DISK STORE DRIVE

The present invention relates to a disk store drive.

According to the present invention there is provided a disk store drive with a brushless drive motor having a stator provided with a winding, and an external rotor coaxially surrounding the stator and spaced therefrom by a substantially cylindrical air gap, said rotor having a permanent magnetic rotor magnet and a soft magnetic yoke; and a hub concentric to the yoke, said hub being connected to the rotor for rotation therewith, and the rotor and hub being rotatably mounted by means of a bearing arrangement on a fixed shaft, wherein the hub is substantially cup-shaped and has an end wall with a shaped bearing bush, and a disk support portion with a cylindrical external circumferential surface which can be passed through a central opening of a storage disk for receiving at least one storage disk, wherein at least half of the axial longitudinal dimension of the stator winding and the motor magnet co-operating therewith are housed within said disk support portion, and wherein at its axial end remote from its end wall the hub is tightly sealed by a cover rotatably mounted on said fixed shaft.

Examples of disk store drives are described and claimed in GB-A-2173049 from which the present case is divided. Disk store drives of this invention have a stationary, rather than a rotating, central shaft.

In a preferred embodiment, the hub on the side remote from the end wall has a radially outwardly projecting flange defining a recess within the hub in which said cover is arranged to engage.

Preferably, the cover is provided with a shaped bearing bush in which bearings of said fixed shaft are arranged. The bearings within the bearing bush of said cover may be sealed by way of at least one magnetic fluid seal. Similarly, in a preferred embodiment, bearings of said fixed shaft are arranged in the bearing bush of said hub and are sealed by way of at least one magnetic fluid seal.

The disk support portion has a substantially cylindrical outer peripheral surface, that is, a peripheral surface free from the known bearing webs or ribs, because this contributes to providing maximum space for the magnetically active motor parts in the diametrically limited area of the central opening of the storage disks as well as the necessary mechanical

strength of the hub for the magnetically active motor parts.

At least those surface parts of the hub located in the clean area or room of a disk store in which the disk(s) are housed must not give off into the latter, even during prolonged use of the disk store drive, significant quantity of dirt particles, e.g. due to oxidation processes. Preferably the hub is made from a material which, even after cutting, is suitable for use in a clean area i.e. a material which following cutting and without a corrosion-inhibiting treatment following the same meets the strict cleanness conditions necessary with disk stores in the clean area receiving the storage disks. Such a construction makes it possible to finish, e.g. grind or turn to size the outer peripheral surface of the disk support portion after assembly of the hub and the drive motor with respect of the centricity with the rotation axis.

Such metal finishing of the installed hub is frequently necessary in order to fulfil the extreme demands in connection with disk stores with respect of accuracy of rotation or minimization of inaccuracy of the hub. It is particularly appropriate to have a hub made from light metal, preferably aluminium or an aluminium alloy. Light metal hubs can be used in clean

areas without further treatment, even after cutting has taken place. For example using a diamond tool, and whilst respecting the necessary precision, such hubs can be turned, which is less expensive than grinding, particularly in the case of a disk support portion with a cylindrical outer circumferential surface. The hub is preferably extruded or cast and is pressed hot on to the magnetic yoke. However, in principle, other possibilities for joining hub and yoke exist, e.g. a bonding together of the two parts.

In known manner, the magnetic yoke can have a cup or pot-shaped construction. However, it is advantageous to provide a substantially cylindrical magnetic yoke, with an annular magnetic shield ring in the hub which extends radially inwardly along the end wall of the hub. As a result of both these features the necessary guidance of the magnetic flux and an efficient magnetic shielding of the storage disks with respect to the drive motor are achieved. The combination of yoke and shield ring can be produced less expensively than a cup or pot. The shield ring can be relatively thin, so that the overall axial size of the drive can be further reduced or, for a constant axial size, more space provided for the hub end wall at the closed end of the subassembly comprising the hub,

magnetic yoke and motor magnet. The magnetic yoke can be appropriately constructed as a rolled ring, particularly a steel ring, or as a tube portion.

Preferably, the leads of the stator winding pass through the fixed shaft to the outside of the drive.

A control magnet, e.g. in the form of a control magnet ring is preferably connected to the unit comprising a rotor and the hub, and said magnet cooperates with a stationary magnetic field-sensitive rotation position sensor arrangement, whose function is to produce commutating control signals and optionally additional control signals, e.g. a pulse for a given rotor reference position. The control magnet is appropriately located on the axially open end of the unit comprising the rotor and hub. It can be axially aligned with the motor magnet. The motor magnet can optionally serve as the control magnet. The rotation position sensor arrangement is advantageously placed on a printed circuit board, which axially faces the axially open end of the unit comprising the rotor and hub.

The invention is described in greater detail

hereinafter, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is an axial partial section through an embodiment of a disk store drive of the invention having a fixed shaft; and

Fig. 2 is a partial section corresponding to Fig. 1 of a further embodiment of a disk store drive of the invention.

Fig. 1 shows a drive motor having a stator 10 with a stator lamination bundle. The stator lamination bundle is radially symmetrical with respect to a central rotation axis 10A.

As is illustrated in GB-A-2173049, from which this case is divided, the stator laminations may form six stator poles each having a substantially T-shaped configuration and positioned with a reciprocal angular distance of 60°. A sintered iron core can be provided in place of a bundle of laminations. A stator winding is provided on said stator. A permanent magnetic motor magnet 13 may be radially magnetized in quadripolar manner in the circumferential direction to provide two magnetic north poles and two magnetic south poles in alternating sequence. Each such pole can have a width

of substantially 180° el (corresponding to 90° physical).

Motor magnet 13 is fitted within a soft magnetic material yoke 94 which is generally cylindrical and has a magnetic shield ring 95 connected thereto, for example, by bonding. The yoke 94, shield 95 and magnet 13 together form an external rotor of the drive motor. The motor magnet 13, may be a rubber magnet, or a plastic-bonded magnet. The magnetic yoke 94 and/or the magnetic shield 95 may be made of magnetic material in a synthetic binder, a mixture of hard ferrite and elastomeric material, ceramic magnetic material or samarium cobalt.

As is clearly illustrated in Figure 1, the stator 10 provided with its winding is coaxially surrounded by the external rotor 13, 94, 95 which is spaced from the stator 10 by a substantially cylindrical air gap 14. A hub 107, preferably of light metal, of a rigid disk store, is mounted in rotary manner on a stationary shaft 105. This shaft 105 is fitted, in a manner not shown, in the disk store. As can be seen, the hub 107 is substantially cup-shaped and has a cylindrical disk support portion 110 placed, for example, by shrinking, onto the magnetic yoke 94. One or more rigid storage

disks (not shown), preferably magnetic disks, are placed on the disk support portion 110 which passes through a central opening in the storage disks. The storage disks may be axially spaced along the disk support portion by appropriate spacers and may be fixed with respect to hub 107 by a known clamping device. It will be seen that the axial dimension of the magnetically active stator and rotor parts of the drive motor 18, that is the motor magnet 13 and the stator winding are housed within the area surrounded by the disk support portion 110. The wall thickness of the disk support portion 110 of the hub 107 is smaller than the wall thickness of the cylindrical magnetic yoke 94 so that a maximum cross-section is made available for parts 13, 107, 94 in the central opening of a storage disk. In particular, the wall thickness of the disk support portion 110 is made as small as possible consistent with mechanical strength requirements. In order to increase the dimensional stability of the hub 107, the hub carries at its open end a thickened, outwardly radially projecting flange 111 which simultaneously axially supports the rigid storage disk closest to the flange.

Hub 107, together with the storage disks supported thereon is located in a clean area 49 which in a known,

but not shown manner, is defined by disk store casing parts.

The hub 107 is rotatably mounted on the shaft 105 by way of a first ball bearing 106.

The hub 107 has an end wall 108 with a shaped-on bearing bush 109 in which the bearing 106 is received. The reinforcing flange 111 is on the side of the hub 107 remote from the end wall 108. The soft magnetic shield ring 95 engages on the inside of the end wall 108. A motor cover 114 is rotatably mounted by means of a second ball bearing 113 on shaft 105, said cover tightly sealing the motor on the axial end of the hub 107 remote from its end wall 108. It will be seen that the reinforcing flange 111 of the hub 107 defines a recess 119 within the hub in which the cover 114 is arranged to engage. The cover 114 is shaped to provide a bearing bush 120 in which the bearing 113 is arranged. A magnetic fluid or ferro-fluidic seal 72 or 72' is provided on each of the outsides of bearings 106, 113. Seals 72, 72', which are described below, ensure that the bearing arrangements are sealed with respect to the clean area 49, so that the complete drive motor can be located in said clean area. The connections of the stator winding can be led out by

means of a cable 115, which is placed in an axial slot 116 of shaft 105.

A circuit board 38 is suspended to extend radially by way of supports 112 (Figure 2) on the laminations of the stator 10. This circuit board may carry the commutating electronics and/or other circuit components, for example, for speed regulation purposes. Connections to the components of the circuit board 38 can be made by way of the cable 115. In particular, the circuit board 38 carries a sensing arrangement of three rotation position sensors 42 (only one of which is visible in Figure 1). The sensors 42 of the sensing arrangement may be magnet field sensors, for example, Hall generators, field plates, magnetic diodes and the like. Bistable-switching Hall IC's are particularly advantageous. The use of 180° el wide rotor poles makes it possible to use the motor magnet 13 as the control magnet for the position sensors 42. However, in the embodiment illustrated a control magnet 45 separate from the motor magnet 13 is provided for energizing the rotation position sensors 42. The embodiment of Figure 1 shows the rotation position sensors 42 axially facing the control magnet 45. It is also possible, for example, to arrange the rotation position sensors so that they radially face the

control magnet 45. The rotation position sensors 42 are appropriately so peripherally positioned with respect to the coils of the stator that changes to the sensor switching states substantially coincide with the zero crossings of the associated coil voltages.

The magnetic fluid or ferro-fluidic seal 72 seals the ball bearing 106 with respect to the clean area 49. The magnetic fluid seal 72 comprises two annular pole pieces 73, 74, a permanent magnet ring 75 located between thes pole pieces, and a magnetic fluid (not shown), which is introduced into an annular clearance 76 between ring 75 and a portion of the shaft 105. Seals of this type are known under the term "ferro-fluidic seals". Seal 72 effectively prevents the passage of dust particles from the bearing arrangement into the clean area 49. Seal 72 is adjacent to, but axially spaced from the bearing 106. The seal 72' is substantially identical in construction to the seal 72 and seals, and is axially spaced from the bearing 113.

The embodiment of Figure 2 differs from that of Figure 1 substantially in that, in place of the shield ring 95 and the magnetic yoke 94 there is a one-piece soft magnetic material pot 117 with end wall 117A and

a circumferential wall 117B. In place of this one-piece pot 117, dish-shaped magnet segments can be bonded or in some way fixed into the pot 117.

The disk store drives described and claimed herein are described and illustrated in copending application No. 2173049 (8513759) from which the present application is divided. Embodiments of the disk store drives are also described and claimed in copending divisional applications GB2217522A(8910359.2) and GB2218857A(8910559.7).

CLAIMS

1. A disk store drive with a brushless drive motor having a stator provided with a winding, and an external rotor coaxially surrounding the stator and spaced therefrom by a substantially cylindrical air gap, said rotor having a permanent magnetic rotor magnet and a soft magnetic yoke; and a hub concentric to the yoke, said hub being connected to the rotor for rotation therewith, and the rotor and hub being rotatably mounted by means of a bearing arrangement on a fixed shaft, wherein the hub is substantially cup-shaped and has an end wall with a shaped bearing bush, and a disk support portion with a cylindrical external circumferential surface which can be passed through a central opening of a storage disk for receiving at least one storage disk, wherein at least half of the axial longitudinal dimension of the stator winding and the motor magnet co-operating therewith are housed within said disk support portion, and wherein at its axial end remote from its end wall the hub is tightly sealed by a cover rotatably mounted on said fixed shaft.

2. A disk store drive as claimed in Claim 1, wherein said hub on the side remote from the end wall has a radially outwardly projecting flange defining a recess

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within the hub in which said cover is arranged to engage.

3. A disk store drive as claimed in Claim 1 or 2, wherein said cover is provided with a shaped bearing bush in which bearings of said fixed shaft are arranged.

4. A disk store drive as claimed in Claim 3, wherein the bearings within the bearing bush of said cover are sealed by way of at least one magnetic fluid seal.

5. A disk store drive as claimed in any preceding claim, wherein bearings of said fixed shaft are arranged in the bearing bush of said hub and are sealed by way of at least one magnetic fluid seal.

6. A disk store drive as claimed in any preceding claim, wherein said hub is made from a material which which is still suitable for clean area use after cutting.

7. A disk store drive as claimed in Claim 6, wherein said material is light metal.

8. A disk store drive as claimed in any preceding

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claim, wherein the external circumferential surface of the disk support portion, following assembly of hub and drive motor, is finished with respect to centricity with the rotation axis.

9. A disk store drive as claimed in Claim 8, wherein said surface is ground or turned to size.

10. A disk store drive as claimed in any preceding claim, wherein the hub is extruded or cast.

11. A disk store drive as claimed in Claim 10, wherein the hub is pressed hot onto the magnetic yoke.

12. A disk store drive as claimed in any preceding claim, wherein the magnetic yoke is cylindrical and an annular magnetic shield ring is placed in the hub and extends radially inwardly along the end wall of the hub.

13. A disk store drive as claimed in any of Claims 1 to 11, wherein a one-piece soft magnetic material pot is received within said hub, a circumferential wall of said magnetic material pot defining said soft magentic yoke.

14. A disk store drive as claimed in any preceding claim, wherein leads for the stator winding pass through the fixed shaft or a slot therein to the outside of the drive.

15. A disk store drive as claimed in any preceding claim, wherein a control magnet is supported by said rotor, and a co-operating sensor arrangement is supported by said stator to face said control magnet.

16. A disk store drive as claimed in Claim 15, wherein said sensor arrangement, comprising one or more sensors, is mounted on a printed circuit board which is suspended by means of supports on laminations of said stator.

17. A disk store comprising a disk store drive as claimed in any preceding claim and having one or more disks received on the hub and located in a clean area defined within a housing of the store.

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