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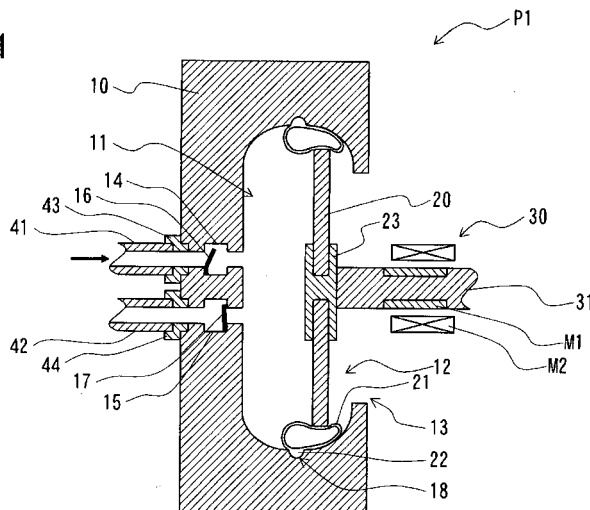
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(54) **PUMP**

(57) The present invention provides a diaphragm-type pump for feeding a low-viscosity fluid such as air under high pressure while miniaturizing the size of a feeding means. In the pump connected with a feeding pipe and a delivery pipe for delivering a fluid fed from the feeding pipe through the delivery pipe, the pump includes a housing provided with a storage chamber connecting with the feeding pipe and the delivery pipe through a one-way valve respectively and storing the fluid therein temporarily, a vibration plate arranged to face the storage

chamber in an opposed manner and driven in a reciprocating manner so as to push out the fluid to the delivery pipe after sucking the fluid from the feeding pipe into the storage chamber, and a drive part for driving the vibration plate in a reciprocating manner. A ring-shaped tube is arranged along an outer periphery of the vibration plate, and the vibration plate is mounted on the housing by way of the tube thus enabling driving of the vibration plate in a reciprocating manner while elastically deforming the tube.

Fig.1



Description

Technical Field

[0001] The present invention relates to a diaphragm-type pump which performs the feeding and the delivery of a fluid by driving a vibration plate having a plate shape in a reciprocating manner in place of a diaphragm of a diaphragm pump.

Background of the Invention

[0002] Conventionally, a diaphragm pump has been popularly used as a drive source for feeding and delivering a fluid. In such a diaphragm pump, a storage chamber for temporarily storing the fluid is formed in a housing which constitutes an outer frame of the diaphragm pump, a diaphragm is arranged to face the storage chamber, and the storage chamber, a feeding pipe and a delivery pipe are respectively connected with each other by way of one-way valves.

[0003] In operation, by elastically deforming the diaphragm to bring the diaphragm into a retracting state relative to the storage chamber, a pressure in the storage chamber is lowered so that the fluid is sucked into the storage chamber from the feeding pipe, while by elastically deforming the diaphragm to bring the diaphragm into an advancing state relative to the storage chamber, the fluid in the storage chamber is discharged to the delivery pipe by the diaphragm. By repeating such an operation, the fluid can be intermittently discharged.

[0004] As a drive means for driving the diaphragm in a reciprocating manner, there has been known a drive means which connects a crankshaft to a center portion of a diaphragm and drives the crankshaft in a reciprocating manner (see patent document 1, for example). There has been also known a drive means which mounts a magnet on a center portion of the diaphragm and linearly drives the magnet using an electromagnet which changes over magnetic poles (see patent document 2, for example).

[0005] Such a diaphragm-type pump is configured to perform a pump function by elastically deforming the diaphragm formed of an elastic body. However, the diaphragm is often made of a material having relatively high rigidity and hence, it is difficult to elastically deform the diaphragm thus requiring a large driving force for elastically deforming the diaphragm.

[0006] Accordingly, recently, there has been proposed a technique which forms a ring-shaped easy-to-deform region for decreasing the deformation resistance on a diaphragm along a frame body to which an outer periphery of the diaphragm is fixed. By making the diaphragm easily elastically deformable in this manner, the diaphragm can be driven with a relatively small driving force.

[0007] In the easy-to-deform region, the deformation resistance can be lowered by decreasing a wall thickness of the diaphragm or by forming a cross-sectional shape

of the diaphragm in an arcuate shape so as to impart a deformation margin to the diaphragm.

Patent document 1: JP-A-2004-257337

Patent document 2: JP-A-2004-060641

Disclosure of the Invention

Problems that the Invention is to Solve

[0008] However, in adopting the technique which makes the diaphragm easily elastically deformable by forming the easy-to-deform region on the diaphragm as described above, when a pressure of a fluid in a storage chamber is raised to increase a discharge pressure of the fluid, there exists the possibility that the deformation which bulges in the retracting direction arises in the easy-to-deform region of the diaphragm when the diaphragm advances toward a storage chamber side for pushing out the fluid from the storage chamber.

[0009] When such deformation in the reverse direction arises in the diaphragm, a discharge quantity of the fluid is lowered and hence, the diaphragm cannot perform its original performance and, at the same time, the diaphragm is liable to be easily broken. Accordingly, the diaphragm pump is used only under a condition that the deformation in the direction opposite to the driving direction of the diaphragm does not arise thus giving rise to a problem that it is difficult to obtain a high discharge pressure.

Means for Solving the Problems

[0010] Accordingly, the present invention provides a pump connected with a feeding pipe and a delivery pipe for delivering a fluid fed from the feeding pipe through the delivery pipe. The pump includes: a housing provided with a storage chamber communicating with the feeding pipe and the delivery pipe through a one-way valve respectively and storing the fluid therein temporarily; a vibration plate arranged to face the storage chamber in an opposed manner and driven in a reciprocating manner so as to push out the fluid to the delivery pipe after sucking the fluid from the feeding pipe into the storage chamber; and a drive part for driving the vibration plate in a reciprocating manner. In the pump, a ring-shaped tube is arranged along an outer periphery of the vibration plate, and the vibration plate is mounted on the housing by way of the tube thus enabling driving of the vibration plate in a reciprocating manner.

[0011] The pump according to the present invention is also characterized by following constitutions.

(1) A pressure in the tube is equal to or higher than a pressure of the fluid in the storage chamber.

(2) An outwardly-protruding flange is formed on an outer periphery of the tube, a fitting groove which allows fitting of the flange therein is formed in the

housing, and the vibration plate is mounted on the housing by fitting the flange in the fitting groove.

(3) A ring-shaped first supporting wall and a ring-shaped second supporting wall protruding inwardly are formed on an inner peripheral surface of the housing parallel to each other with a predetermined distance therebetween, and the vibration plate is mounted on the housing by fitting the tube between the first supporting wall and the second supporting wall.

(4) The tube includes a fluid filling means for adjusting a pressure in the tube by filling the fluid in the tube.

Advantage of the Invention

[0012] According to the present invention called for in claim 1, there is provided a pump connected with a feeding pipe and a delivery pipe for delivering a fluid fed from the feeding pipe through the delivery pipe. The pump includes: a housing provided with a storage chamber communicating with the feeding pipe and the delivery pipe through a one-way valve respectively and storing the fluid therein temporarily; a vibration plate arranged to face the storage chamber in an opposed manner and driven in a reciprocating manner so as to push out the fluid to the delivery pipe after sucking the fluid from the feeding pipe into the storage chamber; and a drive part for driving the vibration plate in a reciprocating manner. In the pump, a ring-shaped tube is arranged along an outer periphery of the vibration plate, and the vibration plate is mounted on the housing by way of the tube thus enabling driving of the vibration plate in a reciprocating manner. Due to such a constitution, the bulging deformation in the direction opposite to the driving direction of the vibration plate driven in a reciprocating manner can be suppressed thus providing the pump of a high discharge pressure. Further, by mounting the vibration plate on the housing by way of the tube, a displacement quantity of the vibration plate driven in a reciprocating manner can be increased thus enabling the acquisition of a large discharge quantity.

[0013] According to the present invention called for in claim 2, in the pump described in claim 1, the pressure in the tube is set equal to or higher than the pressure of the fluid in the storage chamber. Due to such a constitution, it is possible to prevent a phenomenon that the elastic deformation of the tube is obstructed due to the pressure of the fluid in the storage chamber and hence, the vibration plate can be stably driven in a reciprocating manner while maintaining a hermetic state of the storage chamber.

[0014] According to the present invention called for in claim 3, in the pump described in claim 1 or claim 2, the outwardly-protruding flange is formed on the outer periphery of the tube, the fitting groove which allows fitting of the flange therein is formed in the housing, and the vibration plate is mounted on the housing by fitting the flange in the fitting groove. Due to such a constitution, it is possible to prevent a phenomenon that the tube slips

in the housing due to the difference between pressures generated on both side surfaces of the vibration plate respectively along with the reciprocating operation of the vibration plate and generates the positional displacement of the vibration plate. Further, the vibration plate can be extremely easily mounted on the housing and the maintenance of the pump can be enhanced.

[0015] According to the present invention called for in claim 4, in the pump described in claim 1 or claim 2, the ring-shaped first supporting wall and the ring-shaped second supporting wall protruding inwardly are formed on an inner peripheral surface of the housing parallel to each other with a predetermined distance therebetween, and the vibration plate is mounted on the housing by fitting the tube in a space defined between the first supporting wall and the second supporting wall. Due to such a constitution, it is possible to prevent a phenomenon that the tube slips in the housing due to the difference between pressures generated on both side surfaces of the vibration plate respectively along with the reciprocating operation of the vibration plate so that the positional displacement of the vibration plate is generated. Further, the vibration plate can be extremely easily mounted on the housing and the maintenance of the pump can be enhanced.

[0016] According to the present invention called for in claim 5, in the pump described in claim 2, the tube includes a fluid filling means for adjusting a pressure in the tube by filling the fluid in the tube. Due to such a constitution, the pressure in the tube can be easily adjusted thus enabling the stable driving of the vibration plate in a reciprocating manner.

Brief Description of the Drawings

[0017]

Fig. 1 is a schematic longitudinal cross-sectional view of a pump according to a first embodiment.

Fig. 2 is a schematic longitudinal cross-sectional view of the pump according to the first embodiment.

Fig. 3 is a schematic longitudinal cross-sectional view of a pump according to a second embodiment.

Fig. 4 is a schematic longitudinal cross-sectional view of the pump according to the second embodiment.

Fig. 5 is an explanatory view of a tube according to another embodiment of the present invention.

Fig. 6 is a schematic longitudinal cross-sectional view of a modification of a pump according to the first embodiment.

Fig. 7 is a schematic longitudinal cross-sectional view of the modification of the pump according to the first embodiment.

Fig. 8 is a schematic longitudinal cross-sectional view of the modification of the pump according to the first embodiment.

Fig. 9 is a schematic longitudinal cross-sectional

view of the modification of the pump according to the first embodiment.

Fig. 10 is a partially enlarged schematic longitudinal cross-sectional view of the modification of the pump according to the first embodiment.

Fig. 11 is a partially enlarged schematic longitudinal cross-sectional view of the modification of the pump according to the first embodiment.

Description of the Reference Numerals and Signs

[0018]

- P1: pump
- M1: magnet
- M2: electromagnet
- 10: housing
- 11: storage chamber
- 12: cavity
- 13: vibration plate insertion opening
- 14: feeding flow passage
- 15: delivery flow passage
- 16: feeding-side one-way valve
- 17: delivery-side one-way valve
- 18: fitting groove
- 20: vibration plate
- 21: tube
- 22: flange
- 23: connection socket
- 30: drive part
- 31: reciprocating rod
- 41: feeding pipe
- 42: delivery pipe
- 43: feeding-pipe connection socket
- 44: delivery-pipe connection socket

Best Mode for Carrying Out the Invention

[0019] A pump according to the present invention is a pump for feeding a low-viscosity fluid such as air by applying a desired pressure to the fluid, that is, a so-called diaphragm pump which can realize a high discharging pressure.

[0020] That is, the pump according to the present invention includes, in the same manner as a general diaphragm pump, a housing provided with a storage chamber connecting with the feeding pipe and the delivery pipe through a one-way valve respectively and storing the fluid temporarily, a vibration body arranged to face the storage chamber in an opposed manner and driven in a reciprocating manner so as to push out the fluid to the delivery pipe after sucking the fluid from the feeding pipe into the storage chamber, and a drive part which drives the vibration body in a reciprocating manner.

[0021] Further, while the vibration body is formed of a thin-film-shaped diaphragm in a general diaphragm pump, the pump according to the present invention adopts a vibration plate formed of a plate body having

high rigidity as the vibration body.

[0022] Further, a ring-shaped tube is arranged along an outer periphery of the vibration plate, and the vibration plate is mounted on the housing by way of the tube. The vibration plate is reciprocated while deforming the tube elastically.

[0023] In this manner, by adopting the vibration plate which mounts the tube on the outer periphery thereof in place of a conventional diaphragm, it is possible to prevent the vibration plate from being deformed due to a pressure in the storage chamber thus providing a pump which can realize the high discharging pressure.

[0024] Here, the pressure in the storage chamber is also applied to the tube. However, the pressure applied to one side surface of the tube is dispersed into the whole tube due to a pressure of a fluid filled in the tube and hence, the elastic deformation of the tube is not hardly obstructed thus ensuring the stable reciprocation of the vibration plate.

[0025] Particularly, by forming the tube in a hollow shape and by setting the internal pressure of the tube to a value equal to or higher than the pressure of the fluid in the storage chamber, it is possible to prevent a phenomenon that the elastic deformation of the tube is obstructed due to the pressure of the fluid in the storage chamber thus ensuring the stable reciprocating driving of the vibration plate. Here, the state in which the internal pressure of the tube is equal to the pressure of the fluid in the storage chamber is not limited to a state in which these pressures completely agree with each other but implies a state in which these pressures are set substantially equal to each other with slight difference therebetween.

[0026] With the use of a material having high elasticity such as rubber as a material for forming the tube, it is possible to enhance durability of the tube compared to durability of a conventional diaphragm thus prolonging a lifetime of the pump.

[0027] Here, it is desirable that the tube is not largely inflated by the internal pressure of the tube. Accordingly, a wall thickness of the tube may preferably be chosen such that the large expansion of the tube by the internal pressure can be prevented. Alternatively, the tube may adopt not only the single-layer structure made of an elastic material such as rubber but also the laminated structure formed by laminating different kinds of elastic materials to each other or formed by laminating a reinforcing sheet such as a cloth to the elastic material for suppressing the inflation of the tube. Further, an appropriate coating may be applied to a surface of the tube as a protecting film for suppressing a reaction between the tube and the fluid.

[0028] Further, an outwardly-protruding flange is formed on an outer periphery of the tube, a fitting groove which allows the fitting of the flange therein is formed in the housing, and the vibration plate is mounted on the housing by fitting the flange in the fitting groove. Due to such a constitution, it is possible to prevent the generation of positional displacement of the vibration plate attributed

to slipping of the tube in the housing, and it is also possible to extremely easily mount the vibration plate on the housing and hence, the maintenance of the pump can be enhanced.

[0029] Alternatively, a ring-shaped first supporting wall and a ring-shaped second supporting wall protruding inwardly are formed on an inner peripheral surface of the housing parallel to each other with an appropriate distance therebetween, and the vibration plate is mounted on the housing by fitting the tube between the first supporting wall and the second supporting wall. Due to such a constitution, it is possible to prevent the positional displacement of the vibration plate attributed to slipping of the tube in the housing and, it is also possible to extremely easily mount the vibration plate on the housing and hence, the maintenance of the pump can be enhanced.

[0030] Hereinafter, embodiments of the present invention are explained in detail in conjunction with drawings. Fig. 1 and Fig. 2 are schematic longitudinal cross-sectional views of a pump P1 of a first embodiment.

[0031] The pump P1 of this embodiment is constituted of a housing 10 having a storage chamber 11, a vibration plate 20 arranged in the housing 10 and facing the storage chamber 11 in an opposed manner, and a drive part 30 for driving the vibration plate 20 in a reciprocating manner.

[0032] In this embodiment, the housing 10 is made of Teflon (registered trademark). A flattened-spherical-shaped cavity 12 is formed in the housing 10 having an approximately rectangular parallelepiped shape. A vibration-plate insertion opening 13 is formed in the housing 10 in a state that a portion of the cavity 12 communicates with the outside of the housing 10.

[0033] Further, in the housing 10, a feeding flow passage 14 communicating with a feeding pipe 41 for feeding a fluid and a delivery flow passage 15 communicating with a delivery pipe 42 for delivering the fluid are formed in a state that the feeding flow passage 14 and the delivery flow passage 15 face the vibration-plate insertion opening 13 in an opposed manner. A feeding-side one-way valve 16 which allows the feeding of the fluid in the predetermined direction is arranged in a middle portion of the feeding flow passage 14. Also in a middle portion of the delivery flow passage 15, a delivery-side one-way valve 17 which allows the feeding of the fluid in the predetermined direction is arranged.

[0034] In Fig. 1 and Fig. 2, numeral 43 indicates a feeding-pipe connecting socket for connecting the feeding pipe 41 to the housing 10, and numeral 44 indicates a delivery-pipe connecting socket for connecting the delivery pipe 42 to the housing 10.

[0035] The vibration plate 20 is a plate body which can be inserted into the cavity 12 in the housing 10. In this embodiment, the vibration plate 20 is constituted of a plate body made of Teflon (registered trademark).

[0036] A ring-shaped tube 21 is mounted on an outer periphery of the vibration plate 20. In this embodiment, the tube 21 is constituted of a hollow tube body made of

rubber and air is filled in the tube so as to bring the tube into a predetermined air-pressurized state. The tube 21 may be filled with, in place of air, a nitrogen gas or a liquid having predetermined viscosity, for example.

[0037] Further, an outwardly-protruding flange 22 is formed on an outer periphery of the tube 21. The flange 22 is used for mounting the vibration plate 20 on the housing 10. A fitting groove 18 which allows the fitting of the flange 22 therein is formed in an inner peripheral surface of the cavity 12 in the housing 10, and the vibration plate 20 is mounted on the housing 10 in a state that the flange 22 is fitted in the fitting groove 18.

[0038] By mounting the vibration plate 20 on the housing 10 in this manner, a storage chamber 11 surrounded by the vibration plate 20 and the housing 10 can be formed. Further, the storage chamber 11 is communicably connected with the feeding pipe 41 by way of the feeding flow passage 14, and is also communicably connected with the delivery pipe 42 by way of the delivery flow passage 15.

[0039] In this embodiment, a reciprocating rod 31 is mounted on a center portion of the vibration plate 20 by way of a connecting socket 23.

[0040] A magnet M1 is mounted on a middle portion of the reciprocating rod 31. An electromagnet M2 is arranged around the magnet M1, and an AC source not shown in the drawings is connected to the electromagnet M2. By supplying an AC current to the electromagnet M2, the reciprocating rod 31 is driven in a reciprocating manner. Such a structure constitutes a drive part 30 in this embodiment.

[0041] By moving the vibration plate 20 toward a vibration-plate insertion opening 13 side by the drive part 30, a pressure in the storage chamber 11 is lowered. Due to such lowering of pressure, as shown in Fig. 1, the feeding-side one-way valve 16 in the feeding flow passage 14 is brought into a valve-open state and, at the same time, the delivery-side one-way valve 17 in the delivery flow passage 15 is brought into a valve-closed state and hence, the fluid is sucked into the storage chamber 11 from the feeding pipe 41.

[0042] Next, by moving the vibration plate 20 toward a side opposite to the vibration-plate insertion opening 13 by the drive part 30, the pressure in the storage chamber 11 is increased. Due to such an increase of pressure, as shown in Fig. 2, the feeding-side one-way valve 16 in the feeding flow passage 14 is brought into a valve-closed state and, at the same time, the delivery-side one-way valve 17 in the delivery flow passage 15 is brought into a valve-open state and hence, the fluid in the storage chamber 11 is discharged to the delivery pipe 42.

[0043] In this manner, the vibration plate 20 is driven in a reciprocating manner by the drive part 30 thus discharging the fluid.

[0044] Particularly, in the pump P1 of this embodiment, the vibration plate 20 is constituted of the plate body having the rigidity and hence, the vibration plate 20 in itself is not deformed elastically. Accordingly, it is possible to

suppress the bulging deformation of the vibration plate 20 in the direction opposite to the direction along which the vibration plate 20 is driven in a reciprocating manner and hence, the lowering of the discharging pressure of the pump P1 can be suppressed.

[0045] Furthermore, in the pump P1 of the embodiment, the vibration plate 20 is reciprocated by elastically deforming the tube 21 mounted on the outer periphery of the vibration plate 20 instead of directly reciprocating the vibration plate 20. Accordingly, a moving quantity (traveling distance) of the reciprocating vibration plate 20 can be increased. As a result, the pump can acquire a large discharging quantity and a high discharging pressure. To be more specific, the discharging pressure of the pump of this embodiment can be increased to a level several times as large as a discharging pressure of a usual diaphragm pump.

[0046] In this embodiment, the inner pressure of the tube 21 is set higher than the pressure of the fluid in the storage chamber 11 and hence, an outer surface of the tube 21 can be deformed into a shape bulged toward a storage-chamber-11 side. Accordingly, it is possible to prevent the tube 21 from being deformed by the pressure of the fluid in the storage chamber 11 thus stably driving the vibration plate 20 in a reciprocating manner. Here, it is not always necessary to set the inner pressure of the tube 21 higher than the pressure of the fluid in the storage chamber 11. It is sufficient that the inner pressure of the tube 21 is set to a value at least approximately as same as the pressure of the fluid in the storage chamber 11.

[0047] Further, a degree of deformation of a cross-sectional shape of the tube 21 can be adjusted by adjusting the inner pressure of the tube 21 and hence, the tube 21 can be adjusted in conformity with the pump performance such as the discharging quantity or the discharging pressure.

[0048] As described above, by forming a flange 22 which protrudes outwardly on an outer periphery of the tube 21 and by fitting the flange 22 in the fitting groove 18 formed in the housing 10, it is possible to prevent a phenomenon that the tube 21 slips in the housing 10 due to a pressure difference generated on the vibration plate 20 during vibrations so that the vibration plate 20 is displaced and, at the same time, it is also possible to extremely easily mount the vibration plate 20 on the housing 10.

[0049] In the pump P1 of the embodiment having the above-mentioned constitution, although the vibration plate 20 is mounted on one end of the reciprocating rod 31, the vibration plate 20 may be mounted on both ends of the reciprocating rod 31 respectively.

[0050] Hereinafter, a pump P2 of a second embodiment is explained in conjunction with Fig. 3 and Fig. 4. Fig. 3 and Fig. 4 are schematic longitudinal cross-sectional views of the pump P2 of the second embodiment.

[0051] In the pump P2 of this embodiment, by threadedly engaging a first housing 50 with a second housing 60 with a vibration plate 70 sandwiched therebetween,

a first storage chamber 51 surrounded by the first housing 50 and the vibration plate 70 is formed, and a second storage chamber 61 surrounded by the second housing 60 and the vibration plate 70 is formed. That is, the first storage chamber 51 and the second storage chamber 61 are formed with the vibration plate 70 sandwiched therebetween.

[0052] In this embodiment, the vibration plate 70 is formed of a magnet as described later, and a first electromagnet 52 and a second electromagnet 62 which interact with a magnetic pole of the vibration plate 70 are mounted on the first housing 50 and the second housing 60 respectively. An AC source not shown in drawings is connected to the first electromagnet 52 and the second electromagnet 62 respectively. By supplying an AC current to the electromagnets 52, 62, fluctuating magnetic fields are generated and a drive part 80 which drives the vibration plate 70 in a reciprocating manner is formed by an interaction between the fluctuating magnetic fields and the magnet of the vibration plate 70.

[0053] In this embodiment, the first housing 50 is made of Teflon (registered trademark). A first recessed portion 53 having a flattened hemispherical shape is formed in an upper surface of the first housing 50 having a columnar shape, and a ring-shaped first fitting groove 54 for mounting the first electromagnet 52 is formed in a lower surface of the first housing 50.

[0054] Further, in a center portion of a lower surface of the first housing 50, a first feeding flow passage 55 which makes a first feeding pipe 91 for feeding a fluid and the first storage chamber 51 communicably connected with each other and a first delivery flow passage 56 which makes a first delivery pipe 92 for delivering the fluid and the first storage chamber 51 communicably connected with each other are formed. In the first feeding flow passage 55, a first feeding-side one-way valve 57 which allows the feeding of the fluid in the predetermined direction is arranged on a middle portion of the first feeding flow passage 55. Also in the first delivery flow passage 56, a first delivery-side one-way valve 58 which allows the feeding of the fluid in the predetermined direction is arranged on a middle portion of the first delivery flow passage 56.

[0055] Further, a male screw portion 59 for threadedly engaging the first housing 50 with the second housing 60 is formed on a peripheral portion of an upper surface side of the first housing 50.

[0056] The second housing 60 is also made of Teflon (registered trademark). A second recessed portion 63 having a flattened hemispherical shape is formed in an upper surface of the second housing 60 having a columnar shape, and a ring-shaped second fitting groove 64 for mounting the second electromagnet 62 is formed in a lower surface of the second housing 60.

[0057] Further, in a center portion of a lower surface of the second housing 60, a second feeding flow passage 65 which makes a second feeding pipe 93 for feeding a fluid and the second storage chamber 61 communicably

connected with each other and a second delivery flow passage 66 which makes a second delivery pipe 94 for delivering the fluid and the second storage chamber 61 communicably connected with each other are formed. In the second feeding flow passage 65, a second feeding-side one-way valve 67 which allows the feeding of the fluid in the predetermined direction is arranged on a middle portion of the second feeding flow passage 65. Also in the second delivery flow passage 66, a second delivery-side one-way valve 68 which allows the feeding of the fluid in the predetermined direction is arranged on a middle portion of the second delivery flow passage 66.

[0058] Further, a female screw portion 69 is formed on a peripheral portion of an upper surface side of the second housing 60 and is threadedly engaged with the male screw portion 59 formed on the first housing 50.

[0059] In Fig. 3 and Fig. 4, numeral 95 indicates a first feeding-pipe connecting socket for connecting the first feeding pipe 91 to the first housing 50, and numeral 96 indicates a first delivery-pipe connecting socket for connecting the first delivery pipe 92 to the first housing 50. Further, numeral 97 indicates a second feeding-pipe connecting socket for connecting the second feeding pipe 93 to the second housing 60, and numeral 98 indicates a second delivery-pipe connecting socket for connecting the second delivery pipe 94 to the second housing 60.

[0060] The vibration plate 70 is constituted of a laminated plate formed by laminating thin-plate-shaped magnets in this embodiment. By laminating the thin-plate-shaped magnets, it is possible to protect the magnets which are highly fragile. Here, for protecting the magnets, the vibration plate may be formed by coating a necessary magnet plate with a sheet made of Teflon (registered trademark) or the vibration plate may be constituted of a plate body made of Teflon (registered trademark). Further, magnets may be embedded in the vibration plate at predetermined positions.

[0061] A ring-shaped tube 71 is mounted on an outer periphery of the vibration plate 70. In this embodiment, the tube 71 is constituted of a ring-shaped spacer 71a, a first ring-shaped sheet 71b which has an inner periphery thereof joined to a first-storage-chamber-51-side outer periphery of the vibration plate 70 and an outer periphery thereof joined to the spacer 71a, and a second ring-shaped sheet 71c which has an inner periphery thereof joined to a second-storage-chamber-61-side outer periphery of the vibration plate 70 and an outer periphery thereof joined to the spacer 71a.

[0062] Particularly, the first ring-shaped sheet 71b is formed of a thin-film-shaped sheet made of Teflon (registered trademark) and is formed in a bulged shape bulging toward a first-storage-chamber-51 side. Further, the second ring-shaped sheet 71c is also formed of a thin-film-shaped sheet made of Teflon (registered trademark) and is formed in a bulged shape bulging toward a second-storage-chamber-61 side.

[0063] In this manner, by forming the tube 71 using the first ring-shaped sheet 71b and the second ring-shaped

sheet 71c which are constituted of a sheet having a bulged shape, in the reciprocating driving of the vibration plate 70 described later, it is possible to prevent a phenomenon that the elastic deformation of the tube 71 is obstructed thus ensuring the stable reciprocating driving of the vibration plate 70.

[0064] By bringing the inside of the tube 71 into a pressurized state at a pressure substantially equal to or more than a pressure of a fluid in the first storage chamber 51 and a second storage chamber 61 in addition to filling of air into the tube 71, it is possible to impart the elastic deformation to the tube 71 in a more stable manner.

[0065] Particularly, the tube 71 may be filled with, in place of simply filling air into the tube 71, a nitrogen gas or a liquid having predetermined viscosity.

[0066] By joining the respective outer peripheries of the first ring-shaped sheet 71b and the second ring-shaped sheet 71c to the ring-shaped spacer 71a, an outwardly-protruding flange 72 is formed on the outer periphery of the tube 71 by the spacer 71a.

[0067] The flange 72 is provided for fixedly mounting the vibration plate 70 using the first housing 50 and the second housing 60. A first fitting-groove recessed portion 76 is formed in the first housing 50 along an end periphery of the first storage chamber 51, while a second fitting-groove recessed portion 77 is formed in the second housing 60 along an end periphery of the second storage chamber 61. In threadedly engaging the first housing 50 and the second housing 60 with each other, a fitting groove is formed of the first fitting-groove recessed portion 76 and the second fitting-groove recessed portion 77, and a flange 72 is housed in the fitting groove.

[0068] Particularly, in this embodiment, the spacer 71a is made of rubber and also functions as a packing for enhancing the hermetic property between the first housing 50 and the second housing 60 thus enhancing the hermetic property between the first storage chamber 51 and the second storage chamber 61.

[0069] In the pump P2 having such a constitution, the drive part 80 generates a fluctuating magnetic field by operating the first electromagnet 52 mounted on the first housing 50 and the second electromagnet 62 mounted on the second housing 60 in an interlocking manner using an AC power source, and the vibration plate 70 is driven in a reciprocating manner due to an interaction between the fluctuating magnetic field and magnets of the vibration plate 70.

[0070] Further, as shown in Fig. 3, by moving the vibration plate 70 toward the second-housing-60 side, the pressure in the first storage chamber 51 is lowered to bring the first-feeding-side one-way valve 57 in the first feeding flow passage 55 into a valve-open state and, at the same time, to bring the first-delivery-side one-way valve 58 in the first delivery flow passage 56 into a valve-closed state thus sucking a fluid into the first storage chamber 51 from the first feeding pipe 91.

[0071] Further, simultaneously with the above-mentioned operation, the pressure in the second storage

chamber 61 is increased to bring the second-feeding-side one-way valve 67 in the second feeding flow passage 65 into a valve-closed state and, at the same time, to bring the second-delivery-side one-way valve 68 in the second feeding flow passage 66 into a valve-open state thus discharging a fluid in the second storage chamber 61 to the second feeding pipe 94.

[0072] Next, by moving the vibration plate 70 toward the first-housing-50 side, the pressure in the first storage chamber 51 is increased to bring the first-feeding-side one-way valve 57 in the first feeding flow passage 55 into a valve-closed state and, at the same time, to bring the first-delivery-side one-way valve 58 in the first delivery flow passage 56 into a valve-open state thus discharging the fluid in the first storage chamber 51 to the first delivery pipe 92.

[0073] Further, simultaneously with the above-mentioned operation, the pressure in the second storage chamber 61 is lowered to bring the second-feeding-side one-way valve 67 in the second feeding flow passage 65 into a valve-open state and, at the same time, to bring the second-delivery-side one-way valve 68 in the second feeding flow passage 66 into a valve-closed state thus sucking the fluid into the second storage chamber 61 from the second feeding pipe 93.

[0074] By driving the vibration plate 70 in a reciprocating manner by the drive part 80 in this manner, the fluid can be discharged. Particularly, in the pump P2 of this embodiment, the fluid can be discharged by the first storage chamber 51 and the second storage chamber 61 alternately. When the same fluid is supplied to the first storage chamber 51 and the second storage chamber 61, a discharge interval can be halved and hence, the generation of pulsation of the discharged fluid can be suppressed.

[0075] By arranging the first storage chamber 51 and the second storage chamber 61 parallel to each other with the vibration plate 70 sandwiched therebetween, the pump P2 can be miniaturized.

[0076] The tube 71 formed on the outer periphery of the vibration plate 70 is not limited to the above-mentioned constitution which is formed of the spacer 71a, the first ring-shaped sheet 71b and the second ring-shaped sheet 71c. Provided that the tube 71 can resist the pressure of the fluid in the first storage chamber 51 and the pressure of the fluid in the second storage chamber 61, the tube 71 may adopt any constitution. For example, the tube may be, as shown in Fig. 5(a), constituted of a ring-shaped tube 71-1 formed in a ring shape or may be, as shown in Fig. 5(b), constituted of a ring 71-2 having a circular cross section. Particularly, the tube 71-2 may preferably be made of an elastic material such as silicone rubber.

[0077] In Fig. 5(a), numeral 70-1 indicates a vibration plate, and numeral 72-1 indicates an outwardly-protruding flange which is mounted on an outer periphery of the ring-shaped tube 71-1. Further, in an inner periphery of the ring-shaped tube 71-1, a fitting groove 74-1 which allows fitting of an outer periphery of the vibration plate

70-1 therein is formed. In Fig. 5(b), numeral 70-2 indicates a vibration plate, and numeral 72-2 indicates an outwardly-protruding flange which is mounted on an outer periphery of the ring-shaped tube 71-1. Also in an inner periphery of the ring-shaped tube 71-2, a fitting groove 74-2 which allows fitting of an outer periphery of the vibration plate 70-2 therein is formed.

[0078] Further, as another embodiment, as shown in Fig. 5(c), a vibration-plate support film 75-3 may be arranged inside a ring-shaped tube 71-3 formed in a ring shape, and a first vibration plate 70-3a and a second vibration plate 70-3b may be respectively adhered to both surfaces of the vibration-plate support film 75-3.

[0079] By respectively adhering the first vibration plate 70-3a and the second vibration plate 70-3b to the vibration-plate support film 75-3 in this manner, the ring-shaped tube 71-3 and the first vibration plate 70-3a can be firmly adhered to each other, while the ring-shaped tube 71-3 and the second vibration plate 70-3b can be firmly adhered to each other. In Fig. 5(c), numeral 72-3 indicates an outwardly-protruding flange mounted on an outer periphery of the ring-shaped tube 71-3.

[0080] Alternatively, as another embodiment, as shown in Fig. 5(d), a tube with no flange may be used by eliminating the flange from the ring-shaped tube 71-4. In Fig. 5(d), numeral 70-4 indicates a vibration plate, and a fitting groove 74-4 which allows fitting of an outer periphery of a vibration plate 70-4 therein is formed in an inner periphery of the ring-shaped tube 71-4.

[0081] When such a flangeless tube is adopted, in mounting the vibration plate on the housing by way of the tube, the pump includes a slip preventing means for preventing a phenomenon that the tube slips with respect to the housing so that the position of the vibration plate is displaced.

[0082] Hereinafter, an embodiment of the pump P3 which uses the flangeless tube is explained in conjunction with Fig. 6 and Fig. 7. The pump P3 of this embodiment is a modification of the pump P1 of the first embodiment explained in conjunction with Fig. 1 and Fig. 2. In this embodiment, parts identical with the parts of the previous embodiments are indicated by the same symbols and the repeated explanation of these parts is omitted.

[0083] The pump P3 of this embodiment is also constituted of a housing 10 provided with a storage chamber 11, a vibration plate 20 arranged in the housing 10 to face the storage chamber 11 in an opposed manner, and a drive part 30 for driving the vibration plate 20 in a reciprocating manner.

[0084] A flattened-spherical-shaped cavity 12 is formed in an approximately rectangular parallelepiped housing 10 made of Teflon (registered trademark) and, at the same time, a vibration-plate inserting opening 13 is formed in the housing 10 in a state that a portion of the cavity 12 is connected with the outside.

[0085] Particularly, in this embodiment, in a mounting portion of the housing 10 on which the vibration plate 20

is mounted, a ring-shaped first supporting wall 101 and a ring-shaped second supporting wall 102 protruding inwardly are formed on an inner peripheral surface of the housing 10 parallel to each other with a predetermined distance therebetween. The first supporting wall 101 and the second supporting wall 102 constitute slip preventing means.

[0086] The first supporting wall 101 and the second supporting wall 102 are respectively formed in a convex mountain-like shape having the same height. Between the first supporting wall 101 and the second supporting wall 102, a valley-shaped supporting recessed portion 103 curved in a recessed shape is formed.

[0087] Further, in this embodiment, a delivery flow passage 15 communicating with a delivery pipe 42 for delivering the fluid is formed in the housing 10 in a state that the delivery flow passage 15 faces the vibration-plate insertion opening 13 in an opposed manner. A delivery-side one-way valve 17 which allows the feeding of the fluid in the predetermined direction is arranged on a middle portion of the delivery flow passage 15.

[0088] A ring-shaped tube 21' is mounted on an outer periphery of the vibration plate 20 which is constituted of a plate body made of Teflon (registered trademark). In this embodiment, the tube 21' is constituted of a rubber-made hollow cylindrical body and is brought into an air-pressurized state at a predetermined pressure by filling air into the inside of the tube 21'.

[0089] In this embodiment, a flange is not formed on the tube 21'. By fitting the tube 21' into a supporting recessed portion 103 formed in the housing 10 in a state that the tube 21' is elastically deformed, a protruding portion which protrudes along the supporting recessed portion 103 is formed on the tube 21'. Due to the provision of the projecting portion, the tube 21' can be stably mounted on the housing 10 in the same manner as the above-mentioned flange thus enabling the mounting of the vibration plate 20 on the housing 10.

[0090] By mounting the vibration plate 20 on the housing 10 in this manner, it is possible to form a storage chamber 11 surrounded by the vibration plate 20 and the housing 10 and, it is also possible to make the delivery pipe 42 communicably connected with the storage chamber 11 by way of the delivery flow passage 15.

[0091] Further, in this embodiment, a through hole 104 is formed in a portion of the vibration plate 20, a one-way valve 105 is mounted on a storage-chamber-11 side of the through hole 104, and a fluid is fed into the storage chamber 11 through the through hole 104.

[0092] Accordingly, in the pump P3 of this embodiment, by driving a reciprocating rod 31 in a reciprocating manner by a drive part 30, the vibration plate 20 is driven in a reciprocating manner so that the fluid is fed to the storage chamber 11 from the through hole 104 and the fluid fed to the storage chamber 11 is discharged through the delivery pipe 42.

[0093] In this manner, by fitting the tube 21' into the slip preventing means formed of the first supporting wall

101 and the second supporting wall 102 mounted on the housing 10 without forming the flange on the tube 21', a portion having a substantially flange shape can be formed on the tube 21' and hence, it is possible to prevent slipping of the tube 21' relative to the housing 10 and, at the same time, the vibration plate 20 can be extremely easily mounted on the housing 10 by way of the tube 21' thus enhancing the maintenance of the pump P3.

[0094] As another modification, as shown in Fig. 8, only a valley-shaped supporting recessed portion 103' curved in a recessed shape maybe formed on the housing 10 as a slip preventing means without forming the first supporting wall 101 and the second supporting wall 102. By fitting the tube 21' into the supporting recessed portion 103' in a state that the tube 21' is elastically deformed, a protruding portion which protrudes along the supporting recessed portion 103' is formed on the tube 21'. Due to the provision of the projecting portion, slipping of the tube 21' relative to the housing 10 can be prevented thus also enabling the mounting of the vibration plate 20 on the housing 10.

[0095] Alternatively, when the combination which increases a friction coefficient between a material of the housing and a material of the tube is selected, as shown in Fig. 9, without forming the first supporting wall 101, the second supporting wall 102 and the supporting recessed portion 103, 103' on the housing 10, an arc-shaped recessed curved surface 106 is formed in an tube-21'-arranged portion. By fitting the tube 21' on which the flange is not mounted into the recessed curved surface 106 in a state that the tube 21' is elastically deformed, the vibration plate 20 can be mounted on the housing 10 by way of the tube 21'.

[0096] In this case, it is desirable that a radius of curvature of the tube 21' in a non-deformed state is equal to or larger than one half of a radius of curvature of a recessed curved surface 106.

[0097] In the above-mentioned embodiments, as the tube which surrounds the vibration plate, the tube which fills the fluid such as air therein at a predetermined pressure or the tube which is constituted of the elastic body having no hollow portion is used. When the tube which fills the fluid therein is adopted, as shown in Fig. 10, a pressurized air feeding pipe 130 formed in a tubular shape is mounted in a tube 120 as a fluid filling means. By feeding a fluid such as air into the inside of the tube 120 under pressure by way of the pressurized air feeding pipe 130, the pressure in the tube 120 is adjusted thus adjusting the modulus of elasticity of the tube 120. Although the explanation is made hereinafter with respect to the feeding of air into the tube 120 under pressure, the fluid to be fed into the tube 120 under pressure is not limited to air and may be any proper fluid. For example, a liquid having high viscosity may be fed to the tube 120 under pressure.

[0098] A cylindrical insertion portion 121 for allowing the insertion of the pressurized air feeding pipe 130 therein is formed in the tube 120. By inserting an insertion

sleeve portion 131 of the pressurized air feeding pipe 130 into the insertion portion 121, the pressurized air feeding pipe 130 can be mounted in the tube 120.

[0099] The tube 120 in which the pressurized air feeding pipe 130 is arranged is mounted in the housing 110 in a state that the pressurized air feeding pipe 130 projects outwardly from the pressurized-air-feeding-pipe insertion hole 111 formed in the housing 110.

[0100] Particularly, a flange 132 is mounted on an outer peripheral surface of the pressurized air feeding pipe 130. When the pressurized air feeding pipe 130 is inserted into the pressurized-air-feeding-pipe insertion hole 111 formed in the housing 110, the flange 132 is engaged with the housing 110. While bringing a protruding sleeve portion 133 of the pressurized air feeding pipe 130 into a protruding state from the housing 110, a fixing nut 140 is threadedly engaged with the protruding sleeve portion 133 so as to fixedly mount the pressurized air feeding pipe 130 on the housing 110. Although not shown in the drawing, on an outer peripheral surface of the protruding sleeve portion 133 of the pressurized air feeding pipe 130, male screws threadedly engaged with the fixing nut 140 are formed.

[0101] A ventilation hole 134 is formed in at least one portion of the cylindrical peripheral surface of the insertion sleeve portion 131 of the pressurized air feeding pipe 130. The ventilation hole 134 is provided for introducing air fed into the pressurized air feeding pipe 130 under pressure into the tube 120 through the ventilation hole 134.

[0102] The ventilation hole 134 is closed by an insertion portion 121 of the tube 120 in a state that air is not fed into the pressurized air feeding pipe 130 under pressure thus preventing leaking of air in the tube 120.

[0103] A slit 112 is formed in a portion of the housing 110 which corresponds to the ventilation hole 134 formed in the pressurized air feeding pipe 130. The slit 112 is provided for facilitating the elastic deformation of the insertion portion 121 of the tube 120 at a slit-112-formed portion of the housing 110.

[0104] That is, when air is fed into the pressurized air feeding pipe 130 under pressure, the insertion portion 121 of the tube 120 at the slit-112-portion is elastically deformed due to a pressure at the time of feeding air under pressure and hence, a gap is formed between the insertion portion 121 of the tube 120 and the pressurized air feeding pipe 130 thus bringing a state in which the inside of the tube 120 and the ventilation hole 134 are communicated with each other through the gap whereby air is introduced into the tube 120. Here, an end portion of the pressurized air feeding pipe 130 on an insertion-sleeve-portion-131 side is closed so that ventilation is performed only through the ventilation hole 134.

[0105] In the tube 120 of this embodiment, a recessed fitting groove 122 which allows fitting of an end peripheral portion of a plate-shaped vibration plate 150 therein is formed, and the end peripheral portion of the vibration plate 150 is fitted in the fitting groove 122. The fitting

groove 122 is preliminarily formed to have a recessed cross-sectional shape. By fitting the vibration plate 150 in the fitting groove 122 and by feeding air into the tube 120 under pressure, a fastening force generated by the inflated tube 120 acts on the vibration plate 150 fitted in the fitting groove 122 thus creating a stronger connection state.

[0106] By detachably engaging the vibration plate 150 and the tube 120 with each other in this manner, when the tube 120 is deteriorated, only the tube 120 can be exchanged and hence, the vibration plate 150 can be reused thus reducing a management cost.

[0107] It may be possible to provide another embodiment which does not use the above-mentioned pressurized air feeding pipe 130. That is, as shown in Fig. 11, a fitting groove 122' formed in the tube 120' is formed of a deep groove, and a ventilation hole 123' is formed in a predetermined portion of the fitting groove 122'. Further, an air feeding hole 152' which constitutes one opening of an air introducing passage 151' formed in a vibration plate 150' in a penetrating manner is formed in an end peripheral portion of the vibration plate 150' fitted in the fitting groove 122', and an air intake hole 153' which constitutes another opening of the air introducing passage 151' is formed in the vibration plate 150' at a position outside the fitting groove 122'. It is desirable that the ventilation hole 123' is formed in a bottom portion of the fitting groove 122'.

[0108] In this case, to create a desired pressure in the tube 120', a fluid such as air to be filled in the tube 120' is fed to a storage chamber which is formed by the housing 110, the vibration plate 150' and the tube 120' and which the air intake hole 153' of the air introducing passage 151' faces. Then, the fluid is pressurized to the desired pressure.

[0109] Along with the increase of the pressure in the storage chamber, the fluid is introduced into the air introducing passage 151', and the fluid is introduced into the fitting groove 122' from the air feeding hole 152' through the air introducing passage 151'. Due to the pressure of the fluid, the inside of the fitting groove 122' is elastically deformed so that the inside of the fitting groove 122' is communicated with the ventilation hole 123' and hence, the fluid is introduced into the inside of the tube 120' through the ventilation hole 123' to create the desired pressure in the tube 120'. In this case, as a matter of course, the pressure in the tube 120' is set to a value substantially equal to the pressure in the storage chamber.

[0110] In operating the pump provided with such tube 120' and vibration plate 150', by filling the storage chamber with an operating fluid and pressurizing a fluid periodically, the tube 120' is replenished with the fluid thus preventing lowering of the pressure in the tube 120'.

[0111] By setting the pressure in the tube 120' larger than the pressure in the storage chamber when the pump is operated, it is possible to prevent a gas or a liquid in the storage chamber from flowing into the tube 120'.

[0112] It is desirable that the fitting groove 122' is brought into close contact with the vibration plate 150' for preventing the formation of a gap therebetween. Particularly, by creating the high pressure in the tube 120', a fastening force of the vibration plate 150' generated by the fitting groove 122' can be increased to bring the fitting groove 122' into a close contact with the vibration plate 150'.

[0113] In Fig. 11, numeral 113' indicates a supporting wall which is mounted on an inner peripheral surface of the housing 110' in an inwardly protruding manner for fixing the tube 120'.

[0114] With respect to the fluid to be filled in the tube 120', it is desirable to use a fluid which exhibits small compressibility such as liquid rather than a fluid which exhibits large compressibility such as air. With the use of such a liquid, a discharge pressure can be increased.

Industrial Applicability

[0115] The pump of the present invention is applicable as a miniaturized feeding device which feeds a fluid such as liquid or gas under high discharge pressure.

Claims

1. A pump connected with a feeding pipe and a delivery pipe for delivering a fluid fed from the feeding pipe through the delivery pipe, the pump comprising:

a housing provided with a storage chamber connecting with the feeding pipe and the delivery pipe through a one-way valve respectively and storing the fluid therein temporarily;

a vibration plate arranged to face the storage chamber in an opposed manner and driven in a reciprocating manner so as to push out the fluid to the delivery pipe after sucking the fluid from the feeding pipe into the storage chamber; and
a drive part for driving the vibration plate in a reciprocating manner, wherein

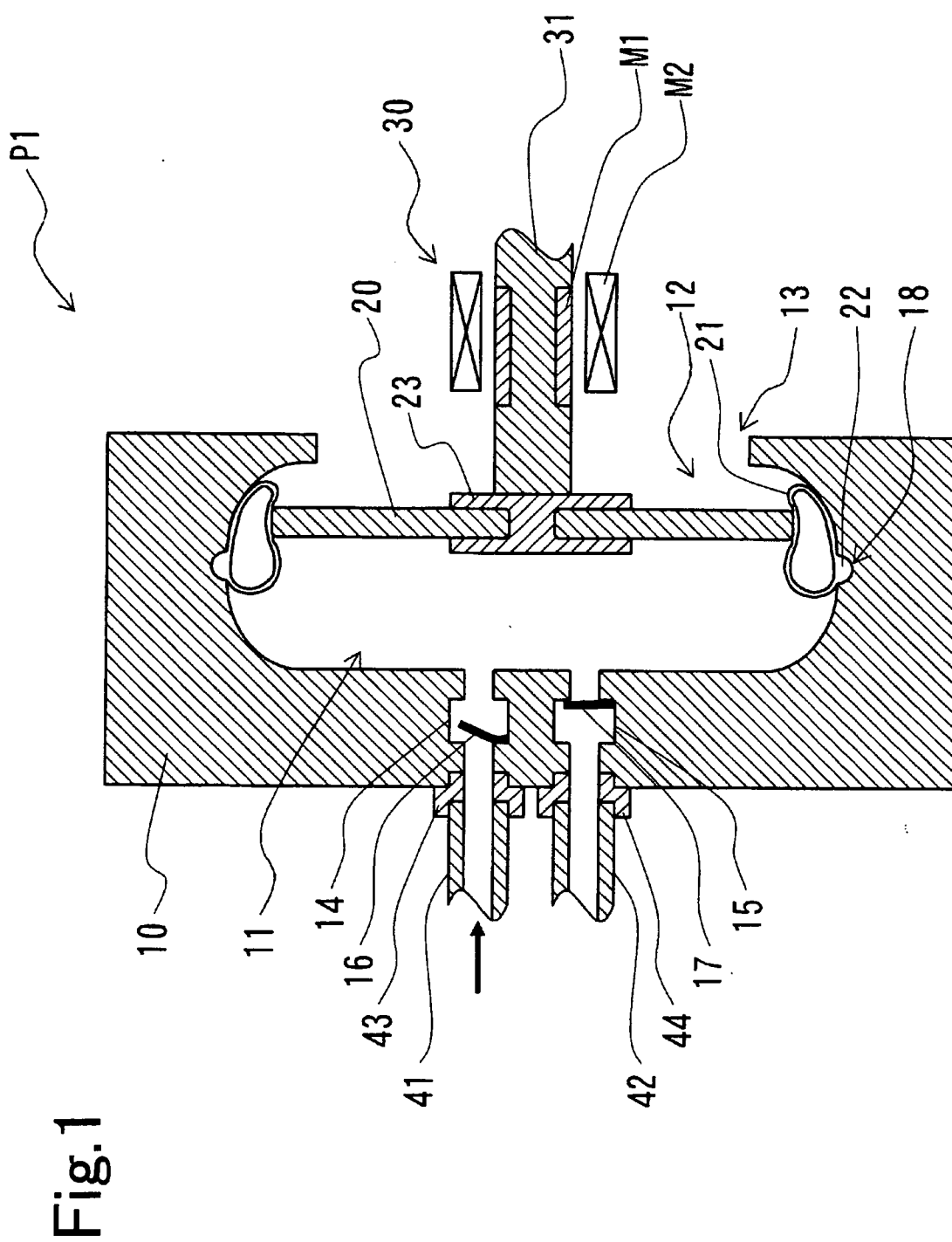
a ring-shaped tube is arranged along an outer periphery of the vibration plate, and the vibration plate is mounted on the housing by way of the tube thus enabling driving of the vibration plate in a reciprocating manner.

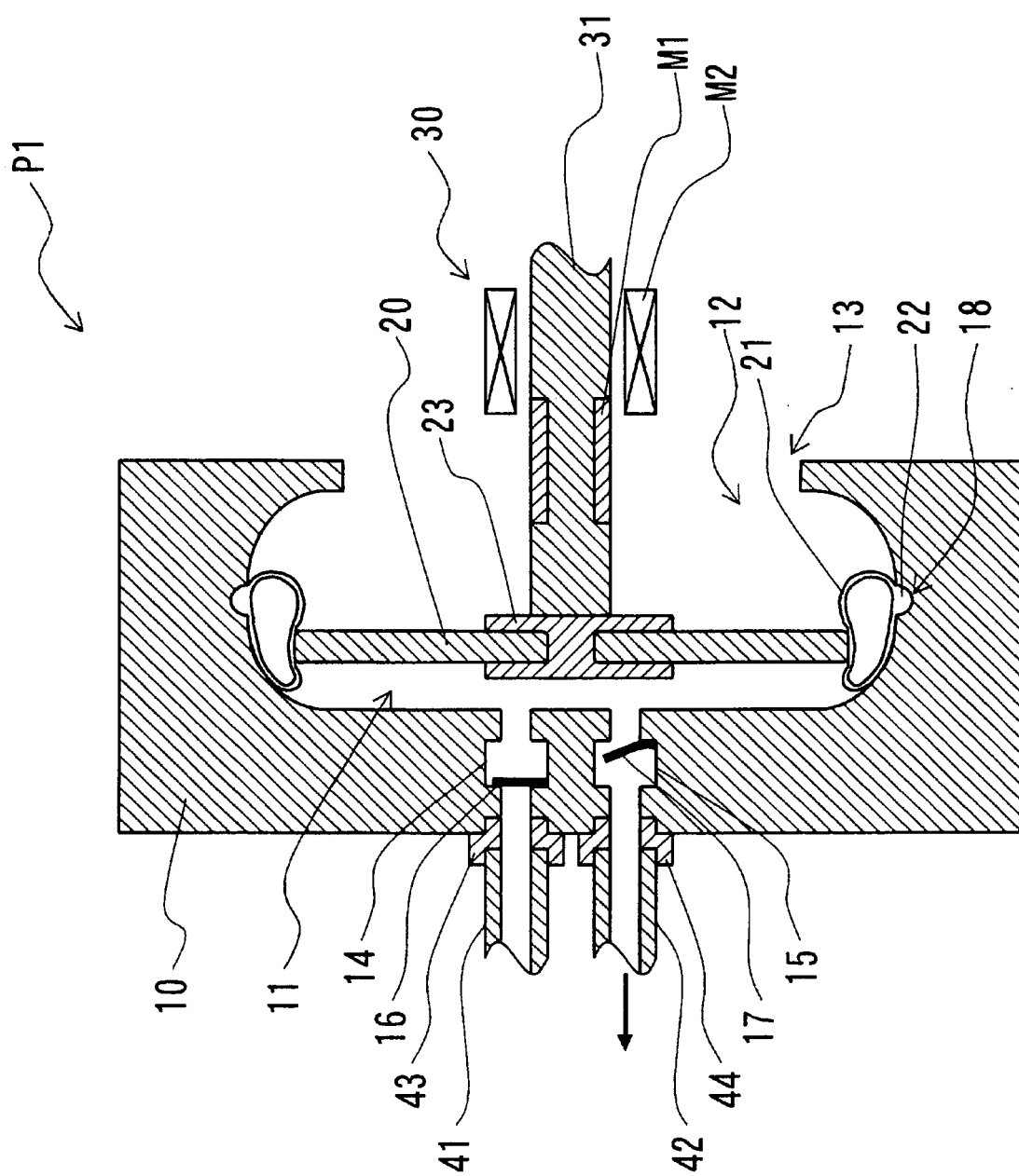
2. A pump according to claim 1, wherein a pressure in the tube is equal to or higher than a pressure of the fluid in the storage chamber.

3. A pump according to claim 1 or claim 2, wherein an outwardly-protruding flange is formed on an outer periphery of the tube, a fitting groove which allows fitting of the flange therein is formed in the housing, and the vibration plate is mounted on the housing by fitting the flange in the fitting groove.

4. A pump according to claim 1 or claim 2, wherein a ring-shaped first supporting wall and a ring-shaped second supporting wall protruding inwardly are formed on an inner peripheral surface of the housing parallel to each other with a predetermined distance therebetween, and the vibration plate is mounted on the housing by fitting the tube between the first supporting wall and the second supporting wall.

5. A pump according to claim 2, wherein the tube includes a fluid filling means for adjusting a pressure in the tube by filling the fluid in the tube.





Fi. 2

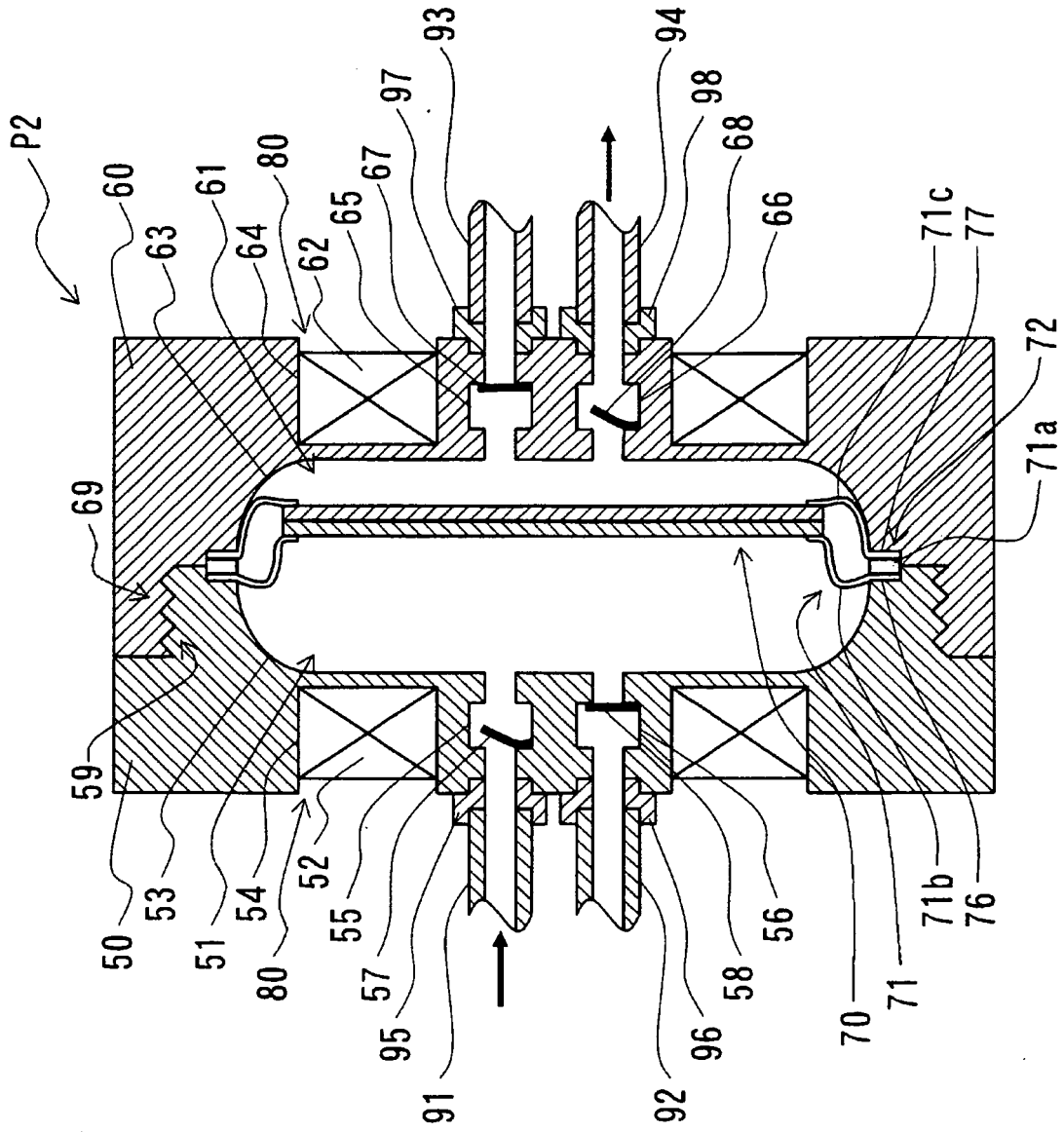


Fig.3

Fig.4

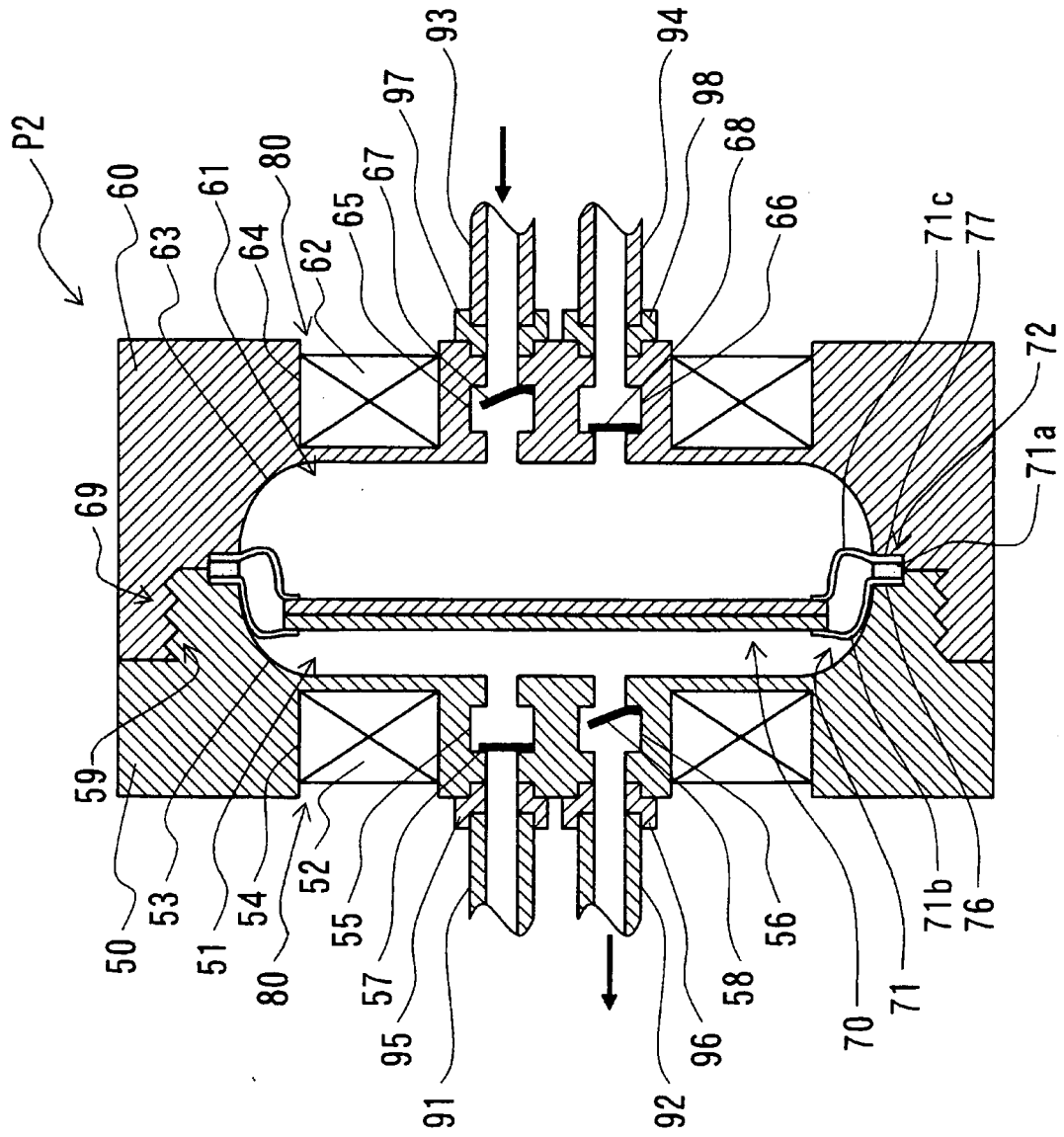


Fig.5 (a) Fig.5 (b) Fig.5 (c) Fig.5 (d)

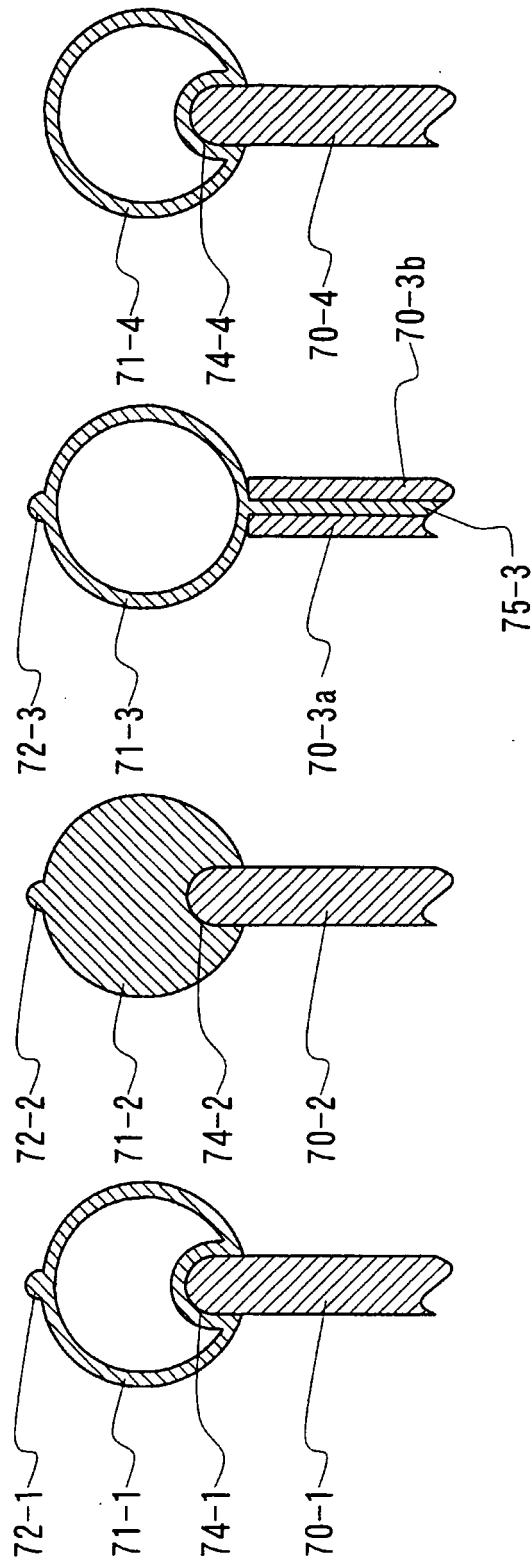
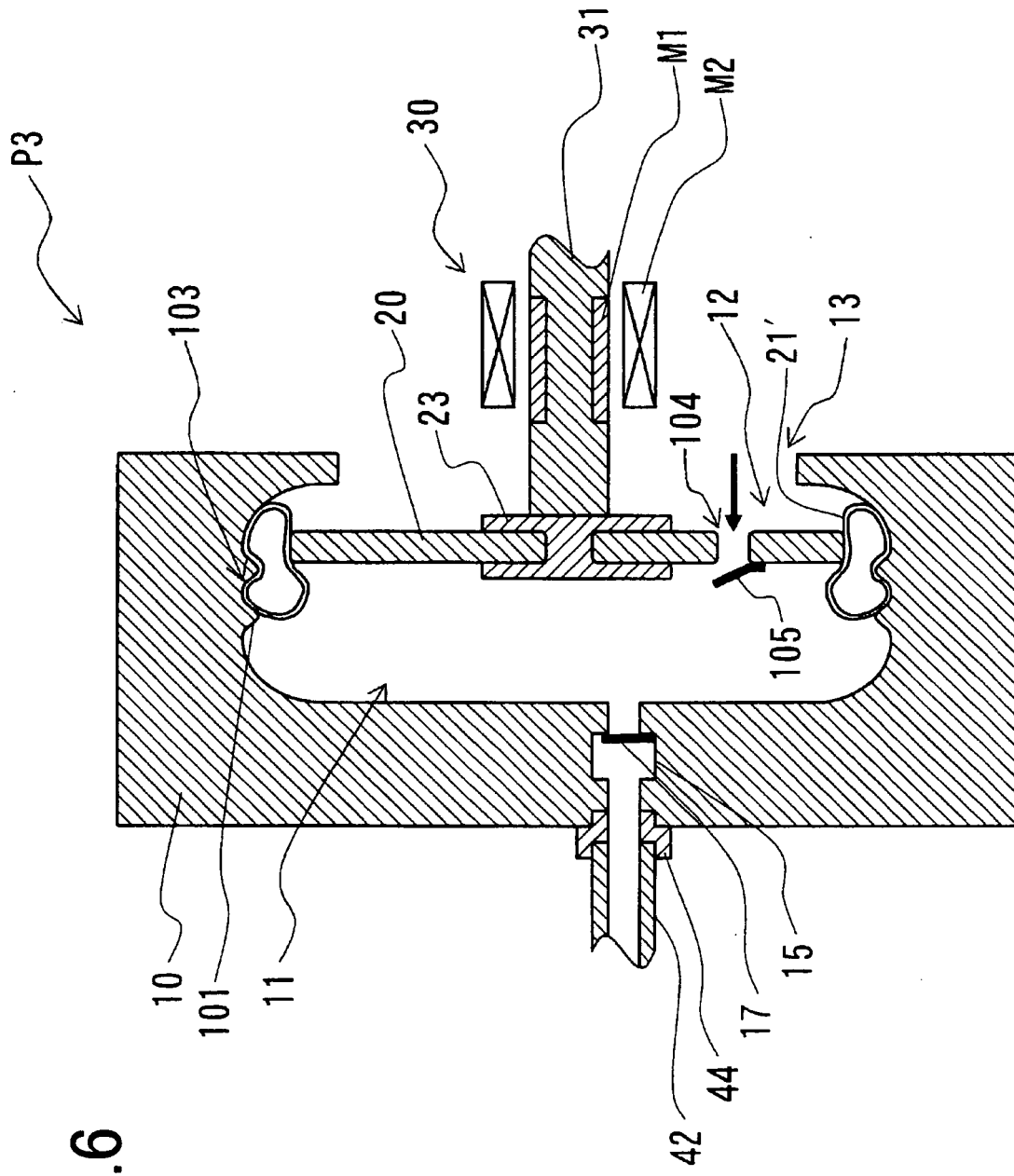
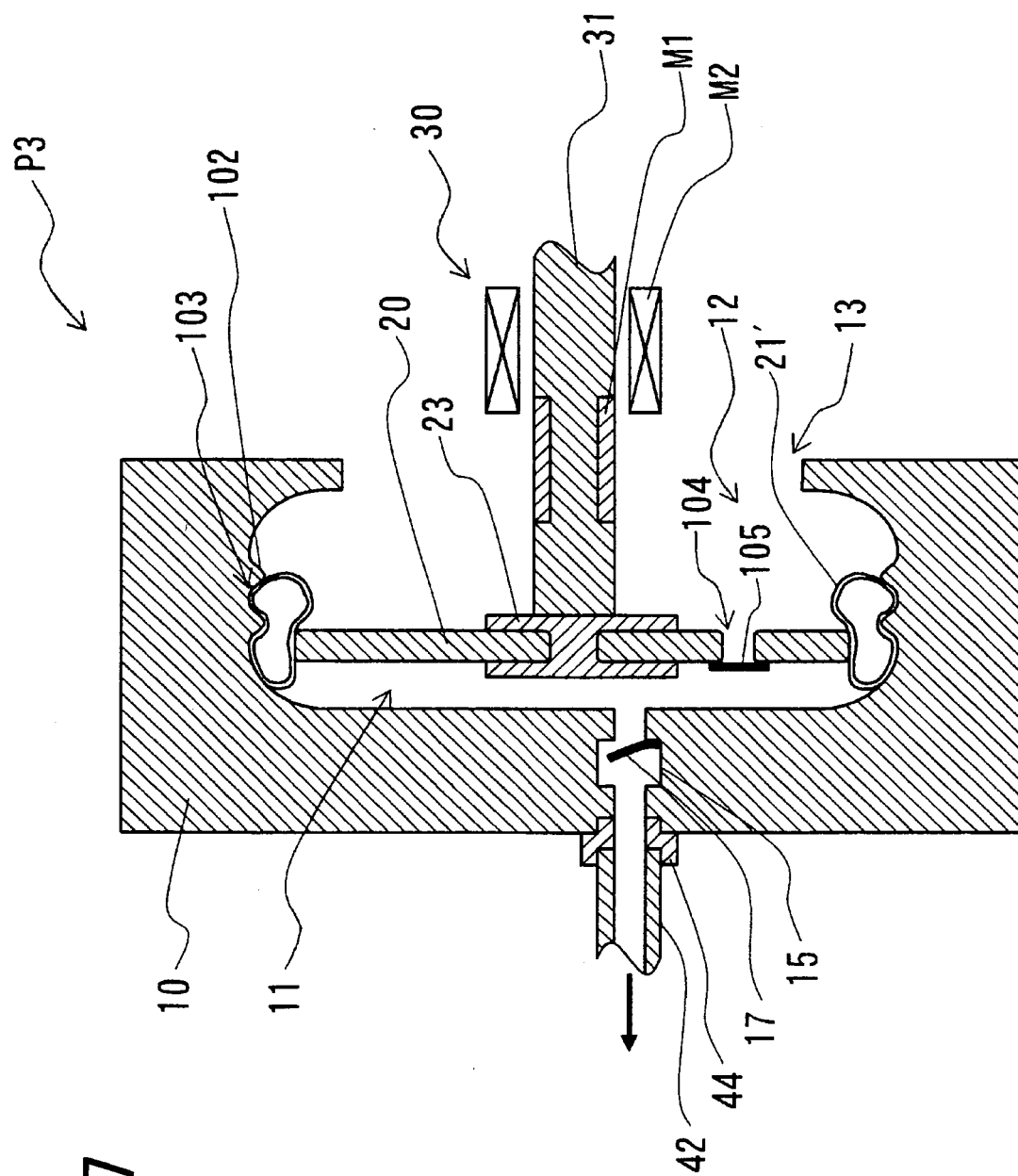
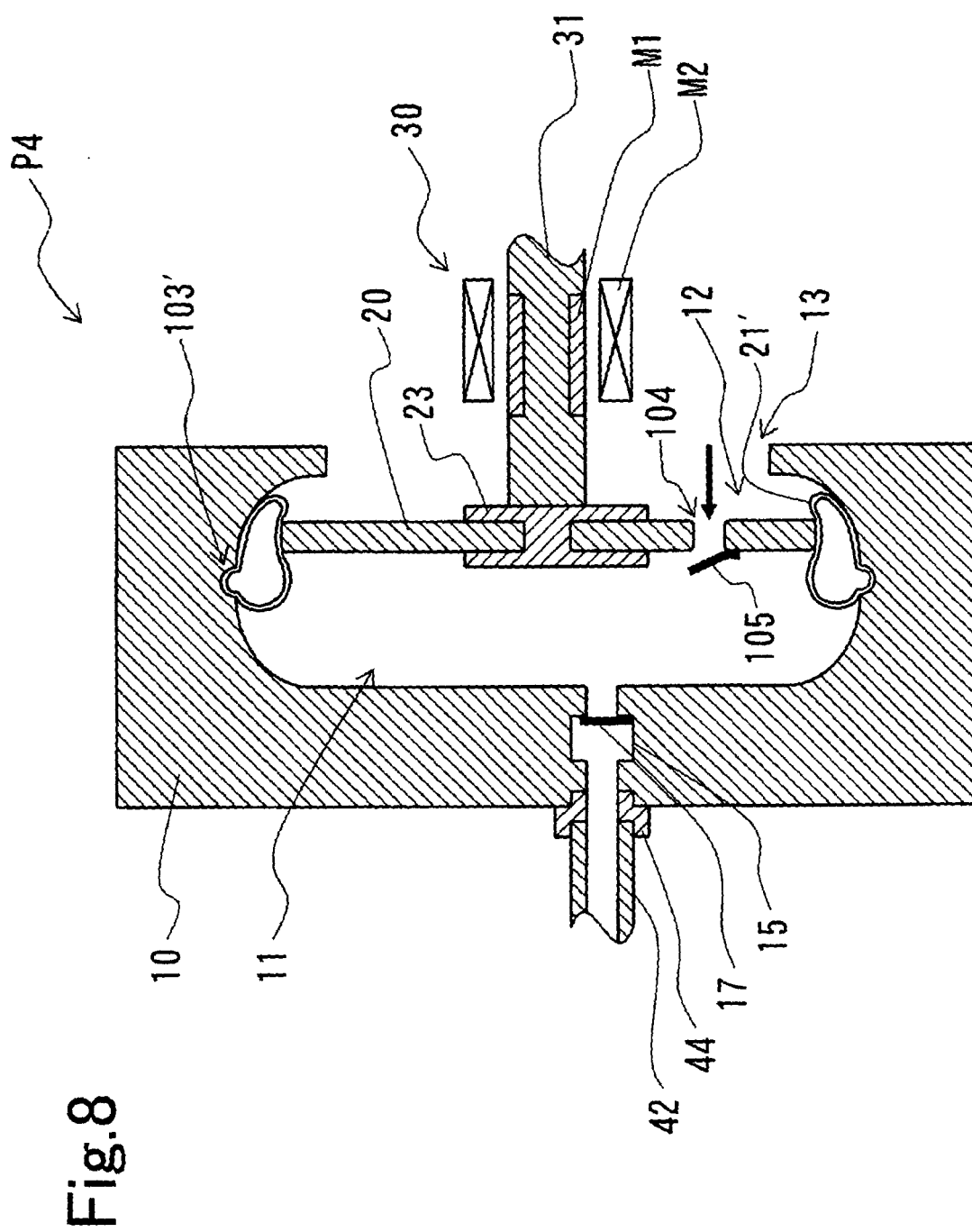


Fig.6

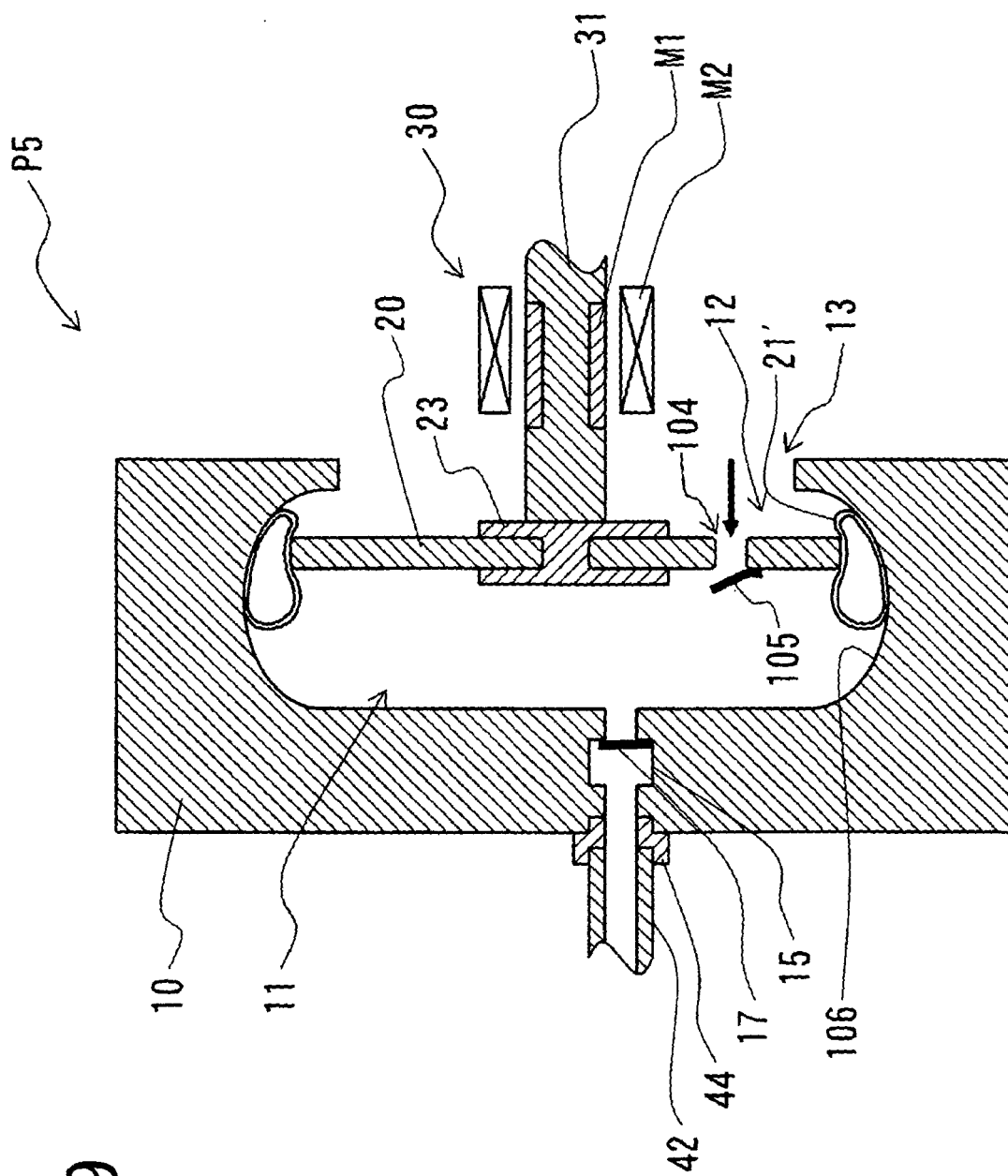


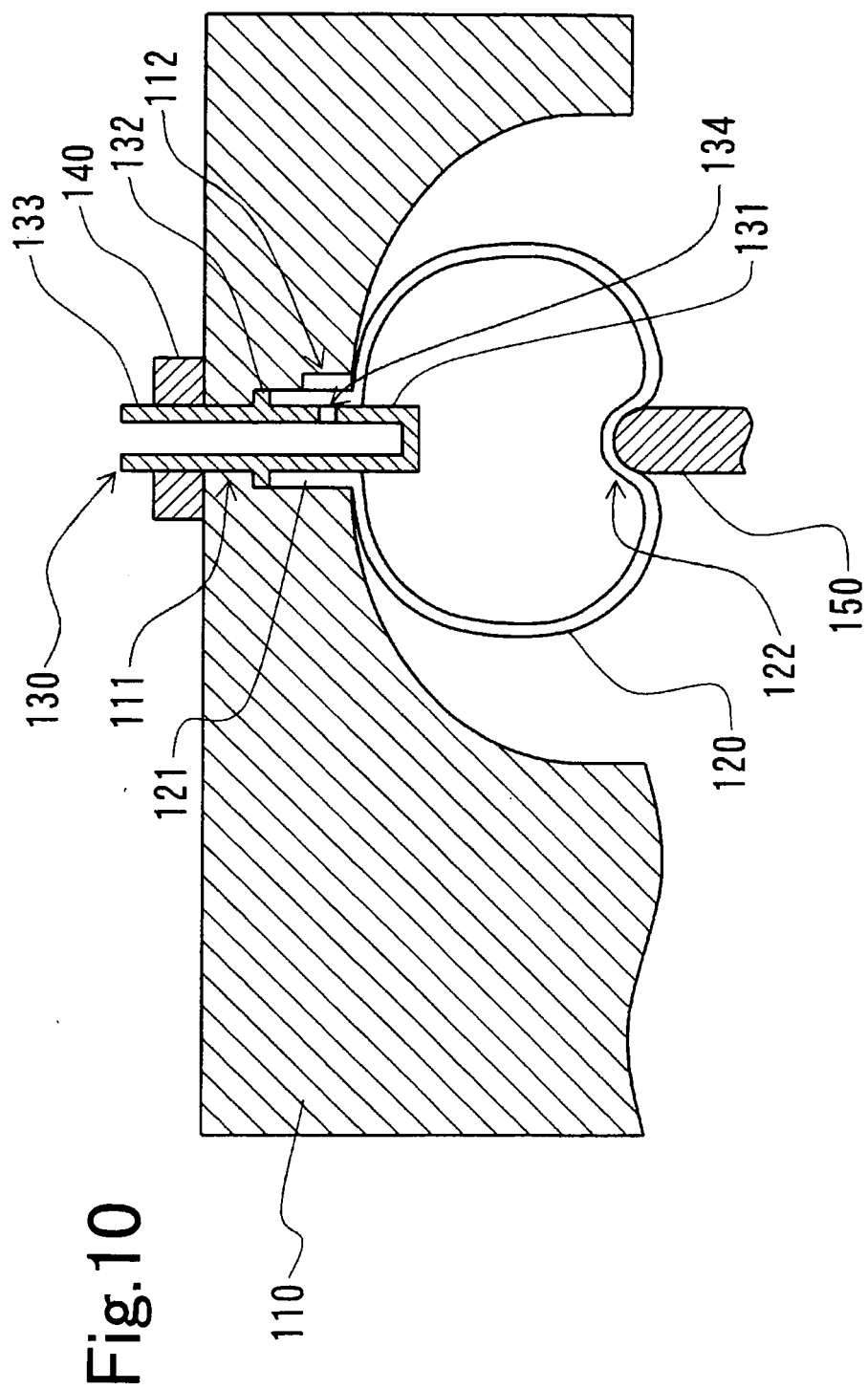


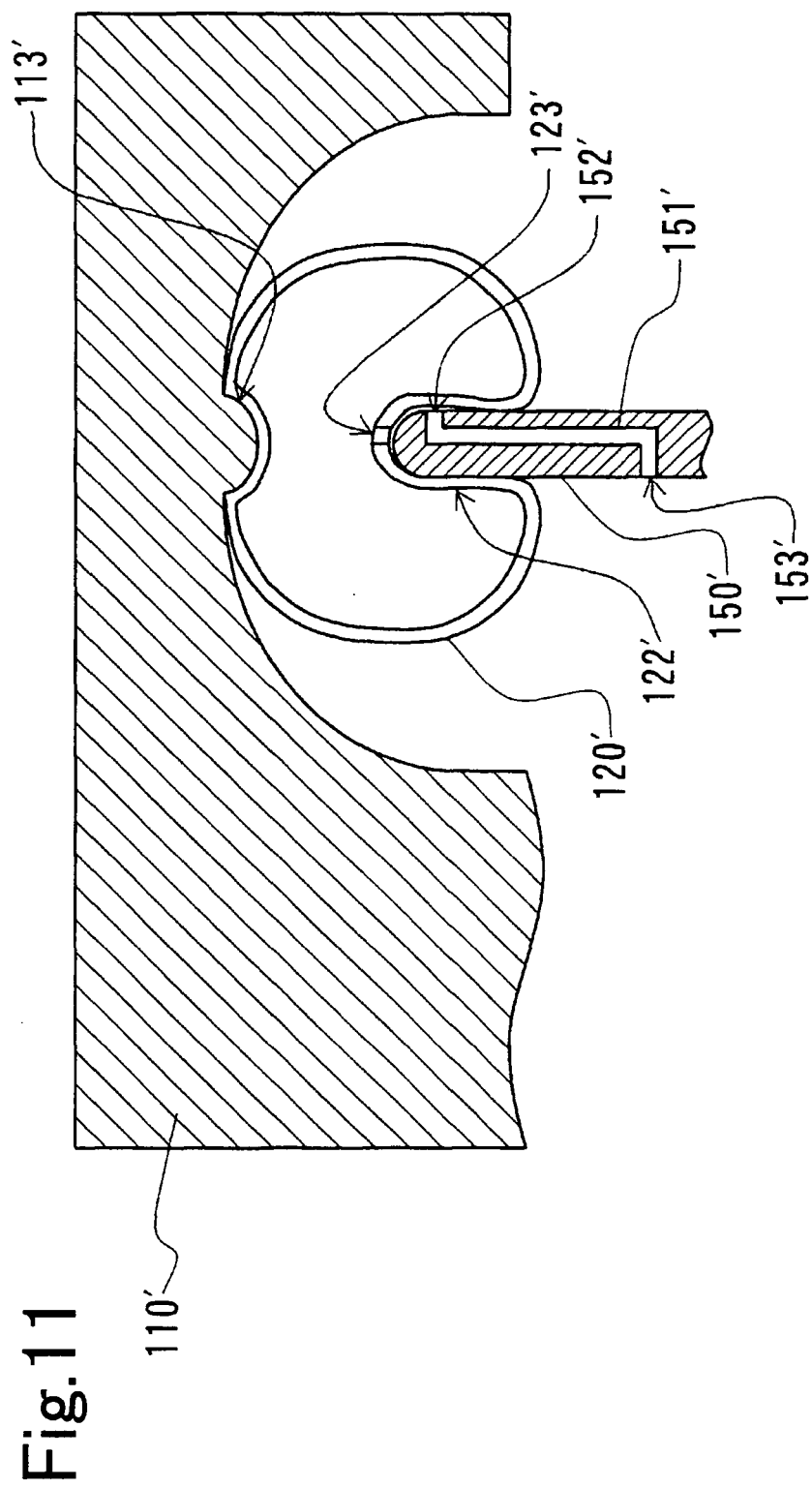
Fi. 7



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/319172

A. CLASSIFICATION OF SUBJECT MATTER

F04B43/04(2006.01)i, F04B9/08(2006.01)i, F04B19/22(2006.01)i, F04B35/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04B43/04, F04B9/08, F04B19/22, F04B35/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2006
Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 98022/1989(Laid-open No. 37292/1991) (Kabushiki Kaisha Nagano Keiki Seisakusho), 11 April, 1991 (11.04.91), Fig. 1 (Family: none)	1-4 5
Y A	JP 2001-271756 A (Nippon Keiki Works Co., Ltd.), 05 October, 2001 (05.10.01), Figs. 11, 12 (Family: none)	1-4 5

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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Date of the actual completion of the international search
18 December, 2006 (18.12.06)

Date of mailing of the international search report
26 December, 2006 (26.12.06)

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004257337 A [0007]
- JP 2004060641 A [0007]