US 20160336875A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2016/0336875 A1

Yamamoto (43) Pub. Date: Nov. 17, 2016

(54) **VIBRATION TYPE ACTUATOR AND ULTRASONIC MOTOR**

(71) Applicant: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(72) Inventor: **Harushige Yamamoto**, Yamato-shi (JP)

(21) Appl. No.: **15/146,243**

(22) Filed: **May 4, 2016**

(30) **Foreign Application Priority Data**

May 11, 2015 (JP) 2015-096177

Publication Classification

(51) **Int. Cl.**

H02N 2/00 (2006.01)

H01L 41/09 (2006.01)

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

CPC ***H02N 2/001*** (2013.01); ***H01L 41/09*** (2013.01)

(57) **ABSTRACT**

A vibration type actuator including a vibrator configured to vibrate due to a driving voltage, a slider configured to come into friction contact with the vibrator, a pressing plate for pressing the vibrator on the slider, a base to which the vibrator is fixed, a holding member configured to hold the base, and a coupling unit is provided. The vibration type actuator couples the vibrator and the holding member without backlash in a relative movement direction of the vibrator and the slider due to vibrations of the vibrator and freely moves the base with respect to the holding member in a direction of pressure of the pressing plate.

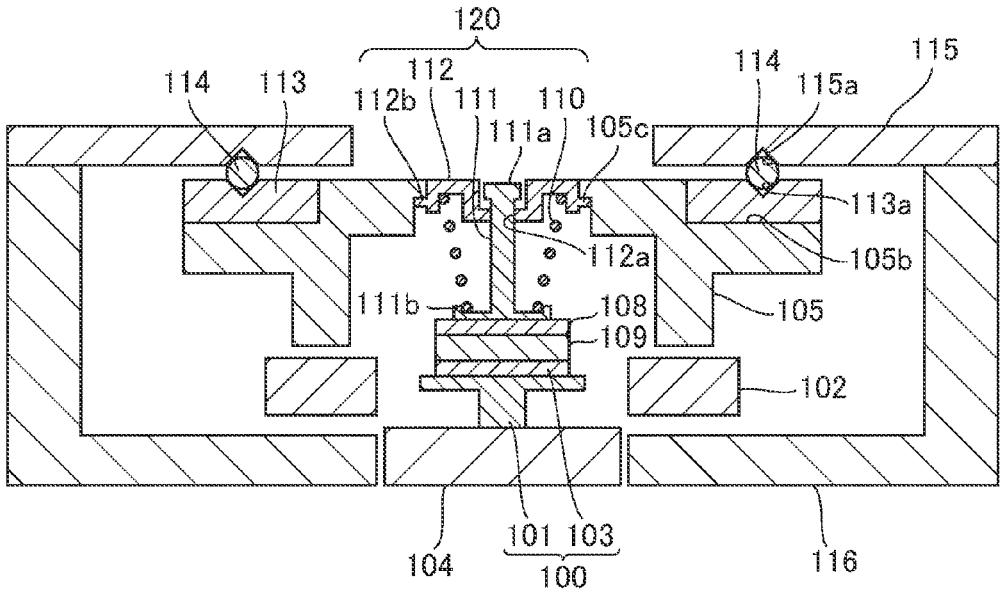


FIG. 1

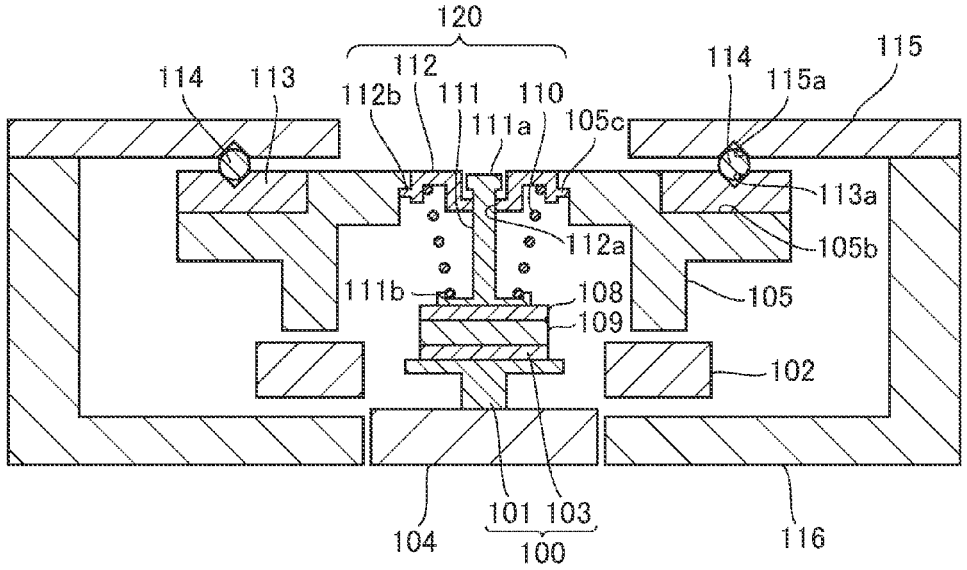

120
112
114
113
112b
111
110
111a
105c
114
115a
115
113a
112a
105b
111b
108
105
109
102
104
101
103
100
116

FIG. 2

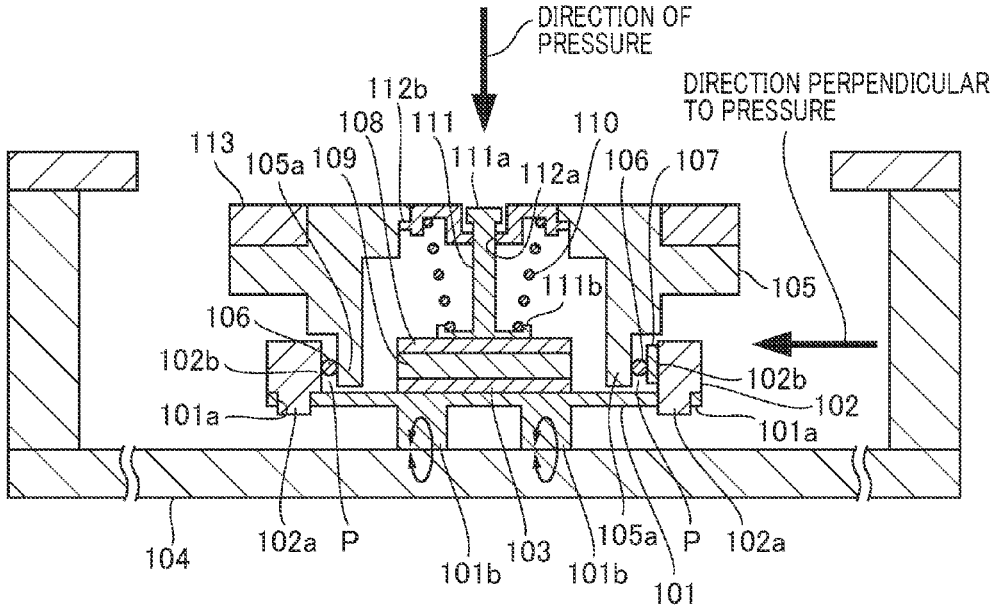

DIRECTION OF PRESSURE
DIRECTION PERPENDICULAR TO PRESSURE
112b
108
111
110
113
105a
109
111a
112a
106
107
105
111b
106
102b
102b
102
101a
101a
104
102a
P
101b
103
101b
105a
P
102a
101

FIG. 3

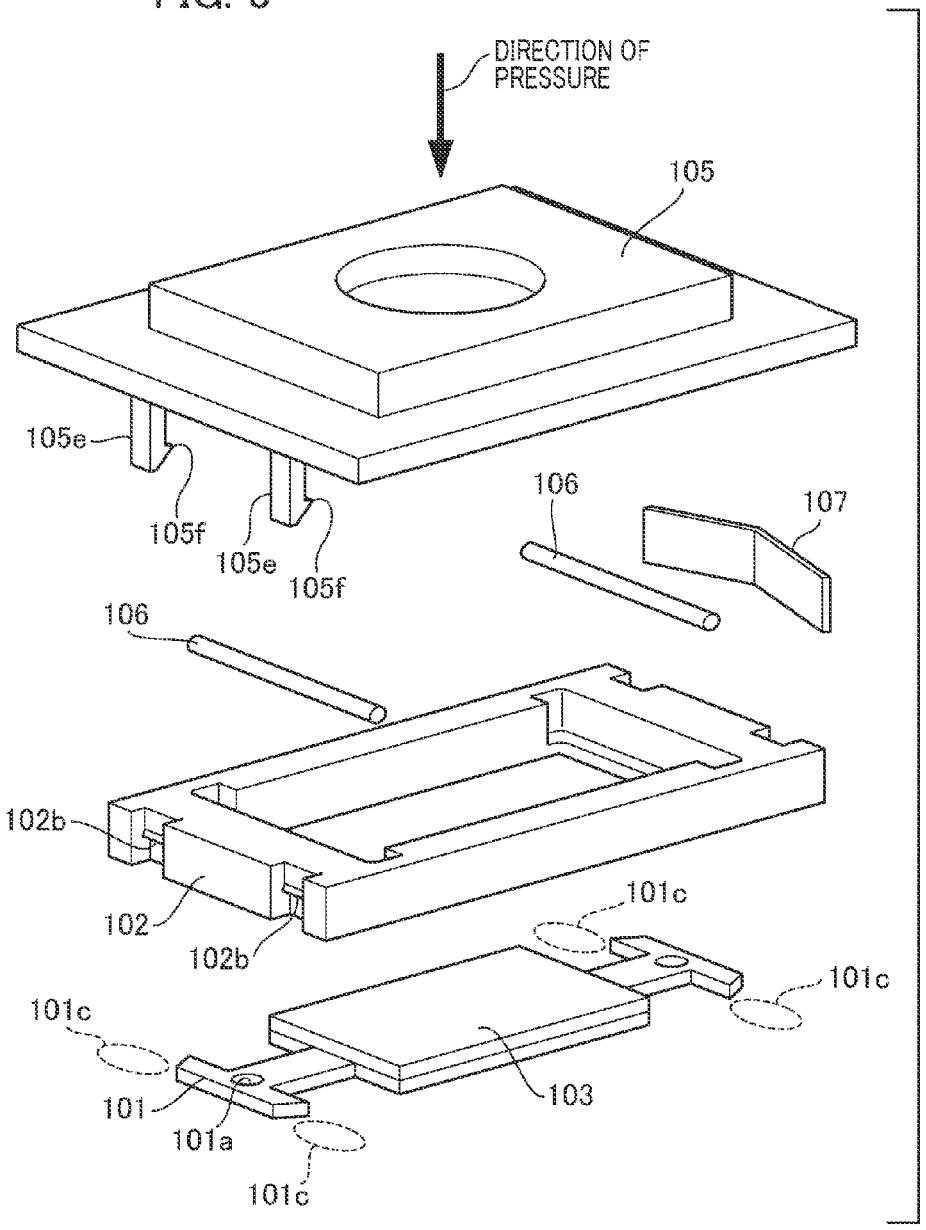

DIRECTION OF PRESSURE
105
105e
105f
105e
105f
106
107
106
102b
102
102b
101c
101c
101c
103
101
101a
101c

FIG. 4A

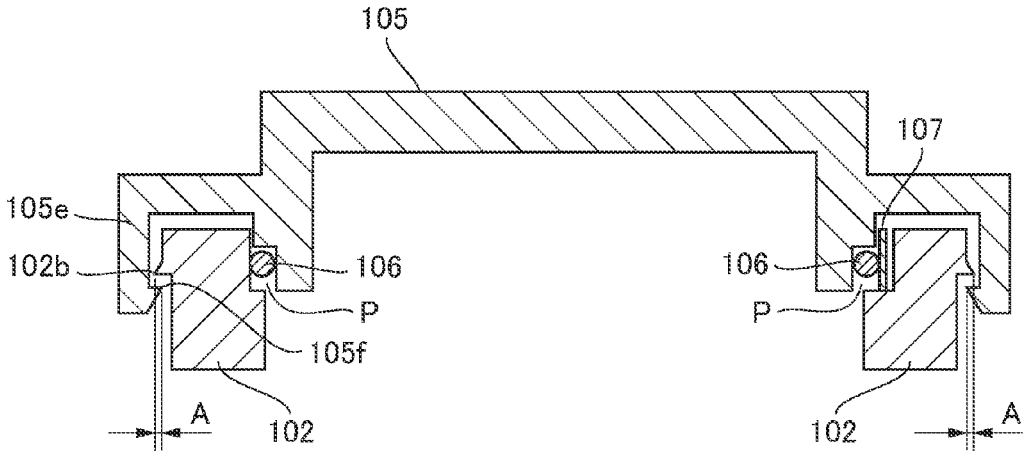

105
107
105e
102b
106
106
P
P
105f
A
102
102
A

FIG. 4B

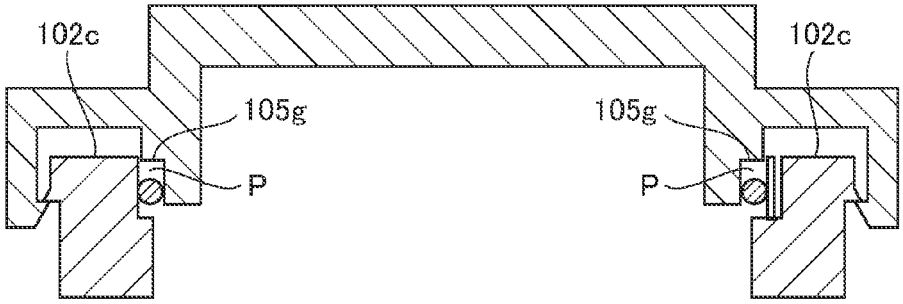
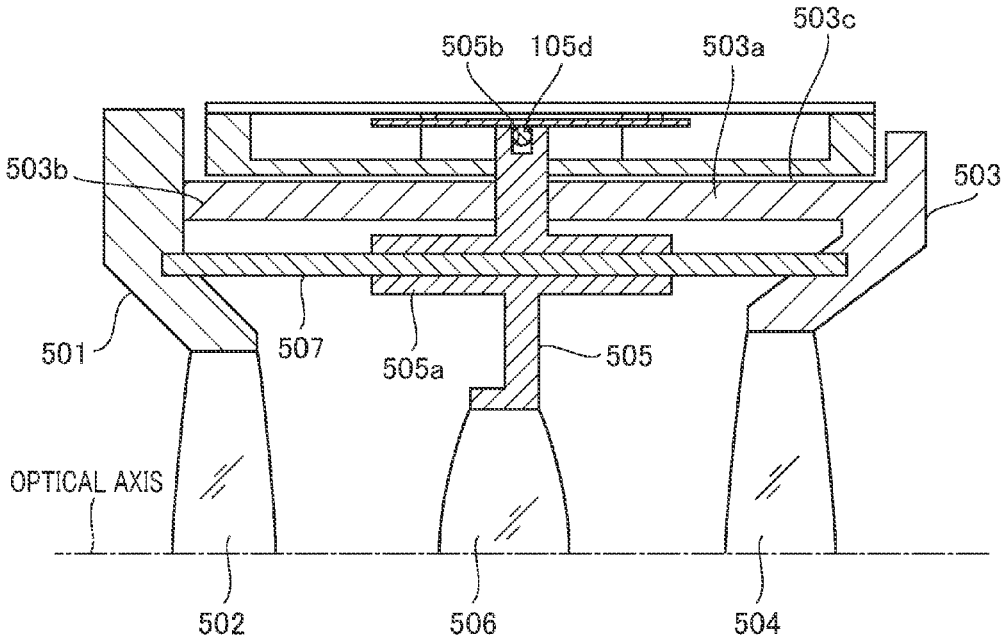

102c
102c
105g
105g
P
P

FIG. 5


505b
105d
503a
503c
503b
503
501
507
505a
505
OPTICAL AXIS
502
506
504

VIBRATION TYPE ACTUATOR AND ULTRASONIC MOTOR

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a vibration type actuator and an ultrasonic motor.

[0003] 2. Description of the Related Art

[0004] Japanese Patent Laid-Open No. 2011-200053 discloses a vibration type actuator which brings a vibrator configured to periodically vibrate due to application of a high frequency voltage into pressure contact with a sliding member to drive the sliding member.

[0005] Since the vibrator is held by a thin plate in the vibration type actuator disclosed in Japanese Patent Laid-Open No. 2011-200053, a variation is generated in a pressing force when the vibrator is brought into pressure contact with the sliding member. Thus, a stabilized pressing force cannot be generated. Also, the thin plate is deformed in a direction of pressure of the vibrator on a slider, thereby resulting in component failure. Therefore, meticulous care needs to be taken at the time of assembly, and assembling workability of the vibration type actuator is not good. In addition, when an external force is applied in a direction of a pressing force, the thin plate is deformed and a function of the vibration type actuator is not stabilized.

SUMMARY OF THE INVENTION

[0006] The present invention provides a vibration type actuator which generates a stabilized pressing force of a vibrator on a sliding member and has excellent assembling workability.

[0007] A vibration type actuator of an embodiment according to the present invention includes a vibrator configured to vibrate due to a driving voltage, a sliding member configured to come into friction contact with the vibrator, a pressing unit for pressing the vibrator on the sliding member, a base to which the vibrator is fixed, a holding member configured to hold the base, a coupling unit for coupling the vibrator and the holding member without backlash in a relative movement direction of the vibrator and the sliding member due to vibrations and freely moving the base with respect to the holding member in a direction of pressure of the pressing unit, and a temporary fixing part formed at the base and the holding member and configured to restrict a movement in the direction of pressure of the base and the holding member.

[0008] According to the present invention, the vibration type actuator which generates the stabilized pressing force of the vibrator to the sliding member and has excellent assembling workability can be provided.

[0009] Further features of the invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is an example of a cross-sectional view of a major part of a vibration type actuator.

[0011] FIG. **2** is another example of the cross-sectional view of the major part of the vibration type actuator.

[0012] FIG. **3** is a perspective view of a major part of a temporary fixing part.

[0013] FIGS. **4**A and **4**B are cross-sectional views of the major part for describing a structure of the temporary fixing part.

[0014] FIG. **5** is a view illustrating a lens barrel of an optical device into which an ultrasonic motor is incorporated.

DESCRIPTION OF THE EMBODIMENTS

[0015] FIGS. **1** and **2** are examples of cross-sectional views of a major part of a vibration type actuator of an embodiment. FIG. **1** shows the cross-sectional view in a direction perpendicular to a driving direction of the vibration type actuator. FIG. **2** shows the cross-sectional view in the driving direction of the vibration type actuator. Hereinafter, although a case in which a linear motion type ultrasonic motor serves as the vibration type actuator will be described as an example, a rotary type or other types can also be applied.

[0016] A vibrator **100** includes a vibration plate **101** and a piezoelectric element **103** and is driven due to a driving voltage. A joined portion **101***a* of the vibration plate **101** is fixed to a joint convex portion **102***a* of a base **102** using adhesion and the like. (see FIG. **2**) . The base **102** is constituted by a quadrangular frame body and is constituted by a resin or a metal thicker than a thickness of the vibration plate **101**. Also, the piezoelectric element **103** is firmly fixed to the vibration plate **101** using well-known adhesives and the like.

[0017] The piezoelectric element **103** is set such that the vibration plate **101** generates resonance in a longitudinal direction and a lateral direction when a high frequency voltage is applied. The vibrator **100** generates ultrasonic vibrations when a high frequency driving voltage is applied. As a result, as shown in FIG. **2**, a tip of a pressure contact portion **101***b* formed on the vibration plate **101** moves elliptically. A frequency or a phase of a high frequency voltage applied to the piezoelectric element **103** is changed so that a rotational direction or an elliptical ratio can be appropriately changed to move as desired. Therefore, the vibrator **100** frictionally contacts with a slider **104** which is a sliding member so that a driving force causing relative movement between the vibrator **100** and the slider **104** is generated. In other words, the vibrator **100** itself can be driven using an optical axis (a direction perpendicular to the paper surface in FIG. **1** and a horizontal direction in FIG. **2**) as a movement direction. The slider **104** is fixed to a unit support member **116** using well-known fastening means such as screws.

[0018] A holding member **105** holds the base **102**. The vibrator **100** is fixed to the base **102**. The holding member **105** is coupled to the vibrator **100** fixed to the base **102** using coupling unit to be described below.

[0019] Roller shafts **106** are rolling members. The two roller shafts **106** are disposed at both sides to sandwich the pressure contact portion **101***b* of the vibration plate **101**. In other words, the two roller shafts **106** are disposed at a front side and a rear side in the movement direction of the vibrator **100**. A leaf spring **107** is an elastic biasing member configured to elastically bias the roller shaft **106** in a relative movement direction of the vibrator **100** and the slider **104**.

[0020] Two extending portions **105***a* extending downward in FIG. **2** are formed at the holding member **105**. The roller shaft **106** and the leaf spring **107** are incorporated into

incorporation space P which is a space between the extending portions **105***a* and coupling portions **102***b* of the base **102**.

[0021] The leaf spring **107** is incorporated into the right incorporation space P in FIG. **2** along with one of the roller shafts **106**. The leaf spring **107** elastically biases the roller shaft **106** so that the holding member **105** and the base **102** are biased in directions opposite to each other by means of one of the roller shafts **106** (right in FIG. **2**). In the present embodiment, the holding member **105** is biased left in FIG. **2** and the base **102** is biased right in FIG. **2**. The biased directions are directions (directions perpendicular to pressure) perpendicular to a direction of the pressure of the vibrator.

[0022] The roller shaft **106** incorporated into the other incorporation space P on the left in FIG. **2** is also sandwiched by the other extending portion **105***a* of the holding member **105** and the other coupling portion **102***b* of the base **102**. Thus, a coupling unit for coupling the vibrator **100** and the holding member **105** can be realized without backlash in the relative movement direction of the vibrator **100** and the slider (the horizontal direction in FIG. **2**). The coupling unit can serve to prevent most sliding resistance due to actions of the roller shafts in the direction of pressure of the vibrator **100** (the vertical direction in FIG. **2**). Thus, the base **102** freely moves in the direction of pressure of a pressing plate with respect to the holding member **105**. A biasing force of the leaf spring **107** is set to be larger than an inertial force due to acceleration and deceleration occurring when operations of the holding member **105** and driven parts start and stop. The driven parts are, for example, a second lens holding member **505** and a second lens **506** to be described below shown in FIG. **5**. The base **102**, the vibrator **100**, and the holding member **105** can be controlled to be stably driven without generating relative displacement in the movement direction due to an inertial force at the time of driving through a setting of the biasing force of the leaf spring **107**.

[0023] The pressing plate **108** presses the vibrator **100** into the slider **104**. To be specific, the pressing plate **108** surrounds an elastic member **109** to press and hold the piezoelectric element **103**. A pressing spring **110** is incorporated between a spring holding member **111** and a spring bottom plate **112** and is configured as a pressing spring unit. Since a large diameter tip **111***a* of the spring holding member **111** is lightly press-fitted to be incorporated into a fitting portion **112***a* of the spring bottom plate **112**, the unit state can be maintained against a spring force of the pressing spring **110** after they are assembled.

[0024] A plurality of bayonet protrusions **112***b* are formed at an outer diameter portion of the spring bottom plate **112** in a circumferential direction. Positions of the bayonet protrusions **112***b* in the direction of pressure are defined due to a bayonet engaging portion **105***c* formed at the holding member in an incorporated state. At this time, a tip pressing portion **111***b* of the spring holding member **111** generates a pressing force pressing the vibrator **100** into the slider **104** by means of the pressing plate **108** and the elastic member **109** due to a biasing force of the pressing spring **110**. Thus, the vibrator **100** and the slider **104** can frictionally contact with each other. A pressing unit **120** includes the pressing spring **110**, the spring holding member **111**, and the spring bottom plate **112**.

[0025] A movement plate **113** is configured as a part of a guide portion fixed to a contact portion **105***b* of the holding member **105** using well-known methods such as adhesion or screwing. A plurality of V groove portions **113***a* into which balls **114** are fitted and configured to guide the holding member **105** in an optical direction are formed in the movement plate **113** (see FIG. **1**). A cover plate **115** is fixed to the unit support member **116** using well-known screws and the like. The cover plate **115** is also configured as a part of the guide portion and surrounds the balls **114** using V groove portions **115***a* provided at positions facing the V groove portions **113***a* of the movement plate **113**. Thus, the holding member **105** can be supported to be capable of advancing or retreating in the movement direction (the direction perpendicular to the paper surface in FIG. **1** and the horizontal direction of the paper surface in FIG. **2**).

[0026] FIG. **3** is a perspective view of a major part of a temporary fixing part. The temporary fixing part configured to restrict a movement of the direction of pressure of the base **102** and the holding member **105** is formed at the base **102** and the holding member **105**. A plurality of arms **105***e* extending in the direction of pressure and hooks **105***f* formed at tips thereof are formed at the holding member **105** as a single body. The arms **105***e* are formed opposite the coupling unit across the base **102**. The temporary fixing part in which the plurality of engaging portions **102***b* are formed so that the holding member **105** and the base **102** are prevented from being separated from each other or the roller shaft **106** which is the rolling member incorporated therein are prevented from dropping out in the temporarily held state is realized at the base **102**. As shown in FIG. **3**, the temporary fixing part is set at both side portions **101***c* of the joined portion **101***a* formed at a tip of the vibrator so that miniaturization thereof in the direction perpendicular to the pressure (see FIG. **2**) is realized.

[0027] FIGS. **4**A and **4**B are cross-sectional views of the major part for describing a structure of the temporary fixing part. As shown in FIG. **4**B, the hooks **105***f* formed at the holding member **105** interfere with the engaging portions **102***b* formed on the base **102** so that the hooks **105***f* and the engaging portions **102***b* cannot be separated from each other in the temporarily held state. This is because tips of the hooks **105***f* overlap tips of the engaging portions **102***b* by A in a horizontal direction in FIG. **4**A in the incorporated state as shown in FIG. **4**A. A so-called snap-fitting in which the arms **105***e* are elastically deformed using flexibility thereof and pass over and are incorporated into the engaging portions **102***b* formed at the base **102** is performed at the time of incorporating.

[0028] As shown in FIG. **4**A, the hooks **105***f* and the engaging portions **102***b* are configured not to come into contact with each other in a usage state. Also, as shown in FIG. **4**B, dropout preventing portions **105***g* are formed at the holding member **105** such that the roller shafts **106** do not drop out of an incorporated portion even in a state in which the hooks **105***f* formed at the holding member **105** are engaged with the engaging portions **102***b* formed at the base **102**. At this time, as shown in FIG. **4**B, the dropout preventing portions **105***g* are set to be level with or lower than an upper surface **102***c* of the base **102** (to be positioned at a lower side in FIG. **4**B) to prevent the roller shafts **106** from dropping out.

[0029] FIG. **5** is a view illustrating a lens barrel of an optical device into which an ultrasonic motor is incorpo-

rated. A first lens holding member **501** holds a first lens **502**. A third lens holding member **503** holds a third lens **504**. An outer circumferential portion of the third lens holding member **503** has a cylindrical portion **503***a* and a distal portion **503***b* thereof is fastened to the first lens holding member **501** using screws. A unit receiving portion **503***c* to which the ultrasonic motor is fixed is provided at a part of an outer diameter portion of the cylindrical portion **503***a* to be detachably fixed using well-known screws. Also, the second lens holding member **505** configured to hold the second lens **506** is disposed at an inner diameter portion of the cylindrical portion **503***a*.

[0030] The second lens **506** moves along an optical axis due to the ultrasonic motor as a focusing lens. At this time, since a well-known guide bar **507** and a bearing portion **505***a* are fitted to each other to be capable of relative sliding in the second lens holding member **505**, the second lens can be caused to move along the optical axis. The second lens holding member **505** and the holding member **105** may be coupled to each other, for example, through engagement of an engagement pin **105***d* provided at the holding member **105** and an engaged portion **505***b* provided at the second lens holding member **505** and using a rack and an engagement pin which are well known.

[0031] As described above, the vibration type actuator of the embodiment has the configuration in which the holding member **105** and the base **102** to which the vibrator **100** is fixed are coupled to each other by means of the roller shafts **106** and the leaf spring **107**. Therefore, the vibrator **100** and the base **102** can stabilize the pressing force with respect to the holding member **105** in the direction of pressure by means of the pressing unit **120** through a rolling action. Also, the movement direction of the driven member is maintained without backlash due to an action of the leaf spring **107** so that, for example, a focusing lens **306** of the optical device can be accurately controlled to be driven in an optical axis direction. In addition, since a structure in which temporary assembly is possible such that damage of workability such as separation of the holding member **105** from the base **102**, dropout of the roller shafts **106**, and the like does not occur at the time of assembling is provided, an ultrasonic mode in which the pressing force is stabilized and having excellent assembling workability can be realized. Although a specific example of the vibration type actuator of the embodiment and the lens barrel of the optical device into which the vibration type actuator is incorporated has been described in detail above, the present invention is not limited to the above-described embodiment.

[0032] While the invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0033] This application claims the benefit of Japanese Patent Application No. 2015-096177, filed May 11, 2015 which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A vibration type actuator comprising:

a vibrator that vibrates due to a driving voltage;

a sliding member that frictionally contacts with the vibrator;

a pressing unit that presses the vibrator to the sliding member;

a base to which the vibrator is fixed;

a holding member that holds the base;

a coupling unit that couples the vibrator with the holding member without backlash in a relative movement direction between the vibrator and the sliding member due to the vibration, and freely moves the base with respect to the holding member in a direction of pressure of the pressing unit; and

a temporary fixing part that is formed at the base and the holding member and restricts a movement in the direction of pressure of the base and the holding member.

2. The vibration type actuator according to claim **1**, wherein the coupling unit includes a rolling member and an elastic biasing member which are incorporated into an incorporation space between the base and the holding member,

wherein the rolling member freely move the base with respect to the holding member in the direction of pressure of the pressing unit, and the elastic biasing member elastically biases the rolling member in the relative movement direction between the vibrator and the sliding member.

3. The vibration type actuator according to claim **2**, wherein the incorporation space is formed between the base and an extending portion extending in the direction of pressure of the pressing unit included in the holding member.

4. The vibration type actuator according to claim **2**, wherein the incorporation space is formed in two locations at a front side and a rear side in the relative movement direction of the vibrator and the sliding member across a pressure contact portion pressed against the sliding member of the vibrator.

5. The vibration type actuator according to claim **2**, wherein the elastic biasing member elastically biases the rolling members so that the holding member and the base are biased in directions opposite to each other.

6. The vibration type actuator according to claim **1**, wherein the temporary fixing part comprises:

arms provided at the holding member and extending in the direction of pressure;

hooks formed at tips of the arms; and

engaging portions provided at the base and configured to be engaged with the hooks.

7. The vibration type actuator according to claim **6**, wherein the arms are formed opposite the coupling unit across the base.

8. The vibration type actuator according to claim **6**, wherein the holding member includes dropout preventing portions that prevent the rolling members from dropping out in a state in which the hooks and the engaging portions are engaged with each other.

9. The vibration type actuator according to claim **6**, wherein the hooks and the engaging portions do not contact with each other in a state in which the vibration type actuator is in use.

10. The vibration type actuator according to claim **1**, wherein the vibrator generates ultrasonic vibrations due to an applied high frequency voltage.

* * * * *