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Specification

1. Title of the Invention:

Flexible cable assembly, fabrication method thereof, and disk drive employing the flexible cable assembly

2. Detailed Description of the Invention:

[0001]

[Field of the invention]

The present invention relates to a flexible cable assembly pasting a reinforcing plate on a flexible cable such as a flexible printed circuit (FPC) cable, a fabrication method thereof, and a disk drive employing the flexible cable assembly. More particularly, the invention relates to a flexible cable assembly which can enhance pasting precision between the flexible cable and the reinforcing plate and also can ensure clearance between the flexible cable and the enclosure case (comprising a base and a top cover) of a disk drive when it is mounted in the drive disk.

[0002]

[Background art]

Generally, disk drives have an enclosure case where a shallow, box-shaped base is closed by a top cover. The enclosure case houses disks, such as magnetic disks which are data storage

media, and a spindle motor for spinning the disk at a constant speed. The enclosure case also houses a carriage and a voice coil motor (VCM) for moving the carriage toward or away from the disk. A head slider with a converter head for reading or writing data from or to the disk and a voice coil constituting the VCM are mounted on the carriage. Also, a circuit board for controlling the spindle motor and the VCM and for transmitting and receiving data between it and the converter head is attached to the exterior surface of the enclosure case.

[0003]

A FPC cable assembly is employed for connection between the circuit board, the converter head, and the voice coil. The FPC cable assembly has a FPC cable and a reinforcing plate pasted on the FPC cable. The FPC cable is a flat cable comprising a transmission portion where a first attaching portion and a second attaching portion are formed integrally on the opposite ends of a ribbon-shaped flexible cable, and a component mounting portion formed integrally on the second attaching portion. Also, wiring patterns for transmitting data which is read from or written to the disk and for supplying current to the voice coil are formed on the FPC cable.

[0004]

The first attaching portion of the FPC cable is attached to the carriage by a reinforcing plate and follows movement of the carriage. Also, the second attaching portion is fixed to the enclosure case by another reinforcing plate. The reinforcing plates are pasted on one surface of the FPC cable, respectively. The flexible portion between the first and second attaching portions bend according to movement of the carriage. The transmission portion of the FPC cable is fixed to the carriage

and the base so that the cable surface becomes perpendicular to the bottom of the base and the surface of the top cover.

[0005]

In the process of pasting the flexible cable and the reinforcing plate together, a pasting tool with positioning pins is employed. The positioning pins are inserted into the positioning holes provided in the flexible cable and the reinforcing plate respectively, thereby positioning the reinforcing plate with respect to the flexible cable or positioning the flexible cable with respect to the reinforcing plate.

[0006]

[Problems to be solved by the invention]

As the disk drive is made thinner, there is the tendency that the vertical space within the enclosure which is given to the FPC cable (particularly the transmission portion) becomes smaller. With this tendency, it has become difficult to sufficiently ensure clearance for preventing friction between the flexible FPC cable and the base or the top cover.

[0007]

In the aforementioned process of pasting the FPC cable and the reinforcing plate together, the first or second attaching portion of the FPC cable is deformed depending upon the degree that the FPC cable is pulled, thereby sometimes giving rise to a pasting mismatch alignment. This pasting mismatch alignment causes the rotational offset of the flexible portion. Because of the rotational offset, the position of the flexible portion in the disk drive is considerably moved to the base side or the top cover side, so that the aforementioned clearance will be reduced.

Therefore, if the pasting mismatch alignment is improved, the aforementioned clearance can be ensured and the contact between the FPC cable and the enclosure case can be avoided.

[0008]

In view of problems such as described, an object of the present invention is to provide a flexible cable assembly which can enhance pasting precision between the flexible cable and the reinforcing plate and thereby can ensure clearance between the flexible cable and the enclosure case of a disk drive. Another object of the invention is to provide a method of fabricating the flexible cable assembly.

[0009]

[Summary of the invention]

To achieve the aforementioned objects, a flexible cable assembly of the present invention has the stacked structure where a reinforcing plate is pasted on the pasted portion between a flexible portion and a reinforcing film. In the procedure of fabricating the flexible cable assembly, the reinforcing film has previously been pasted on the flexible cable, and furthermore, a reinforcing plate is pasted on the pasted portion between the reinforcing film and the flexible cable.

[0010]

Thus, the reinforcing film has previously been pasted on the flexible cable, whereby the deformation of the flexible cable can be suppressed in the process of pasting the flexible cable and the reinforcing plate together. Therefore, pasting precision can be enhanced between the flexible cable and the reinforcing plate,

and consequently, clearance can be ensured between the enclosure case of a disk drive and the flexible cable assembly.

[0011]

[Preferred embodiment]

Figures 1 through 3 are perspective views showing the constitution of a disk drive according to an embodiment of the present invention, some parts having been exploded. The disk drive shown in Figures 1 through 3 houses a disk 1, a spindle motor 2, a carriage 3, a head slider 4, a voice coil motor (VCM) 5, and a FPC cable assembly 10 (flexible cable assembly) in an enclosure case 6. Also, a circuit board 7 is attached to the exterior surface (lower surface) of the enclosure case 6.

[0012]

The disk 1 which is a data storage medium is fixed to the exterior circumference of the spindle 21 of the spindle motor 2 disposed in the base 61 of the enclosure case 6, as shown in Figure 1. The spindle motor 2 spins the disk 1 at a constant speed. In this embodiment, two disks 1a and 1b are stacked with a spacer 11 between them and also are coaxially fixed to the spindle 21 with a clamp 12 disposed on the upper surface of the upper disk 1a.

[0013]

The carriage 3, as shown in Figure 2, has an intermediate portion 31, a head arm 32 extending from one end of the intermediate portion 31, and a coil arm 33 extending from the other end of the intermediate portion 31. The intermediate portion 31 is fitted on a carriage shaft 35 through a bush 34 so as to be free to rotate. The outer end of the head arm 32 has a head slider 4

mounted thereon, and the head slider 4 has a converter head 41 which reads or writes data from or to the disk 1. On the coil arm 33 a voice coil 51 is mounted.

[0014]

On the interior surfaces of a yoke 52 which is fixed to the base 61, permanent magnets 53a and 53b are mounted. The coil arm 33 is inserted into the space between the permanent magnets 53a and 53b. The voice coil 51 and the permanent magnets 53a and 53b as a whole constitute the VCM 5. This VCM 5 moves the carriage 3 toward or away from the disk 1, thereby moving the converter head 41 along approximately the radial direction of the disk 1.

[0015]

The enclosure case 6, as shown in Figure 3, is one where the open upper surface of the shallow box-shaped base 61 is closed by a top cover 62. The top cover 62 is connected to the open upper surface of the base 61 through a seal frame 63 by means of screws.

[0016]

On the circuit board 7 a connector connecting pattern 71 is formed. Also, on the circuit board 7 a CPU (not shown), a spindle driver (not shown), a VCM driver (not shown), and the like are mounted. The CPU controls an operation of the disk drive, and the CPU transmits and receives data between it and the converter head 41. The spindle driver drives the spindle motor 2 in accordance with an instruction from the CPU. The VCM driver supplies a VCM current to the voice coil 51 in accordance with an instruction from the CPU, thereby driving the VCM 5.

[0017]

The first attaching portion 111 of the FPC cable assembly 10 is attached to the side surface of the carriage 3, while the second attaching portion 113 of the FPC cable assembly 10 is fixed to the base 61. On the connector mounting portion 116 of the FPC cable assembly 10 a connector 131 with a spring pin is mounted. The connector 131 is inserted into a connector inserting hole 64 provided in the base 61. The spring pin of the connector 131 abuts the connector connecting pattern 71 formed on the circuit board 7 and connects with this. The connector mounting portion 116 faces the base 61 at the circumferential portion of the connector inserting hole 64 through a seal frame 65 attached to the circumferential portion of the connector 131. The FPC cable assembly 10 transmits the data read from the disk 1 by the converter head 41 to the circuit board 7 and also transmits data from the circuit board 7 to the converter head 41. In addition, the FPC cable assembly 10 supplies a VCM current from the VCM driver of the circuit board 7 to the voice coil 51.

[0018]

Figure 4 illustrates the circumferential structure of the carriage 3. Figure 4(a) is an exploded perspective view, Figure 4(b) a top plan view, and Figure 4(c) a front view. Figure 5 illustrates the folded structure of the FPC cable assembly 10. Figure 5(a) is a top view, Figure 5(b) a front view, and Figure 5(c) a bottom view. Figure 6 illustrates the developed structure of the FPC cable assembly 10 (before it is folded). Figure 6(a) is a top plan view (seen from the surface) and Figure 6(b) a front view (seen from the end surface). Figure 7 is a developed view showing the positions at which the reinforcing films 102, 103, and 104 and the reinforcing plates 105, 106, and 107 are pasted on the FPC cable 101 of the FPC cable assembly 10. Figure 8 illustrates the structure of the reinforcing plate 105. Figure

8(a) is a top plan view, Figure 8(b) a front view, and 8(c) a left side view. Figure 9 illustrates the structure of the reinforcing plate 106. Figure 9(a) is a top plan view, Figure 9(b) a front view, and 9(c) a left side view. Figure 10 illustrates the structure of the reinforcing plate 107. Figure 10(a) is a top plan view, Figure 10(b) a front view, and 10(c) a left side view.

[0019]

In Figure 4 the head arm 32 extends from one end of the intermediate portion 31 in a horizontal direction. In this embodiment, three head arms 32a, 32b, and 32c extend in the form of a comb. The upper and lower head arms 32a and 32c have a single suspension assembly 36a and a single suspension assembly 36d, respectively. The intervening head arm 32b has two suspension assemblies 36b and 36c. The suspension assembly 36 has a head slider 4 mounted thereon, and the head slider 4 has the converter head 41 at the outer end thereof. The two disk 1a and 1b shown in Figure 1 are interposed between the suspension assemblies 36a and 36b and between the suspension assemblies 36c and 36d, respectively. From the other end of the intermediated portion 31 opposite the extended portion of the head arm 32 the coil arm 33 on which the voice coil 51 is mounted extends in a horizontal direction.

[0020]

On one side surface of the intermediate portion 31 between the extended portion of the head arm 32 and the extended portion of the coil arm 33 a FPC cable supporting portion 37 is protruded. On this FPC cable supporting portion 37 the attaching bracket 153 (for the detail structure, see Figure 8) of the FPC cable assembly 10 is connected by means of screws. The head wire 42 from the converter head 41 is clamped by the edge portion of the

head arm 32. Furthermore, the head wire 42 is clamped by the wire bracket 152 (for the detail structure, see Figure 8) of the FPC cable assembly 10 and is guided to the first attaching portion 111 (for the detail structure, see Figure 6) of the FPC cable assembly 10. Finally, the head wire 42 is soldered on a head wire pad electrode (122 in Figure 6) formed on the first attaching portion 111. Also, the lead wire 54 of the voice coil 51 is soldered on a voice coil pad electrode (123 in Figure 6) formed on the pull-turn portion 114 (for the detail structure, see Figure 6) of the FPC cable assembly 10.

[0021]

The FPC cable assembly 10 has a FPC cable (flexible cable) 101, reinforcing films 102, 103, and 104 (In Figure 7 oblique line portions), and reinforcing plates 105, 106, and 107, as shown in Figures 6 and 7.

[0022]

The FPC cable 101 is a flat cable where the first attaching portion 111, flexible portion 112, second attaching portion 113, pull-turn portion 114, electric-component mounting portion 115, and connector mounting portion 116 are formed integrally with one another. The first attaching portion 111 and the second attaching portion 113 are formed integrally on the longitudinal opposite ends of the ribbon-shaped flexible portion 112, respectively. The first attaching portion 111, the flexible portion 112, and the second attaching portion 113 as a whole constitute a ribbon-shaped transmission portion 117. The pull-turn portion 114 is formed integrally on the first attaching portion 111 and extends in a direction perpendicular to the transmission portion 117.

[0023]

On the end portion forming one long edge of the transmission portion 117 and also forming one edge of the second attaching portion 113, the generally rectangular electric-component mounting portion 115 is formed integrally. On the edge of the electric-component mounting portion 115 opposite the second attaching portion 113, the connector mounting portion 116 is formed integrally. The electric-component mounting portion 115 and the connector mounting portion 116 extend in a direction perpendicular to the transmission portion 117. The electric-component mounting portion 115 and the connector mounting portion 116 constitute a component mounting portion 118. That is, the FPC cable 101, in the developed structure, is one where the pull-turn portion 114 and the component mounting portion 118 are formed integrally in the form of a crank on the longitudinal opposite ends of the ribbon-shaped transmission portion 117.

[0024]

Also, on the FPC cable 101 there are formed wiring patterns 121, such as a signal line 121a for connecting the converter head 41 and a VCM current line 121b for connecting the voice coil 51. On the way of the signal line 121a, there are provided electronic devices, such as an AE chip 132 for amplifying a transmission signal, a resistor 133, and a capacitor 143.

[0025]

On the front surface of the first attaching portion 111 the head wire pad electrode 122 is opened and formed. Also, on the front surface of the pull-turn portion 114 the voice coil pad electrode 123 is opened and formed. On the back surface of the first attaching portion 111, there is pasted the reinforcing film 102 for suppressing deformation of the first attaching portion 111

in pasting the reinforcing plate 105 and the first attaching portion 111 together. Furthermore, on this reinforcing film 102 there is pasted the reinforcing plate 105 for attaching the first attaching portion 111 and the pull-turn portion 114 to the carriage 3. The pasted portion between the first attaching portion 111 and the reinforcing film 102 is formed with positioning holes 111a, 111b, and 111c. The pull-turn portion 114 is formed with a screw hole 114h and engaging holes 114k and 114l.

[0026]

The reinforcing plate 105 is one where a wire bracket 152 and an attaching bracket 153 are formed integrally on a main body portion 151, as shown in Figure 8. The main body portion 151 is formed with positioning holes 151a, 151b, and 151c. The front surface 154 of the main body portion 151 is flat in shape and pasted on the reinforcing film 102. On the back surface 155 of the main body portion 151 an engaging protrusion 151k is formed. The wire bracket 152 is protruded from one end surface of the main body portion 151. The wire bracket 152 is formed with grooves 156 for clamping the head wires 42 (see Figure 4). The attaching bracket 153 is protruded from the back surface 155 of the main body portion 151. The attaching bracket 153 is formed with a screw hole 153h and an engaging protrusion 153l.

[0027]

The first attaching portion 111, the reinforcing film 102, and the reinforcing plate 105, as shown in Figures 6 and 7, are pasted together so that the positions of the positioning holes 111a and 151a are aligned with each other, the positions of the positioning holes 111b and 151b are aligned with each other, and so that the positions of the positioning holes 111c and 151c are aligned with each other.

[0028]

On the back surface of the second attaching portion 113, there is pasted the reinforcing film 103 for suppressing deformation of the second attaching portion 113 in pasting the reinforcing plate 106 and the second attaching portion 113 together. Furthermore, on this reinforcing film 103 there is pasted the reinforcing plate 106 for fixing the second attaching portion 113 to the base 61. The pasted portion between the second attaching portion 113 and the reinforcing film 103 is formed with positioning holes 113d and 113e.

[0029]

The reinforcing plate 106 is one where a side plate 161 and a bottom plate 162 are formed integrally with each other so that the cross section has an L-letter shape, as shown in Figure 9. The side plate 161 is formed with positioning holes 161d and 161e. Also, the bottom plate 162 is formed with a screw hole 162i and engaging holes 162m and 162n. The inner surface 163 and outer surface 164 of the side plate 161 and the inner surface 165 and outer surface 166 of the bottom plate 162 are all flat in shape. The outer surface 164 of the side plate 161 is pasted on the reinforcing film 103.

[0030]

The second attaching portion 113, the reinforcing film 103, and the reinforcing plate 106, as shown in Figures 6 and 7, are pasted together so that the positions of the positioning holes 113d and 161d are aligned with each other and also the positions of the positioning holes 113e and 161e are aligned with each other.

[0031]

On the front surface of the electric-component mounting portion 115, an AE chip pad electrode 124 and an electronic device pad electrode 125 are opened and formed and also electric components, such as an AE chip 132, a resistor 133, and a capacitor 134, are mounted. The AE chip 132 is soldered on the AE chip pad electrode 124. The resistor 133 and the capacitor 134 are soldered on the electronic device pad electrode 125. On the back surface of the electric-component mounting portion 115, there is pasted a reinforcing plate 107 for fixing the mounting portion 115 to the base 61 and also ensuring the flatness of the electric-component mounting portion 115 in soldering the AE chip 213 and the like. The electric-component mounting portion 115 is formed with positioning holes 115f and 115g and a screw hole 115j.

[0032]

The reinforcing plate 107 is one where a thick plate 171, a thin plate 172, and an intermediate plate 173 are formed integrally on a plane, as shown in Figure 10. The intermediate plate 173 is formed with a positioning hole 173f, a screw hole 173i, and engaging protrusions 173m and 173n. The thick plate 171 is formed with a screw hole 171j. The thin plate 172 is formed with a positioning hole 172g. The front surface 174 of the thick plate 171, the front surface 176 of the thin plate 172, and the front surface 178 of the intermediate plate 173 as a whole form a single plane and are pasted on the back surface of the electric-component mounting portion 115. Between the back surface 177 of the thin plate 172 and the back surface 175 of the thick plate 171, there is difference in level. Similarly, between the back surface 175 of the thick plate 171 and the back surface 177 of the intermediate plate 173, there is difference in level. When the FPC cable assembly 10 is folded as shown in

Figure 5, the inner surface 165 of the bottom plate 162 of the reinforcing plate 106 shown in Figure 9 is superimposed on the back surface 179 of the intermediate plate 173. At this time, the back surface 175 of the thick plate 174 of Figure 10 and the outer surface 166 of the bottom plate 162 of Figure 9 as a whole form a single plane.

[0033]

The electric-component mounting portion 115 and the reinforcing plate 107, as shown in Figures 6 and 7, are pasted together so that the positions of the positioning holes 115f and 173f are aligned with each other, the positions of the positioning holes 115g and 172g are aligned with each other, and so that the screws 115j and 171j are aligned with each other.

[0034]

On the front surface of the connector mounting portion 116, connector pad electrodes 126 are opened and formed and also a connector 131 with spring pins 131a for connecting the wiring pattern 121 to the circuit board 7 (see Figure 3) is mounted. The connector 131 is soldered on the connector pad electrodes 126. On the back surface of the connector mounting portion 116, there is pasted a reinforcing film 104 for ensuring the flatness of the connector mounting portion 116 in soldering the connector 131 on the connector pad electrodes 126. The pasted portion between the connector mounting portion 116 and the reinforcing film 104 is formed with screw holes 116i and 116j and an engaging hole 116m.

[0035]

The fabrication process of the developed FPC cable assembly 10 shown in Figures 6 and 7 will hereinafter be described. Figures

11 through 16 are diagrams for explaining an example of the process of fabricating the FPC cable assembly 10. First, as shown in Figure 11, FPC cable patterns 202 are formed on a base film material 201a. More specifically, a conductive film (not shown) is pasted on the base film material 201a with an adhesive material, and this conductive film is patterned, thereby forming the wiring patterns 121 (see Figure 6). Next, a base film material 201b is pasted with an adhesive material on the side of the base film material 201a on which the wiring patterns 121 have been formed. Next, the base film material 201b is formed with pad openings to which the head wire pad electrode 122, the voice coil pad electrode 123, the AE chip pad electrode 124, the electronic device pad electrode 125, and, the connector pad electrode 126 (see Figure 6) are exposed.

[0036]

In this embodiment, the base film materials 201a and 201b employ polyimide (for example, trade name "Kapton" made by NOK). The thickness of the base film materials 201a and 201b is at about 12.5 μm . Therefore, the thickness of the base film material 201 with structure pasting the base film materials 201a and 201b together is at about 25 μm .

[0037]

Next, as shown in Figure 12, a reinforcing film material 203 is stamped into a predetermined configuration to generate a reinforcing film pattern 204. In this embodiment, the reinforcing film material 203 employs polyether imide (for example, trade name "ULTEM 1000" made by MECTRON). The reinforcing film material 203 is, for example, at about 75 to 125 μm in thickness and has a thickness about 3 to 5 times the thickness of the base film material 201.

[0038]

Next, as shown in Figure 13, the reinforcing film pattern 204 is pasted on the side of the base film material 201a with an adhesive material. The reinforcing film pattern 204 will be the reinforcing films 102 through 104 (see Figure 7) and therefore is pasted on the FPC cable pattern 202 so as to include the predetermined areas of the first attaching portion 111, second attaching portion 113, and connector mounting portion 116 (see Figure 7) provided on the FPC cable pattern 202.

[0039]

Next, as shown in Figure 14, screw holes (screw holes 114h, 115j, 116i, and 116j shown in Figure 7), engaging holes (engaging holes 114h, 114l, and 116m shown in Figure 7), and positioning holes 111a, 111b, 111c, 113d, 113e, 115f, and 115g are opened in the FPC cable pattern 202. Note that in Figure 14, screw holes and engaging holes have not been shown. The FPC cable pattern 202 is stamped from the base film material 201, thereby forming the FPC cable 101 to which the reinforcing films 102 through 104 have been pasted. In the FPC cable 101, the reinforcing films 102 through 104 are pasted on the back surface, that is, the side of the base film material 201a, and pad openings (not shown) are formed on the front surface, that is, the side of the base film material 201b.

[0040]

Next, as shown in Figures 15 and 16, the reinforcing plates 105 through 107 (for the detail structures, see Figures 8 through 10) are pasted on the FPC cable 101 with a pasting tool 301. The reinforcing plates 105 and 106 are pasted on the FPC cable 101 through the reinforcing films 102 and 103, respectively. That is, the reinforcing plates 105 and 106 are pasted on the

reinforcing films 102 and 103, respectively. The pasting tool 301 has a flat portion 311 and positioning pins 312a, 312b, 312c, 312d, and 312e stood up vertically in the flat portion 311. The positioning pins 312a through 312e are disposed at the positions on the flat portion 311 corresponding to the positioning holes 111a, 111b, 111c, 113d, 113e, 115f, and 115g on the FPC cable 101.

[0041]

First, the FPC cable 101 is faced to the flat portion 311, and the positioning holes 111a, 111b, 111c, 113d, 113e, 115f, and 115g on the FPC cable 101 are engaged by the positioning pins 312a through 312e of the pasting tool 301, respectively. Then, the FPC cable 101 is placed on the flat portion 311 (Figure 15) of the pasting tool 301. Next, the front surface 154 of the main body of the reinforcing plate 105 is faced to the flat portion 311, and the positioning holes 151a through 151c are engaged by the positioning pins 312a through 312c, respectively. With the positioning holes and the positioning pins engaged with each other, the reinforcing plate 105 is moved toward the reinforcing film 102 and then the reinforcing plate 105 is pasted on the reinforcing film 102 with an adhesive agent. Similarly, the outer surface 154 of the side plate of the reinforcing plate 106 is faced to the flat portion 311, and the positioning holes 161d and 161e are engaged by the positioning pins 312d and 312e, respectively. The side plate 161 of the reinforcing plate 106 is pasted on the reinforcing film 102 with an adhesive agent. Furthermore, the front surfaces 174, 176, and 178 of the reinforcing plate 107 is faced to the flat portion 311, and the positioning holes 173f and 172g are engaged by the positioning pins 312f and 312g, respectively. The reinforcing plate 107 is pasted on the back surface of the FPC cable 101 with an adhesive agent (Figure 16).

[0042]

Thereafter, the connector 131, the AE chip 132, the resistor 133, and the capacitor 134 are soldered on the front surface of the FPC cable 101, and the FPC cable assembly 10 is fabricated as shown in Figures 6 and 7. Note that since the reinforcing plate 107 does not need to be positioned with high precision on the FPC cable 101, the reinforcing plate 107 is pasted directly on the FPC cable 101 without intervention of a reinforcing film.

[0043]

As shown in Figure 17, in a conventional FPC cable assembly, a first attaching portion 111 and a reinforcing plate 105 are directly pasted together and a second attaching portion 113 and a reinforcing plate 106 are directly pasted together, without pasting reinforcing films on the first and second attaching portions 111 and 113. Therefore, when the positioning holes provided in the first and second attaching portions 111 and 113 are inserted onto the positioning pin 312 of a pasting tool 301, the first and second attaching portions 111 and 113 (particularly positioning holes) are deformed. These deformations cause a pasting mismatch alignment between the first attaching portion 111 and the reinforcing plate 105 and between the second attaching portion 113 and the reinforcing plate 106. Furthermore, the pasting mismatch alignment between the first attaching portion 111 and the reinforcing plate 105 results in the rotational offset 321 of the flexible portion 112. Similarly, the pasting mismatch alignment between the second attaching portion 113 and the reinforcing plate 106 results in the rotational offset 322 of the flexible portion 112. These rotational offsets have been causative of a reduction in the clearance between the enclosure case 6 and the flexible portion 112.

[0044]

However, in the FPC cable assembly 10 of the present invention, the reinforcing films 102 and 103 have previously been pasted on the first and second attaching portions 111 and 113, whereby deformations of the first and second attaching portions 111 and 113 can be suppressed when the positioning holes provided in the pasted portion are inserted on the positioning pins 312 of the pasting tool 301. Therefore, pasting precision can be enhanced between the first attaching portion 111 and the reinforcing plate 105 and between the second attaching portion 113 and the reinforcing plate 106, and the rotational offset of the flexible portion 112 can be suppressed.

[0045]

Figures 18 and 19 are diagrams describing a process of fabricating a conventional FPC cable assembly. Figure 18 corresponds to the process shown in Figure 12, and Figure 19 corresponds to the process shown in Figure 13. As shown in Figure 17, even in the conventional FPC cable assembly, since a reinforcing film 104 is pasted on a connector mounting portion 116, the fabrication process of the conventional FPC cable assembly shown in Figures 18 and 19 and the fabrication process of the FPC cable assembly shown in Figures 12 and 13 are the same in operational procedure and material (reinforcing film material 203), except that the configuration of a conventional reinforcing film pattern 404 is changed to the reinforcing film pattern 204. Therefore, the fabrication cost of the FPC cable assembly 10 is the same as the conventional FPC cable assembly, although the reinforcing films 102 and 103 have been added.

[0046]

A process of folding the developed FPC cable assembly 10 shown in Figures 6 and 7 and fabricating the FPC cable assembly 10 shown in Figure 5 will hereinafter be described. First, at the line A-A' of the FPC cable 101 shown in Figures 6 and 7, the pull-turn portion 114 is folded back on the back surface side of the main body 151 of the reinforcing plate 105, and the engaging hole 114k of the pull-turn portion 114 is engaged by the engaging protrusion 151k of the main body 151 of the reinforcing plate 105. Then, the pull-turn portion 114 is folded at a right angle so that the surface becomes concave at the line B-B' of the FPC cable 101, and the engaging hole 114l is engaged by the engaging protrusion 153l of the attaching bracket 153 of the reinforcing plate 105. At this time, the positions of the screw hole 114h and 153h are aligned with each other.

[0047]

Next, the engaging holes 162m and 162n of the reinforcing plate 106 are engaged by the engaging protrusions 173m and 173n, and the inner surface 165 of the bottom plate 162 of the reinforcing plate 106 (see Figure 9) is superimposed on the back surface 179 of the intermediate plate 173 of the reinforcing plate 107 (see Figure 10). At this time, the screw holes 162i and 173i are aligned with each other. Also, the FPC cable 101 is folded back so that the surface becomes convex at line C-C' shown in Figures 6 and 7. Furthermore, the FPC cable 101 is folded at approximately a right angle so that the surface becomes concave at line D-D' shown in Figures 6 and 7. Also, the outer surface 166 of the bottom plate 162 of the reinforcing plate 105 (Figure 9) and the back surface 175 of the thick plate 174 of the reinforcing plate 107 (Figure 10) form a single plane.

[0048]

Next, at the line E-E' of the FPC cable 101 shown in Figures 6 and 7, the connector mounting portion 116 is folded back on the side of the reinforcing plate 107, and the engaging hole 116m of the connector mounting portion 116 is engaged by the engaging protrusion 173m of the reinforcing plate 107. Then, the back surface of the connector mounting portion 116 (on which the reinforcing film 104 has been pasted) is superimposed on the aforementioned plane formed by the outer surface 166 of the reinforcing plate 106 and the back surface 175 of the reinforcing plate 107. At this time, the positions of the screw holes 116i, 162i and 173i are aligned with one another. Also, the positions of the screw holes 116j, 115j and 171j are aligned with one another. In the aforementioned way, the folded FPC cable assembly 10 shown in Figure 5 is fabricated.

[0049]

A process of incorporating the folded FPC cable assembly 10 shown in Figure 5 into the aforementioned disk drive will hereinafter be described. The first attaching portion 111 and the pull-turn portion 114 of the FPC cable 101 are attached to the side surface of the carriage 3, by connecting the attaching bracket 153 of the reinforcing plate 105 to the FPC cable supporting portion 37 (see Figure 4) of the carriage 3 by means of screws inserted in the screw holes 114h and 153h. Furthermore, the head wire 42 is soldered on the head wire pad electrode 122, and the lead wire of the voice coil 51 is soldered on the voice coil pad electrode 123. The head wire 42 has been clamped by the groove 156 (see Figure 8) provided in the wire bracket 152 of the reinforcing plate 105 and has been guided to the head wire pad electrode 122.

[0050]

Next, the coil arm 33 of the carriage 3 to which one end (first attaching portion 111, etc.) of the FPC cable assembly 10 has been attached is inserted into the space between the permanent magnets 53a and 53b of the yoke 52. The intermediate portion 31 of the carriage 3 is inserted onto the carriage shaft 35 through the bush 34 so that the intermediate portion 31 can be freely moved toward or away from the disk 1, and also the yoke 52 is connected to the base 61 by means of screws.

[0051]

On the other hand, the second attaching portion 113, the electric-component mounting portion 115, and the connector mounting portion 116 of the FPC cable 101 are connected to the base 61 by means of screws inserted in the screw holes 173i, 162i, and 116i and screws inserted in the screw holes 115j and 171j. At this time, the connector 131 is inserted into the connector inserting hole 64 through the seal frame 65 attached to the circumference of the connector 131. Then, the spring pins 131a of the connector 131 abut the connector connecting pattern 71 formed on the circuit board 7 and connect with this pattern.

[0052]

As described above, the first attaching portion 111 and the reinforcing plate 105 have been positioned with a high degree of precision and the second attaching portion 113 and the reinforcing plate 106 have been positioned with a high degree of precision. In addition, in the process of fabricating the FPC cable assembly 10, the occurrence of the rotational offset of the flexible portion 12 with respect to the reinforcing plates 105 and 106 can be suppressed. Therefore, the FPC cable assembly 10

incorporated in the disk drive can ensure clearance with respect to the base 61 and the top cover 62 of the enclosure case 6.

[0053]

Thus, according to the FPC cable assembly 10 of the present invention, the reinforcing films 102 and 103 have previously been pasted on the first and second attaching portions 111 and 113, and the reinforcing plates 105 and 106 are pasted on the previously pasted portions, respectively. With this arrangement, pasting precision can be enhanced between the first attaching portion 111 and the reinforcing plate 105 and between the second attaching 113 and the reinforcing plate 106, and the rotational offset of the flexible portion 112 can be suppressed. Furthermore, since the FPC cable assembly 10 can be fabricated only by a change in the configuration of the reinforcing film pattern in the process of fabricating the conventional FPC cable assembly, there is no increase in the fabrication cost, although the reinforcing films 102 and 103 have been added. By employing this FPC cable assembly 10 in a disk drive, clearance can be ensured between the FPC cable assembly and the enclosure case 6.

[0054]

In the aforementioned embodiment, while polyimide has been employed as the base film material of the FPC cable and polyether imide as the reinforcing film material, the base film and reinforcing film materials are arbitrary. The base film and the reinforcing film of the FPC cable may be formed from the same material. Furthermore, the reinforcing plate may be formed from the same material as the base film and the reinforcing film.

[0055]

While the aforementioned embodiment has employed the stacked structure where a FPC cable and a reinforcing plate are pasted together through a reinforcing film, the second attaching portion 113 where no pad electrode is formed on the surface, for example, may also have the stacked structure where a reinforcing film and a reinforcing plate are pasted together through a FPC cable.

[0056]

Also, in the aforementioned structure, although the FPC cable, the reinforcing film, and the reinforcing plate have been formed into the structure where each is a single stacked layer, the stacked structure is arbitrary in stacked number and stacked order. For example, two layers of FPC cables and two layers of reinforcing films may be pasted together, and reinforcing plates may be pasted on both sides of the pasted portion, respectively.

[0057]

Furthermore, the configurations of the FPC cable, the reinforcing film, and the reinforcing plate are not limited to those shown in Figures 6 through 10 but arbitrary.

[0058]

[Advantages of the invention]

According to the aforementioned flexible cable assembly and fabrication method of the present invention, a reinforcing film has previously been pasted on a flexible cable and, furthermore, a reinforcing plate is pasted on the previously pasted portion, whereby there are the advantages that pasting precision can be enhanced between the flexible cable and the reinforcing plate and

the rotational offset of the flexible cable to the reinforcing plate can be suppressed, without requiring additional cost.

[0059]

In addition, by employing the flexible cable assembly of the present invention in a disk drive, there is the advantage that clearance can be ensured between the flexible cable assembly and the enclosure case of the disk drive.

3. Brief Description of the Drawings:

Figure 1 is a perspective view showing the constitution of a disk drive according to an embodiment of the present invention, some parts having been exploded;

Figure 2 is a perspective view showing the constitution of the disk drive according to an embodiment of the present invention, some parts having been exploded;

Figure 3 is a perspective view showing the constitution of the disk drive according to an embodiment of the present invention, some parts having been exploded;

Figure 4 is a diagram showing the circumferential structure of a carriage provided in the disk drive according to an embodiment of the present invention;

Figure 5 is a folded structure diagram of a FPC cable assembly in the disk drive according to an embodiment of the present invention;

Figure 6 is an exploded structure diagram of the FPC cable assembly in the disk drive according to an embodiment of the present invention;

Figure 7 is an exploded view showing the positions at which reinforcing films and the reinforcing plates are pasted on the FPC cable in the FPC cable assembly of the disk drive according to an embodiment of the present invention;

Figure 8 is a diagram showing the structure of a reinforcing plate which is pasted on the first attaching portion of the FPC cable in the FPC cable assembly of the disk drive according to an embodiment of the present invention;

Figure 9 is a diagram showing the structure of a reinforcing plate which is pasted on the second attaching portion of the FPC cable in the FPC cable assembly of the disk drive according to an embodiment of the present invention;

Figure 10 is a diagram showing the structure of a reinforcing plate which is pasted on the electric-component mounting portion of the FPC cable in the FPC cable assembly of the disk drive according to an embodiment of the present invention;

Figure 11 is a diagram showing an example of a process of fabricating the FPC cable assembly which is employed in the disk drive according to an embodiment of the present invention;

Figure 12 is a diagram showing an example of the process of fabricating the FPC cable assembly which is employed in the disk drive according to an embodiment of the present invention;

Figure 13 is a diagram showing an example of the process of fabricating the FPC cable assembly which is employed in the disk drive according to an embodiment of the present invention;

Figure 14 is a diagram showing an example of the process of fabricating the FPC cable assembly which is employed in the disk drive according to an embodiment of the present invention;

Figure 15 is a diagram showing an example of the process of fabricating the FPC cable assembly which is employed in the disk drive according to an embodiment of the present invention;

Figure 16 is a diagram showing an example of the process of fabricating the FPC cable assembly which is employed in the disk drive according to an embodiment of the present invention;

Figure 17 is an exploded diagram showing a position of paste on the reinforcing film and the reinforcing plate for FPC cable in a conventional FPC cable;

Figure 18 is a diagram showing a process of fabricating a conventional FPC cable assembly; and

Figure 19 is a diagram showing the process of fabricating the conventional FPC cable assembly.

[Description of symbols]

- 1 ... Disk
- 3 ... Carriage
- 4 ... Head slider
- 6 ... Enclosure case
- 7 ... Circuit board
- 10 ... FPC cable assembly
- 101 ... FPC cable
- 102, 103 ... Reinforcing film
- 105, 106 ... Reinforcing plate
- 111 ... First attaching portion
- 112 ... Flexible portion

113 ... Second attaching portion

111a through 111c, 113d, 113e, 115f, 115g, 151a through 151c,
161d, 161e, 173f, 172g ... Positioning hole

201 ... FPC cable base film material

312 ... Positioning pin

4. Claims:

(1) A flexible cable assembly comprising:

a flexible cable;

a reinforcing film for reinforcing said flexible cable; and

a reinforcing plate for reinforcing said flexible cable;
and

wherein said reinforcing plate is pasted on a portion where
said flexible cable and said reinforcing film are pasted
together.

(2) The flexible cable assembly as set forth in Claim 1,
wherein:

said flexible cable is one where a first attaching portion
and a second attaching portion are formed integrally on
opposite ends of a ribbon-shaped flexible portion; and

said reinforcing film and said reinforcing plate are pasted
on said first attaching portion and said second attaching
portion, respectively.



- (3) The flexible cable assembly as set forth in Claim 1, wherein said reinforcing film has a thickness 3 to 5 times the thickness of said flexible cable.
- (4) The flexible cable assembly as set forth in Claim 1, wherein a base film of said flexible cable and said reinforcing film are either polyimide film or polyether imide film.
- (5) The flexible cable assembly as set forth in Claim 1, wherein a base film of said flexible cable and said reinforcing film comprise the same material.
- (6) A method of fabricating a flexible cable assembly, comprising the steps of:

 pasting a reinforcing film on a flexible cable, and

 pasting a reinforcing plate on a pasted portion between said reinforcing film and said flexible cable.
- (7) The method of fabricating a flexible cable assembly as set forth in Claim 6, further comprising a step of providing positioning holes in the pasted portion between said reinforcing film and said flexible cable, and where said step of pasting a reinforcing plate on the pasted portion is one which positions said reinforcing plate on said pasted portion so that said positioning holes of said pasted portion are aligned with positioning holes provided in said reinforcing plate.
- (8) The method of fabricating a flexible cable assembly as set forth in Claim 7, wherein said step of pasting a reinforcing plate on the pasted portion is one which positions said reinforcing plate on said pasted portion, by



* C L M S *

inserting positioning pins provided in a flat portion into the positioning holes of said pasted portion and the positioning holes of said reinforcing plate.

(9) A disk drive comprising:

a disk which is a data storage medium;

a carriage for supporting a converter head which writes data on said disk or reads data from said disk;

a circuit board for transmitting and receiving a signal between it and said carriage;

an enclosure case in which said disk and said carriage are housed and on which said circuit board is mounted; and

a flexible cable assembly for connection between said carriage and said circuit board; and

wherein said flexible cable assembly comprises a flexible cable, a reinforcing film for reinforcing said flexible cable, and a reinforcing plate for reinforcing said flexible cable and wherein said reinforcing plate is pasted on a pasted portion between said flexible cable and said reinforcing film.

(10) The disk drive as set forth in Claim 9, wherein:

said flexible cable is one where a first attaching portion and a second attaching portion are formed integrally on opposite ends of a ribbon-shaped flexible portion;

