US 20250266061A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2025/0266061 A1**

Yamaguchi et al. (43) **Pub. Date: Aug. 21, 2025**

(54) **DISK DEVICE**

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(21) Appl. No.: **18/824,283**

(22) Filed: **Sep. 4, 2024**

(30) **Foreign Application Priority Data**

Feb. 15, 2024 (JP) 2024-021139

Publication Classification

(51) **Int. Cl.**

G11B 33/14	(2006.01)
H05K 1/02	(2006.01)
H05K 1/11	(2006.01)

(52) **U.S. Cl.**

CPC ***G11B 33/14*** (2013.01); ***H05K 1/0215*** (2013.01); ***H05K 1/115*** (2013.01)

(57) **ABSTRACT**

A disk device according to an embodiment includes a housing, a magnetic disk, a printed wiring board, and a film. The housing is provided with an internal space filled with gas different from air and a penetration hole that makes the internal space communicate with an outside. The magnetic disk is disposed in the internal space. The printed wiring board includes a first surface attached to the housing, a second surface located opposite to the first surface, and a side surface provided between an outer edge of the first surface and an outer edge of the second surface. The printed wiring board is configured to seal the penetration hole. The film covers the side surface.

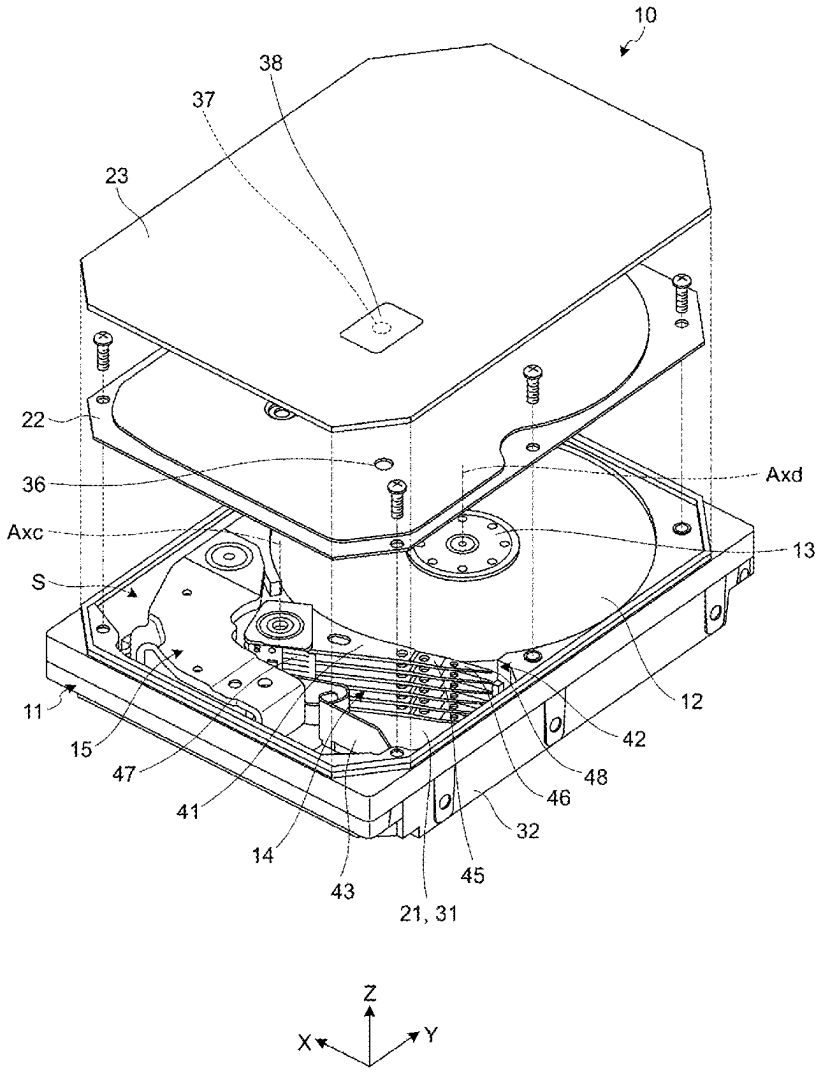

FIG.1

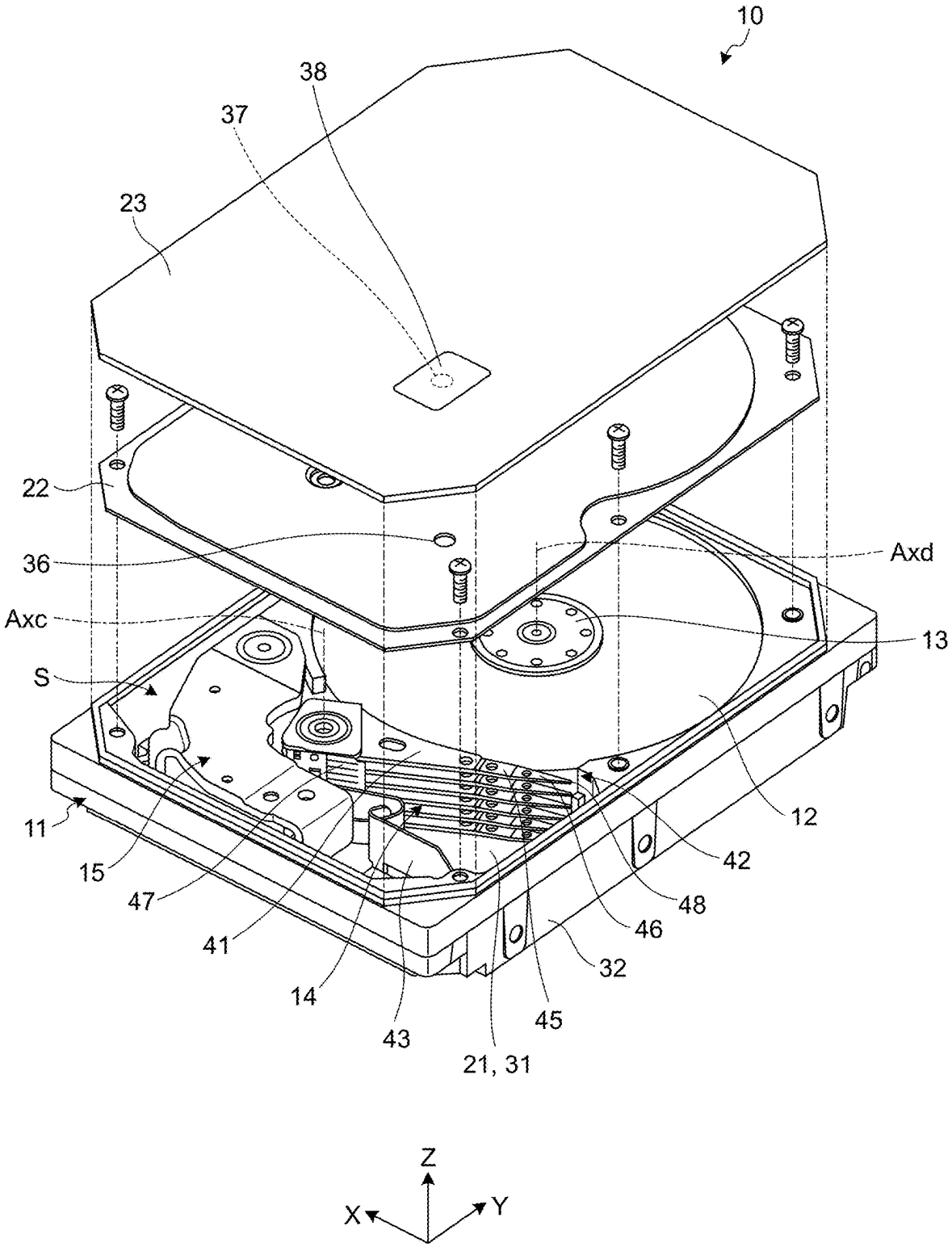
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FIG.2

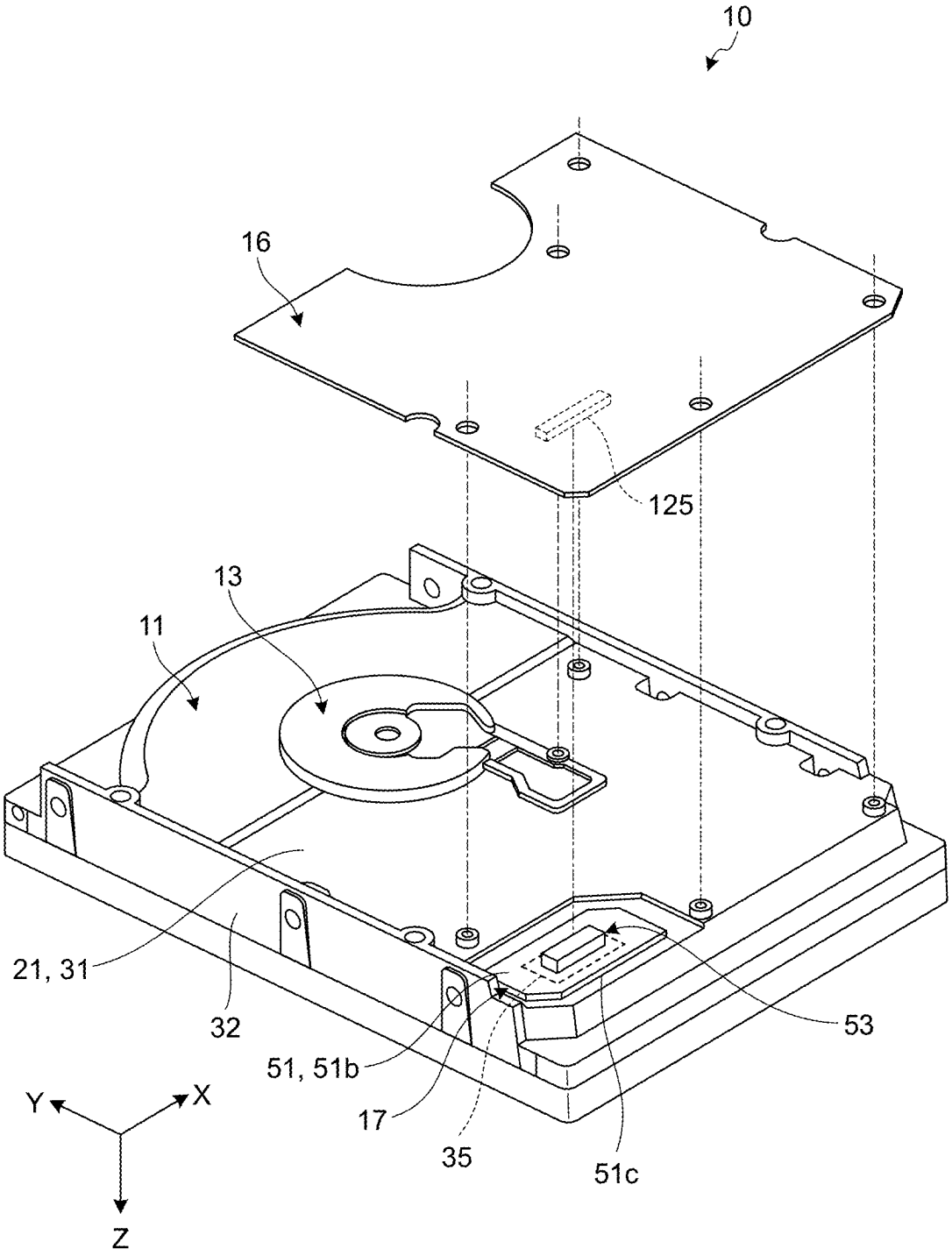
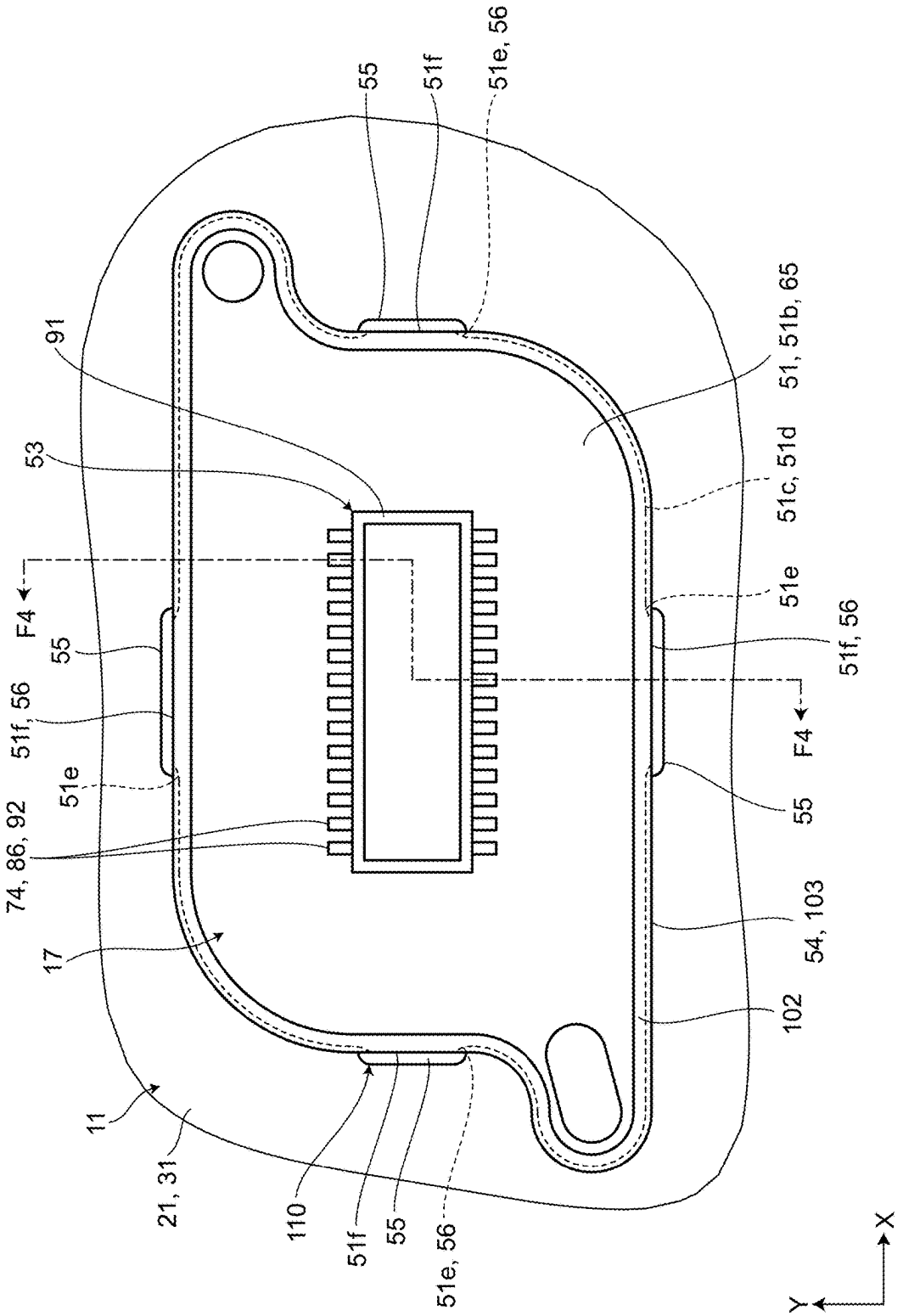


FIG.3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51, 51b, 65
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F4
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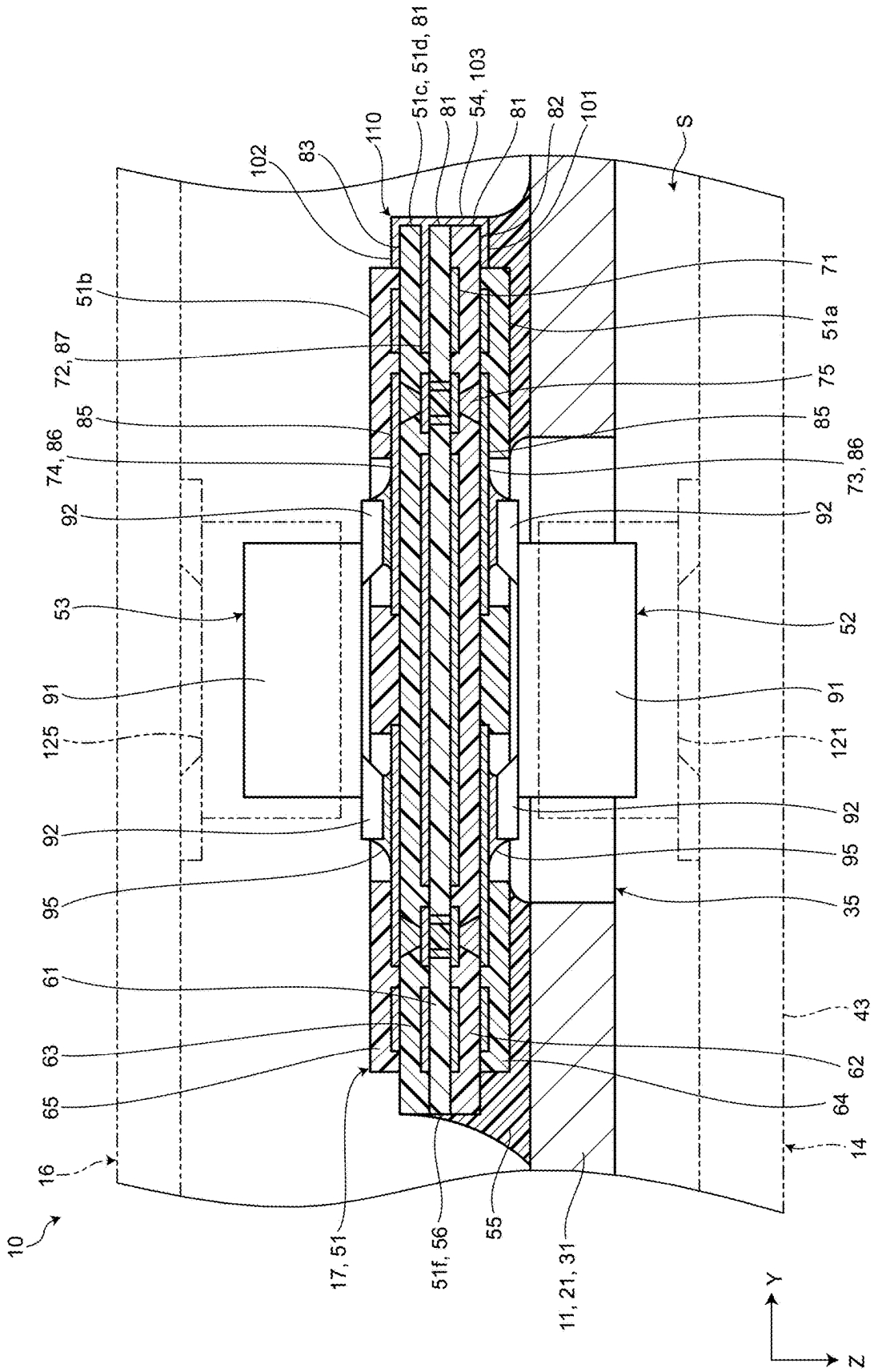
FIG.4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54, 103
81
82
101
S
71
51a
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73, 86
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17, 51
51f, 56
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11, 21, 31
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FIG.5

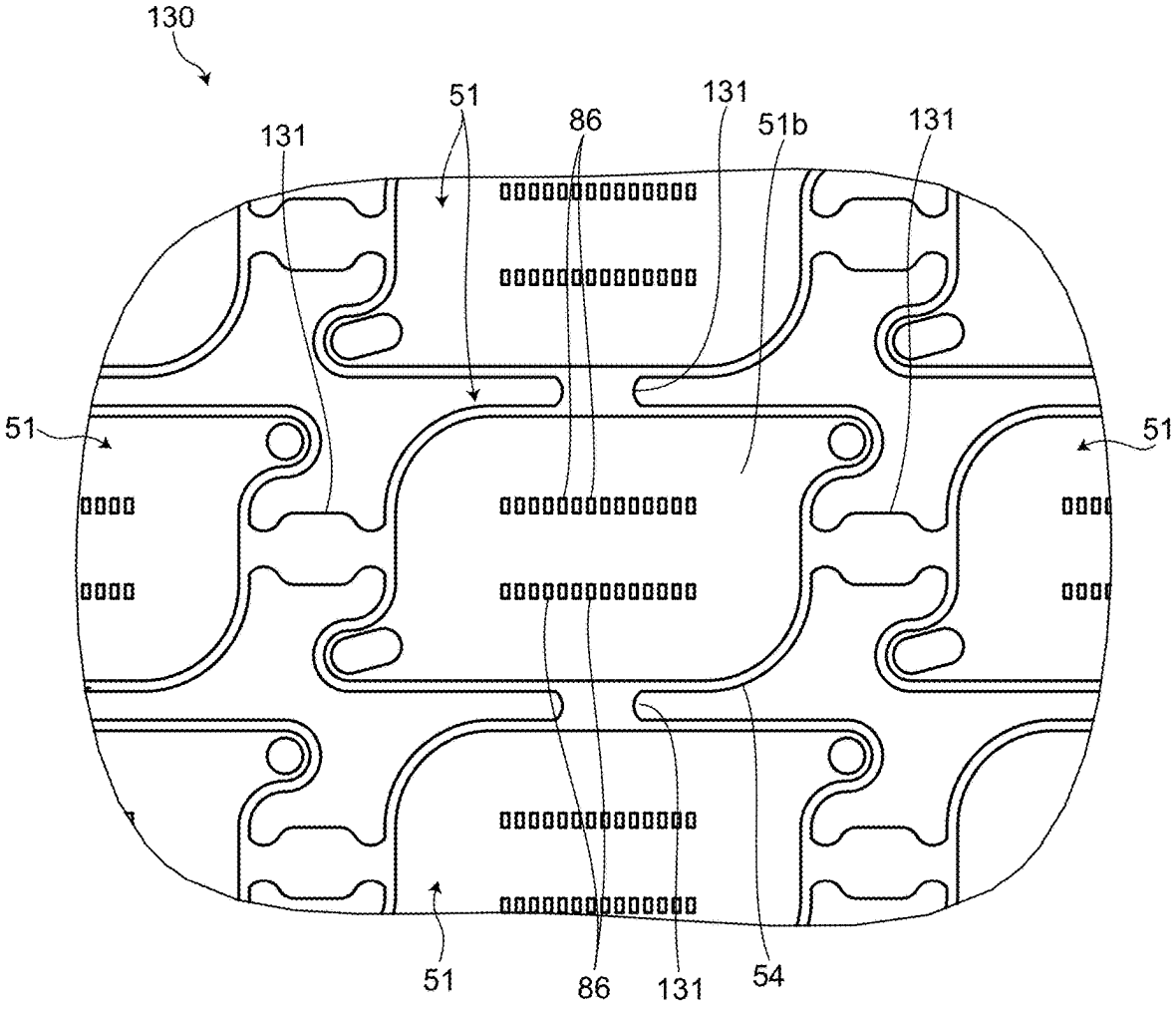

FIG.6

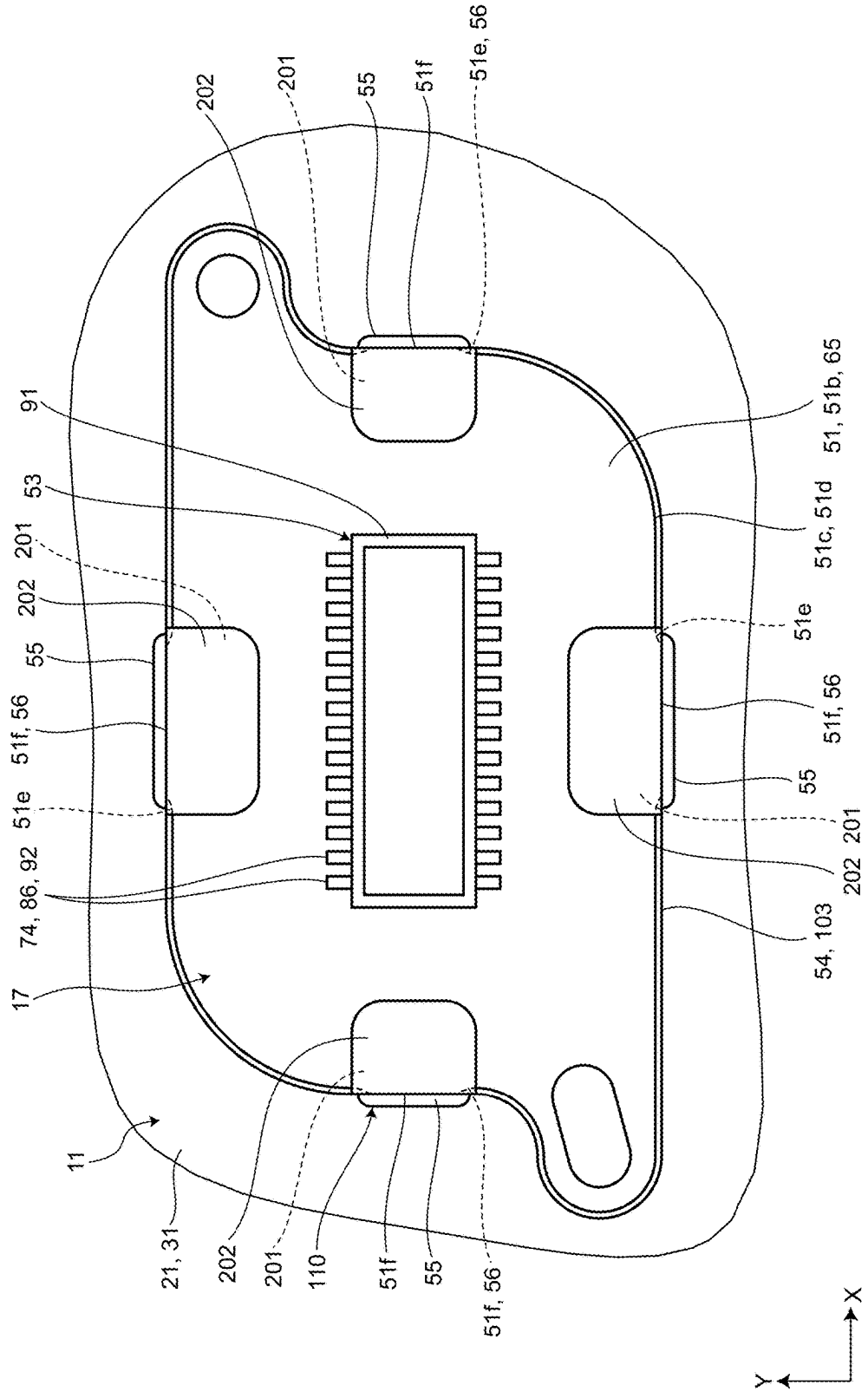
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FIG.7

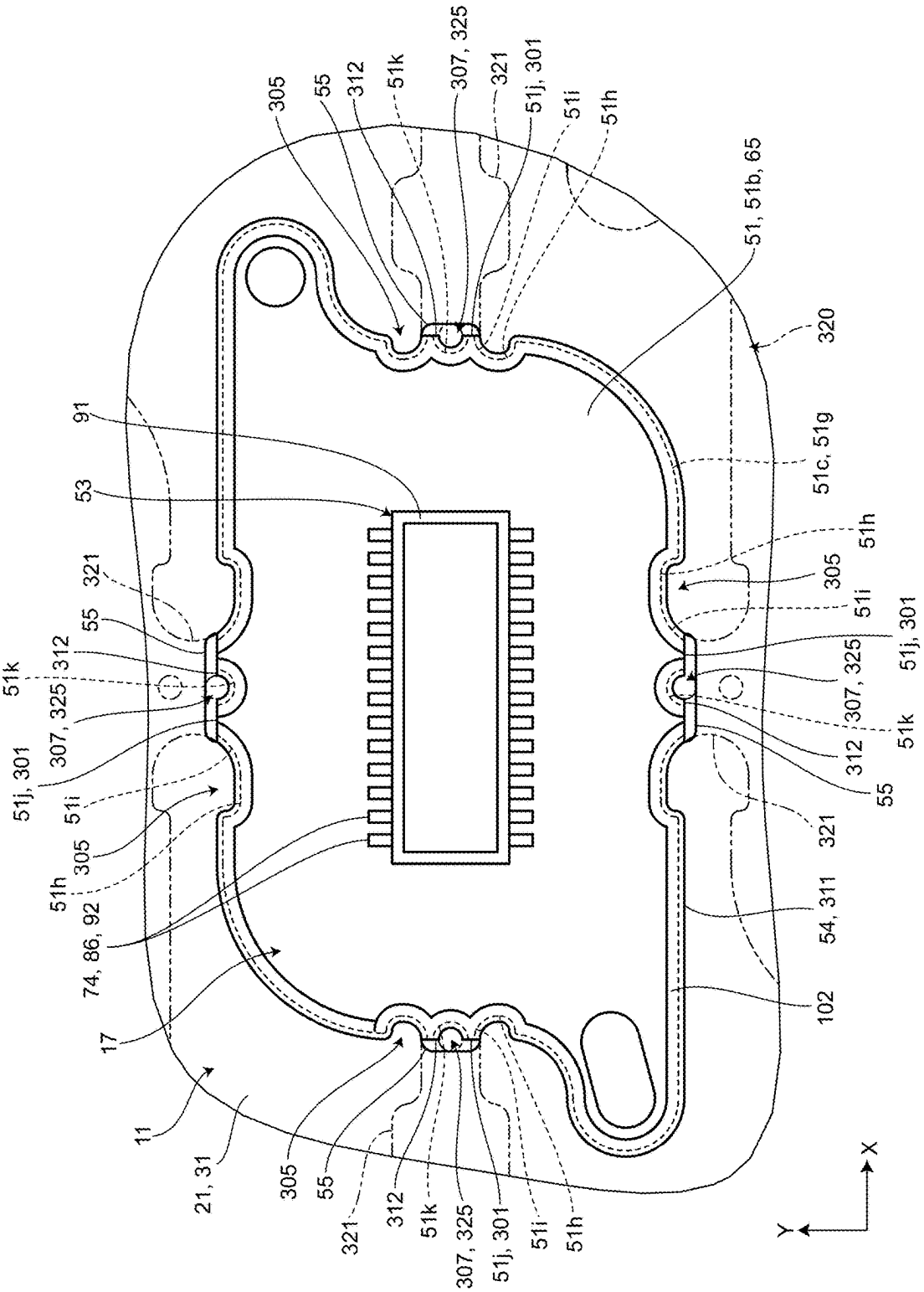
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FIG.8

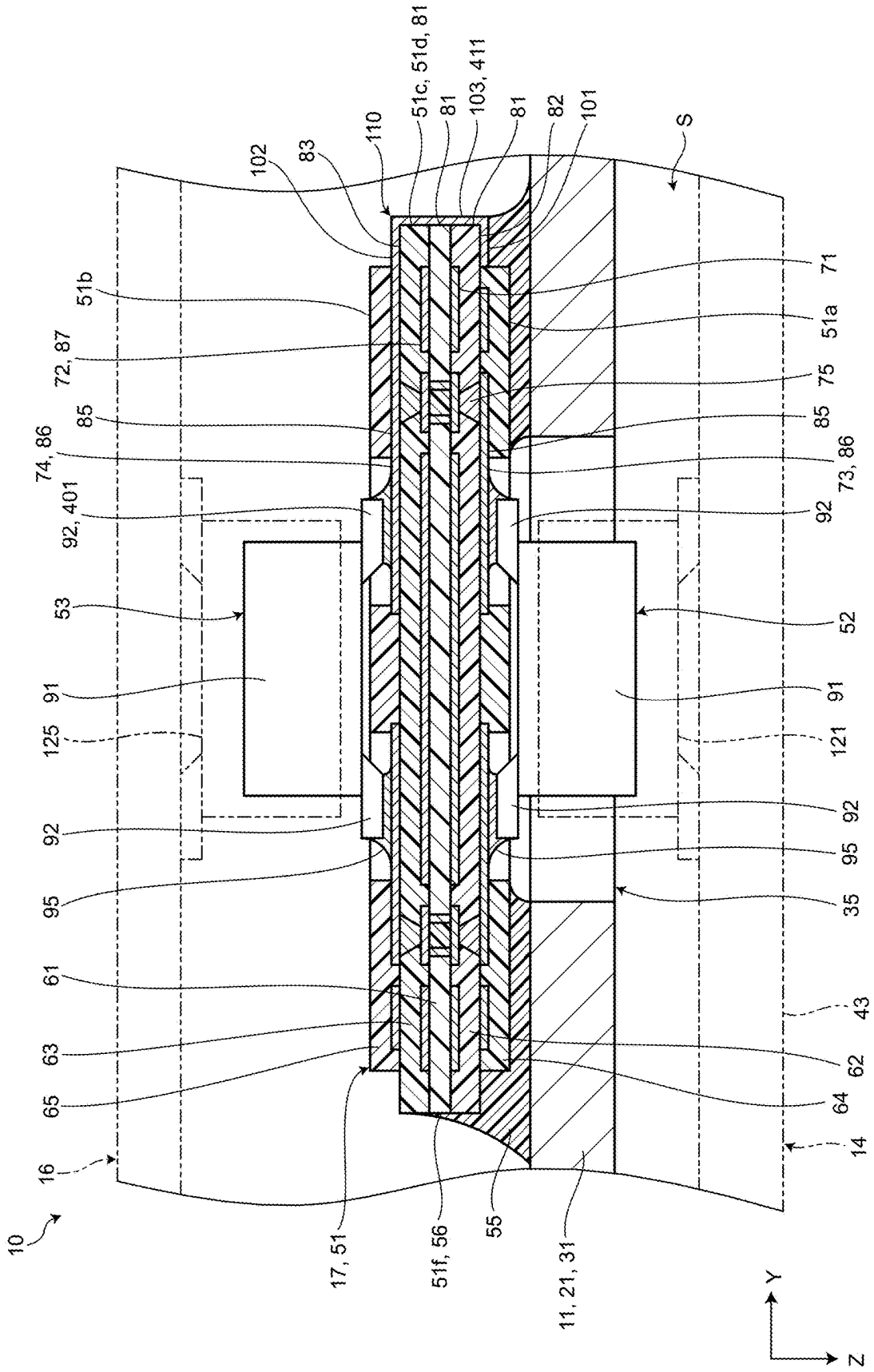
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FIG.9

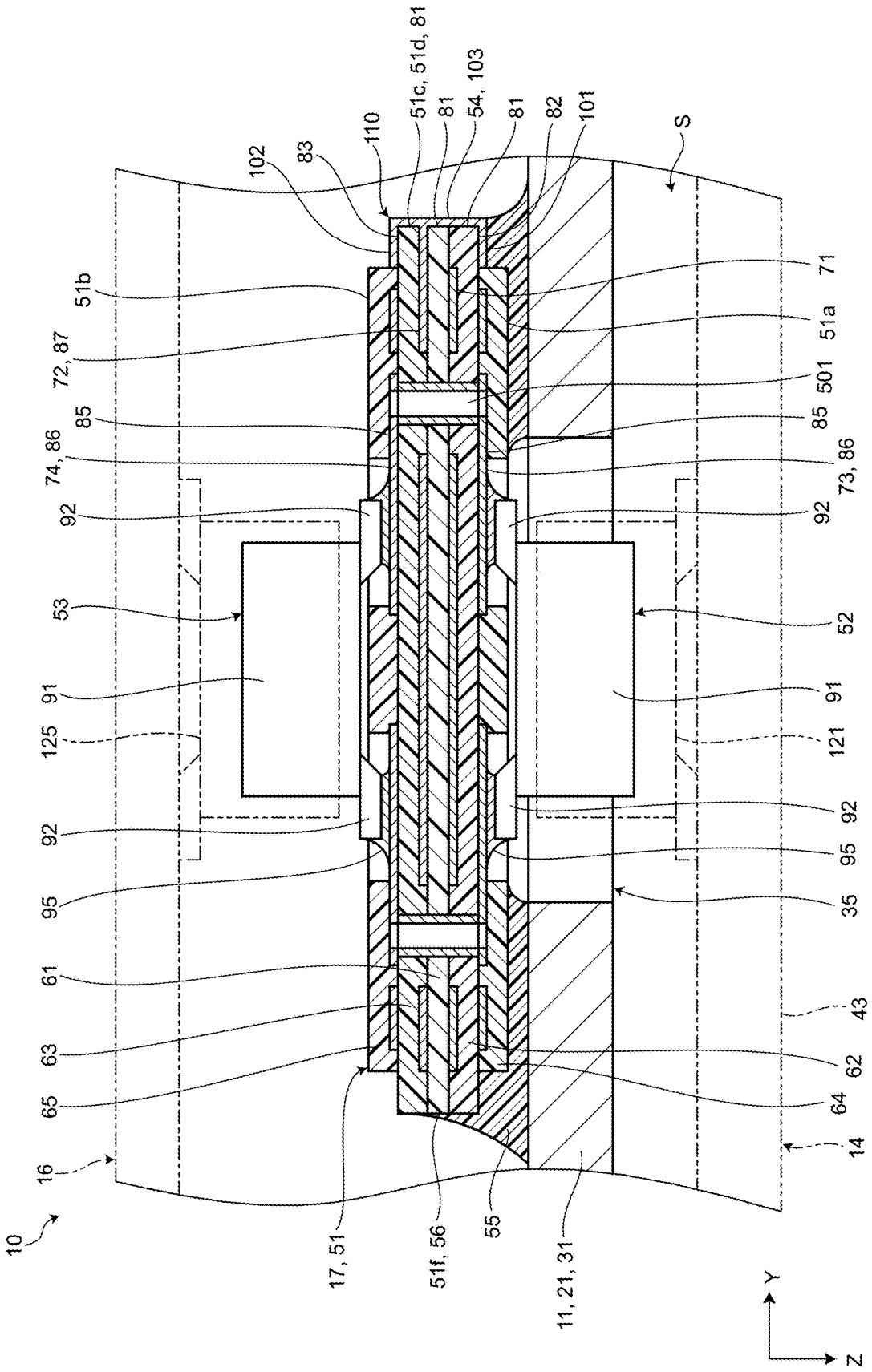
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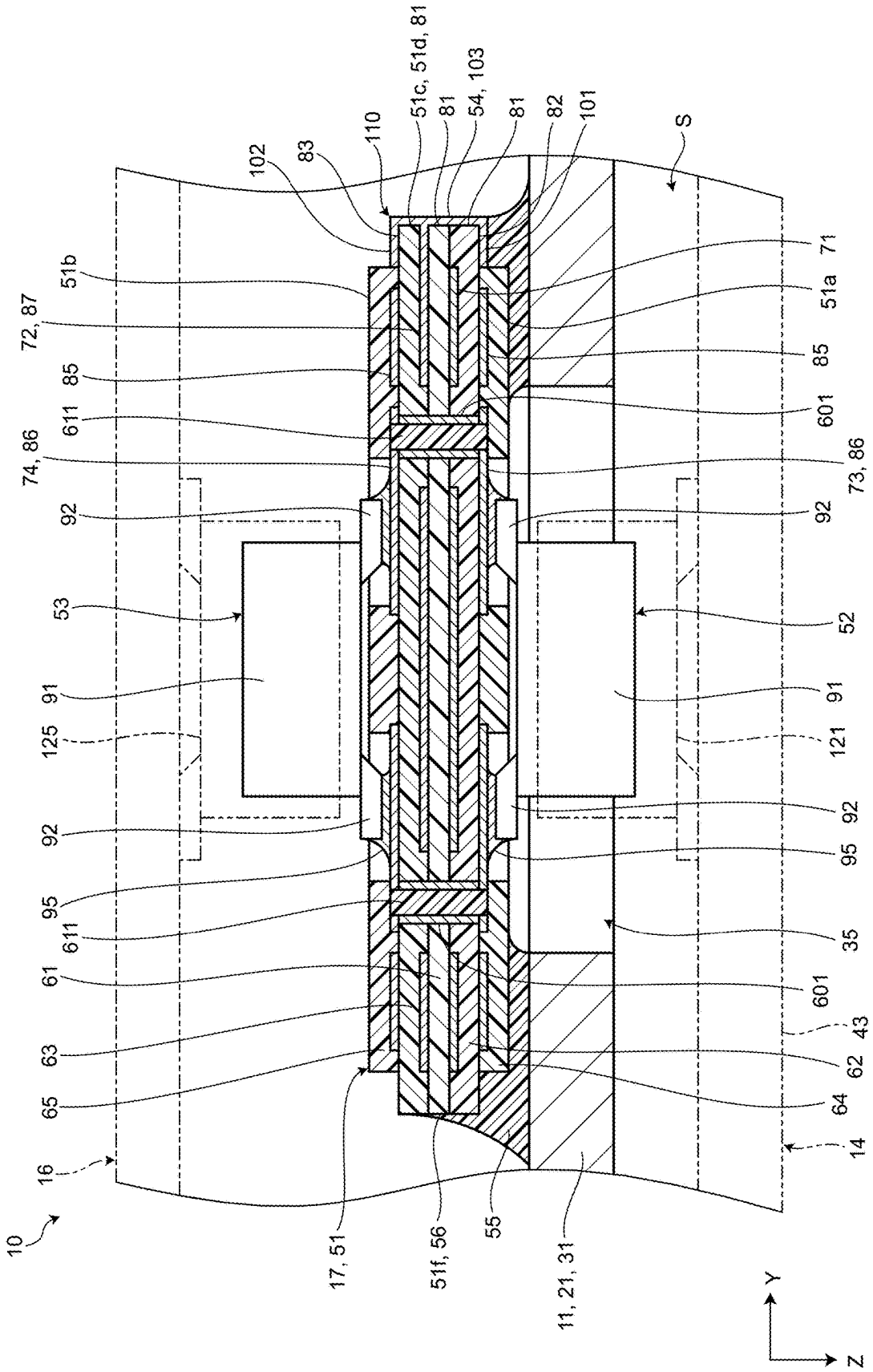
FIG.10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DISK DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2024-021139, filed on Feb. 15, 2024; the entire contents of which are incorporated herein by reference.

FIELD

[0002] Embodiments described herein relate generally to a disk device.

BACKGROUND

[0003] A disk device such as a hard disk drive (HDD) includes, for example, a housing, a magnetic disk, and a printed wiring board (PWB). The magnetic disk is disposed in an internal space of the housing. The internal space of the housing may be filled with gas such as helium different from air. In this case, the PWB seals a penetration hole of the housing.

[0004] An insulating part of the PWB is exposed on a side surface of the PWB. Dust may fall off or outgas may be released from the exposed insulating part.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is an exemplary perspective view illustrating an HDD according to a first embodiment in an exploded manner;

[0006] FIG. **2** is an exemplary perspective view illustrating the HDD of the first embodiment in an exploded manner from a direction different from that in FIG. **1**;

[0007] FIG. **3** is an exemplary plan view illustrating a part of a housing and a relay board of the first embodiment;

[0008] FIG. **4** is an exemplary cross-sectional view illustrating a part of the HDD of the first embodiment along a line F**4**-F**4** of FIG. **3**;

[0009] FIG. **5** is an exemplary plan view illustrating a PWB in a manufacturing process of the first embodiment;

[0010] FIG. **6** is an exemplary plan view illustrating a part of a housing and a relay board according to a second embodiment;

[0011] FIG. **7** is an exemplary plan view illustrating a part of a housing and a relay board according to a third embodiment;

[0012] FIG. **8** is an exemplary cross-sectional view illustrating a part of an HDD according to a fourth embodiment;

[0013] FIG. **9** is an exemplary cross-sectional view illustrating a part of an HDD according to a fifth embodiment; and

[0014] FIG. **10** is an exemplary cross-sectional view illustrating a part of an HDD according to a sixth embodiment.

DETAILED DESCRIPTION

[0015] In general, according to an embodiment, a disk device includes a housing, a magnetic disk, a printed wiring board, and a film. The housing is provided with an internal space filled with gas different from air and a penetration hole that makes the internal space communicate with an outside. The magnetic disk is disposed in the internal space. The printed wiring board includes a first surface attached to the housing, a second surface located opposite to the first surface, and a side surface provided between an outer edge of the first surface and an outer edge of the second surface. The printed wiring board is configured to seal the penetration hole. The film covers the side surface.

First Embodiment

[0016] Hereinafter, a first embodiment will be described with reference to FIGS. **1** to **5**. Note that, in the present specification, component elements according to embodiments and descriptions of the elements may be described in a plurality of expressions. The component elements and the description thereof are examples, and are not limited by the expression of the present specification. The component elements may also be identified with names different from those in the present specification. In addition, the component elements may be described by an expression different from the expression in the present specification.

[0017] In the following description, "suppress" is defined as, for example, preventing the occurrence of an event, an action, or an influence, or reducing the degree of the event, the action, or the influence. In addition, in the following description, "restrict" is defined as, for example, preventing movement or rotation, or allowing movement or rotation within a predetermined range and preventing movement or rotation beyond the predetermined range.

[0018] FIG. **1** is an exemplary perspective view illustrating a hard disk drive (HDD) **10** according to a first embodiment in an exploded manner. FIG. **2** is an exemplary perspective view illustrating the HDD **10** of the first embodiment in an exploded manner from a direction different from that in FIG. **1**. The HDD **10** is an example of a disk device, and may also be referred to as an electronic device, a storage device, an external storage device, or a magnetic disk device.

[0019] As illustrated in the drawings, in the present specification, an X axis, a Y axis, and a Z axis are defined for convenience. The X axis, the Y axis, and the Z axis are orthogonal to each other. The X axis is provided along the width of the HDD **10**. The Y axis is provided along the length of the HDD **10**. The Z axis is provided along the thickness of the HDD **10**.

[0020] Furthermore, in the present specification, an X direction, a Y direction, and a Z direction are defined. The X direction is a direction along the X axis and includes a +X direction indicated by an arrow of the X axis and a −X direction which is an opposite direction of the arrow of the X axis. The Y direction is a direction along the Y axis, and includes a +Y direction indicated by an arrow of the Y axis and a −Y direction which is an opposite direction of the arrow of the Y axis. The Z direction is a direction along the Z axis and includes a +Z direction indicated by an arrow of the Z axis and a −Z direction which is an opposite direction of the arrow of the Z axis.

[0021] As illustrated in FIG. **1**, the HDD **10** includes a housing **11**, a plurality of magnetic disks **12**, a spindle motor **13**, a head stack assembly (HSA) **14**, and a voice coil motor (VCM) **15**. The magnetic disk **12** may also be referred to as a disk or a platter. As illustrated in FIG. **2**, the HDD **10** further includes a printed circuit board (PCB) **16** and a relay board **17**.

[0022] As illustrated in FIG. **1**, the housing **11** is formed in a box shape provided with an internal space S. The plurality of magnetic disks **12**, the spindle motor **13**, the HSA **14**, and the VCM **15** are disposed in the internal space

S. The housing **11** includes a base **21**, an inner cover **22**, and an outer cover **23**. Note that, the housing **11** is not limited to this example.

[0023] Each of the base **21**, the inner cover **22**, and the outer cover **23** is made of a metal material such as aluminum alloy. Note that, the materials of the base **21**, the inner cover **22**, and the outer cover **23** may be different from each other.

[0024] The base **21** is formed in a substantially rectangular parallelepiped box shape opened in the +Z direction. The internal space S is provided inside the base **21** and communicates with the outside through an end portion of the base **21** in the +Z direction. The base **21** includes a bottom wall **31** and a side wall **32**.

[0025] The bottom wall **31** is formed in a substantially rectangular (quadrangular) plate shape disposed to be substantially orthogonal to the Z direction. As illustrated in FIG. **2**, a penetration hole **35** is provided in the bottom wall **31**. The penetration hole **35** penetrates the bottom wall **31** substantially in the Z direction and makes the internal space S communicate with the outside. The side wall **32** protrudes substantially in the +Z direction from the edge of the bottom wall **31** and is formed in a substantially rectangular frame shape.

[0026] As illustrated in FIG. **1**, the inner cover **22** is attached to the side wall **32** by a screw, for example. Accordingly, the inner cover **22** covers the internal space S. For example, a gasket is disposed between the inner cover **22** and the side wall **32**. The gasket seals a gap between the inner cover **22** and the side wall **32**. The outer cover **23** covers the inner cover **22** and is attached to the side wall **32** by welding, for example.

[0027] A vent **36** is provided in the inner cover **22**. Furthermore, a vent **37** is provided in the outer cover **23**. After components are attached to the inside of the base **21** and the inner cover **22** and the outer cover **23** are attached to the base **21**, the air in the internal space S is removed from the vents **36** and **37**. Furthermore, gas different from air is charged into the internal space S.

[0028] The gas with which the internal space S is filled is, for example, low density gas having a density lower than that of air, inert gas having low reactivity, or the like. For example, helium is charged into the internal space. Note that, another fluid may be charged into the inside of the housing **11**.

[0029] For example, a seal **38** blocks the vent **37** of the outer cover **23**. The seal **38** hermetically seals the vent **37** to restrict leakage of the gas with which the internal space S is filled from the vent **37**. Note that, the vents **36** and **37** may be sealed by other methods.

[0030] The plurality of magnetic disks **12** is arranged in the Z direction with a gap interposed therebetween. The plurality of magnetic disks **12** is formed in a disk shape disposed so as to be substantially orthogonal to the Z direction. A magnetic recording layer is provided on the surface of the magnetic disk **12**.

[0031] The spindle motor **13** supports the plurality of magnetic disks **12**. The plurality of magnetic disks **12** is held by the hub of the spindle motor **13** with, for example, a clamp spring. The spindle motor **13** integrally rotates the plurality of magnetic disks **12** about a central axis Axd.

[0032] The central axis Axd is a virtual axis extending substantially in the Z direction. The central axis Axd is, for example, a central axis of the magnetic disk **12** and the spindle motor **13**. Note that, the central axis Axd is not limited to this example.

[0033] The HSA **14** includes a carriage **41**, a plurality of head gimbal assemblies (HGA) **42**, and a flexible printed circuit board (FPC) **43**. Note that, the HSA **14** is not limited to this example.

[0034] The carriage **41** is attached to the base **21** so as to be rotatable about a central axis Axc. The central axis Axc is a virtual axis extending substantially in the Z direction. The central axis Axc is disposed apart from the central axis Axd.

[0035] The plurality of HGAs **42** is attached to an arm of the carriage **41** and rotates integrally with the carriage **41** about the central axis Axc. The plurality of HGAs **42** is arranged in the Z direction with a gap interposed therebetween. Each of the plurality of HGAs **42** includes a base plate **45**, a load beam **46**, a flexure **47**, and a magnetic head **48**. The magnetic head **48** may also be referred to as a slider.

[0036] The base plate **45** and the load beam **46** are made of, for example, stainless steel. The base plate **45** is formed in a plate shape and is attached to the arm of the carriage **41**. The load beam **46** is formed in a plate shape thinner than the base plate **45**. The load beam **46** is attached to the base plate **45**.

[0037] The flexure **47** is a kind of flexible printed wiring board formed in an elongated belt shape. The flexure **47** includes, for example, a metal backing plate, an insulating base layer, a conductive layer, and an insulating cover layer.

[0038] The flexure **47** extends along the carriage **41**, the base plate **45**, and the load beam **46**. A rotatable gimbal portion is provided at one end portion of the flexure **47**. The magnetic head **48** is mounted on the gimbal portion of the flexure **47**. Therefore, the magnetic head **48** moves with respect to the magnetic disk **12** in accordance with rotation of the carriage **41**.

[0039] The magnetic head **48** records and reproduces information with respect to a corresponding one of the plurality of magnetic disks **12**. In other words, the magnetic head **48** reads and writes information from and to the magnetic disk **12**.

[0040] One end portion of the FPC **43** is attached to the carriage **41**. The other end portions of the plurality of flexures **47** are connected to the FPC **43**. Therefore, the flexure **47** electrically connects the magnetic head **48** and the FPC **43**. The other end portion of the FPC **43** is attached to the bottom wall **31**. A part of the FPC **43** is bent between the carriage **41** and the bottom wall **31** in accordance with rotation of the carriage **41**.

[0041] The VCM **15** moves the magnetic head **48** to a desired position along the magnetic disk **12** by rotating the carriage **41** around the central axis Axc. The VCM **15** includes a voice coil, a pair of yokes, and a magnet provided on the yokes. The voice coil is held by the carriage **41**.

[0042] As illustrated in FIG. **2**, the PCB **16** and the relay board **17** are disposed outside the internal space S and attached to the bottom wall **31**. The relay board **17** is located between the PCB **16** and the bottom wall **31**. Note that, the relay board **17** may be disposed in the internal space S.

[0043] The PCB **16** includes various electronic components such as an interface (I/F) connector connected to a host computer and a controller that controls the operation of the HDD **10**.

[0044] FIG. **3** is an exemplary plan view illustrating a part of the housing **11** and the relay board **17** of the first embodiment. FIG. **4** is an exemplary cross-sectional view illustrating a part of the HDD **10** of the first embodiment along a line F**4**-F**4** of FIG. **3**. FIG. **4** virtually illustrates the HSA **14** and the PCB **16** by two-dot chain lines for convenience. As illustrated in FIG. **4**, the relay board **17** connects the PCB **16** and the FPC **43**.

[0045] The relay board **17** includes a printed wiring board (PWB) **51**, two relay connectors **52** and **53**, and a plating **54**. Note that, the relay board **17** is not limited to this example. The relay connectors **52** and **53** are examples of electronic components and connectors. The plating **54** is an example of a metal film.

[0046] The HDD **10** further includes an adhesive **55**. The adhesive **55** is made of synthetic resin, and is an example of a resin film. The PWB **51** is bonded to the bottom wall **31** of the housing **11** by the adhesive **55** to hermetically seal the penetration hole **35**. The PWB **51** includes a first surface **51***a*, a second surface **51***b*, and a side surface **51***c*.

[0047] Each of the first surface **51***a* and the second surface **51***b* is formed to be substantially flat. The first surface **51***a* faces substantially in the +Z direction. The first surface **51***a* faces the bottom wall **31** and the penetration hole **35**, and is attached to the bottom wall **31** of the housing **11** by the adhesive **55**. That is, the adhesive **55** bonds the first surface **51***a* and the housing **11** to each other. The second surface **51***b* is located opposite to the first surface **51***a*. The second surface **51***b* faces the PCB **16**.

[0048] The side surface **51***c* is provided between the outer edge of the first surface **51***a* and the outer edge of the second surface **51***b*. The side surface **51***c* faces a direction substantially orthogonal to the Z axis. In other words, the side surface **51***c* faces the direction along the first surface **51***a*.

[0049] As illustrated in FIG. **3**, the side surface **51***c* includes a plurality of regions **51***d*, **51***e*, and **51***f*. Each of the regions **51***d*, **51***e*, and **51***f* is a part of the side surface **51***c*. In addition, the PWB **51** further includes four protrusions **56**.

[0050] Each of the four protrusions **56** protrudes from the region **51***d*. The regions **51***e* and **51***f* are provided in each of the four protrusions **56**. That is, the protrusion **56** includes a part of the side surface **51***c*. The region **51***e* is connected to the region **51***d*. The region **51***f* is provided at the end portion of the protrusion **56** and connected to the region **51***e*.

[0051] As illustrated in FIG. **4**, the PWB **51** of the present embodiment is, for example, a rigid board such as a glass epoxy board and is a build-up board. Note that, the PWB **51** may be another rigid board or a flexible printed wiring board. The PWB **51** includes five insulating layers **61**, **62**, **63**, **64**, and **65**, four conductive layers **71**, **72**, **73**, and **74**, and a plurality of vias **75**. Note that, the PWB **51** is not limited to this example.

[0052] At least one of the insulating layers **61**, **62**, and **63** may also be referred to as an insulating substrate. Each of the insulating layers **61**, **62**, and **63** includes, for example, glass fiber and synthetic resin such as an epoxy resin or polyimide (PI). Note that, the insulating layers **61**, **62**, and **63** are not limited to this example. The insulating layers **64** and **65** are solder resists, for example.

[0053] The five insulating layers **61**, **62**, **63**, **64**, and **65** are stacked in the Z direction. The insulating layer **61** is located between the two insulating layers **62** and **63**. The insulating layer **62** is located between the two insulating layers **61** and **64**. The insulating layer **63** is located between the two insulating layers **61** and **65**.

[0054] Each of the insulating layers **61**, **62**, and **63** includes an end surface **81** in the direction along the first surface **51***a*. The side surface **51***c* of the PWB **51** includes the end surfaces **81** of the insulating layers **61**, **62**, and **63**. The side surface **51***c* may further include at least one end surface of the insulating layers **64** and **65** and the conductive layers **71**, **72**, **73**, and **74**.

[0055] The insulating layer **62** further includes a surface **82**. The surface **82** is formed to be substantially flat and faces substantially in the +Z direction. The insulating layer **64** covers the surface **82**. The insulating layer **63** further includes a surface **83**. The surface **83** is formed to be substantially flat and faces substantially in the −Z direction. The insulating layer **65** covers the surface **83**.

[0056] Each of the conductive layers **71**, **72**, **73**, and **74** is made of a metal material such as copper, for example. The conductive layer **71** is provided between the two insulating layers **61** and **62**. The conductive layer **72** is provided between the two insulating layers **61** and **63**. The conductive layer **73** is provided on the surface **82**, and is located between the two insulating layers **62** and **64**. The conductive layer **74** is provided on the surface **83**, and is located between the two insulating layers **63** and **65**.

[0057] Each of the conductive layers **71**, **72**, **73**, and **74** includes at least one of a wiring **85**, a pad **86**, and a ground plane **87**. The ground plane **87** is an example of a conductor set to ground potential. Each of the conductive layers **73** and **74** includes a plurality of pads **86**.

[0058] Each of the plurality of vias **75** penetrates at least one of the plurality of insulating layers **61**, **62**, and **63**, and connects at least two of the four conductive layers **71**, **72**, **73**, and **74** to each other. Each of the plurality of vias **75** is a blind via or a buried via, for example. The plurality of pads **86** of the conductive layer **73** and the plurality of pads **86** of the conductive layer **74** are electrically connected to each other through the plurality of vias **75**.

[0059] The insulating layer **64** covers the wiring **85** and the ground plane **87** of the conductive layer **73**. For example, the insulating layer **64**, the exposed surface **82** of the insulating layer **62**, and the exposed pads **86** of the conductive layer **73** form the first surface **51***a* of the PWB **51**. In other words, the pads **86** of the conductive layer **73** are provided on the first surface **51***a* of the PWB **51**.

[0060] The insulating layer **65** covers the wiring **85** and the ground plane **87** of the conductive layer **74**. For example, the insulating layer **65**, the exposed surface **83** of the insulating layer **63**, and the exposed pads **86** of the conductive layer **74** form the second surface **51***b* of the PWB **51**. In other words, the pads **86** of the conductive layer **74** are provided on the second surface **51***b* of the PWB **51**.

[0061] Each of the two relay connectors **52** and **53** includes a frame **91** and a plurality of leads **92**. The frame **91** is made of synthetic resin, for example. The lead **92** is made of a metal material and attached to the frame **91**.

[0062] The plurality of leads **92** is connected to the pads **86** by solder **95**, for example. The relay connector **52** is mounted on the first surface **51***a* of the PWB **51** by connecting the leads **92** to the pads **86** of the conductive layer **73**. The relay connector **52** is disposed in the penetration hole **35**. A relay connector **53** is mounted on the second

surface **51***b* of the PWB **51** by connecting the leads **92** to the pads **86** of the conductive layer **74**.

[0063] Similarly to the conductive layers **71**, **72**, **73**, and **74**, the plating **54** is made of a metal material such as copper. Note that, the material of the plating **54** and the materials of the conductive layers **71**, **72**, **73**, and **74** may be different from each other.

[0064] The plating **54** is electrically connected to the ground plane **87**. For example, the plating **54** and the ground plane **87** are integrally formed. The plating **54** may be electrically connected to the ground plane **87** through the wiring **85**, for example.

[0065] The plating **54** includes two surface plating **101** and **102** and side surface plating **103**. Each of the surface plating **101** and **102** is connected to the side surface plating **103**. Note that, in the plating **54**, at least one of the surface plating **101** and **102** may be omitted.

[0066] The surface plating **101** covers a part of the first surface **51***a*. For example, the surface plating **101** covers the exposed surface **82** of the insulating layer **62** and adheres to the surface **82**. In the present embodiment, the surface plating **101** is formed in a frame shape extending along the outer edge of the first surface **51***a* of the PWB **51**, and covers the entire region of the outer edge of the first surface **51***a*.

[0067] The surface plating **102** covers a part of the second surface **51***b*. For example, the surface plating **102** covers the exposed surface **83** of the insulating layer **63** and adheres to the surface **83**. As illustrated in FIG. **3**, the surface plating **102** of the present embodiment is formed in a frame shape extending along the outer edge of the second surface **51***b* of the PWB **51**, and covers the entire region of the outer edge of the second surface **51***b*.

[0068] The side surface plating **103** covers at least a part of the side surface **51***c*. For example, the side surface plating **103** covers the regions **51***d* and **51***e* of the side surface **51***c*. In the present embodiment, the side surface plating **103** does not cover the region **51***f* of the side surface **51***c* and is separated from the region **51***f*. Note that, the side surface plating **103** is not limited to this example.

[0069] The regions **51***d* and **51***e* of the side surface **51***c* covered with the side surface plating **103** are larger than the region **51***f* of the side surface **51***c* separated from the side surface plating **103** without being covered with the side surface plating **103**. Note that, the side surface **51***c* is not limited to this example.

[0070] As illustrated in FIG. **4**, a part of the adhesive **55** covers the region **51***f* of the side surface **51***c*. The plating **54** and the adhesive **55** form a protective film **110**. That is, the HDD **10** includes the protective film **110** covering the side surface **51***c*. The protective film **110** includes the metal plating **54** and the adhesive **55** made of resin. Note that, the protective film **110** is not limited to this example. The protective film **110** is an example of a film. Instead of the adhesive **55**, another resin film may cover the side surface **51***c*.

[0071] In the present embodiment, the protective film **110** covers the substantially entire region of the side surface **51***c*. That is, the regions **51***d*, **51***e*, and **51***f* of the side surface **51***c* covered with the protective film **110** are larger than the region of the side surface **51***c* separated from the protective film **110** without being covered with the protective film **110**.

[0072] The HSA **14** further includes a relay connector **121** mounted at the end portion of the FPC **43**. The relay connector **121** is connected to the relay connector **52**. Accordingly, the PWB **51** is electrically connected to the magnetic head **48** through the relay connectors **52** and **121**, the FPC **43**, and the flexure **47**. That is, the FPC **43** electrically connects the magnetic head **48** and the PWB **51**.

[0073] The PCB **16** further includes a relay connector **125**. The relay connector **125** is connected to the relay connector **53**. As a result, a controller of the PCB **16** is electrically connected to the magnetic head **48** through the relay connectors **125** and **53**, the PWB **51**, the relay connectors **52** and **121**, the FPC **43**, and the flexure **47**.

[0074] FIG. **5** is an exemplary plan view illustrating the PWB **51** in the manufacturing process of the first embodiment. As illustrated in FIG. **5**, in the manufacturing process of the PWB **51**, a panel **130** is manufactured by a build-up method. The panel **130** includes a plurality of PWBs **51** and a plurality of suspenders **131**. The PWB **51** and the suspender **131** are integrally formed.

[0075] Each of the plurality of suspenders **131** connects two adjacent PWBs **51** of the plurality of PWBs **51** to each other. For example, when the suspender **131** is cut by a router bit, the plurality of PWBs **51** is separated from the panel **130**.

[0076] The protrusion **56** is, for example, a part of the suspender **131** cut by the router bit. The region **51***f* of the side surface **51***c* is a surface of the protrusion **56** formed by cutting with a router bit. Therefore, the region **51***f* is not covered with the plating **54**.

[0077] When the relay board **17** is attached to the bottom wall **31** of the housing **11**, for example, a dispenser supplies the adhesive **55** between the bottom wall **31** and the first surface **51***a*. Furthermore, the dispenser applies the adhesive **55** to the region **51***f*. As a result, the region **51***f* exposed by cutting is covered with the adhesive **55**.

[0078] As illustrated in FIG. **4**, the side surface **51***c* of the PWB **51** includes the end surfaces **81** of the plurality of insulating layers **61**, **62**, and **63**. That is, at least a part of the side surface **51***c* includes glass fiber and synthetic resin which are materials of the insulating layers **61**, **62**, and **63**.

[0079] When the side surface **51***c* is exposed, from the side surface **51***c*, dust such as fine particles of glass fiber or synthetic resin may fall off, or outgas may be released. However, by covering the side surface **51***c*, the protective film **110** of the present embodiment suppresses falling of dust from the side surface **51***c* and suppresses release of outgas from the side surface **51***c*. Therefore, the protective film **110** suppresses contamination of a manufacturing device such as a curing furnace or the HDD **10** due to the dust and the outgas.

[0080] In the HDD **10** according to the first embodiment described above, the internal space S and the penetration hole **35** are provided in the housing **11**. The internal space S is filled with gas different from air. The penetration hole **35** makes the internal space S communicate with the outside. The magnetic disk **12** is provided in the internal space S. The PWB **51** includes the first surface **51***a*, the second surface **51***b*, and the side surface **51***c*, and is configured to seal the penetration hole **35**. The first surface **51***a* is attached to the housing **11**. The second surface **51***b* is located opposite to the first surface **51***a*. The side surface **51***c* is provided between the outer edge of the first surface **51***a* and the outer edge of the second surface **51***b*. The protective film **110** covers the side surface **51***c*.

[0081] In general, the PWB **51** includes an insulating layer. The insulating layer includes glass fiber and synthetic

resin, for example. When the side surface **51***c* of the PWB **51** is exposed, dust such as glass fiber or synthetic resin may fall off, or outgas may be released from the side surface **51***c*. By covering the side surface **51***c* with the protective film **110**, the HDD **10** can suppress falling of dust and release of outgas from the side surface **51***c*. As a result, the HDD **10** can suppress contamination of a manufacturing device of the PWB **51**, and eventually, can suppress entry of dust into the internal space S in the manufacturing device.

[0082] The protective film **110** includes the plating **54** which is a metal film. Metal is generally less permeable to gas than resin. Therefore, the plating **54** can more reliably suppress release of outgas from the side surface **51***c*. In addition, the plating **54** can be formed simultaneously with the conductive layers **71**, **72**, **73**, and **74** and the via **75** of the PWB **51**, for example. Therefore, the HDD **10** can facilitate manufacturing of the PWB **51** and the protective film **110**.

[0083] The metal protective film **110** is electrically connected to a conductor set to the ground potential. As a result, the metal protective film **110** can suppress generation of noise.

[0084] The PWB **51** includes the ground plane **87**. The metal protective film **110** is electrically connected to the ground plane **87**. For example, the metal protective film **110** can include copper foil extending from the ground plane **87**. Therefore, the HDD **10** can facilitate manufacturing of the PWB **51** and the protective film **110**.

[0085] The protective film **110** includes the adhesive **55** which is a resin film. As a result, even if it is difficult to provide a metal film on the side surface **51***c* of the PWB **51** in the wiring design of the PWB **51**, the protective film **110** can cover the side surface **51***c*.

[0086] The adhesive **55** includes a resin film covering the side surface **51***c*, and bonds the first surface **51***a* and the housing **11** to each other. That is, the adhesive **55** that bonds the first surface **51***a* to the housing **11** covers the side surface **51***c* of the PWB **51**. As a result, the HDD **10** can facilitate manufacturing of the PWB **51** and the protective film **110**.

[0087] The protective film **110** further covers the first surface **51***a* and the second surface **51***b*. During manufacturing of the PWB **51**, the plurality of PWBs **51** is integrally manufactured and separated from each other. At this time, the protective film **110** may peel off from the side surface **51***c*. However, since the protective film **110** covers not only the side surface **51***c* but also the first surface **51***a* and the second surface **51***b*, the protective film **110** firmly adheres to the PWB **51**. Therefore, peeling of the protective film **110** from the side surface **51***c* can be suppressed.

[0088] The protective film **110** covers the entire region of the outer edge of the first surface **51***a* and the entire region of the outer edge of the second surface **51***b*. As a result, the protective film **110** firmly adheres to the PWB **51**. Furthermore, since the protective film **110** covers a corner between the side surface **51***c* and the first surface **51***a* and a corner between the side surface **51***c* and the second surface **51***b*, it is possible to suppress falling of dust and release of outgas from the corner.

[0089] The regions **51***d*, **51***e*, and **51***f* of the side surface **51***c* covered with the protective film **110** are larger than the region of the side surface **51***c* separated from the protective film **110**. As a result, the HDD **10** can more effectively suppress falling of dust and release of outgas from the side surface **51***c*.

[0090] The PWB **51** includes the plurality of the stacked insulating layers **61**, **62**, and **63**. The side surface **51***c* includes the ends (the end surfaces **81**) of the plurality of insulating layers **61**, **62**, and **63** in the direction along the first surface **51***a*. That is, the protective film **110** collectively covers the side surface **51***c* of the PWB **51** that is a multilayer substrate. As a result, the HDD **10** can facilitate manufacturing of the PWB **51** and the protective film **110**.

[0091] The magnetic head **48** is disposed in the internal space S and is configured to read and write information from and to the magnetic disk **12**. The FPC **43** is disposed in the internal space S and electrically connects the magnetic head **48** and the PWB **51**. That is, the PWB **51** can electrically connect a component such as a controller outside the internal space S to the magnetic head **48** and seal the penetration hole **35**.

[0092] The PWB **51** is located outside the internal space S. As a result, the PWB **51** can suppress contamination of the internal space S even if dust falls off and outgas is released from the PWB **51**.

Second Embodiment

[0093] Hereinafter, a second embodiment will be described with reference to FIG. **6**. Note that, in the following description of the plurality of embodiments, component elements having functions similar to those of the component elements already described are denoted by the same reference signs as those of the component elements already described, and the description thereof may be omitted. In addition, the plurality of component elements denoted by the same reference signs does not necessarily have all the functions and properties in common, and may have different functions and properties according to each embodiment.

[0094] FIG. **6** is an exemplary plan view illustrating a part of the housing **11** and the relay board **17** according to the second embodiment. As illustrated in FIG. **6**, the plating **54** of the second embodiment includes a plurality of surface plating **201** and **202** instead of the surface plating **101** and **102**. Note that, the surface plating **201** and **202** are substantially equal to the surface plating **101** and **102** except for the points described below.

[0095] Four pieces of the surface plating **201** cover the first surface **51***a*. The four pieces of surface plating **201** are separated from each other and connected to the side surface plating **103** in the vicinity of the four protrusions **56**. Therefore, a part of the outer edge of the first surface **51***a* is exposed without being covered with the plating **54**.

[0096] The four pieces of surface plating **202** cover the second surface **51***b*. The four pieces of surface plating **202** are separated from each other and connected to the side surface plating **103** in the vicinity of the four protrusions **56**. Therefore, a part of the outer edge of the second surface **51***b* is exposed without being covered with the plating **54**. The four pieces of surface plating **201** and the four pieces of surface plating **202** have substantially the same shape.

[0097] In the HDD **10** of the second embodiment described above, the plating **54** is separated from at least one of a part of the outer edge of the first surface **51***a* and a part of the outer edge of the second surface **51***b*. That is, the plating **54** does not need to cover the entire region of the outer edge of the first surface **51***a* and the outer edge of the second surface **51***b*. As a result, the HDD **10** can improve flexibility in wiring design in the PWB **51**.

Third Embodiment

[0098] Hereinafter, a third embodiment will be described with reference to FIG. **7**. FIG. **7** is an exemplary plan view illustrating a part of the housing **11** and the relay board **17** according to the third embodiment. As illustrated in FIG. **7**, the side surface **51***c* of the third embodiment includes regions **51***g*, **51***h*, **511**, **51***j*, **51***k* instead of the regions **51***d*, **51***e*, and **51***f*. The region **51***g* is an example of the first region. The region **51***h* is an example of the second region. Furthermore, the PWB **51** includes four protrusions **301** instead of the four protrusions **56**.

[0099] Each of the regions **51***g*, **51***h*, **511**, **51***j*, and **51***k* is a part of the side surface **51***c*. Each of the four regions **51***h* defines a recess **305**. The recess **305** is a notch depressed from the region **51***g*. The region **51***h* is connected to the region **51***g*.

[0100] The four protrusions **301** protrude from the four regions **51***h*. The protrusion **301** is located inside the recess **305**. That is, the protrusion **301** does not protrude to the outside of the recess **305** beyond the region **51***g*.

[0101] The regions **511**, **51***j*, and **51***k* are provided in each of the four protrusions **301**. The region **51***i* is connected to the region **51***h*. The region **51***j* is connected to the regions **51***i* and **51***k* and is provided between the regions **51***i* and **51***k*. The region **51***k* is a semi-cylindrical curved surface, and defines a notch **307**. The notch **307** is recessed from the region **51***j*.

[0102] The plating **54** of the third embodiment includes a plurality of side surface plating **311** and **312** instead of the side surface plating **103**. The side surface plating **311** and **312** are substantially equal to the side surface plating **103** except for the points described below.

[0103] The side surface plating **311** covers the regions **51***g*, **51***h*, and **51***i* of the side surface **51***c*. The side surface plating **312** is separated from the side surface plating **311**. The side surface plating **312** covers the region **51***k* of the side surface **51***c*. The side surface plating **311** and **312** does not cover the region **51***j* of the side surface **51***c* and is disposed apart from the region **51***j*. That is, the protective film **110** covers the region **51***g*, the region **51***h*, and a part of the protrusion **301**.

[0104] FIG. **7** virtually illustrates a panel **320** and a plurality of suspenders **321** of the third embodiment by two-dot chain lines. The panel **320** and the suspender **321** are substantially equal to the panel **130** and the suspender **131** except for the points described below. In the third embodiment, a through hole **325** is provided in the suspender **321**. The side surface plating **312** is a conductor of the through hole **325**.

[0105] For example, the router bit cuts the suspender **321** from the region **51***i*, which is one side surface of the suspender **321**, to the through hole **325**. Next, the router bit cuts the suspender **321** from the region **51***i*, which is the other side surface of the suspender **321**, to the through hole **325**. As a result, the router bit cuts the suspender **321**.

[0106] The router bit exerts a force on the plating **54** in a direction of peeling off from the side surface **51***c* at an end of a portion to be cut. However, by cutting the suspender **321** from both sides thereof, the router bit can suppress peeling of the plating **54** from the side surface **51***c*.

[0107] The router bit cuts the suspender **321** so as to chip a part of the through hole **325**. The protrusion **301** is, for example, a part of the suspender **321** cut by the router bit. The notch **307** is a part of the remaining through hole **325**. The region **51***j* of the side surface **51***c* is a surface of the protrusion **301** formed by cutting with the router bit. Therefore, the region **51***j* is not covered with the plating **54**.

[0108] The side surface plating **311** covering the region **51***i* and the side surface plating **312** covering the region **51***k* are disposed close to each other. Therefore, the region **51***j* not covered with the plating **54** is set to be relatively small.

[0109] In the HDD **10** of the third embodiment described above, the side surface **51***c* includes the region **51***g* and the region **51***h*. The region **51***h* forms the recess **305** depressed from the region **51***g*. The PWB **51** includes the protrusion **301** protruding from the region **51***h* and located inside the recess **305**. The protective film **110** covers the region **51***g*, the region **51***h*, and a part of the protrusion **301**.

[0110] During manufacturing of the PWB **51**, the plurality of PWBs **51** is integrally manufactured and separated from each other. For example, the suspender **321** connecting two adjacent PWBs **51** is cut. A part of the suspender **321** remaining in the PWB **51** becomes the protrusion **301**. A tool such as a router bit that cuts the suspender **321** can suppress, for example, contact of the tool with the side surface **51***c* by cutting the suspender **321** (the protrusion **301**), and eventually, can reduce the amount of the protective film **110** removed by the tool. Since the protrusion **301** is located inside the recess **305**, the protrusion **301** does not protrude beyond the region **51***g*. Therefore, the protrusion **301** can suppress generation of burr that interferes with other components.

Fourth Embodiment

[0111] Hereinafter, a fourth embodiment will be described with reference to FIG. **8**. FIG. **8** is an exemplary cross-sectional view illustrating a part of the HDD **10** according to the fourth embodiment. As illustrated in FIG. **8**, the plurality of leads **92** of the fourth embodiment includes a ground line **401**. The ground line **401** is an example of a terminal.

[0112] The ground line **401** is set to the ground potential. The ground line **401** is connected, by the solder **95**, to one of the plurality of pads **86** set to the ground potential. The ground line **401** is electrically connected to another ground such as the base **21** through, for example, the relay connector **121** or the relay connector **125**.

[0113] The protective film **110** of the fourth embodiment includes plating **411** instead of the plating **54**. The plating **411** is substantially equal to the plating **54** except for the points described below. The plating **411** is electrically connected to the ground line **401** through, for example, the wiring **85** and the pad **86**. Therefore, the plating **411** is electrically connected to a conductor set to the ground potential.

[0114] In the fourth embodiment, the adhesive **55** may be conductive. For example, the adhesive **55** may include metal filler. The adhesive **55** bonds the plating **411** and the base **21** to each other and electrically connects the plating **411** and the base **21**. Therefore, the plating **411** is electrically connected to the base **21**, which is ground, through the conductive adhesive **55**.

[0115] In the HDD **10** of the fourth embodiment described above, the relay connector **53** includes the ground line **401** and is mounted on the PWB **51**. The ground line **401** is set to the ground potential. The plating **411** is electrically connected to the ground line **401**. Thus, the plating **411** can be electrically connected to the ground outside the PWB **51**.

Fifth Embodiment

[0116] Hereinafter, a fifth embodiment will be described with reference to FIG. **9**. FIG. **9** is an exemplary cross-sectional view illustrating a part of the HDD **10** according to the fifth embodiment. As illustrated in FIG. **9**, a plurality of through holes **501** is provided in the PWB **51** of the fifth embodiment.

[0117] The through hole **501** connects the two conductive layers **73** and **74**. The through hole **501** is disposed apart from the penetration hole **35** in the direction along the first surface **51***a*. In other words, the through hole **501** is located outside the inner edge of the penetration hole **35**. Therefore, the bottom wall **31** of the housing **11** covers the through hole **501**.

[0118] In the HDD **10** of the fifth embodiment described above, the through hole **501** is provided in the PWB **51**. The through hole **501** is disposed apart from the penetration hole **35** in the direction along the first surface **51***a*. As a result, the PWB **51** can suppress the through hole **501** making the internal space S communicate with the outside.

Sixth Embodiment

[0119] Hereinafter, a sixth embodiment will be described with reference to FIG. **10**. FIG. **10** is an exemplary cross-sectional view illustrating a part of the HDD **10** according to the sixth embodiment. As illustrated in FIG. **10**, a plurality of through holes **601** is provided in the PWB **51** of the sixth embodiment.

[0120] The through hole **601** connects the two conductive layers **73** and **74**. The through hole **601** overlaps the penetration hole **35** in the Z direction. Note that, the through hole **601** may be disposed apart from the penetration hole **35**.

[0121] The PWB **51** of the sixth embodiment further includes resin **611**. The resin **611** is, for example, epoxy resin or synthetic resin such as PI. The through hole **601** is filled with the resin **611**. As a result, the resin **611** hermetically seals the through hole **601**.

[0122] In the HDD **10** of the sixth embodiment described above, the through hole **601** is provided in the PWB **51**. The PWB **51** includes the resin **611** with which the through hole **601** is filled. As a result, the PWB **51** can suppress the through hole **601** making the internal space S communicate with the outside.

[0123] The structures of the fourth to sixth embodiments described above may be applied to any of the first to third embodiments.

[0124] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel methods and systems described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

What is claimed is:

1. A disk device comprising:
a housing provided with an internal space filled with gas different from air and a penetration hole that makes the internal space communicate with an outside;
a magnetic disk disposed in the internal space;
a printed wiring board including a first surface attached to the housing, a second surface located opposite to the first surface, and a side surface provided between an outer edge of the first surface and an outer edge of the second surface, the printed wiring board being configured to seal the penetration hole; and
a film covering the side surface.

2. The disk device according to claim **1**, wherein
the film includes a metal film.

3. The disk device according to claim **2**, wherein
the metal film is electrically connected to a conductor set to ground potential.

4. The disk device according to claim **3**, wherein
the printed wiring board includes a ground plane, and
the metal film is electrically connected to the ground plane.

5. The disk device according to claim **3**, further comprising:
an electronic component that has a terminal set to ground potential and is mounted on the printed wiring board, wherein
the metal film is electrically connected to the terminal.

6. The disk device according to claim **5**, wherein
the electronic component is a connector.

7. The disk device according to claim **1**, wherein
the film includes a resin film.

8. The disk device according to claim **7**, further comprising:
an adhesive including the resin film and bonding the first surface and the housing to each other.

9. The disk device according to claim **1**, wherein
the film further covers the first surface and the second surface.

10. The disk device according to claim **9**, wherein
the film covers an entire region of the outer edge of the first surface and an entire region of the outer edge of the second surface.

11. The disk device according to claim **1**, wherein
the side surface includes a first region and a second region that defines a recess depressed from the first region,
the printed wiring board includes a protrusion protruding from the second region and located inside the recess, and
the film covers the first region, the second region, and a part of the protrusion.

12. The disk device according to claim **1**, wherein
the printed wiring board is provided with a through hole, and
the through hole is disposed apart from the penetration hole in a direction along the first surface.

13. The disk device according to claim **1**, wherein
the printed wiring board is provided with a through hole and includes resin with which the through hole is filled.

14. The disk device according to claim **1**, wherein
a region of the side surface covered with the film is larger than a region of the side surface separated from the film.

15. The disk device according to claim **1**, wherein
the printed wiring board includes a plurality of stacked insulating layers, and
the side surface includes ends of the plurality of insulating layers in a direction along the first surface.

16. The disk device according to claim **1**, further comprising:

a magnetic head disposed in the internal space and configured to read and write information from and to the magnetic disk; and

a flexible printed circuit board that is disposed in the internal space and electrically connects the magnetic head and the printed wiring board.

17. The disk device according to claim **1**, wherein

the printed wiring board is located outside the internal space.

18. A disk device comprising:

a housing provided with a penetration hole;

a magnetic disk disposed inside the housing;

a printed wiring board including a first surface attached to the housing, a second surface located opposite to the first surface, and a side surface provided between an outer edge of the first surface and an outer edge of the second surface, the printed wiring board being configured to seal the penetration hole; and

a film covering the side surface.

* * * * *