

AN ELECTRIC DRIVE MOTOR

The present invention relates to an electric drive motor.

5 Electric motors for directly driving rotary loads, such as information storage disks, require "clean room" conditions. In the market for information storage disk drives, there is a continuing demand for compactness. Previously, this demand has been satisfied by providing drive motors of the external
10 rotor type, which could be axially relatively short. Now there is demand for the information storage disks to have ever-diminishing diameters so that the apparatuses which hold them can also be compact. At the same time, the motor must
15 still supply adequate torque, have a certain minimum angular momentum and smooth-running operation, and inhibit the passage of dirt particles from its bearings and torque-generating regions toward a "clean room" region, all without increasing its overall axial dimension.

20 According to the present invention there is provided an electric drive motor 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
25 be external relative to, and to substantially surround, said stator winding, wherein a mounting flange for supporting said stator is arranged substantially coaxially relative to said central axis, and said shaft is arranged to support a hub for rotation by said motor, wherein said mounting flange has an
30 axially extending recess surrounded by a mounting rim, and said rotor comprises a cup-shaped rotor of magnetic material which projects into said recess, wherein said hub comprises a disk-bearing element having a substantially radially extending lower surface, and wherein said cup-shaped rotor has
35 a substantially radially extending, substantially planar base with which said lower surface of said hub is engaged.

In an embodiment, said mounting rim of said mounting flange is substantially radially aligned with said planar base of the rotor.

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In an embodiment, the mounting flange has an axially-deepened tank form which facilitates the provision of the mounting rim, which is preferably axially offset relative to said recess. As this rim is aligned substantially in the back plane of the rotor, axial lengthening of the motor is avoided. The offset mounting rim together with the rotor may be arranged to provide an approximation of an outer labyrinth seal for dust particles from the motor and provide superior magnetic shielding.

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Preferably, the motor has a stationary shaft enabling axial separation of ball bearings and a central annulus of the flange. This may lead to a corresponding reduction in the diameter of the motor.

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In a preferred embodiment, a conductor plate and/or a shielding ring is located between said mounting flange and the winding of the stator, and for example, is or are partially or entirely cast or moulded with plastics on both sides.

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Preferably, parts of the cup-shaped rotor are connected to each other by a plastics layer, wherein the layer is applied point-like, annularly, radially, or sheetlike.

5 The rotor surface may be connected to a rotor magnet by way of a plastics layer.

10 In a preferred embodiment, the magnetic components or the rotor and stator are arranged symmetrically to one another.

15 An embodiment of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawing, in which the sole Figure shows a section of half of a drive motor of the invention.

20 In Figure 1 there is shown in section a drive unit which serves, for example, as a hard disk storage drive. The drive unit incorporates a drive motor 30 having a substantially cup-shaped or bell-shaped rotor 33. The rotor 33 is preferably
25 deep-drawn out of soft iron sheet and surrounds a generally annular permanent magnetic rotor magnet 21. The permanent magnetic rotor magnet 21 is fastened to the inner surface of a substantially cylindrical wall of the rotor 33. One end surface of the rotor magnet 21 terminates approximately at the
30 edge of the cylindrical wall at the open end of the rotor 33. The opposite end surface of the rotor magnet 21 is spaced from the inner surface of the base of the rotor 33, but alternatively, may be connected thereto, for example, by a hard and tough plastics layer, for example of a hot-setting adhesive.

35 The drive motor 30 has a shaft 5 which is substantially centrally mounted and fixed to a mounting flange 8. The shaft 5 supports axially spaced ball bearings 6, 7, the inner rings of which 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 the hub 11. The hub 11 is arranged to be rotatable relative to the shaft 5 which is stationary. Preferably the hub 11 is a one-piece part made of aluminium. The hub 11 has a first
5 projection 35 extending centrally into the base of the bell-shaped rotor 33 and is rigidly connected thereto, for example, circumferentially by sputtering or gluing. 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
10 projection 36 and the annular groove 37 acts as a labyrinth seal. 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
15 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
20 upper ball bearing 7.

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

25 The mounting flange 8 comprises a cup-shaped flange having an axially extending recess defined therein into which the cup-shaped rotor 33 projects. The flange 8 has a substantially annular, axially projecting rim 81 having a
30 substantially radially extending outer surface which extends substantially in the same plane as that containing the outer surface 32 of the base of the cup-shaped rotor 33.

The stationary shaft 5 is arranged substantially
35 centrally of the floor of the recess of the flange 8 and is rigidly inserted within the central bore of the projection 39

of the mounting flange 8.

The base surface of the cup-shaped rotor 33 extends radially inwardly towards the shaft 5, preferably to extend over or beyond the windings 19. In this manner, the base surface of the rotor 33 provides magnetic shielding for the disk chamber adjacent the hub 11, where magnetic information disks, and reading and recording heads are housed.

The drive unit illustrated, which has a stationary shaft, has a very compact arrangement. A cover disk 41 is arranged to rotate with the hub 11, and in the illustrated embodiment forms the upper axial termination of the hub 11. The cover disk 41, which extends over the ball bearing 7, is bonded to the hub 11. In this manner, a flawless separation or seal of the upper ball bearing 7 from the "clean room" disk chamber is provided.

The labyrinth seal 36, 37, 38 is arranged below the lower ball bearing 6 and also extends into the space defined by said cup-shaped rotor and within the recess in the mounting flange 8.

In the illustrated embodiment, the central stationary shaft 5 is held in the projection 39, and the one piece hub 11 extends, by way of at least the ridge-like projection 36, downwardly into the annular groove formed within the annular part 38. The hub 11 is arranged to carry at least one disk (not shown) on its outer cylindrical surface 24. Preferably, the one or the first disk is supported also on a generally flat shoulder 25 of the hub 11. The cup-shaped rotor 33 is held on the shoulder 35 of the hub from below, and the hub also supports the cover disk 41 that rotates with it over the upper bearing 7. The projection 36 of the hub is rotatable relative to the annular part 38 and extends lower than the lower ball bearing 6. Between the labyrinth seal and the

cover disk 41 the two ball bearings 6 and 7 are axially arranged.

5 The hub-like projection 39 is arranged centrally of the mounting flange 8 and holds, for example, by a press-fit, the stationary shaft. The stator 19 is fastened to the annular part 38, for example, by means of glue. This mounting can also be accomplished by injecting the entire stator block (laminated core grooved winding) together with at least the 10 recessed part of the flange 8. Outer winding extremities 75, 76 of the stator winding may be overlaid with a casting resin seal so that there is no risk that dirt particles will move out of the stator winding region 75, 76 into the "clean room". To achieve this casting resin is injected in the crucial 15 places well and compactly.

The mounting flange 8 is provided at its extreme outer edge with a radial projection or rim 45 which is utilised to fasten the motor 30 into disk information storage apparatus. 20 In general, this projection 45 will be connected to a lower wall defining the "clean room", for example, by screw or a screw-connection.

25 In the embodiment illustrated, full use can be made of the radial spacing between the preferably stationary shaft 5 and the inner wall of the cylindrical hub. For example, the radial spacing, and the entire available axial space to the adjacent motor region can be used for storage.

30 The outer diameter of the cylindrical air gap is not the same as the hub diameter. This enables the inner stator surface to be shifted radially away from the shaft axis. The axial projections from both the rotor and stator sides which are axially annularly interdigitated among one another for 35 rotary motion (which could also be a larger number of ridge-like projections) are arranged radially between the stator and

the shaft. This near shaft region also receives the cover which covers the bearing space to separate it from the "clean room", as well as any arrangements for separating or sealing the inner motor space from the "clean room".

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This radially extending, intermediate space between the central shaft and its support and the inner surface of the stator annulus is available because there is no need to provide a radially wider electromagnetic field for the laminated stator magnetic stock.

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Embodiments of the invention have the advantage that an increased momentum requirement is producible (achievable because the air gap can be kept large, and in any case is not dependent upon hub diameter) which is dependent upon the standardisation requirements for information storage disks. Since the tendency is towards ever-smaller disks, output drive diameter also tending to be smaller, so the power requirements for a drive motor placed in the hub is set at pre-existing limits.

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In a drive unit as described, the diametrical moment arm of the air gap of an outer rotor motor may be increased as desired, practically at will, through radial enlargement of the axially deepened flange configuration. The deepening of the flange configuration in itself permits an axial compactness because the bearings 6, 7 and axial projection 39 are axially, rather than radially aligned.

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The iron cup-shaped rotor 33 in the motor housing provides relatively good magnetic shielding because it also acts as the magnetic return path. Generally, the cup 33 is thicker than would be needed for magnetic shielding.

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In this way, all of the space between the outer surface of the stationary shaft and the inner wall of the hub for the

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output system is put to good use.

If the outer hub diameter must become smaller, because of the ever-diminishing diameter of the information storage disks, and therewith also a diminishing size above a minimum size of a central hole must be set, there is virtually no alternative to the one-piece hub 11 as described above, to be made out of low-remanence magnetic material.

A circuit board 43 is supported on the base of the recess of the flange 8. The circuit board 43 has a printed circuit thereon, and may form part of the connection of the stator-side casting resin seal. The motor thus provided, which boasts a large ratio of air gap diametrical dimension to axial length, is, for example, a brushless outer rotor motor with three strings provided for a three-or-six pulse drive, or for a two- or one-pulse drive provided, such as that described in the following patent documents DE-05 22 25 442; (offenlagungshaft) and DE-PS 23 46 380 and/or DE-PS 23 14 259.

The invention is especially suitable for motors whose diameter D is large compared to the overall 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.



CLAIMS

1. An electric drive motor 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 for supporting said stator is arranged substantially coaxially relative to said central axis, and said shaft is arranged to support a hub for rotation by said motor, wherein said mounting flange has an axially extending recess surrounded by a mounting rim, and said rotor comprises a cup-shaped rotor of magnetic material which projects into said recess, wherein said hub comprises a disk-bearing element having a substantially radially extending lower surface, and wherein said cup-shaped rotor has a substantially radially extending, substantially planar base with which said lower surface of said hub is engaged.
2. An electric drive motor as claimed in Claim 1, wherein said mounting rim of said mounting flange is substantially radially aligned with said planar base of said rotor.
3. An electric drive motor as claimed in Claim 2, wherein said mounting rim of said mounting flange is axially offset relative to said recess and, together with said rotor, provides an approximation to an outer labyrinth seal.
4. An electric drive motor as claimed in any preceding claim, wherein said shaft is stationary and extends beyond said stator, and wherein bearing means are arranged on said shaft on which said hub is supported.
5. An electric drive motor as claimed in any preceding claim, wherein said stator is supported within said recess in



the mounting flange within the limits of said rotor.

6. An electric drive motor as claimed in any preceding claim, wherein said cup-shaped rotor is deep-drawn, of soft magnetic material, and carries permanent magnetic elements, and is arranged to define with the stator an axially extending air gap, said cup-shaped magnetic material and said permanent magnet elements effectively covering the stator.

7. An electric drive motor as claimed in any preceding claim, wherein said hub comprises support means for information storage disks, and a cover plate rotatable with the hub, and wherein said cup-shaped rotor is positioned to form magnetic shielding means for shielding the stator from said support means.

8. An electric drive motor as claimed in any preceding claim, wherein seal means are arranged between the hub and the stator.

9. An electric drive motor as claimed in Claim 8, wherein said seal means comprise elements radially within the stator and axially offset relative to bearing means for said hub toward the flange.



10. An electric drive motor as claimed in any preceding claim, wherein a bearing arrangement for said hub is provided, said bearing arrangement comprising two or more bearings axially spaced along said shaft.

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11. An electric drive motor as claimed in any preceding claim, wherein said shaft is stationary, a first part of the shaft being mounted in the recess of said mounting flange, and a second part of the shaft carrying bearing means for said hub, wherein the axial length of said bearing means approaches that of said second part of the shaft, and wherein the axial length of said first and second parts of the shaft is substantially the same.

12. An electric drive motor as claimed in any preceding claim, wherein the stator with its winding is connected rigidly with respect to the stationary shaft by way of said mounting flange, and the rotor is rotatable relative to said shaft.

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13. An electric drive motor as claimed in any preceding claim, wherein a conductor plate and/or a shielding ring is located between said mounting flange and the winding of the stator, and for example, is or are partially or entirely cast or moulded with plastics on both sides.

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14. An electric drive motor as claimed in any preceding claim, wherein parts of the cup-shaped rotor are connected to each other by a plastics layer, wherein the layer is applied point-like, annularly, radially, or sheetlike.

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15. An electric drive motor as claimed in any preceding claim, wherein the rotor surface is connected to a rotor magnet by way of a plastics layer.

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16. An electric drive motor as claimed in any preceding



claim, wherein the magnetic components of the rotor and stator are arranged symmetrically to one another.

17. An electric drive motor substantially as hereinbefore
5 described with reference to the accompanying drawings.
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