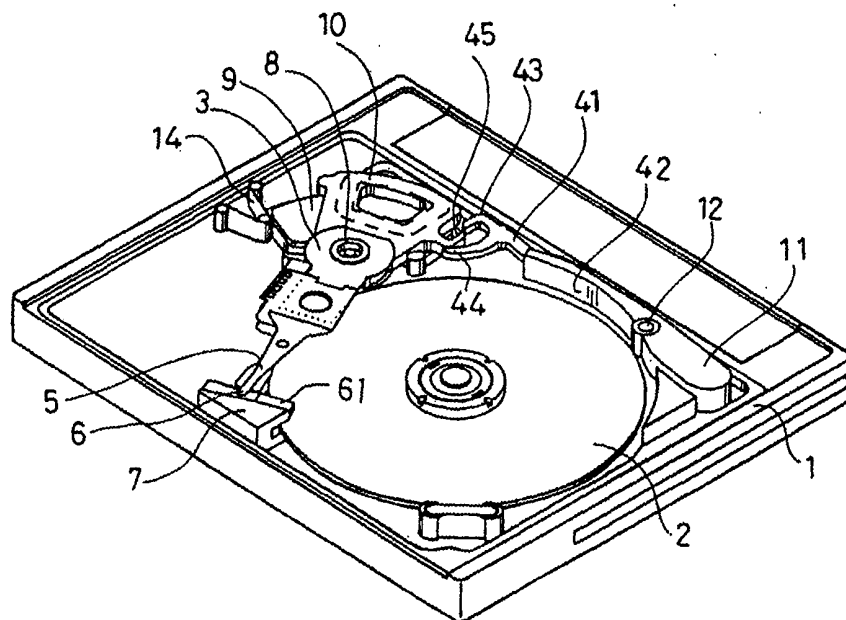




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**(54) Title:** DISK APPARATUS**(57) Abstract**

The disk apparatus of the present invention comprises an actuator (3) holding a head (5) and having an engagement finger portion (45), and an inertia latch lever (11) rotatably supported near the outer peripheral portion of a disk (2) while keeping a weight balance and having a hook (43) capable of engaging the finger portion (45) of the actuator (3). The hook (43) of the inertia latch lever (11) engages the finger portion (45) of the actuator (3) at the time of non-operation. At the time of operation, the inertia latch lever (11) is rotated by airflow generated by the rotation of the disk (2) to disengage the hook (43) from the finger portion (45).

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## DESCRIPTION

## DISK APPARATUS

## TECHNICAL FIELD

The present invention relates to a disk apparatus for writing and reading data on a disk-shaped recording medium. More particularly, the present invention relates to a disk apparatus used for laptop, portable and other compact computers.

## BACKGROUND ART

In many computer systems, data is recorded on a magnetic film formed on the surface of a disk-shaped recording medium, such as a hard disk and a floppy disk. Data is written or read in concentric tracks on a magnetic film by a magnetic head. When writing or reading data, the magnetic head is disposed on a thin laminar-flow boundary-layer of air formed on a disk rotating at high speed so that the magnetic head does not directly make contact with the magnetic surface of the magnetic film.

In the drive mechanism of a disk apparatus, a magnetic head is generally installed near the tip of an actuator. A rotary actuator rotates around a rotation shaft disposed near the peripheral portion of the disk, and the magnetic head disposed at the tip of the actuator swings so as to draw a constant arc over the surface of the disk.

The rotary actuator is formed to balance substantially around the rotation shaft. Therefore, when a

completely linear impact is applied to the disk apparatus, the impact force is equally exerted to the actuator portions provided on both sides of the rotation shaft, thereby maintaining the actuator stationary. In addition, a small imbalance due to general variations in the production process of the actuator does not cause such a large inertia force that a non-driven latch mechanism is disengaged by a completely linear impact.

Since a conventional rotary actuator is configured to finely rotate around its rotation shaft, it tends to be moved by an impact or acceleration causing a force particularly in the rotation direction thereof. Therefore, the actuator is required to be provided with a mechanism for protection against an inertia force caused by the impact in the rotation direction. The rotary actuator is structured to easily rotate around the rotation shaft by drawing an arc over the surface of the disk. Therefore, this protection mechanism is used to prevent the magnetic head disposed near the tip of the actuator from making unnecessary contact with the disk. The necessity of this protection has increased further because of the progress in laptop computers or smaller computers. In particular, these computers sometimes undergo impacts causing forces in the rotation direction when used in adverse conditions, during transportation or at the time of being shaken, bumped or dropped in some cases.

To attain protection against the above-mentioned

impacts, a protection mechanism has been proposed to securely hold the actuator at a specific position while the drive mechanism of the disk is not operating. For example, a conventional protection mechanism is disclosed in the drawing (FIG. 11) showing the invention of Japanese Patent No. 2718573. This protection mechanism is provided with an inertia latch that temporarily engages a projection formed at one end of the actuator when the disk apparatus undergoes a strong force causing angular acceleration in the clockwise direction. In this inertia latch, an inertia body is spring-loaded at its unlocking position. When an impact force to the disk apparatus causes angular acceleration, the moment of inertia generated in the inertia body exceeds the preloaded spring force, and the inertia body rotates to lock the actuator. Therefore, when an external impact force is such a low level that the moment of inertia does not exceed the preloaded spring force, the conventional inertia latch does not function.

As the disk apparatus is made smaller to meet the needs of the time, the area for accommodating an inertia body for generating the moment of inertia becomes more restricted because of limitations in space. Therefore, in conventional disk apparatuses, it is more difficult to have a configuration wherein a generated moment of inertia exceeds the preloaded spring force.

On the other hand, instead of increasing the moment of inertia, it is possible to use a method of decreasing the

preloaded spring force by making the spring smaller. However, making the spring smaller causes problems in the spring with respect to workability, assembling, malfunction due to friction, etc.

Therefore, the problem of non-operation in the conventional inertia latch at the time when a low-level external impact force is applied is serious particularly for ultra-compact drive mechanisms having one inch in diameter for example.

A protection mechanism has been disclosed in the Japanese Published Unexamined Patent Application, Publication No. Hei 8-339645 to solve the above-mentioned problem of non-operation at the time when a low-level external impact force is applied. This protection mechanism has a magnetic latch using a magnetic force, besides an inertia latch. The mechanism is therefore a dual latch mechanism provided for impact forces of all levels including low, intermediate and high levels. However, the protection mechanism having this kind of configuration is high in production cost, and has such a problem that the two latch mechanisms of the inertia latch and the magnetic latch cannot be mounted in more ultra-compact disk apparatuses.

#### DISCLOSURE OF INVENTION

Accordingly, an object of the present invention is to provide a disk apparatus, although simpler in structure than

conventional disk apparatuses, capable of securely locking its actuator regardless of the direction of an impact force when the impact force is applied to the disk apparatus at the time of non-operation of the disk apparatus.

Another object of the present invention is to provide a disk apparatus having a simple configuration and being capable of locking its actuator by securely responding to even a low-level impact force.

In order to attain the above-mentioned objects, a disk apparatus in accordance with the present invention comprises:

- a head for writing data on the data recording area of a disk or for reading data from the data recording area,

- an actuator for holding and moving the head over the data recording area of the disk and having an engagement finger portion,

- actuator drive device for driving the actuator,

- actuator movement control means for controlling the movement of the actuator with a friction force at the time of non-operation of the disk apparatus, and

- an inertia latch lever rotatably supported on a support shaft near the outer peripheral portion of the disk while keeping a weight balance and having a hook capable of engaging the finger portion of the actuator, wherein

- the hook of the inertia latch lever engages the finger portion of the actuator at the time of non-operation, and the

inertia latch lever is rotated around the support shaft by airflow generated by the rotation of the disk to disengage the hook from the finger portion at the time of operation.

The disk apparatus of the present invention configured as described above has reduced number of parts, is simple in structure, and can securely lock the actuator even when an impact is caused outside the disk apparatus at the time of non-operation.

The head of the disk apparatus in accordance with the present invention may carry out both writing data and reading data. Of course, a head capable of carrying out either writing data or reading data is applicable to the present invention.

A disk apparatus in accordance with the present invention of another aspect comprises:

a head for writing data on the data recording area of a disk or for reading data from the data recording area,

an actuator for holding and moving the head over the data recording area of the disk and having an engagement finger portion and a tongue portion projecting like a rod,

actuator drive device for driving the actuator,

actuator movement control means for controlling the movement of the actuator with a friction force at the time of non-operation of the disk, and

an inertia latch lever rotatably supported on a support shaft near the outer peripheral portion of the disk while keeping a weight balance and having a hook capable of engaging



the finger portion of the actuator, wherein

the hook of the inertia latch lever engages the finger portion of the actuator at the time of non-operation, and the inertia latch lever is rotated around the support shaft by airflow generated by the rotation of the disk to disengage the hook from the finger portion at the time of operation.

The disk apparatus of the present invention configured as described above has reduced number of parts, is simple in structure, and can securely lock the actuator even when a low-level impact force is caused outside the disk apparatus at the time of non-operation.

While the novel features of the invention are set forth particularly in the appended claims, the invention, both as to organization and content, will be better understood and appreciated, along with other objects and features thereof, from the following detailed description taken in conjunction with the drawings.

#### BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view showing the configuration of a disk apparatus of Embodiment 1 in accordance with the present invention;

FIG. 2 is a plan view showing the major configuration of the disk apparatus of Embodiment 1 in accordance with the present invention;

FIG. 3 is an enlarged plan view showing the vicinity

of the inertia latch lever of the disk apparatus of Embodiment 1;

FIG. 4 is a side view showing the inertia latch lever of the disk apparatus of Embodiment 1;

FIG. 5 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 1;

FIG. 6 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 1;

FIG. 7 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 1;

FIG. 8 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 1;

FIG. 9 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 1;

FIG. 10 is a plan view showing the major configuration of the disk apparatus of Embodiment 2 in accordance with the present invention;

FIG. 11 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 2;

FIG. 12 is a side view showing the inertia latch lever

of the disk apparatus of Embodiment 2;

FIG. 13 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 2;

FIG. 14 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 2;

FIG. 15 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 2;

FIG. 16 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 2;

FIG. 17 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 2;

FIG. 18 is a plan view showing the major configuration of the disk apparatus of Embodiment 3 in accordance with the present invention;

FIG. 19 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 3;

FIG. 20 is a side view showing the inertia latch lever of the disk apparatus of Embodiment 3;

FIG. 21 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of

the disk apparatus of Embodiment 3;

FIG. 22 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 3;

FIG. 23 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 3;

FIG. 24 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 3;

FIG. 25 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 3;

FIG. 26 is a plan view showing the major configuration of the disk apparatus of Embodiment 4 in accordance with the present invention;

FIG. 27 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 4;

FIG. 28 is a side view showing the inertia latch lever of the disk apparatus of Embodiment 4;

FIG. 29 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 4;

FIG. 30 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of

the disk apparatus of Embodiment 4;

FIG. 31 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 4;

FIG. 32 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 4; and

FIG. 33 is an enlarged plan view showing the vicinity of the inertia latch lever and illustrating the operation of the disk apparatus of Embodiment 4.

It will be recognized that some or all of the Figures are schematic representations for purposes of illustration and do not necessarily depict the actual relative sizes or locations of the elements shown.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Preferred embodiments of the disk apparatus of the present invention will be described below referring to the accompanying drawings.

#### << Embodiment 1 >>

A disk apparatus of Embodiment 1 in accordance with the present invention will be described by using FIGs. 1 and 2. FIG. 1 is a perspective view showing the configuration of the disk apparatus of Embodiment 1 in accordance with the present invention. FIG. 2 is a plan view showing the major parts configuration of the disk apparatus of Embodiment 1. The disk

apparatus of Embodiment 1 is a magnetic disk drive having dynamic-loading system. This magnetic disk drive has a disk 2 used as a recording medium and an actuator 3 on a base 1. The disk 2 is driven to rotate by a spindle motor 4. A magnetic head 5 for writing data on the recording area of the disk 2 or for reading data from the data recording area and a cam follower 6 are installed near the tip (near the lower end in FIG. 2) of the actuator 3. The cam follower 6 makes contact with the upper surface of an oblique block 61 of a ramp 7 at the time of non-operation of the disk apparatus to hold the actuator 3 at a predetermined position. The upper surface of the oblique block 61 which makes contact with the cam follower 6 is formed to have a down gentle slope toward the disk 2. At the time of non-operation, the cam follower 6 is supported by a recess formed on the upper surface of the oblique block 61. The actuator 3 is supported by a pivot shaft 8, and is driven so that the magnetic head 5 draws an arc over the surface of the disk by the known control by the mutual electromagnetic action of a magnet 9 and an actuator coil 10. The actuator coil 10 and the magnet 9 together form a voice coil motor. This voice coil motor rotates the actuator 3 to position the magnetic head 5 at a desired position over the disk 2.

Crash stops 13 and 14, provided on both sides of the actuator 3, are used to control the rotation range of the actuator 3 by making contact therewith. In addition, the crash stops 13 and 14 serves to relieve an shock at the time of collision. The

crash stop 13, one of the crash stops, is formed of a cylindrical elastic material and is secured to the base 1. The crash stop 14, the other crash stop, is formed of a leaf spring and mounted on plural pins disposed on the base 1 in a bent pre-loaded condition.

Referring to FIG. 2, an inertia latch lever 11 is disposed near the actuator coil 10 outside the outer peripheral portion of the disk 2. FIG. 3 is a plan view showing the details of the inertia latch lever 11 in accordance with Embodiment 1.

As shown in FIG. 3, the inertia latch lever 11 has an arm 41 and an airflow receiving portion 42, and is rotatably supported by a shaft 12. The tip of the arm 41 (on the side wherein the actuator coil 10 is disposed) is provided with a bent hook 43 and a guide portion 44 formed concave at the face opposed to the actuator coil 10.

The inertia latch lever 11 is rotatably supported by the shaft 12 which is secured by press fitting on the base 1; and the inertia latch lever 11 is balanced in weight on the right and left sides around the shaft 12.

FIG. 4 is a side view of the inertia latch lever 11 of Embodiment 1 as viewed from direction A of FIG. 3. Referring to FIG. 4, the portion indicated by the shaded area is formed concave corresponding with the shape of the outer peripheral portion of the disk 2. The airflow receiving portion 42 formed at the central part of this concave face receives airflow generating around the disk 2 at the rotation time of the disk

2.

Next, the operation of the disk apparatus of Embodiment 1 will be described.

First, the operation of the inertia latch lever 11 is described. This description is applied in the case where the disk apparatus undergoes an impact force causing acceleration and clockwise rotation as a whole (hereinafter referred to as a impact rotation force) while the disk apparatus is not operating, in other words, while the disk 2 is not revolving. FIGs. 3 and 5 are plan views showing ordinary conditions while the disk apparatus is not operating. FIG. 3 shows a condition wherein the finger portion 45 of the actuator 3 makes contact with the guide portion 44 of the inertia latch lever 11. FIG. 5 shows a condition wherein the finger portion 45 is disposed at a position in which it can engage the hook 43 of the inertia latch lever 11. While the disk apparatus is not operating, the inertia latch lever 11 is usually located at the position shown in FIG. 3 or FIG. 5 or an intermediate position therebetween.

In the disk apparatus of Embodiment 1, the finger portion 45 is formed on an end portion of the actuator 3, the opposite end of which the magnetic head 5 is provided. And, the finger portion 45 is formed at the side surface of the end portion facing the inertia latch lever 11. The finger portion 45 is formed so as to extend in a counterclockwise direction around the pivot shaft 8 from the above-mentioned side surface of the actuator 3. The above-mentioned counterclockwise direction is



defined as the direction in which the actuator 3 moves the magnetic head 5 from the outside of a disk onto the disk. In Embodiment 1, The hook 43 formed at the arm 41 of the inertia latch lever 11 is located at the position opposing to the finger portion 45. This hook 43 is disposed at the position to be engaged with the finger portion 45 when the inertia latch lever 11 rotates counterclockwise, and is formed to extend from the arm 41 in a direction opposed to the direction of the finger portion 45. And, the guide portion 44 formed at the arm 41 is located at the position so as to be pushed by a part of the finger portion 45 when the actuator 3 rotates clockwise.

In the case where the inertia latch lever 11 is in the condition shown in FIG. 5, the hook 43 of the inertia latch lever 11 is located at a position in which it can engage the finger portion 45 of the actuator 3. The actuator 3 is held by the contact between the cam follower 6 and the ramp 7 so that the magnetic head 5 does not move to the surface of the disk 2. Therefore, even if the disk apparatus externally undergoes a impact rotation force causing a force in a rotation direction, the actuator 3 is locked and does not rotate.

In the case where the inertia latch lever 11 is located at the position shown in FIG. 3 or an intermediate position between the positions shown in FIGs. 3 and 5, and when the disk apparatus undergoes a clockwise impact rotation force as a whole, the inertia latch lever 11 instantaneously rotates counterclockwise relatively. The inertia latch lever 11 then

moves until the inner edge of the hook 43 makes contact with the finger portion 45 of the actuator 3 (see FIG. 5). In this condition, the hook 43 of the inertia latch lever 11 engages the finger portion 45 of the actuator 3, whereby the actuator 3 is locked so that the magnetic head 5 does not move to the surface of the disk 2.

While the disk apparatus is not operating, the cam follower 6 of the actuator 3 makes contact with the ramp 7 (slope way), whereby a friction force generates therebetween. Therefore, even if a small impact rotation force is applied to the disk apparatus, the actuator 3 is not rotated, but remains at a certain position in the disk apparatus. On the other hand, the inertia latch lever 11 is not provided with an energizing means, such as a spring, or friction means, for controlling the movement. Therefore, the inertia latch lever 11 is instantaneously rotated counterclockwise relatively by a small clockwise impact rotation force to the disk apparatus.

Therefore, when the disk apparatus of Embodiment 1 undergoes a impact rotation force, the inertia latch lever 11 rotates counterclockwise earlier than the actuator 3. This completely prevents the hook 43 of the inertia latch lever 11 from not engaging.

Next, the operation of the disk apparatus of Embodiment 1 is described when it undergoes a counterclockwise impact rotation force while it is not operating. FIGS. 6 and 7 are plan views showing conditions wherein a counterclockwise

impact rotation force is applied to the disk apparatus.

When the counterclockwise impact rotation force is applied to the disk apparatus as shown in FIG. 6, the actuator 3 rotates clockwise relatively to the disk apparatus, and the side face 48 of the actuator 3 collides with the crash stop 13. In the case of a normal impact, the actuator 3 stops at the position shown in FIG. 6.

If the disk apparatus undergoes an excessive counterclockwise impact rotation force, the actuator 3 rotates clockwise relatively to the disk apparatus as the result of the collision. The actuator 3 is bounced back by the elasticity of the crash stop 13, and this force may be sometimes larger than the friction force between the cam follower 6 and the ramp 7. However, when the disk apparatus of Embodiment 1 undergoes this large impact rotation force, the corner portion 47 (see FIG. 6) of the finger portion 45 pushes the guide portion 44 of the inertia latch lever 11, thereby rotating the inertia latch lever 11 counterclockwise. This condition is shown in FIG. 7.

Referring to FIG. 7, the inertia latch lever 11 moves from position B indicated by broken lines to position C indicated by solid lines. As a result, even if the disk apparatus undergoes a large impact rotation force, and the actuator 3 is attempted to be bounced back counterclockwise, the finger portion 45 of the actuator 3 engages the hook 43 of the inertia latch lever 11 as shown in FIG. 8. This prevents the counterclockwise bouncing movement of the actuator 3, thereby

completely preventing the magnetic head 5 from making contact with the surface of the disk 2.

Next, the operation of the inertia latch lever 11 is described in the case that the disk apparatus of Embodiment 1 is operating, in other words, while the disk 2 is rotating. FIG. 9 is a plan view showing the condition of the inertia latch lever 11 at the time when the disk apparatus of Embodiment 1 is operating.

While the disk apparatus is operating, the airflow shown by arrows is generated around the disk 2 by the counterclockwise rotation of the disk 2 as shown in FIG. 9. This airflow applies a clockwise rotation force around the shaft 12 to the airflow receiving portion 42 of the inertia latch lever 11. For this reason, the inertia latch lever 11 is moved to an unlocking position (the position shown in FIG. 9). As a result, the cam follower 6 of the actuator 3 can freely rotate over the disk 2 away from the ramp 7. Therefore, the disk apparatus of Embodiment 1 can stably carry out recording/playback on the surface of the disk 2 by using the magnetic head 5 disposed near the tip of the actuator 3.

<< Embodiment 2 >>

Next, a disk apparatus of Embodiment 2 in accordance with the present invention will be described referring to FIGs. 10 to 17. FIG. 10 is a plan view showing the major internal configuration of the disk apparatus of Embodiment 2. The components of Embodiment 2 having the same functions and

configurations as those of the above-mentioned Embodiment 1 are represented by the same numerals, and their redundant detailed descriptions are omitted. The disk apparatus of Embodiment 2 is a dynamic loading magnetic disk drive. The configuration of the disk apparatus of Embodiment 2 differs from that of the above-mentioned Embodiment 1 in that the crash stop 13 is omitted. In other respects, they are the same with each other.

FIG. 11 is a plan view showing the details of an inertia latch lever 111. The inertia latch lever 111 has an arm 141 and an airflow receiving portion 142, and is supported by the shaft 12 which is secured by press fitting on the base 1. The tip of the arm 141 (on the side wherein the actuator coil 10 is disposed) is provided with a hook 143 and a guide portion 144. The inertia latch lever 111 is rotatably supported by the shaft 12, and is balanced in weight on the right and left sides around the shaft 12.

FIG. 12 is a side view of the inertia latch lever 111 of Embodiment 2 as viewed from direction A of FIG. 11. Referring to FIG. 12, the shaded portion of the inertia latch lever 111 is formed concave corresponding with the shape of the outer peripheral portion of the disk 2. The airflow receiving portion 142 formed at the central part of this concave face receives airflow generating around the disk 2 at the rotation time of the disk 2.

Next, the operation of the disk apparatus of Embodiment 2 will be described.

First, the operation of the inertia latch lever 111 is described. This description is applied in the case where the disk apparatus undergoes a impact rotation force while the disk apparatus is not operating, in other words, while the disk 2 is not rotating. FIGs. 11 and 13 are plan views showing ordinary conditions while the disk apparatus is not operating. FIG. 11 shows a condition wherein the finger portion 45 of the actuator 3 makes contact with the guide portion 144 of the inertia latch lever 111. FIG. 13 shows a condition wherein the finger portion 45 is disposed at a position in which it can engage the hook 143 of the inertia latch lever 111. While the disk apparatus is not operating, the inertia latch lever 111 is usually located at the position shown in FIG. 11 or FIG. 13 or an intermediate position therebetween.

In the case where the inertia latch lever 111 is located at the position shown in FIG. 13, the inertia latch lever 111 locks the actuator 3. Therefore, even if a impact rotation force is applied outside the disk apparatus, the actuator 3 does not rotate.

In the case where the inertia latch lever 111 is located at the position shown in FIG. 11 or an intermediate position between the positions shown in FIGs. 11 and 13, and when the disk apparatus undergoes a clockwise impact rotation force as a whole, the inertia latch lever 111 instantaneously rotates counterclockwise. As a result, the inner edge of the hook 143 of the inertia latch lever 111 makes contact with the

finger portion 45 of the actuator 3 (see FIG. 13). In this condition, the hook 143 of the inertia latch lever 111 can engage the finger portion 45, thereby preventing the counterclockwise rotation operation of the actuator 3.

While the disk apparatus is not operating, the cam follower 6 of the actuator 3 makes contact with the ramp 7, whereby a friction force generates therebetween. Therefore, even if a small impact rotation force is applied to the disk apparatus, the actuator 3 is prevented from being rotated by the impact. On the other hand, the inertia latch lever 111 is not provided with an energizing means, such as a spring, or friction means, for controlling the movement. Therefore, the inertia latch lever 111 is instantaneously rotated counterclockwise even when a small clockwise impact rotation force is applied to the disk apparatus. Since the disk apparatus of Embodiment 2 is configured as described above, the inertia latch lever 111 rotates counterclockwise earlier than the actuator 3. Thereby, the finger portion 45 never fails to engage the hook 143.

Next, the operation of the disk apparatus of Embodiment 2 is described when it undergoes a counterclockwise impact rotation force. FIG. 14 is a plan view showing a condition wherein the actuator 3 is rotated clockwise relatively to the disk apparatus at the time when the disk apparatus undergoes a counterclockwise impact rotation force. As shown in FIG. 14, the actuator 3 rotates clockwise and collides with

the crest portion 146 of the hook 143. In the case of a normal impact, the actuator 3 stops at the position shown in FIG. 14. In the aforementioned Embodiment 1, the actuator 3 makes contact with the crash stop 13, whereby its stop position is determined. In the disk apparatus of Embodiment 2, the crest portion 146 of the hook 143 has the function of the crash stop. This configuration of the disk apparatus of Embodiment 2 eliminates the need for the crash stop.

If the disk apparatus of Embodiment 2 undergoes an excessive counterclockwise impact rotation force, the actuator 3 is bounced back by the slight elasticity of the arm 141 as the result of the collision. This force may be sometimes larger than the friction force between the cam follower 6 and the ramp 7. However, when the disk apparatus of Embodiment 2 undergoes this large impact rotation force, the corner portion 47 (see FIG. 14) of the finger portion 45 pushes the guide portion 144 of the inertia latch lever 111. As a result, the inertia latch lever 111 rotates counterclockwise. This condition is shown in FIG. 15. Referring to FIG. 15, the inertia latch lever 111 moves from position B indicated by broken lines to position C indicated by solid lines. As a result, even if the disk apparatus undergoes a large impact rotation force, and the actuator 3 is attempted to be bounced back counterclockwise, the finger portion 45 of the actuator 3 securely engages the hook 143 of the inertia latch lever 111 as shown in FIG. 16. This prevents the counterclockwise movement of the actuator 3, thereby



completely preventing the magnetic head 5 (see FIG. 10) from making contact with the surface of the disk 2.

Next, the operation of the inertia latch lever 111 is described in the case that the disk apparatus of Embodiment 2 is operating, in other words, while the disk 2 is rotating. FIG. 17 is a plan view showing the condition of the inertia latch lever 111 at the time when the disk apparatus of Embodiment 2 is operating.

While the disk apparatus is operating, the airflow shown by arrows is generated around the disk 2 by the counterclockwise rotation of the disk 2 as shown in FIG. 17. This airflow applies a clockwise rotation force to the airflow receiving portion 142 of the inertia latch lever 111. Therefore, the inertia latch lever 111 is moved to an unlocking position (the position shown in FIG. 17). As a result, the cam follower 6 of the actuator 3 can freely rotate over the disk 2 away from the ramp 7. Therefore, the disk apparatus of Embodiment 2 can stably carry out recording/playback on the surface of the disk 2 by using the magnetic head 5 disposed near the tip of the actuator 3.

<< Embodiment 3 >>

Next, a disk apparatus of Embodiment 3 in accordance with the present invention will be described referring to FIGs. 18 to 25. FIG. 18 is a plan view showing the major internal configuration of the disk apparatus of Embodiment 3. The components of Embodiment 3 having the same functions and

configurations as those of the aforementioned Embodiment 1 are represented by the same numeral codes, and their descriptions are omitted. The disk apparatus of Embodiment 3 is a dynamic loading magnetic disk drive. The configuration of the disk apparatus of Embodiment 3 differs from that of the aforementioned Embodiment 1 in the configuration of an inertia latch lever 211 and the shape of the engagement portion of the actuator 3 engaging the inertia latch lever 211. In other respects, they are the same with each other.

FIG. 19 is a plan view showing the details of the inertia latch lever 211 of the disk apparatus of Embodiment 3. The inertia latch lever 211 of Embodiment 3 has an arm 241 and an airflow receiving portion 242, and is supported by the shaft 12 which is secured by press fitting on the base 1. The tip of the arm 241 (on the side wherein the actuator coil 10 is disposed) is provided with a hook 243. The inertia latch lever 211 is rotatably supported by the shaft 12; and the inertia latch lever 211 is balanced in weight on the right and left sides around the shaft 12.

FIG. 20 is a side view of the inertia latch lever 211 of Embodiment 3 as viewed from direction A of FIG. 19. Referring to FIG. 20, the shaded portion of the inertia latch lever 211 is formed concave corresponding with the shape of the outer peripheral portion of the disk 2. The airflow receiving portion 242 formed at the central part of this concave face receives airflow generating around the disk 2 at the rotation time of

the disk 2.

Next, the operation of the disk apparatus of Embodiment 3 will be described.

First, the operation of the inertia latch lever 211 is described in the case where the disk apparatus undergoes a impact rotation force while the disk apparatus is not operating, in other words, while the disk 2 is not rotating. FIGs. 19 and 21 are plan views showing ordinary conditions while the disk apparatus is not operating. FIG. 19 shows a condition wherein the tongue portion 15 of the actuator 3 makes contact with the corner portion of the hook 243 formed at the tip of the inertia latch lever 211. FIG. 21 shows a condition wherein the finger portion 45 of the actuator 3 is disposed at a position in which it can engage the hook 243 of the inertia latch lever 211. While the disk apparatus is not operating, the inertia latch lever 211 is usually located at the position shown in FIG. 19 or FIG. 21 or an intermediate position therebetween.

In the disk apparatus of Embodiment 3, the hook 243 formed at the arm 241 of the inertia latch lever 211 is located at the position opposing to the finger portion 45. This hook 243 is disposed at the position to be engaged with the finger portion 45 when the inertia latch lever 211 rotates counterclockwise, and is formed to extend from the arm 241 in a direction opposed to the direction of the finger portion 45. The tongue portion 15 is formed on an end portion of the actuator 3, the opposite end of which the magnetic head 5 is provided.

And, the tongue portion 15 is formed at the side surface of the end portion facing the inertia latch lever 211. The tongue portion 15 is formed so as to extend in the direction to the hook 243 from the above-mentioned side surface of the actuator 3.

In the case where the inertia latch lever 211 is located at the position shown in FIG. 21 while the disk apparatus is not operating, the inertia latch lever 211 locks the actuator 3. Therefore, even if a impact rotation force is applied outside the disk apparatus, the magnetic head does not move over the surface of the disk 2.

On the other hand, in the case where the inertia latch lever 211 is located at the position shown in FIG. 19 or an intermediate position between the positions shown in FIGs. 19 and 21, and when the disk apparatus undergoes a clockwise impact rotation force as a whole, the inertia latch lever 211 instantaneously rotates counterclockwise relatively to the disk apparatus. As a result, the inner edge of the hook 243 of the inertia latch lever 211 makes contact with the finger portion 45 of the actuator 3 (see FIG. 21). In this condition, the hook 243 engages the finger portion 45, thereby preventing the counterclockwise rotation of the actuator 3.

While the disk apparatus is not operating, the cam follower 6 of the actuator 3 makes contact with the ramp 7, whereby a friction force generates therebetween. Therefore, even if a small impact rotation force is applied to the disk

apparatus, the actuator 3 is prevented from being rotated by the impact. On the other hand, the inertia latch lever 211 is not provided with an energizing means such as a spring, or friction means, for controlling the movement. Therefore, the inertia latch lever 211 is instantaneously rotated counterclockwise even when a small impact rotation force is applied to the disk apparatus. Since the disk apparatus of Embodiment 3 is configured as described above, the inertia latch lever 211 rotates counterclockwise earlier than the actuator 3. Thereby, the finger portion 45 never fails to engage the hook 243.

Next, the operation of the disk apparatus of Embodiment 3 is described when it undergoes a counterclockwise impact rotation force. FIG. 22 is a plan view showing the vicinity of the inertia latch lever 211 at the time when the disk apparatus of Embodiment 3 undergoes a counterclockwise impact rotation force. When the disk apparatus undergoes the counterclockwise impact rotation force as shown in FIG. 22, the actuator 3 rotates clockwise, and the right side face 48 of the actuator 3 collides with the crash stop 13. In the case of a normal impact, the actuator 3 stops at the position shown in FIG. 22.

If the disk apparatus of Embodiment 3 undergoes an excessive counterclockwise impact rotation force, the actuator 3 is bounced back by the elasticity of the crash stop 13 as the result of the collision. This impact force may be sometimes

larger than the friction force between the cam follower 6 and the ramp 7. However, when the disk apparatus of Embodiment 3 undergoes this large impact rotation force, the tongue portion 15 pushes the corner portion of the hook 243 of the inertia latch lever 211, whereby the inertia latch lever 211 rotates counterclockwise. This condition is shown in FIG. 23.

Referring to FIG. 23, the inertia latch lever 211 moves from position B indicated by broken lines to position C indicated by solid lines. As a result, even if the disk apparatus undergoes a large impact rotation force and the actuator 3 is about to be bounced back counterclockwise, the finger portion 45 of the actuator 3 engages the hook 243 of the inertia latch lever 211 as shown in FIG. 24. This engagement prevents the counterclockwise movement of the actuator 3, thereby completely preventing the magnetic head 5 from making contact with the surface of the disk 2.

Next, the operation of the inertia latch lever 211 is described in the case that the disk apparatus of Embodiment 3 is operating, in other words, while the disk 2 is rotating. FIG. 25 is a plan view showing the condition of the inertia latch lever 211 at the time when the disk apparatus of Embodiment 3 is operating.

While the disk apparatus is operating, the airflow shown by arrows is generated around the disk 2 by the counterclockwise rotation of the disk 2 as shown in FIG. 25. This airflow applies a clockwise rotation force to the airflow

receiving portion 242 of the inertia latch lever 211. For this reason, the inertia latch lever 211 is moved to an unlocking position (the position shown in FIG. 25). As a result, the cam follower 6 of the actuator 3 can freely rotate over the disk 2 away from the ramp 7. Therefore, the disk apparatus of Embodiment 3 can stably carry out recording/playback on the surface of the disk 2 by using the magnetic head 5 disposed near the tip of the actuator 3.

<< Embodiment 4 >>

Next, a disk apparatus of Embodiment 4 in accordance with the present invention will be described referring to FIGs. 26 to 33. FIG. 26 is a plan view showing the major internal configuration of the disk apparatus of Embodiment 4. The components of Embodiment 4 having the same functions and configurations as those of the aforementioned Embodiment 1 are represented by the same numeral codes, and their descriptions are omitted. The disk apparatus of Embodiment 4 is a dynamic-loading magnetic disk drive. The configuration of the disk apparatus of Embodiment 4 differs from that of the above-mentioned Embodiment 3 in that the crash stop 13 is omitted. In other respects, they are the same with each other. In the disk apparatus of Embodiment 4, a portion of a hook 343 has the function of the crash stop.

FIG. 27 is a plan view showing the details of the inertia latch lever 311 of Embodiment 4. The inertia latch lever 311 of Embodiment 4 has an arm 341 and an airflow receiving

portion 342, and is supported by the shaft 12. The tip of the arm 341 (on the side wherein the actuator coil 10 is disposed) is provided with a hook 343. The inertia latch lever 311 of Embodiment 4 is rotatably supported by the shaft 12 press-fitted and secured to the base 1, and is balanced in weight on the right and left sides around the shaft 12.

FIG. 28 is a side view of the inertia latch lever 311 of Embodiment 4 as viewed from direction A of FIG. 27. Referring to FIG. 28, the shaded portion of the inertia latch lever 311 is formed concave corresponding with the shape of the outer peripheral portion of the disk 2. The airflow receiving portion 342 formed at this concave face receives airflow generating around the disk 2 at the rotation time of the disk 2.

Next, the operation of the disk apparatus of Embodiment 4 will be described.

First, the operation of the inertia latch lever 311 is described. This description is applied in the case where the disk apparatus undergoes a impact rotation force while the disk apparatus is not operating, in other words, while the disk 2 is not rotating. FIGs. 27 and 29 are plan views showing ordinary conditions while the disk apparatus is not operating. FIG. 27 shows a condition wherein the tongue portion 15 of the actuator 3 makes contact with the corner portion of the hook 343 formed at the tip of the inertia latch lever 311. FIG. 29 shows a condition wherein the finger portion 45 of the actuator 3 is disposed at a position in which it can engage the hook 343 of



the inertia latch lever 311. While the disk apparatus is not operating, the inertia latch lever 311 is usually located at the position shown in FIG. 27 or FIG. 29 or an intermediate position therebetween.

In the case where the inertia latch lever 311 of Embodiment 4 is located at the position shown in FIG. 29, the inertia latch lever 311 locks the actuator 3. Therefore, even if a impact rotation force is applied outside the disk apparatus in this case, the magnetic head does not move over the surface of the disk 2.

On the other hand, in the case where the inertia latch lever 311 of Embodiment 4 is located at the position shown in FIG. 27 or an intermediate position between the positions shown in FIGs. 27 and 29, and when the disk apparatus undergoes a clockwise impact rotation force as a whole, the inertia latch lever 311 instantaneously rotates counterclockwise. As a result, the inner edge of the hook 343 makes contact with the finger portion 45 of the actuator 3 as shown in FIG. 29. In this condition, the hook 343 is located so that it can engage the finger portion 45, thereby preventing the counterclockwise rotation of the actuator 3.

While the disk apparatus is not operating, the cam follower 6 of the actuator 3 makes contact with the ramp 7, whereby a friction force generates therebetween. Therefore, even if a small impact rotation force is applied to the disk apparatus, the actuator 3 is prevented from being rotated by

the impact. On the other hand, the inertia latch lever 311 is not provided with an energizing means, such as a spring, or friction means, for controlling the movement. Therefore, the inertia latch lever 311 is instantaneously rotated counterclockwise relatively even when a small clockwise impact rotation force is applied to the disk apparatus. Since the disk apparatus of Embodiment 4 is configured as described above, the inertia latch lever 311 rotates counterclockwise earlier than the actuator 3. Thereby, the finger portion 45 never fails to engage the hook 343.

Next, the operation of the disk apparatus of Embodiment 4 is described when it undergoes a counterclockwise impact rotation force. FIG. 30 is a plan view showing the vicinity of the inertia latch lever 311 at the time when the disk apparatus of Embodiment 4 undergoes a counterclockwise impact rotation force.

When the disk apparatus of Embodiment 4 undergoes the counterclockwise impact rotation force, the actuator 3 rotates clockwise as shown in FIG. 30, and collides with the crest portion 346 of the hook 343. In the case of a normal impact, the actuator 3 stops at the position shown in FIG. 30. In the aforementioned Embodiment 3, the actuator 3 collides with the crash stop 13 in the case described above, and stops at the position. In the disk apparatus of Embodiment 4, however, the crest portion 346 of the hook 343 has the function of the crash stop, thereby eliminating the need for the crash stop.

If the disk apparatus of Embodiment 4 undergoes an excessive counterclockwise impact rotation force, the actuator 3 is bounced back by the slight elasticity of the arm 341 as the result of the collision. This force may be sometimes larger than the friction force between the cam follower 6 and the ramp 7. However, when the disk apparatus of Embodiment 4 undergoes this large impact rotation force, the tongue portion 15 pushes the corner portion of the hook 343 of the inertia latch lever 311, whereby the inertia latch lever 311 rotates counterclockwise. This condition is shown in FIG. 31.

Referring to FIG. 31, the inertia latch lever 311 moves from position B indicated by broken lines to position C indicated by solid lines. As a result, even if the disk apparatus undergoes a large impact rotation force, and the actuator 3 is attempted to be bounced back counterclockwise, the finger portion 45 of the actuator 3 engages the hook 343 of the inertia latch lever 311 as shown in FIG. 32. This prevents the counterclockwise movement of the actuator 3, thereby completely preventing the magnetic head 5 from making contact with the surface of the disk 2.

Next, the operation of the inertia latch lever 311 is described in the case that the disk apparatus of Embodiment 4 is operating, in other words, while the disk 2 is rotating. FIG. 33 is a plan view showing the condition of the inertia latch lever 311 at the time when the disk apparatus of Embodiment 4 is operating.

When the disk apparatus is operating, the airflow shown by arrows is generated around the disk 2 by the counterclockwise rotation of the disk 2 as shown in FIG. 33. This airflow applies a clockwise rotation force to the airflow receiving portion 342 of the inertia latch lever 311. For this reason, the inertia latch lever 311 is moved to an unlocking position (the position shown in FIG. 33). As a result, the cam follower 6 of the actuator 3 can freely rotate over the disk 2 away from the ramp 7. Therefore, the disk apparatus of Embodiment 4 can stably carry out recording/playback on the surface of the disk 2 by using the magnetic head 5 disposed near the tip of the actuator 3.

In each of the above-mentioned embodiments, although the inertia latch lever (11, 111, 211, 311) is disposed along the outer peripheral portion of the disk 2, it is also possible to dispose along a radial direction of the disk 2 so as to receive an airflow which generates under the disk 2, and engage with the finger portion of the actuator.

An inertia latch lever used for a magnetic disk apparatus for storing information on magnetic recording media is explained in each embodiment described above. However, the technological concept of the present invention is also applicable to other data storage disk apparatuses, such as magneto-optical disk apparatuses and phase change optical disk apparatuses.

The present invention has the following effects as

has been made obvious from the detailed descriptions of the embodiments.

In accordance with the disk apparatus of the present invention, although simpler in structure than conventional disk apparatuses, the actuator is securely locked regardless of the direction of an impact force and the like applied outside the disk apparatus at the time of non-operation. As a result, the magnet head is prevented from swinging over the surface of the disk.

Furthermore, in accordance with the present invention, it is not necessary to provide a special movement control member for the actuator, such as a crash stop, thereby being effective in reducing number of parts.

Besides, in accordance with the present invention, unlike conventional disk apparatuses, it is not necessary to provide an energizing means, such as a spring, or friction means, for holding the inertia latch lever at the unlocking position at the time of non-operation. Therefore, the present invention is effective in providing a disk apparatus having a high-performance latch mechanism capable of locking the actuator by securely responding to even a low-level impact force.

Although the present invention has been described in terms of the presently preferred embodiments, it is to be understood that such disclosure is not to be interpreted as limiting. Various alterations and modifications will no doubt become apparent to those skilled in the art to which the present

invention pertains, after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the true spirit and scope of the invention.

#### INDUSTRIAL APPLICABILITY

The present invention provides a disk apparatus for writing and reading data on a disk-shaped recording medium used for laptop, portable and other compact computers. More particularly, the present invention provides a disk apparatus capable of locking the actuator regardless of the direction of an impact force applied outside the disk apparatus, having reduced number of parts, being simple in structure and compact, and capable of responding to even a low-level impact force.

## CLAIMS

1. A disk apparatus comprising:

a head for writing data on said data recording area of a disk or for reading data from said data recording area,

an actuator for holding and moving said head over said data recording area of said disk and having a finger shaped engaging member,

actuator drive device for driving said actuator,

actuator movement controller means for controlling the movement of said actuator with a friction force at the time of non-operation of said disk, and

an inertia latch lever rotatably supported on a support shaft near the outer peripheral portion of said disk while keeping a weight balance and having a hook capable of engaging said finger shaped engaging member of said actuator, wherein

said hook of said inertia latch lever engages said finger shaped engaging member of said actuator at the time of non-operation, and said inertia latch lever is rotated around said support shaft by airflow generated by the rotation of said disk to disengage said hook from said finger shaped engaging member at the time of operation.

2. A disk apparatus in accordance with claim 1, wherein, when said inertia latch lever undergoes a impact rotation force outside said disk apparatus, said inertia latch lever rotates earlier than said actuator and engages said finger

shaped engaging member to prevent the movement of said actuator.

3. A disk apparatus in accordance with claim 1, wherein said inertia latch lever has an arm projecting to said actuator and an airflow receiving portion, a bent hook and a guide portion are formed at the tip of said arm, and when said disk apparatus externally undergoes a impact rotation force at the time of non-operation, said finger shaped engaging member of said actuator pushes said guide portion to move said hook to a position in which said hook engages said finger shaped engaging member.

4. A disk apparatus in accordance with claim 1, wherein, when said disk apparatus externally undergoes a impact rotation force at the time of non-operation, the tip of said arm of said inertia latch lever makes contact with said actuator to control the movement range of said actuator.

5. A disk apparatus in accordance with claim 3, wherein, said airflow receiving portion of said inertia latch lever has a concave face corresponding with the shape of the outer peripheral portion of said disk to receive airflow generated by the rotation of said disk at the time of operation of said disk.

6. A disk apparatus comprising:

a head for writing data on said data recording area of a disk or for reading data from said data recording area,

an actuator for holding and moving said head over said data recording area of said disk and having a finger shaped



engaging member and a tongue shaped pushing member projecting like a rod,

actuator drive device for driving said actuator,

actuator movement control means for controlling the movement of said actuator with a friction force at the time of non-operation of said disk, and

an inertia latch lever rotatably supported on a support shaft near the outer peripheral portion of said disk while keeping a weight balance and having a hook capable of engaging said finger shaped engaging member of said actuator, wherein

said hook of said inertia latch lever engages said finger shaped engaging member of said actuator at the time of non-operation, and said inertia latch lever is rotated around said support shaft by airflow generated by the rotation of said disk to disengage said hook from said finger shaped engaging member at the time of operation.

7. A disk apparatus in accordance with claim 6, wherein, when said inertia latch lever undergoes a impact rotation force outside said disk apparatus, said inertia latch lever rotates earlier than said actuator and engages said finger shaped engaging member to prevent the movement of said actuator.

8. A disk apparatus in accordance with claim 6, wherein said inertia latch lever has an arm projecting to said actuator and an airflow receiving portion, said hook is formed at the tip of said arm, and when said disk apparatus externally

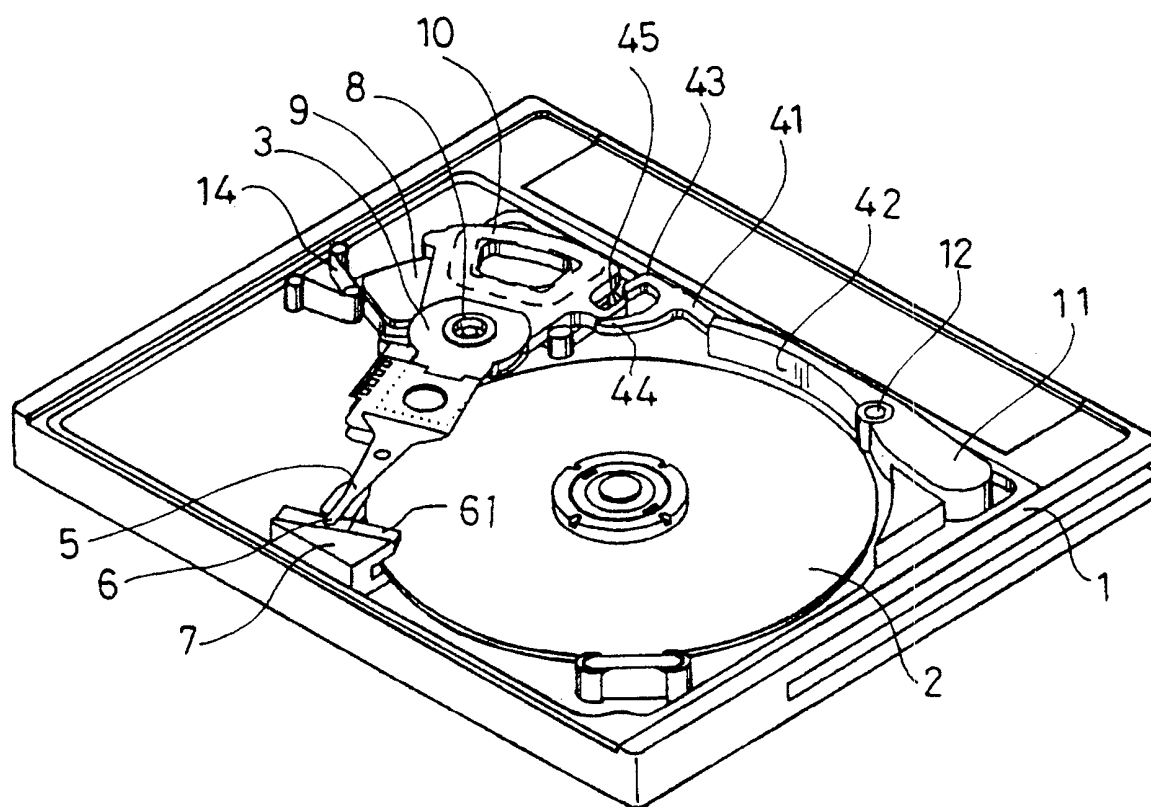
undergoes a impact rotation force at the time of non-operation, said tongue shaped pushing member of said actuator pushes said hook to move said hook to a position in which said hook engages said finger shaped engaging member.

9. A disk apparatus in accordance with claim 6, wherein, when said disk apparatus externally undergoes a impact rotation force at the time of non-operation, the tip of said arm of said inertia latch lever makes contact with said actuator to have a function to control the movement range of said actuator.

10. A disk apparatus in accordance with claim 8, wherein said airflow receiving portion of said inertia latch lever has a concave face corresponding with the shape of the outer peripheral portion of said disk to receive airflow generated by the rotation of said disk at the time of operation of said disk.

1 / 2 1

FIG. 1





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FIG. 7

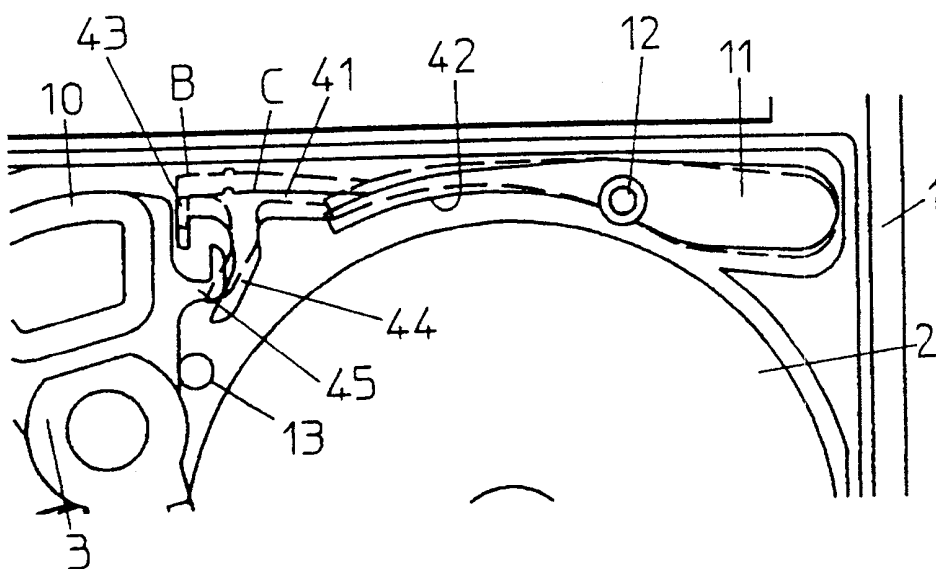
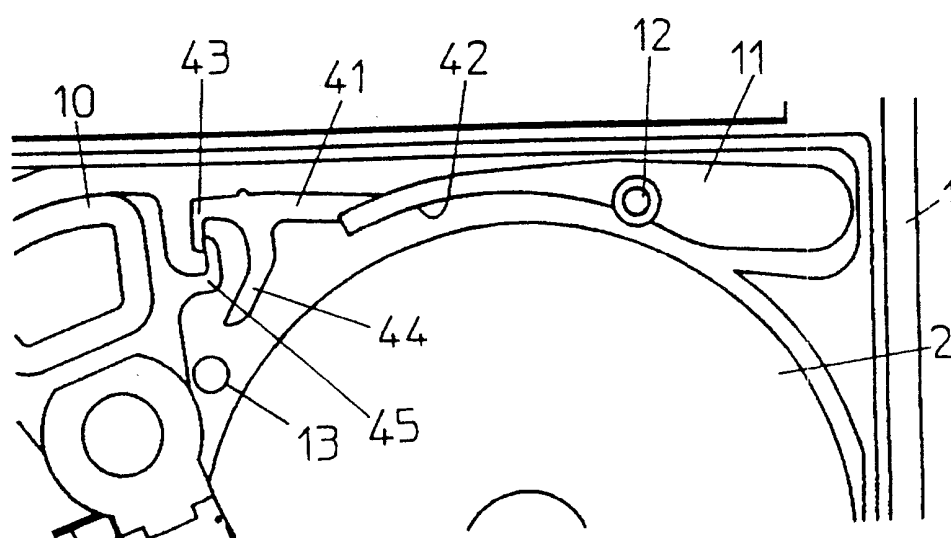
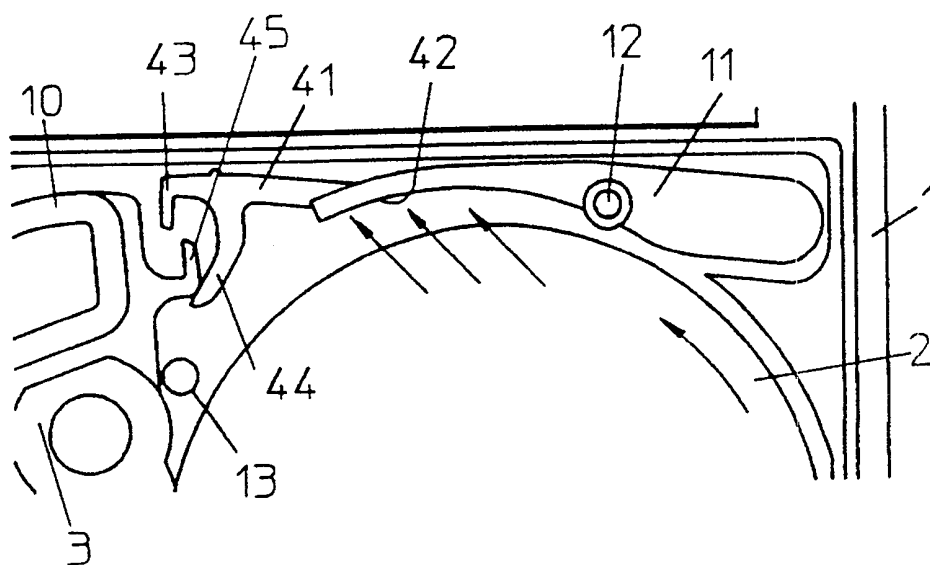


FIG. 8



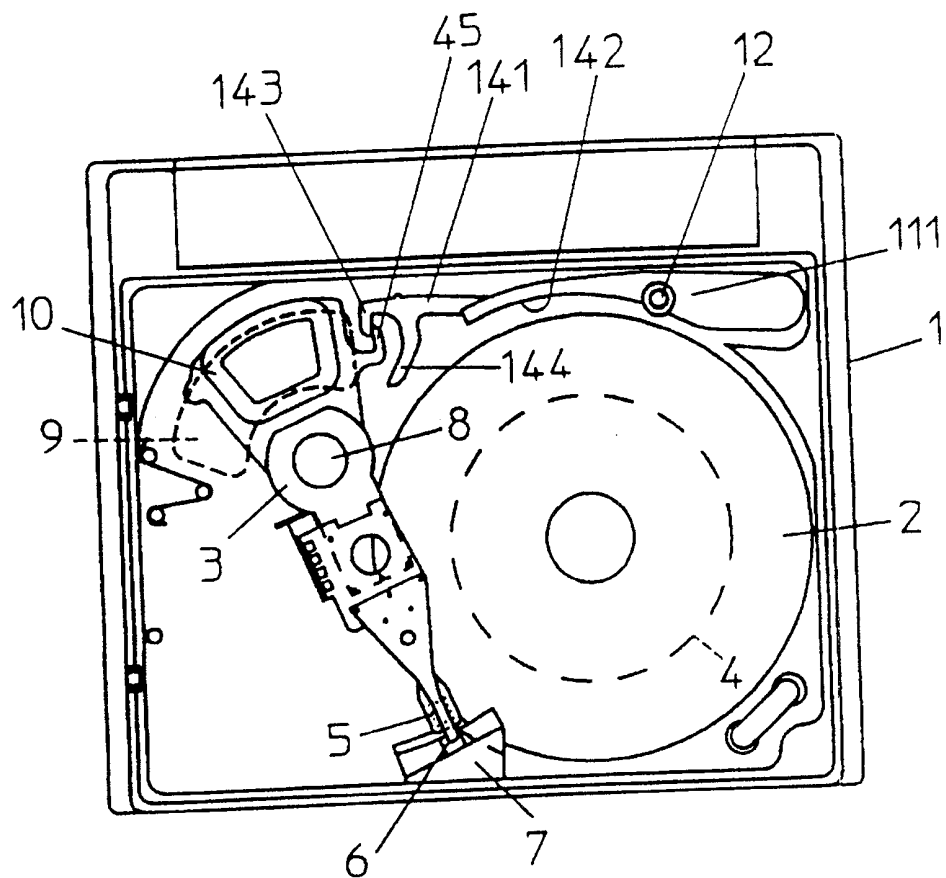
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FIG. 9



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FIG. 10



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FIG. 11

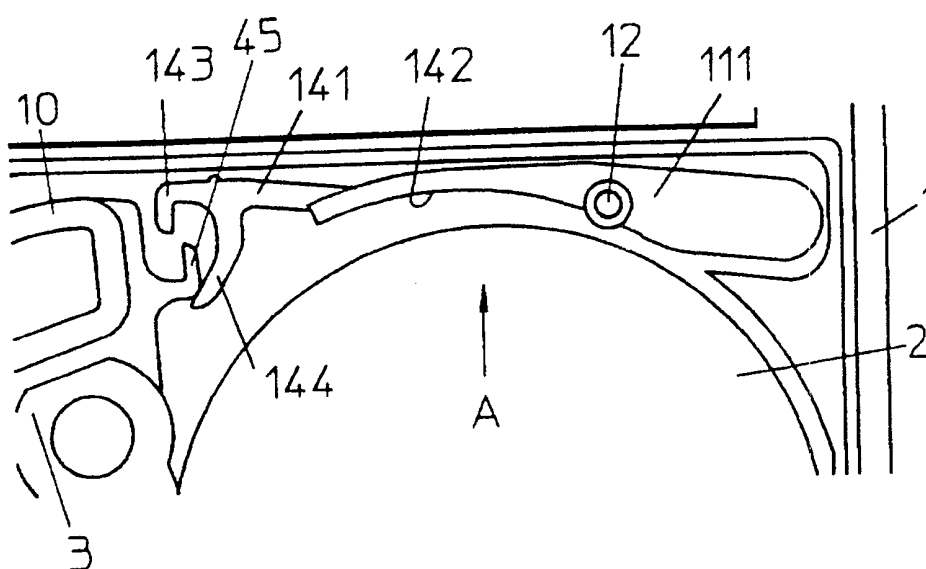
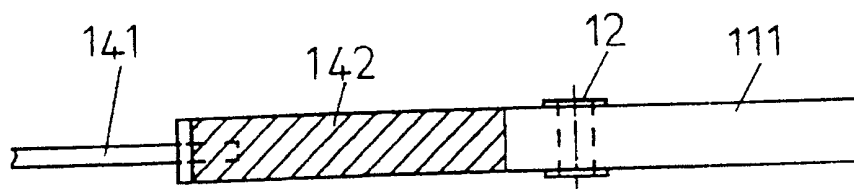


FIG. 12





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FIG. 13

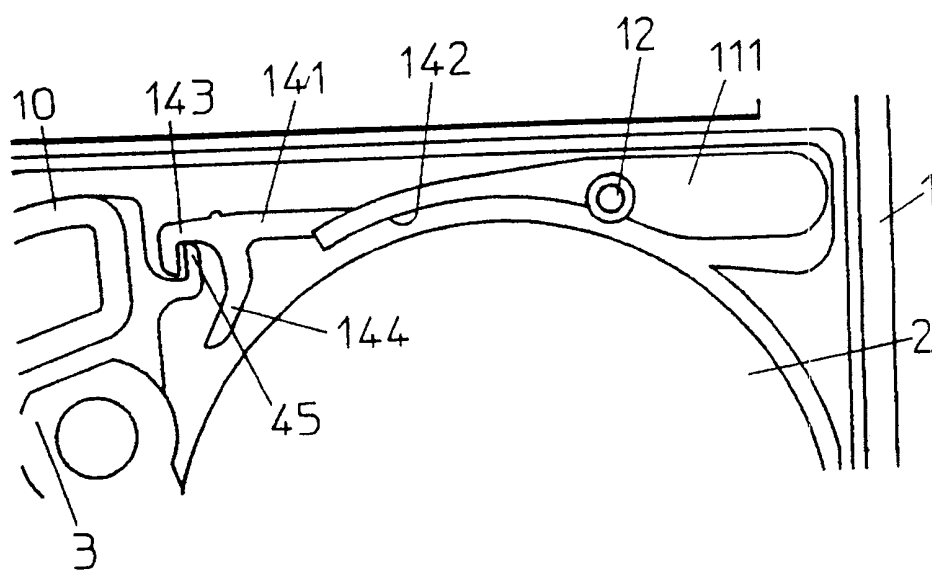
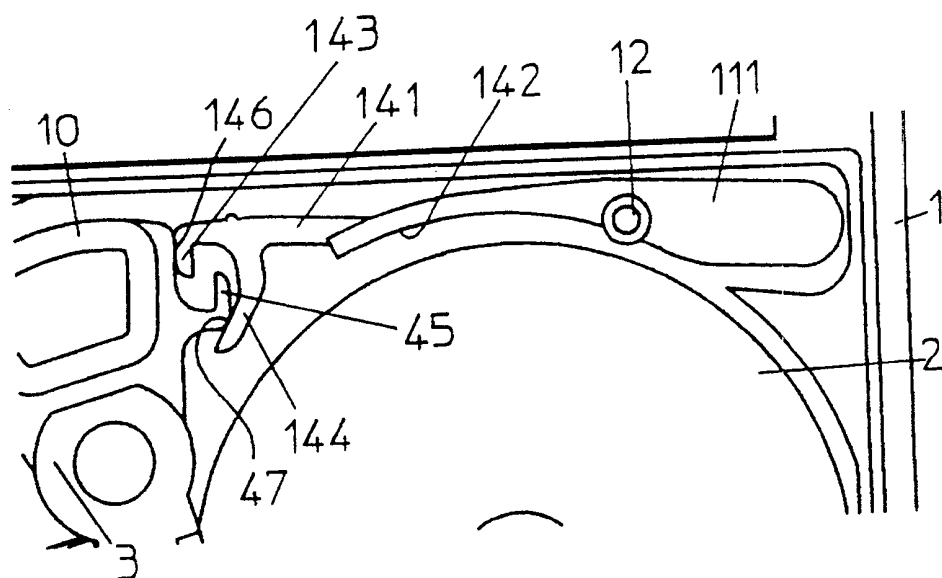


FIG. 14



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FIG. 15

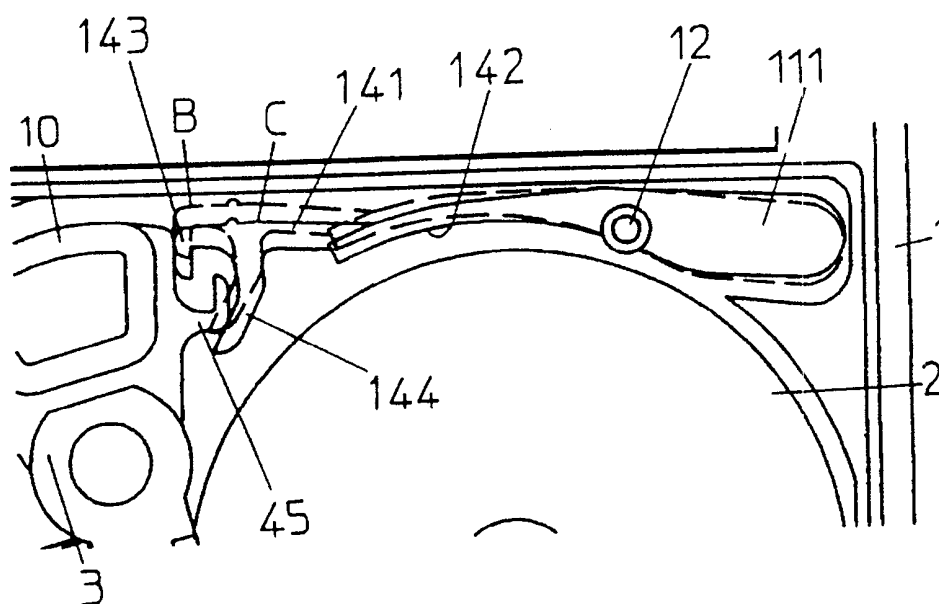
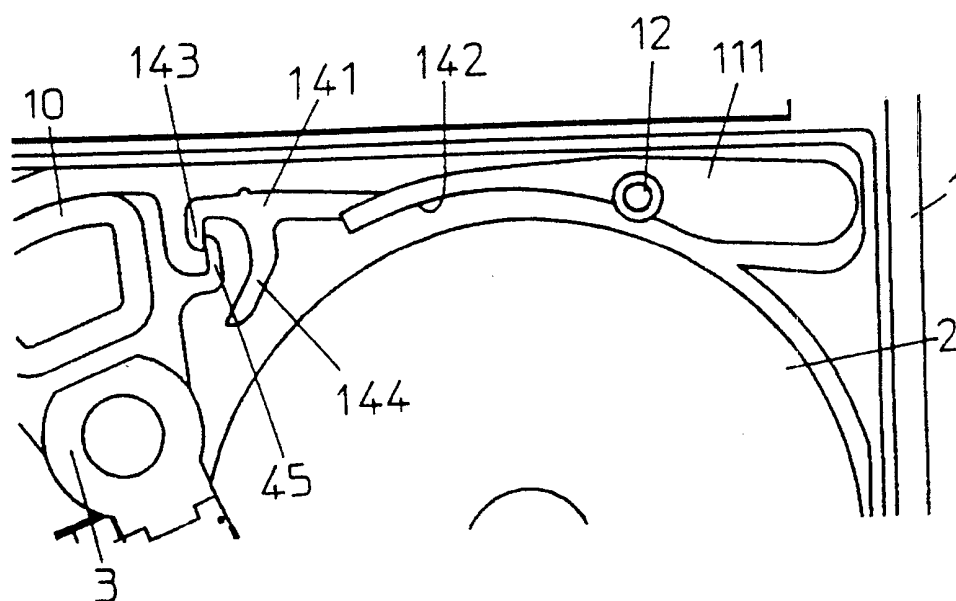
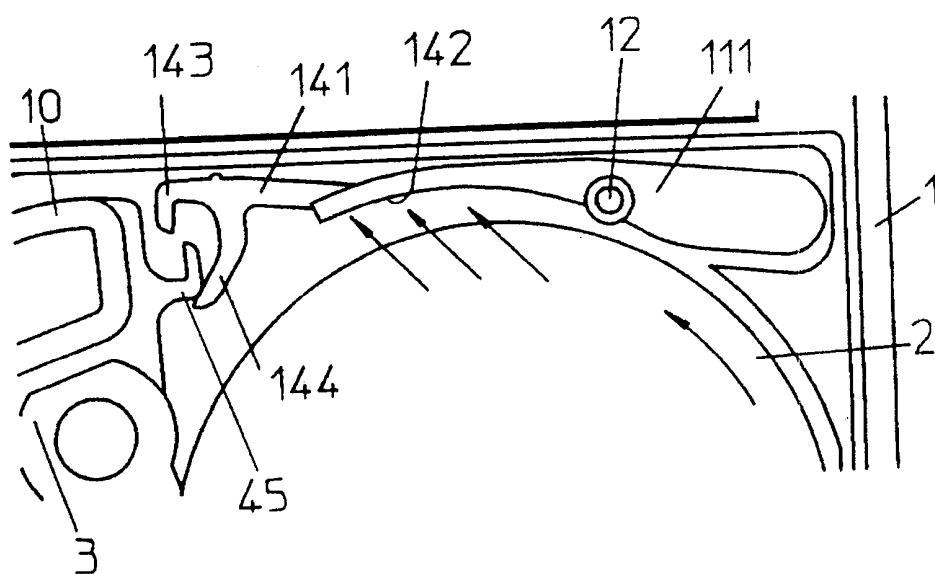


FIG. 16



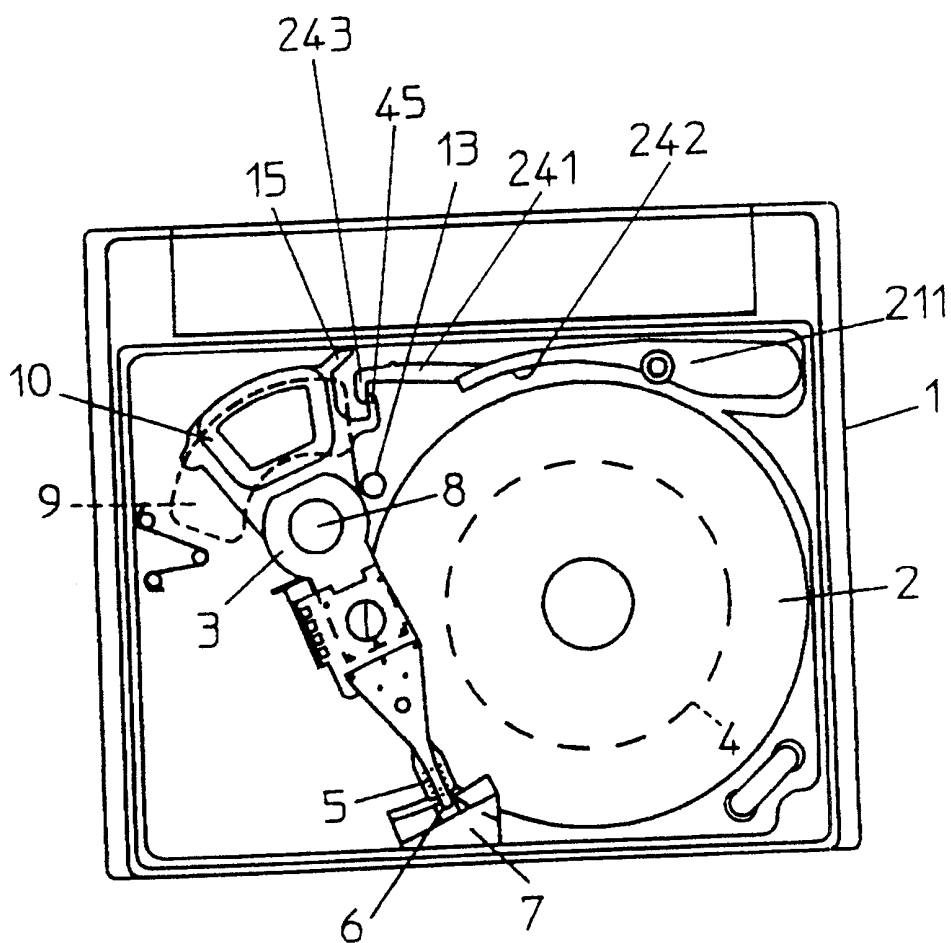
1 1 / 2 1

FIG. 17



1 2 / 2 1

FIG. 18



1 3 / 2 1

FIG. 19

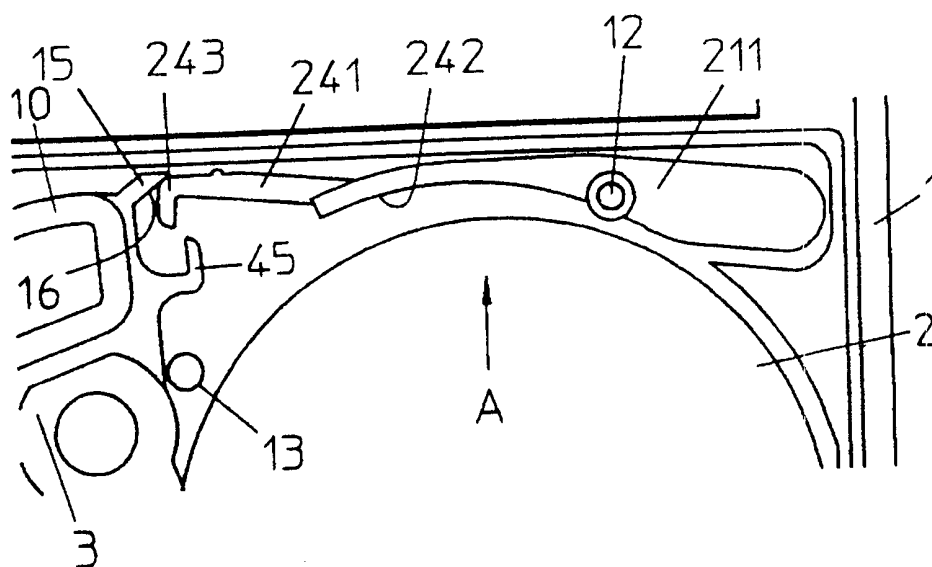
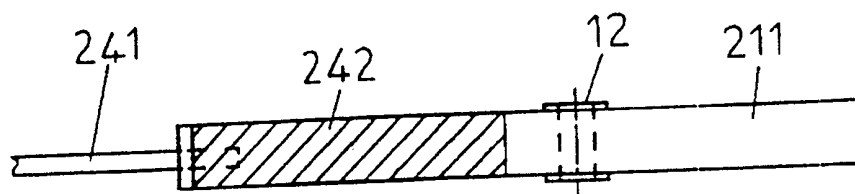


FIG. 20



1 4 / 2 1

FIG. 21

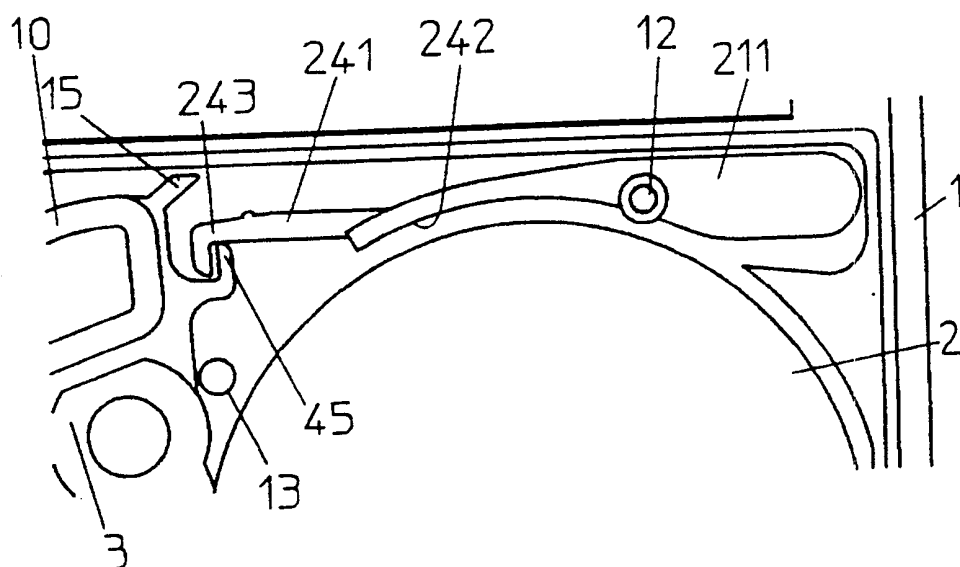
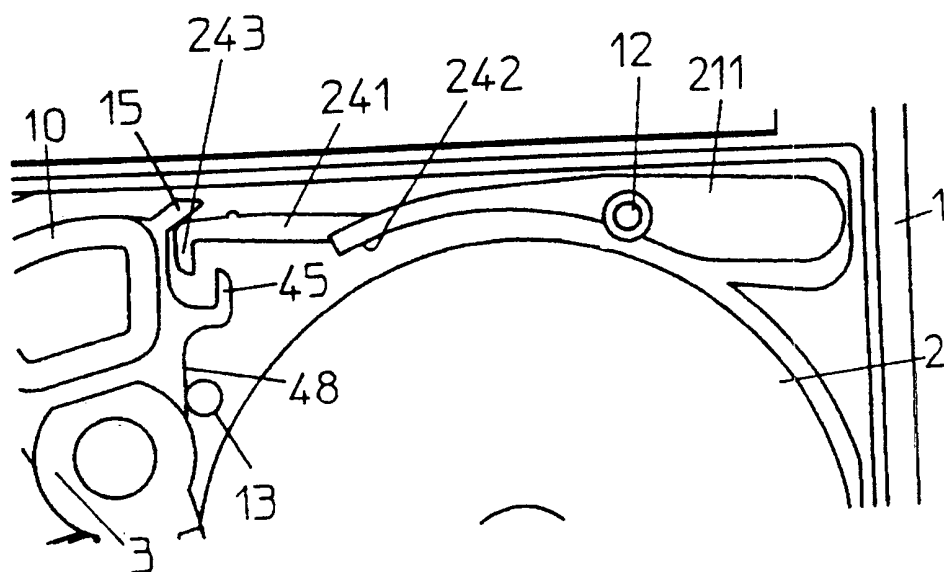


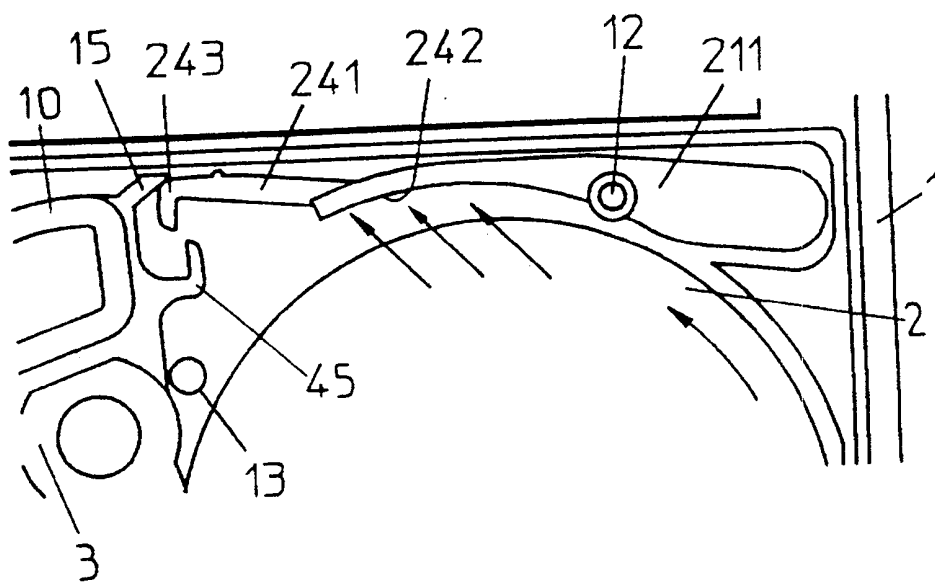
FIG. 22





1 6 / 2 1

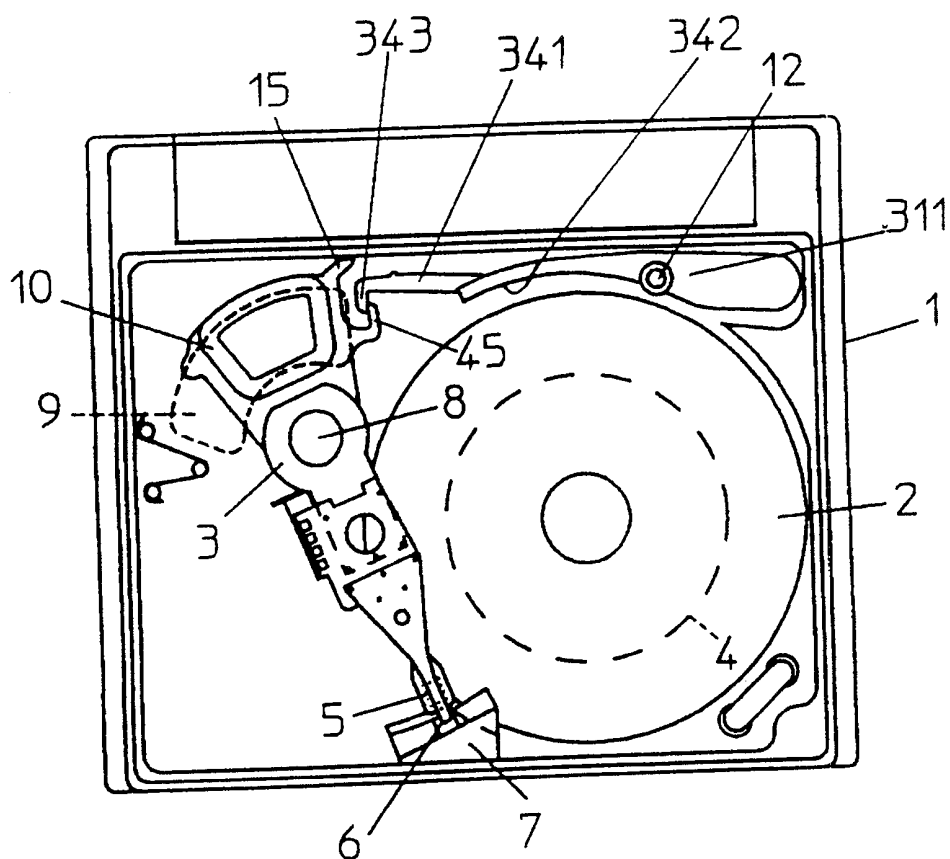
FIG. 25





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FIG. 26



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FIG. 27

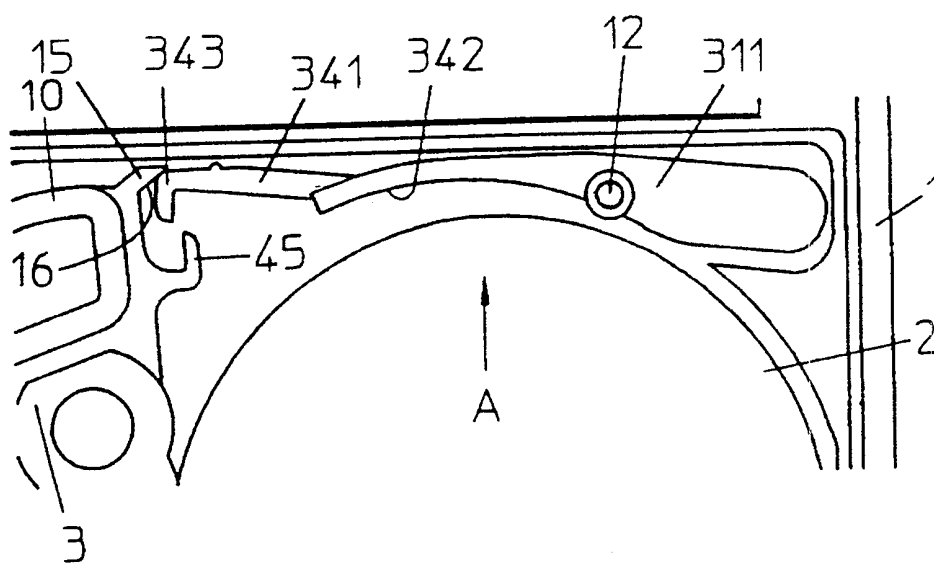
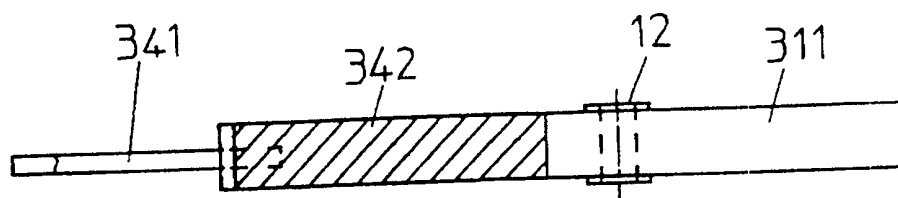


FIG. 28



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FIG. 29

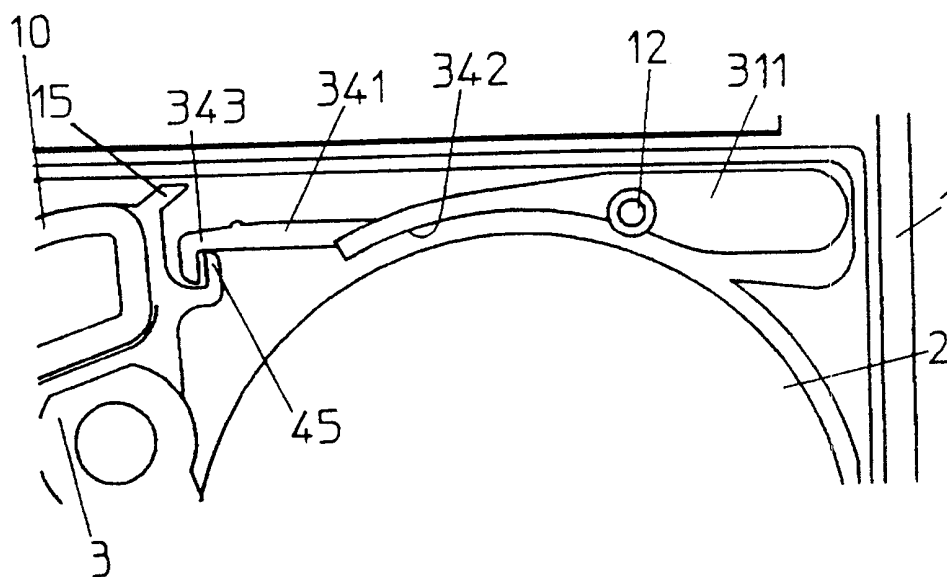
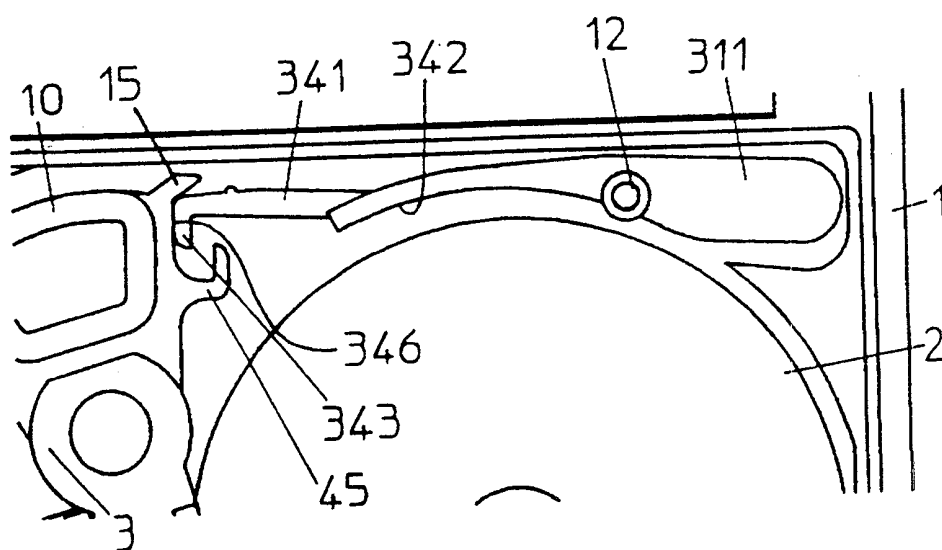


FIG. 30



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FIG. 31

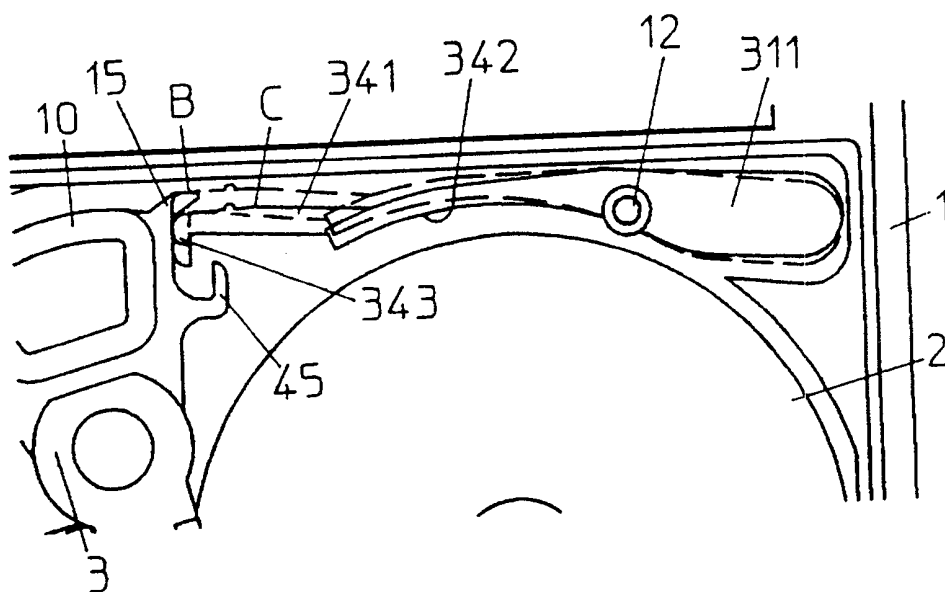
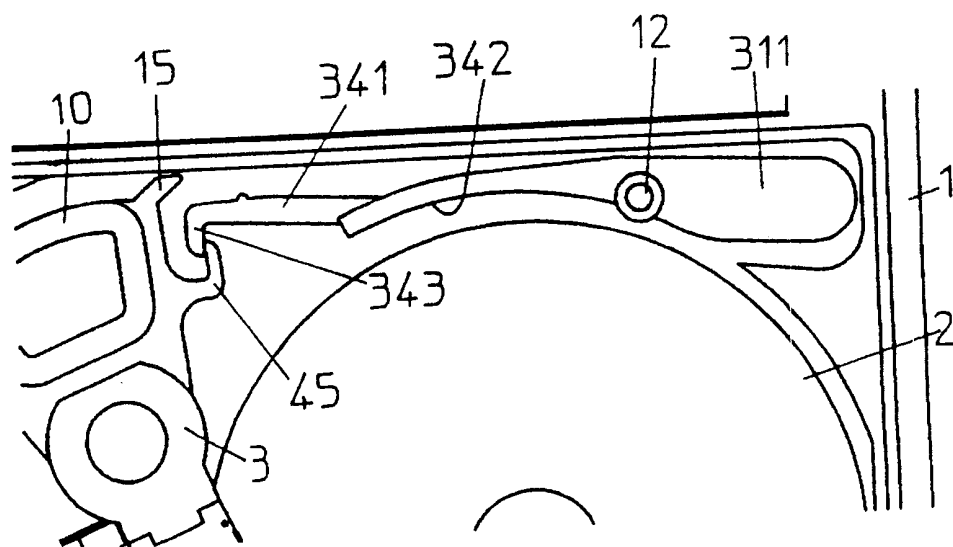


FIG. 32



2 1 / 2 1

FIG. 33

