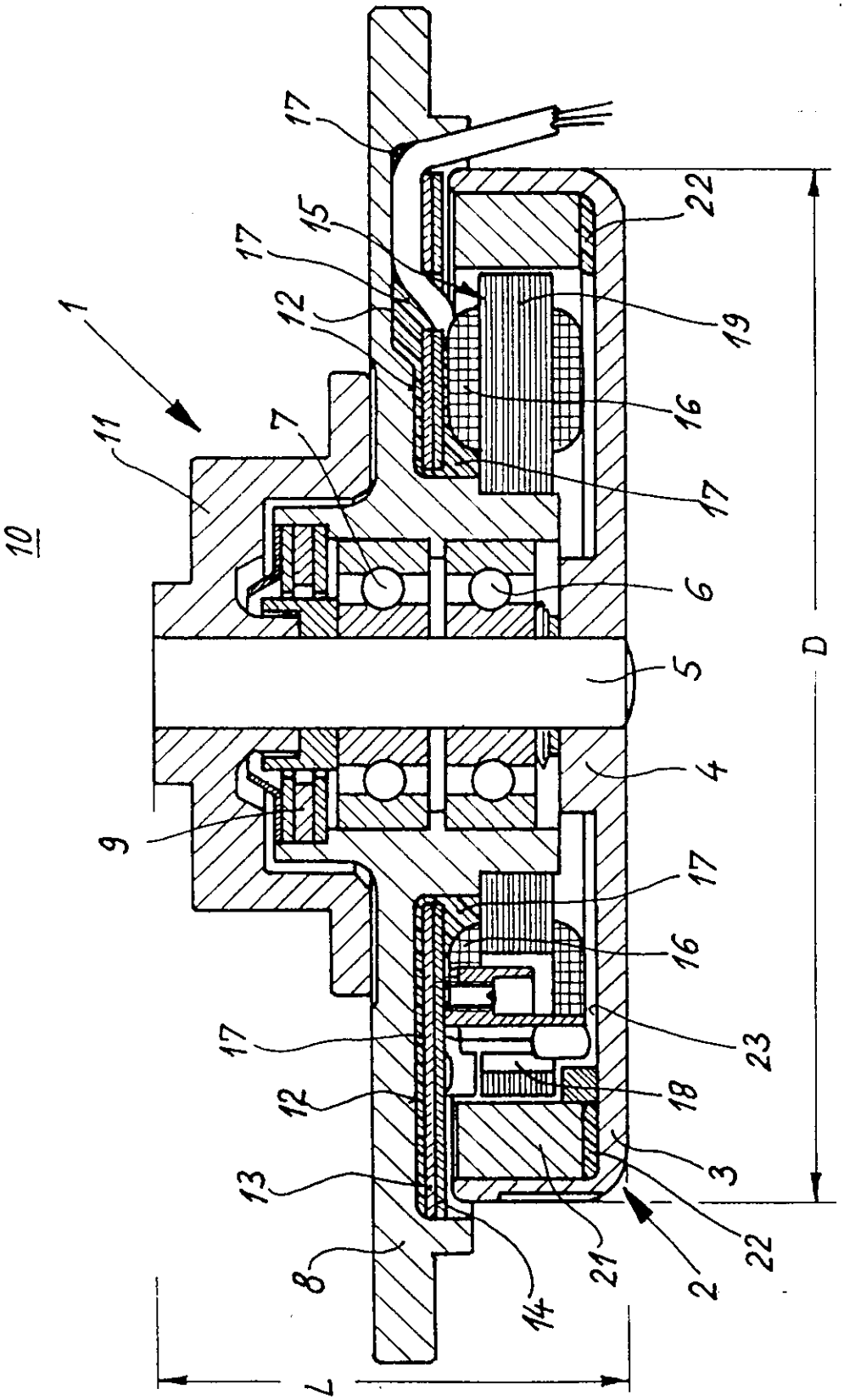

Fig.1

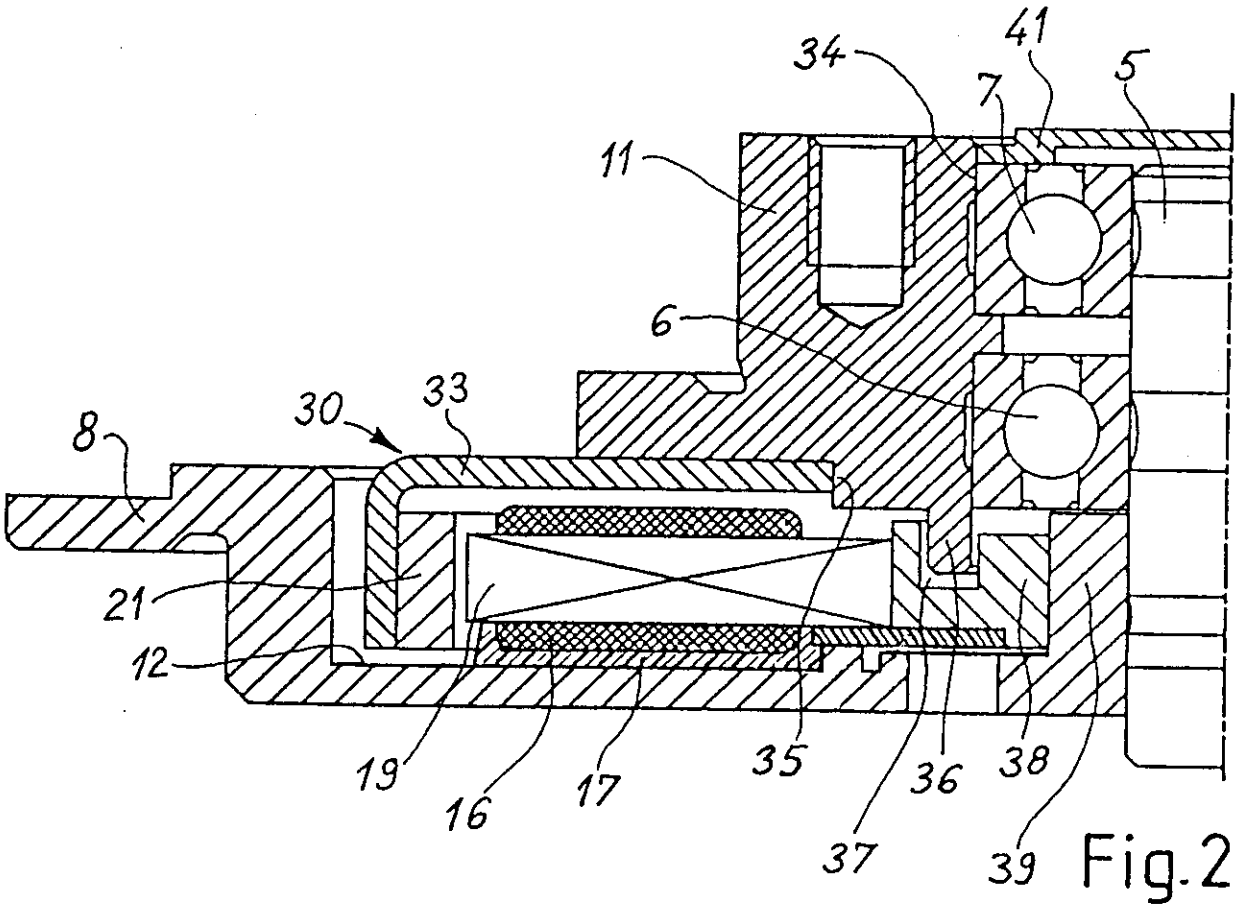

Fig.2

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AN ELECTRIC DRIVE MOTOR

The present invention relates to an electric drive motor.

Brushless electric drive motors of the external rotor type, which are used for example in disk storage drives, usually have a mounting flange for the stator which also supports the bearing for the shaft. The noise from such motors when operational arises as rolling noise in the bearings, and as electro-mechanical noise in the stator winding. These noise-generating vibrations are transferred to the mounting flange. As this flange has usually to be formed to have a large area (often disk-shaped) and, for reasons of space, is often very thin, it acts as a membrane which passes on or gives out interference noise generated by these vibrations.

It is known, from DE-OS 16 13 343, to provide an elastic material between the mounting flange and a shielding ring or printed circuit board. This "sandwich" - construction dampens the vibrations.

The present invention seeks to provide drive motors having a much higher noise reduction than previously.

According to the present invention there is provided a drive motor of the external rotor type comprising a shaft defining a central axis, a stator carrying a winding arranged substantially coaxially relative to said central axis, and a rotor arranged substantially coaxially relative to said central axis and to be external relative to, and to substantially surround, said stator winding, wherein a mounting flange supporting said stator is arranged

substantially coaxially relative to said central axis, and wherein the space between facing surfaces of said stator and said mounting flange is filled with plastics such that said mounting flange and said stator are effectively a one piece unit.

The invention also provides an axially short, brushless motor of the external rotor type having a mounting flange which has an area which is relatively large as compared to the axial extent of the motor, and said mounting flange being rigidly connected to a tube-shaped bearing element, a stator carrying a winding being mounted on said mounting flange, and a rotor being rotatable about said stator, the rotor being held by a shaft which is fixed to the centre of the rotor and which extends coaxially longitudinally through said bearing element, wherein the space between an inner wall of the flange and at least one flange-sided winding head of the winding of the stator is filled with plastics so that the flange forms a one piece unit with the stator and with any intermediate elements situated within said space.

According to a further aspect of the invention there is provided an axially short, brushless motor of the external rotor type having a mounting flange which has an area which is relatively large as compared to the axial extent of the motor, said mounting flange being rigidly connected to a stationary shaft, a stator carrying a winding being connected to said mounting flange, and a rotor being supported by a bearing element through which said shaft extends for rotation about said shaft and about said stator, wherein the space between an inner wall of the flange and the winding of the stator is filled with plastics so that the flange forms a one piece unit with the stator.

The annular application of the plastics around the point of rotation of the motor allows a more economical

production.

For a lot of cases it is sufficient to fill only the space between the winding head of the stator and the flange with plastics, and in some cases, due to reasons of economy, a partial filling is sufficient. The plastics material may be injected into the space.

If there is a conductor plate, and/or a printed circuit board, and/or a shielding ring, these are not only sound-dampened by the surrounding casting or moulding, but are also fixed to the stator at the same time. Thus the glueing of the conductor plate (PCB), of the shielding ring, and of the winding, which has been practised up to now, becomes superfluous.

An additional dampening of the stator is achieved by filling the grooves of the laminated sheet plate with plastics as well.

The dampening of the noises produced by the rotor is also achieved by connecting the parts with a hard and tough plastics layer. Even a point-like distributed layer leads to good results.

In a preferred embodiment, said rotor is substantially bell-shaped, and parts of the rotor are connected to each other by a plastics layer, wherein the layer is applied point-like, annularly, radially, or sheetlike.

In the stator, electro-magnetically produced noise can be prevented from being reflected backwards and forwards between the stator and the bearing. Such electromagnetically produced noise can in particular occur due to axial and/or radial electromagnetic disturbing forces between rotor and stator.

Axial electromagnetic disturbing forces can be minimized to reduce noise between the rotor and

stator. The magnetic components of the rotor and stator can be arranged symmetrically to one another to minimize disturbing forces. However, this solution is not always practicable with constructional means.

Particularly when in the case of a brushless direct current motor for the rotor position-dependent commutation of the currents in the motor windings, one or more galvanomagnetic sensors, e.g. Hall generators or Hall-IC's are used, which are located in the influence range of the rotor magnetic field, a certain axial projection of the rotor magnets is required on the side facing the sensor or sensors, in order to ensure a magnetic flux density adequate for controlling the sensors. On the opposite side, the axial projection is appropriately much smaller, in order to economize on expensive magnetic material and/or the axial overall length. Thus, a permanent magnetic rotor is obtained, which is arranged asymmetrically with respect to the axial plane of symmetry of the stator iron. The different sizes of the axial projections leads to an axial force being exerted on the rotor, whose magnet attempts to adjust itself symmetrically to the stator iron. This force is generally rotation position-dependent, e.g. because the air gap between the rotor and the stator does not have the same dimensions throughout. This can lead to the aforementioned electromagnetically produced noise. However, in a further development of the invention, this can be counteracted in such an asymmetrical arrangement in that the stator carries an end plate, which co-operates with the rotor magnet for the axial symmetrization of the magnetic field and preferably defines at least part of the air gap in the vicinity of the larger projection.

In an embodiment, electromagnetically caused noise can

be reduced in that, in the vicinity of the larger axial projection, the induction in the central part of the rotor magnetic poles is made at least zonally weaker than in the marginal areas of said poles adjacent to the pole clearances. This also ensures an axial force symmetrization, together with a reliable response or operation of the rotation position sensors.

What is decisive is that the magnetic components of the rotor and stator are arranged symmetrically to one another, i.e. that a magnetic symmetrization takes place in such a way that the sum of the magnetic axial forces between the rotor and the stator are as small as possible and preferably zero in the case of the finally fitted motor.

Embodiments of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 shows a section of a drive motor of the invention, and

Fig. 2 shows a section of half of a second embodiment of a drive motor of the invention.

In Fig. 1 there is shown in section a drive unit 1, which serves for example as a hard disk storage drive. This drive unit 1 incorporates a drive motor 2 having a substantially cup-shaped or bell-shaped rotor 3. A shaft 5 is connected at one end to the centre of the base 4 of the rotor 3. The shaft 5 is supported in ball bearings 6 and 7. The outer rings of these ball bearings 6, 7 are mounted on a mounting flange 8 and are arranged concentrically. To the upper ball

bearing 7 there is connected a ferro-fluidic seal 9 which prevents liquid or solid particles from entering in an axial direction the "clean-room" environment from the motor environment. A hub 11 is connected rigidly to the end of the shaft 5 remote from its end connected to the rotor 3. Hard storage disks (not shown) can be mounted on this hub 11, for example.

A shielding ring 13 and a plate 14, for example, a printed circuit board, are received within a recess 12 in the inner wall of the flange 8 and are embedded therein by way of a hot-setting, a thermo-setting, a fusion or another suitable adhesive. A hard and tough plastics material is preferably provided as the fusion adhesive. In this way, a unitary or one piece part is formed comprised by the connection of the flange 8 with the shielding ring 13, the circuit board 14 and a stator 15. The adhesive is introduced into all or part of the area of a gap 17 defined between the flange 8 and a winding head 16 of the winding of the stator 15. The glueing of the circuit board, the shielding ring and the winding which has been required up to now, is replaced by a generous application of plastics material, preferably hot-setting adhesive. The one piece part (8, 13, 14, 15) now formed is a poor sound transducer because of its increased weight and its increased rigidity, and this provides a distinct noise reduction. The stator laminations 19 of the stator 15 are generally grooved, as indicated at 18, and these grooves 18 can also be filled with plastics material.

Most or all of any cavities or gaps between the mounting flange 8 and the winding of the stator 15 are also filled, either partially or wholly, with plastics material.

Depending upon the size and construction of the motor 2, a partial casting or moulding with plastics material is sufficient. It has been found to be advantageous to apply the plastics annularly coaxially around the point of rotation of the motor.

The printed circuit board 14 and/or the shielding ring 13 arranged between the flange 8 and the winding head 16 are cast or moulded partially or entirely with plastics material, a partial casting being sufficient in many cases. Hot-setting adhesives which can be introduced with a dosing device are particularly suitable for the casting or moulding. The use of a dosing device enables an economical use of material.

A permanent magnetic rotor magnet 21 is fastened to the inner surface of a substantially cylindrical wall of the rotor 3. One end surface of the rotor magnet 21 terminates approximately at the edge of the cylindrical wall at the open end of the rotor 3. The opposite end surface of the rotor magnet 21 is connected to the inner surface 23 of the base of the rotor 3 by a hard and tough plastics layer 22, for example, of a hot-setting adhesive. Other parts of the rotor 3 can also be covered point-like, annularly, radially or sheetlike by means of plastics layers. The connection of the rotor 3 and the rotor magnet 21 by means of plastics material to form a substantially one piece rotor part leads to further noise reductions.

Fig. 2 shows a second embodiment of a drive unit including a drive motor 30 having a substantially cup-shaped or bell-shaped rotor 33. The shaft 5 is substantially centrally mounted and fixed to the mounting flange 8. The inner rings of the axially spaced ball bearings 6, 7 are rigidly mounted on the

shaft 5. The outer rings of the ball bearings 6, 7 are mounted at a predetermined spacing on the inner wall 34 of the central bore of hub 11. The hub 11 has a first projection 35 extending centrally into the base of the bell-shaped rotor 33 and is rigidly connected thereto. A second projection 36 of the hub 11 extends into an annular groove 37 of an annular part 38. A U-shaped gap defined between the projection 36 and the annular groove 37 acts as a labyrinth packing. The central bore of the annular part 38 is fixed rigidly to a hub-like projection 39 of the mounting flange 8. Stator laminations 19, preferably in the form of a grooved stack of sheets, are fixed with the winding to the radial outer side of the annular part 38. Hot-setting adhesive or a different plastics is inserted into the gap 17 between the flange-sided winding head 16 and the inner wall of a recess 12 of the flange 8. A cover disk 41 sealing the mounting of the motor from the "clean-room" environment is arranged on the upper ball bearing 7. The dampening measures applied to at the rotor described in Fig. 1 also lead to a reduction of the noise level with the embodiment according to Fig. 2.

Instead of hot-setting adhesive, other plastics can be used for the sound-dampening connection of motor parts as, for example, easy to work casting resins.

The invention is especially suitable for motors whose diameter D is large compared to the over-all axial length L, that is, D/L amounts to at least 2.

It will be appreciated that modifications and variations to the invention as described and illustrated can be made.

The motor claimed and illustrated herein is also described and illustrated in our copending application No. 2256975 which was divided out of the present application and which claims protection for a drive motor of the external rotor type.

CLAIMS

1. A drive motor of the external rotor type comprising a shaft defining a central axis, a stator carrying a winding arranged substantially coaxially relative to said central axis, and a rotor arranged substantially coaxially relative to said central axis and to be external relative to, and to substantially surround, said stator winding, wherein a mounting flange supporting said stator is arranged substantially coaxially relative to said central axis, and wherein the space between facing surfaces of said stator and said mounting flange is filled with plastics such that said mounting flange and said stator are effectively a one piece unit.

2. An axially short, brushless motor of the external rotor type having a mounting flange which has an area which is relatively large as compared to the axial extent of the motor, and said mounting flange being rigidly connected to a tube-shaped bearing element, a stator carrying a winding being mounted on said mounting flange, and a rotor being rotatable about said stator, the rotor being held by a shaft which is fixed to the centre of the rotor and which extends coaxially longitudinally through said bearing element, wherein the space between an inner wall of the flange and at least one flange-sided winding head of the winding of the stator is filled with plastics so that the flange forms a one piece unit with the stator and with any intermediate elements situated within said space.

3. An axially short, brushless motor of the external rotor type having a mounting flange which has an area which is relatively large as compared to the axial extent of the motor, said mounting flange being rigidly connected to a stationary shaft, a stator carrying a winding being connected to said mounting flange, and a rotor being supported by a bearing element through which said shaft extends for rotation about said shaft and about said

stator, wherein the space between an inner wall of the flange and the winding of the stator is filled with plastics so that the flange forms a one piece unit with the stator.

4. A motor as claimed in any preceding claim, wherein in the plastics material is applied coaxially in annular form around the point of rotation of the motor.

5. A motor as claimed in any preceding claim, wherein the space between the stator and the flange is partially or entirely cast or moulded with plastics.

6. A motor as claimed in any preceding claim, wherein a conductor plate and/or a shielding ring is located in said space between the flange and the stator and is or are partially or entirely cast or moulded with plastics on both sides.

7. A motor as claimed in any preceding claim, wherein the stator is laminated, the laminations thereof are grooved and said grooves are also, at least partially, filled with plastics.

8. A motor as claimed in any preceding claim, wherein said rotor is substantially bell-shaped, and parts of the rotor are connected to each other by a plastics layer, wherein the layer is applied point-like, annularly, radially, or sheetlike.

9. A motor as claimed in Claim 8, wherein the bottom surface of said bell-shaped rotor is connected to a face of a rotor magnet by way of a plastics layer.

10. A motor as claimed in any preceding claim, wherein the plastics used for the connection or the surrounding of motor parts is an easy to work casting resin.

11. A motor as claimed in any of Claims 1 to 9, wherein the plastics used for the connection or the surrounding of motor parts is a hot-settable adhesive.

12. A motor as claimed in Claim 11, wherein the hot-settable adhesive is injected by means of a dosing device.

13. An electric motor as claimed in any preceding claim, wherein the magnetic components of the rotor and stator are arranged symmetrically to one another.

14. A drive motor substantially as hereinbefore described with reference to the accompanying drawings.

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by virtue of deed of assignment dated (06.06.1994) Certified copy filed on GB2256975
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**** END OF REGISTER ENTRY ****

RENEWAL DETAILS

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