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(54) **Ultrasonic piezoelectric pump**

Piezoelektrische Ultraschallpumpe

Pompe piézoélectrique à ultrasons

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a piezoelectric pump, and more particularly, to an ultrasonic piezoelectric pump in which a piezoelectric pump is integrated with a fluid pipe without a check valve so that the structure can be simplified.

Description of the Related Art

[0002] In general, since parts for small sized electronic products and medical equipment possibly malfunction or are damaged due to heat generated therein because degree of integration of transistors is improved, cooling of the electronic parts is becoming a critical issue in electronic apparatuses using small electronic parts.

[0003] WO 97/24528 considered at the closest prior art, discloses a pumping apparatus which has a body portion with a chamber and channels for receiving fluid that has entered the chamber through an opening in the body portion. The chamber is covered by a membrane and the channels terminate in orifices, through which fluid exits the pump. Electrosensitive members, movable in response to electric signals, are positioned on portions of the membrane corresponding to the respective channels, forming micropumps with the respective channels, within the pump body and the respective orifices. A control mechanism controls pumping of this apparatus by sending electrical signals to the electrosensitive members, that force fluid through the respective channels and out the respective orifice for delivery to the desired site. The control mechanism permits movement of at least one of the electrosensitive members independent of the other electrosensitive members, as well as concurrent and simultaneous movement of the electrosensitive members, depending upon the pumping mode desired.

[0004] It is proposed a refrigerant circulation system using a piezoelectric pump, as a solution for cooling the small sized electronic components, for suctioning liquid refrigerant and for vibrating the liquid refrigerant by applying a force to the liquid refrigerant to discharge the refrigerant in a desired phase.

[0005] FIG. 13 is a conceptual view illustrating a conventional piezoelectric pump. Referring to FIG. 13, the conventional piezoelectric pump includes a piezoelectric actuator 100 having a suction port 110 and a discharge port 120, and a piezoelectric device 200 installed in the piezoelectric actuator 100. The suction port 110 and the discharge port 120 communicate with fluid pipes 300, respectively.

[0006] Ends of the piezoelectric device 200 are connected to a controller 400 by lead wires 410 such that the controller 400 applies an electric field to the piezoelectric device 200 to pump a fluid while being deflected.

[0007] In this structure, the fluid supplied through the fluid pipe 300 is fed into the piezoelectric actuator 100 through the suction port 110, and the fed fluid is pumped when a voltage is applied to the piezoelectric device 200 by the controller 400 and then is discharged out through the discharge port 120.

[0008] The conventional piezoelectric pump includes check valves 500 respectively installed to the suction port 110 and the discharge port 120 to prevent the fluid from flowing backward when the fluid is pumped by the deflection of the piezoelectric device 200.

[0009] As such, since the conventional piezoelectric pump is provided independently from the fluid pipe 300 and the check valves 500 for preventing fluid from flowing backward are provided independently from the pump, the conventional piezoelectric pump is not suitable for minimizing electronic products and medical equipment because it is difficult to make the piezoelectric pump in a small size.

SUMMARY OF THE INVENTION

[0010] Therefore, the present invention has been made in view of the above problems, and it is an aspect of the present invention to provide an ultrasonic piezoelectric pump in which: a piezoelectric actuator is installed at a center of a fluid pipe; a plurality of fluid-flow holes is formed around the piezoelectric actuator; and a tapered nozzle is tapered forward and downwardly in front of the piezoelectric actuator to force a fluid to be easily discharged and to have difficulty to flow backward so that a fluid can be smoothly pumped by the piezoelectric actuator without a check valve while preventing the fluid from flowing backward.

[0011] It is another aspect of the present invention to provide an ultrasonic piezoelectric pump in which a voltage applied to a piezoelectric device is adjusted to quickly deform the piezoelectric device for the fluid discharge and a frequency is adjusted to have a voltage waveform to force the piezoelectric device to be restored slowly so that a fluid can be smoothly discharged.

[0012] It is still another aspect of the present invention to provide an ultrasonic piezoelectric pump, a piezoelectric device of which is driven by ultrasonic waves to force a fluid to flow while causing flow resonance so that efficiency of heat transfer can be improved.

[0013] In order to achieve the object, there is provided an ultrasonic piezoelectric pump comprising: a fluid pipe having a hollow part formed therein to permit a fluid to flow from a fluid source; a piezoelectric actuator inserted into the hollow part and including a piezoelectric device and a plurality of fluid holes; a controller connected to a lead wire to apply a driving power to the piezoelectric device; and a tapered nozzle inserted into the hollow part in front of the piezoelectric actuator and tapered forward and downwardly;

[0014] wherein the piezoelectric actuator comprises: a case having a through-hole formed at the center there-

of; a frame inserted into the through-hole; a piezoelectric ceramic to generate a deflection in the radial direction; wherein the fluid holes are formed in the vicinity of the frame to penetrate the front side to the rear side of the case; characterized by the piezoelectric ceramic being provided in the frame; an elastic member contacting the front side of the piezoelectric ceramic, a part of the elastic member inserted into the frame and another part of the elastic member protruding from the front side of the frame, and the protruded part having a smaller diameter than that of the part inserted into the frame and vibrating due to ultrasonic waves applied to the piezoelectric device, and a fixed body to fix the elastic member to the frame, and through which the elastic member penetrates

[0015] The ultrasonic piezoelectric pump further comprises a distance adjusting circular ring provided in the fluid pipe to adjust a distance between the piezoelectric actuator and the tapered nozzle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above and other aspects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a sectional view illustrating an ultrasonic piezoelectric pump according to an illustrative example which may help to promote better understanding of the present invention;

FIG. 2 is a perspective view illustrating an actuator in FIG. 1;

FIGS. 3 and 4 are sectional views illustrating a piezoelectric device in FIG. 1;

FIG. 5 is a sectional view illustrating an ultrasonic piezoelectric pump according to another illustrative example which may help to promote better understanding of the present invention;

FIG. 6 is a sectional view illustrating an ultrasonic piezoelectric pump according to still another illustrative example which may help to promote better understanding of the present invention;

FIG. 7 is a perspective view illustrating an actuator in FIG. 6;

FIG. 8 is a sectional view illustrating another example of the actuator in FIG. 6

FIG. 9 is a waveform chart illustrating a voltage applied to the piezoelectric device according to an illustrative example which may help to promote better understanding of the present invention;

FIG. 10 is a sectional view illustrating an ultrasonic piezoelectric pump according to still another illustrative example which may help to promote better understanding of the present invention;

FIG. 11 is a sectional view illustrating an ultrasonic piezoelectric pump according to still an embodiment of the present invention;

FIG. 12 is an enlarged view illustrating the piezoelectric device in FIG. 11;

FIG. 13 is a conceptual view illustrating a conventional piezoelectric pump.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0018] FIG. 1 is a sectional view illustrating an ultrasonic piezoelectric pump according to a first illustrative example provided to promote better understanding of the present invention. . The ultrasonic piezoelectric pump includes a fluid pipe 1, a piezoelectric actuator 2, a controller 3, and a tapered nozzle 4.

[0019] The fluid pipe 1 has a hollow part 11 formed therein through which a fluid flows from a fluid source.

[0020] Moreover, the piezoelectric actuator 2 is inserted into the hollow part 11 and includes a piezoelectric device 23 and a plurality of fluid holes 24.

[0021] FIG. 2 is a perspective view illustrating the piezoelectric actuator of FIG. 1. The actuator 2 includes a case 21 with through-holes 211 formed at the center thereof, a frame 22, inserted into the through-holes 211, in which the piezoelectric device 23 is installed to the front side of the frame 22, and the plurality of fluid holes 24 formed in the vicinity of the frame 22 to penetrate the front side to the rear side of the case 21 and to permit the fluid supplied to the fluid pipe 1 to flow therethrough.

[0022] In this case, the piezoelectric device 23, as illustrated in FIG. 3, is made in the form of a unimorph having a thin plate 231 and a piezoelectric ceramic 232 contacting one side of the thin plate 231, but may be made in the form of a bimorph, as illustrated in FIG. 4, having a thin plate 231 and piezoelectric ceramics 232 contacting sides of the thin plate 231.

[0023] The controller 3 is connected to the piezoelectric device 23 through a lead wire 31 to apply a driving power to the piezoelectric device 23.

[0024] The tapered nozzle 4 has a tapered opening 41 inserted into the hollow part 11 in front of the piezoelectric actuator and tapered forward and downwardly. Since the opening 41 is tapered forward and downwardly, the fluid can be easily discharged and has difficulty to flow backward so that the backflow of the fluid can be prevented.

[0025] FIG. 5 is a sectional view illustrating an ultrasonic piezoelectric pump according to a second illustrative example . Hereinafter, structures and operations of the same components as those of FIG. 1 will be omitted.

[0026] Referring to FIG. 5, a distance adjusting circular ring 5 is provided in the hollow part 11 of the fluid pipe 1 between the piezoelectric actuator 2 and the tapered nozzle 4 to adjust a distance from the piezoelectric actuator 2 and the tapered nozzle 4.

[0027] In this case, the distance between the piezoelectric actuator 2 and the tapered nozzle 4 is preferably

adjusted by the distance adjusting circular ring 5 to optimize the transmission of kinetic energy of the fluid.

[0028] FIG. 6 is a sectional view illustrating an ultrasonic piezoelectric pump according to a third illustrative example and structures and operations of the same components as those of the first and second illustrative examples will be omitted.

[0029] According to this example, the ultrasonic piezoelectric pump includes a fluid pipe 1, a piezoelectric actuator 2, a controller 3, and a tapered nozzle 4.

[0030] FIG. 7 is a perspective view illustrating the actuator in FIG. 6, and as illustrated in FIGS. 6 and 7, the actuator 2 includes a case 21, a cylinder 25, a rear plate 26, a front plate 27, and a piezoelectric device 23.

[0031] The case has a through-hole 211 formed at the center and the cylinder 25 has a pipe shape and is inserted into the through-hole 211.

[0032] Moreover, the case 21 has a plurality of fluid holes 24 penetrating from the front side of the case 21 to the rear side thereof in the vicinity of the cylinder 25 to permit the fluid to flow from the front side to the rear side of the case 21.

[0033] The rear plate 26 is fixed to the rear side of the cylinder 25 to close the rear side of the cylinder 25 and the front plate 27 contacts the inner wall of the cylinder 25 and plays a role of a reciprocating piston.

[0034] The piezoelectric device 23 connects the rear plate 26 to the front plate 27 and a plurality of piezoelectric ceramics 232 are laminated on the piezoelectric device 23 such that the piezoelectric device 23 plays a role of a rod for moving the front plate 27 forward and backward due to an external applied voltage.

[0035] Moreover, a distance adjusting circular ring 5 is provided in the hollow part 11 of the fluid pipe 1 between the piezoelectric actuator 2 and the tapered nozzle 4 to adjust a distance between the piezoelectric actuator 2 and the tapered nozzle 4.

[0036] FIG. 8 is a sectional view illustrating another example of the actuator in FIG. 6. Referring to FIGS. 6 to 8, a circular rubber ring 271 is provided to the front plate 27 to seal the case to prevent a fluid from entering.

[0037] By doing so, the fluid flowing from the hollow part of the fluid pipe 1 to outside the case 21 is prevented from entering the actuator.

[0038] The controller 3 is connected to the piezoelectric device 23 by the lead wire 31 to apply a driving power to the piezoelectric device 23.

[0039] Meanwhile, the tapered nozzle 4 is inserted into the hollow part 11 in front of the piezoelectric actuator and has an opening 41 tapered downwardly and forwardly. Since the opening 41 is tapered forward and downwardly, the fluid is easily discharged and has difficulty to flow backward so that the fluid can be prevented from flowing backward.

[0040] The fluid is pumped using the ultrasonic piezoelectric pump according to the first to third illustrative examples by adjusting the voltage applied to the piezoelectric device 23 such that the voltage, as illustrated in FIG. 9, has a waveform of a voltage slowly increasing during the suctioning of the fluid and quickly decreasing during the discharge of the fluid.

[0041] In other words, the frequency of the voltage is adjusted to have a waveform of the voltage such that the piezoelectric device is quickly deformed to discharge the fluid and slowly returns to suction the fluid, therefore the fluid can be smoothly discharged.

[0042] According to the illustrative examples, the ultrasonic piezoelectric device transmits kinetic energy to fluid particles such that the fluid particles flow due to an inertial force.

[0043] In other words, the movement of the fluid caused by the inertial force resonates in association with the flow frequency of the fluid so that heat transfer can be accelerated.

[0044] FIG. 10 is a sectional view illustrating an ultrasonic piezoelectric pump according to a fourth illustrative example.

[0045] The ultrasonic piezoelectric pump includes a fluid pipe 1, a piezoelectric actuator 2, a controller 3, and a tapered nozzle 4.

[0046] The fluid pipe 1 has a hollow part 11 formed therein through which a fluid flows from a fluid source.

[0047] Moreover, the piezoelectric actuator 2 is inserted into and fixed in the hollow part 11, and has a piezoelectric device 23 and a plurality of fluid holes 24.

[0048] Here, the actuator 2 includes a case 21 having a through-hole 211 formed at the center, a frame 22, inserted into the through-hole 211, to which the piezoelectric device 23 is installed, and a plurality of fluid holes 24 formed in the vicinity of the frame 22 to penetrate the front side to the rear side of the case 21 and to permit the fluid supplied to the fluid pipe 1 to flow therethrough.

[0049] The piezoelectric device 23 may include a multilayer piezoelectric disc having a plurality of thin piezoelectric ceramics 232 which resonate in the thickness direction by the application of ultrasonic waves.

[0050] Moreover, the controller 3 is connected to the piezoelectric device 23 by a lead wire 31 to adjust a frequency applied to the piezoelectric device 23.

[0051] In other words, the controller 3 applies ultrasonic waves higher than 5 MHz to the piezoelectric device 23 having several tens of piezoelectric ceramics 232 through the lead wire 31 so that vibration in the thickness direction is obtained to discharge the fluid through the tapered nozzle 4.

[0052] Here, a distance adjusting circular ring 5 may be provided in the hollow part 11 of the fluid pipe 1 between the piezoelectric actuator 2 and the tapered nozzle 4 to adjust a distance from the piezoelectric actuator 2 and the tapered nozzle 4.

[0053] FIG. 11 is a sectional view illustrating an ultrasonic piezoelectric pump according to an embodiment of the present invention and FIG. 12 is an enlarged view illustrating the piezoelectric device 23 in FIG. 11. Referring to FIG. 11, the ultrasonic piezoelectric pump includes a fluid pipe 1, a piezoelectric actuator 2, a controller 3,

and a tapered nozzle 4.

[0054] Here, the piezoelectric actuator 2 includes a case 21 with through-holes 211 formed at the center thereof, a frame 22 inserted into the through-holes 211, the piezoelectric device 23 installed in the frame 22, and a plurality of fluid holes 24 formed in the vicinity of the frame 22 to penetrate the front side to the rear side of the case 21.

[0055] The piezoelectric device 23 includes a piezoelectric ceramic 232a, an elastic member 232b, and a fixed body 234.

[0056] Here, the piezoelectric ceramic 232a is provided in the frame 22 and generates deflection in the radial direction.

[0057] The elastic member 232b contacts the front side of the piezoelectric ceramic 232a, is partially inserted into the frame 22, and is partially protruded outwardly from the front side of the frame 22.

[0058] The part of the elastic member 232b protruded from the frame 22 has a diameter smaller than that of the part of the elastic member 232b inserted into the frame 22, and due to the small diameter, generates a large deflection.

[0059] The elastic member 232b vibrates at ultrasonic waves with a preset frequency applied to the piezoelectric ceramic 232a in the longitudinal direction.

[0060] In other words, the elastic member 232b does not vibrate when the frequency applied to the piezoelectric ceramic 232a is low, but vibrates in the longitudinal direction by which ultrasonic vibration is transmitted thereto when the frequency applied to the piezoelectric ceramic 232a is in the form of ultrasonic waves with several hundreds of kHz or higher.

[0061] Meanwhile, the elastic member 232b is inserted into the fixed body 234 to penetrate the same, and the fixed body 234 fixes the elastic member 232b to the frame 22.

[0062] The controller 3 is connected to the piezoelectric device 23 by the lead wire 31 to adjust the frequency applied to the piezoelectric device 23.

[0063] In the fifth embodiment of the present invention, the intensity of the frequency applied to the piezoelectric device by the controller 3 is set by modes to vibrate only the piezoelectric ceramic 232a generating a radial directional deflection or to apply a higher frequency to vibrate the piezoelectric ceramic 232a and all the piezoelectric ceramics 232a generating the longitudinal deflection.

[0064] As such, according to the embodiments of the present invention, the fluid is pumped using the piezoelectric actuator installed at the center of the fluid pipe and the tapered nozzle tapered forward and downwardly without a check valve so that the fluid is smoothly pumped. Moreover, since the ultrasonic piezoelectric pump does not include the fluid pipe separated from the fluid pump and a check valve, the ultrasonic piezoelectric pump can be made in a simple structure and is easily made in a small size.

[0065] Meanwhile, although the ultrasonic piezoelectric pump is described for use with a fluid, the ultrasonic piezoelectric pump can be used for gas such as air and its description will be omitted since the structure and operation thereof is identical to the case of for use with the fluid.

[0066] As described above, according to the ultrasonic piezoelectric pump, the piezoelectric actuator is installed at the center of the fluid pipe, a plurality of fluid-flow holes is formed around the piezoelectric actuator, and the tapered nozzle is tapered forward and downwardly in front of the piezoelectric actuator to force the fluid to be easily discharged and to have difficulty flowing backward so that the fluid can be smoothly pumped by the piezoelectric actuator without a check valve while preventing the fluid from flowing backward and the pumping efficiency can be improved.

[0067] Moreover, a voltage applied to the piezoelectric device is adjusted to quickly deform the piezoelectric device for the fluid discharge and a frequency is adjusted to have a voltage waveform to force the piezoelectric device to be restored slowly so that a fluid can be smoothly discharged.

[0068] According to the ultrasonic piezoelectric pump, the piezoelectric device is driven by ultrasonic waves to force the fluid to flow while causing flow resonance so that efficiency of heat transfer can be improved.

[0069] According to the ultrasonic piezoelectric pump, the flow of a fluid is controlled by the piezoelectric ceramic vibrating in the longitudinal direction or in the radial direction by the application of ultrasonic waves and the elastic member vibrating in the longitudinal direction by ultrasonic waves applied to the piezoelectric device, so that the fluid can be smoothly pumped without the backflow by the piezoelectric actuator without a check valve and the ultrasonic piezoelectric pump can be applied to small sized products.

[0070] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the accompanying claims.

Claims

1. An ultrasonic piezoelectric pump comprising:

a fluid pipe (1) having a hollow part (11) formed therein to permit a fluid to flow from a fluid source;

a piezoelectric actuator (2) inserted into the hollow part (11) and including a piezoelectric device (23) and a plurality of fluid holes (24);

a controller (3) connected to a lead wire (31) to apply a driving power to the piezoelectric device (23); and

a tapered nozzle (4) inserted into the hollow part

(11) in front of the piezoelectric actuator (2) and tapered forward and downwardly;
wherein the piezoelectric actuator (2) comprises:

a case (21) having a through-hole (211) formed at the center thereof;
a frame (22) inserted into the through-hole (211);
a piezoelectric ceramic (232a) to generate a deflection in the radial direction;
wherein the fluid holes (24) are formed in the vicinity of the frame (22) to penetrate the front side to the rear side of the case (21);
characterized by
the piezoelectric ceramic (232a) being provided in the frame (22);
an elastic member (232b) contacting the front side of the piezoelectric ceramic (232a), a part of the elastic member (232b) inserted into the frame (22) and another part of the elastic member (232b) protruding from the front side of the frame (22), and the protruded part having a smaller diameter than that of the part inserted into the frame (22) and vibrating due to ultrasonic waves applied to the piezoelectric device (23); and
a fixed body (234) to fix the elastic member (232b) to the frame (22), and through which the elastic member (232b) penetrates.

2. The ultrasonic piezoelectric pump according to claim 1, further comprising a distance adjusting circular ring (5) provided in the fluid pipe (1) to adjust a distance between the piezoelectric actuator (2) and the tapered nozzle (4).

Patentansprüche

1. Piezoelektrische Ultraschallpumpe, die umfasst:

ein Fluid-Rohr (1), in dem ein hohler Teil (11) ausgebildet ist, um ein Fluid von einer Fluidquelle strömen zu lassen;
einen piezoelektrischen Aktor (2), der in den hohlen Teil (11) eingeführt ist und eine piezoelektrische Vorrichtung (23) sowie eine Vielzahl von Fluid-Löchern (24) enthält;
eine Steuereinrichtung (3), die mit einem Zuleitungsdraht (31) verbunden ist, um der piezoelektrischen Vorrichtung (23) eine Antriebsenergie zuzuführen; und
eine konische Düse (4), die vor dem piezoelektrischen Aktor (2) in den hohlen Teil (11) eingeführt ist und sich nach vorn und nach unten verjüngt;
wobei der piezoelektrische Aktor (2) umfasst:

ein Gehäuse (21), in dessen Mitte ein Durchgangsloch (211) ausgebildet ist;
einen Rahmen (22), der in das Durchgangsloch (211) eingeführt ist;
ein piezoelektrisches Keramikmaterial (232a) zum Erzeugen einer Auslenkung in der radialen Richtung;
wobei die Fluidlöcher (24) in der Nähe des Rahmens (22) so ausgebildet sind, dass sie von der Vorderseite zur Rückseite durch das Gehäuse (21) hindurch verlaufen;
gekennzeichnet
dadurch, dass das piezoelektrische Keramikmaterial (232a) in dem Rahmen (22) vorhanden ist;
durch ein elastisches Element (232b), das mit der Vorderseite des piezoelektrischen Keramikmaterials (232a) in Kontakt ist, einen Teil des elastischen Elementes (232b), der in den Rahmen (22) eingeführt ist, und einen anderen Teil des elastischen Elementes (232b),
der von der Vorderseite des Rahmens (22) vorsteht, wobei der vorstehende Teil einen kleineren Durchmesser hat als der in den Rahmen (22) eingeführte Teil und aufgrund von Ultraschallwellen schwingt, die auf die piezoelektrische Vorrichtung (23) wirken; und
durch einen stationären Körper (234) zum Befestigen des elastischen Elementes (232b) an dem Rahmen (22), durch den das elastische Element (232b) hindurch verläuft.

2. Piezoelektrische Ultraschallpumpe nach Anspruch 1, die des Weiteren einen kreisförmigen Distanzeinstell-Ring (5) umfasst, der in dem Fluidrohr (1) vorhanden ist, um eine Distanz zwischen dem piezoelektrischen Aktor (2) und der konischen Düse (4) einzustellen.

Revendications

1. Pompe piézoélectrique et ultrasonore comprenant :

une pompe (1) comprenant une partie creuse (11) formée à l'intérieur pour permettre à un fluide de circuler depuis une source de fluide ;
un actionneur piézoélectrique (2) introduit dans la partie creuse (11) et comprenant un dispositif piézoélectrique (23) et plusieurs orifices de fluide (24) ;
un organe de commande (3) connecté à un fil

de sortie (31) afin d'appliquer une puissance d'excitation au dispositif piézoélectrique (23) ; et une buse effilée (4), introduite dans la partie creuse (11) devant l'actionneur piézoélectrique (2) et effilée à l'avant et vers le bas ;
dans laquelle l'actionneur piézoélectrique (2) comprend :

un boîtier (21) comprenant un orifice traversant (211) formé en son centre ;
un cadre (22) introduit dans l'orifice traversant (211) ;
un élément céramique piézoélectrique (232a) pour générer un fléchissement dans la direction radiale ;
dans lequel les orifices de fluide (24) sont formés au voisinage du cadre (22) pour pénétrer le côté avant jusqu'au côté arrière du boîtier (21) ;
caractérisée par
l'élément céramique piézoélectrique (232a) disposé dans le cadre (22) ;
un élément élastique (232b) entrant en contact avec le côté avant de l'élément céramique piézoélectrique (232a), une partie de l'élément élastique (232b) étant introduite dans le cadre (22) et une autre partie de l'élément élastique (232b) faisant saillie à partir du côté avant du cadre (22), et la partie saillante ayant un diamètre inférieur à celui de la partie introduite dans le cadre (22) et vibrant en raison des ondes ultrasonores appliquées au dispositif piézoélectrique (23) ; et
un corps fixe (234) pour fixer l'élément élastique (232b) au cadre (22), et à travers lequel pénètre l'élément élastique (232b).

2. Pompe piézoélectrique et ultrasonore conformément à la revendication 1 comprenant en outre un anneau circulaire de réglage de distance (5) disposé dans la pompe (1) pour régler la distance entre l'actionneur piézoélectrique (2) et la buse effilée (4).

FIG. 1

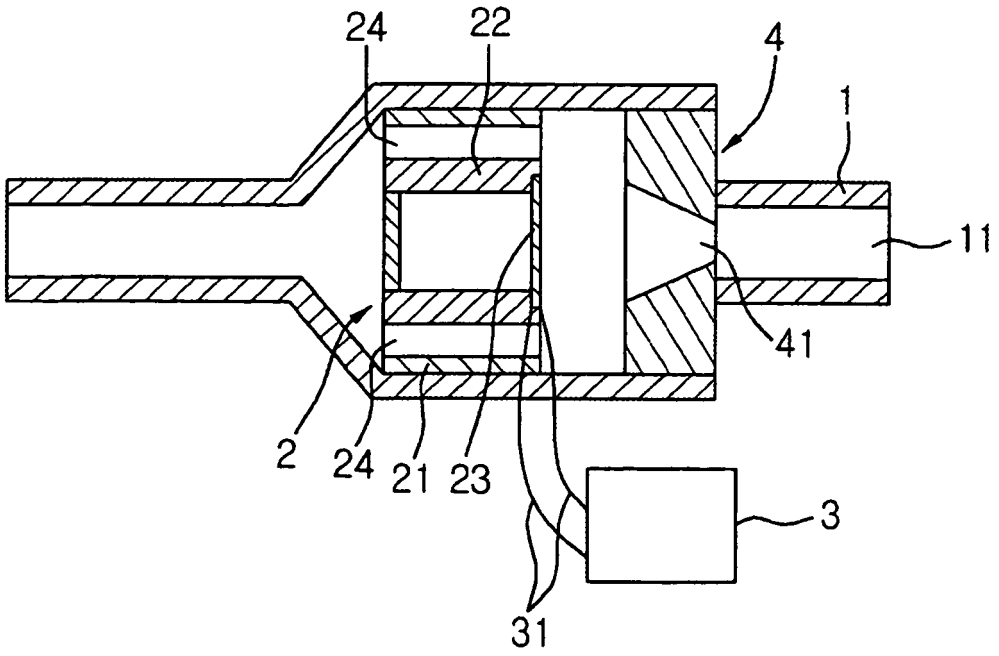


FIG.2

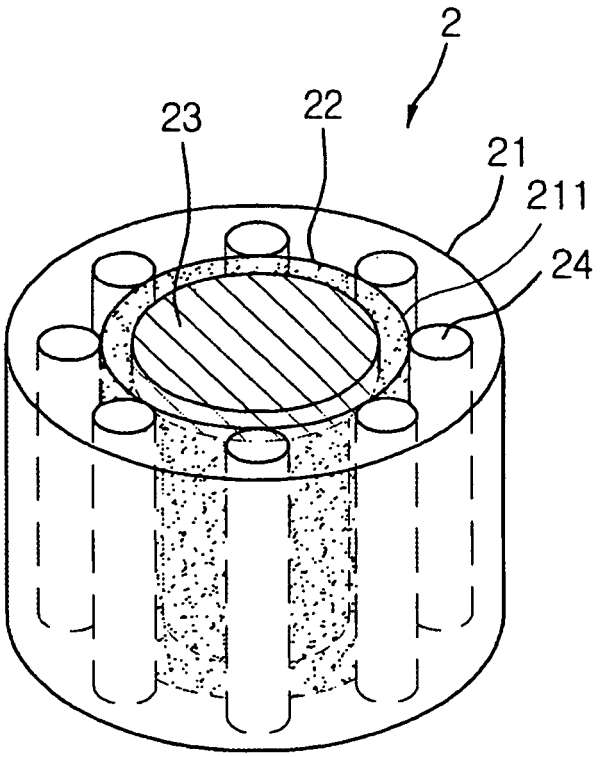


FIG.3

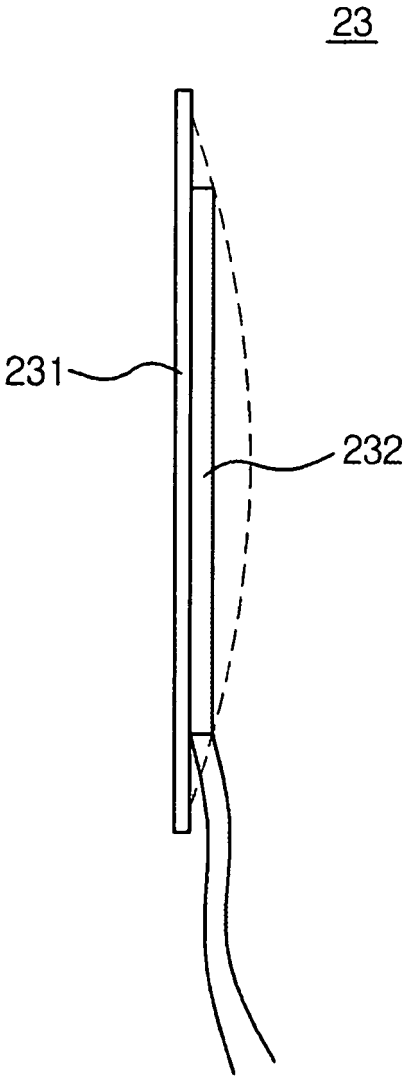


FIG.4

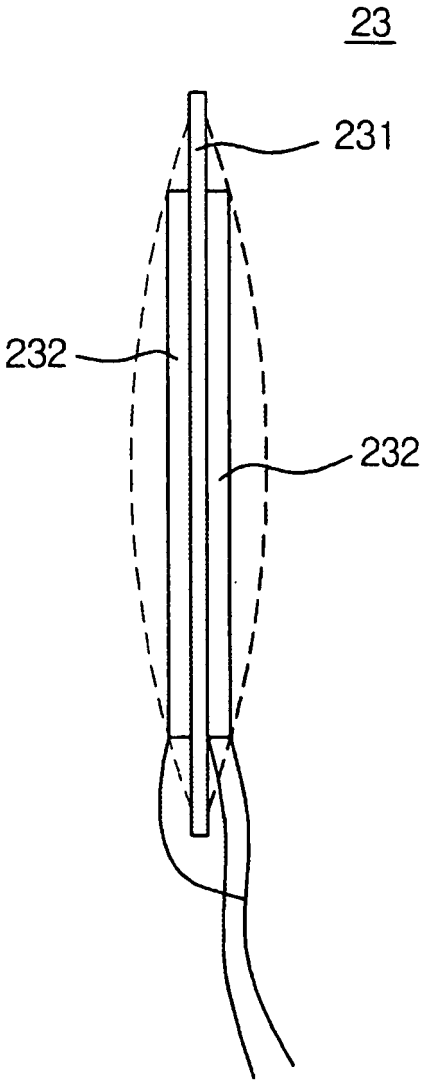


FIG.5

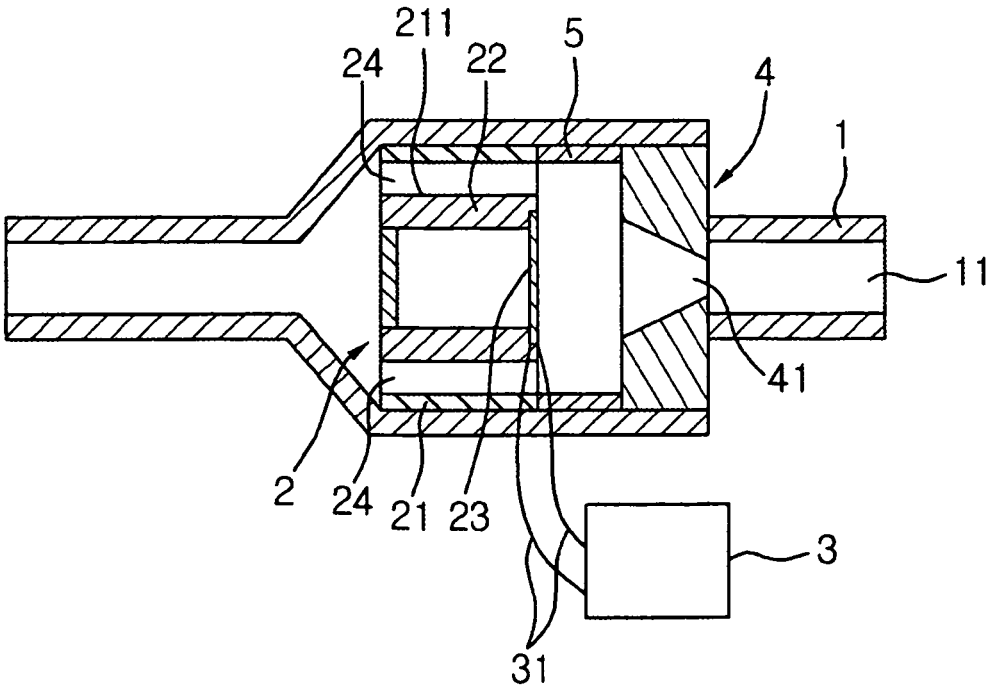


FIG.6

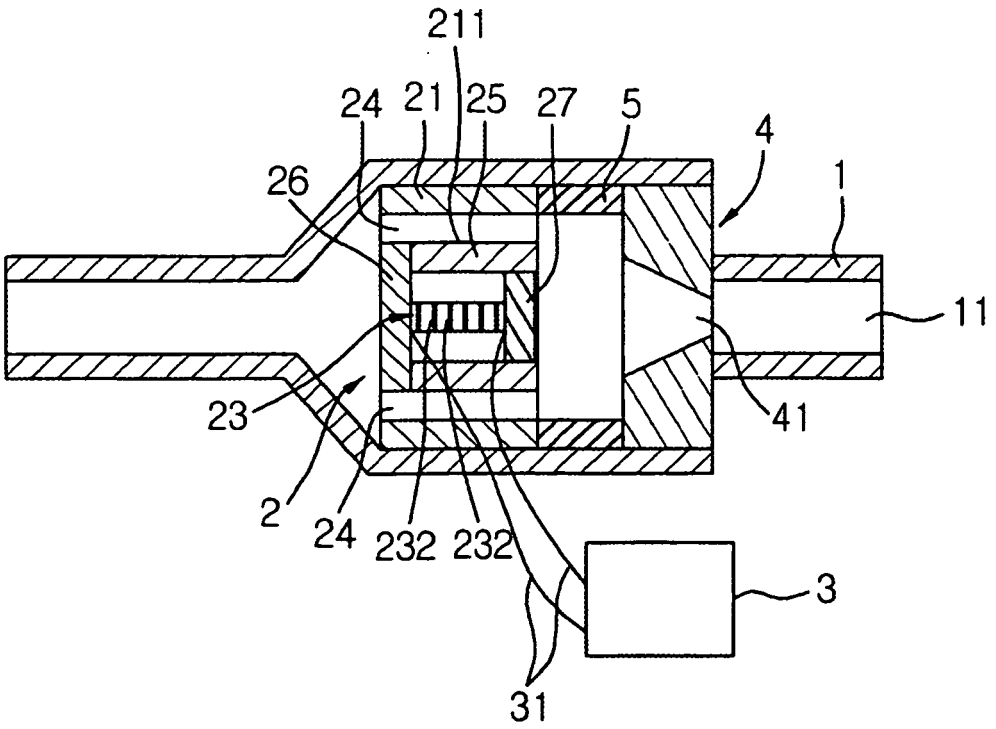


FIG.7

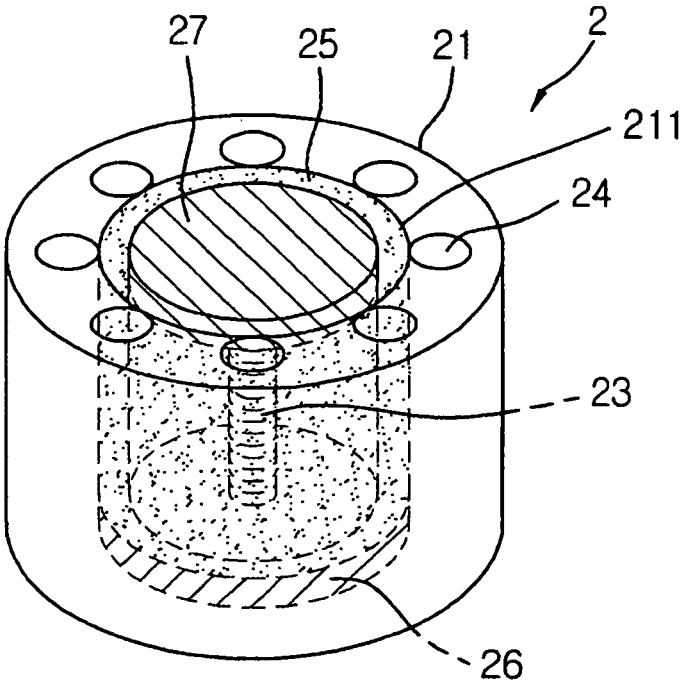


FIG.8

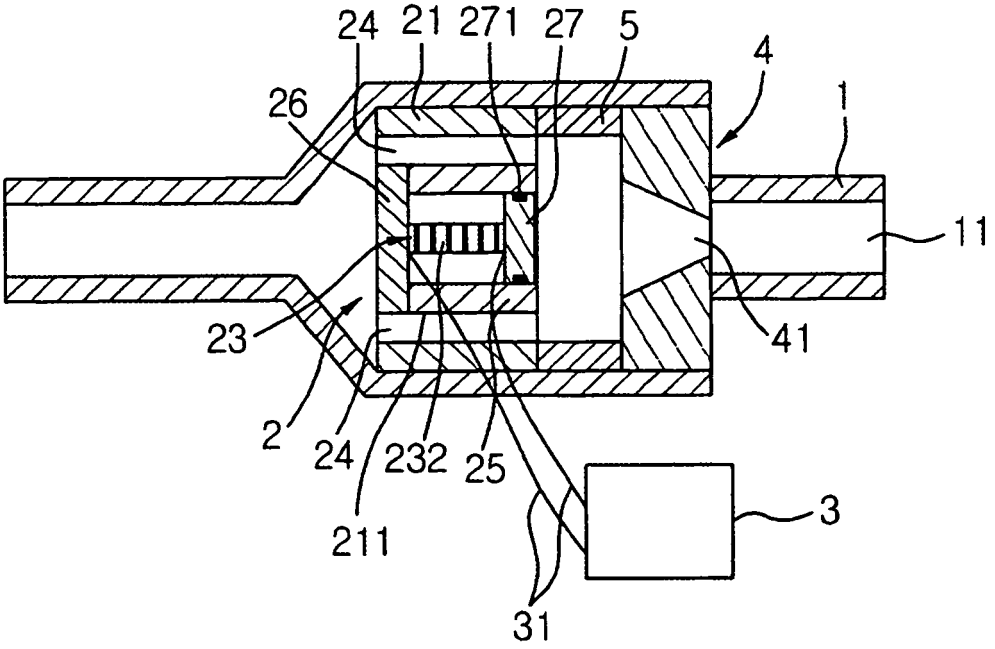


FIG.9

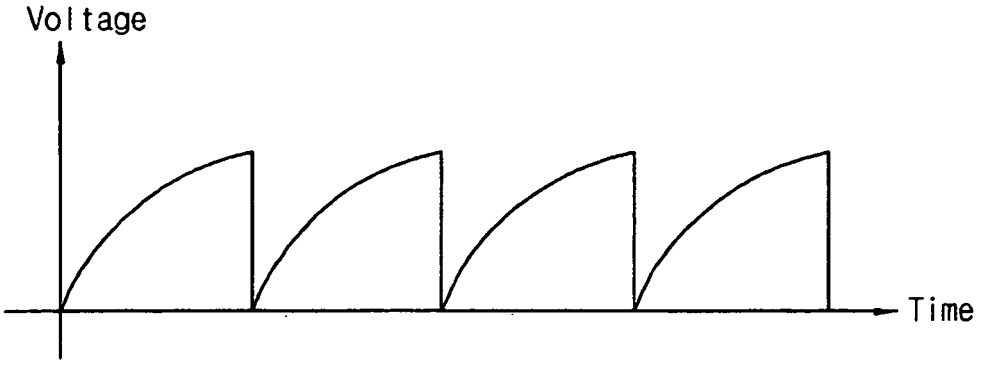


FIG. 10

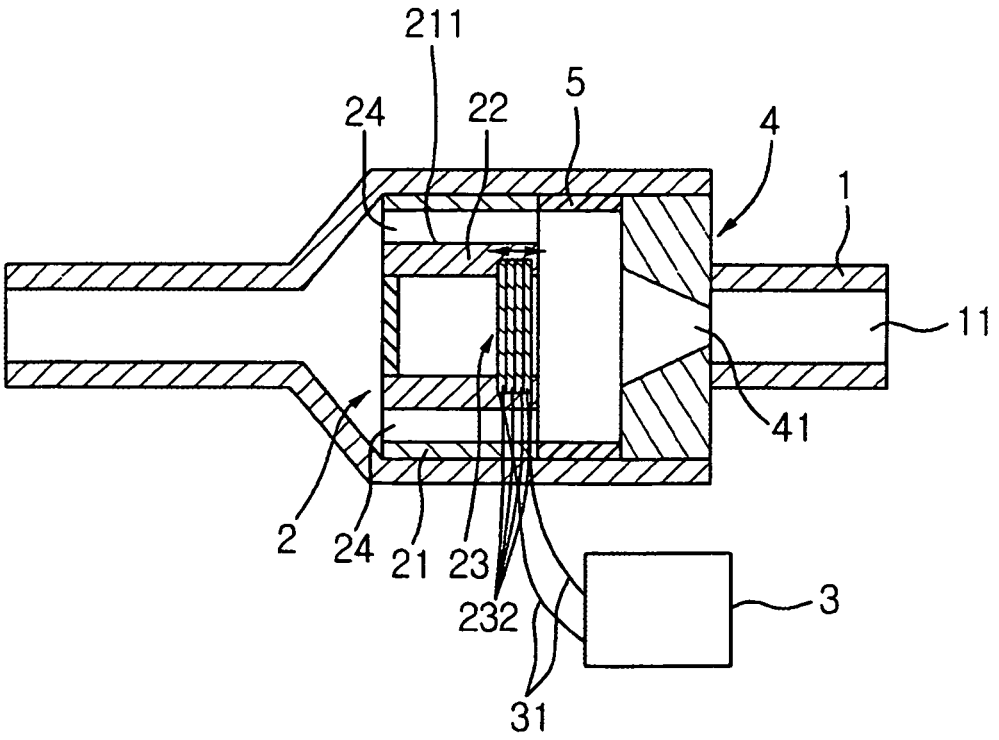


FIG. 11

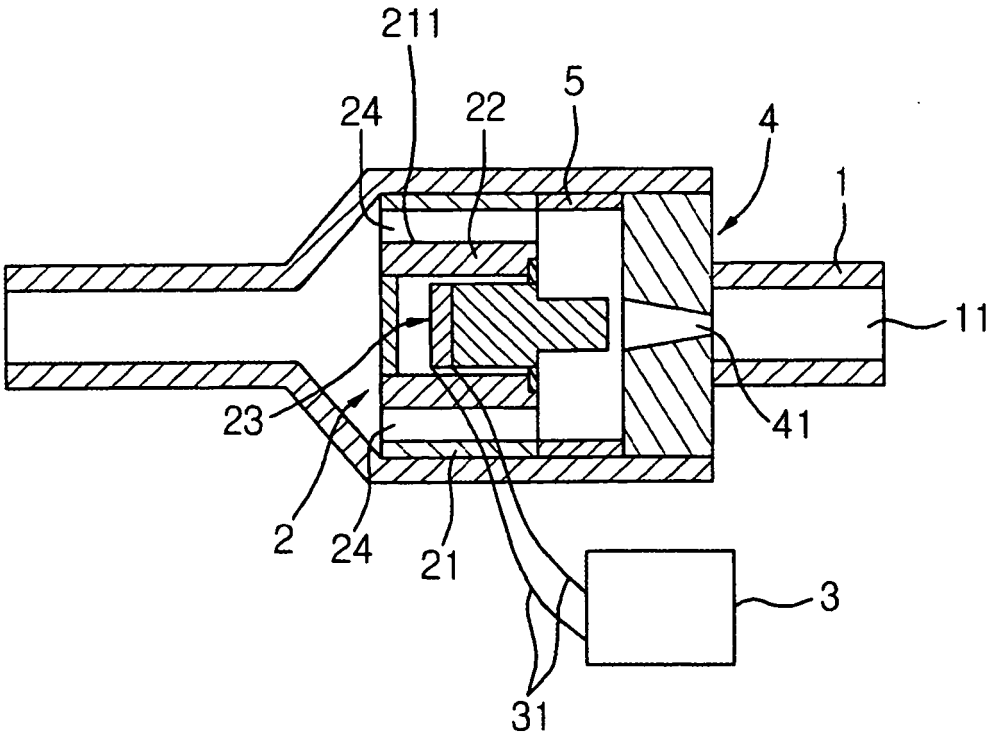


FIG. 12

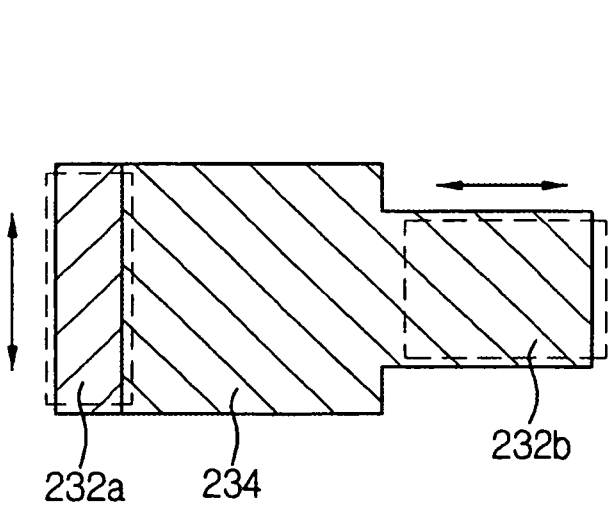
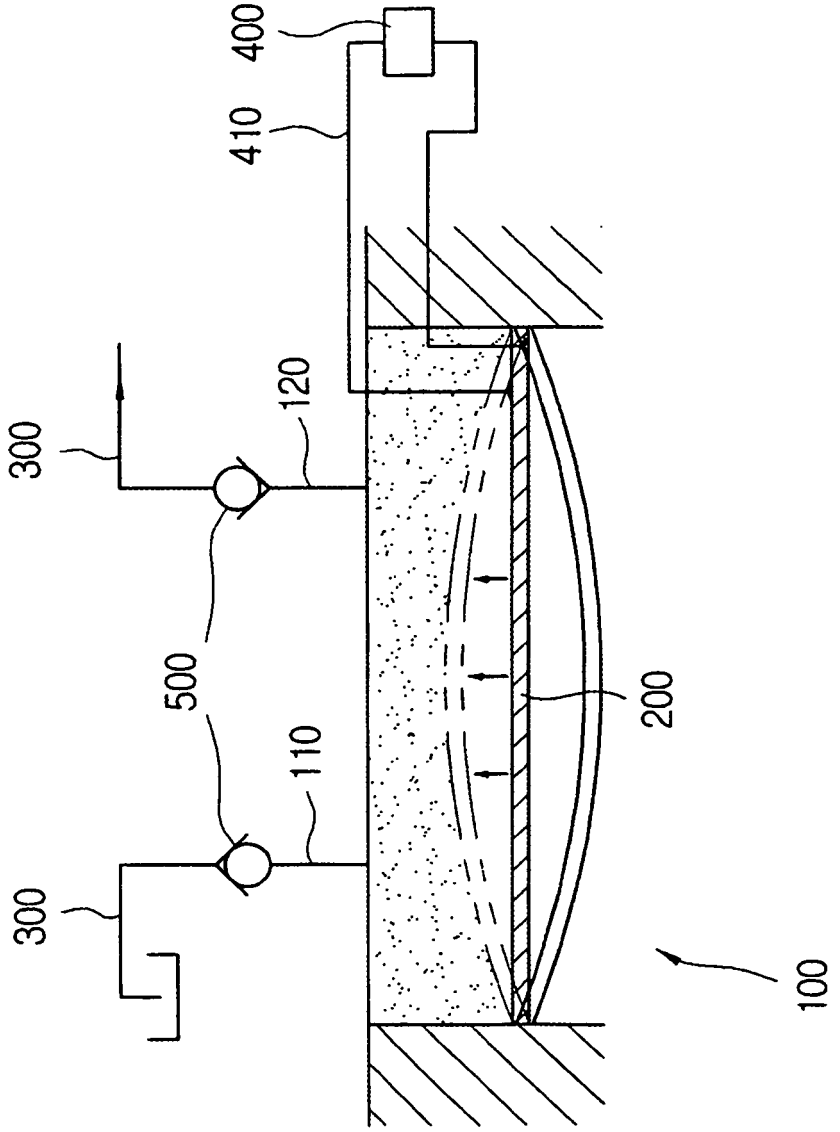


FIG. 13 PRIOR ART



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Patent documents cited in the description

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