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# DISK DRIVE SUSPENSION


## Abstract

A flexure of a suspension includes a metal base, a circuit portion, and a slider arrangement portion. The slider arrangement portion includes an aperture portion formed in the metal base and a slider support portion provided on the metal base. The aperture portion is provided at a position on which the slider is provided. An embedding circuit portion is provided inside the aperture portion. The embedding circuit portion constitutes a part of a length direction of the circuit portion. The slider support portion supports the slider with the embedding circuit portion being provided in the aperture portion. The embedding circuit portion has an abutting portion contacting a protrusion portion of a load beam.



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## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2024-021019, filed Feb. 15, 2024, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a disk drive suspension comprising a load beam, a flexure, and the like.

2. Description of the Related Art

[0003] A disk drive is used in an information processing apparatus such as a personal computer. The disk drive includes a magnetic disk rotatable about a spindle, a carriage pivotable about a pivot, etc. A disk drive suspension is provided on an arm of the carriage.

[0004] The disk drive suspension comprises a baseplate, a load beam, a flexure arranged along the load beam, and the like. The flexure includes a metal base composed of a thin stainless steel plate and a circuit portion provided along the metal base. The disk drive suspension is simply called a suspension hereinafter.

[0005] A swingable gimbal structure is formed near the tip of the flexure. The gimbal structure includes a slider arrangement portion on which the slider is arranged. A part of the flexure constituting the slider arrangement portion is called a tongue as well. The tongue is formed on a portion of the metal base. The gimbal structure is supported by a protrusion portion formed on the load beam. The protrusion portion is called a dimple as well in the industry. The apex of the protrusion portion (the apex of the dimple) supports the tongue in a swingable manner.

[0006] A slider functioning as a magnetic head is attached to the slider arrangement portion. The slider is provided with elements for accessing data, that is, for reading or writing data stored in a disk. The disk rotates, producing an air bearing between the slider and the disk. The distance between an air bearing formation surface of the slider and the disk surface (Head Media Spacing) is, for example, 10 nm or less. That is, the distance is significantly small.

[0007] JP 4993524 B (Patent Literature 1) discloses an example of the slider and the circuit portion. The circuit portion is connected to the slider. The circuit portion of Patent Literature 1 extends in the length direction of the flexure along a side surface and the other side surface of the slider. The slider is secured to a metal base of the flexure by bonding and the like. In this case, both sides of the slider necessitate space for the circuit portion. This configuration is disadvantageous for achieving more compact suspensions.

[0008] JP 5931624 B (Patent Literature 2) discloses another example of the suspension. The suspension includes a circuit portion between the rear surface of a slider and a metal base. That is, the metal base, the circuit portion, and the slider overlap in the thickness direction. In this case, an adhesive secures the rear surface of the slider to the circuit portion. This configuration can reduce the width of the slider arrangement portion and thus is advantageous for achieving more compact suspensions.

[0009] In the suspension of Patent Literature 2, the circuit portion and the slider overlap in the thickness direction. The circuit portion includes a plurality of independent conductors each covered by a cover resin. Thus, when these conductors and the cover resin are not flush with one another, the slider is inaccurately oriented, which is disadvantageous. Further, the metal base, the circuit portion, and the slider overlap in the thickness direction. This configuration further disadvantageously increases the distance between the apex of the dimple and the air bearing formation surface of the slider by the thickness of the circuit portion.

[0010] The present invention aims to provide a suspension capable of stabling an orientation of a slider provided on the slider arrangement portion.

BRIEF SUMMARY OF THE INVENTION

[0011] An embodiment is a disk drive suspension comprising a load beam and a flexure. The flexure includes a metal base, a circuit portion provided along the metal base, and a slider arrangement portion on which the slider is arranged. The slider arrangement portion includes an aperture portion formed in the metal base, a slider support portion formed on the metal base, an embedding circuit portion constituting a part of a length direction of the circuit portion, and an abutting portion. The slider support portion supports the slider. A protrusion portion of the load beam abuts the abutting portion. The aperture portion is provided at a position in which the slider is provided. The slider is supported by the slider support portion with the embedding circuit portion being provided in the aperture portion.

[0012] An embodiment of the present invention can stable the orientation of the slider provided on the slider arrangement portion, in the suspension comprising the circuit portion, the slider arrangement portion, and the like.

[0013] In the suspension of the present embodiment, the embedding circuit portion may include a base resin layer, a conductor along the base resin layer, a cover resin covering the conductor, and an abutting portion. The slider arrangement portion may include a foundation resin overlapping the base resin layer. A metal portion composed of a part of the metal base may be provided inside the aperture portion. The metal portion may include the slider support member. The metal portion may include the abutting portion.

[0014] The embedding circuit portion may include a load beam-side face facing the load beam, a slider-side face facing the slider, a first conductor, and a second conductor. The first conductor includes a terminal portion exposed to the load beam-side face. The second conductor includes a terminal portion exposed to the slider-side face. A ground conductor for electrically connecting the metal base and the conductors of the embedding circuit portion may be provided.

[0015] The slider support portion may include the metal portion and an electrically insulating pedestal member provided between the metal portion and the slider. The slider support portion may include a first pedestal member and a second pedestal member, the first pedestal member and the second pedestal member being electrically insulating. The first pedestal member covers the aperture portion. The second pedestal member is provided between the slider and the first pedestal member.

[0016] Additional objects and advantages of the invention will be set forth in the description which 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 hereinafter.

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## Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0017] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

[0018] FIG. **1** is a perspective view of a suspension of the first embodiment.

[0019] FIG. **2** is a plan view showing a part of this suspension.

[0020] FIG. **3** is a cross-sectional view showing an example of a disk drive.

[0021] FIG. **4** is a cross-sectional view of a slider arrangement portion along F**4**-F**4** line in FIG. **2**.

[0022] FIG. **5** is a cross-sectional view of the slider arrangement portion along F**5**-F**5** line in FIG.

**4**.
[0023] FIG. **6** is a cross-sectional view of a slider arrangement portion of the second embodiment.
[0024] FIG. **7** is a cross-sectional view of a slider arrangement portion of the third embodiment.
[0025] FIG. **8** is a cross-sectional view of a slider arrangement portion of the fourth embodiment.
[0026] FIG. **9** is a cross-sectional view of a slider arrangement portion of the fifth embodiment.
[0027] FIG. **10** is a cross-sectional view of a slider arrangement portion of the sixth embodiment.
[0028] FIG. **11** is a cross-sectional view of a slider arrangement portion of the seventh embodiment.
[0029] FIG. **12** is a cross-sectional view of a slider arrangement portion of the eighth embodiment.

## DETAILED DESCRIPTION OF THE INVENTION

### First Embodiment

[0030] The following describes a suspension comprising a slider arrangement portion of the first embodiment with reference to FIG. **1** to FIG. **5**.
[0031] FIG. **1** is a perspective view of a suspension **1**. FIG. **2** is a plan view of a part of the suspension **1**. Double-headed arrow X**1** in FIG. **1** indicates the length direction of the suspension **1**. Double-headed arrow Y**1** in FIG. **1** indicates the width direction of the suspension **1**.
[0032] FIG. **3** is a cross-sectional view schematically showing an example of a disk drive **10**. The disk drive **10** comprises a casing **11** (partially shown), a disk **12** rotating around a spindle, a carriage **14**, a positioning motor **15**, and the like. The carriage **14** pivots around a pivot **13**. The motor **15** drives the carriage **14**. A lid hermetically seals the casing **11**. The suspension **1** is attached to the tip portion of an arm **16** of the carriage **14**.
[0033] As shown in FIG. **1**, the suspension **1** includes a baseplate **20**, a load beam **21**, and a flexure **22**. The baseplate **20** is formed of, for example, a plate of stainless steel. A boss portion **23** of the baseplate **20** is secured to the carriage **14** (shown in FIG. **3**). For example, the baseplate **20** has a thickness of 100 to 300 μm. The thickness is not limited to these values.
[0034] The load beam **21** extends in the length direction of the suspension **1**. For example, the load beam **21** has a thickness of 20 to 40 μm. The thickness is not limited to these values. The load beam **21** has a first face **21***a* on which the flexure **22** is provided, and a second face **21***b* opposite to the first face **21***a*.
[0035] A dimple portion **30** is formed near the tip of the load beam **21**. The dimple portion **30** includes a protrusion portion **30***a*. The protrusion portion **30***a* protrudes from the first face **21***a* of the load beam **21** to the flexure **22**. The dimple portion **30** is inwardly bent from the second face **21***b* of the load beam **21**. Thus, the protrusion portion **30***a* is called a dimple as well in the industry. The protrusion portion **30***a* protrudes toward the flexure **22**.
[0036] The flexure **22** is secured to the load beam **21** by welding portions **35** and **36** (partially shown in FIG. **1** and FIG. **2**). The flexure **22** extends along the load beam **21** in the length direction of the suspension **1**. The flexure **22** includes a metal base **40** and a circuit portion **41**. The metal base **40** is formed of a stainless-steel plate thinner than the load beam **21**. The circuit portion **41** is provided along the metal base **40**. The metal base **40** has a thickness of, for example, 20 μm (12 to 25 μm). The thickness is not limited to these values.
[0037] A slider arrangement portion **50** is formed near the tip of the flexure **22**. A slider **51** functioning as a magnetic head is provided on the slider arrangement portion **50**. The slider **51** is provided with elements for magnetically recording data on the disk **12**, elements for reading data recorded on the disk **12**, and the like.
[0038] The slider arrangement portion **50** includes a plate portion **55** (shown in FIG. **2**) composed of a part of the metal base **40**. The plate portion **55** is called a tongue as well in the industry. The plate portion **55** of the present embodiment is supported by arm portions **56** and **57**, limiter portions **58** and **59**, and the like such that the plate portion **55** is swingable with respect to the load beam **21**. The plate portion **55** includes a first plate **55***a* and a second plate **55***b*. The first plate **55***a* and the second plate **55***b* each can slightly move slightly in the width direction of the suspension **1** with

respect to a slit **55***c*.
[0039] Actuator elements **61** and **62** are provided on respective sides of the slider **51**. Each of the actuator elements **61** and **62** is formed of a piezoelectric body such as zirconate titanate (PTZ). When a voltage is applied to the actuator elements **61** and **62**, a piezoelectric body extends and contracts in accordance with the applied voltage. Thus, the tip side of the slider **51** can be slightly moved in the width direction (direction indicated by the Double-headed arrow Y**1** in FIG. **1**) of the suspension **1**. Elements for reading and writing of data are provided on the tip side of the slider **51**.
[0040] FIG. **4** is a cross-sectional view of the slider arrangement portion **50** along F**4**-F**4** line in FIG. **2**. FIG. **5** is a cross-sectional view of the slider arrangement portion **50** along F**5**-F**5** line in FIG. **4**. Double-headed arrow X**2** in FIG. **4** indicates the thickness direction of the metal base **40**. The metal base **40** includes a first surface **40***a* corresponding to a side on which the slider **51** is arranged, and a second surface **40***b* facing the load beam **21**.
[0041] The slider arrangement portion **50** includes an aperture portion **70** formed in the metal base **40**. The aperture portion **70** is open in the thickness direction of the metal base **40**. The aperture portion **70** of the present embodiment is open toward the first surface **40***a* and the second surface **40***b* of the metal base **40**. The aperture portion **70** may be open toward the first surface **40***a* (the side on which the slider **51** is provided) alone. A width W**1** (shown in FIG. **4**) of the aperture portion **70** is smaller than a width W**2** of the slider **51**.
[0042] As shown in FIG. **4** and FIG. **5**, an embedding circuit portion **41***a* may be provided inside the aperture portion **70**. The embedding circuit portion **41***a* constitutes a part of the length direction of the circuit portion **41**. Double-headed arrow X**3** in FIG. **2** indicates the length direction of the circuit portion **41**.
[0043] The embedding circuit portion **41***a* includes a base resin layer **72**, a plurality of conductors (for example, the first conductor **81** and the second conductor **82**), and a cover resin **73**. Each of the base resin layer **72** and the cover resin **73** is formed of an electrically insulating resin such as polyimide. The first conductor **81** and the second conductor **82** are described as examples in the present embodiment. The number of the conductors and the shape are not limited to the examples to be described in the present embodiment. The conductors **81** and **82** are covered with the base resin layer **72** and the cover resin **73**.
[0044] As shown in FIG. **2** and FIG. **5**, a terminal portion **85** and an electrically conductive member **86** electrically connect an end of the circuit portion **41** to a terminal of the slider **51**. The conductors **81** and **82** are mainly formed of copper. A plated layer of gold and the like is provided outside copper as necessary. To simplify the figures, the illustration of the plated layer is omitted in the figures. The plated layer may not be provided on the conductor.
[0045] A slider support portion **90** is formed on the first surface **40***a* of the metal base **40**. The slider support portion **90** is a part of the metal base **40** and is substantially flat. The slider **51** is fixed to the slider support portion **90** by means of a fixing means such as bonding. A gap G (shown in FIG. **4**) is formed between the cover resin **73** of the embedding circuit portion **41***a* and the slider **51**. Electrically insulating resins may fill the gap G.
[0046] As shown in FIG. **4** and FIG. **5**, an abutting portion **91** is formed on the base resin layer **72** of the embedding circuit portion **41***a*. The protrusion portion **30***a* (near the apex of the dimple portion **30**) of the load beam **21** contacts the abutting portion **91**. The protrusion portion **30***a* protrudes from the first face **21***a* of the load beam **21** to the slider arrangement portion **50**. Thus, the slider arrangement portion **50** can swing around the protrusion portion **30***a* in the thickness direction of the metal base **40**.
[0047] The slider arrangement portion **50** of the present embodiment may include the embedding circuit portion **41***a*. The embedding circuit portion **41***a* is provided inside the aperture portion **70**. The slider support portion **90** supports the slider **51** with the embedding circuit portion **41***a* being provided in the aperture portion **70**. The slider support portion **90** is a part of the metal base **40** and is substantially flat. Therefore, the slider **51** is supported by the slider support portion **90** in a stable

orientation. Further, the distance between the disk **12** and an air bearing formation surface **51***a* (flying height of the slider) can be accurately controlled. The flying height of the slider is extremely small. Thus, accurate control of the orientation of the slider **51** is crucial.

[0048] In the slider arrangement portion **50** of the present embodiment, the protrusion portion **30***a* (the apex of the dimple) of the load beam **21** contacts the abutting portion **91** of the embedding circuit portion **41***a*. The embedding circuit portion **41***a* is provided in the aperture portion **70**. Thus, the distance between the apex of the dimple and the air bearing formation surface **51***a* can be reduced. This contributes to providing a slider arrangement portion **50** that is low profile. Further, the width of the slider arrangement portion **50** can be reduced.

[0049] The rotation of the disk **12** produces an air bearing between the disk **12** and the slider **51**. Pivoting of the carriage **14** caused by the positioning motor **15** (shown in FIG. **3**) moves the suspension **1** in the radial direction of the disk **12**. The slider **51** is thereby moved to a desired position on the disk **12**. When a voltage is applied to the actuator elements **61** and **62**, the actuator elements **61** and **62** extend and contract. Thus, the tip side of the slider **51** can be moved in the width direction (direction indicated by the Double-headed arrow Y**1** in FIG. **1**) accurately and rapidly.

[0050] The following describes slider arrangement portions **50**A to **50**G of the second embodiment to the eighth embodiment with reference to FIG. **6** to FIG. **12**. In these embodiments, the same reference numerals are added to the constituent elements that the slider arrangement portion **50** of the first embodiment and those of these embodiments have in common. Explanations of these elements are omitted.

Second Embodiment

[0051] FIG. **6** is a cross-sectional view of a slider arrangement portion **50**A of the second embodiment. The slider arrangement portion **50**A includes a foundation resin **100**. An abutting portion **91** contacting the apex of a dimple portion may be formed on the foundation resin **100**. The foundation resin **100** is formed of an electrically insulating resin such as polyimide and overlaps a base resin layer **72**. Since the other structures are common to those of the slider arrangement portion **50** of the first embodiment and the slider arrangement portion **50**A, explanations thereof are omitted by adding common reference numbers to the common constituent elements.

Third Embodiment

[0052] FIG. **7** is a cross-sectional view of a slider arrangement portion **50**B of the third embodiment. The slider arrangement portion **50**B includes a metal portion **110** composed of a part of a metal base **40**. The metal portion **110** is formed inside an aperture portion **70**. A slider support portion **90** is formed on the metal portion **110**. Therefore, a slider **51** is supported by the slider support portion **90**.

Fourth Embodiment

[0053] FIG. **8** is a cross-sectional view of a slider arrangement portion **50**C of the fourth embodiment. The slider arrangement portion **50**C includes an aperture portion **70**. A metal portion **111** formed of a part of a metal base **40** is formed at the center of the aperture portion **70** in the width direction. A slider support portion **90** is formed on the slider-side face of the metal portion **111**. An abutting portion **91** is formed on the load beam-side face of the metal portion **111**.

Fifth Embodiment

[0054] FIG. **9** is a cross-sectional view of a slider arrangement portion **50**D of the fifth embodiment. An embedding circuit portion **41***a* of the slider arrangement portion **50**D includes a load beam-side face **121** and a slider-side face **122**. A terminal portion **81***a* is formed on a part of a first conductor **81**. The terminal portion **81***a* is exposed to the load beam-side face **121**. The terminal portion **81***a* is electrically connected to a terminal **130** of a flexure **22**. A terminal portion **82***a* is formed on a part of a second conductor **82**. The terminal portion **82***a* is exposed to the slider-side face **122**. The terminal portion **82***a* is electrically connected to a terminal (a top-bond pad) **131** located on the rear surface side of the slider **51**.

Sixth Embodiment

[0055] FIG. **10** is a cross-sectional view of a slider arrangement portion **50**E of the sixth embodiment. The slider arrangement portion **50**E includes a ground connecting conductor **140**. The ground connecting conductor **140** electrically connects a part of the metal base **40** (the metal portion **111**) and a terminal **131** located on the rear surface side of the slider **51**. A connecting conductor **141** electrically connecting a plurality of second conductors **82** one another may be provided.

Seventh Embodiment

[0056] FIG. **11** is a cross-sectional view of a slider arrangement portion **50**F of the seventh embodiment. The slider arrangement portion **50**F includes a metal portion **110** including a slider support portion **90** and a pedestal member **150** provided on the metal portion **110**. The pedestal member **150** is formed of an electrically insulating resin. The slider support portion **90** including the pedestal member **150** supports the slider **51**. An electrically insulating embedding resin **160** fills an aperture portion **70** formed in a metal base **40**. Conductors **81** and **82** are provided on a foundation resin **100**. The conductors **81** and **82** are embedded in the embedding resin **160**.

Eighth Embodiment

[0057] FIG. **12** is a cross-sectional view of a slider arrangement portion **50**G of the eighth embodiment. The slider arrangement portion **50**G includes a first pedestal member **161** and a second pedestal member **162**. The first pedestal member **161** covers an aperture portion **70**. The second pedestal member **162** overlaps the first pedestal member **161** in the thickness direction. The first pedestal member **161** and the second pedestal member **162** each are formed of an electrically insulating resin. A slider **51** is supported by a slider support portion **90** including the first pedestal member **161** and the second pedestal member **162**. Since the other structures are common to those of the slider arrangement portion **50**F of the seventh embodiment and those of the slider arrangement portion **50**G, explanations thereof are omitted by adding common reference numbers to common structural elements.

[0058] Each of the slider arrangement portions **50**, and **50**A to **50**G includes the embedding circuit portion **41***a* provided in the aperture portion **70**. The metal base **40** includes the slider support portion **90**. The slider **51** is supported by the slider support portion **90** with the embedding circuit portion **41***a* being provided in the aperture portion **70**. This configuration enables arranging the slider **51** in a stable orientation and reducing the width of the slider arrangement portion as well.

[0059] In the slider arrangement portions **50** and **50**A to **50**G of the embodiments, the protrusion portion **30***a* (the apex of the dimple) of the load beam **21** contacts the abutting portion **91** with the embedding circuit portion **41***a* being provided in the aperture portion **70**. This configuration shortens the distance between the apex of the dimple and the air bearing formation surface **51***a* and contributes to provide a slider arrangement portion that is low profile.

[0060] Needless to say, when implementing the present invention, the configuration of each element, such as the metal base and the circuit portion constituting the flexure can be modified variously. In addition, the aperture portion formed in the metal base, the slider support portion, and the abutting portion can also be implemented in various forms, as long as they do not deviate from the present invention.

[0061] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

## Claims

**1**. A disk drive suspension comprising: a load beam; and a flexure, wherein the flexure includes: a metal base; a circuit portion provided along the metal base; and a slider arrangement portion on which a slider is arranged; the slider arrangement portion includes: an aperture portion formed in the metal base; an embedding circuit portion arranged inside the aperture portion in a part of the circuit portion; a slider support portion formed on the metal base and supporting the slider with the embedding circuit portion being arranged in the aperture portion; and an abutting portion contacting a protrusion portion formed on the load beam.

**2**. The suspension of claim 1, wherein the embedding circuit portion includes a base resin layer, a conductor along the base resin layer, a cover resin covering the conductor, and the abutting portion.

**3**. The suspension of claim 2, wherein the slider arrangement portion includes a foundation resin overlapping the base resin layer.

**4**. The suspension of claim 1, further comprising: a metal portion provided inside the aperture portion and formed of a part of the metal base, wherein the metal portion includes the slider support portion.

**5**. The suspension of claim 4, wherein the metal portion includes the abutting portion.

**6**. The suspension of claim 1, wherein the embedding circuit portion includes: a load beam-side face facing the load beam; a slider-side face facing the slider; a first conductor including a terminal portion exposed to the load beam-side face; and a second conductor including a terminal portion exposed to the slider-side face.

**7**. The suspension of claim 1, further comprising: a ground connecting conductor electrically connecting the metal base and a conductor of the embedding circuit portion.

**8**. The suspension of claim 4, wherein the slider support portion includes: an electrically insulating pedestal member provided between the metal portion and the slider.

**9**. The suspension of claim 1, wherein the slider support portion includes: an electrically insulating first pedestal member covering the aperture portion; and an electrically insulating second pedestal member between the slider and the first pedestal member.