



A HARD DISC STORAGE DRIVE

The present invention relates to a hard disc storage drive.

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 rotor type which could be axially relatively short. Now there is
10 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 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
15 room" region, all without increasing its overall axial dimension.

US-A-4,760,298 discloses a drive motor for a magnetic disc having a stator fixed to a central shaft carried by a mounting frame. An outer cup-shaped rotor is mounted for rotation about the shaft and the stator. A
20 magnetic disk support is fixed to an outer surface of the rotor.

According to the present invention there is provided a hard disk storage drive incorporating a drive motor having a hub, and one or more information storage disks carried by said hub, the hard disk storage drive having a clean
25 room chamber adjacent the hub in which the information storage disks, and read and recording heads therefor, are housed, the hub having a generally cylindrical portion which carries at least one information storage disk, with the one or a first disk supported on a generally flat, radially extending, shoulder of the hub, the drive motor being sealed off from the clean room disk chamber,
30 and the drive motor comprising a shaft defining a central axis and arranged to support said hub for rotation by the motor, and a stator and a rotor defining a substantially cylindrical air gap therebetween, wherein a cup-shaped mounting flange for supporting said stator is arranged substantially coaxially relative to said central axis, said mounting flange having an axially extending recess
35 defined therein, wherein said rotor faces into said recess, and carries a generally annular permanent magnetic rotor magnet, wherein said air gap defined between said rotor and said stator is axially extending and within said



recess, and wherein the stator is supported within said recess, wherein said rotor is contiguous with said hub and the permanent magnetic rotor magnet is located within said recess axially below said flat shoulder of the hub, and wherein seal means are arranged between the hub and the stator.

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In an embodiment, the stator carries a winding arranged substantially coaxially relative to said central axis, and the rotor is arranged substantially coaxially relative to said central axis and to be external relative to, and to substantially surround, said stator winding, and wherein said shaft extends axially beyond said mounting flange and is arranged to support said hub for rotation by said rotor. Preferably, the motor has a stationary shaft enabling axial separation of ball bearings therefor. This may lead to a reduction in the diameter of the motor.

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Preferably, the drive motor has a cover disc which provides a flawless separation or seal of the mounting of the motor from the clean room chamber.

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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.

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In Figure 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 30 having a substantially cup-shaped or bell-shaped rotor 33. The rotor 33 is preferably deep-drawn out of soft iron sheet and surrounds a generally annular permanent magnetic rotor magnet 21 which serves as the magnetic return path in a simultaneously provided outer rotor housing. 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 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

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example, of a hot-setting adhesive.

05 The drive motor 30 has a shaft 5 which is
substantially centrally mounted and fixed to a mounting
flange 8. The shaft 5 is supported in 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 a hub 11. The
10 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 projection 35 extending centrally into the base of
the bell-shaped rotor 33 and is rigidly connected
15 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 projection 36 and the
annular groove 37 acts as a labyrinth packing. The
20 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.
25 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
30 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.

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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 substantially radially
05 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
10 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
15 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
20 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
25 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
30 provided.

Under the lower ball bearing 6 and also within the rotor bell-shape, the labyrinth seal 23, 36, 37, 38 is provided. This seal or packing extends into the stator
35 side of the flange 8. These stator-side labyrinth elements 23, 38, engage or extend around a rotor-side,

ridge-like projection 36 and are supported on the
hub-like projection 39 of the flange or on the flange
base. Alternatively, the stator could be directly fixed
to the mounting flange 8, for example, to its projection
05 39. In this case, a seal or packing is not required.

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
10 ridge-like projection 36, downwardly into the annular
groove formed by the walls of elements 23 and 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
15 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
hub has at least one axially extending projection 36,
20 which rotates in the stator-side labyrinth seal
projections, and extends below the lower ball bearing 6.
Between the labyrinth seal and the cover disk 41 the two
ball bearings 6 and 7 are axially arranged.

25 The hub-like projection 39 centrally arranged of
the flange 8, which holds the, for example, press-fit
stationary shaft, supports the stator 19. The stator is
set over the annular part 23 (including the axial
groove) to which it is fastened, for example, by means
30 of glue. This mounting can also be accomplished by
injecting the entire stator block (laminated_core
grooved winding) together with at least the recessed
part of the flange 8. Outer winding extremities 75, 76
of the stator winding may be overlaid with a casting
35 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 places well and compactly.

05 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. In general, this projection 45 will
be connected to a lower wall defining the "clean room",
for example, by screws or a screw-connection.

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15 The axial integration of a direct drive, external
rotor, motor (with cylindrical air gap) makes possible
the full use in the hub of an in-hub-motor of the
radially intermediate space between the preferable
stationary shaft and the output-bearing cylindrical hub
wall for the storage arrangement, which can also occupy
the entire available axial space reaching to the
adjacent motor region.

20 The outer diameter of the cylindrical air gap is
not dependent upon the hub diameter. This enables the
stator to be more annular, because the inner stator is,
so-to-speak, shifted radially away from the shaft axis.
The axial projections from both the rotor and stator
25 sides which are axially annularly interdigitated among
one another for 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
30 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".

35 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 with a large air gap diameter for the stator annulus, that is, for the laminated stator magnetic stock.

05 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 standardization requirements for
10 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.

15 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
20 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.

25 The iron cup or 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 therefore thicker than would be needed for
magnetic shielding.

30 In this way, all of the space between the outer
surface of the stationary shaft and the inner wall of
the hub for the output system is put to good use.

35 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
5 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
10 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
15 one-pulse drive provided, such as that described in the following patent documents DE-05 22 25 442; (offenlagungschafft) and DE-PS 23 46 380 and/or DE-PS 23 14 259.

20 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
25 variations to the invention as described and illustrated can be made. In particular each feature described and illustrated can be used alone or in conjunction with any one or more of any of the outer features described and illustrated.

CLAIMS

1. A hard disk storage drive incorporating a drive motor (30) having a hub (11), and one or more information storage disks carried by said hub, the
5 hard disk storage drive having a clean room chamber adjacent the hub (11) in which the information storage disks, and read and recording heads therefor, are housed, the hub having a generally cylindrical portion (24) which carries at least one information storage disk, with the one or a first disk supported on a generally flat, radially extending, shoulder (25) of the hub, the drive motor (30)
10 being sealed off from the clean room disk chamber, and the drive motor (30) comprising a shaft (5) defining a central axis and arranged to support said hub for rotation by the motor, and a stator (19) and a rotor (33) defining a substantially cylindrical air gap therebetween, wherein a cup-shaped mounting flange (8) for supporting said stator is arranged substantially coaxially relative to
15 said central axis, said mounting flange (8) having an axially extending recess (12) defined therein, wherein said rotor (33) faces into said recess (12), and carries a generally annular permanent magnetic rotor magnet (21), wherein said air gap defined between said rotor (33) and said stator (19) is axially extending and within said recess (12), and wherein the stator (19) is supported within said
20 recess (12), wherein said rotor (33) is contiguous with said hub (11) and the permanent magnetic rotor magnet (21) is located within said recess (12) axially below said flat shoulder (25) of the hub (11), and wherein seal means (36, 37, 38) are arranged between the hub (11) and the stator (19).
- 25 2. A hard disc storage drive as claimed in Claim 1, wherein the magnetic components of the rotor (33) and stator (19) are arranged symmetrically to one another.
- 30 3. A hard disc storage drive as claimed in Claim 1 or Claim 2, wherein the stator (19) carries a winding arranged substantially coaxially relative to said central axis, and the rotor (33) is arranged substantially coaxially relative to said central axis and to be external relative to, and to substantially surround, said stator winding, and wherein said shaft (5) extends axially beyond said mounting flange and is arranged to support said hub (11) for rotation by said rotor (33).
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4. A hard disc storage drive as claimed in Claim 3, wherein said shaft (5) is stationary.

5. A hard disc storage drive as claimed in Claim 3 or Claim 4, wherein said hub (11) comprises a cup-shaped rotor of magnetic material facing into the recess (12) of the mounting flange (8) and supporting the outer rotor (33).
- 5 6. A hard disc storage drive as claimed in Claim 5, wherein the stator (19) is supported within said recess (12) within the limits of the outer rotor.
7. A hard disc storage drive as claimed in any preceding claim, wherein bearing means (6, 7) for the hub are arranged on the shaft (5), and wherein the
10 stator (19) is fitted to a bearing support part for the rotor shaft bearing (6, 7) and wherein the rotor (33) is arranged to directly drive said hub (11).
8. A hard disc storage drive as claimed in any preceding claim, wherein the
15 rotor (33) comprises a cup-shaped rotor carrying the generally annular permanent magnetic rotor magnet (21) which is arranged to surround the stator (19) and define said axially extending air gap therewith, said cup-shaped rotor and permanent magnetic rotor magnet effectively covering the stator, and wherein the flange (8) comprises an axially offset mounting rim (45).
- 20 9. A hard disc storage drive as claimed in any preceding claim, wherein said hub (11) comprises support means (24) for the information storage disks, and a cover disc (41) is provided which is rotatable with the hub, and wherein said rotor is shaped to form, or carries, magnetic shielding means for shielding the stator from said support means and from the disk chamber.
- 25 10. A hard disc storage drive as claimed in any preceding claim, wherein said seal means (36, 37, 38) comprise elements radially within the stator (19) and axially offset relative to bearing means (6, 7) for said hub (11) toward the flange (8).
- 30 11. A hard disc storage drive as claimed in any preceding claim, wherein bearing means are provided for said hub and comprise two or more rotor shaft bearings (6, 7) axially spaced along said shaft (5).
- 35 12. A hard disc storage drive as claimed in any preceding claim, wherein said generally flat shoulder is formed on a disk-bearing element of aluminium which has a lower surface, and wherein said rotor (33) comprises a cup-shaped

rotor of magnetic material which is held firmly to said lower surface of said disk-bearing element (25).

13. A hard disc storage drive as claimed in any preceding claim, wherein
5 said shaft (5) is stationary and has first and second approximately comparable axial lengths comprising substantially its whole length, said first length being the length of the portion of the shaft mounted in an axially extending recess (12) of said flange (8), and said second length being the length of the shaft upon which
10 bearings means (6, 7) for said hub are mounted and which is substantially occupied thereby.

14. A hard disc storage drive as claimed in any preceding claim, wherein the mounting flange (8) has a relatively large area, and the stator (19) with a
15 winding is connected rigidly to the stationary shaft (5), and the rotor (33) is rotatable relative to said shaft.

15. A hard disc storage drive as claimed in any preceding claim, wherein the drive motor (30) further comprises a cover disc (41) sealing the mounting of the motor from the clean room disk chamber.
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16. A hard disc storage drive as claimed in any preceding claim, wherein a conductor plate and/or a shielding ring (17) is located between said mounting flange (8) and the winding (16) of the stator, and for example, is or are partially or entirely cast or moulded with plastics on both sides.
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17. A hard disc storage drive as claimed in any preceding claim, wherein parts of the preferably, substantially bell-shaped rotor (33) are connected to each other by a plastics layer, wherein the layer is applied point-like, annularly, radially, or sheetlike.
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18. A hard disc storage drive as claimed in any preceding claim, wherein the rotor surface is connected to the rotor magnet (21) by a plastics layer.