

Head loading/unloading positioning control system
for use in a disk memory device

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to head loading/unloading disk memory device and a method for unloading a read/write head included in the device, and more particularly, for automatically retracting the read/write head onto a head placing mechanism contained in the device when a shutdown of a power source of the device occurs.

Description of the Related Art

The most recent trend in the computer industry is to develop magnetic disk memory devices that can be used in thin, handheld computers. In the head loading/unloading process of these conventional disk memory devices, a magnetic head initially rests upon a head placing mechanism (hereinafter, simply referred to as a "ramp block"), which is positioned near the outer edge of the magnetic disk memory device. During reading/writing operations of the disk memory device, the magnetic head is

loaded onto the surface of the magnetic disk from the ramp block and when the operations have finished, the magnetic head is retracted onto the ramp block.

During the reading/writing operations, the magnetic head is loaded from the ramp block so as to float closely onto the surface of a disk medium when the rotation speed of the disk medium reaches a steady state. Both the disk rotation and the head loading operation are powered from a device source. Consequently, if the power supply from the device source happens to stop during the reading/writing operations of the disk memory device, there is a possibility for the surface of the head to contact the surface of the disk medium due to the sudden stop of the rotation of the disk medium.

To prevent this defect from occurring, there is a need to immediately retract the head back to the ramp block when a shutdown of the power source has occurred. In essence, a head unloading operation must be reliably achieved when a shutdown of the rotation power is detected.

Usually, the head loading/unloading disk memory device is designed to retract the head back onto a ramp block in order to prevent the head surface from contacting the disk surface. The head retracting operation is achieved by driving a head moving mechanism to follow predetermined sequences when the power source has shutdown. Typically, the head moving mechanism comprises a head actuator for holding the read/write head and a voice coil motor (VCM).

When the head loading/unloading disk memory device is applied to a thin-body, handheld computer, it must be designed so that the head floating height is very small. In other words, the head surface is floated very closely to the surface of the disk medium during the stable state of disk rotation in order to increase the data recording density in the disk. The data recording density is increased by enhancing the smoothness of the mirror surface of the disk medium and also by reducing the head floating height from the disk surface. For example, the head floating height of a disk device for a thin-body handheld computer is designed to be approximately 10 nanometers (nm). By reducing the head floating height, the data recording density can be increased. However, the danger of the head contacting the disk surface due to a shutdown of the power source also increases when the head floating power is reduced. Accordingly, when a head loading/unloading disk memory device is applied to a thin body handheld computer and a shutdown of the power source occurs, there is a need to automatically measure the distance required to reliably unload the read/write head back onto the ramp block provided near the outer edge of the disk medium.

Since the power source has already shutdown, in order to return the head unloading operation back to the ramp block, the head holding mechanism requires a VCM that must be driven by an additional power source. As the additional power source for driving the VCM, the head loading/unloading disk device usually relies upon the back electromotive force, which is generated by the inertia rotation of the spindle motor (SPM) after the shutdown of the power source. That is, the back electromotive force generated by the inertia rotation of the spindle motor (SPM) is rectified and supplied as driving power to drive the head unloading operation. The rectified power of

the back electromotive force of the inertia rotation of the SPM is sufficient to rotate the head back to the ramp block. However, the power is not sufficient to raise the head up to a head retracted position onto the ramp block. The head retracted position is usually located on the top of the ramp block, which has a greater height above the disk surface than the head floating height. For example, the ramp block used in a disk device for a handheld computer is approximately one mm high. In comparison, the head floating height is approximately 10 nm. Consequently, another additional power source, other than the rectified power of the back electromotive force, is needed to raise the head up to a head retracted position onto the ramp block.

Recently, manufacturers of handheld computer systems are beginning to develop computers having smaller and thinner bodies. As a result, disk devices used within these size-reduced handheld computers, also need to reduce their size. For example, a disk diameter, which used to range in size from 3.5 inches to 2.5 inches, now has been reduced to a 1.8-inch-sized disk. In conjunction with the reduction in the size of the disk diameter, the spindle motor (SPM) for rotating the disk has also become smaller in size. Naturally, the usable rectified power of the back electromotive force of the inertia rotation of the SPM has also become smaller. This produces a problem when the conventional disk device attempts to use the reduced rectified power of the back electromotive. Now, the head mechanism can no longer be reliably retracted onto the ramp block.

To solve this problem, it has been proposed to have a voltage converting means consisting of a condenser as a head unloading power source (a secondary power) when a

shutdown of a device power source (a primary power) occurs. According to this method, during normal operations, the voltage converting means supplies a boosted voltage of the primary power source to the condenser for the secondary power. For example, in a 3.5-inch-sized disk device, the voltage of the primary power is approximately 12V, and the voltage converting means generally boosts the voltage up to approximately 30V for charging up the secondary power in the condenser. When the primary power has shut down, the secondary power stored in the condenser is used for retracting the head onto the ramp block.

However recently, the voltage of the primary power of the size-reduced disk devices has decreased with smaller sized disks. For example, the primary voltage for a 2.5-inch-sized disk device is now about 5V, and the primary voltage for a 1.8-inch-sized disk device is reduced to about 3.3V. Consequently, in order to achieve a reliable head unloading operation, there is a need for a larger condenser having a larger capacity which is capable of sufficiently charging the secondary power through the use of the reduced primary voltage.

Generally, the condenser capacity depends upon the outer size of the condenser. This means there is a need to use a condenser having a larger outer size in order to sufficiently charge the secondary power. In essence, a larger-sized condenser must be used as the secondary power supply source in order to achieve reliable head unloading operations. In order to use a larger-sized condenser, the disk device must have a larger mounting space for the condenser. The space required for the enlarged condenser conflicts with the manufacturer's desires to reduce the disk's size. Thus, the reduction

in the disk device's size and the reliable execution of the head unloading operation during a shutdown of the primary power cannot be achieved simultaneously.

With the recent advancements in the size-reduced disk devices, a 2.5-inch disk device and a card-sized disk device, such as a 1.8-inch disk card, have been developed. Unfortunately, the process of boosting the primary power cannot be applied when these small sized or card-sized disk devices are used. Consequently, it is difficult for conventional devices to achieve the head unloading operation using the secondary power based on the primary power.

SUMMARY OF THE INVENTION

Therefore, there is a need for a device and method to reliably unload a head mechanism in size-induced disk device. The disk devices and methods according to the present invention solve the aforementioned problems and defects of a conventional disk device and of the head unloading method thereof. Namely, the object of the present invention is to provide a disk memory device and a method for reliably achieving a head unloading operation when a shutdown of a device power source occurs and to simultaneously decrease the size of small-sized disk memory device.

In order to achieve the above-mentioned objects, according to the invention, there is provided a head mechanism, a first and second power source and a circuit for sequentially powering the head mechanism with the first power source and the second power source to move the head from an operative position to a rest position.

Additional objects and advantages of the invention will be set forth in the description that follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the present invention and many of the attendant advantages thereof will be obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate identical or corresponding parts throughout the several views.

Figure 1 is a plain view showing an embodiment of the head loading/unloading magnetic disk device according to the present invention.

Figure 2 depicts a partially enlarged view illustrating the main components of the magnetic disk device as depicted in Figure 1 in order to explain the head unloading operation with regards to a ramp block.

Figure 3 is a schematic diagram of a head unloading circuit according to the present invention.

Figures 4A-4F are timing charts for explaining the operations of the head unloading circuit of Figure 3 at the time of a shutdown of the power source of the disk device, that is:

Figure 4A shows a power source voltage V_S .

Figure 4B shows a rectified back electromotive voltage V_R .

Figure 4C shows a condenser voltage V_C .

Figure 4D is an unloading instruction signal 380.

Figure 4E is a power switching signal 370.

Figure 4F shows a head unloading voltage V_U .

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Figure 1 illustrates the main components of a magnetic disk device 10 consistent with the present invention. The magnetic disk device 10 comprises at least one disk medium 11, a magnetic head 12, a rotary actuator 13, a ramp block 14, a spindle motor (SPM) 15 for driving the disk medium 11 at a high rotation of speed, and a voice coil

motor (VCM) 16 for driving the rotary actuator to load and unload the magnetic head 12 to and from the ramp block 14.

The disk medium 11 includes a plurality of concentric recording tracks (not shown) for recording servo data and user data. The servo data are used to determine a head position on the recording tracks so that a reading/writing operation can be performed. Each recording track includes on its surface servo areas disposed at predetermined interval. The area between two servo areas serves as a user data storage area. The user area includes a plurality of data sectors.

In Figure 1, for the purpose of simplifying the disclosure, a single disk medium 11 is illustrated. But, of course, it is possible to apply a circuit and method consistent with the present invention to a disk device in which a plurality of disk media is stacked along spindle motor (SPM) 15.

In order to read or write data on the recording tracks, a magnetic head 12 flies very close to the recording surface of the disk medium 11. The flying height of the magnetic head 12 is the distance from the recording surface of the disk medium 11 to the recording/writing surface of the flying head. The flying height may be, for example, 20~30 nm (nanometers).

The magnetic head 12 attaches to a suspension arm 131 of the rotary actuator 13. The rotary end of the actuator 13 is magnetically coupled to a voice coil motor (VCM) 16 to load and unload the head 12 according to the path indicated by arrow A, from and

to a position shown in phantom in Figure 1, respectively. The rotary actuator 13 and the voice coil motor (VCM) 16 comprise a head moving mechanism. A loading/unloading operation of moving the head 12 against the ramp block 14 is executed by rotating the head moving mechanism.

That is, the loading/unloading of the head 12 is executed by rotating the head actuator 13 along a radius direction of the disk 11. Angular rotation of the head actuator 13 is achieved by driving the voice coil motor (VCM) 16 to follow a predetermined sequence.

During the head loading operation, in order to locate the head position over a recording track of the disk medium 11, the suspension arm 131 moves in an inward circular direction toward the disk medium 11 in accordance with the angle of rotation of the actuator 13.

When the device stops operating or there is a detection of a shutdown of the device's power source during operation, the head unloading operation is automatically executed in order to prevent the head surface from contacting the disk surface. That is, the suspension arm 131 moves to an outer edge of the disk medium 11 and retracts onto the ramp block 14 provided near the outer edge of the disk medium 11.

Figure 2 explains the details of the head retracting operation of head 12 onto the ramp block 14.

During an unloading operation of the head 12, a drive current for the VCM coil is supplied in a direction opposite the direction used during the loading operation. By supplying the unloading current to the VCM coil, the actuator 13 is moved to outside of the disk medium so that the suspension arm 131, which holds the head 12, reaches the ramp block 14.

As shown in Figures 1 and 2, the suspension arm 131 includes a top tab 131a for guiding and retracting the suspension arm 131 to the ramp block 14. The ramp block 14 is provided on the rotating path of the top tab 131a of the suspension arm 131 and positioned close to the outer edge of the disk medium 11.

The ramp block 14 includes a slanted portion 141 for guiding the top tab 131a of the suspension arm 131 and for sliding the head 12 away from the surface of the disk medium 11. The ramp block 14 illustrated in Figure 2 includes a U-shaped groove 140 for holding a non-data area of the outer edge of the disk. The slanted portion 141 of the ramp block 14 is formed on the upper side of the groove 140.

When the top tab 131a reaches the slanted portion 141 of the ramp block 14, the driving force of the VCM 16 (Figure 1) slides the top tab 131a of the suspension arm 131 upward along the slanted portion 141 of the ramp block 14 in order to separate the head from the disk surface so that the head reaches a head retracted position on the upper portion 142 of the ramp block 14. That is, in the embodiment of Figure 2, the top tab 131a of the suspension arm 131 retracts to a V-shaped stopper position formed by a pair of slide surfaces 143 and 144 on the ramp block 14, which serves as the retracted

position. The head is lifted to the head retracted position by sliding on the slanted portion 141 of the ramp block 14.

In a disk device comprising a 1.5-inch-sized disk according to the present invention, during reading/writing operations, the head surface flying height from the disk surface is approximately 20 ~ 30 nm. In comparison, when the head is retracted onto the top of the ramp block 14, the head surface height becomes approximately 1 mm. The head is at a greater distance away from the disk surface when it is positioned in the retracted position.

During a head unloading operation, the power needed to slide the suspension arm tab 131a along the slant portion 141 of the ramp block 14 to the head retracting position is greater than the power needed to rotate the head actuator 13 from the disk to the ramp block 14. By using a small condenser having a small size, the disk device according to the present invention provides both of the needed power levels to achieve the goals of a reliable head unloading operation onto the ramp block and producing compact-sized disk devices.

Figure 3 illustrates a block diagram of the disk device consistent with the present invention. Referring to Figure 3, the head unloading operation that occurs when a shutdown of the power source is detected, will now be explained.

The shutdown of the power source is detected when a voltage of the power source of the device is reduced below a predetermined voltage. At this time, the rotation

speed of the SPM 15 is also reduced. When the shutdown of power source is detected, a CPU (not shown) executes a head unloading operation. In order to rotate the head actuator 13 toward the outer edge side of the disk medium 11, a drive current, which is opposite of the direction used during the loading operation, is supplied to the VCM coil 161. In Figure 3, the unloading drive current flows from a first terminal 161 of the VCM coil to a second terminal 162 of the VCM coil to rotate the actuator in the opposite direction.

During normal operating conditions, a reading/writing operation of the magnetic disk is achieved by rotating the SPM 15, which is driven by supplying three phase driving current to the SPM coil from the SPM driver 31. A control logic circuit 33 controls the switching of the SPM's 15 driving phases. The drive control of the VCM 16 for rotating the head actuator 13 is achieved by supplying a VCM drive current between the first terminal 161 and the second terminal 162 of the VCM coil. The VCM drive current flows from a VCM driver 32 through a pair of coupled switches 41,42 to the first and second terminals 161 and 162.

In the embodiment, when a VCM driving current is supplied from the first terminal 161 to the second terminal 162 of the VCM driving coil, the head actuator 13, which holds the head 12, moves toward the periphery of the disk. Of course, when the driving current is supplied in the opposite direction from the second terminal 162 to the first terminal 161, the head actuator 13 rotates toward the center of the disk.

The control logic circuit 33 controls both the SPM driver 31 and the VCM driver 32 by establishing the control amount of the driving currents supplied to the SPM 15 and the VCM 16, respectively. That is, the SPM driver 31 and the VCM driver 32 are commonly controlled by the control logic circuit 33.

The disk device according to the present invention further includes a head unloading circuit 30 for conducting a shutdown of the power source. The head unloading circuit 30 includes a back electromotive rectifying circuit 34, a power source voltage boosting circuit 35, a condenser 36, a timer 39, a power switching circuit 37, a power source shutdown detecting circuit 38, and a first and second pairs of coupled switches 41, 42 and 43, 44. The back electromotive rectifying circuit rectifies the back electromotive force generated by the inertia of the rotation of the SPM 15 after the shutdown of the power source occurs. The power source voltage boosting circuit 35 boosts the power source voltage to a predetermined voltage during the normal high speed rotation of the disk medium. The condenser 36 stores an electric charge corresponding to the boosted voltage of the power source voltage boosting circuit 35. The timer 39 counts from the time when a shutdown of the power source occurs to a predetermined time interval T_a . The power switching circuit 37 switches the power supplied to the VCM coil based on a power switching signal 370 received from the timer 39. The first pair of coupled switches 41, 42 and the second pair of coupled switches 43, 44 operate in response to the head unloading instruction signal 380 received from the power source shutdown detecting circuit 38.

As discussed above, the power source voltage for a compact-size enhanced disk device may be as low as approximately 3.3V. In the embodiment of the present invention, the power source voltage boosting circuit 35 boosts the power source voltage to almost twice as much, approximately 6V, as the conventional voltage. Namely, the condenser 36 stores electric charge by the boosted voltage (6V) during normal operation.

When a shutdown of the power source occurs, the unloading circuit 30 supplies a head unloading power of voltage (V_U) to the VCM coil through the power switching circuit 37. That is, the output voltages from the back electromotive force rectifying circuit 34 and the voltage stored in the condenser 36 are sequentially supplied to the VCM coil.

If the voltage of the power source falls below a predetermined value, the power source shutdown detecting circuit 38 generates a head unloading instruction signal 380 to the timer 39 and the first and second pair of linked switches 41, 42, 43, 44, respectively. The first pair of linked switches 41, 42 are turned OFF to disconnect the first terminal 161 and the second terminal 162 of the VCM driving coil from the VCM driver 32. At the same time, the second linked switches 43, 44 are turned ON to supply the output voltage of the back electromotive force rectifying circuit 34 to the VCM driving coil through the power switching circuit 37 as a head unloading driving voltage. Thus, a driving current flows in the VCM driving coil from the first terminal 161 to the grounded second terminal 162. As a result, the head suspension arm 131 rotates toward the ramp block causing the head to retract towards the ramp block.

The power switching circuit 37 includes field-effect transistor (FET) elements that supply the driving voltage supplied to the VCM 16 from the lower output voltage of the back electromotive force rectifying circuit 34 at initiation of an unloading operation. The FET elements switch at a predetermined period during the unloading operation to supply the higher output voltage of the condenser 36, which is charged by a boosted voltage of the power source voltage boosting circuit 35 during the normal operation of the device.

After the shutdown of the power source is detected, the timer 39 counts a predetermined period and then supplies a power source switching instruction signal 370 to the power switching circuit 37. A driving power D_a is supplied from the condenser 36 to the timer 39. It is also possible to supply the driving power D_b from the back electromotive force rectifying circuit 34 to the timer 39. The timer counts the rotation pulses generated from the inertia of the rotation of the SPM 15. When the predetermined period T_a has elapsed, the timer 39 sends a power source switching instruction signal to switch the output signal 370 from a high level to a low level. Consequently, the power switching circuit 37 switches the VCM driving voltage to the higher voltage received from the charged condenser 36.

At the initialization of a normal operation of the disk device, the first pair of linked switches 41, 42 are set to the ON position and the second pair of linked switches 43, 44 are set to the OFF position. Further, the power switching signal 370 and the unloading instruction signal 380 are initialized at a high level.

If a shutdown of the power source is detected during a normal reading/writing operation, for example, when the magnetic head 12 is flying close to the surface of a rotated disk medium at a high rate of speed, the head unloading operation is initially achieved by supplying a relatively small power from the back electromotive force rectifying circuit to the VCM driving coil. This small power is provided to move the head actuator so that it reaches the slanted portion 141 of the ramp block. When a predetermined period, which is sufficient to permit the head actuator to reach the slanted portion 141 of the ramp block, has lapsed, the voltage supplied to the VCM driving coil is switched to a boosted higher voltage from the relatively small condenser 36. Since a larger unloading current flows in the VCM driving coil after the head actuator reaches the slanted portion 141, it is easier for the suspension tab 131a of the head actuator to slide along the slanted portion 141 upward to the head retracted position on the ramp block. As a result, a reliable head retracting operation is achieved by using a relatively small condenser.

The timing sequence for switching the unloading power supply to the VCM coil is achieved by setting the predetermined period of the timer 39 after detecting a shutdown of the power source. The predetermined period is determined, for example, based upon the time it takes to move the head actuator from a center track to an outer edge track on a disk. Other methods of determining the predetermined period may be used with the present invention such as using other reference points on the disk to calculate the predetermined period or the predetermined period may be arbitrarily set by the user.

The head unloading circuit of the present invention serves to automatically retract the head onto the ramp block when a shutdown of the power source occurs. The head unloading circuit includes two reserve power sources for driving the VCM to achieve the head unloading operation. One is a rather small voltage produced by rectifying a back electromotive force generated from the inertia of the rotations of a SPM. The other is a relatively large voltage stored in a relatively small condenser that is boosted to twice the normal operating voltage. Thus, when a shutdown of the power source is detected during a reading/writing operation, an automatic head unloading operation can be reliably achieved by effectively switching between the two reserve power sources.

Since the electric energy needed to move the head actuator to the slanted portion of the ramp block is relatively small, it is sufficient to use a small electric energy generated by the back electromotive force rectifying circuit. On the contrary, a much larger electric energy is needed to lift the head actuator onto the ramp block. Accordingly, after the head actuator reaches the ramp block, a larger electric energy is switched to supply the power source voltage in order to drive the VCM.

In comparison to a conventional disk device that only uses a power source voltage charged in a condenser, the present invention uses a relatively small sized condenser installed within a compact-size enhanced disk to achieve a reliable head unloading operation.

Figure 4 explains the switching operation of the two back-up power sources of the present invention for unloading a read/write head in a disk memory device.

Figure 4A illustrates the power source voltage V_S . During normal reading/writing operations, the power source voltage V_S in the disk device of this embodiment is, for example, 3.3 V. Figure 4A further indicates a threshold voltage V_T of 2.9 V for detecting a shutdown of the power source. Namely, the power source shutdown detecting circuit shown in Figure 3 issues an unloading instruction signal 380 when the power source voltage drops to a level lower than the threshold voltage.

For example, suppose that the power source voltage V_S drops to the threshold level at time t_1 and the power source shutdown detecting circuit 38 emits a head unloading instruction signal 380 as depicted in Figure 4D. The head unloading instruction signal 380 turns off the first pair of linked switches 41, 42 in order to stop the loading operation driven by the VCM driver 32. Concurrently, the head unloading instruction signal 380 turns on the second pair of linked switches 43, 44 to supply a head unloading drive power to the VCM 16 through the power switching circuit 37.

Even though the shutdown of the power source is detected at time t_1 , the SPM 15 still continues to rotate by inertia. The inertia rotation induces a back electromotive force. Consequently, the back electromotive force rectifying circuit 34 generates a rectified back electromotive force voltage V_R as shown in Figure 4B. The back electromotive force voltage V_R produced by the inertia rotation is relatively small. At its highest level, the back electromotive force voltage V_R is approximately 1.5 V.

Further, the back electromotive force voltage V_R is gradually reduced in accordance to the reduction of the inertia rotation of the SPM as illustrated in Figure 4B.

Consequently, the back electromotive force voltage V_R is initially utilized as a non-chargeable backup power source for unloading the head mechanism in the device. That is, the back electromotive force voltage V_R is supplied to the VCM coil as an unloading voltage V_U through the power switching circuit 37 from the occurrence of the shutdown detection time t_1 as illustrated in Figure 4F.

Accordingly, the back electromotive force voltage V_R is utilized as the driving power during the unloading rotation of the head actuator as the head is moved backwards toward the edge of the ramp mechanism.

However, as explained above, the back electromotive force voltage V_R is gradually reduced with time as illustrated in Figure 4B. Consequently, the unloading voltage also drops as the time from the shutdown detection time t_1 passes. This means that as the unloading voltage V_U drops, it becomes difficult to slide the head actuator along the ramp block.

The disk memory device consistent with the present invention includes a second back up power source for sliding and lifting the head actuator along the ramp block. Namely, the disk memory device includes a condenser 36 which stores a voltage that is boosted from the voltage of the power source supplied during normal operating conditions. As depicted in Figure 4C, the condenser voltage V_C is, boosted to 5 or 6 V,

approximately double the power source V_S . This voltage V_C is rather small in comparison to a conventional method for unloading the head actuator that is driven by energy stored in a condenser only.

From the occurrence of the shutdown detection time t_1 , it takes a period T_a before the head actuator reaches the edge portion of the ramp mechanism. As shown in Figure 4F, at time t_2 , the head actuator reaches the edge portion of the ramp mechanism. Timer 39 counts the period T_a by counting the number of rotation pulses generated from the SPM 15. When the head actuator reaches the slanted portion of the ramp block, the timer 39 issues a power switching instruction signal 370 to the power switching circuit 37 as shown in Figure 4E. That is, the head unloading voltage V_U is switched to the condenser voltage V_C at time t_2 , which occurs before the head unloading voltage V_U of the rectified voltage V_R reaches zero as shown in Figure 4F.

As shown in Figure 3, the timer 39, used in this embodiment of the disk memory device, is driven by an output voltage D_a transmitted from the condenser 36. The predetermined period T_a may be determined by calculating the time necessary to rotate the head actuator using the rectified voltage from the inner most track of the disk to the outer most track of the disk. In the case of a 2.5-inch-sized disk medium placed in the present disk memory device, the period T_a is determined, for example, as approximately 20 ms.

When the predetermined interval time T_a has passed from the power source shutdown t_1 , i.e., at a time t_2 , the head unloading voltage V_U is changed automatically

to the higher voltage V_C from the condenser. When the loading voltage is changed to the condenser, the voltage V_C is approximately 6 V. The power source voltage is boosted to approximately twice the normal operating power source voltage of 3.3 V.

By switching to the higher condenser voltage V_C , the head unloading voltage V_U jumps rapidly up to the boosted voltage 6V at the time t_2 as shown in Figure 4F. This higher power is sufficient to drive the head actuator in order to slide it up and onto the slanted portion of the ramp block to the retracted position. Consequently, it becomes possible to automatically achieve a reliable head unloading operation onto the ramp block.

As explained above, the disk memory device according to the present invention and a method thereof is characterized in that two different types of backup power sources are utilized as a head unloading drive power by switching between a non-chargeable power and a chargeable power. These are beneficial for effectively achieving the head unloading operation in spite of the fact that a relatively smaller condenser which is suitable in size for a thin, compact sized computer system is used.

Other embodiments of the present invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. In particular, the invention is applicable to any types of the head loading/unloading disk memory devices. It is intended that the specification and examples be considered as exemplary only, with the true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. A disk memory device comprising:
 - a head mechanism having a head;
 - a first power source;
 - a second power source;
 - a circuit for sequentially powering the head mechanism with the first power source and the second power source to move the head from an operative position to a rest position.
2. A disk memory device according to claim 1, wherein the second power source has greater voltage than the first power source.
3. A disk memory device according to claim 2 further comprising:
 - a ramp mechanism, the head being positioned on the ramp mechanism in the rest position and the first power source powers the head mechanism to move the head to the ramp mechanism and the second power source powers the head mechanism to move the head onto the ramp mechanism.
4. A disk memory device according to claim 1 wherein the first power source is a rectifying circuit, and the second power source is a condenser.
5. A disk memory device comprising:
 - a head mechanism;



a spindle motor (SPM) for rotating at least one disk medium;

a condenser for storing charges generated during normal operation of the disk memory device;

a rectifying circuit for rectifying back electromotive force generated by the inertia rotation of the spindle motor to move the head mechanism from an operative position to an intermediate position;

said condenser uses the stored charges to move the head mechanism into a rest position.

6. A disk memory device according to claim 5, wherein the condenser has a greater voltage than the rectifying circuit.

7. A disk memory device according to claim 6, wherein:

the rectifying circuit moves the head mechanism from the operative position to the intermediate position after the shutdown of a power source of the spindle motor occurs; and

the condenser moves the head mechanism into the rest position after a predetermined time has elapsed after the shutdown of the power source of the spindle motor has occurred.

8. A disk memory device according to claim 6, further comprising:

a ramp mechanism, the head being positioned on the ramp mechanism in the rest position;



the rectifying circuit powers the head mechanism to move the head to the ramp mechanism; and

the condenser powers the head mechanism to move the head onto the ramp mechanism.

9. A disk memory device comprising:

a spindle motor (SPM) for rotating at least one disk medium having a plurality of data recording tracks;

a head mechanism for holding a read/write head on the data recording tracks of the at least one disk medium;

a voice coil motor (VCM) for driving the head mechanism by angular rotation; and

a head unloading circuit for retracting the head mechanism onto a ramp mechanism when a shutdown of a power source of the spindle motor is detected;

wherein,

the ramp mechanism is positioned near the outer edge of the disk medium;

the head unloading circuit is comprised of:

a head unloading instruction generating circuit for detecting when the shutdown of the power source for the spindle motor has occurred;

a circuit for rectifying back electromotive force generated by the inertia rotation of the spindle motor after the shutdown of the power source has been detected;

a condenser for storing electrical charges generated during the normal operation of the disk memory device; and



a switching circuit for supplying an output signal of the rectifying circuit to the VCM to unload the head mechanism away from the disk medium towards the ramp mechanism when the shutdown of the power source for the spindle motor has been detected and for switching the power supplied to the VCM by switching from the output signal of the rectifying circuit to the output signal of the condenser after a predetermined period has elapsed after the shutdown of the power source has been detected.

10. The disk device according claim 9 further comprises:

a timer for counting the predetermined period triggered by the head unloading instruction;

wherein the switching circuit switches the power supplied to the VCM by switching from the output signal of the rectifying circuit to the output signal of the charging condenser when the timer counts the predetermined period after the shutdown of the power source has been detected.

11. The disk device according to claim 9 further comprises:

a VCM driver;

a first pair of linked switches for coupling the VCM driver to the VCM; and

a second pair of linked switches for forming an unloading current path between the power switching circuit and a ground potential through the VCM.



12. The disk device according to claim 9, wherein the head unloading circuit further comprises a power source voltage boosting circuit for providing a boosted voltage to the condenser.

13. The disk device according to claim 9, wherein:
the condenser supplies a greater amount of electric energy to the VCM than the back electromotive force rectifying circuit to the VCM for positioning the head mechanism onto the ramp block.

14. The disk device according to claim 12, wherein the power source voltage boosting circuit supplies to the condenser a boosted voltage which is approximately double the voltage of the power source.

15. The disk device according to claim 10, wherein the timer is driven by utilizing the power supplied from the condenser.

16. The disk device according to claim 10, wherein the timer is driven by utilizing the power supplied from the back electromotive force rectifying circuit.

17. A method for unloading a read/write head in a disk device comprising:
controlling a circuit to sequentially supply power from a first power source and a second
power source to move a head mechanism from an operative position to a rest position.



18. A method according to claim 17, further comprising supplying a greater voltage from the second power source than from the first power source.

19. A method according to claim 17, wherein the controlling includes:
using the first power source to move the head mechanism to a ramp mechanism;
and
using the second power source to move the head onto the ramp mechanism.

20. A method for unloading a read/write head in a disk device comprising:
using a spindle motor (SPM) to rotate at least one disk medium;
storing charges generated during normal operation of the disk memory device;
rectifying back electromotive forces generated by the inertia of the spindle motor to move a head mechanism from an operative position to an intermediate position; and
using the stored charges to move the head mechanism into a rest position.

21. A method according to claim 20, wherein:
the rectifying employs a rectifying circuit to rectify the back electromotive forces; and

the storing includes storing the charges in a condenser.

22. A method according to claim 21, further comprising:
supplying a voltage from the rectifying circuit to a voice coil motor (VCM); and

supplying a voltage from the condenser to the VCM that is greater than



the voltage supplied from the rectifying circuit to the VCM.

23. A method according to claim 20, further comprising moving the head mechanism onto a ramp mechanism in the rest position.

24. A method for unloading a read/write head in a disk device comprising:
driving a spindle motor(SPM) to rotate at least one disk medium;
employing a voice coil motor(VCM) to move a head mechanism radially along the disk medium;

boosting a voltage of a power source and charging a condenser with the boosted voltage during a normal operation of the device;

generating a head unloading instruction signal by detecting a shutdown of the power source;

rectifying a back electromotive force produced by the inertia of the rotations of the SPM after the shutdown of the power source occurs;

supplying the rectified back electromotive force to the VCM as an unloading drive power for moving the head mechanism toward a ramp mechanism based on the head unloading instruction signal;

counting a predetermined period after the detection of the shutdown of the power source; and

supplying an output signal received from the charged condenser when the predetermined period has elapsed to move the head mechanism onto the ramp mechanism.



25. The method for unloading a read/write head in a disk device according to claim 24, wherein the counting of the predetermined period is achieved by a timer that counts the rotation pulses of the spindle motor.

26. The method for unloading a read/write head in a disk device according to claim 24, further comprising:

using a pair of linked first switches to establish an ON/OFF switch connection between a VCM drive circuit and terminals of the VCM;

supplying the unloading power to the VCM by coupling a power source switching circuit and the VCM through a pair of linked second switches.

27. The method for unloading a read/write head in a disk device according to claim 24, wherein an electric energy from the condenser to the VCM is greater than the rectified back electromotive force supplied to the VCM.

28. The method for unloading a read/write head in a disk device according to claim 24, wherein the boosting supplies approximately twice as much voltage as the voltage of the power source supplied to the condenser.

29. The method for unloading a read/write head in a disk device according to claim 26, wherein the timer is driven by a charged power of the condenser.

30. The method for unloading a read/write head in a disk device according to claim 26, wherein the timer is driven by the rectified back electromotive force.

