



\*G00002\*

1



\*159159\*

30 OCT 2002

200206607-4

## SPECIFICATION

### PIEZOELECTRIC DRIVING DEVICE

#### 5 BACKGROUND OF THE INVENTION

##### Field of the Invention:

The present invention relates to a piezoelectric driving device and its fabricating method, particularly to a piezoelectric driving device used for an actuator or the like for performing precise position control and its fabricating method.

##### Description of the prior Art:

In recent years, the recording density of a magnetic disk set to a magnetic disk drive has been continuously improved at an annual rate of 10%. A magnetic head used to record and reproduce data in and from a magnetic disk is normally mounted on a slider and the slider with the magnetic head mounted on it is supported by a head-supporting mechanism set in a magnetic disk drive.

To improve the recording density of a magnetic disk, it is necessary to very accurately position a magnetic head to the magnetic disk. To realize the above mentioned, a piezoelectric driving device using a piezoelectric-member element is set to a head-supporting mechanism. In the case of the piezoelectric-member element of the piezoelectric

driving device, an electrode metallic film is formed on the both principal planes of a thin-film piezoelectric member and when a voltage is applied between two electrode metallic films, the thin-film piezoelectric member expands or contracts in the in-plane direction. Position control of a magnetic head is accurately performed by using the fluctuation due to the above telescopic motion (e.g. refer to Japanese Non-examined Publication No. 2001-216748).

In the case of the above thin-film piezoelectric-member element, a voltage is applied to an electrode metallic film through a bonding wire joined to the surface of the metallic film. The bonding wire is joined to a predetermined position on the electrode metallic film through ultrasonic joining.

However, when ultrasonic-joining a bonding wire to an electrode metallic film, a damage such as a crack occurs in an electrode metallic film and thin-film piezoelectric member and moisture and steam enter the electrode metallic film and thin-film piezoelectric member. Thereby, the metal in the electrode metallic film ionizes, diffuses in a thin-film piezoelectric member between adjacent conductors (electrode metallic films) having a potential difference and diffuses, and precipitates as a metal on the surface of the opposite conductor again. Thus, because the tree like conductors are cross-linked by the metal, a problem occurs

that a short-circuit-mode failure (ion migration) occurs and resultantly, the reliability of a piezoelectric element deteriorates. The above phenomenon is particularly remarkable under a high-humidity environment.

5       The present invention is made to solve the above problem and its object is to provide a piezoelectric driving device in which a short circuit does not easily occur between electrode metallic films even if performing bonding-wire joining and its fabricating method.

10

#### SUMMARY OF THE INVENTION

To achieve the above object, a piezoelectric driving device of the present invention is a piezoelectric driving device in which a piezoelectric thin plate is joined to one side of a substrate and a terminal electrode for applying a  
15       signal for expanding or contracting the piezoelectric thin plate is further formed on the plane and the terminal electrode is formed on one side of the substrate through a piezoelectric-member pedestal separated from the  
20       piezoelectric thin plate.

In the case of the piezoelectric driving device of the present invention constituted as described above, because the piezoelectric thin plate serving as a piezoelectric displacement region is separated from the piezoelectric  
25       pedestal on which the terminal electrode is formed, it is

possible to decrease a mechanical impact or vibrations under wire bonding to the piezoelectric displacement region and prevent a crack or the like from occurring in the piezoelectric thin plate.

5           Moreover, in the case of a piezoelectric driving device of the present invention, it is preferable that the above piezoelectric thin plate and piezoelectric-member pedestal have the same laminated structure when a plurality of layers are laminated respectively.

10           Furthermore, in the case of a piezoelectric driving device of the present invention, it is allowed to use a substrate which can be expanded or contracted correspondingly to expansion or contraction of the above piezoelectric thin plate as the above substrate or use a  
15 non-retractable substrate which can be deflected as the above piezoelectric thin plate.

          In the case of a piezoelectric driving device of the present invention, it is possible to constitute the above non-retractable substrate by fixing a metal thin plate (e.g.  
20 stainless-steel thin plate) opposite to the above piezoelectric thin plate and a wiring metal connected to the above terminal electrode by a resin.

          In the case of a piezoelectric driving device of the present invention, it is allowed that two piezoelectric-  
25 member-driving portions are included and the above

piezoelectric thin plate is divided into two plates correspondingly to each piezoelectric-member-driving portion.

In the case of a piezoelectric driving device including two piezoelectric-member-driving portions, it is possible to constitute the above terminal electrode by a signal terminal electrode connected to one of the two piezoelectric-driving portions, a signal terminal electrode connected to the other of them, and a ground terminal electrode common to the two piezoelectric-driving portions.

In the case of a piezoelectric driving device of the present invention, it is preferable that the above piezoelectric thin plate has a laminated structure in which a first thin-film piezoelectric-member layer and a second thin-film piezoelectric-member layer on whose both faces an electrode film is respectively formed are joined by an adhesive and electrode films faced each other through the adhesive are used as ground electrode films.

In the case of a piezoelectric driving device of the present invention, it is possible to use the above terminal electrode as a wire-bonding terminal.

Moreover, a piezoelectric-member-driving-device-fabricating method of the present invention comprises:

a first step of forming a first electrode, a first piezoelectric-member thin film, and a second electrode on a

first substrate and forming a third electrode, a second piezoelectric-member thin film, and a fourth electrode on a second substrate;

5 a second step of making the above second electrode face the above fourth electrode, bonding them by an adhesive, and thereby pasting the above first substrate with the above second substrate, and forming a piezoelectric-laminated body layer in which the above first electrode, first piezoelectric-member thin film, second  
10 electrode, fourth electrode, second piezoelectric-member thin film, and third electrode are laminated between the above first and second substrates;

a third step of removing the above second substrate;

15 a fourth step of separating a part of the above piezoelectric laminated-body layer on the above first substrate and thereby forming at least two piezoelectric-member pedestals formed by the separated portion;

20 a fifth step of forming a first bonding electrode connected to the above second and fourth electrodes on one of the two piezoelectric-member pedestals and a second bonding electrode connected to the above first and third electrodes on the other of the two pedestals; and

25 a sixth step of joining a transferring substrate onto the above piezoelectric-laminated-body layer and two piezoelectric-member pedestals, then removing the above

first substrate and transferring substrate, and joining a non-retractable substrate which can be deflected instead of the removed first substrate.

According to a fabrication method of the piezoelectric driving device of the present invention constituted as described above, it is possible to fabricate a piezoelectric driving device in which a piezoelectric-member-laminated body layer functioning as a piezoelectric displacement region is separated from the above piezoelectric-member pedestal on which the above terminal electrode is formed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing a general configuration of a head-supporting mechanism of embodiment 1 of the present invention;

Fig. 2 is an exploded perspective view of the head-supporting mechanism of the embodiment 1;

Fig. 3 is a top view of a thin-film piezoelectric-member element used for the head-supporting mechanism of the embodiment 1;

Fig. 4 is a sectional view of the thin-film piezoelectric-member element in Fig. 3 taken along the line A-A' of Fig. 3;

Fig. 5 is a top view of a flexure used for the head-

supporting mechanism of the embodiment 1;

Fig. 6 is a sectional view of the flexure in Fig. 5 taken along the line X-X' of Fig. 5;

Fig. 7 is a side view of the head-supporting mechanism  
5 of the embodiment 1;

Fig. 8A is a sectional view for explaining operations of the piezoelectric-driving portion of the head-supporting mechanism of the embodiment 1 and Figs. 8B and 8C are graphs showing waveforms of voltages to be applied;

10 Fig. 9 is a top view for explaining operations of the head-supporting mechanism of the embodiment 1;

Fig. 10 is a local perspective top view showing an electrode configuration of a thin-film piezoelectric-member element used for the head-supporting mechanism of the  
15 embodiment 1;

Fig. 11 is a sectional view showing an electrode configuration of a thin-film piezoelectric-member element used for the head-supporting mechanism of the embodiment 1;

Fig. 12 is a sectional view (#1) for explaining a  
20 film-forming step of an electrode and a thin-film piezoelectric member in a method for fabricating the piezoelectric driving portion of the embodiment 1;

Fig. 13 is a sectional view (#2) for explaining a film-forming step of an electrode and a thin-film  
25 piezoelectric member in a method for fabricating the

piezoelectric driving portion of the embodiment 1;

Fig. 14 is a sectional view for explaining a bonding step in a method for fabricating the piezoelectric driving portion of the embodiment 1;

5        Fig. 15 is a sectional view showing a state in which a substrate is removed after bonded in a method for fabricating the piezoelectric driving portion of the embodiment 1;

10       Figs. 16A and 16B are a top view and a sectional view for explaining a first etching step in a method for fabricating the piezoelectric driving portion of the embodiment 1;

15       Figs. 17A and 17B are a top view and a sectional view for explaining second and third etching steps in a method for fabricating the piezoelectric driving portion of the embodiment 1;

20       Figs. 18A and 18B are a top view and a sectional view for explaining a fourth etching step in a method for fabricating the piezoelectric driving portion of the embodiment 1;

      Figs. 19A and 19B are a top view and a sectional view for explaining a first coating-film-forming step in a method for fabricating the piezoelectric driving portion of the embodiment 1;

25       Fig. 20A and 20B are a top view and a sectional view

for explaining a metallic-terminal-film-forming step in a method for fabricating the piezoelectric driving portion of the embodiment 1;

5 Figs. 21A and 21B are a top view and a sectional view for explaining a second coating-film-forming step in a method for fabricating the piezoelectric driving portion of the embodiment 1;

10 Fig. 22 is a sectional view for explaining a transferring step in a method for fabricating the piezoelectric driving portion of the embodiment 1;

Fig. 23 is a sectional view showing a state after transferring in a method for fabricating the piezoelectric driving portion of the embodiment 1;

15 Fig. 24 is an exploded perspective view of a head-supporting mechanism of embodiment 2 of the present invention;

Fig. 25 is a top view of a flexure used for the head-supporting mechanism of the embodiment 2;

20 Fig. 26 is a sectional view of the flexure in Fig. 25 taken along the line X-X' of Fig. 25;

Fig. 27 is a side view of the head-supporting mechanism of the embodiment 2;

25 Fig. 28 is a sectional view showing an electrode configuration of a thin-film piezoelectric-member element used for the head-supporting mechanism of the embodiment 2;

and

Fig. 29 is a sectional view showing an electrode configuration of a thin-film piezoelectric-member element of a modification of the present invention.

5

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

##### Embodiment 1

A head-supporting mechanism of the embodiment 1 of the present invention is described below.

10

As shown in Fig. 1, the head-supporting-mechanism portion of the embodiment 1 is constituted by a load beam 4, a slider 2 provided for the front end of the load beam 4, and a flexure 7 to whose front end the slider 2 is connected. In the case of the head-supporting mechanism of the embodiment 1, a piezoelectric-member-driving portion 100 is formed on a part of the flexure 7 by using a thin-film piezoelectric-member element 10 and the magnetic head 1 set to one end face of the slider 2 can be positioned by rotating the slider 2 by the piezoelectric-member-driving portion 100.

20

The load beam 4 is fixed to a base plate 5 at the proximal end of the beam 4 through beam welding.

In the case of the head-supporting mechanism portion of this embodiment 1, the thin-film piezoelectric-member element 10 is constituted by two thin-film piezoelectric-

25

member elements 10A and 1B formed by dividing a trapezoidal piezoelectric-laminated body into two parts at its central portion. Moreover, the thin-film piezoelectric-member element 10 is provided with a signal terminal portion 40 set to the thin-film piezoelectric-member element 10A and 10B respectively and a ground terminal portion 30 set as a common terminal of the thin-film piezoelectric-member elements 10A and 10B so that the two thin-film piezoelectric-member elements 10A and 10B can be separately controlled correspondingly to an applied voltage.

As shown in Fig. 4 (sectional view taken along the line A-A' in Fig. 3), the piezoelectric laminated body constituting the thin-film piezoelectric-member element 10 is constituted by joining a first thin-film piezoelectric-member layer 11A on whose upper face an upper electrode (electrode metallic film) 12B is formed and on whose lower face a lower electrode (electrode metallic film) 12A is formed with a second thin-film piezoelectric-member layer 11B on whose upper face a lower electrode film (electrode metallic film) 12C is formed and on whose lower face an upper electrode (electrode metallic film) 12D is formed by an adhesive 18 so that an upper electrode film 12B and an upper electrode film 12D are faced each other.

The first and second thin-film piezoelectric-member layers 11A and 11B are constituted so that they are changed

in the same direction when grounding the upper electrode films 12B and 12D and applying the same voltage to the lower electrode film 12A of the first thin-film piezoelectric-member layer 11A and the lower electrode (electrode metallic film) 12C of the second thin-film piezoelectric-member layer 11B.

In this case, the change in the same direction denotes that when the first thin-film piezoelectric-member layer 11A extends, the second thin-film piezoelectric-member layer 11B also extends and when the first thin-film piezoelectric-member layer 11A contracts, the second thin-film piezoelectric-member layer 11B also contracts.

Moreover, the thin-film piezoelectric-member element 10 is entirely covered with flexible coating resins 41 and 50.

Furthermore, the lower electrode film 12C of the thin-film piezoelectric-member element 10A is electrically separated from the lower electrode film 12C of the thin-film piezoelectric-member element 10B and the lower electrode film 12A of the thin-film piezoelectric-member element 10A is electrically separated from the lower electrode film 12A of the thin-film piezoelectric-member element 10B.

Moreover, in the head-supporting mechanism portion of this embodiment 1, the flexure 7, as shown in Figs. 2 and 5,

is a flexible film-like substrate in which a metallic wiring 7H connected to the magnetic head 1 and a metallic plate 15 (15A, 15B) constituting the piezoelectric-member-driving portion 100 by being pasted with the thin-film piezoelectric-member element 10 are held by an insulating material 16 made of a polyimide resin or the like as shown in Fig. 6 (sectional view taken along the line X-X' in Fig. 5), which is constituted by a slider-setting portion 7X, a wiring portion 9, and a thin-film piezoelectric-member-pasting portion 8 (8A, 8B) located between the slider-setting portion 7X and wiring portion 9.

In this case, the metallic plates 15A and 15B are formed into flat shapes almost same as the thin-film piezoelectric-member elements 10A and 10B respectively and arranged on the piezoelectric-member-pasting portion 8 so as to face the thin-film piezoelectric-member elements 10A and 10B respectively.

Moreover, in the case of the flexure 7, thin-film piezoelectric-member terminals 9A and 9D are formed nearby the boundary between the wiring portion 9 and thin-film piezoelectric-member-pasting portions 8A and 8B so as to approach signal terminal portions 40 of the thin-film piezoelectric-member elements 10A and 10B and the thin-film piezoelectric-member terminals 9B and 9C are formed nearby the boundary between the wiring portion 9 and thin-film

piezoelectric-member-pasting portion 8 so as to approach the ground terminal portion 30 common to two thin-film piezoelectric-member elements.

It is enough that either of the thin-film piezoelectric-member terminals 9B and 9C is connected to the common ground terminal portion 30 or it is allowed to use one terminal as a thin-film piezoelectric-member terminal.

Moreover, a magnetic-head terminal 6 serving as a connection-terminal electrode for each metallic wiring to connect with an input/output terminal of the magnetic head 1.

The piezoelectric-member thin-film element 10 and flexure 7 constituted as described above are combined with other components on the load beam 4 as shown in Figs. 2 and 7.

The thin-film piezoelectric-member element 10 is pasted onto the thin-film piezoelectric-member-pasting portion 8 of the flexure 7 so that the thin-film piezoelectric-member elements 10A and 10B face the metallic plates 15A and 15B respectively.

Moreover, the slider 2 is set onto the slider-setting portion 7X of the flexure 7 (magnetic head 1 is mounted), a slider-holding plate 3A is set to the side opposite to the slider 2 (lower face of the slider-setting portion 7), and

a wiring-holding plate 3 is set below the wiring portion 9 of the flexure 7, and the slider 2 is set on the load beam 4 so that the slider 2 is located at the front end of the load beam 4.

5        The slider-holding plate 3A and wiring-portion-holding plate 3 are formed by stainless-steel plates having the same thickness.

         In this case, a protrusion 3B is formed on the slider-holding plate 3A as shown in Fig. 2 and moreover, a dimple  
10       4G is formed at the front end of the load beam 4 and the slider-holding plate 3A is held so as to be rotatable about the dimple 4G when the protrusion 3B is pressed by the dimple 4G.

         The head-supporting mechanism portion of the  
15       embodiment 1 constituted as described above can be operated as described below.

         The thin-film piezoelectric-member terminals 9B and 9C serving as ground terminals are grounded as shown in Fig. 8A and voltages having phases opposite to each other about  
20       the bias voltage  $V_0$  are applied to the thin-film piezoelectric-member terminals 9A and 9D as shown in Figs. 8B and 8C.

         Thus, degrees of curves of the thin-film piezoelectric-member elements 10A and 10B are changed while  
25       they are always curved in the same direction

correspondingly to a voltage applied to the thin-film piezoelectric-member terminals 9A and 9D.

Thereby, as shown in Fig. 9A, when the thin-film piezoelectric-member element 10A is slight curved and the thin-film piezoelectric-member element 10B is greatly curved, the portion shown as 19A is loosened and the portion shown as 19B is pulled and thereby, the slider-holding plate 3A can be rotated.

The head-supporting-mechanism portion constituted as described above to position a magnetic head by using a thin-film piezoelectric element can accurately position a magnetic head compared with a supporting mechanism for positioning a magnetic head by using a conventional voice coil motor or a head-supporting mechanism using another piezoelectric element.

Then, connection between the terminal configuration of the thin-film piezoelectric element 10 which is a characteristic portion of the head-supporting mechanism of this embodiment 1 and the thin-film piezoelectric-member terminals 9A to 9D is described below.

Fig. 10 is a transmission view showing the terminal structure of the thin-film piezoelectric-member element 10 in detail and Fig. 11 is a sectional view of the terminal structure.

The sectional view of Fig. 11 is a sectional view

(taken along the line Y-Y' in Fig. 5) when the thin-film piezoelectric-member element 10 is connected with the flexure 7.

As described above, the piezoelectric-member thin-film element 10 of this embodiment 1 is constituted by two piezoelectric-member thin-film elements 10A and 10B that can be independently driven.

In the case of this embodiment 1, these two piezoelectric-member thin-film elements 10A and 10B are formed by dividing a trapezoidal piezoelectric laminated body into two parts at its central portion and an external-connection electrode for two piezoelectric-member thin-film elements 10A and 10B is formed at a portion along the lower bottom of the trapezoidal piezoelectric laminated body.

A fabrication method of the piezoelectric-member-driving portion 100 of this embodiment 1 and a detailed configuration of the piezoelectric-member-driving portion 100 are clarified by explaining the method and the configuration while referring to Figs. 12 to 23.

The thin-film piezoelectric-member elements 10A and 10B have the same structure (symmetric to right and left) as shown in Fig. 11. Therefore, portions of the thin-film piezoelectric-member element 10B are omitted in the following drawings for explaining this fabricating method.

(Film-forming step)

As shown in Fig. 12, in the case of the fabricating method of this embodiment 1, the electrode metallic film 12C, thin-film piezoelectric member 11B, and electrode metallic film 12D are formed on one principal plane of a single-crystal substrate 13B in order from the single-crystal substrate 13B.

As shown in Fig. 13, the electrode metallic film 12A, thin-film piezoelectric member 11A, and electrode metallic film 12B are formed on one principal plane of a single-crystal substrate 13A in order from the single-crystal substrate 13A.

(Bonding step)

Then, as shown in Fig. 14, the single-crystal substrates 13A and 13B are bonded each other by an adhesive layer 18 by facing the electrode metallic films 12D and 12B each other.

Thereby, a laminated body is constituted in which the electrode metallic film 12A, thin-film piezoelectric member 11A, electrode metallic film 12B, adhesive layer 18, electrode metallic film 12D, thin-film piezoelectric member 11B, and electrode metallic film 12C are laminated in this order.

Though bonding is performed by the adhesive layer 18 in the case of this embodiment 1, it is also allowed to bond the electrode metallic films 12D and 12B each other

through the thermal welding using ultrasonic vibrations.

Then, as shown in Fig. 15, one single-crystal substrate 13B is removed through etching.

(First etching step)

5        Then, as shown by the top view in Fig. 16A and the sectional view in Fig. 16B, the laminated body is divided into piezoelectric displacement regions 51A and 51B (not illustrated), a signal-terminal piezoelectric-member pedestal 40A, and a ground-terminal piezoelectric-member  
10        pedestal 30A.

(Second etching step)

Then, as shown by the top view in Fig. 17A and the sectional view in Fig. 17B, the electrode metallic film 12A is exposed around the piezoelectric displacement region 51A  
15        through etching (by removing the portions shown by symbols E1 and E2 in Fig. 17B).

The portion shown by the symbol E2 in Fig. 17B is set so that the width of the electrode metallic film 12A (connective portion) exposed by removing the portion E2  
20        increases compared to the width of the electrode metallic film exposed around the piezoelectric displacement region 51A.

(Third etching step)

Then, as shown by the top view in Fig. 17A and the  
25        sectional view in Fig. 17B, a concave portion 20A is formed

by removing the electrode metallic film 12C and thin-film piezoelectric member 11B through etching at the portion close to the ground terminal region 30A of the piezoelectric displacement region 51A and the electrode metallic film 12D is exposed at the bottom of the concave portion 20A.

(Fourth etching step)

Then, as shown in Figs. 18A and 18B, a concave portion 20B is formed by removing the electrode metallic film 12D and adhesive layer 18 at the bottom of the concave portion 20A through etching and the electrode metallic film 12B is exposed at the bottom of the concave portion 20B.

The concave portion 20B is formed at the central portion of the bottom of the concave portion 20A and the electrode metallic film 12D is exposed around the concave portion 20B so that at least the electrode metallic film 12D can be securely connected by a metallic terminal film 21C to be described later.

(First coating-film-forming step)

Then, as shown in Figs. 19A and 19B, a coating film 41 is formed so as to almost entirely cover the thin-film piezoelectric-member element 10 except exposing the following portions.

Portions exposed without forming the coating film 41 are;

(i) the electrode metallic film 12B at the bottom of the concave portion 20B,

(ii) the electrode metallic film 12D around the concave portion 20B (electrode metallic film 12D around the concave portion 20B exposed at the bottom of the concave portion 20A),

(iii) the electrode metallic film 12A exposed adjacently to the signal-terminal piezoelectric-member pedestal 40A, and

(iv) the electrode metallic film 12C exposed by an opening 12C0 formed on the coating film 41 so as to approach the electrode metallic film 12A between the concave portion 20A and the electrode metallic film 12A exposed adjacently to the signal-terminal piezoelectric-member pedestal 40A.

(Metallic-terminal-film formation)

Then, as shown in Figs. 20A and 20B, the metallic terminal film 21C connected to the electrode metallic film 12B (i) at the bottom of the concave portion 20B and the electrode metallic film 12D (ii) exposed around the concave portion 20B is formed so as to extend onto the ground-terminal region 30A and a metallic terminal film 21A connected to (iii) the electrode metallic film 12A exposed adjacently to the signal-terminal piezoelectric-member pedestal 40A and (iv) the electrode metallic film 12A

exposed by the opening 12C0 is formed so as to extend onto the signal-terminal piezoelectric-member pedestal 40A.

(Second coating-film-forming step)

Then, as shown in Figs. 21A and 21B, a coating film 50 almost entirely covering the thin-film piezoelectric-member element 10 is formed so as to expose the metallic terminal film 21C formed on the ground-terminal piezoelectric-member pedestal 30A and the metallic terminal film 21A formed on the signal-terminal piezoelectric-member pedestal 40A.

10 (Transferring step)

Then, as shown in Fig. 22, a transferring substrate 60 is joined onto the coating film 50 and then, the single-crystal substrate 13A is removed through, for example, etching, and moreover the transferring substrate 60 is removed.

Then, a flexure 7 serving as a non-retractable substrate that can be deflection-deformed is joined to the side where the substrate 60 is removed instead of the single-crystal substrate 13A.

20 (Wire-bonding step)

Then, the wire-bonding portions 40 formed by surfaces of the metallic terminal films 21A and 21B exposed on the signal-terminal piezoelectric-member pedestals 40A and 40B respectively are connected with the signal terminals 9A and 9D by a wire 25.

Moreover, the wire-bonding portion 30 formed by the surface of the metallic terminal film 21C exposed on the signal-terminal piezoelectric-member pedestal 30A is connected with the ground terminal 9B or 9C by the wire 25.

5        In this case, any one of various bonding machines including an ultrasonic bonding machine can be used in this bonding step.

Thus, as shown in Fig. 11, the thin-film piezoelectric-member element 10 is joined onto the thin-  
10 film-piezoelectric-member-pasting portion 8 of the flexure 7 and the piezoelectric-member-driving portion of this embodiment 1 is formed.

In the case of the piezoelectric-member-driving portion of the head-supporting mechanism of the embodiment  
15 1 thus constituted, because the piezoelectric displacement regions 51A and 51B are separated from the terminal piezoelectric-member pedestals 30A and 40A on which the wire-bonding portions 30 and 40 are formed, transfer of mechanical impacts or vibrations to the piezoelectric  
20 displacement regions 51A and 51B under wire bonding is suppressed by separated portions and thereby, it is possible to prevent the piezoelectric displacement regions 51A and 51B from cracking.

Thereby, it is possible to fabricate the head-  
25 supporting mechanism of this embodiment 1 at a high yield

and secure a high reliability.

#### Embodiment 2

A head-supporting mechanism of embodiment 2 of the present invention is described below.

5       The basic configuration of the head-supporting mechanism of the embodiment 2 is the same as that of the head-supporting mechanism portion of the embodiment 1 except that neither metallic plate 15A nor 15B is provided for the thin-film-piezoelectric-member-pasting portion of  
10       the flexure.

That is, in the case of the head-supporting mechanism portion of the embodiment 1, the piezoelectric-member-driving portion 100 is constituted by the thin-film piezoelectric-member elements 10A and 10B and the metallic  
15       plates 15A and 15B to rotate the slider-holding plate 3A in accordance with operations of the thin-film piezoelectric-member elements 10A and 10B followed by curves.

However, the head-supporting mechanism portion of this embodiment 2 is constituted so as to rotate the slider-  
20       holding plate 3A by pasting the thin-film piezoelectric-member elements 10A and 10B without using the metallic plates 15A and 15B on polyimide more retractable than a metal and thereby, directly using extension or contraction of the thin-film piezoelectric-member elements 10A and 10B.

25       More specifically, the piezoelectric-member-driving

portion of the embodiment 2 comprising a polyimide substrate and the thin-film piezoelectric-member elements 10A and 10B pasted on the polyimide substrate can directly obtain a driving force for rotating the slider-holding plate 3A in accordance with extension and contraction of the thin-film piezoelectric-member elements 10A and 10B because the polyimide substrate extends and contracts together with the thin-film piezoelectric-member elements 10A and 10B though the driving portion is slightly curved due to extension and contraction of the thin-film piezoelectric-member elements 10A and 10B.

The head-supporting mechanism portion of the embodiment 2 of the present invention is described below in detail by referring to the accompanying drawings.

In the following drawings, components same as those of the embodiment 1 (components having the same function though their shapes are different from each other) are provided with the same symbol.

Fig. 24 is an exploded perspective view of the head-supporting mechanism of the embodiment 2, in which a magnetic head 1, slider 2, thin-film piezoelectric-member element 10, and load beam 4 are constituted the same as those of the head-supporting mechanism of the embodiment 1, and a flexure 70 is different from the flexure of the embodiment 1 in that thin-film-piezoelectric-member-pasting

portion 16A or 16B does not include the metallic plate 15A or 15B as shown in fig 26 (sectional view taken along the line X-X' in Fig. 25).

5       The thin-film piezoelectric-member-pasting portions 16A and 16B are a part of a flexible film-like substrate formed by an insulating material 16 such as a polyimide resin and formed into flat shapes almost same as those of the thin-film piezoelectric-member elements 10A and 10B.

10       In the case of the flexure 70, the wiring pattern of a metallic wiring 7H connected to a magnetic head 1 is different from that of the embodiment 1 and only one thin-film piezoelectric-member terminal 9B is used though two thin-film piezoelectric-member terminals 9B and 9C are used for the embodiment 1. However, the above mentioned does  
15       not influence basic operations.

      In the case of the head-supporting mechanism portion of the embodiment 2, the flexure 70 and piezoelectric-member thin-film element 10 constituted as described above are combined with other components on the load beam 4 and  
20       a piezoelectric-member-driving portion is constituted on the load beam 4 as shown in Fig. 27.

      Moreover, the head-supporting mechanism portion of the embodiment 2 is constituted so that a wiring-portion-holding plate 3 is set while facing a terminal-forming  
25       portion (portion on which the terminal piezoelectric-member

pedestals 30A and 40A are formed) which is a portion not contributing to the extension and contraction of the thin-film piezoelectric member 10 are not prevented by the terminal-forming portion.

5       The head-supporting mechanism portion of the embodiment 2 constituted as described above can be operated as described below.

10       Similarly to the case of the embodiment 1, the thin-film piezoelectric-member terminal 9B serving as a ground terminal is grounded and voltages whose phases are opposite to each other about a bias voltage  $V_0$  are applied to thin-film-piezoelectric-member terminals 9A and 9D as shown in Figs. 8B and 8C.

15       Thus, extension/contraction degrees of the thin-film-piezoelectric-member elements 10A and 10B change correspondingly to a voltage applied to the thin-film-piezoelectric-member terminals 9A and 9D.

20       Thereby, for example, when the thin-film-piezoelectric-member element 10A greatly extends but the thin-film-piezoelectric-member element 10B slightly extends, the portion shown by symbol 19A loosens and the portion shown by symbol 19B is pulled and thereby, the slider-holding plate 3A can be rotated.

25       The head-supporting mechanism portion of the embodiment 2 constituted as described above to position a

magnetic head by using a thin- film piezoelectric element can accurately position the magnetic head compared to the case of a head-supporting mechanism portion for positioning a magnetic head by using a conventional voice coil motor and the case of head-supporting mechanism by using other piezoelectric elements.

Fig. 28 shows the terminal configuration and connection of the thin- film piezoelectric-member element 10 that is a characteristic portion of the head-supporting mechanism of the embodiment 2 with the thin-film piezoelectric-member terminals 9A, 9B and 9D.

#### Modification:

A head-supporting mechanism of a modification of the present invention is constituted the same as the head-supporting mechanism of the embodiment 2 is except that the head-supporting mechanism of the embodiment 2 is constituted by the thin-film piezoelectric-member element shown by a sectional view in Fig. 29.

That is, in the case of the thin-film piezoelectric-member element of the modification, step portions S11A and S11B are formed on etching cross sections of a first thin-film piezoelectric-member layer 11A and a second thin-film piezoelectric-member layer 11B by etching the first thin-film piezoelectric-member layer 11A and second thin- film

piezoelectric-member layer 11B in two stages respectively.

In the case of the thin-film piezoelectric-member element thus constituted, conductive sidewall accretions accreting to a wall parallel with the etching direction in the dry etching step in a fabrication process are electrically separated by the step portions S11A and S11B.

Therefore, the thin-film piezoelectric-member element of the modification makes it possible to decrease a leak current and realize a higher-reliability head-supporting mechanism.

As described above in detail, in the case of a piezoelectric driving device of the present invention, it is possible to control the transfer of mechanical impacts or vibrations to the above piezoelectric displacement region under wire bonding and prevent cracks from occurring in the above piezoelectric thin plate because the above terminal electrode is formed on one side of the above substrate through a piezoelectric-member pedestal separated from the piezoelectric displacement region.

Thereby, it is possible to provide a piezoelectric driving device in which a shortcircuit does not easily occur between electrode metallic films even if bonding-wire junction is performed.

Moreover, a piezoelectric-member-driving-device fabrication method of the present invention makes it

possible to easily fabricate a high-reliability piezoelectric driving device.

## WHAT IS CLAIMED IS:

1. A piezoelectric driving device comprising a substrate having a first surface and a second surface, a piezoelectric thin plate on said first surface of said substrate and terminal electrodes for applying a signal for  
5 expanding or contracting said piezoelectric thin plate, each of said terminal electrodes being formed on a piezoelectric-member pedestal on said first surface,

wherein said piezoelectric-member pedestal is  
10 separated from said piezoelectric thin plate.

2. The piezoelectric driving device according to claim 1,

wherein said piezoelectric thin plate and said piezoelectric-member pedestal have the same laminated  
15 structure having a plurality of layers.

3. The piezoelectric driving device according to claim 1,

wherein said substrate is a substrate capable of expanding and contracting correspondingly to expansion and  
20 contraction of said piezoelectric thin plate.

4 The piezoelectric driving device according to claim 3,

wherein said substrate is made of polyimide.

5. The piezoelectric driving device according to  
25 claim 1,

wherein said substrate is a non-retractable substrate capable of deflecting.

6. The piezoelectric driving device according to claim 5,

5 wherein said non-retractable substrate constituted by fixing a metal thin plate opposite to said piezoelectric thin plate by a resin.

7. The piezoelectric driving device according to claim 1,

10 wherein said piezoelectric thin plate is divided into two plates so as to form two piezoelectric-member-driving portions.

8. The piezoelectric driving device according to claim 7,

15 wherein said terminal electrodes consist of a signal terminal electrode connected to one of the two piezoelectric-driving portions, a signal terminal electrode connected to the other of them, and a ground terminal electrode common to the two piezoelectric-driving portions.

20 9. The piezoelectric driving device according to claim 1,

wherein said piezoelectric thin plate has a laminated structure in which a first thin-film piezoelectric-member layer and a second thin-film piezoelectric-member layer on  
25 whose both faces an electrode film is respectively formed

are joined by an adhesive and said electrode films faced each other through said adhesive are used as ground electrode.

10. The piezoelectric driving device according to  
5 claim 1,

wherein each of said terminal electrodes is a wire-bonding terminal.

11. A piezoelectric-member-driving-device-fabricating method comprising :

10 a first step of forming a first electrode, a first piezoelectric-member thin film, and a second electrode on a first substrate and forming a third electrode, a second piezoelectric-member thin film, and a fourth electrode on a second substrate;

15 a second step of making the above second electrode face the above fourth electrode, bonding them by an adhesive, and thereby pasting the above first substrate with the above second substrate, and forming a piezoelectric-laminated body layer in which the above first  
20 electrode, first piezoelectric-member thin film, second electrode, fourth electrode, second piezoelectric-member thin film, and third electrode are laminated between the above first and second substrates;

a third step of removing the above second substrate;

25 a fourth step of separating a part of the above

piezoelectric laminated-body layer on the above first substrate and thereby forming at least two piezoelectric-member pedestals formed by the separated portion;

5 a fifth step of forming a first bonding electrode connected to the above second and fourth electrodes on one of the two piezoelectric-member pedestals and a second bonding electrode connected to the above first and third electrodes on the other of the two pedestals; and

10 a sixth step of joining a transferring substrate onto the above piezoelectric-laminated-body layer and two piezoelectric-member pedestals, then removing the above first substrate and transferring substrate, and joining a non-retractable substrate which can be deflected instead of the removed first substrate.