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MAGNETIC HEAD DEVICE

Field of the Invention

The present invention relates to a magnetic head device including a slider having a magnetic head mounted thereon, a resilient suspension structure carrying the slider and a head IC chip. The present invention further pertains to a magnetic disc device provided with such magnetic head device.

Prior Art

In conventional magnetic head devices having a magnetic head for writing and/or reading information on a magnetic recording medium such as a magnetic disc, it has been common to mount the magnetic head on a slider which is maintained in a floating relationship with respect to the magnetic recording medium. The slider is generally formed from a resilient metallic material sheet which is arranged to extend from a movable arm structure and supported by a suspension member.

The movable arm is provided for supporting one end of the suspension member and it has been common to mount a head IC chip on the movable arm. The head IC is provided for including electronic circuits for amplifying writing current which is to be suppled to the magnetic head and reading voltage from the magnetic head, and for controlling the writing and/or reading operation. In an arrangement wherein the head IC chip is mounted on the movable arm, an increased length of connecting lead is required between the head IC chip and the magnetic head and this increased length of the

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connecting lead may be a cause of noise generation. Such increased length of the connecting lead may produce a parasitic capacitance and an inductance which have an effect of undesirably increasing rising time and falling time of pulse signals. Thus, high speed data transmission will be disturbed.

In order to solve the problems, there has been proposed by the Japanese Laid-Open Patent Publication No. Sho 53-69623 to mount the head IC chip on the slider. Further, the Japanese Laid-Open Patent Publication No. Hei 3-108120 proposes to divide the head IC into an IC main body and an IC sub-body, and mount the IC main body on the movable arm supporting the suspension member and the IC sub-body on the slider or the suspension member.

In these known structures, it is possible to decrease to a certain extent the distance between the head IC chip and the magnetic head so that it may be possible to suppress noise which may otherwise be produce because of the length of the connecting lead. However, the structure has another unsolved problem in that the temperature of the IC chip is increased due to the writing current which flows through the head IC chip during recording operation. It should further be noted that in the structure the IC chip is located close to the magnetic head so that the magnetic head may receive an adverse thermal effect from the head IC chip which generally generates heat in operation.

More specifically, in a structure where the head IC chip is mounted on the movable arm which has a sufficient thermal capacity as well as a substantial area for heat

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radiation, the temperature of the IC chip can be maintained sufficiently low. Further, since the head IC chip is located far from the magnetic head, there is least possibility that the magnetic head is adversely affected by the heat generated in the head IC chip. To the contrary, where the head IC chip is located on the slider, it is difficult to ensure sufficient surface area for heat dissipation so that it cannot be expected to have the temperature of the IC chip decreased through dissipation of heat. It should further be noted that the slider usually has a limited thermal capacity so that it cannot be an effective tool for providing a temperature deacrease through thermal conduction. As the result, there will be a possibility in the aforementioned structures that the temperature of the head IC chip is undesirably increased to an extent that the reliability of the IC chip will be lowered. It should further be noted that since the magnetic head is located close to the head IC chip the magnetic head is thermally affected by the heat generated in the head IC chip. Thus, the temperature of the magnetic head itself may increase to an unacceptable level. Similar problem will also be encountered in a structure where the head IC chip is located on the suspension member if the location of the head IC chip is close to an tip end of the suspension member.

Summary of the Invention

It is therefore an object of the present inventioin to provide a magnetic head device of the type as described above wherein the temperature increase in the head IC chip can be suppressed to a satisfactory level and the heat generated in the head IC chip is effectively prevented from being transmitted to the magnetic head.

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It is another object of the present invention to provide a magnetic head device wherein noise caused by the connecting lead between the head IC chip and the magnetic head can be suppressed so that a high speed data transmission is made practical.

It is another object of the present invention to provide a magnetic disc device which includes the aforementioned magnetic head device.

According to one aspect of the present invention, the is provided a magnetic head device including a slider having a magnetic head thereon, a suspension structure having one end supporting the slider, and a head IC chip which is mounted on said suspension structure at a side adapted to face to a recording medium.

According to another aspect of the present invention, there is provided a magnetic head device including a slider having a magnetic head thereon, a suspension structure formed from a resilient metallic sheet and having one end supporting the slider, and a head IC chip, the suspension structure being attached at the other end to another member such as a movable arm, the head IC chip being mounted on the suspension structure at a location defined by $0.2 \leqq Lb/La \leqq 1$, where La is a distance between the slider and the point of connection of the slider to the aforementioned other member, and Lb is a distance between the slider and the head IC chip.

In the aforementioned aspect of the present invention wherein the head IC chip is mounted on the suspension structure at the side facing to the magnetic recording

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medium, the magnetic recording medium is moved relative to the slider and the head IC chip and there is produced flow of air between the magnetic recording medium and the slider and also between the magnetic recording medium and the head IC chip. Usually, the slider and the head IC chip are held stationary and the magnetic recording medium is in the form of a rotatably driven disc. Then, flow of air is produced as the magnetic recording disc rotates in the vicinity of the surface of the disc and serves to cool off the head IC chip. As the result, the temperature of the head IC chip can be suppressed to a substantially low value.

In this aspect of the present invention, it is preferable that the height of the head IC chip as measured in the mounted state from the suspension structure is smaller than the height of the slider. In this instance, the head IC chip is preferably in the form of a bare chip which is p-preferably mounted or attached to the suspension structure by means of flip-chip-bonding. By adopting the flip-chip-bonding for mounting such bare chip, it is possible to decrease the height of the head IC chip in the mounted state. Therefore, with this arrangement, the IC chip can be mounted on the recording medium side of the suspension structure without having any risk of the head IC chip interfering with the magnetic recording medium in use.

In an arrangement wherein the suspension structure is attached at the other end to the other member such as a movable arm, it is preferable that the location of the head IC chip on the suspension structure be, in terms of La which is a distance between the slider and the point of connection of the slider to the aforementioned other member, and Lb

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which is a distance between the slider and the head IC chip, within a range $0.2 \leqq Lb/La \leqq 1$, more preferably within a range $0.3 \leqq Lb/La \leqq 0.7$, and most preferably within a range $0.4 \leqq Lb/La \leqq 0.6$.

In a structure wherein the head IC chip is mounted on the suspension structure, it may be possible because of a thin structure of the suspension that heat may not be sufficiently dissipated nor conducted depending on the location of the head IC chip as described with reference to the prior art. Thus, there is a risk that the temperature of the IC chip is increased to an unacceptable level and the magnetic head may receive an adverse thermal effect from the high temperature IC chip. It has now been found that the temperature of the head IC chip is greatly increased when the IC chip is mounted on the suspension structure at a location close to its tip end. The reason for this is understood that the thermal conduction takes place substantially in one direction only so that the IC chip cannot be cooled off sufficiently. It has also been realized that the temperature of the magnetic head increases higher as the location of the IC chip becomes closer to the tip end of the suspension structure. This is because the IC chip which is considered as a heat source is located close to the magnetic head. It has also been found that, in the structure of the aforementioned prior art wherein the head IC chip is mounted on the slider, both the temperature of the IC chip itself and that of the magnetic head increase to an extremely high level.

It should be noted that in the aforementioned aspect of the present invention wherein the head IC chip is mounted

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on the suspension structure at the side facing to the magnetic recording medium and the location on the suspension structure in the range as defined, it is possible to maintain the temperature of the IC chip sufficiently below an acceptable level and to suppress the temperature of the magnetic head to a low value.

The suspension structure may be made of a resilient metallic material such as a corrosion resistant steel. It is preferable that the head IC chip be attached to a surface of the suspension structure through a layer of an electrically insulating material such as a resin material like polyimide.

In a preferable mode of the present invention, the suspension structure comprises a load beam formed from resilient metallic material such as a corrosion resistant steel, and a flexure member made of a resilient metallic material such as a corrosion resistant steel having a width smaller than the load beam and provided on a side of the load beam where the head IC chip is to be attached. It is preferable that the flexure member is coated with a first layer of an insulating material such as a resin material like polyimide, and at least one conductive layer is provided on the first insulating layer to form a portion of connecting lead or leads for connection with the magnetic head and the head IC chip. It is also preferable to cover the conductive layer with a second layer of an insulating material such as a resin material like polyimide. In this instance, it is preferable to locate the head IC chip on the second insulating layer and connected with the conducive layer by soldering.

In the mode of the present invention wherein the head

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IC chip is mounted on the suspension structure at the side facing to the magnetic recording medium, it is preferable that the surface of the head IC chip facing to the magnetic recording medium has such a configuration that a substantial heat dissipating area can be ensured. More specifically, the head IC chip may have a wide and flat surface at the side facing to the magnetic recording medium. Alternatively, the head IC chip may have a rough surface at the side facing to the magnetic recording medium or an undulated surface as well. In a still alternative structure, the head IC chip may be formed at the side facing to the magnetic recording medium with one or more grooves for allowing flow of air to pass through. The groove or each of the grooves may have a width which is large at an end opposite to the direction of movement of the magnetic recording medium with respect to the head IC chip and gradually decreasing toward the direction of the movement of the medium.

It is preferred that the head IC chip has a mass less than 1.0 mg so that the head IC chip may not have any adverse effect on the mechanical vibration characteristics of the suspension structure when the chip is mounted on the suspension structure.

It is further preferable in the magnetic head device and the magnetic disc device having a magnetic recording disc located to be opposed to the magnetic head of the magnetic head device that the spacing between mutually facing surfaces of the head IC chip and the magnetic disc is maintained to be less than 1000 μm. It has been found that with this arrangement, the cooling effect of air flow can be enhanced and the temperature of the head IC chip can always be

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maintained below 150 ℃.

It should further be noted that in another aspect of the present invention there is provided a magnetic disc device comprising a magnetic head device and a rotatable magnetic recording disc. The magnetic head device includes a slider having a magnetic head thereon and a suspension structure having one end supporting the slider. The magnetic head is arranged so that it is faced to the magnetic head of the magnetic head device. There are provided a head IC chip and at least one connecting lead member for connecting the magnetic head with the head IC chip. The head IC chip is mounted on the connecting lead member at a location where the head IC chip is always exposed to flow of air which is produced by a rotation of the magnetic recording disc.

According to the arrangement wherein the head IC chip is mounted on the connecting lead member at a location where the head IC chip is always exposed to flow of air which is produced by a rotation of the magnetic recording disc, the head IC chip is always exposed to a cooling air flow throughout the stroke of the movement of the magnetic head between the inner and outer peripheries of the recording area of the magnetic recording disc so that the temperature increase in the IC chip can be substantially suppressed.

It is preferred that in the aforementioned arrangement the head IC chip is located radially inside the outer periphery of the magnetic recording disc and is opposed to the disc. It is also preferable in order to enhance the cooling effect by the air flow that the distance between the opposing surfaces of the head IC chip and the rotating

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magnetic recording medium is maintained to be less than 1000 μm. It is possible with this arrangement to suppress the temperature of the head well below 150 ℃.

Brief Description of the Drawings

Figure 1 is a perspective view showing essential portion of the magnetic disc device having a magnetic head device in accordance with one embodiment of the present invention;

Figure 2 is a side view showing a carriage arrangement adopted in the embodiment shown in Figure 1;

Figure 3 is a plan view showing an example of the magnetic head device in the embodiment of Figure 1 as seen from a side of the magnetic recording disc;

Figure 4 is a sectional view taken substantially along the line A-A in Figure 3;

Figure 5 is a sectional view taken substantially along the line B-B in Figure 3;

Figure 6 is a diagram showing the temperature change in the IC chip in relation to the writing current;

Figure 7 is a diagram showing the temperature change in the suspension structure at the side opposite to the IC chip in relation to the writing current;

Figure 8 is a diagram showing the temperature change

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in the slider in relation to the writing current;

Figure 9 is a diagrammatical illustration designating the distance D between opposing surfaces of the head IC chip and the magnetic recording disc in the embodiment of Figure 1;

Figure 10 is a diagram showing the temperature change in the head IC chip in reflation to the distance between the opposing surfaces of the IC chip and the magnetic recording disc;

Figure 11 is a diagram showing the relationship between the location of the head IC chip and the temperature of the head IC chip in operation;

Figure 12 is a diagram showing the relationship between the location of the head IC chip and the temperature of the slider during operation;

Figure 13 shows various possible configuration of the head IC chip;

Figure 14 is a side view of the structure around the carriage assembly; and,

Figure 15 is a diagrammatical illustration similar to Figure 9 but showing another example of the distance D.

Description of the Preferred Embodiment

Referring now to the drawings, particularly to Figure

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1, there is shown in a perspective view a magnetic disc device using a magnetic head device in accordance with one embodiment of the present invention. Figure 2 shows a carriage assembly used in the magnetic disc device shown in Figure 1.

In the arrangement shown in the drawings, it will be understood that a plurality of magnetic recording discs 10 are provided for rotation about an axis of a shaft 11. The magnetic recording discs 10 are rotated by a mechanism which is well known in the art. Adjacent to the magnetic recording discs 10, there is provided a carriage assembly 12 for locating sliders with respect to the discs 10. Each of the sliders has a magnetic head mounted thereon. The carriage assembly 12 primarily comprises a carriage 14 which is rotatable about a shaft 13 and an actuator 15 such as a voice coil motor (VCM) for rotationally driving the carriage 14.

The carriage 14 supports a plurality of movable arms 16 which are stack one over the other along the shaft 13 and attached to the carriage 14 at the base ends thereof. Each of the movable arms 16 has one or two magnetic head devices 17 mounted on tip ends of the movable arms 16. Each of the magnetic head devices 17 is structured in the form of a head suspension assembly including a suspension structure 18 carrying at its tip end a slider 19 having a magnetic head and at its intermediate portion a head IC chip 20. Both of the slider 19 and the head IC chip 20 are mounted on the suspension structure 18 at a side facing to one of the recording surfaces of respective one of the magnetic recording discs 10 so that they are opposed to the one recording surface of the disc 10.

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There is provided a connecting lead cable comprising a flexible print cord (FPC) 21 which is connected with an internal circuit (not shown) in the magnetic disc device. The connecting lead cable has a tip end which is divided into a plurality of end portions extending to tip ends of the respective ones of the movable arms 16 in the carriage 14.

Figure 3 is a plan view showing the magnetic head device 17 of the embodiment of Figure 1 as seen from the side facing to the magnetic disc 10. Figure 4 is a sectional view in an enlarged scale taken along the line A-A in Figure 3. Figure 5 is a sectional view taken along the line B-B in Figure 3.

As shown in Figure 3, the suspension structure 18 includes a load beam 31 and a flexure member 30 secured to the load beam at one side thereof. The flexure member 30 has one end carrying the slider 19 and supports the head IC chip 20 on its intermediate portion. The load beam 31 has a base plate 32 which is formed at a root end portion of the load beam 31.

In the illustrated embodiment, the flexure member 30 is made of a sheet of a corrosion resistant steel (for example, SUS304TA) of approximately 25 mm thick. The flexure member 30 is smaller in width than the load beam 31. To provide the flexure member 30 with a corrosion resistant steel sheet as described is advantageous as compared with a structure wherein the flexure member is totally made of plastics material. Where the flexure member is totally made of plastics material, flatness of the slider attachment surface may very often not be satisfactory, and the slider

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attachment surface may be accurately parallel with the movable arm attachment surface. By providing the flexure member 30 with a corrosion resistant steel as described, the aforementioned problems can be avoided.

On the flexure member 30, there is formed a pattern of thin film electrically conductive layer 33 providing a required number of connecting leads which extend along the length of the flexure member 30. The connecting leads of the conductive layer 33 have ends adjacent to the base plate 32 connected with connecting terminals 34 which are in turn connected with respective ones of connecting leads formed in the flexible print cord 21 constituting the connecting cable. The other ends of the connecting leads in the conductive layer 33 are connected with connecting terminals 35 provided on the tip portion of the flexure member 39.

The thin film pattern can be formed by means of a known patterning process which are generally adopted in providing a print board on a metallic plate. More specifically, as shown in Figures 4 and 5, the flexure member 30 is covered by a first layer 36 of an electrically insulation material such as a resin material like polyimide. The first layer may be approximately 5 μm thick. On the first layer 36, there is formed a patterned layer 33 of an electrically conductive material such as copper, which is covered by a second layer 37 of an electrically insulation material such as a resin like polyimide. The second layer 37 may be 5 μm thick. These layers can be formed in this order on the flexure member 30 by a laminating technique. The connecting terminals 34 and 35 may be formed by laminating layers of nickel or gold on the layers of copper. The connecting terminals are not

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covered by the second insulation layer 37. In Figure 3, the conductive layer 33 is shown by solid lines for clarity although it is covered by the second insulation layer 37.

The load beam 31 is made of a corrosion resistant steel sheet having a thickness of approximately 70 to 75 μm and is configured to have a width gradually decreasing from the end adjacent to the base plate to the tip. The load beam 31 supports the flexure member 30 throughout its length. The flexure member 30 is connected to the load beam 31 through a plurality of welding points.

The base plate 32 is made of a corrosion resistant steel or iron and secured to the base portion of the load beam by welding. The suspension structure 18 is attached to the movable arm 16 by securing the base plate 32 thereto at the attachment 38. The base plate 32 may not necessarily be a separate part but may be made integrally with the load beam 31.

As already described, the slider 19 having a magnetic head 39 is mounted on the flexure member 30 by placing the magnetic head 39 on the second insulation layer 37 as shown in Figure 4. In Figure 3, it will be noted that the conductive layer 33 providing a required number of leads passes along the opposite sides of the slider 19 to the tip end of the flexure member 30 and then turned back from the tip end of the flexure member 30 to be connected with input and output electrodes provided on the slider 19. The portion connecting the conductive layer 33 to the electrodes on the slider 19 is covered by a layer 41 of an electrically insulation material such as a resin. Although not shown in the

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drawings, the flexure member 30 and the load beam 31 may be dimpled at the portion where the slider 19 is to be mounted.

The head IC chip 20 is mounted on the suspension structure 18 at an intermediate portion of its length on the side where the slider 19 is to be mounted. In other words, the head IC chip 20 is mounted on the side of the suspension structure 18 which is opposed to the magnetic disc 10. The head IC chip 20 is preferably in the form of a bare chip desirably having a mass of less than 1.0 mg. With this light weight structure, it is possible to suppress any undesirable mechanical vibration when the chip 20 is mounted on the suspension structure 18.

As shown in detail in Figure 4, the head IC chip 20 is connected by means of a flip-chip bonding using a solder 42 with the conductive layer 33 which is formed on the flexure member 30 of the suspension structure 18 through the first insulation layer 36. The gap between the lower surface of the head IC chip 20 and the first insulation layer 36 and the second insulation layer 37 is filled with a layer 43 of an insulation material having a good thermal conductivity such as a mixture of a resin like polyimide and an electrically insulation material so that heat generated in the IC chip 20 is dissipated through conduction through the insulation layer 43 to the suspension structure 18.

As already described, the head IC chip 20 is mounted on the suspension structure 18 at the side facing to the magnetic disc 10 which is rotated with respect to the slider 16 and head IC chip 20 which are held stationary. Thus, flow of air produced by the rotating magnetic disc 10 in the

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vicinity of the surface thereof flows around the head IC chip 20 to cool the IC chip. It is therefore possible to suppress increase in temperature of the IC chip 20 to a substantial extent even when the writing current is flowing through the IC chip. As the result, it is also possible to suppress increase in temperature of the slider 19.

Referring to Figures 6, 7 and 8, there are respectively shown the temperature change in head IC chip 20, the temperature change in the surface of the suspension structure 18 at the location of IC chip and the temperature change of the slider 19 with respect to a change in the write current. In the drawings, the curve a designate the temperature when the write current is continuously supplied while the magnetic disc 10 is stationary, b the temperature when the write current of 50 % duty factor is supplied while the magnetic disc 10 is stationary, c the temperature when the write current is continuously supplied while the magnetic disc 10 is rotated with a linear speed of 24.9 m/sec, and d the temperature when the write-in current of 50 % duty factor is supplied while the magnetic disc 10 is rotated with a linear speed of 24.9 m/sec.

In Figure 6 and 7, it will be understood that the temperature increase in the head IC chip 20 itself and that in the chip mounting surface of the suspension structure 18 can be suppressed to a substantial degree when the magnetic disc 10 is rotated as compared with the situation wherein the magnetic disc 10 is stationary, since the head IC chip 20 is cooled be the flow of air which is produced by the rotating magnetic disc 10. It will also be noted in Figure 8 that the temperature increase in the slider 19 can be maintained at

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a low value when the magnetic disc is rotated. This is because the temperature in the head IC chip 20 does not increase to a noticeable level and the slider 19 itself is also cooled by the flow of air.

In order that the head IC chip 20 be effectively cooled by the flow of air produced by the rotating magnetic disc 10, it is desirable to maintain as small as possible the distance D between the IC chip 20 and the surface of the magnetic disc 10 facing to the IC chip 20. It should however be noted that care must be taken that the head IC chip 20 does not contact with the surface of the magnetic disc 10.

The inventors have noticed through research that, with the distance D between the IC chip 20 and the surface of the magnetic disc 10 facing to the IC chip 20 not larger than 1000 μm, it is possible to maintain the temperature of the IC chip 20 to a sufficiently low value, for example below 150 ℃. Figure 10 shows changes in temperature in the IC chip 20 with respect to the distance D between the IC chip 20 and the surface of the magnetic disc 10 facing to the IC chip 20. The data shown in Figure 10 is the one which has been obtained through a relatively severe condition wherein the write current of 40 mA is continuously supplied under an environmental temperature of 50 ℃ which corresponds to the working temperature in the magnetic disc device. It is generally understood that the permissible temperature at the junctions in the IC of the chip is 150 ℃ at the highest. If the IC is operated for an extended time under a temperature exceeding 150 ℃, transistor junctions or other parts may gradually be led to failure. As noted in Figure 10, however, it is possible to maintain the temperature of the IC chip 20

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below the critical temperature of 150 ℃ by maintaining the distance D not larger than 1000 μm.

With the structure adopting the bare chip element for the head IC chip 20 and mounting the head IC chip by flip-chip bonding, the overall height of the head IC chip as mounted can be kept to a lower value. More specifically, referring to Figure 4, it is recommendable to provide the relationship H1<H2 where H1 is the height of the head IC chip 20 as mounted as measured from the upper surface of the load beam 31 and H2 is the height of the slider 19 as mounted as measured from the upper surface of the load beam 31. It will thus be noted that even with the structure where the head IC chip 20 is mounted on the suspension structure 18 at the side facing to the magnetic disc 10, it is possible to completely avoid any interference between the head IC chip 20 and the surface of the magnetic disc 10.

It is preferable to determine the distance Lb between the slider 19 and the head IC chip 20 and the distance La between the slider 19 and the mounting point 38 of the suspension structure 18 as shown in Figure 3 so that the ratio Lb/La is in the range between 0.2 and 1. In Figure 11, there is shown a relationship between the temperature in the head IC chip 20 during operation and the ratio Lb/La. In Figure 12, there is shown a relationship between the temperature in the slider 19 during operation and the ratio Lb/La. In these figures, it will be noted that the temperature in the head IC chip 20 as well as that in the slider 19 will increase beyond a permissible value when the head IC chip 20 is located too close to the slider 19.

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As shown in Figure 11, the temperature in the head IC chip 20 decreases as the location of the head IC chip 20 is moved away from the slider 19 and the temperature will become below the permissible limit when the ratio Lb/La increases up to 0.2. As the location of the head IC chip 20 is moved further away from the slider 19 beyond this point, the temperature of the head IC chip is further decreased and maintained at a substantially constant value in the range of the ratio Lb/La between 0.4 and 0.6. Thereafter, as the location of the head IC chip 20 is moved further away from the slider 19, the temperature in the head IC chip 20 shows a tendency of gradual increase to reach a peak value at the ratio Lb/La of 0.8 to again decrease.

In Figure 11, it will be noted that the temperature in the head IC chip 20 in operation is below the acceptable upper limit with $Lb/La < 0.2$ and the temperature is lower in the range $0.3 \leqq Lb/La < 0.7$ than at the Lb/La value of 0.2. It should further be noted that more preferable results can be obtained with the range $0.4 \leqq Lb/La < 0.6$. As far as the temperature of the head IC chip 20 is concerned, a preferable result can be obtained with the location of the head IC chip 20 closer to the point 38 of the attachment. However, locating the head IC chip 20 too far from the magnetic head is not recommendable. Therefore, the permissible range for the location of the head IC chip 20 is $0.2 \leqq Lb/La <$, preferably, $0.3 \leqq Lb/La < 0.7$, and more preferably $0.4 \leqq Lb/La < 0.6$.

In Figure 11, it will further be noted that the temperature of the head IC chip 20 in operation shows a low value with the head IC chip 20 located in the vicinity of the

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longitudinally center of the suspension structure 18. It is understood that this tendency is derived by the fact that the heat in the head IC chip 20 is conducted in opposite directions along the length of the suspension structure 18 both toward the base portion and the tip end thereof. This tendency has been confirmed with the TYPE 1930 and TYPE 830 suspension structures, however, it is understood that this tendency will be seen in any type of suspension structures.

As shown in Figure 12, the temperature of the slider 19 in operation decreases as the location of the head IC chip 20 is away from the slider 19. It will therefore be understood that the location of the head IC chip 20 in the range as described above is also effective to maintain the temperature of the slider 19 and therefore the temperature of the magnetic head 39 within the permissible range.

As regards the configuration of the head IC chip 20, it is preferable that the heat radiating area at the side facing to the magnetic disc 10 be as large as possible. More specifically, as shown in Figure 13(A), the IC chip 200 may be a thin flat configuration having a substantial area on the surface 200a facing the magnetic disc 10. In an alternative configuration shown in Figure 13(B), the IC chip 201 may have an undulated surface configuration at the side facing to the magnetic disc 10. In this instance, it is preferable that recesses in the undulated pattern be directed substantially parallel to the direction of the flow of air. In a still alternative configuration shown in Figure 13(C), the IC chip 202 may have a rough surface 202a at the side facing to the magnetic disc 10. In a still further alternative structure shown in Figure 13(D), the IC chip 203 may be provide with

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a surface 203a facing to the magnetic disc 10 having one or more grooves 203b for allowing the flow of air to pass through. The groove 203b may have a wide opening opposing to the flow of air and a width gradually decreasing toward the other end along the direction of rotation of the magnetic disc 10. Still further, although not shown in the drawings, the IC chip may be provided at a side facing to the magnetic disc 10 with fins or projections which may increase the capability of heat radiation.

In order that the heat dissipation be enhanced by anyone of the surface configurations of the head IC chip as shown in Figure 13, it is advisable to mount the IC chip by flip-chip bonding on the suspension structure as already described.

Referring now to Figure 14, there is shown the structure around the carriage assembly in the magnetic disc device in accordance with one embodiment of the present invention.

In the structure illustrated therein, the head IC chip 20 is not mounted on the suspension structure 18 but mounted on the connecting lead member such as the flexible print cord 21 which is connected with an internal circuit of the magnetic disc device. It should however be noted that, in this structure, the IC chip 20 is located inside the outer periphery of the magnetic recording disc 10 during operation and is confronted to the magnetic recording disc 10. The connecting lead member such as the flexible print cord 21 may be secured to the movable arm 16 or, alternatively, held apart from the movable arm 16.

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Thus, it will be noted that the head IC chip 20 is located at a position on the connecting lead member where the IC chip 20 is subjected during operation to the flow of air produced by the rotation of the magnetic disc 10. It will therefore be understood that the IC chip 20 receives always a cooling action by the flow of air throughout the stroke of the movement of the magnetic head for seeking operation between the inner and outer peripheries of the magnetic disc 10. As the result, it is possible to decrease temperature increase in the IC chip to a substantial extent.

In order to cool the head IC chip effectively by the flow of air produced by the rotation of the magnetic disc 10, it is preferable that the distance D between the IC chip 20 and the surface of the magnetic disc 10 facing to the IC chip 20 as shown in Figure 15 be maintained as small as possible. In this instance, care must be taken so that any interference between the IC chip 20 and the adjacent surface of the magnetic disc 10 is avoided. As in the embodiment of Figure 1, it is possible in the present embodiment to maintain the temperature of the IC chip 20 below 150 ℃ with the distance D between the IC chip 20 and the adjacent surface of the magnetic disc 10 not larger than 1000 μm.

In other respects, the structure and function of this embodiment are the same as those in the embodiment of Figure 1.

It should be noted that the embodiments illustrated and described above are examples only but not restrictive, so that it should be understood that the invention can be put into practice with changes and modifications in various

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ways. Therefore, the invention shall be limited only by the scope of the appended claims and its equivalents.

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CLAIMS:

1. A magnetic head device comprising at least one slider having a magnetic head, at least one suspension structure having one end supporting the slider, and at least one head IC chip, said head IC chip being mounted on said suspension structure at a side adapted to be faced to a magnetic recording medium.

2. A magnetic head device in accordance with claim 1, wherein the head IC chip has a height as measured from said suspension structure in a mounted state which is smaller than a height of the slider as measured from the suspension structure as mounted on the suspension structure.

3. A magnetic head device in accordance with one of claim 1 or 2, wherein the other end of the suspension structure is attached to another member, said head IC chip being mounted on said suspension structure at a location as defined by,

$$0.2 \leqq Lb/La \leqq 1$$

where La is a distance between said slider and a point of attachment of the suspension structure to said other member, and Lb a distance between said slider to said head IC chip.

4. A magnetic head device comprising at least one slider having a magnetic head, at least one suspension structure made of a thin resilient metal and having one end supporting the slider, said suspension structure being attached at the other end to another member, and at least one head IC chip, said head IC chip being mounted on said suspension structure at a location as defined by,

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$0.2 \leqq Lb/La \leqq 1$

where La is a distance between said slider and a point of attachment of the suspension structure to said other member, and Lb a distance between said slider to said head IC chip.

5. A magnetic head device in accordance with anyone of claims 1 to 4, wherein said head IC chip is a bare chip.

6. A magnetic head device in accordance with anyone of claims 3 to 5, wherein said location of said head IC chip on said suspension structure is in a range as defined by $0.3 \leqq Lb/La \leqq 0.7$.

7. A magnetic head device in accordance with anyone of claims 3 to 5, wherein said location of said head IC chip on said suspension structure is in a range as defined by $0.4 \leqq Lb/La \leqq 0.6$.

8. A magnetic head device in accordance with anyone of claims 1 to 7, wherein said suspension structure is made of a resilient metal, the head IC chip being attached to said suspension structure through an electrically insulation material provided on said suspension structure.

9. A magnetic head device in accordance with anyone of claims 1 to 8, wherein said suspension structure comprises a load beam made of a resilient metallic material and a flexure member made of a resilient metallic material which is smaller in width than said load beam and provided on said load beam at a side where said head IC chip is to be attached, a first layer of an electrically insulation material formed on said flexure member, at least one

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conductive layer provided on said first insulation layer for providing a portion of at least one connecting lead for connecting to said magnetic head or said head IC chip, and a second layer of an electrically insulation material covering said conductive layer.

10. A magnetic head device in accordance with claim 9, wherein said head IC chip is located on said second insulation layer and connected with said conductive layer through soldering.

11. A magnetic head device in accordance with anyone of claims 1 to 9 wherein said head IC chip is mounted on said suspension structure by flip-chip bonding.

12. A magnetic head device in accordance with anyone of claims 1 to 11 wherein said head IC chip has a configuration with a surface opposite to said suspension structure which has a large heat radiating area.

13. A magnetic head device in accordance with claim 12 wherein said surface of said head IC chip opposite to said suspension structure is of a planar configuration of a large area.

14. A magnetic head device in accordance with claim 12 wherein said surface of said head IC chip opposite to said suspension structure is of a large surface roughness.

15. A magnetic head device in accordance with anyone of claim 12 or 13 wherein said surface of said head IC chip opposite to said suspension structure is of an undulated

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configuration.

16. A magnetic head device in accordance with anyone of claim 12 or 13 wherein said surface of said head IC chip opposite to said suspension structure has at least one groove having an opening at an end opposing to a direction of movement of said magnetic recording medium and a width which gradually decreases in the direction of the movement of said magnetic recording medium.

17. A magnetic head device in accordance with anyone of claim 1 to 16 wherein said head IC chip has a mass smaller than 1.0 mg.

18. A magnetic disc device comprising a magnetic head device as defined by anyone of claims 1 to 17 and a magnetic disc located to be opposed to the magnetic head of said magnetic head device and adapted to be rotationally driven, the head IC chip of said magnetic head device being mounted on the suspension structure of the magnetic head device at a side facing to said magnetic disc, said head IC chip has a surface opposed to said magnetic disc with a distance between said surface of the head IC chip and an adjacent surface of said magnetic disc smaller than 1000 μm.

19. A magnetic disc device comprising a magnetic head device including a slider having a magnetic head and a suspension structure having one end supporting said slider, a rotatable magnetic disc arranged to be opposed to said magnetic head device, a head IC chip, and a electrically conductive connecting device for establishing an electrical connection between said magnetic head and said head IC chip,

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said head IC chip being located on said connecting device at a position where said head IC chip is always exposed to a flow of air produced by rotations of said magnetic disc.

20. A magnetic disc device in accordance with claim 19 wherein said head IC chip is located inside an outer periphery of said magnetic disc and opposed to said magnetic disc.

21. A magnetic disc device in accordance with claim 20 wherein said head IC chip is located with respect to the magnetic disc with a distance between opposing surfaces of said head IC chip and said magnetic disc is less than 1000 μm.

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