EUROPEAN QUALIFYING EXAMINATION 2002

PAPER **A**
ELECTRICITY / MECHANICS

This paper comprises:

CLIENT'S LETTER

We, Rifle incorporated, are a major manufacturer of hard disk drives. We have specialised in products designed for portable computers. Power consumption and resistance to shocks are major concerns in this market segment. We already have a successful patented product that addresses these concerns.

Figures 1 and 2, taken from one of our published patents, are plan views from above of a disk drive 1 comprising a disk 2 with a data storage area 3 for storing information. A read/write head 4 is mounted on an actuator 5 which pivots about an axis 6. A magnet 7 and a coil 8 form a motor 9 for rotating the actuator 5 about the axis 6 so that the head 4 can be placed over selected positions of the data storage area 3 on the disk 2 for reading and/or writing information. The head 4 has a well-known aerodynamic design such that, when the disk is rotating, an air cushion forms under the head 4 to prevent it touching and scratching the surface of the data storage area 3. In the present example the disk 2 rotates counterclockwise in operation as represented by the arrow 16.

When the disk drive 1 is not in operation, the head 4 is parked in a parking zone 10 near the centre of the disk 2, outside the data storage area 3. In order to prevent the head 4 from leaving the parking zone 10, for example if the disk drive is subjected to external mechanical shocks, it is necessary to lock the actuator 5 so that the head 4 remains in the parking zone 10. To this end a lock 11 is provided. This lock operates without any electrical components, so that electrical power consumption is minimised.

Figure 1 shows a first state wherein the actuator 5 is locked and Figure 2 shows a second state wherein the actuator 5 is unlocked. The lock 11 is pivotally mounted about a pivot 14 and includes a first portion 12 in the form of an elongate wing and a second portion 13 having at its end an abutment 13a for contacting the actuator 5.

In the locked state, the abutment 13a contacts the actuator 5, preventing the actuator 5 from rotating clockwise and thus preventing the head 4 from leaving the parking zone 10. The lock 11 is biased in a counterclockwise direction about the pivot 14 by means of a spring 15 shown schematically in Figures 1 and 2. In this position the lock 11 blocks clockwise movement of the actuator 5.

When the disk 2 is rotating, a counterclockwise airflow is generated above the disk 2 as illustrated by the arrow 16. When the disk 2 reaches a predetermined rotational speed (typically 5400 revolutions per minute), the airflow acting on the first portion 12 of the lock 11 generates a force that exceeds the force exerted by the spring 15. As a result, the lock 11 rotates in a clockwise direction about the pivot 14 as represented by the arrow 30 in Figure 2. In this state the second portion 13 of the lock 11 is rotated away from the actuator 5 so that the actuator 5 is then able to pivot about its axis 6 for accessing the data storage area 3, as shown in Figure 2.

When the disk drive is switched off after use, the actuator 5 is driven to the parking zone 10 by the motor 9. The rotational speed of the disk 2 then diminishes, whereby the force exerted on the first portion 12 of the lock 11 by the airflow is reduced. As a result, the force exerted by the spring 15 rotates the lock 11 counterclockwise so that the second portion 13 moves back into contact with the actuator 5.

The mass distribution of the lock 11 is balanced with respect to the pivot 14 such that the lock 11 maintains its position when the disk drive is subjected to linear shocks. By a linear shock we mean a sudden and rapid linear (i.e. translational) movement of the disk drive.

However, we have found that in some instances, the disk drive can also be vulnerable to rotational shocks. By a rotational shock we mean a sudden and rapid rotational movement of the disk drive. When the disk drive is subjected to a counterclockwise rotational shock, the lock 11, due to its inertia, tends not to rotate with the remainder of the disk drive. The effect of this inertia can be significant enough to overcome the force of the spring 15, whereby the lock undergoes a relative clockwise rotation with respect to the remainder of the disk drive (which is rotating counterclockwise) such that the second portion 13 loses its contact with the actuator 5. The actuator 5 is then released, whereby a similar effect of inertia can cause the actuator 5 to undergo relative rotation about its axis 6. This causes the head 4 to skate over the data storage area 3 of the disk 2 with the risk of damaging the surface of the data storage area 3.

We have now improved our disk drive so that it may also resist rotational shocks. Figures 3 and 4 illustrate our new disk drive 20, Figure 3 illustrating the locked state and Figure 4 the unlocked state of the disk drive. Like components are given the sa reference numerals as in Figures 1 and 2.

In order to protect the disk drive against rotational shocks the disk drive of the invention includes a counter inertia member 17 rotatably mounted on a shaft 18 and a modified lock 21. The counter inertia member 17 and the lock 21 each have a mass distribution balanced about their respective axes of rotation so that the protection against linear shocks is not compromised.

The counter inertia member 17 has the form of gear wheel. The teeth of the gear wheel mesh with teeth of a corresponding gear segment 22 formed integrally with the lock 21. The configuration of the counter inertia member 17 is so chosen that the effect of the inertia of this member will balance the effect of the inertia of the lock 21 via the meshing gear teeth. This does not necessarily mean that the respective inertias of the counter inertia member 17 and the lock 21 have to be the same. However, the ratio of the inertias of the counter inertia member 17 and the lock 21 should be equal to the ratio of the radius of the gear wheel (counter inertia member 17) and of the radius of the gear segment 22 of the lock 21. The counter inertia member 17 moves with, and rotates in the opposite direction to, the modified lock 21

.The counter inertia member 17 does not play any active role in the unlocked state of the actuator 5 shown in Figure 4, ie. the counter inertia member 17 does not have any negative influence on the normal operation of the disk drive.

While meshed gears are employed to couple the counter inertia member 17 and the lock 21 in the present example, other coupling arrangements may be employed, such as friction coupling.

We should also mention that the various rotational directions described relate to our specific embodiment. In other embodiments, for example, the disk 2 could be arranged to rotate clockwise. Also, some of our competitors make disk drives with the parking zone at the outer periphery of the disk 2 rather than near its centre.

For your information we attach the published document D1 which describes a locking device used in the current products of our major competitor, Dissdur.

CLIENT'S DRAWINGS

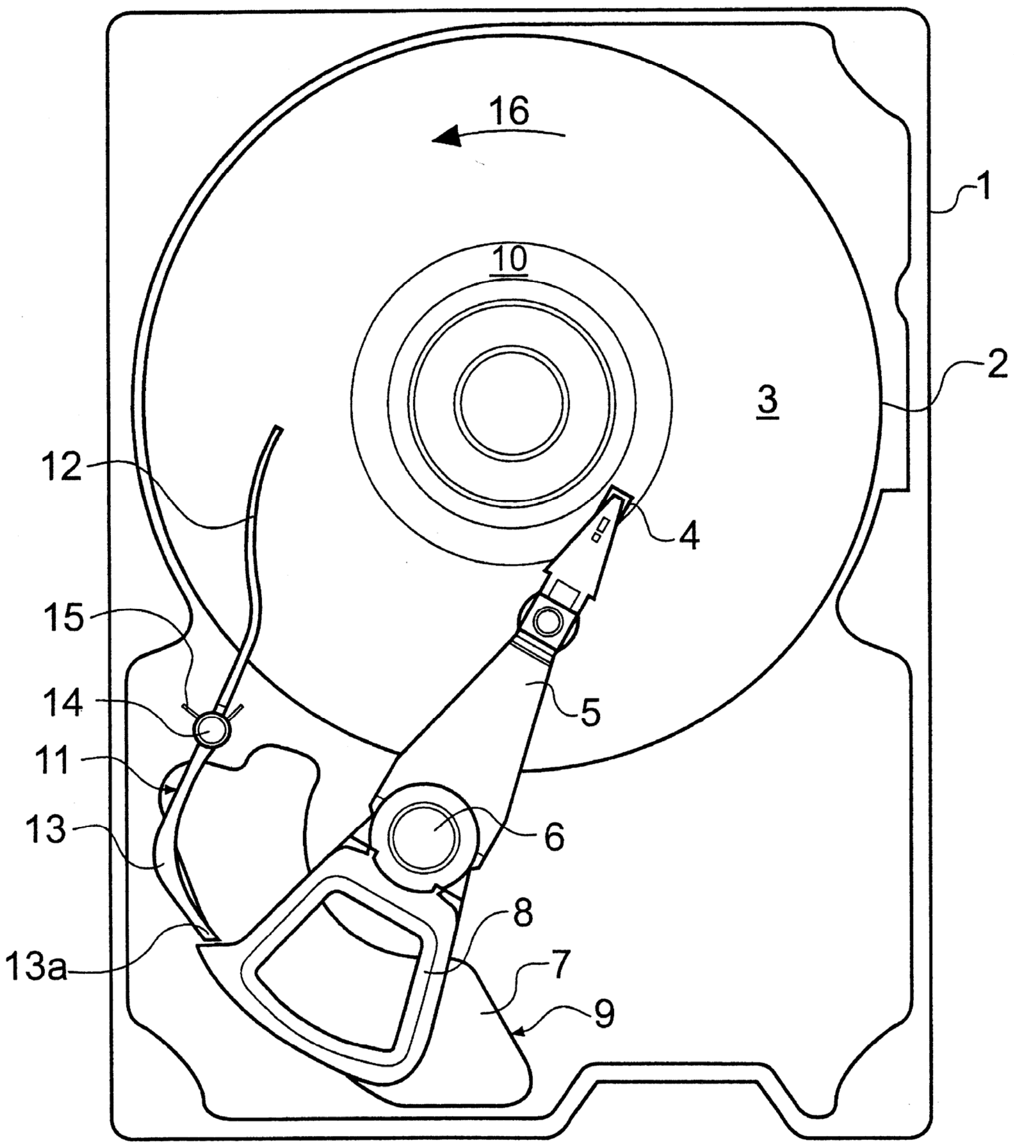

Fig. 1
(Stand der Technik)

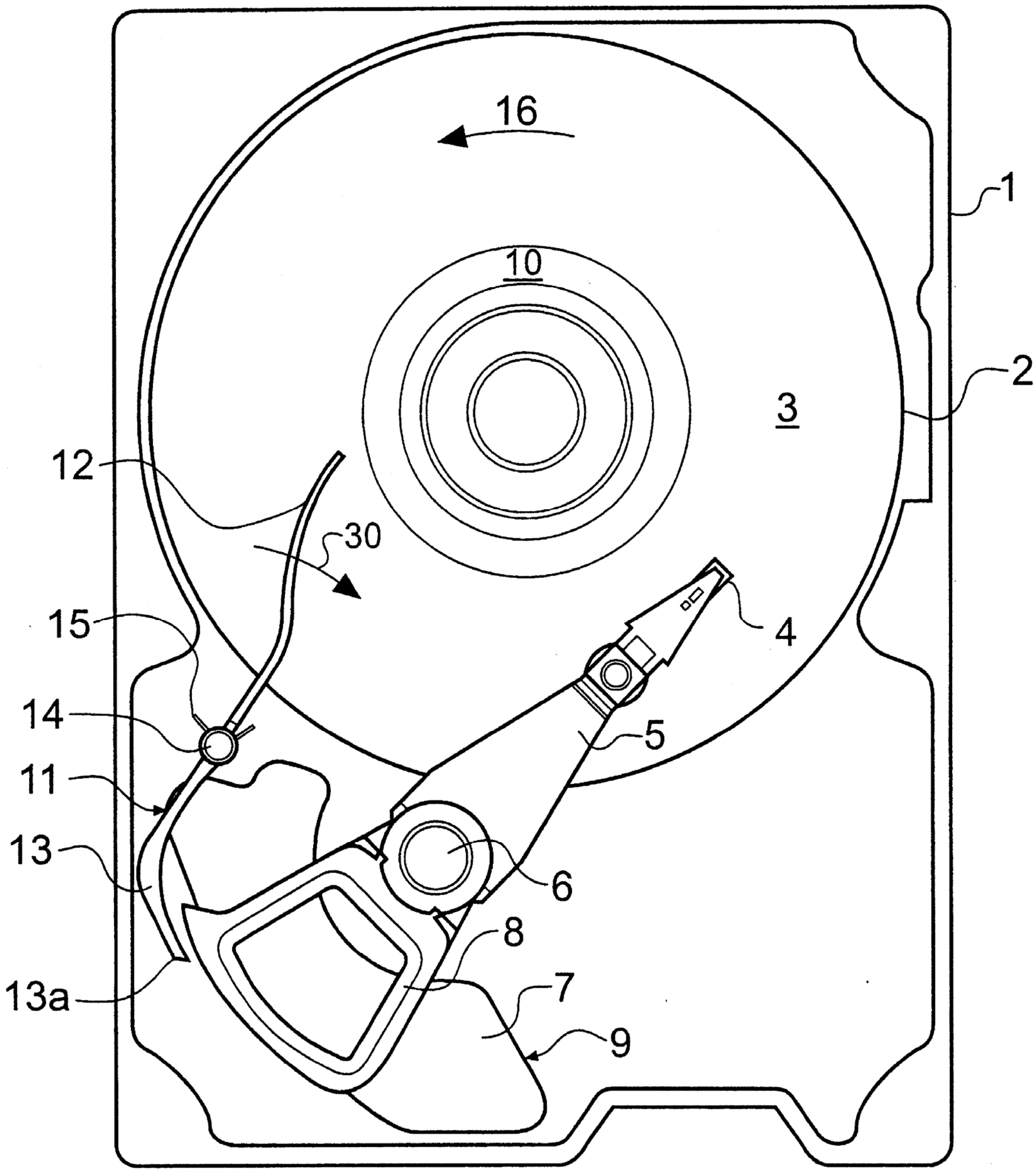

Fig. 2
(Stand der Technik)

CLIENT'S DRAWINGS

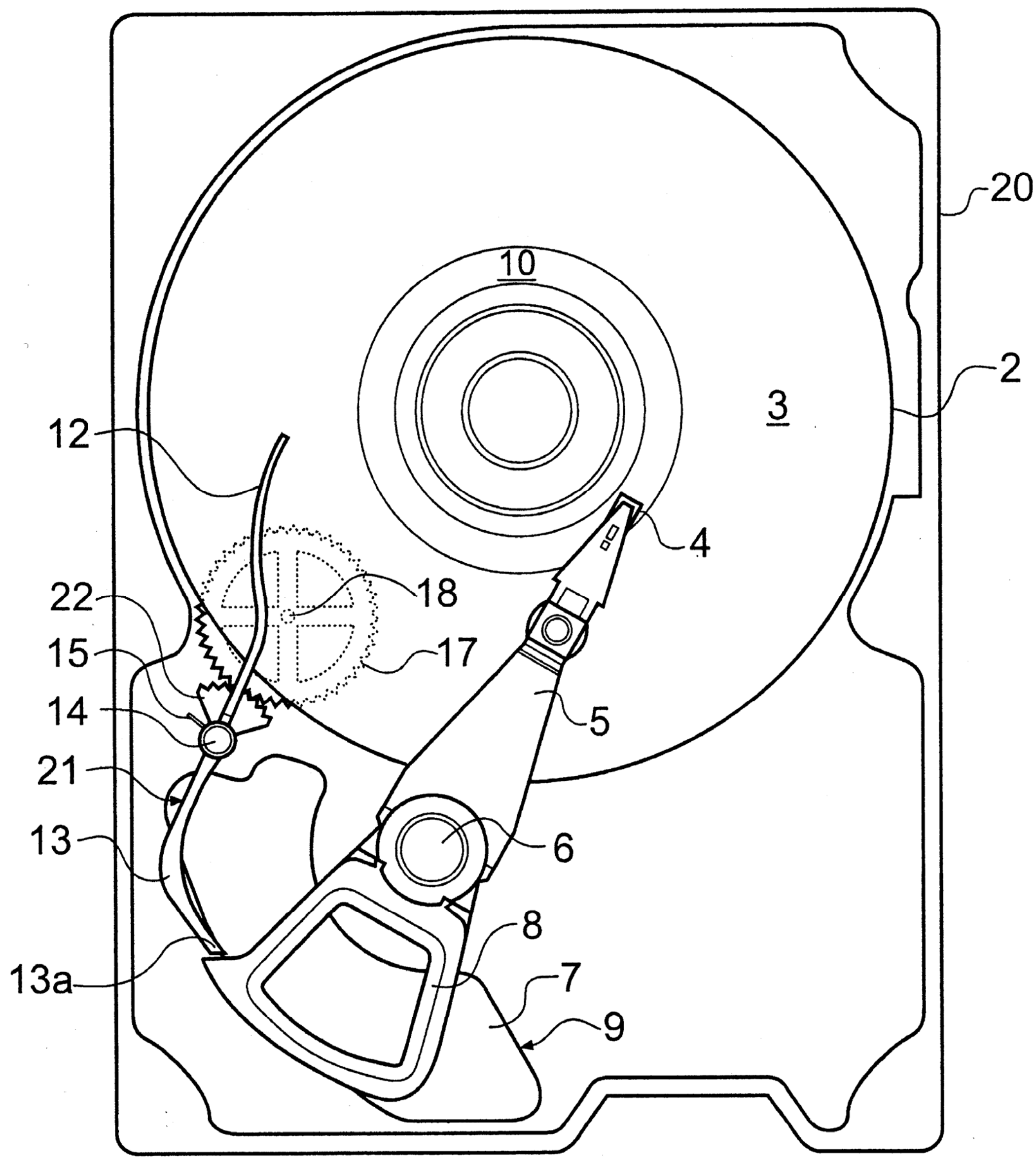

Fig. 3

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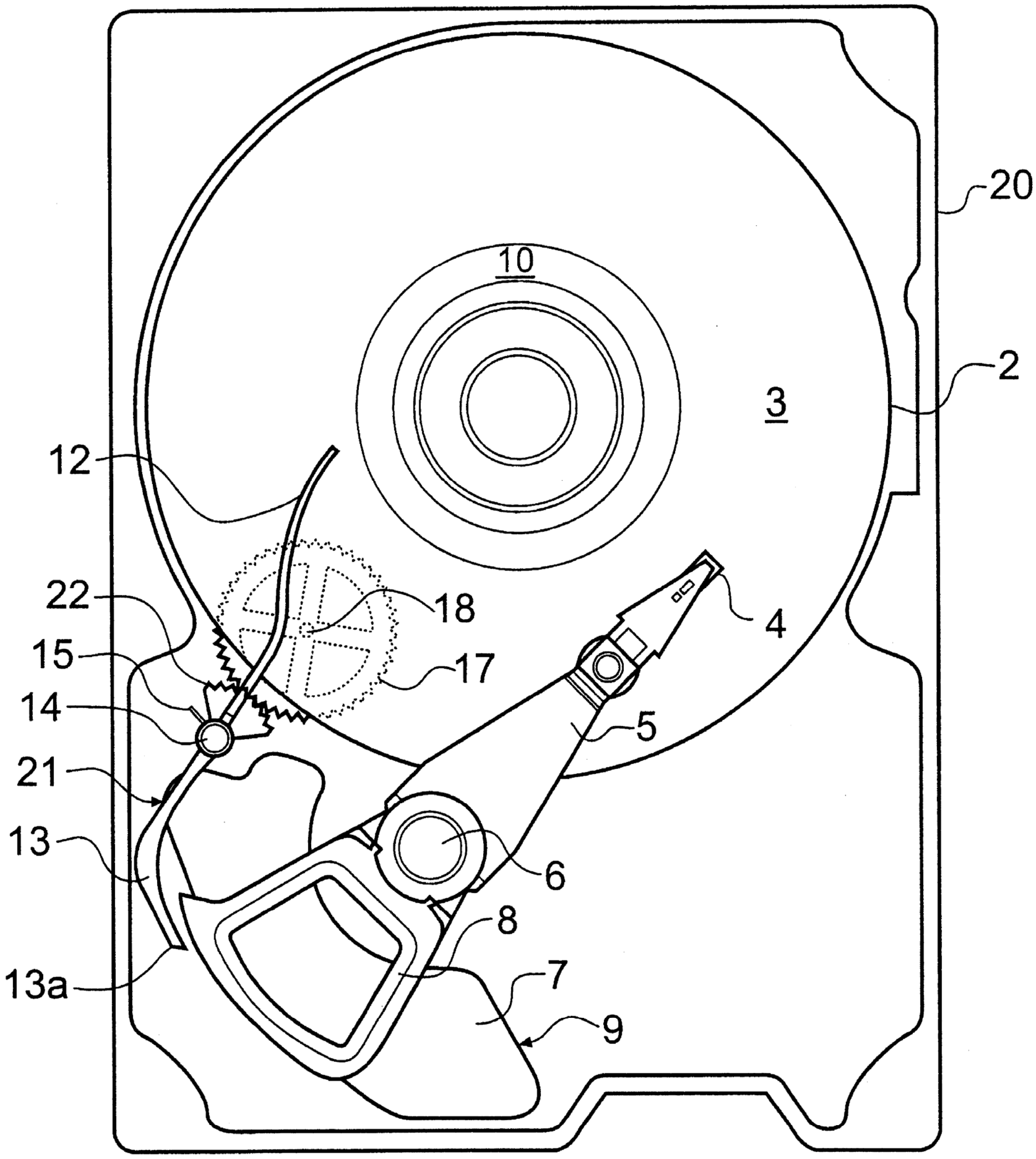

Fig. 4

DOCUMENT D1

In computer systems, information is frequently stored in a magnetic film on the surface of a hard or flexible disk. The information is stored in concentric tracks in the magnetic film, and is written on or read from the film by means of a magnetic head mounted on the end of a rotary actuator. When writing or reading data, the magnetic head rides on a thin laminar layer of air over the rapidly rotating disk, thereby avoiding direct contact with the magnetic surface.

When the disk drive is not in operation, the head rests in a "park" position, that is, a position on a "non-data" zone of the disk which is reserved for landings and take-offs of the head. It is important that the head be held in its park position, as any physical contact between the head and the data zone of the disk may damage the magnetic film.

Rotary actuators are particularly vulnerable to rotational shocks and acceleration, which can cause the rotary actuator to swing about its axis out of the park position, thereby bringing the magnetic head in unwanted contact with the disk. A lock for reducing the chance of damage resulting from rotational shocks is described in the following.

Fig. 1 is a top view of a disk drive with an inertial lock.
Figs. 2 and 3 show a portion of a rotary actuator in the operational and locked states, respectively.

The actuator 1 shown in Figure 1 is rotatably driven about an axis 2 by means of a motor constituted by a coil 3 and a magnet (not shown). The motor rotates the actuator 1 to position the magnetic head 4 over a desired location on the disk. An inertial lock 6 is positioned adjacent the actuator 1.

Figure 2 shows the inertial lock 6 in an unlocked condition. An inertia member 8 is rotatably mounted about a shaft 7. A pin 9 is attached to the surface of the inertia member 8. In the operational state of the actuator 1 the inertial lock 6 is in its rest position which is determined by means of a helical spring 10 extending between a fixed pin 11 and a pin 12 located on the inertia member 8. A finger 13 protrudes from the actuator 1 and is so arranged that, when the actuator 1 is in the park position, the locking pin 9 is

able to engage the inner surface 14 of the finger 13 to block clockwise rotation of t
actuator 1.

If the disk drive is submitted to a counterclockwise rotational shock, the actuator 1, due to its inertia, tends to maintain its absolute position in space or, in other words, the actuator 1 rotates in a clockwise direction relative to the disk drive. The inertial lock 6 overcomes the force of the spring 10 and also rotates in a clockwise direction relative to the disk drive. The inertial lock 6, however, responds to the rotational shock much quicker than the actuator 1, whereby the inertial lock 6 rotates before the actuator 1 has hardly moved. Due to the rotation of the inertial lock 6, the pin 9 moves through an angle β as shown in Fig. 3 until it strikes the inner surface 14 of the finger 13. In this position, the pin 9 blocks any clockwise movement of the actuator 1 relative to the disk drive.

Following the shock, the spring 10 urges the inertial lock 6 back to the unlocked position shown in Figure 2.

It can be seen therefore that the inertial lock 6 activates in response to a counterclockwise rotational shock. There is no need to provide a lock activated in the case of a clockwise shock since in this case the head does not leave the non-data zone. Besides, in most of the known disk drives, the movement of the actuator from the park position towards the centre of the disk is limited by stop members (not shown). Stop members are also generally provided to prevent the head from moving outwardly beyond the disk outer circumference.

If desired, additional measures could be taken to protect against linear shocks.

DRAWINGS DOCUMENT D1

1/2

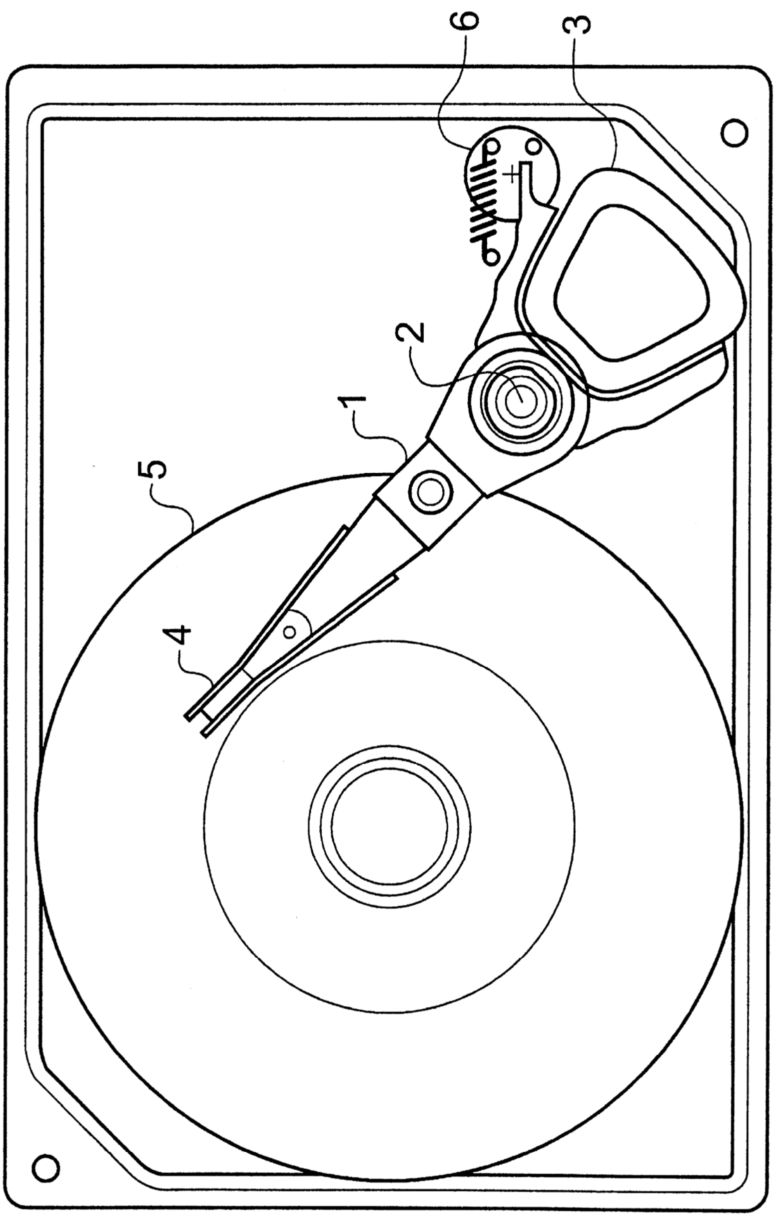

Fig. 1

DRAWINGS DOCUMENT D1

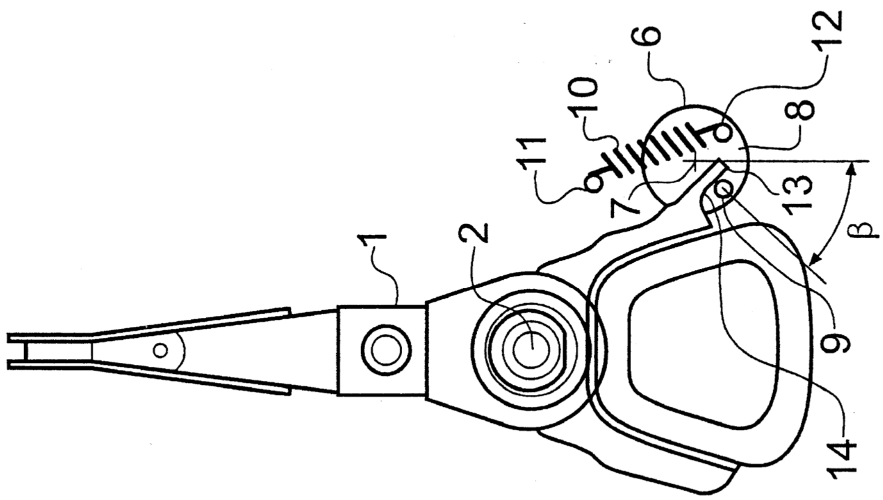

Fig. 3

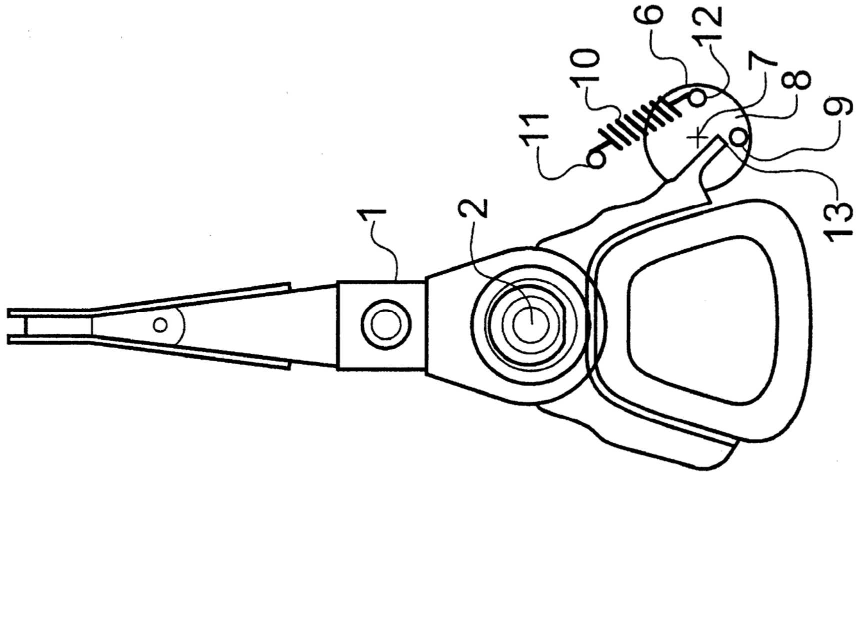

Fig. 2