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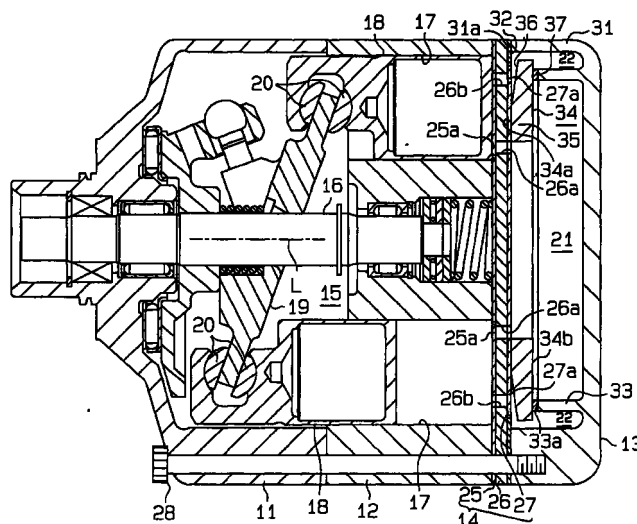
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(54) **Swash plate compressor**

(57) A compressor has a cylinder block (12) and rear housing (13) fixed to the cylinder block. The cylinder block has a plurality of cylinder bores (17) arranged along a first phantom circle about an axis (L) of a drive shaft (16) supported by the cylinder block. Each of the cylinder bore has a piston (18) movably disposed therein. A partition (33) is formed within the rear housing to define a discharge chamber (21) and a suction chamber (22) in the rear housing. A valve plate (14) is interposed between the chambers and the cylinder bores to selectively connect and disconnect the chambers with the cylinder bores. A separator (34) is located between an end of the partition and the valve plate to urge the valve plate against the cylinder block on a second phantom circle about the axis of the drive shaft in such a manner as to maintain selectively connecting and disconnecting the chambers with the cylinder bores.

**Fig.1**



**EP 1 072 792 A2**

**Description****BACKGROUND OF THE INVENTION**

[0001] The present invention relates to a piston-type compressor for air-conditioning vehicles.

[0002] Fig. 8 shows this type of compressor. A front housing member 101 is joined to the front (left in Fig. 8) of a cylinder block 102. A rear housing member 103 is joined to the rear of the cylinder block 102 through a valve plate 104. A drive shaft 105 is supported by the front housing member 101 and the cylinder block 102. Several cylinder bores 106 are formed in the cylinder block 102. The cylinder bores 106 are equally spaced from the axis L of the drive shaft 105 at equal angular intervals. Pistons 107 are located in the corresponding cylinder bores 106.

[0003] An annular partition wall 108 is formed in the rear housing member 103 and is centered on the axis L. The end surface 108a of the partition wall 108 contacts the valve plate 104. A suction chamber 109 is formed inside the partition wall 108, and a discharge chamber 110 is formed outside the partition wall 108. The valve plate 104 includes suction ports 104a, suction valves 104b, discharge ports 104c, and discharge valves 104d.

[0004] Rotation of the drive shaft 105 is converted into reciprocation of the pistons 107. During the rotation of the pistons 107, refrigerant gas is drawn from the suction chamber 109 to the cylinder bores 106 through the corresponding suction ports 104a and suction valves 104b. The refrigerant gas in the cylinder bores 106 is compressed and discharged to the discharge chamber 110 through the corresponding discharge ports 104c and discharge valves 104d. The cycle of drawing, compressing, and discharging gas is repeated.

[0005] However, the partition wall must directly contact the valve plate 104 to separate the discharge chamber 110 from the suction chamber 109. This limits the shape and size of the partition wall 108, which reduces flexibility in determining the ratio between the volume of suction chamber 109 and that of the discharge chamber 110.

[0006] Further, the partition wall 108 presses a base portion of each discharge valve 104d such that the function of each discharge valve 104d, which is a reed valve, is stable. Accordingly, the shape and size of the partition wall 108 must be formed such that the discharge valves 104d are pressed properly. This also limits the flexibility in determining the ratio of the volume of the suction chamber 109 to that of the discharge chamber 110.

[0007] The pressure pulsation of refrigerant gas causes noise and vibration in the compressor and the pipes of an external refrigerant circuit. In the prior art compressor of Fig. 8, it is necessary to increase the size of the suction chamber 109 and the discharge chamber 110 to attenuate the pressure pulsation. This increases the size of the compressor housing and the compressor.

[0008] Since the space for accommodating the compressor is limited, the compressor must not be enlarged.

**SUMMARY OF THE INVENTION**

[0009] An objective of the present invention is to provide a piston-type compressor that has flexibility in determining the ratio between the volume of a suction chamber and that of a discharge chamber in order to efficiently attenuate the pressure pulsation of refrigerant gas without increasing the size of the compressor.

[0010] To achieve the above objective, the present invention provides a compressor with a cylinder block and rear housing fixed to the cylinder block. The cylinder block has a plurality of cylinder bores arranged along a first phantom circle about an axis of a drive shaft supported by the cylinder block. Each of the cylinder bore has a piston movably disposed therein. A partition is formed within the rear housing to define a discharge chamber and a suction chamber in the rear housing. A valve plate is interposed between the chambers and the cylinder bore to selectively connect and disconnect the chambers with the cylinder bore. A separator is located between an end of the partition and the valve plate to urge the valve plate against the cylinder block on a second phantom circle about the axis of the drive shaft in such a manner as to maintain selectively connecting and disconnecting the chambers with the cylinder bore.

[0011] Other aspects and advantages of the present invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0012] The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a cross-sectional view showing a piston-type compressor according to a first embodiment of the present invention;

Fig. 2 is a partial enlarged cross-sectional view of the compressor of Fig. 1;

Fig. 3 is a partial enlarged cross-sectional view showing a piston-type compressor according to a second embodiment;

Fig. 4 is a partial enlarged cross-sectional view showing a piston-type compressor according to a

third embodiment;

Fig. 5 is a partial enlarged cross-sectional view showing a piston-type compressor according to a further embodiment;

Fig. 6 is a partial enlarged cross-sectional view showing a piston-type compressor according to a further embodiment;

Fig. 7 is a partial enlarged cross-sectional view showing a piston-type compressor according to a further embodiment; and

Fig. 8 is a cross-sectional view showing a prior art piston-type compressor.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0013]** A single-headed-piston compressor for air-conditioning vehicles according to a first embodiment of the present invention will now be described.

**[0014]** As shown in Fig. 1, a front housing member 11 is joined to the front of a cylinder block 12. A rear housing member 13 is joined to the rear of the cylinder block 12 through a valve plate 14. The front housing member 11, the cylinder block 12, and the rear housing member 13 are fastened by bolts 28 and form a compressor housing. The housing members 11, 12, 13 are formed by forging or casting using metal materials such as aluminum or iron.

**[0015]** A crank chamber 15 is formed between the front housing member 11 and the cylinder block 12. A drive shaft 16, which passes through the crank chamber 15, is supported by the front housing member 11 and the cylinder block 12. The drive shaft 16 is connected to and is driven by an external drive source such as an engine (not shown).

**[0016]** Cylinder bores 17 (two shown) are formed in the cylinder block 12. The cylinder bores 17 are equally spaced from the axis L of the drive shaft 16 at equal angular intervals. Single-headed pistons 18 (two shown) are located in the corresponding cylinder bores 17. A space for compressing refrigerant gas is defined in each cylinder bore 17 by the corresponding piston 17 and the valve plate 14.

**[0017]** A swash plate 19 is supported by the drive shaft 16 in the crank chamber 15 to rotate with the drive shaft 16. The pistons 18 are coupled to the periphery of the swash plate 19 through shoes 20. Rotation of the drive shaft 16 is converted into reciprocation of the pistons 18 through the swash plate 19 and the shoes 20.

**[0018]** A discharge chamber 22 is formed in the rear housing member 13 to surround a suction chamber 21. The suction chamber 21 is connected to the discharge chamber 22 by an external refrigerant circuit, which includes a condenser, an expansion valve, and

an evaporator (not shown). The external refrigerant circuit and the compressor form a refrigeration circuit for air-conditioning vehicles.

**[0019]** The valve plate 14 includes a suction valve plate 25, a port plate 26, and a discharge valve plate 27. Suction ports 26a, which are formed in the port plate 26, connect the corresponding cylinder bores 17 with the suction chamber 21. Suction valves 25a, which are reed valves, are formed in the suction valve plate 25. The suction valves 25a open and close the corresponding suction ports 26a. Discharge ports 26b are formed in the port plate 26 outward of the suction ports 26a. The discharge ports 26b connect the corresponding cylinder bores 17 with the discharge chamber 22. Discharge valves 27a, which are reed valves, are formed in the discharge valve plate 27. The discharge valves 27a open and close the corresponding discharge ports 26b.

**[0020]** When the pistons 18 reciprocate, refrigerant gas from the suction chamber 21 is drawn to the cylinder bores 17 through the corresponding suction ports 26a and suction valves 25a. The refrigerant gas in the cylinder bores 17 is compressed and discharged to the discharge chamber 22 through the corresponding discharge ports 26b and discharge valves 27a. The cycle of drawing, compressing, and discharging is repeated.

**[0021]** As shown in Figs. 1 and 2, the rear end of the rear housing member 13 is closed. The front end 31a of the rear housing member 13 is joined to the rear end of the cylinder block 12 through a gasket 32 and the valve plate 14 by the bolts 28.

**[0022]** An annular partition 33 is integrally formed in the rear housing member 13 inward of the peripheral wall 31. The partition 33, which projects frontward, is shorter than the peripheral wall 31. Accordingly, inner and outer chambers are formed in the rear housing 13.

**[0023]** The compressor includes a separator 34, which is an annular metal plate. The separator 34 includes a tapered retainer 36, which is formed on a front surface 34a, and an offset portion 35, which is radially inward of the tapered retainer 36.

**[0024]** The separator 34 is located between the front surface 33a of the partition 33 and the rear surface of the valve plate 14 (or discharge valve plate 27). The annular partition 33 is centered on the axis L, and its front surface 33a contacts the rear surface 34b of the separator 34. The gasket 37 is located between the front surface 33a of the partition 33 and the rear surface 34b of the separator 34. The location of contact between the offset portion 35 and the valve plate 14 (or discharge valve plate 27) is inward of the location of contact between the offset portion 35 and the partition 33. The maximum opening size of each discharge valve 27a is limited by the retainer 36 as shown by the broken line in Fig. 2.

**[0025]** The inner chamber of the rear housing member 13 is closed by the separator 34 and the valve plate 14, which forms the suction chamber 21. The outer chamber of the rear housing member 13 is closed by

the valve plate 14 and the separator 34, which forms the discharge chamber 22. The discharge chamber 22 is separated from the suction chamber 21.

**[0026]** The partition 33 contacts the separator 34 outward of the offset portion 35. In the prior art of Fig. 8, the partition 108 directly contacts the valve plate 104. However, in the embodiment of Fig. 1, if the partition 33 were to extend axially to the valve plate 14, the discharge valves 27a would not be properly supported, and the suction ports 26a would not completely be separated from the discharge ports 26b.

**[0027]** However, since the separator 34 is sandwiched between the partition 33 and the valve plate 14 to urge the valve plate 14 in the present invention, the partition 33 is sealed to the valve plate 14 through the offset portion 35 at a location that is like that of the prior art. Accordingly, the offset portion 35 properly separates the suction ports 26a from the discharge ports 26b and properly supports the proximal portion of each discharge valve 27a.

**[0028]** If the separator 34 were integrally formed with the partition 33, there would be no need to place the independent separator 34 and the gasket 37 between the partition 33 and the valve plate 14. However, the complicated shape of the partition 33 makes it hard to detach the rear housing 13 from a mold when forging or casting. Accordingly, it is necessary to choose the shape of the partition 33 to facilitate forging or casting. Therefore, it is preferred that the separator 34 be independent from the partition 33.

**[0029]** In the present embodiment, the offset portion 35 of the separator 34 contacts the valve plate 14 to separate the suction ports 26a from the discharge ports 26b. Accordingly, the shape and size of the partition 33 is arbitrarily determined as long as the partition contacts the rear surface of the separator 34 and the suction chamber 21 is separated from the discharge chamber 22. This increases the design flexibility of the suction chamber 21 and the discharge chamber 22. That is, the ratio between the volume of the suction chamber 21 and that of the discharge chamber 22 can be freely determined regardless of the positions of the ports 104a, 104c and the discharge valves 104d.

**[0030]** The separator 34 includes the retainer 36, which determines the maximum opening size of the discharge valves 27. Accordingly, there is no need for an independent retainer, which reduces the number of parts. The retainer 36 is a tapered surface that limits the movement of each flexible discharge valve 27a. Accordingly, the discharge valves 27a are entirely supported by the retainer 36, which prevents concentration of stress and improves durability.

**[0031]** A gasket 37, made of metal plate covered with the elastic material, is located between the partition 33 and the separator 34, which are made of metallic materials. Accordingly, the partition 33 and the separator 34 are firmly joined, which effectively separates the suction chamber 21 from the discharge chamber 22.

The gasket also prevents the partition 33 from scratching the separator 34.

**[0032]** A second embodiment of the present invention will now be described.

**[0033]** To avoid a redundant description, like or same reference numerals are given to those components that are the same as the corresponding components of the first embodiment.

**[0034]** As shown in Fig. 3, the separator 34 is disc-shaped. In the first embodiment, the separator 34 is annular so that the suction chamber 21 is connected with the suction ports 26a by the center hole. In the second embodiment, the separator 34 includes through holes 41 corresponding to the suction ports 26a. The through holes 41 connect the suction chamber 21 with the suction ports 26a.

**[0035]** The central part of the separator 34 is fastened to the center of the valve plate 14 by a bolt and nut 42. Accordingly, the separator 34 is firmly joined to the valve plate 14 regardless of the pressing force between the partition 33 and the cylinder block 12. This assures stable operation of the discharge valves 27a and prevents leakage of refrigerant gas between the separator 34 and the valve plate 14. The plates 25-27 are also firmly held together, which prevents leakage of gas between them.

**[0036]** A third embodiment of the present invention, which is shown in Fig. 4, will now be described. The third embodiment permits axial variation of the position of the rear housing member 13. As shown in Fig. 2, in the first embodiment, the peripheral wall 31 is joined to the cylinder block 12 through the gasket 32 and the valve plate 14. Since the gasket 32 and the valve plate 14 have almost no elasticity in the axial direction, they do not permit the location of the front end 31a of the peripheral wall 31 to vary significantly against the rear end of the cylinder block 12.

**[0037]** Suppose that there are dimensional errors in the peripheral wall 31 and the partition 33. If the difference between the axial length of the peripheral wall 31 and that of the partition 33 is greater than a predetermined value, the separator 34 and the valve plate 14 will not be firmly pressed between the partition 33 and the cylinder block 12, the discharge valves 27a may not properly function, and refrigerant gas may leak between the plates 25-27 of the valve plate 14.

**[0038]** In contrast, if the difference between the axial length of the peripheral wall 31 and that of the partition 33 is smaller than a predetermined value, the separator 34 and the valve plate 14 will be pressed between the partition 33 and the cylinder block 12 with too much force, which may deform the separator 34 and the valve plate 14. It would be necessary to increase the thickness of the separator 34 and the valve plate 14 to prevent them from being deformed. This increases the weight of the compressor and also reduces the volumes of the suction chamber 21 and the discharge chamber 22.

[0039] As shown in Fig. 4, a resin elastic seal, which is an O-ring 45 made of elastic material, such as rubber, is located between the peripheral wall 31 and the cylinder block 12, instead of the gasket 32. The space between the peripheral wall 31 and the cylinder block 12 varies by the deformation of the O-ring 45. Accordingly, the dimensional errors of the peripheral wall 31 and the partition 33 in the axial direction are compensated for by the deformation of the O-ring 45. As a result, the separator 34 and the valve plate 14 are properly pressed between the partition 33 and the cylinder block 12, which solves the above mentioned problems and extends the life of the valve plate 14.

[0040] The present invention can further be embodied as follows.

[0041] As shown in Fig. 5, the radius of the partition 33 of the first embodiment may be smaller, which increases the volume of the discharge chamber 22 without increasing the size of the rear housing member 13.

[0042] As shown in Fig. 6, the retainer 36 may be omitted from the separator 34, and a separable retainer 51 may be located on the valve plate 14. In this case, the separator 34 is formed such that the retainer 51 does not interfere with the periphery of the separator 34. That is, the offset portion 35 extends toward the valve plate 14.

[0043] As shown in Fig. 7, if the partition 33 of Fig. 6 has a relatively small radius, the separator 34 can be simply formed as a cylinder. In other words, only the offset portion 35 of Fig. 6 forms the separator 34. The radial thickness of the offset portion 35 is such that there is flexibility in designing the volumes of the suction chamber 21 and the discharge chamber 22 in the rear housing 13.

[0044] In the above embodiments, the suction chamber 21 is located inward of the discharge chamber 22 in the rear housing member 13. However, the suction chamber 21 may be located outward of the discharge chamber 22 in the rear housing member 13.

[0045] The present invention can also be embodied in a double-headed piston compressor. That is, a separator according to the present invention may be located between the partition and the valve plate at least in one of the rear or front side of the suction chamber and discharge chamber.

[0046] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

[0047] A compressor has a cylinder block (12) and rear housing (13) fixed to the cylinder block. The cylinder block has a plurality of cylinder bores (17) arranged along a first phantom circle about an axis (L) of a drive shaft (16) supported by the cylinder block. Each of the

cylinder bore has a piston (18) movably disposed therein. A partition (33) is formed within the rear housing to define a discharge chamber (21) and a suction chamber (22) in the rear housing. A valve plate (14) is interposed between the chambers and the cylinder bores to selectively connect and disconnect the chambers with the cylinder bores. A separator (34) is located between an end of the partition and the valve plate to urge the valve plate against the cylinder block on a second phantom circle about the axis of the drive shaft in such a manner as to maintain selectively connecting and disconnecting the chambers with the cylinder bores.

## 15 Claims

1. A compressor having a cylinder block (12) and rear housing (13) fixed to the cylinder block, said cylinder block having a plurality of cylinder bores (17) arranged along a first phantom circle about an axis (L) of a drive shaft (16) supported by the cylinder block, each cylinder bore has a piston (18) movably disposed therein, wherein a partition (33) is formed within the rear housing to define a discharge chamber (21) and a suction chamber (22) in the rear housing, and wherein a valve plate (14) is interposed between the chambers and the cylinder bores to selectively connect and disconnect the chambers with the cylinder bore, **said compressor being characterized by** a separator (34) located between an end of the partition and the valve plate to urge the valve plate against the cylinder block on a second phantom circle about the axis of the drive shaft in such a manner as to maintain selectively connecting and disconnecting the chambers with the cylinder bore.
2. The compressor as set forth in Claim 1, **characterized in that** said valve plate includes suction ports (26a) and suction valves (25a) both selectively connecting and disconnecting the suction chamber with the cylinder bores, said valve plate further includes discharge ports (26b) and discharge valve (27a) both selectively connecting and disconnecting the discharge chamber with the cylinder bores, and said separator disconnects the suction ports with the discharged ports.
3. The compressor as set forth in Claims 1 or 2, **characterized in that** said separator functions as a retainer that regulates a maximum opening to the discharge valve.
4. The compressor as set forth in Claim 3, **characterized in that** said separator is in a disk-shape, wherein said separator has a surface opposed to the valve plate, wherein said surface has an outer peripheral portion radially tapered, and wherein

said tapered outer peripheral portion functions as the retainer.

plate (14) to disconnect the suction ports (26a) from the discharged ports (26b).

5. The compressor as set forth in any one of the preceding claims, **characterized by** a seal member (37) interposed between the separator and the partition. 5
6. The compressor as set forth in any one of the preceding claims, **characterized by** an resilient seal member (45) interposed between the rear housing and the valve plate. 10
7. The compressor as set forth in any one of the preceding claims, **characterized in that** said valve plate includes a first plate (26) having the suction ports and the discharge ports, a second plate (25) having the suction valve and a third plate (27) having the discharge valve, and wherein the first plate, the second plate and the third plate are fastened with the separator. 15 20
8. The compressor as set forth in any one of Claims 1 to 6, **characterized in that** said separator has a through hole that guarantees a communication between the suction chambers and the suction ports. 25
9. The compressor as set forth in Claim 1, **characterized in that** said separator is in a shape of a hollow cylinder. 30
10. A compressor having a cylinder block (12) and rear housing (13) fixed to the cylinder block, said cylinder block having a plurality of cylinder bores (17) arranged along a first phantom circle about an axis (L) of a drive shaft (16) supported by the cylinder block, each cylinder bore has a piston (18) movably disposed therein, wherein a partition (33) is formed within the rear housing to define a discharge chamber (21) and a suction chamber (22) in the rear housing, and wherein a valve plate (14) is interposed between the chambers and the cylinder bores to selectively connect and disconnect the chambers with the cylinder bores, wherein said valve plate includes suction ports (26a) and suction valves (25a) both selectively connecting and disconnecting the suction chamber with the cylinder bores, and wherein said valve plate further includes discharge ports (26b) and discharge valves (27a) both selectively connecting and disconnecting the discharge chamber with the cylinder bores, **said compressor being characterized by** a separator (34) located between an end of the partition (33) and the valve plate (14), wherein said separator (34) has one end contacting the partition (33) on a second phantom circle about the axis (L) of the drive shaft (16), and other end contacting the valve 35 40 45 50 55

Fig.1

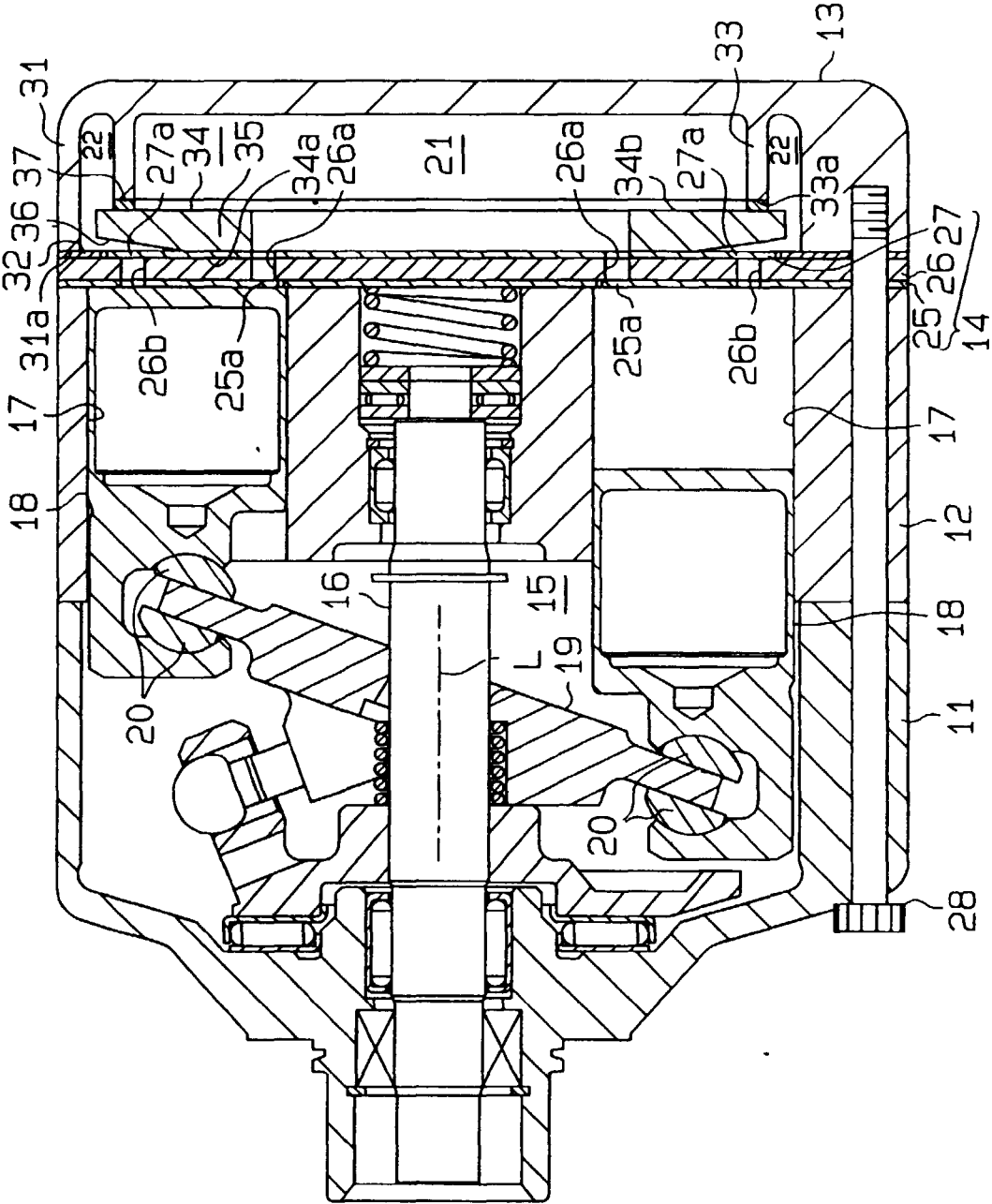


Fig. 2

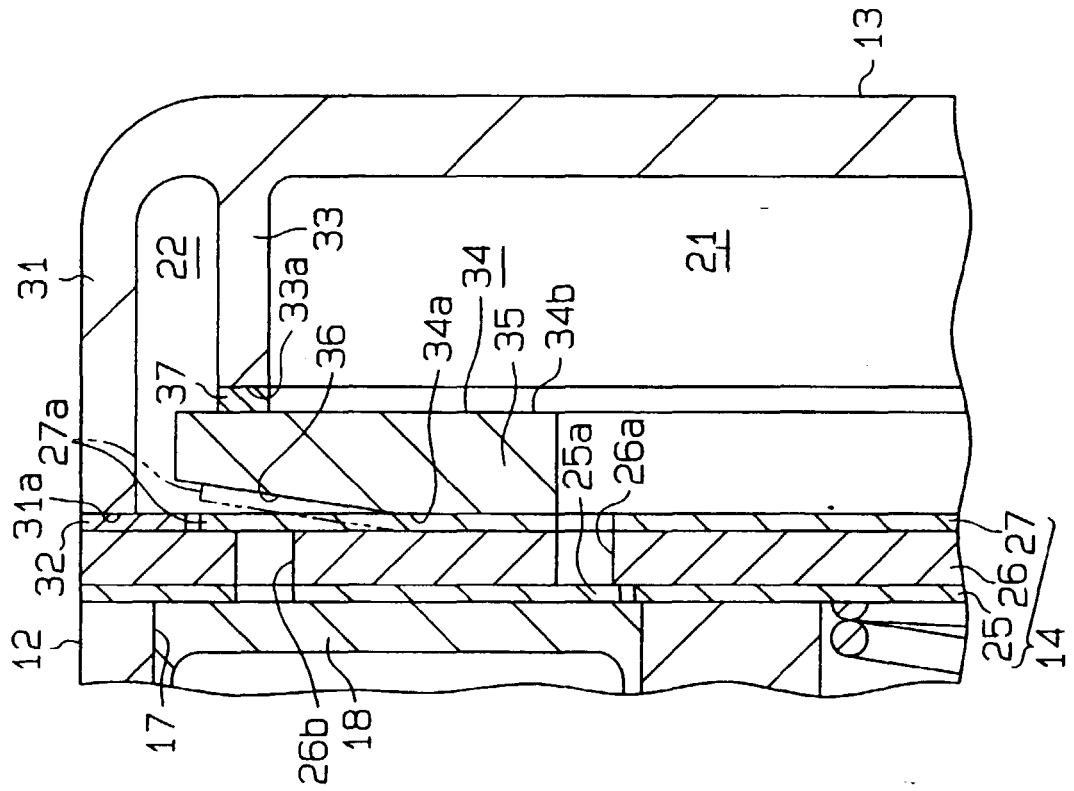
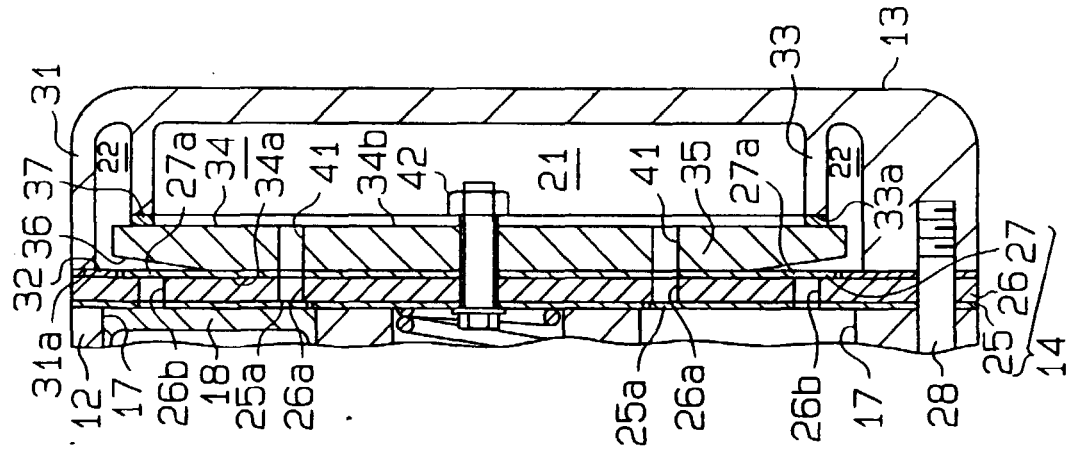
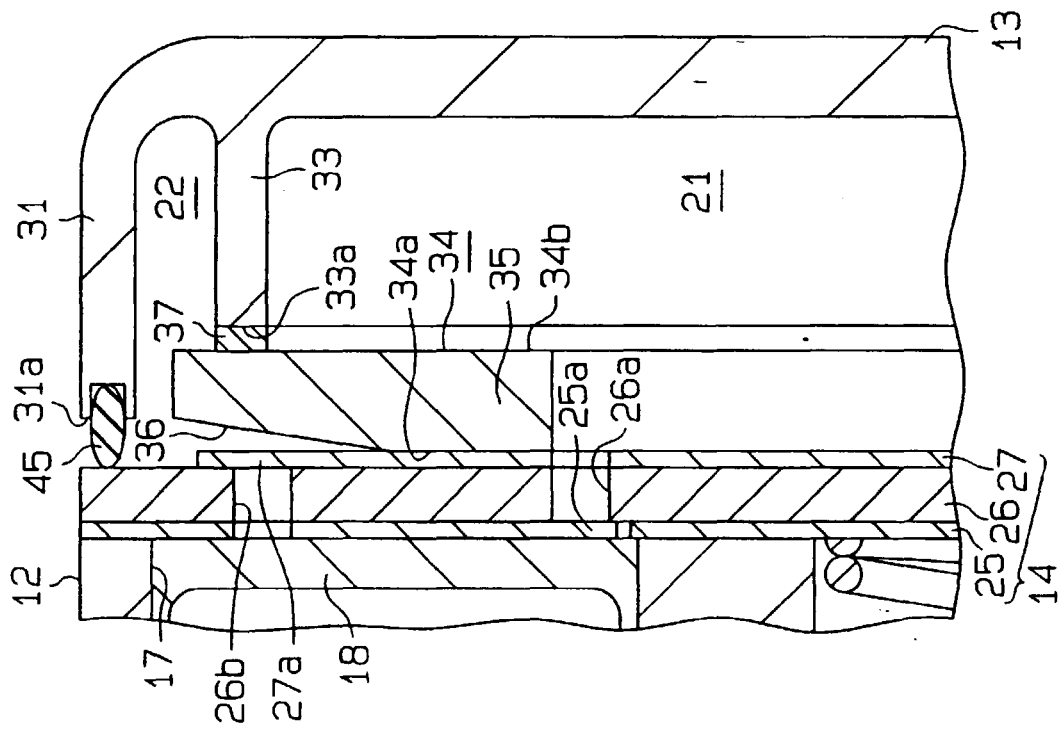


Fig. 3





**Fig. 4**



**Fig. 5**

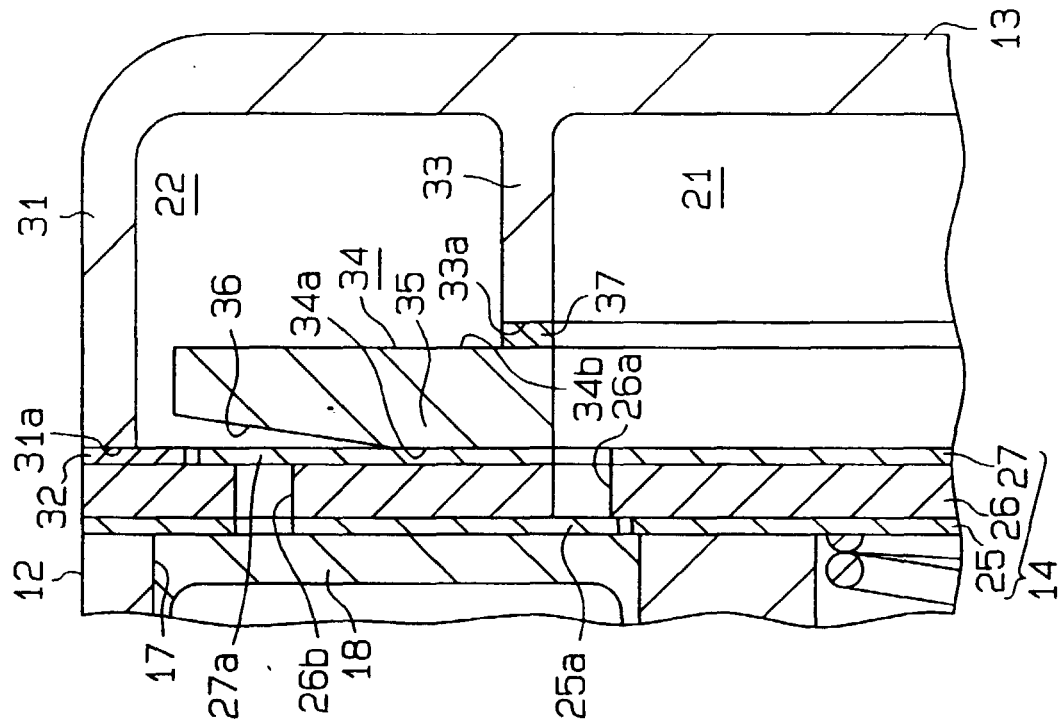


Fig. 6

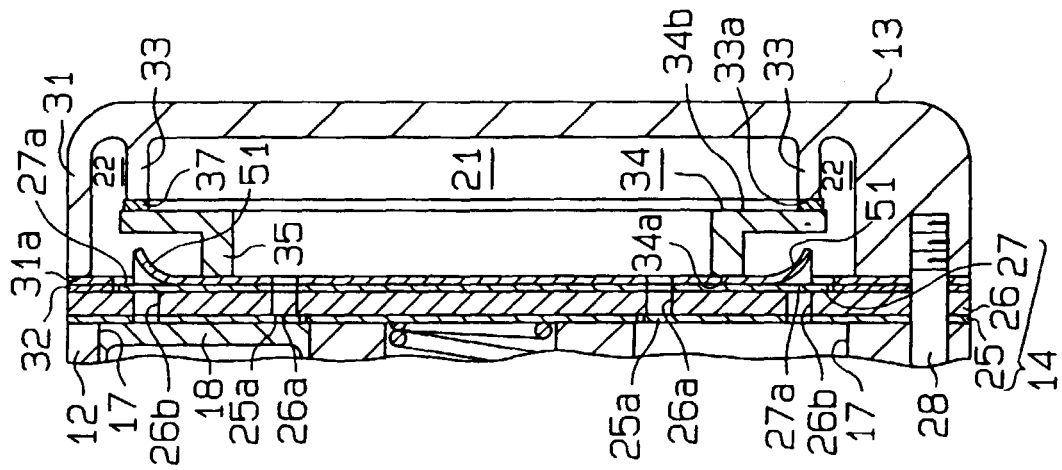
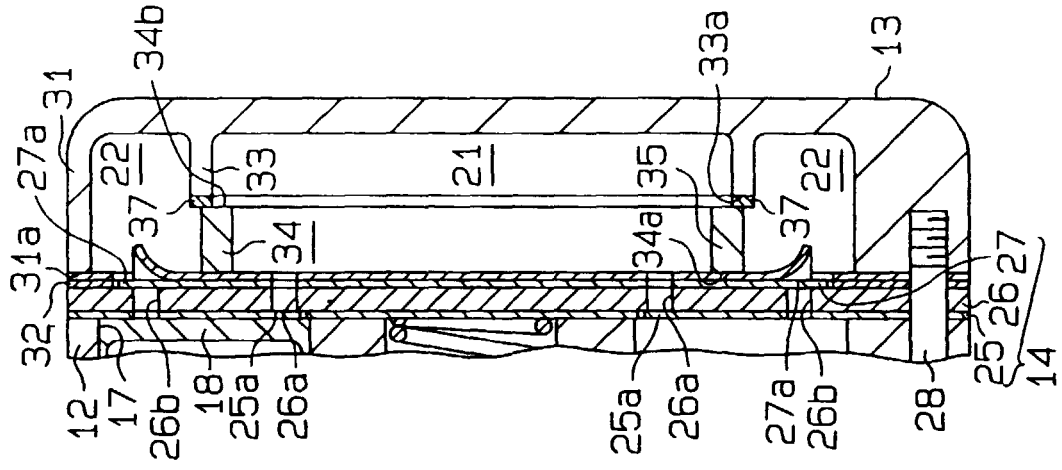


Fig. 7



**Fig. 8**

