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ANTI-ROTATION AIR VANE INERTIA LATCH

The present invention relates to a latch system for use in a disc drive.

It is known in the art that air flow is generated incident to the rotation of data storage discs in a disc drive. The characteristics of the air flow have been analysed and discussed in the prior art, see for example, U.S. Patent 4,647,997 to Westwood and the IBM Journal of Research and Development, November 1974, pages 480-488. It is known that two commonly mounted spaced apart rotating discs generate a significantly greater air flow than generated by a single rotating disc, and that the amount of air flow is also known to be a function of disc diameter and angular velocity. The air flow force is greatest adjacent the periphery of the rotating disc and especially at the region defined between two rotating discs, and falls off rapidly as a non-linear function as one moves away from the disc periphery.

In rotating, non-removable data disc storage devices, a data read/write transducer files upon an air cushion or bearing in extremely close proximity to the data surface. In many disc drives, including those which are of extremely small size, the transducer lands upon and takes off from a particular predefined landing region. It is possible, when shocks are applied to the disc drive, that the transducer can move or bounce across the surface of the disc, causing erosion or scarring of the magnetic film coating on the disc surfacing leading to hard and soft data failures. In addition, the hard transducer head may dent the surface in response to sharp jarring forces attributable to sharp or rough handling of the drive.

While aerodynamically actuated latches have been described in the above referenced Westwood patent as well as in U.S. Patent 4,538,193, such latches have not been effective because of a lack of the sensitivity and responsiveness to the limited air flow in extremely small size disc drives. It has been found that the air flow values in such small disc drives must be carefully accounted for and are,

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in many cases, too small in magnitude to effectively, reliably and responsively release the actuator when the discs begin rotation. Further, the spring force that restrains the transducer actuator assembly in the landing zone must be carefully selected so that the force can be overcome when the discs begin to move.

Thus, a need has arisen for a reliable, responsive, air flow responsive latch mechanism responsive to the air flow generated in a small form factor disc drive to reliably latch and release the actuator mechanism, while restraining the actuator against relatively strong shocks.

U.S. Patent 4,692,829 to Campbell discloses an aerodynamically actuated latch in which an air vane part of the latch extends between two discs of a disc drive assembly.

A general object of the present invention is to overcome limitations and drawbacks to prior art aerodynamically operated latches for transducer actuated assemblies in a disc drive.

A further object of the invention is to provide an effective aerodynamic transducer latch mechanism within the confines of a miniaturised disc drive structure.

Another object of the present invention is to provide an effective, aerodynamically responsive transducer latch which is capable of reliably holding the actuator arm from uncontrolled movement away from a landing zone position in response to significant shocks of up to 80-100 Gs.

Another object of the present invention is to combine a low cost, low-mass non-electrically powered latch mechanism cooperating with a disc drive actuator arm such that while the mass of the latch mechanism is significantly less than the mass of the actuator arm, the latch mechanism is capable of effectively restraining the arm against movement.

Another object of the invention is to adopt a design of an aerodynamically effective latch mechanism which fits very closely adjacent to or even has parts of

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the mechanism disposed beneath the rotating disc such that a minimum amount of housing area needs to be devoted to the latch mechanism.

A further object of the present invention is to provide a latch mechanism which when its restraining arm is latched against the actuator arm, provides the restraining force in a direction almost directly parallel to the direction in which the actuator arm will attempt to move so that a maximum restraining force can be applied to the actuator arm.

Another objective of the present invention is to provide an aerodynamically responsive latch mechanism which is incorporated within the confines of the predefined housing without adaptation of the design of the housing to accommodate the latch.

According to the one aspect of the present invention, there is provided a latch system for use in a disc drive, the latch system comprising a latch arm having an engagement portion for engaging a transducer support arm of the disc drive to substantially prevent movement of the transducer support arm, and a vane characterised in that the vane is located at a distance from the centre of a disc of the disc drive which is greater than the radius of the disc, and in that the latch arm and vane are arranged such that, in the presence of disk rotation-generated wind pressing against the vane, the vane moves away from the disc and the engagement portion disengages the transducer support arm.

According to another aspect of the present invention, there is provided a latch system for use in a disc drive, the latch system comprising a latch arm having an engagement portion for engaging a transducer support arm of the disc drive to substantially prevent movement of the transducer support arm, and a vane, characterised in that the vane is located adjacent a space between two discs of the disc drive and in that the latch arm and vane are arranged such that, in the presence of disk rotation-generated wind pressing against the vane, the vane

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moves away from the disc and the engagement portion disengages the transducer support arm.

The aerodynamically powered latch of the present invention may be incorporated in a disc drive which includes a base casting defining a chamber, and a plurality or at least two rotating data storage discs journaled for rotation relative to the base casting in response to a spindle motor. A transducer actuator assembly may be mounted in the chamber adjacent the rotating discs and supports data transducer heads in close proximity to the major data surface of each of the discs, and moves the heads from track to track over the surface of the disc. An innovative latch mechanism may be provided comprising a latch journaled for rotation immediately adjacent the disc and comprising a latch arm extending substantially perpendicular to the direction of movement of the actuator arm when the actuator arm is at rest with the transducer resting on the landing zone. The arm may have a finger at one end thereof engaging a notch on the radius of the actuator arm pivot region immediately adjacent the centre of rotation of the actuator arm. A wind vane support arm extending in the opposite direction from the centre of rotation of the aerodynamically powered latch may comprise an upright flag member adjacent a space between the two rotating discs and may have a finger supported near the bottom of the flag and inserted in the region between the discs so that air flow generated by rotation of the discs may press against the wind vane and cause the vane to move around its centre of rotation away from the edge of the rotating discs. In this way, rotation of the discs causes the latching finger to move away from the notch on the axis of rotation of the actuator arm releasing the actuator arm for movement of the transducer across the surface of the disc.

The flag finger may be supported on the surface of the flag close to a base housing of the disc drive.

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The aerodynamic latch may further include a coiled spring having at least one end supported from the housing of the disc so that the force of the spring establishes a biasing force of the latching arm of the aerodynamic latch toward the engagement notch on the periphery of the actuator pivot, the force of the biasing spring being defined to be less than the effective force created by the rotation of the discs at normal speed to allow use of the disc drive.

Preferably, the wind vane flag is shaped to follow the contour of the edge of the rotating discs, and has one end extending near to the sidewall of the housing to capture the maximum amount of effective windage generated by rotation of the disc.

In a preferred embodiment of the present invention, a supporting bracket for the aerodynamically powered latch supports the top and bottom of a pin defining the centre of rotation of the latch to define a consistently vertical axis of rotation for the latch, the support bracket further including an upright arm adjacent the extending finger of the windage responsive flag so that the wind responsive flag may be mounted immediately adjacent the curved surface of the discs without creating a likelihood of contact between the wind vane and the edge surface of the discs.

The latch system may releasably lock a disc drive actuator at a fixed position during power down conditions. The latch may withstand considerable shock without allowing the actuator to be dislodged, thereby preventing damage to data storage discs having magnetic storage media coated or deposited thereon. Further, the latch arm may be released automatically in response to the aerodynamic force generated by rotation of the storage disc, and may latch and recapture the transduce support arm and hold the arm and transducer supported thereby in fixed position.

Other objects, advantages and features of the present invention will be better understood and appreciated from a thorough consideration of the following

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detailed description of a preferred embodiment presented in conjunction with the accompanying figures.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:-

FIGURE 1 is a diagrammatic enlarged top plan view of a miniaturised disc drive incorporating some of the principles of the present invention with the latch being shown in the engaged position;

FIGURE 2 is a partial top plan view of the disc drive of Figure 1 with the latch being shown in the disengaged position and the actuator arm having moved the transducer from the landing region of the disc across the surface of the disc;

FIGURE 3 is a an exposed view of various parts of an effective aerodynamically powered wind vane latch;

FIGURE 4 is an exposed view of the wind vane from a different perspective than that shown in Figure 3 and a biasing spring shown adjacent the wind vane to define the manner in which the spring is mounted within the wind vane;

FIGURE 5 is a partially sectional elevational view along the line 5-5 of Figure 1; and

FIGURE 6 is a graph depicting the relationship between the torque of the spring and the torque of the aerodynamic wind vane and the relative relationship therebetween in establishing a proper balance of the forces necessary to provide an operative wind vane latch.

A miniaturised disc drive 1 is illustrated in the enlarged plan view of Figure 1 and the broken away plan view of Figure 2.

Figure 1 further shows in a plan view the basic elements of the latch design with the vane in the latched position. This figure should be contrasted with the view of Figure 2 wherein the disc 10 is spinning in the direction indicated by the arrow A, the spinning disc creating a moving sheet of air which acts against the air vane flag 66 with sufficient force to unlatch the actuator arm assembly 40

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The disc drive includes a unitary housing 3, and a disc spindle 5 having an ; of rotation indicated at 7. The spindle 5 is coupled directly to an :tronically commutated brushless DC spindle motor (not shown) supported n the base casting 4 and rotating at a constant speed to rotated the data storage : 10 in the direction of the arrow A. The rotation is in a counterclockwise ction, as indicated by arrow A, and occurs at a predetermined and constant ular velocity.

The data storage disc 10 provides data storage surfaces on the data storage ons on tracks generally indicated at 20 on the upper and lower surfaces of the : 10. The surfaces are characterised by the presence of suitable magnetic age media, which may be such materials as are well known in the art, which coated, plated or deposited on the surfaces of the disc. The disc 10 in the iaturised mechanism generally indicated at 3 is preferably about 47 imetres in diameter. Typically the disc drive is capable of storing at least roximately 40 megabytes of formatted user data on the surfaces 22, 24, 26, 28 liscs 10, 30, incorporated in the disc drive and shown in the vertical sectional w of Figure 5.

A rotary actuator arm assembly 40 is provided which is bidirectionally :table and is journaled to the base casting 4 about an axis of rotation 42. The iator arm assembly 40 rotates bidirectionally in a range of movement along an of approximately 30° as indicated by the arrow C in Figure 1. The actuator ı assembly 40 includes a coil (not shown) adjacently overlying a magnetized permanent magnet in the region generally indicated at 44. :rgisation of this coil causes selective movement of the actuator arm along the irectional path indicated by arrow C to move a transducer support arm 46.

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head type which causes a transducer to fly as close as 15 microinches above the data surface on an air bearing or cushion of air resulting from disc rotation.

The actuator assembly in the embodiment of this invention further includes a notch 50 adjacent the centre of rotation of the transducer support arm 46; this notch is engaged by the latch finger 61 of latch engagement arm 64 of the aerodynamic latch 60 to hold the actuator arm 40 in a defined location relative to the disc 10 when the disc drive is not in use. Latch finger 61 is shown in figures 1-5.

Each data storage surface has multiple, typically 612, concentric annular data tracks. An inner landing zone generally referenced at 52 comprises a region devoted to landing and takeoff of the transducer slider assembly 48. The remaining region of the surface of the disc which comprises the concentric annular data tracks and is accurately accessed by movement of the actuator arm assembly 40 to cause the transducer slider assembly 48 to be located over one of the data tracks. When the disc drive is no longer in use, then the actuator arm is caused (by means not shown but which are well known in this technology) to move the transducer slider assembly 48 to land over the landing zone 52 and rest on the surface of the disc 10. At this point, the latch engagement arm 64 of aerodynamic latch 60 engages the notch 50 so that in the event of even a severe shock to this small disc drive, the transducer cannot be dislodged and slide across the surface of the disc, causing damage to either or both of the surface of the disc and the transducer.

The latch 60 is shown in the latched position in Figure 1 and in the unlatched position where the actuator arm is free to move the transducer from track to track in Figure 2. As can be seen by comparing the two figures, the latch 60 comprises as its primary moving element a double-ended air vane 62 comprising an engagement or latching finger arm 64 and a flag arm 65 with an upwardly extending flag 66. The latching finger arm 64 and rigid flag 66 are at

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opposite distal ends of the vane 62 which itself is journaled about a post 68 having an axis of rotation 70. Post 68 is in turn fixed to the base casting 4 as shown in Figure 5. It should be noted that all of these elements of the latch are shown clearly in an exploded view in Figure 3.

The latch 60 is journaled about the post 68 by means of a cylindrical shaft 72 shown most clearly in Figure 4; this allows the latch 60 to move freely as the disc drive is started and stopped.

Specifically, when the disc is rotated in the direction of arrow A, the wind which is generated by rotation of the disc blows against the upright flag 66 supported on air vane 62, the upright flag being immediately adjacent the discs and supported between the two discs as appears clearly in Figure 5. The wind is further deflected toward flag 66 by flag finger 67 (see Figures 3 and 4 to see relationship of flag finger 67 and flag 66) which is generally horizontal and extends toward and between the discs (see Figures 1 and 2). As the discs turn in the direction of arrow A, wind is generated and blows over finger 67 and is deflected upward against flag 66 which is aligned (Figure 5) with the opening 69 between the discs. As the wind blows against the flag 66, the flag moves in the direction of arrow B (Figure 1), causing the latch engagement arm 64 to move away from notch 50. It is the engagement of latch engagement arm 64 and notch 50 which restrains the actuator arm 40 from movement of the transducer slider assembly 48 away from landing zone 52; as the finger moves in the direction of arrow B, then the air vane 62 and latch engagement arm 64 move away from notch 50, as shown in Figure 2, releasing the actuator arm to move the transducer slider assembly 48 freely across the surface of the disc in response to commands executed by motor 44.

Means are also provided to bias the latch to the closed, engaged position of Figure 1 so that engagement of the actuator arm remains secure even in the event of significant shock.

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As shown most clearly in Figure 4, a flange 74 is provided surrounding the cylindrical shaft 72 and defining a channel wherein a tightly wound spring 76 is located. This spring, one end of which bears against a post 78 supported from the base of the disc drive (Figure 1), and the other end of which bears against the end of the channel defined above (Figure 4), is the biasing element which normally biases the wind vane latch towards the closed position shown in Figure 1. By "closed position" it is meant that the latch engagement arm 64 has engaged notch 50; the wind vane flag 66 is closely adjacent the discs 10, 30 of the disc drive; and, actuator assembly 40 has moved transducer slider assembly 48 to landing zone 52. The design constraints which apply to this aspect of the present device are illustrated in Figure 6, where the countervailing effects of the spring and the air blowing against the air vane flag 66 are graphically displayed. As can be seen, the spring is provided with a certain level of spring preload which together with frictional effects maintains the air vane flag in its closed or home position with the latch engagement arm 64 securely latching the actuator assembly by engaging notch 50. As the discs begin to turn in the direction of arrow A and air moves against the air vane flag 66, the vane is displaced in the direction of arrow B (Figure 1).

Obviously, for the same speed of rotation of the discs, the further the vane 62 moves from the edge of the disc, the more dispersed the effects of the air blowing against the air vane flag 66; thus the torque of the air against the air vane flag gradually diminishes. By the same token, as the latch engagement arm 64 moves in a direction opposite to arrow B, and away from its latching position, the spring 76 is wound more tightly, increasing the torque exerted by the spring as the spring attempts to restore the actuator arm assembly 40 to the latched or closed position. It is, of course, important to always maintain some margin 84 (Figure 6) between available spring torque and wind torque so that the torque of the spring is not entirely overcome; as the wind caused by the turning of the disc

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ceases to have its effect on the air vane flag, the spring will return the air vane flag to its home position. To maximise the effects of the windage against the air vane flag, especially when the latch engagement arm 64 is engaging notch 50 and some frictional effects between the latch engagement arm and the notch must be overcome, in addition to the force of the spring, the flag should advantageously be positioned overlapping the space between two rotating discs as shown in Figure 5. The discs focus the air flow against the flag; the flag finger 67 further directs the air flow against the flag to move the air vane 62 in the direction of arrow B.

In summary, as shown in Figure 4, the spring 76 is retained in a channel 77 defined by the cylindrical shaft 72 and flange 74. The spring has two ends extending outward along arcs at either end of the channel which retains the coiled portion of the spring; the ends are retained by a pin 78 supported from the base casting an edge of the channel 77 for the entire wind vane latch to maintain the proper spring torque.

Two further significant elements of the present application appear in Figure 3 and comprise the support bracket 80 and the locking ring 90 which is mounted about the same pivot axis as the actuator arm 40. The support bracket 80 together with the pin 81, which extends up through the base housing casting 4, air vane 62 and bracket over hand 102 cooperate to hold the air vane 62 closely adjacent the side of the rotating discs and define the length of the arc described as the vane rotates toward and away from the discs. The support bracket 80 is formed of a single flat piece of metal which is bent and shaped in three separate regions. As can be seen, an arm comprising upright section 100 and a horizontal vane support section 102 is formed and bent so that the pin which is to be inserted through the air vane 62 extends up through the top of the horizontal vane support section 102. This support structure for the air vane is important because of the necessity of

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maintaining the vane and especially the flag 66 thereof in a perpendicular plane adjacent the side of the discs.

The air currents generated by the speed of the rotation of the disc are not very great; it is important that their impact upon the vane 62 and especially the air van flag 66 and air deflection flag finger 67 is significant. The impact of air currents on the air vane flag 66 is at least partially facilitated by the finger 67 which extends toward the discs and in fact slides between the discs (as is shown in the top view of Figures 1 and 2) and optimises the impact of air flow against the face of the air vane flag. It can also be seen by looking at the top view of Figure 1 and considering the effect of air currents against the air vane flag, that the air vane flag 66 is designed to have an arc which substantially parallels the edge of the discs which are rotating past the vane. It also appears from the top plan view of Figure 1, that it is important not to let the air vane approach too close to the edge of the discs so that it cannot strike against the edge of the discs. Thus, as shown in Figure 3, a second small arm including an upright portion 104 and, in this embodiment, an overhang 106 is formed in the support bracket 80, in a location which would be typically nearly adjacent to where the extending flag finger 67 protrudes from the front of the vane 62. As can be seen from Figure 1, the leading edge of the air vane flag finger 67 will butt up against the restraining arm 104 as the vane is urged back toward the closed or locked position under the influence of the spring. The air van flag thus is urged to rest very close to the edge of the disc. The air vane flag does not have to move a very great distance for the latch engagement arm 64 to release from the notch 50 on the locking ring 90. If the vane is very close to the edge of the disc, then the effect of the air currents generated by the rotation of the discs on the vane is maximised, and reliable unlatching of the wind vane latch from the actuator holding notch 50 can be achieved.

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As also appears in Figure 3, the notch 50 is preferably provided along a thin ring 90 which is inserted in the stack which forms the supporting pivot for the actuator arm 40. The ring 90 is inserted in the pivot bore stack below the actuator arm. As appears in Figure 1, when the latch 60 contacts notch 50, the latch 60 is substantially perpendicular to the lengthwise axis of actuator arm 40 so that the locking force on the arm is maximised.

The operation of the wind vane latch can be summarised as follows. With power removed from the spindle motor mechanism, kinetic energy stored in the rotating discs and spindle is converted to electricity by the spindle motor. The electrical energy produced is applied to actuator so that is transports the transducer 48 to the landing zone 52 (Figure 1). When the traducer slider assembly 48 reaches the landing zone 52, as can be seen, the biasing action of the spring 76, coupled with the fact that the reduced rate of speed of rotation of the disc has reduced the wind force against the wind vane 62, causes the wind vane portion to move opposite to the direction of the arrow B, and the latch engagement arm 64 engages the notch 50 (Figure 1). The transducer is in this manner latched in the landing zone position.

When power to the spindle motor is once again applied, air currents are generated by rotation of the discs in the direction A. As can be seen most readily in Figure 5, the wind vane is supported directly adjacent the opening between the two discs, so that air currents generated by rotation of the discs impact upon the vane 62 and air vane flag 66, the air being efficaciously directed against the air vane flag 66 by the protruding flag finger 67 which is directed toward the slot between the discs. As a result, the vane 62 moves away from the edge of the discs in the direction of the arrow B (Figure 1), causing finger 64 to release notch 50. This leaves the actuator arm 40 free to move the transducer slider assembly 48 away from the landing zone 52 and over the surface of the disc.

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The latch mechanism may be arranged so that it can reliably hold the actuator arm from uncontrolled movement away from a landing zone position in response to significant shocks of up to 80-100Gs.

The mass of the latch mechanism may be advantageously significantly less than the mass of the actuator arm but the latch mechanism may still be capable of effectively restraining the arm against movement.

The latch mechanism may be fitted very closely adjacent to, and/or even has parts of the mechanism disposed beneath, the rotating disc such that a minimum of housing area needs to be defined to the latch mechanism. Indeed a standard housing may not need to be adapted all to all accommodate the mechanism.

The latch mechanism may, when its restraining arm is latched against the actuator arm, provide the restraining force in a direction almost directly parallel to the direction in which the actuator arm will attempt to move so that a maximum restraining force can be applied to the actuator arm.

Having now described an embodiment of the invention, it will be appreciated that the objects of the invention may be fully achieved. It will also be understood by those skilled in the art that many changes in construction and circuitry and widely different embodiments and applications of the invention will suggest themselves without departure from the spirit and scope of invention. The disclosures and the description herein are illustrative and are not intended to be in any sense limiting.

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CLAIMS

1. A latch system for use in a disc drive, the latch system comprising a latch arm (64) having an engagement portion (61) for engaging a transducer support arm (46) of the disc drive to substantially prevent movement of the transducer support arm, and a vane (66), characterised in that the vane is located at a distance from the centre of a disc (10,30) of the disc drive which is greater than the radius of the disc, and in that the latch arm (64) and vane (66) are arranged such that, in the presence of disk rotation-generated wind pressing against the vane, the vane moves away from the disc and the engagement portion (61) disengages the transducer support arm (46)

2. A latch system for use in a disc drive, the latch system comprising a latch arm (64) having an engagement portion (61) for engaging a transducer support arm (46) of the disc drive to substantially prevent movement of the transducer support arm, and a vane (66), characterised in that the vane is located adjacent a space between two discs (10,30) of the disc drive and in that the latch arm (64) and vane (66) are arranged such that, in the presence of disk rotation-generated wind pressing against the vane, the vane moves away from the disc and the engagement portion (61) disengages the transducer support arm (46)

3. A latch system as in claim 1 or 2, wherein the air vane further comprises a finger (67) located on the side of the vane (66) for making contact with the disc rotation-generated wind to guide the wind toward the vane.

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4. A latch system according to claim 3, wherein said finger (67) has opposing surfaces which, from a section of the finger closest to the centre of the disc or discs to a section closest to the vane (66), curve gradually away from each other towards said vane and are thereby shaped to capture and direct the wind generated by rotation of said disc or discs against said vane.

5. A latch system as in claims 3 or 4, wherein the finger (67) is arranged for being inserted in a space between two discs.

6. A latch system as in claim 3, 4 or 5, wherein the finger (67) is supported on the surface of the vane (66) close to a base housing (3,4) of the disc drive.

7. A latch system as in any preceding claim, further comprising a biasing means (76) for urging the vane (66) towards a position at the periphery of the disc at which the vane does not contact the disc or discs, and for urging the engagement portion (61) to engage the transducer support arm (46).

8. A latch system as in claim 7, wherein said biasing means comprises a coil spring.

9. A latch system as in claim 7 or 8, wherein the force of the biasing means is defined to be less than the effective force of the wind created by the rotation of the discs at normal speed to allow use of the disc drive.

10. A latch system as in any preceding claim, wherein the vane is shaped to follow the contour of the edge of the rotating disc or discs.

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11. A latch system as in any preceding claims, further comprising a restraining means (104,106) to prevent the flag (66) from contacting the disc or discs (10, 30).

12. In combination, a latch system according to claim 1 or any one of claims 3 to 11 and a disc drive including a least one disc.

13. In combination, a latch system according to claims 2 to 11 and a disc drive including at least two discs.

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