

Removable Disk Drive System

Field of the Invention

The present invention relates to a disk drive system, and in particular a disk drive system of the sort in which a data storage disk in a cartridge is temporarily inserted into a disk drive for a read/write operation, and subsequently removed. This form of disk drive is here referred to as a "removable disk drive".

Background of the invention

The disk for a removable disk drive is normally permanently housed inside a cartridge, and the disk is permanently attached to a hub such that the disk can rotate freely within the cartridge when the hub rotates. When it is desired to read data from the disk and/or write data to the disk (a "Read/Write", or "R/W", operation), the cartridge is inserted into a chamber of the disk drive via an opening in the drive, such as a hinged door which is pushed open as the cartridge is inserted. The disk is attached to a hub, which can rotate freely inside the cartridge. A spindle of the disk drive then engages the hub, so that the disk can be rotated to allow a R/W head to access data on the disk. Conventionally, the cartridge has a sliding door which opens only when the cartridge is inside the drive, and which is otherwise sealed.

One of the major challenges for a removable disk drive is contamination control. This is managed quite differently from the case of a fixed disk drive (i.e. a disk drive in which having the disk permanently located inside), since a fixed disk drive is well sealed once its manufacturing process is completed and environmental contamination such as airborne particles can rarely enter.

Nebenzehl L., Nagarajan R., Wong J.S., Volpe L. and Witney G., in the article "Chemical integration and contamination control in hard disk drive manufacturing", J of the IEST, September/October, p31-35, addressed types

and sources of contamination that can degrade the performance of a removable disk drive. In particular, the internal components of the disk drive are exposed to ambient air whenever the cartridge is inserted into it. Also, contaminants such as oils and debris adhere to the outer surfaces of the cartridge whenever it is handled by a user's fingers. Some of these contaminants will finally be released into the drive due to heating and air flow.

The natural environment is a huge source of particulate contamination. The most abundant will be various forms of silica, sulfides, sulfates, carbonates, or nitrates especially in the region near a desert. Fine particles may become airborne even in light winds. Industries also produce large amount of particulate contamination such as carbon-based fly ash and carbon particles. Humans also produce particles. For example, a motionless person is known to generate some 100,000 particles of 0.3-0.5 microns diameter per minute.

With the rapid increase in the storage density of magnetic hard disk drives, the flying height of the slider is presently as low as 10 to 30 nm, so particle contaminants seriously affect the reliability of disk drives, especially drives with MR (magnetoresistive), GMR (giant magnetoresistive) or TMR (tunnelling magnetoresistive) heads. These types of heads are sensitive to thermal asperities caused by the interaction between particles and the head. Particles of sub-micron order present in the air within the disk drive may adhere to the trailing edge of the slider where the read element is located. Larger particles of micron order which are trapped in the gap between the slider and the disk may penetrate, and become embedded in, the disk surface. Particles may also scratch the air bearing surface of the slider and damage the disk surface as well.

Because of contamination issues, a conventional removable disk drive is not suitable for long time mass information storage, but can only be reliably

employed as an information carrier for exchanging data between two mass information storage systems.

Various proposals have been made to reduce the risk of contamination in a removable disk drive. The following references are incorporated herein by
5 reference.

US Patent No. 5204793 proposes an air filter and removable cartridge door safety stop for reducing contaminants inside the disk drive.

US Patent No. 6094323 proposes two types of seals to prevent contaminants from entering into the drive. The first seal is a foam strip which is attached
10 near the door area of the drive. It seals the door and the gap between the cartridge and drive. The second seal is made of plastic material. It is also intended to prevent debris from entering mechanisms of the disk drive such as the cartridge ejection and head locking mechanism.

US Patent Nos. 4112471, 4607301 and 5530603 propose similar door sealing
15 mechanisms to prevent dust from entering the cartridge and drive.

All the technologies referred to above are subject to the following disadvantages:

- 1) Contaminated surfaces of the cartridge are exposed to the internal components of the disk drive;
- 20 2) Particles or aerosols are propelled into the drive by the leading side of the cartridge as the cartridge is inserted into the disk drive; and
- 3) Particles of sub-micron order can pass through rough seal interfaces.

US patent 4974103 proposes integrating the R/W component and its suspension system into the disk cartridge, which is not provided with an
25 opening. The disk is rotated and the R/W head is actuated by magnetic force

applied from outside the cartridge when the cartridge was inserted into the drive. Therefore, no foreign particles can penetrate the cartridge. One disadvantage of such a system is that if the disk is damaged in some way and must be discarded, the relatively expensive R/W component, and its
5 suspension system, are generally thrown away at the same time.

Note that particles may be spun off the disk surface by centrifugal force during disk spinning. Sealing and filtering systems might be able to remove all aerosol materials, but once particles are inside the drive, filtering is usually not sufficient and some particles will get to the head-disk interface. Many
10 publications suggest advanced head-disk interface designs to avoid contaminants building up on the slider or to drive particles away from the MR reader.

These suggested methods are however effective only for limited head-disk design conditions. Removable disk drives are destined to find more and more
15 applications in mobile devices such as video camcorders, notebooks, PCs, etc. and in domestic appliances such as TVs, Set Top Boxes, Home Servers, Video/audio recorders etc., and in such applications they are usually exposed to quite harsh environments by users. Once the environmental particles are trapped inside the disk cartridge or drive, they will impose a heavy burden on
20 the conventional anti-contamination mechanisms described above.

The present invention proposes new and useful disk drive systems and methods for operating a disk drive.

In general terms the present invention proposes that in a disk drive system including a disk drive and a removable cartridge, the cartridge defines a
25 second enclosed volume containing one or more disks, and the disk drive defines a first enclosed volume. When it is desired to perform a read/write operation on one of the disks, the enclosed volumes are brought into communication to form a joint enclosed volume, within which the read/write

operation is performed. Thus, the present invention proposes arrangements which isolate the disk essentially completely from the ambient atmosphere surrounding the disk drive. Note that each of the enclosed volumes is preferably, though not necessarily, totally airtight.

- 5 Thus, the present invention may provide the drive and cartridge with environments substantially identical to those of a fixed disk drive. This makes it possible to apply to removable disk drives advanced technologies which have so far only been employed successfully in fixed disk drives, making possible greatly increases in the areal density and the reliability of the disk
10 drive.

Specifically, the present invention proposes a removable disk drive system including:

a cartridge defining a first enclosed volume which contains at least one data storage disk, and having first interface means; and

- 15 a disk drive defining a second enclosed volume which contains disk rotation means and data transfer means, and having second interface means;

engagement of the first and second interface means bringing the first and second enclosed volumes into communication to form a joint enclosed volume, and disengagement of the first and second interface means enabling

- 20 separation of the cartridge and disk drive,

the system further comprising displacement means for moving the disk relative to the cartridge within the joint enclosed volume to position it for rotation by the disk rotation means and for data transfer using the data transfer means.

- 25 Preferably, when a Read/Write operation is to be performed the displacement means fully expels the disk from the cartridge to bring it into register with the

disk rotation means and the data transfer means, and after the read/write operation the displacement means returns the disk into the cartridge.

The present invention further provides a cartridge for use in the disk drive system according to the invention, and a disk drive for use in the disk drive
5 system according to the invention.

Note that a technology known as SMIF (Standard Mechanical Interface) is now widely used in semiconductor industries. It makes it possible to use a clean-room based box to carry a wafer disk to or away from processing equipment with a clean room environment inside. US Patent Nos. 4532970,
10 453489, 4674939, 4739882 and 4724874 describe the technology in detail. US Patent No. 5382127 describes a pressurized interface apparatus between an SMIF container and the processing equipment. US Patent No. 6221163 uses pressurized gas to enable molecular contamination free for SMIF box. Although many of the features of these systems are suitable for use in the
15 present invention, to our knowledge there has been no application of SMIF to the field of disk drives, and certainly not to the problem of reducing contamination in a removable data storage disk.

The disk inside the cartridge can be a plastic disk, a floppy disk, or a hard disk (e.g. made of metal, glass or a ceramic material). It is preferably a magnetic
20 storage disk, and is preferably provided within a disk holder in fixed positional relationship to the disk but which permits the disk to rotate within it.

More than one disk can be provided inside a single cartridge. The disks may be fixed on a single hub with separators between them. In this case, the disk drive may include more than one pair of Read/Write elements for accessing
25 data on the disks.

Alternatively each disk may be fixed to a separate hub separately and the disk drive may be arranged to receive any one of the disks from the cartridge. In

this case, the disk cartridge may have more than one disk holder and an internal loading system may be provided to deliver one disk holder to the interface doors for transmission to the read/write means.

5 The air flow path inside the space consisting of the inside of the cartridge and the inside of the disk drive may be designed to ensure that contaminants are carried away by the air and captured finally by a filter.

The sealing material and movable parts inside the cartridge and drive may be made of thermoplastics and fluoroplastics which generate little or no debris. Similarly, the disk loading mechanism may be designed to substantially avoid
10 generating debris.

Non-limiting embodiments of the invention will now be described for the sake of example only with reference to the accompanying figures in which:

Fig. 1 is a cross-sectional top view of a disk drive system which is a first embodiment of the invention, in a first configuration;

15 Fig. 2 is a cross-sectional lateral view of the embodiment of Fig. 1;

Fig. 3 is a cross-sectional top view of a portion of the embodiment of Fig. 1;

Fig. 4 is a second cross-sectional top view of another portion of the embodiment of Fig. 1;

Fig. 5 is a cross-sectional top view of the embodiment of Fig. 1, in a second
20 configuration;

Fig. 6 is a cross-sectional top view of the embodiment of Fig. 1 in a third configuration;

Fig. 7 is a schematic view of a portion of the embodiment of Fig. 1;

Fig. 8 is a cross-sectional top view of a disk drive system which is a second embodiment of the invention; and

Fig. 9 is a cross-sectional lateral view of the disk drive system of Fig. 8.

The disk drive system which is a first embodiment of the invention will be described with reference to Figs. 1 to 7. It has two basic units: a disk cartridge 1 and a disk drive 100. The disk drive 100 has a front face which includes an outer door 109 leading to a "gateway region" into which the cartridge 1 can be inserted and which the cartridge 1 substantially fills. In Fig. 5 the configuration of the disk drive system is such that the cartridge 1 is partially inserted into the disk drive 100 through the outer door 109. In Fig. 1 the configuration of the disk drive system is such that the cartridge 1 is fully inserted through the outer door 109.

The disk drive 100 includes a housing 101 defining an enclosed volume 4, a spindle motor 120 having a head 121, and means 5 for read/write data operations. The spindle motor 120 and read/write means 5 may be of any known design. The read/write means 5 is illustrated as including a head-gimbal assembly 130, a load/unload mechanism 131, a pivot 133 and a VCM (either linear or rotary) 132. It includes further components including electronics (not shown).

Fig. 2 shows a side view of the disk drive 100 (i.e. from the direction which is at the bottom of Fig. 1) in the configuration of Fig. 1, i.e. with the cartridge 1 fully inserted into the disk drive 100.

The cartridge 1 includes a housing 10 having a front door 20. The housing 10 defines an enclosed volume 3. When the cartridge is fully inserted into the disk drive 100, the front door 20 meets an internal door 110 of the disk drive. The cartridge further includes an internal door locking mechanism 50 for

keeping the front door 20 closed while the cartridge 1 and disk drive 100 are not engaged.

As explained in detail below, when the cartridge 1 is fully inserted into the gateway region of the disk drive the door locking mechanism 50 releases the front door 20 to allow it to open. This brings the enclosed volume 3 of the cartridge into communication with the enclosed volume 4 of the disk drive, to form a joint enclosed volume.

The cartridge further includes a disk holder 30 which contains at least one data storage disk mounted on a hub 40. The disk holder 30 is made of a non-contamination type of plastic material (i.e. one which substantially does not generate contaminants). It is fixed to the front door 20 of the cartridge 1. One of its functions is to support the disk inside the cartridge 1 to prevent disk damage due to contact. Another of its functions is to generate special air paths when the disk is spinning. The disk holder 30 has a window 35 through which access is possible to the disk when it is desired to read-write data to/from the disk. A back plate 80 is attached to the back of the holder on the side

When the cartridge 1 is fully inserted into the disk drive 100, as shown in Fig. 5, for a read/write operation to be performed, the front door 20 is locked to the inner door 110, as discussed below. A servo motor 150 is activated to rotate a screw rod 160, having a fitting 170 attached to the inner door 110. Thus the servo motor urges the inner door 110 to the right of Figs 1 and 2. The disk holder 30, front door 20 and inner door 110 move together, until the disk holder 30 moves to cover the area shown dashed as 36 on Fig. 1. The cartridge 1 includes trail-shaped guides with rollers 70, on which the disk holder 30 moves. There are trail-shaped guides with rollers 140 inside the drive to guide the motion of the holder.

When the disk holder 30 covers the area 36, the hub 40 is engaged by the head 121 of the motor 120. This configuration of the disk drive system is shown in Fig. 6, in which the read/write means 5 is accessing the disk within the holder 30. Also as shown in Fig. 6, the back plate 80 mates with the entrance of the cartridge when the holder 30 reaches its furthest position to the right in Fig. 2, and in this position the back plate 80 blocks air from entering the cartridge.

Fig. 3 is a detail of Fig. 1, showing one front corner of the cartridge 1. An image of the other front corner of the cartridge 1 would be exactly like Fig. 3, but in vertical mirror reflection. As the cartridge 1 is inserted into the disk drive 100, a wall 93 of the housing slides along an internal wall 83 of the disk drive until a corner 84 of the housing 10 meets a shoulder 84 of the wall 83. At this time the front door 20 of the cartridge is still locked to the housing 10 by the door locking mechanism 50 comprising interlocking elements 51, 52 respectively attached to the housing 10 and the front door 20.

An O-ring type of seal 113 is mounted in a groove at the periphery of the outer surface of the inner door 110. It ensures that any dirt on the surfaces of the doors 20, 110 is trapped between the doors 20, 110, and is not released into the enclosed volumes 3, 4 of the disk drive and cartridge. The cartridge 1 has seals 23 to ensure that no contamination enters the volume 3 when the front door 20 is closed. The seal 23 is mounted on the inner surface of the housing 10 of the cartridge 1. It surrounds the front door 20 of the cartridge 1. A seal 123 is provided to prevent contamination from entering the enclosed volume 4 in the drive when the inner door 110 is closed. The seal 123 is mounted on the inner surface of the corner 84. It surrounds the inner door 110 of the drive 100.

The internal locking mechanism 50 acts to press the front door 20 of the cartridge 1 firmly on the seal 23. The lock 50 can be unlocked using a key

116. The key 116 is a rod supported by a spring 87. The rod 116 projects through a hole in the wall 83, and into a cavity in the housing 10, where it bears on a portion of the element 51. Pressing the rod 16 upwardly flexes the element 51, thereby releasing the front door 20 of the cartridge 1.

- 5 Fig. 3, and Fig. 4 which is a view of another portion of Fig. 1 slightly overlapping with Fig. 3, illustrate the connections between the front door 20 and the inner door 110.

10 Firstly the inner door 110 includes one or more projecting elements 114 in register with, and for insertion into, corresponding recesses 24 in the front door 20. These ensure that the front door 20 and the inner door 110 are correctly aligned. Note that projecting elements may alternatively, or additionally, be provided in the front door 20 for insertion into recesses in the inner door 110.

15 Secondly, magnets 26, 112 are provided in each of the front door 20 and inner door 110, with polarities such that they tend to hold the front door 20 and the inner door 110 together, and thus ensure that the seals 113 between them are effective.

20 Thirdly, the front door 10 is provided with a protrusion 21 having a head portion 25 and a narrowed neck portion 27. Jaws 118 are provided extending from the outer surface of the inner door 110 of the drive 100, and grip the protrusion 21 firmly to either side of the neck 27.

25 Before the cartridge is inserted into the disk drive, a safety lock 115 firmly presses the front door 110 of the drive 100 to make the seal 123 tight. As illustrated in Fig. 7, when the cartridge 1 is inserted into the disk drive 100 connection element 117 slots into a recess 117' on the bottom surface of the housing of the cartridge 1. Further inserting the cartridge 1 into the disk drive 100 acts on the connection element 117 to stretch an ejection spring 143.

When the cartridge 1 reaches its final position, a sensor 190 gives out a ready signal to the drive 100, an actuator 115' moves the safety lock 115 against the spring 115" until it is hooked by the rod-hook 182, i.e. the safety lock 115 is unlocked. At the same time, connection element 117 is hooked by rod-hook 181, and rod 116 slots into the cavity to release the front door 20. By then, the protrusion 21 has been gripped by the jaws 118, as shown in Fig. 4.

When the doors 20, 110, the holder 30 and the back element 80 move to the right to produce the configuration of Fig. 6, the Head-Gimbal Assembly (HGA) 130 is loaded on to the disk from the load/unload ramp 131 by the VCM 132.

10 The R/W element on the HGA 130 can access the disk through the opening 35 in the holder 30. The back plate 80 encloses the inner space of the cartridge 1 when the disk is spinning and therefore particles are not driven into the cartridge 1 by the air flow due to the spinning disk 40.

When the read/write operation is finished, the HGA 130 is unloaded and goes back to the load/unload ramp 131. If the drive is instructed to be in "long time idle state" or stop working, a retrieving ready signal is sent out. The servo motor 150 rotates the rod 160 in the opposite direction to act on the element 170 and thus move the disk holder 30 back into the cartridge 1. The door 110 is pressed firmly on the seal pad 123 by the servo motor 150. The door 20 is also closed in the meantime. A sensor then sends out an ejection ready signal.

When the injection button 180 located on the front 2 of the disk drive 100 is pressed, and the ejection read signal has been sent, the key 116 is pushed downwards, allowing the element 51 to re-engage the element 52, and thus causing the door locking mechanism 50 to lock the door 20 to the housing 10.

25 At the same time, rod hooks 181 and 182 are pulled to rotate about their respective pivots 183, 184 to release elements 117 and 115 respectively. The safety lock 115 of the drive 100 rises, so as to press firmly on the inner door

110 of the drive 100. The same action compresses springs 119, enabling the jaws 118 to release the protrusion 21, and thus to remove the connection between the doors 20, 110. The force exerted by the ejection spring 143 then draws the cartridge 1 out of the disk drive. A spring 180' is provided for the
5 button 180.

Note that the disk drive of the first embodiment includes a section 6. This section houses an optional pump mechanism for generating a positive pressure within the disk drive 100 and the cartridge 1. The details of its construction are not shown in detail here, but they may for example be identical
10 to the corresponding arrangement discussed below with reference to the second embodiment of the invention.

That second embodiment of the invention will now be described with reference to Figs. 8 and 9. Components of the second embodiment corresponding to those of the first embodiment are numbered using the same
15 reference numerals.

In this embodiment, the front door 20 of the first embodiment is replaced with a door 520 having a hinge 91. The front door 520 opens outwardly. A flexible sheet 92 on the inner surface of cartridge extends to cover the inner surface of the cartridge door.

20 In this embodiment the disk holder 30 is not fixed to the front door 520 of the cartridge 1. The elements of the front door 20 in the first embodiment of the invention which provide the connection to the inner door 110, are in the second element provided on a front plate (not shown) of the disk holder 30.

The inner door 110 of the first embodiment, is replaced in the second
25 embodiment by an inner door 510 which opens outwardly around a hinge 320. A flexible sheet 330 within the drive extends to cover the inner surface of the door 510 when it is opened.

As in the first embodiment the outer door 109 of the disk drive leads to a gateway region into which the cartridge is inserted. The gateway region has a space 8 to allow for both doors 510, 520 to open. The hinges 91 320 are at different levels. When the doors rotate 90 degrees to open, their two inner
5 surfaces face each other to form a clean channel. Seal pads on the outer faces of the doors contact respective walls of the disk drive firmly to confine the contaminant.

The air pressure inside the cartridge and drive is maintained positive by a pump 300. The pump 300 is in contact via tubes 7 with quick connection
10 valves 90, 310. A second pump 301 sucks air from the space 8 between the two opened doors.

When it is desired to transfer data to/from the disk, the servo motor 150 drives a gripper 111 to grip onto the front plate (not shown) of the disk holder 30 and pull it to the right, into the working position. The doors 510 and 520 are then
15 closed. After this, the pump 300 may be deactivated.

After the read/write process is finished, the air pressure inside the cartridge 1 and disk drive 100 is maintained to be positive again by activating the pump 300, the doors 510, 520 are opened, the servo motor 150 then drives the gripper 111 to deliver the disk holder 30 back to the cartridge 1. After the
20 gripper 111 is withdrawn, the doors 510, 520 are closed.

Due to the positive pressure inside the cartridge and drive, contaminant cannot enter them when the doors are opened.

Although only two embodiments of the invention has been described in detail, many modifications are possible within the scope of the invention as will be
25 clear to a skilled reader. For example, embodiments of the invention can be conceived in which the disk is not fully expelled from the cartridge, but in which at least a portion of the disk remains within the cartridge during the read

operation. Conveniently, the read/write head of the disk drive would interact with the portion of the disk which protrudes from the cartridge.

Furthermore, as mentioned above, embodiments of the invention may be constructed having multiple disks within a single cartridge.



Claims

1. A removable disk drive system including:

a cartridge defining a first enclosed volume which contains at least one data storage disk, and having first interface means; and

5 a disk drive defining a second enclosed volume which contains disk rotation means and data transfer means, and having second interface means;

engagement of the first and second interface means bringing the first and second enclosed volumes into communication to form a joint enclosed volume, and disengagement of the first and second interface means enabling
10 separation of the cartridge and disk drive,

the system further comprising displacement means for moving the disk within the joint enclosed space relative to the cartridge to position it for rotation by the disk rotation means and for data transfer using the data transfer means.

15 2. A system according to claim 1 in which the displacement means is operative within the joint enclosed space to expel the disk from the cartridge to position it for rotation by the disk rotation means and for data transfer using the data transfer means, and to return the disk into the cartridge.

3. A system according to claim 1 in which the first and second interface
20 means each include a respective opening, a respective door for closing that respective opening, and respective closure means,

each closure means being operative upon disengagement of the first and second interface means to retain the respective door in a position closing the respective opening, and to release the respective door upon engagement
25 of the first and second interface means.



4. A system according to claim 3 in which each door has an outer surface which not exposed to the joint enclosed volume when the first and second interface means are exposed.
5. A system according to claim 3 or claim 4 in which the doors of the
5 cartridge and disk drive lock together upon engagement of the first and second interface means.
6. A system according to any preceding claim in which the first and second interface means each contain magnetic elements, engagement of the first and second interface means including magnetic engagement of
10 corresponding ones of the elements.
7. A system according to claim 5 in which at least one of the first and second interface means includes projecting elements for reception within corresponding recesses in the other of the first and second interface means.
8. A system according to claim 6 or 7 when dependent upon one of
15 claims 3 to 5 in which said respective elements of the first and second interface means are located on the respective doors.
9. A system according to any preceding claim in which the cartridge contains a disk holder holding the disk and in fixed relationship to the disk, the disk holder including an opening for the data transfer means to access the
20 disk.
10. A system according to any preceding claim in which the cartridge contains a back member for blocking air flow into the cartridge while the disk is rotated.
11. A system according to any preceding claim in which the disk drive
25 includes a cavity for reception of the cartridge and having an opening, the second interface means being provided at a rear portion of the cavity,



whereby the first and second interface means engage upon insertion of the cartridge into the cavity.

12. A system according to claim 11 in which the disk drive includes an outer door for covering the opening of the cavity.

5 13. A system according to any preceding claim further including pump means for generating a positive pressure within the joint enclosed volume.

14. A system according to claim 13 in which the pump means communicates with the first enclosed volume while the first and second interface means are engaged.

10 15. A system according to any preceding claim in which the pump means includes means for expelling air trapped between the cartridge and the disk drive.

16. A cartridge for use in a disk drive system according to any preceding claim.

15 17. A disk drive for use in a disk drive system according to any of claims 1 to 15.

18. A disk drive for transferring data to and/or from at least one data storage disk located within a first enclosed volume defined by a cartridge, the cartridge having first interface means, the disk drive system including:

20 a housing defining a second enclosed volume;

disk rotation means located within the second enclosed volume;

data transfer means located within the second enclosed volume; and

second interface means;



the second interface means being arranged selectively to engage with the first and interface means to bringing the first and second enclosed volumes into communication to form a joint enclosed volume, and to disengage from the second interface means enabling separation of the
5 cartridge and disk drive,

the disk drive further comprising displacement means operative within the joint enclosed volume to bring the disk into register with the disk rotation means for disk rotation and with the data transfer means for data transfer.

19. A cartridge defining a first enclosed volume which contains at least one
10 data storage disk, and having first interface means, the first interface means being arranged selectively to engage with and disengage from second interface means of a disk drive defining a second enclosed volume which contains disk rotation means and data transfer means,

engagement of the first and second interface means bringing the first
15 and second enclosed volumes into communication to form a joint enclosed volume within which the disk rotation means rotates the disk and the data transfer means transfers data to and/from the disk, and disengagement of the first and second interface means enabling separation of the cartridge and disk drive.