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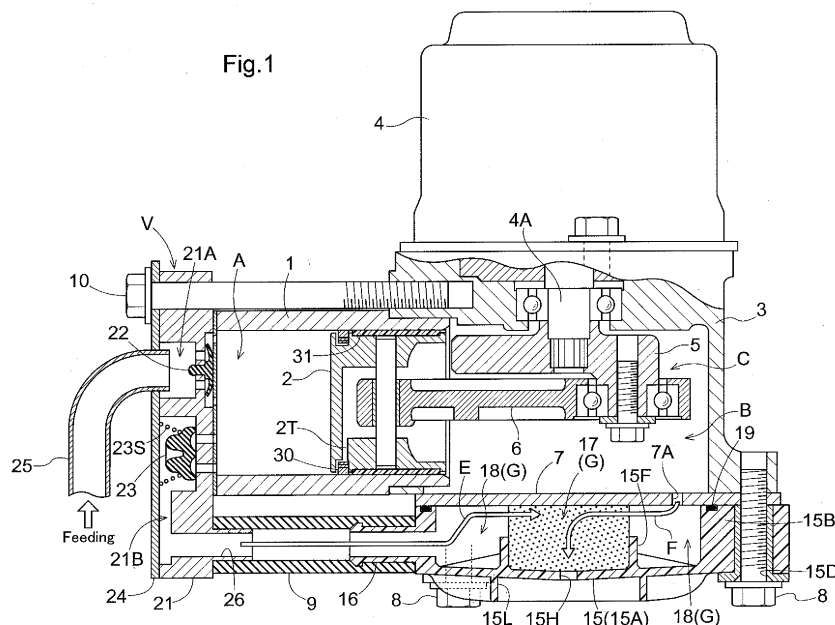
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(54) **FLUID PUMP**

(57) The present invention inhibits suction of dust and moisture into a drive chamber for driving a piston of a fluid pump while reducing drive load through feeding/discharging of fluid to/from the drive chamber. In the interior of a cylinder, a pressure increasing/decreasing chamber is formed between a valve unit on the cylinder head side and the piston. On the opposite side of the

pressure increasing/decreasing chamber, the drive chamber is disposed. There are provided a ventilation path for communicating the drive chamber and the outside space, a fluid path connected to the feeding/discharging space of the valve unit, a merging space where the fluid path is merged with the ventilation path midway, and a fluid filter provided in the merging space.



Description

TECHNICAL FIELD

[0001] The present invention relates to a fluid pump configured to effect feeding/discharging of a fluid through movements of a piston. More particularly, the invention relates to a technique for controlling feeding/discharging of a fluid to/from a drive chamber in which there are disposed a connection rod connected to the piston, a crank mechanism, etc.

BACKGROUND ART

[0002] As an example of a fluid pump, PTL 1 discloses a vacuum pump including a piston mounted inside a cylinder to move back and forth therein, a driving means configured to convert a drive force of a motor into a reciprocal movement via a crank mechanism and transmit this reciprocal movement to the piston, and a valve body having an intake valve and a discharge valve and mounted in the cylinder head.

[0003] In this PTL 1, at a position near a drive chamber (a crank chamber in this document) accommodating a crank mechanism, there is disposed a case; and in the cylinder wall, there is formed a discharge gas path for feeding discharge gas of a valve body to the interior space (a device chamber) of the case. The drive chamber and the interior space (the device chamber) of the case are communicated via a drive chamber side discharge port. And, the case forms a relief chamber side discharge port for discharging discharge gas present in the interior space into the atmosphere. With this, at the time of operation of the piston, the discharge gas is caused to flow through the discharge gas path, the crank chamber, the drive chamber side discharge port, the device chamber and the relief chamber side discharge port in this mentioned order, thus being discharged to the outside and variation in the pulsating pressure at the time of discharging is restricted, thus restricting gas discharging noise.

[0004] Further, as an example of a fluid pump, PTL 2 discloses a compressor (an air compressing mechanism) configured as follows. A piston is mounted inside a cylinder to be movable back and forth. A valve assembly is provided in a cylinder head at an upper portion of a cylinder. A crank case is disposed at a lower portion of the cylinder and a cross-slider crank mechanism as a crank mechanism mounted inside this crank case and the piston are operably coupled with each other via a piston rod.

[0005] According to an arrangement of this PTL 2, an air passage is formed in a support member provided at a lower portion of the cylinder. And, to this air passage, a sealed chamber is connected (the arrangement shown in Fig. 5 in the document). According to an alternative arrangement of the document, to the air passage above, an air filter is connected (the arrangement shown in Fig. 6, Fig. 9, etc. in the document). With these arrangements, when there occurs a drop in the pressure in the space

downwardly of the piston (the side opposite the cylinder head) in association with a movement of the piston, air of the chamber is sucked or the ambient air is sucked via the air filter (an air cleaner in the document). Conversely, when there occurs a rise in the pressure in the space downwardly of the piston, the air of this space is sent out to the sealed chamber or the air is discharged to the outside via the air filter. With these arrangements, reduction of the operational load is sought for and rise of temperature inside the cylinder is restricted.

CITATION LIST

PATENT LITERATURE

[0006]

PTL 1: Japanese Unexamined Patent Application Publication No. 2011-7118

PTL 2: Japanese Unexamined Patent Application Publication No. 10-266966

SUMMARY OF INVENTION

[0007] With a fluid pump configured to feed/discharge fluid to/from a space on the side of the piston head in association with piston movements, at the time of reciprocal movements of the piston, pressure variation occurs also in the drive chamber (the space in which the crank mechanism etc. are mounted) opposite the piston head. And, in case this drive space is configured as a sealed space, the pressure variation in the drive chamber acts as a "drive load" on the actuator.

[0008] In order to resolve the above inconvenience, it is conceivable to arrange such that feeding/discharging of fluid to/from the drive chamber is made possible from the outside, as described in PTL 1 or PTL 2. In particular, with the configuration of the vacuum pump disclosed in PTL 1, at the time of movement of the piston in the discharging direction, there occurs no waste in the flow of the fluid as the discharge air from the space on the side of the cylinder head is guided to the drive chamber. With the configuration of the compressor (air compressing mechanism) disclosed in PTL 2 (the configuration shown in Fig. 6, Fig. 9 of the document), there occurs no waste in the flow of the fluid as a portion of the fluid of the drive chamber is fed to the cylinder at the time of movement of the piston in the feeding direction. With use of these arrangements, the load on the motor driving the piston is alleviated.

[0009] However, in a fluid pump configured to feed/discharge fluid in association with piston movements, when fluid is sucked to the drive chamber which has reached a negative pressure state, if dust and/or moisture is/are contained in this fluid, this will invite operation failure of the drive system, and/or corrosion thereof. In this regard, there is room for improvement.

[0010] The object of the present invention is to config-

ure a fluid pump rationally which is capable of restricting suction of dust and/or moisture into the drive chamber while reducing the drive load through feeding/discharging of fluid to/from the drive chamber that drives a piston.

[0011] According to a characterizing feature of the present invention, a fluid pump comprises:

a cylinder;
a piston mounted inside the cylinder to be moved back and forth, the piston partitioning the inside of the cylinder between a pressure increasing/decreasing chamber on the side of the cylinder head and a drive chamber opposite the pressure increasing/decreasing chamber;
a valve unit having a control space for causing fluid of the pressure increasing/decreasing chamber to act on a pressurizing/depressurizing object and a feeding/discharging space for feeding/discharging fluid between the pressure increasing/decreasing chamber and the outside space, the valve unit being provided in the cylinder head so as to control flow of the fluid to the pressure increasing/decreasing chamber at the time of a reciprocal movement of the piston:

a ventilation path communicating the drive chamber and the outside space with each other;
a fluid path connected to the feeding/discharging space of the valve unit;
a merging space in which the fluid path is merged with the ventilation path midway; and
a fluid filter mounted in the merging space.

[0012] With the above-described arrangement, when the drive chamber reaches a negative pressure state as the piston is moved in the discharging direction, the fluid from the ventilation path is sucked to the drive chamber with the fluid being filtered through the fluid filter. Simultaneously, the fluid from the fluid path connected to the merging path is also sucked to the drive chamber. Conversely, when the drive chamber reaches a positive pressure state as the piston is moved in the sucking direction, the fluid from the drive chamber is sent from the ventilation path to the outside while being filtered through the fluid filter. Simultaneously, a portion of the fluid of the drive chamber is fed to the fluid path connected to the merging path.

[0013] As a result, there is realized a fluid pump capable of restricting suction of dust and/or moisture into the drive chamber while reducing the drive load through feeding/discharging of fluid to/from the drive chamber that drives a piston. In particular, with the above-described arrangement, at the time of movement of the piston, there would normally occur a feeding/discharging noise in association with variation in the pressure of the drive chamber. But, since the ventilation path and the fluid path are connected to this drive chamber, sharp variation in the air pressure of these spaces is restricted, so that noise

restriction effect is achieved.

[0014] In the present invention, preferably, the valve unit includes:

an intake valve disposed in the control space and configured to be opened only when the piston is operated in the sucking direction for sucking air as the fluid from a depressurizing object as the pressurizing/depressurizing object to the pressure increasing/decreasing chamber;
a discharge valve disposed in the feeding/discharging space and configured to be opened only when the piston is operated in the discharging direction for feeding air as the fluid to the pressure increasing/decreasing space; and
a discharging path as the fluid path for feeding air from the discharge valve to the merging space.

[0015] With the above-described arrangement, when the piston is operated in the sucking direction, air from the depressurizing object is sucked via the intake valve into the pressure increasing/decreasing chamber and also in association with rise in the pressure of the drive chamber, the air of the drive chamber is sent from the ventilation path to the outside space. Conversely, when the piston is operated in the discharging direction, the discharge valve is opened to feed the air of the pressure increasing/decreasing chamber to the discharge path as the fluid path. At the time of this operation, a negative pressure is developed in the drive chamber. So, the air of the outside space is sucked via the ventilation path into the drive chamber as being filtered through the fluid filter and also the air from the fluid path merged with this ventilation path is sucked into the drive chamber. That is, the air sucked from the outside space into the drive chamber is always filtered through the fluid filter, whereby dust and/or moisture will be removed therefrom. And, a portion of the air fed to the discharge path from the pressure increasing/decreasing chamber at the time of this sucking operation is sucked into the drive chamber via the merging space. Therefore, the load on the piston is reduced and at the same time the amount of air to be sucked from the outside space can be reduced.

[0016] In the present invention, preferably, the valve unit includes:

a discharge valve disposed in the control space and configured to be opened only when the piston is operated in the discharging direction for feeding air as the fluid from the pressure increasing/decreasing space to a pressurizing object as the pressurizing/depressurizing object;
an intake valve disposed in the feeding/discharging space and configured to be opened only when the piston is operated in the sucking direction for sucking air as the fluid to the pressure increasing/decreasing chamber; and
an intake path as the fluid path for feeding fluid

sucked via the fluid filter to the intake valve.

[0017] With the above-described arrangement, when the piston is operated in the sucking direction, the air of the outside space is fed, while being filtered through the fluid filter, from the merging space via the intake path as the fluid path to the pressure increasing/decreasing chamber and also the air of the drive chamber is fed from the ventilation path to the merging space, and a portion of this air fed to the merging space is fed to the intake path. Conversely, when the piston is operated in the discharging direction, air from the pressure increasing/decreasing chamber is fed via the discharge valve to a pressurizing object; and also since a negative pressure is developed in the drive chamber at the time of this operation, the air of the outside space is sucked into the drive chamber via the ventilation path while being filtered through the fluid filter and a portion of the air of the intake path is also sucked into the drive chamber.

[0018] In the present invention, preferably, the fluid pump includes a path block forming the merging space and an opening defined in a bottom wall of the path block for establishing communication between the interior space of the path block and the outside space; and an upper face of the bottom wall is formed with an inclined posture such that the upper face is positioned lower as it extends toward a position closer to the opening.

[0019] With the above arrangement, when water drops are formed inside the path block, these water drops will flow along the inclination of the upper face of the bottom wall to reach the opening, through which opening the water drops will be easily drained to the outside of the path block.

[0020] In the present invention, preferably, in an annular area surrounding the opening as its center, there are formed a plurality of vertical walls extending upward from the upper face of the bottom wall, the merging space is formed by the region surrounded by the vertical walls, and the fluid path and the ventilation path are communicated with each other outside the merging space.

[0021] With the above arrangement, the fluid filter can be easily disposed under a condition of its movement being restricted by the vertical walls, e.g. by inserting the fluid filter to the space surrounded by the vertical walls.

[0022] In the present invention, preferably, a tubular body may be provided to project downwards at a position on the side of the lower face of the bottom wall of the path block and surrounding the opening.

[0023] With the above arrangement, even when water drops adhere to the bottom wall of the path block, the tubular body will prevent occurrence of phenomenon of these water drops moving toward the opening. Hence, even when the water drops are frozen, this freezing will not interfere with the flow of fluid at the opening.

BRIEF DESCRIPTION OF DRAWINGS

[0024]

[Fig. 1] is a section view of a vacuum pump relating to a first embodiment,

[Fig. 2] is a perspective view showing a path block as seen from its upper face,

[Fig. 3] is a perspective view showing the path block as seen from its lower face,

[Fig. 4] is a side view in vertical section of the path block,

[Fig. 5] is a section view showing the positional relationship between a piston ring and a communication hole when the piston of the first embodiment is moved in the discharging direction and sucking direction, and

[Fig. 6] is a section view of a compressor relating to a second embodiment.

DESCRIPTION OF EMBODIMENTS

[0025] Next, a first embodiment will be explained with reference to the accompanying drawings.

[Basic Construction]

[0026] As shown in Fig. 1, a reciprocating type vacuum pump, as an example of a fluid pump, comprises a piston 2 mounted inside a cylinder 1 to be movable back and forth therein, a pressure increasing/decreasing chamber A formed on the side of a cylinder head relative to the piston 2, and a drive chamber B formed opposite the pressure increasing/decreasing chamber A relative to the piston 2 and accommodating a crank mechanism C for transmitting a drive force to the piston 2.

[0027] This vacuum pump is used as a negative pressure source for a brake booster (not shown) for an automobile. In operation, when the piston 2 is operated in a sucking direction (to the right-hand side in Fig. 1), a negative pressure is developed in the pressure increasing/decreasing chamber A. When the piston 2 is operated in a discharging direction (to the left-hand side in Fig. 1), air as a fluid is discharged from the pressure increasing/decreasing chamber A to the outside. Incidentally, the use of this vacuum pump is not limited for an automobile. This pump can be used in various devices that require a negative pressure and can be used with a gas other than air as the fluid.

[Specific Construction]

[0028] In this vacuum pump, as a valve unit V is disposed at one end (on the side of the cylinder head) of the cylinder 1, this valve unit V and the piston 2 delimit the pressure increasing/decreasing chamber A therebetween. Further, as a pump housing 3 is disposed at the other end of the cylinder 1, the interior space of this pump housing 3 forms the drive chamber B.

[0029] The pump housing 3 mounts an electric motor 4, and to a crank arm 5 rotatable together with an output shaft 4A of this electric motor 4, a base end of a connect-

ing rod 6 is connected. And, the piston 2 is operably connected to the leading end of this connecting rod 6. In this way, the crank mechanism C includes the crank arm 5 and the connecting rod 6. With this arrangement, the crank mechanism C converts the rotational drive force of the output shaft 4A of the electric motor 4 to a reciprocal operational force and transmits this force to the piston 2, whereby the piston 2 is moved back and forth, i.e. in reciprocation.

[0030] The drive chamber B is configured such that a space opened laterally in the pump housing 3 is closed by a plate-like closure member 7. This closure member 7 defines a ventilation opening 7A. A path block 15 having an interior space communicated with this ventilation opening 7A is mounted on the lower face of the closure member 7 on the outer side thereof. And, this path block 15 and the closure member 7 are fixedly connected to the pump housing 3 with a fastener bolt 8. Further, a tubular portion 16 communicated with the interior space of the path block 15 is provided in the form of a projection toward the valve unit V.

[0031] The valve unit V includes an intake valve 22 mounted at a position thereof communicated with a sucking space 21A (an example of "a control space") of a valve body 21 and a discharge valve 23 at a portion communicated with a discharging space 21 B (an example of "a feeding/discharging space") of this valve body 21. The valve unit V further includes a cover plate 24 for isolating the sucking space 21 A and the discharging space 21 B from the outside. To this cover plate 24, there is connected a tube 25 for applying a negative pressure to an external brake booster (an example of "a pressurizing/depressurizing object"). The intake valve 22 is formed of a material such as a resin which is flexibly deformable. In operation, when the flow of air is to be blocked, its rip portion at the outer perimeter is placed in tight contact with the valve body 21. When the flow of air is to be allowed, the rip portion will float off the valve body 21 to form a space for allowing the air flow. Further, the discharge valve 23 is configured to be urged by a spring 23S toward its closing direction. Then, when the air flow is to be blocked, with the urging force of the spring 23S, the outer perimeter of the valve 23 is placed into tight contact with the valve body 21. When the air flow is to be allowed, the outer perimeter will float off the valve body 21 against the urging force of the spring 23S to form a space for allowing the air flow. Incidentally, as the intake valve 22 and the discharge valve 23, a ball or poppet or the like which is urged by a spring toward the closing direction or a plate-like member operable with a hinge may be employed.

[0032] The valve body 21 includes a tubular projecting portion 26 communicated with the discharging space 21 B, with the projecting portion 26 projecting toward the pump housing 3. A tubular connecting pipe 9 is provided for interconnecting this projecting portion 26 and the tubular portion 16 under a mutually communicated state, and this connecting pipe 9 has one end thereof fitted on

the projecting portion 26 and the other end thereof fitted on the tubular portion 16.

[0033] The valve unit V is connected to the pump housing 3 in such a manner that the leading ends of connecting bolts 10 inserted to through holes of the valve body 21 and the cover plate 24 are threaded into female thread portions of the pump housing 3. This connection is done with a plurality of connecting bolts 10. At the time of this connection, the cylinder 1 will be bound between the valve unit V and the pump housing 3 and the connecting pipe 9 is bound between the valve unit V and the path block 15, whereby these components are united together.

[0034] A ventilation path F is formed to extend from the ventilation opening 7A through the interior space of the path block 15 to be communicated with an opening 15H defined in the outer face of the path block 15. A fluid path E, functioning as a discharge path, is formed to extend from the discharging space 21 B of the valve body 21 through the connecting pipe 9 to be communicated with the interior space of the path block 15. This fluid path E is merged in a merging space G formed at an intermediate position of the ventilation path F, and an air filter 17 (an example of "a fluid filter") is mounted in this merging space G.

[0035] This vacuum pump, as shown in Fig. 1, is designed to be used under a posture that the electric motor 4 is disposed at an upper portion and the path block 15 is disposed at the lower side. The path block 15, as shown in Figs. 2-4, is configured such that at an upper position of a block body having a circular bottom wall 15A and a tubular wall 15B continuous from the outer perimeter of the wall 15A, a laterally projecting flange body 15C is formed integral therewith. The flange body 15C defines bolt holes 15D in which fastener bolts 8 are to be inserted, and at a position surrounding the block body, there is formed a seal groove 15E for accommodating a seal 19.

[0036] At the center position of the bottom wall 15A, there is defined an opening 15H which establishes communication between the interior space of the path block 15 and the outside space. And, the upper face of this bottom wall 15A is formed with an inclined posture such that the upper face is positioned lower as it extends toward a position closer to the opening 15H. In the upper face of this bottom wall 15A and within an annular area surrounding the opening 15H, there are formed a plurality of vertical walls 15F rising from the bottom wall 15A and formed integral with the bottom wall 15A. Reinforcing ribs 15G interconnecting these plurality of vertical walls 15F and the bottom wall 15A are formed as extending radially about the opening 15H. Through the gaps formed between adjacent vertical walls 15F, water can be caused to flow along the inclination of the upper face of the bottom wall 15A. The dimension of the vertical wall 15F in the vertical direction is set shorter than the distance from the upper face of the flange body 15C of the path block 15 to the bottom wall 15A.

[0037] As shown in Fig. 3, on the lower face side of the

bottom wall 15A and at the position surrounding the opening 15H, there is formed a tubular body 15L formed integral with the bottom wall 15A, the tubular body 15L having a cylindrical form and projecting downwards. Rib bodies 15M interconnecting this tubular body 15L and the lower face of the bottom wall 15A are formed to extend radially about the opening 15H.

[0038] On the lateral wall of this path block 15, the tubular portion 16 mentioned above is formed. And, this tubular portion 16 is communicated with the interior space of the block body consisting of the bottom wall 15A and the cylindrical wall 15B. Further, an arrangement is provided such that when this path block 15 is connected to the closure member 7, the ventilation opening 7A defined in the closure member 7 is communicated with the interior space of the block body.

[0039] In particular, of the interior space of the path block 15, the space surrounded by the vertical walls 15F forms a filter space in which an air filter 17 is to be mounted and a hollow type silencer 18 is formed in the form of a doughnut shape surrounding this filter space. A silencer space constituting this silencer 18 and the filter space together form the merging space G. Incidentally, the filter space is formed midway in a ventilation path F on the outside air side (the side closer to the opening 15H than the filter space) of the merging space G. The silencer space constituting the silencer 18 and the filter space are formed between the outer wall of the closure member 7 and the inner wall of the path block 15. In the filter space, the air filter 17 is mounted as being placed in tight contact with the outer wall of the closure member 7 and the inner wall of the path block 15. This air filter 17 employs wool felt, paper material, urethane foam, etc. having dust removing property.

[0040] That is, the path block 15 has the interior space that constitutes the fluid path E, the ventilation path F and the merging space G, and also realizes dust removal and moisture removal by the air filter 17 as well as noise reduction by the silencer 18. Further, as the bottom wall 15A of the path block 15 is formed with an inclination, water drops formed inside or moisture removed by the air filter 17 are caused to flow toward the opening 15H along the inclination of the upper face of the bottom wall 15A to be drained through this opening 15H to the outside.

[0041] As the tubular body 15L projects from the lower face of the bottom wall 15A, even when water drop adhere to the lower face of the bottom wall 15A and freeze thereon, it is possible to avoid inconvenience of these water drops being frozen in the vicinity of the opening 15H, so that the ventilation condition of the opening 15H can be maintained favorably. Incidentally, the downward projection amount of the tubular body 15L is set smaller than the downward projection amount of the head of the fastener bolt 8, thereby to restrict damage to this tubular body 15L.

[Piston Ring]

[0042] As shown in Fig. 5, along the entire perimeter of the outer circumference of the piston 2, an annular groove 2G is formed and a piston ring 30 is fitted with a width narrower than the groove width of the annular groove 2G, with the ring 30 being displaceable within this annular groove 2G along the width direction (the operational direction of the piston 2). Further, in the outer circumference of the piston 2, a piston guide bush 31 is fitted. In the inner perimeter face of the cylinder 1, the piston ring 30 and the piston guide bush 31 are placed in contact with each other and the outer perimeters at the opposed ends of the piston 2 are placed out of contact with the inner perimeter face of the cylinder 1. The annular groove 2G includes a first lateral wall 2Ga on the side of the pressure increasing/decreasing chamber, a second lateral wall 2Gb on the side of the drive chamber, and a bottom wall 2Gc located therebetween and forming the bottom of the annular groove 2G. The piston ring 30 has a triple construction formed of an inner ring 30A, an intermediate ring 30B and an outer ring 30C superposed with each other.

[0043] The inner ring 30A is formed of stainless steel and defining a slit at the ring portion. The intermediate ring 30B and the outer ring 30C are formed of polytetrafluoroethylene resin and form a slit at the ring portion, respectively. Incidentally, the slits of the inner ring 30A, the intermediate ring 30B and the outer ring 30C do not differ from those ordinarily formed for facilitating extension of the inner diameter when being fitted in the annular groove 2G. Further, relative to the slit of the inner ring 30A, the position of the slit of the intermediate ring 30B is set with 180 degree angular difference, and relative to this position of the slit of the intermediate ring 30B, the slit of the outer ring 30C is set with 180 degree angular difference. With these arrangements, there is provided improvement in the sealing performance.

[0044] This piston ring 30 is subject to an urging force for increasing the radius of the inner ring 30A. And, with this urging force, the outer perimeter of the outer ring 30C is placed into contact with the inner perimeter face of the cylinder 1 and a gap is formed between the inner perimeter face of the inner ring 30A and the bottom wall 2Gc of the annular groove 2G.

[0045] A plurality of communication holes 2T are formed for establishing communication between the bottom wall 2Gc of the annular groove 2G and the interior of the piston 2. The communication holes 2T are communicated with the drive chamber B. And, when the piston 2 is operated in the sucking direction, as illustrated in Fig. 5 (b), the piston ring 30 is displaced toward the first lateral wall 2Ga to eventually come into contact with this first lateral wall 2Ga, thus blocking flow of air from the pressure increasing/decreasing chamber A toward the communication holes 2T. Conversely, when the piston 2 is operated in the discharging direction, as illustrated in Fig. 5 (a), this piston ring 30 is displaced toward

the second lateral wall 2Gb to eventually come into contact with this second lateral wall 2Gb, thus forming a gap between this piston ring 30 and the first lateral wall 2Ga; hence, the flow of air from the pressure increasing/decreasing chamber A toward the communication holes 2T is allowed.

[Operation Mode of First Embodiment]

[0046] With the above-described configuration, when the piston 2 is operated in the sucking direction, the piston ring 30 is displaced to the position in contact (gapless contact) with the first lateral wall 2Ga, thus blocking the flow of air from the pressure increasing/decreasing chamber A toward the drive chamber B. In response to this operation of the piston 2, the intake valve 22 is opened to suck the air from the tube 25 into the pressure increasing/decreasing chamber A to provide a negative pressure, whereby the air of the drive chamber B is fed via the ventilation opening 7A into the ventilation path F and discharged via the opening 15H to the outside of the pump.

[0047] Further, when the piston 2 is operated in the discharging direction, the discharge valve 23 is opened to send the air from the pressure increasing/decreasing chamber A to the fluid path E. Simultaneously with this, the piston ring 30 is displaced to the position in contact with the second lateral wall 2Gb, so that the air of the pressure increasing/decreasing chamber A is sent via the gap between the piston ring 30 and the first lateral wall 2Ga to the communication holes 2T. With this operation, the drive chamber B reaches a negative pressure condition. However, since the air is fed via the communication holes 2T into the drive chamber B, the degree of the negative pressure is low; hence, the amount of air drawn via the ventilation opening 7A into the drive chamber B is reduced. In particular, since the ventilation path F for feeding air to the communication opening 7A is merged with the fluid path E (discharge path) in the merging space G, it is possible to feed the air from the fluid path E (discharge path) to the ventilation path F. Hence, even when air is drawn into the drive chamber B under the negative pressure, the air of the fluid path E (discharge path) and the air drawn via the opening 15H will be mixed. As a result, the amount of ambient air to be drawn can be reduced. Incidentally, when air is sucked via the opening 15H, air filtered through the air filter 17 will be sucked. Hence, dust and/or moisture (water content) will be removed by the air filter 17 and will not enter the drive chamber B.

[0048] Moreover, when the piston 2 is operated in the discharging direction, the air of the pressure increasing/decreasing chamber A will flow directly into the drive chamber B via the communication holes 2T. Hence, this drive chamber B restricts build-up of negative pressure, thus reducing the drive load variation, whereby the drive torque of the electric motor 4 is rendered stable. Further, as the electric motor 4 is driven under a constant load,

there occurs no change in the power supplied to the electric motor 4. As a result, the durability of the electric motor 4 is improved. When the piston 2 is moved back and forth, there occur intermittent flows of the air of the fluid path E and the ventilation path F, and in association with pressure variation, noise will be generated. But, the silencer 18 reduces this noise.

[0049] Incidentally, in this first embodiment, it is possible to employ a simple arrangement of the piston ring 30 being provided in the piston 2, without forming the communication holes 2T in the piston 2.

[0050] Next, a second embodiment of the present invention will be described with reference to the accompanying drawings.

[Basic Construction]

[0051] As shown in Fig. 6, a reciprocating type compressor, as an example of a fluid pump, comprises a piston 2 mounted inside a cylinder 1 to be movable back and forth therein, a pressure increasing/decreasing chamber A formed on the side of the cylinder head relative to the piston 2, and a drive chamber B formed opposite the pressure increasing/decreasing chamber A relative to the piston 2 and accommodating a crank mechanism C for transmitting a drive force to the piston 2.

[0052] With this compressor in operation, when the piston 2 is operated in a sucking direction (to the right-hand side in Fig. 6), air as a fluid is sucked into the pressure increasing/decreasing chamber A. When the piston 2 is operated in an discharging direction (to the left-hand side in Fig. 1), compressed air as a fluid is discharged from the pressure increasing/decreasing chamber A to the outside. Incidentally, this compressor can be used for a gas other than air as the fluid.

[Specific Construction]

[0053] In this compressor, as compared with the first embodiment, the arrangement of the valve unit V differs and the compressor differs also in that the piston 2 does not have the communication holes 2T. The rest of the arrangement is identical to that of the first embodiment.

[0054] Namely, as the valve unit V is disposed at one end (the side of cylinder head) of the cylinder 1, a pressure increasing/decreasing chamber A is formed between this valve unit V and the piston 2. Further, as a pump housing 3 is disposed at the other end of the cylinder 1, a drive chamber B is formed by the interior space of this pump housing 3.

[0055] The pump housing 3 mounts an electric motor 4, and to a crank arm 5 rotatable together with an output shaft 4A of this electric motor 4, a base end of a connecting rod 6 is connected. And, the piston 2 is operably connected to the leading end of this connecting rod 6. In this way, the crank mechanism C includes the crank arm 5 and the connecting rod 6.

[0056] The drive chamber B is configured such that a

space opened laterally in the pump housing 3 is closed by a plate-like closure member 7. This closure member 7 defines a ventilation opening 7A. A path block 15 having an interior space communicated with this ventilation opening 7A is mounted on the outer side of the closure chamber 7. And, this path block 15 and the closure member 7 are fixedly connected to the pump housing 3 with a fastener bolt 8. Further, a tubular portion 16 communicated with the interior space of the path block 15 is provided in the form of a projection from the path block 15 toward the valve unit V.

[0057] The valve unit V includes an intake valve 22 mounted at a position thereof communicated with a sucking space 21A (an example of "a feeding/discharging space") of a valve body 21 and a discharge valve 23 at a portion communicated with a discharging space 21 B (an example of "a control space") of this valve body 21. The valve unit V further includes a cover plate 24 for isolating the sucking space 21 A and the discharging space 21 B from the outside. To this cover plate 24, there is connected a tube 25 for feeding compressed air from the pressure increasing/decreasing chamber A to an external pressurizing object (an example of "a pressurizing/depressurizing object"). The intake valve 22 is formed of a material such as rubber or a resin which is flexibly deformable. In operation, when the flow of air is to be blocked, its rip portion at the outer perimeter is placed in tight contact with the valve body 21. When the flow of air is to be allowed, the rip portion will float off the valve body 21 to form a space for allowing the air flow. Further, the discharge valve 23 is configured to be urged by a spring 23S toward its closing direction. Then, when the air flow is to be blocked, with the urging force of the spring 23S, the outer perimeter of the discharge valve 23 is placed into tight or gapless contact with the valve body 21. When the air flow is to be allowed, the outer perimeter will float off the valve body 21 against the urging force of the spring 23S to form a space for allowing the air flow.

[0058] The valve body 21 includes a tubular projecting portion 26 communicated with the sucking space 21A, with the projecting portion 26 projecting toward the pump housing 3. A tubular connecting pipe 9 is provided for interconnecting this projecting portion 26 and the tubular portion 16 under a mutually communicated state, and this connecting pipe 9 has one end thereof fitted on the projecting portion 26 and the other end thereof fitted on the tubular portion 16.

[0059] The valve unit V is connected to the pump housing 3 in such a manner that the leading ends of connecting bolts 10 inserted to through holes of the valve body 21 and the cover plate 24 are threaded into female thread portions of the pump housing 3. This connection is done with a plurality of connecting bolts 10. At the time of this connection, the cylinder 1 will be bound between the valve unit V and the pump housing 3 and the connecting pipe 9 is bound between the valve unit V and the path block 15, whereby these components are united together.

[0060] A ventilation path F is formed to extend from the ventilation opening 7A through the interior space of the path block 15 to be communicated with an opening 15H defined in the outer face of the path block 15. A fluid path E, functioning as an intake path, is formed to extend from the sucking space 21 A of the valve body 21 through the connecting pipe 9 to be communicated with the interior space of the path block 15. This fluid path E is merged in a merging space G formed at an intermediate position of the ventilation path F, and an air filter 17 (an example of "a fluid filter") is mounted in this merging space G.

[0061] In particular, of the interior space of the path block 15, the space surrounded by the vertical walls 15F forms a filter space in which the air filter 17 is to be mounted and a hollow type silencer 18 is formed in the form of a doughnut shape surrounding this filter space. A silencer space constituting this silencer 18 and the filter space together form the merging space G. Incidentally, the filter space is formed midway in a ventilation path F on the outside air side (the side closer to the opening 15H than the filter space) of the merging space G. The silencer space constituting the silencer 18 and the filter space are formed between the outer wall of the closure member 7 and the inner wall of the path block 15. In the filter space, the air filter 17 is mounted as being placed in tight contact with the outer wall of the closure member 7 and the inner wall of the path block 15. This air filter 17 employs wool felt, paper material, urethane foam, etc. having dust removing property.

[0062] Incidentally, like the first embodiment, the path block 15 has the interior space that constitutes the fluid path E, the ventilation path F and the merging space G, and also realizes dust removal and moisture removal by the air filter 17 as well as noise reduction by the silencer 18. Further, as the bottom wall 15A of the path block 15 is formed with an inclination, water drops formed inside or moisture removed by the air filter are caused to flow toward the opening 15H along the inclination of the upper face of the bottom wall 15A to be drained through this opening 15H to the outside.

[0063] Further, along the entire perimeter of the outer circumference of the piston 2, an annular groove is formed and a piston ring 30 is fitted therein. Though not shown in details, this piston ring 30 has a construction formed by superposing a plurality of rings from the inner side to the outer side. And, the outermost ring employs polytetrafluoroethylene resin. Along the outer perimeter of the piston 2, a piston guide bush 31 is fitted therein, and in the inner perimeter face of the cylinder 1, the piston ring 30 and the piston guide bush 31 are placed in contact with each other and the outer perimeters at the opposed ends of the piston 2 are out of contact with the inner perimeter face of the cylinder 1.

[Operation Mode of Second Embodiment]

[0064] With the above-described configuration, when the piston 2 is operated in the sucking direction, the intake

valve 22 is opened, whereby air of the external space is sucked through the opening 15H and filtered through the air filter 17 and then fed via the fluid path E (intake path) into the pressure increasing/decreasing chamber A. When this suction operation is effected, there occurs increase in the pressure of the drive chamber B. So that, the air of the drive chamber B is sent out to the ventilation path F and a portion of this air is merged in the merging space G (the filter space and the silencer space) and fed to the fluid path E. That is, when the piston 2 is operated in the sucking direction, ambient air and the air fed from the drive chamber B are merged in the merging space G and fed to the pressure increasing/decreasing chamber A.

[0065] Further, when the piston 2 is operated in the discharging direction (compressing direction), the discharge valve 23 is opened whereby the air from the pressure increasing/decreasing chamber A is fed to the tube 25. Simultaneously therewith, a negative pressure is developed in the drive chamber B. Thus, ambient air is fed via the opening 15H to the ventilation path F and sucked into the drive chamber B and also a portion of the air of the fluid path E is sucked as being merged in the merging space G. That is, when the piston 2 is operated in the discharging direction, the fluid path E is placed out of communication with the pressure increasing/decreasing chamber A, but when the drive chamber B reaches a negative pressure, air can be sent out like a chamber. Hence, the amount of air to be sucked from the outside space can be reduced. Further, since the ambient air to be sucked into the drive chamber B is always filtered through the air filter 17, dust and/or moisture (water content) are removed by the air filter 17 and will not enter the drive chamber B.

[0066] Further, at the time of operations of the piston 2, when the piston 2 is operated in the sucking direction, the air of the drive chamber B is sent out. When the piston 2 is operated in the discharging direction, the air is sucked into the drive chamber B. Therefore, the variation in the pressure of the drive chamber B can be restricted, so that the drive torque of the electric motor 4 is rendered stable. Further, as the electric motor 4 is driven under a constant load, there occurs no change in the power supplied to the electric motor 4. As a result, the durability of the electric motor 4 is improved. When the piston 2 is moved back and forth, there occur intermittent flows of the air of the fluid path E and the ventilation path F, and in association with pressure variation, noise will be generated. But, the silencer 18 reduces this noise.

INDUSTRIAL APPLICABILITY

[0067] The present invention may be used for fluid pumps in general that are configured such that a piston is operated inside a cylinder.

Claims

1. A fluid pump comprising:

a cylinder;
a piston mounted inside the cylinder to be moved back and forth, the piston partitioning the inside of the cylinder between a pressure increasing/decreasing chamber on the side of the cylinder head and a drive chamber opposite the pressure increasing/decreasing chamber;
a valve unit having a control space for causing fluid of the pressure increasing/decreasing chamber to act on a pressurizing/depressurizing object and a feeding/discharging space for feeding/discharging fluid between the pressure increasing/decreasing chamber and the outside space, the valve unit being provided in the cylinder head so as to control flow of the fluid to the pressure increasing/decreasing chamber at the time of a reciprocal movement of the piston:

a ventilation path communicating the drive chamber and the outside space with each other;
a fluid path connected to the feeding/discharging space of the valve unit;
a merging space in which the fluid path is merged with the ventilation path midway;
and
a fluid filter mounted in the merging space.

2. The fluid pump according to claim 1, wherein the valve unit includes:

an intake valve disposed in the control space and configured to be opened only when the piston is operated in the sucking direction for sucking air as the fluid from a depressurizing object as the pressurizing/depressurizing object to the pressure increasing/decreasing chamber;
a discharge valve disposed in the feeding/discharging space and configured to be opened only when the piston is operated in the discharging direction for feeding air as the fluid to the pressure increasing/decreasing space; and
a discharging path as the fluid path for feeding air from the discharge valve to the merging space.

3. The fluid pump according to claim 1, wherein the valve unit includes:

a discharge valve disposed in the control space and configured to be opened only when the piston is operated in the discharging direction for feeding air as the fluid from the pressure increasing/decreasing space to a pressurizing object

- as the pressurizing/depressurizing object;
 an intake valve disposed in the feeding/dis-
 charging space and configured to be opened on-
 ly when the piston is operated in the sucking
 direction for sucking air as the fluid to the pres-
 sure increasing/decreasing chamber; and
 an intake path as the fluid path for feeding fluid
 sucked via the fluid filter to the intake valve. 5
4. The fluid pump according to any one of claims 1-3, 10
 further comprising:
- a path block forming the merging space and an
 opening defined in a bottom wall of the path
 block for establishing communication between
 the interior space of the path block and the out-
 side space; and 15
- wherein an upper face of the bottom wall is
 formed with an inclined posture such that the
 upper face is positioned lower as it extends to-
 ward a position closer to the opening. 20
5. The fluid pump according to claim 4, wherein in an
 annular area surrounding the opening as its center,
 there are formed a plurality of vertical walls extending 25
 upward from the upper face of the bottom wall,
 the merging space is formed by the region surround-
 ed by the vertical walls, and
 the fluid path and the ventilation path are communi-
 cated with each other outside the merging space. 30
6. The fluid pump according to claim 4 or 5, wherein a
 tubular body is provided to project downwards at a
 position on the side of the lower face of the bottom
 wall of the path block and surrounding the opening. 35

Amended claims under Art. 19.1 PCT

1. (Currently Amended) A fluid pump comprising: 40
- a cylinder;
 a piston mounted inside the cylinder to be moved
 back and forth, the piston partitioning the inside
 of the cylinder between a pressure increas- 45
 ing/decreasing chamber on the side of the cyl-
 inder head and a drive chamber opposite the
 pressure increasing/decreasing chamber;
 a valve unit having a control space for causing
 fluid of the pressure increasing/decreasing 50
 chamber to act on a pressurizing/depressurizing
 object and a feeding/discharging space for feed-
 ing/discharging fluid between the pressure in-
 creasing/decreasing chamber and the outside
 space, the valve unit being provided in the cyl- 55
 inder head so as to control flow of the fluid to
 the pressure increasing/decreasing chamber at
 the time of a reciprocal movement of the piston:

a path block mounted to the cylinder;
 a ventilation path communicating the drive
 chamber and the outside space with each
 other via the path block;
 a fluid path connected to the feeding/dis-
 charging space and the path block so as to
 be merged with the ventilation path in a
 merging space inside the path block;
 a fluid filter mounted in the merging space;
 and
 an opening defined in a bottom wall of the
 path block for establishing communication
 between the interior space of the path block
 and the outside space; and
 wherein an upper face of the bottom wall is
 formed with an inclined posture such that
 the upper face is positioned lower as it ex-
 tends toward a position closer to the open-
 ing.

2. The fluid pump according to claim 1, wherein the
 valve unit includes:

an intake valve disposed in the control space
 and configured to be opened only when the pis-
 ton is operated in the sucking direction for suck-
 ing air as the fluid from a depressurizing object
 as the pressurizing/depressurizing object to the
 pressure increasing/decreasing chamber;
 a discharge valve disposed in the feeding/dis-
 charging space and configured to be opened on-
 ly when the piston is operated in the discharging
 direction for feeding air as the fluid to the pres-
 sure increasing/decreasing space; and
 a discharging path as the fluid path for feeding
 air from the discharge valve to the merging
 space.

3. The fluid pump according to claim 1, wherein the
 valve unit includes:

a discharge valve disposed in the control space
 and configured to be opened only when the pis-
 ton is operated in the discharging direction for
 feeding air as the fluid from the pressure increas-
 ing/decreasing space to a pressurizing object
 as the pressurizing/depressurizing object;
 an intake valve disposed in the feeding/dis-
 charging space and configured to be opened on-
 ly when the piston is operated in the sucking
 direction for sucking air as the fluid to the pres-
 sure increasing/decreasing chamber; and
 an intake path as the fluid path for feeding fluid
 sucked via the fluid filter to the intake valve.

4. (Currently Canceled)

5. (Currently Amended) The fluid pump according to

any one of claims 1-3, wherein in an annular area surrounding the opening as its center, there are formed a plurality of vertical walls extending upward from the upper face of the bottom wall, the merging space is formed by the region surrounded by the vertical walls, and the fluid path and the ventilation path are communicated with each other outside the merging space.

6. (Currently Amended) The fluid pump according to any one of claims 1-3 and 5, wherein a tubular body is provided to project downwards at a position on the side of the lower face of the bottom wall of the path block and surrounding the opening.

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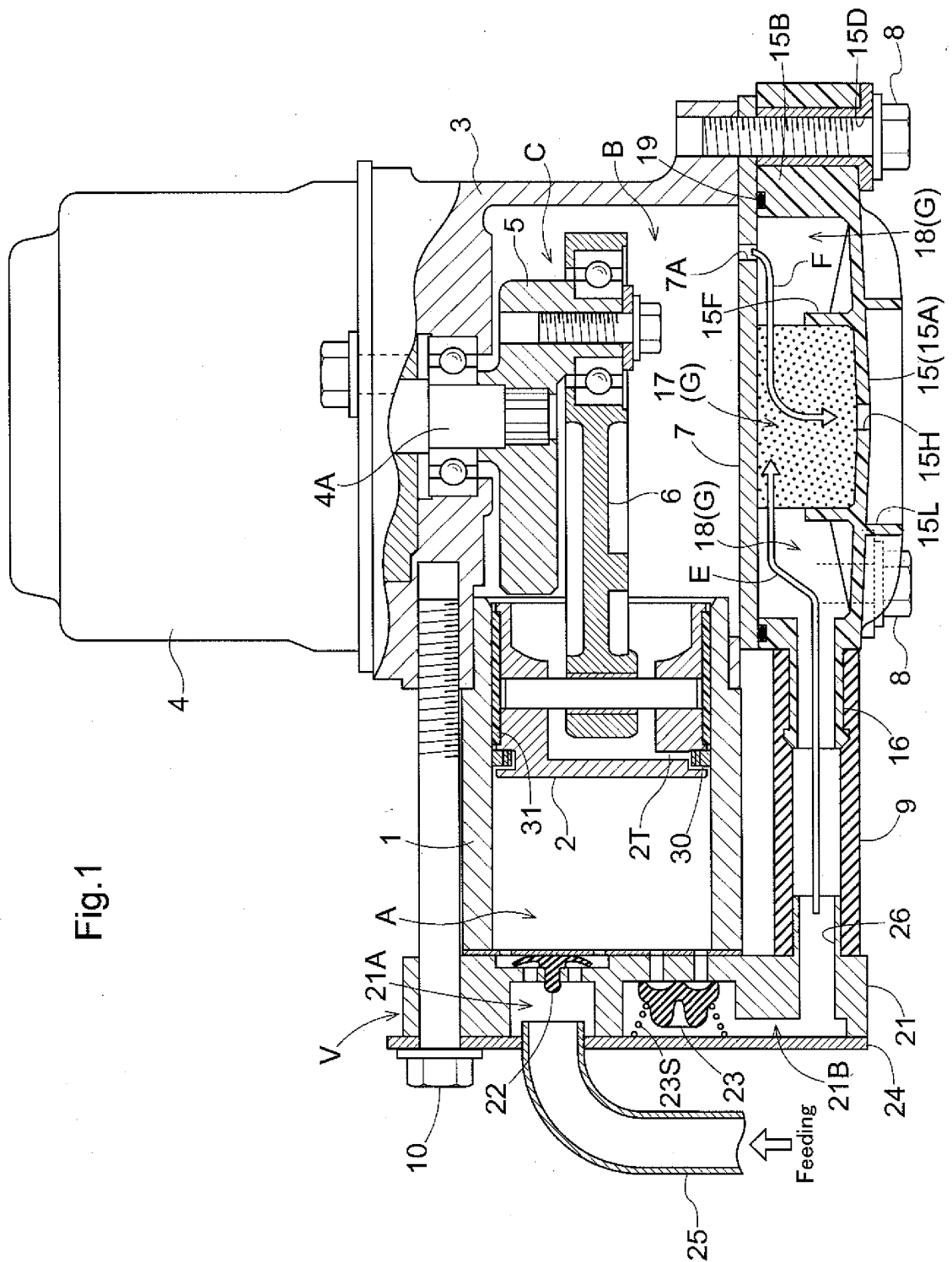


Fig.1

Fig.2

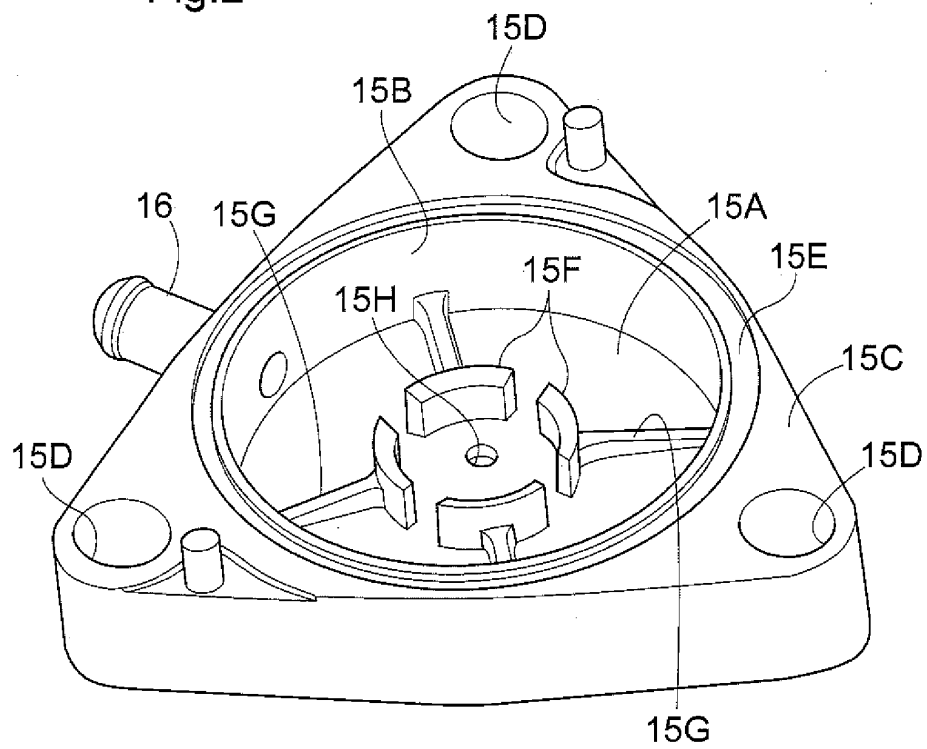


Fig.3

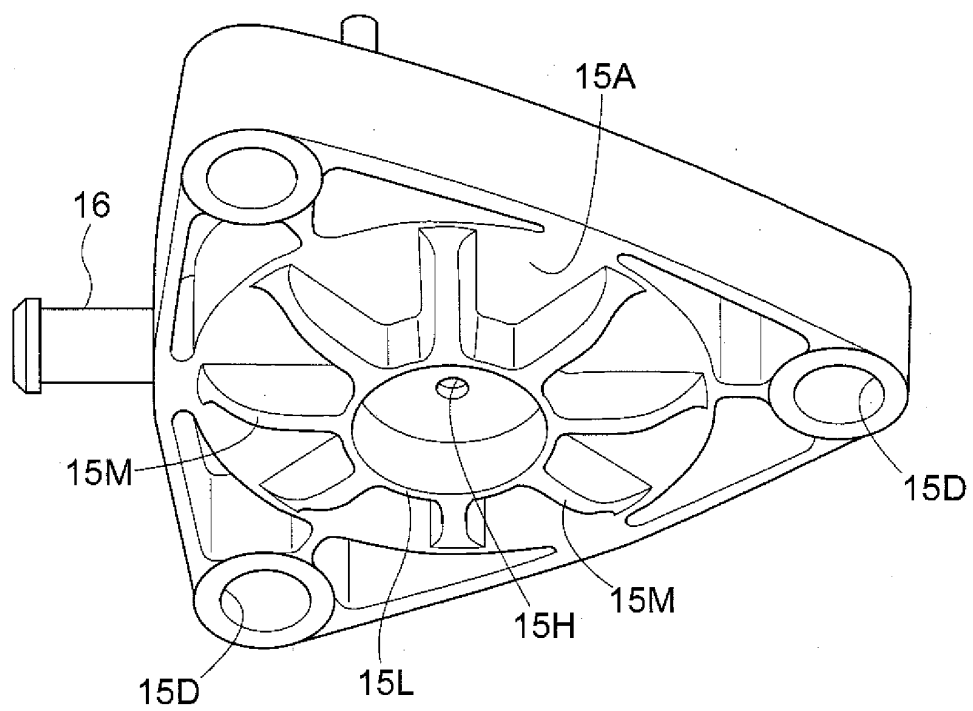


Fig.4

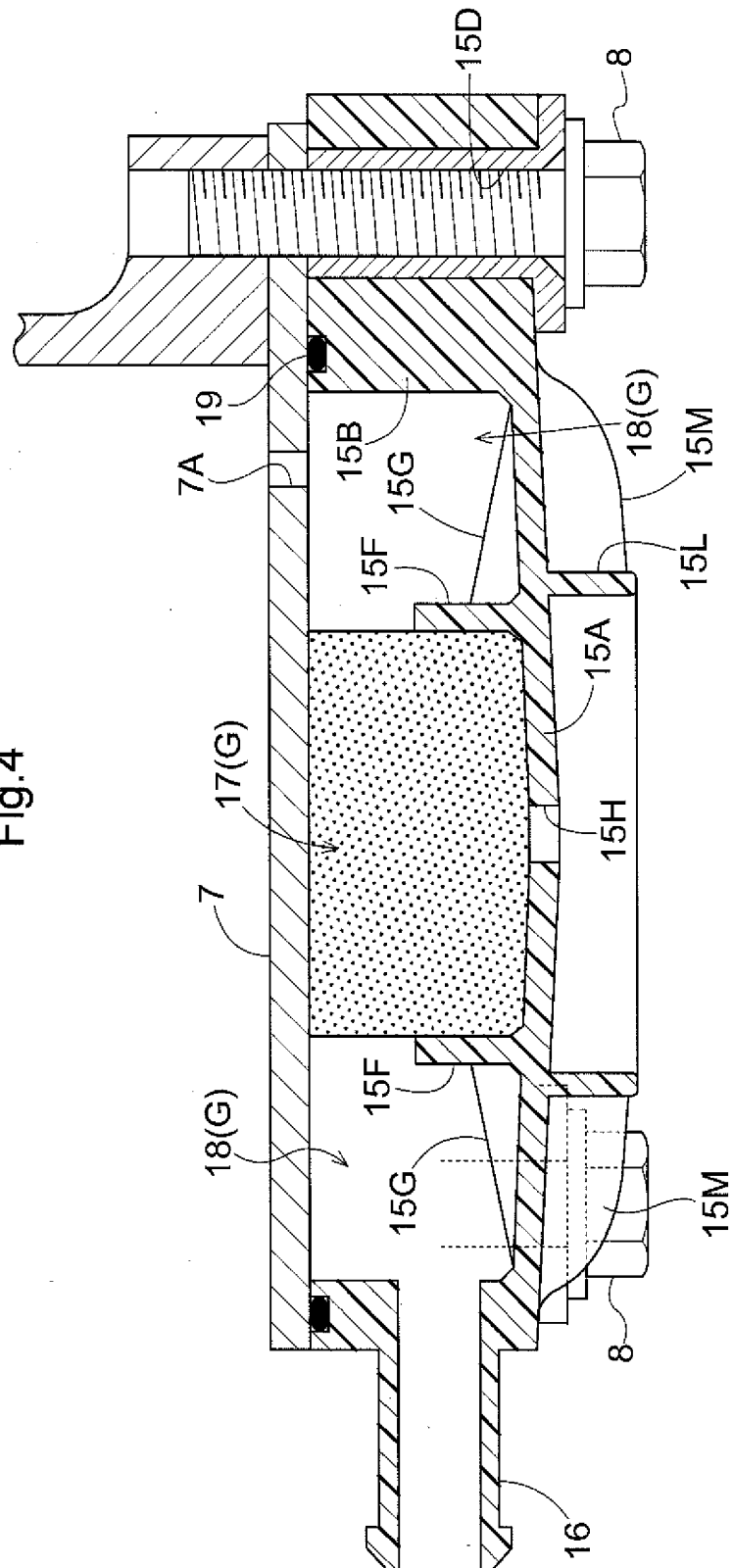


Fig.5A

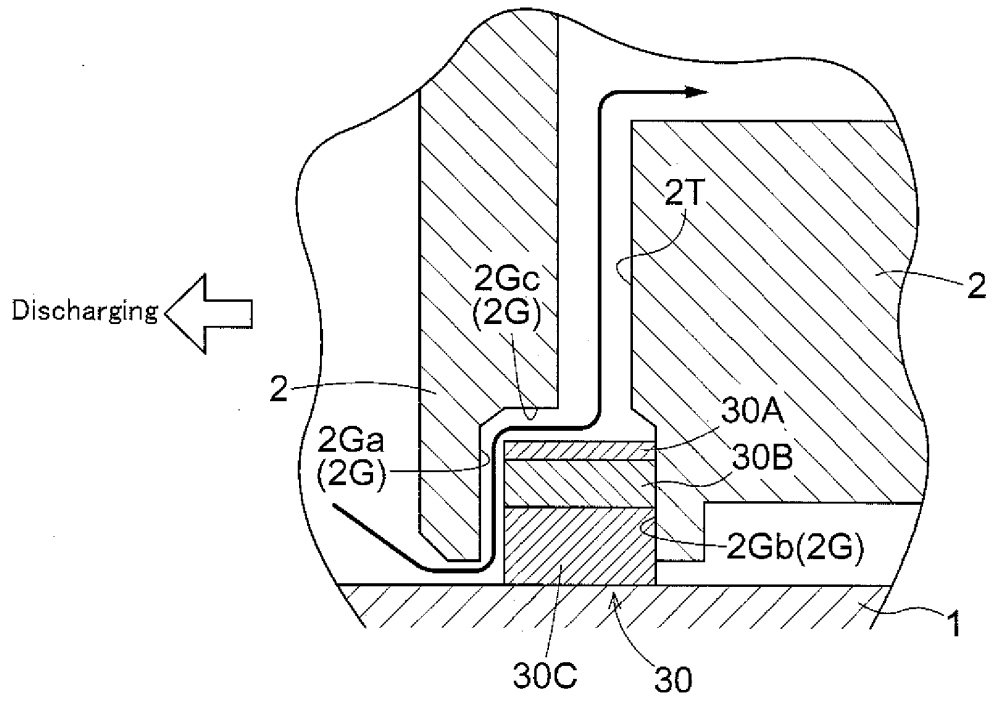
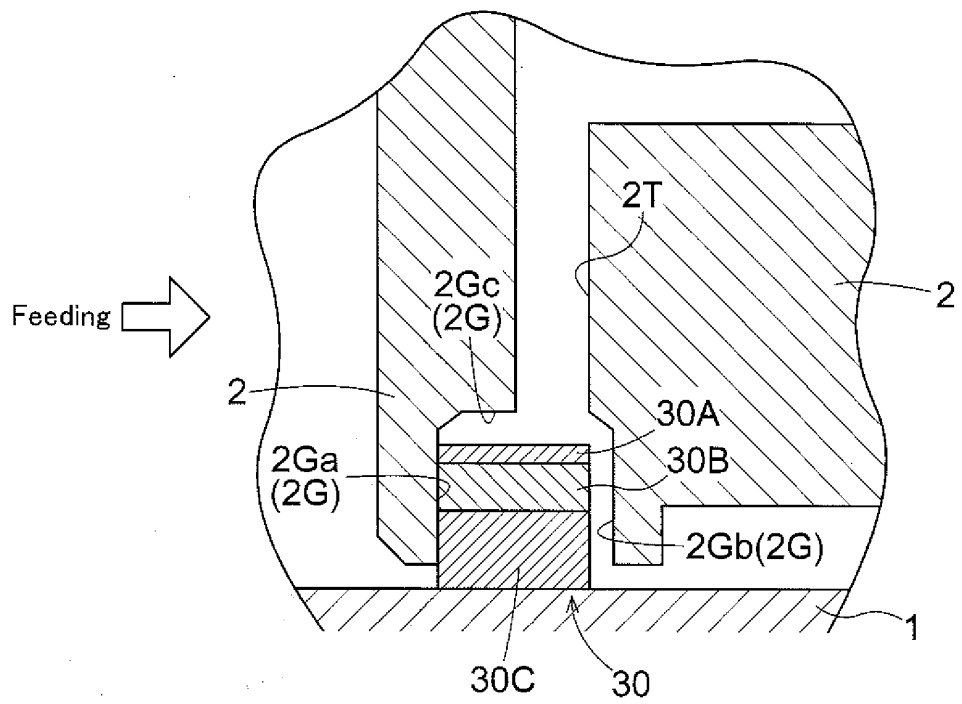
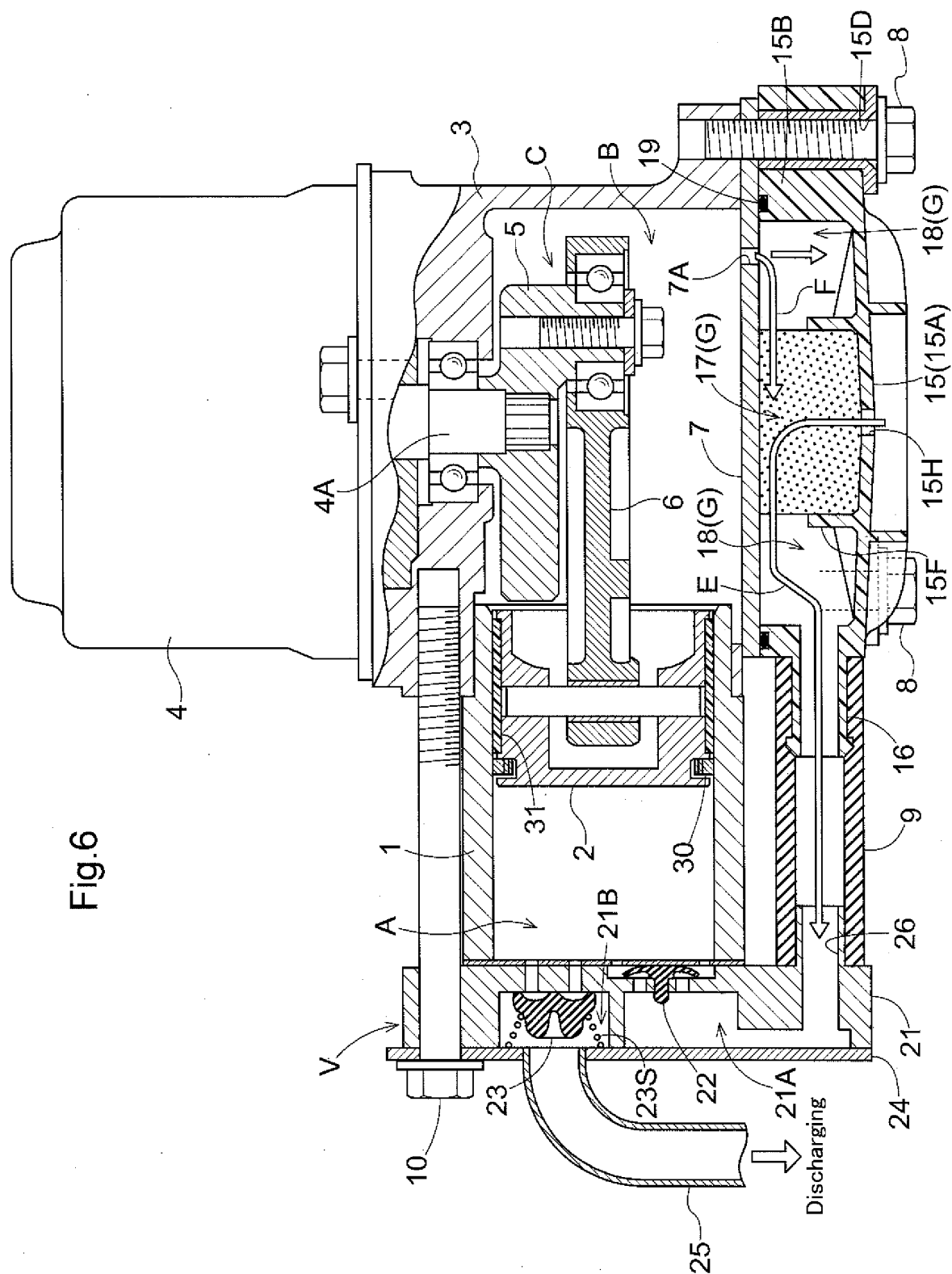


Fig.5B





INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/064173

A. CLASSIFICATION OF SUBJECT MATTER

F04B39/12 (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)

F04B39/12

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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.
X A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 84688/1979 (Laid-open No. 4693/1981) (Tokico, Ltd.), 16 January 1981 (16.01.1981), entire text; all drawings (Family: none)	1-2 3-6
X A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 101477/1991 (Laid-open No. 47375/1993) (Kioritz Corp.), 22 June 1993 (22.06.1993), entire text; all drawings (Family: none)	1, 3 2, 4-6

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
13 August, 2012 (13.08.12)Date of mailing of the international search report
21 August, 2012 (21.08.12)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/064173

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Since the documents 1 and 2 disclose the configuration of the invention of claim 1, the invention of claim 1 cannot be considered to be novel in the light of the inventions disclosed in the documents 1 and 2 and does not have a special technical feature.

Consequently, claim 1 and claims 2-6 do not comply with the requirement of unity.

As a result of judging special technical features with respect to claims dependent on claim 1, it is considered that two inventions linked by respective special technical features indicated below are involved.

(Continued to extra sheet)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/064173

Continuation of Box No.III of continuation of first sheet(2)

Meanwhile, the invention of claim 1 having no special technical feature is classified into invention 1.

(Invention 1) claims 1-2 and 4-6

(Invention 2) claims 3-6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2011007118 A [0006]
- JP 10266966 A [0006]