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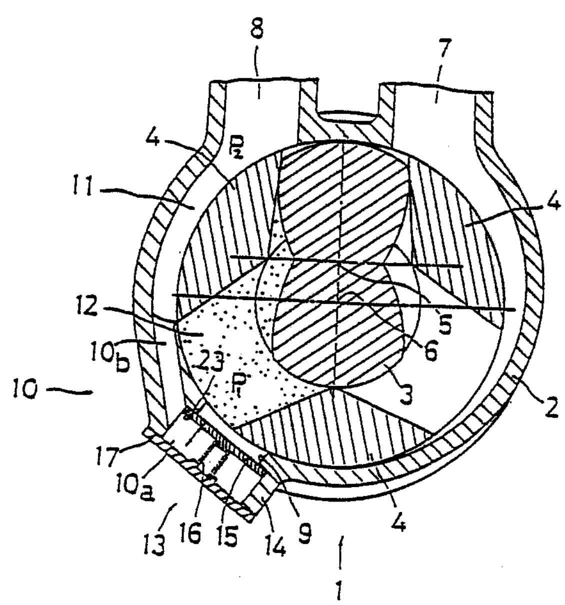
(54) Rotor assembly.

(57) A rotor assembly used in an automobile supercharger includes a casing in which a rotor rototes to draw in, compress and discharge a gas. The casing and the rotor define a compression chamber, and the casing is provided with an opening over a rotational angular range of the compression chamber which includes the latter half of the rotor compression stroke, and with a passageway for communicating the compression chamber with a discharge pipe via the opening. Switching means are arranged in the passageway for opening and closing the passageway in dependence upon discharge pressure produced by the compression stroke and supercharging pressure inside the discharge pipe.

Fig. 1



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ROTOR ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to a rotor assembly used in an automobile supercharger or the like, and more particularly, to an exhaust pressure regulating mechanism of such a rotor assembly.

Fig. 9 illustrates a rotor assembly which does not possess an exhaust pressure regulating mechanism. The rotor assembly includes a casing 91, an inner rotor 92, an outer rotor 93, a suction port 94 and a discharge port 95. The two-vaned rotors 92, 93 rotate at equal angular speeds about respective rotary shafts 96, 97, through which process a gas is drawn in, compressed and discharged.

Fig. 5 depicts a system having an engine equipped with a supercharger. The system includes an air filter 51, a throttle valve 52, a supercharger 53, an engine 54 and a muffler 55. P1 represents exhaust pressure formed by the compression stroke of the supercharger 53. Supercharging pressure P_2 produced on the engine intake side is decided by the rotational speed of the supercharger and the throttle opening.

Figs. 3 and 4 show P-V diagrams of a rotor assembly. The curve in each diagram comprises a suction stroke a, a compression stroke b and a discharge stroke c. The P-V diagram of Fig. 3 is obtained when the discharge pressure P_1 of the rotor assembly is greater than the supercharging pressure P_2 (i.e. when $P_1>P_2$ holds). In the absence of an exhaust pressure regulating mechanism, excess work is performed up to pressure P_1 even though compression up to pressure P_2 would be sufficient. This results in an equivalent amount of drive loss, and vibration and noise are produced when there is a sudden change from P_1 to P_2.

The P-V diagram takes on the form shown in Fig. 4 when the exhaust pressure P_1 is less than the supercharging pressure P_2 (i.e. when $P_1<P_2$ holds). In the absence of the aforementioned pressure regulating mechanism, vibration and noise are produced when there is a sudden change from P_1 to P_2.

Accordingly, it is desired that the exhaust pressure be regulated in such a manner that the relation $P_1 = P_2$ is established.

A rotor assembly equipped with a conventional exhaust pressure regulating mechanism is disclosed in the specification of Japanese Patent **KOKAI Publication** No. 61-4802 and is illustrated in Figs. 7 and 8. As shown in Fig. 7, exhaust pressure is regulated by movement of a wall member 43 along the peripheral wall of a casing 73, namely by the disposition of the opening (the angular position) of a discharge port 74. In the arrangement of Fig. 8, exhaust pressure is regulated by movement of a plurality of wall members 46 in the radial direction.

SUMMARY OF THE DISCLOSURE

A problem with these conventional arrangements is that the peripheral structure for moving the wall members is complicated and troublesome to design.

Fig. 6 illustrates the peripheral mechanism, which is indicated at numeral 61. The mechanism 61 includes a gear 63 rotated by a motor 62, a rack 64 engaging with the gear 63 and provided on the wall member 43, and rollers 65 on which the wall member 43 is revolved along the inner wall of the casing 73.

The wall member 43 also functions to seal the rotor. In order to obtain a high efficiency, sealing performance must be improved. This requires that rotor gaps be reduced, which in turn requires that the wall member be machined to a high precision and exhibit a high positional accuracy. The complexity. of the structure and the high precision required are the drawbacks of the prior art.

Accordingly, an object of the present invention is to provide a novel exhaust pressure regulating mechanism that solves the aforementioned problems of the prior art.

According to the present invention, the foregoing object is attained by providing a rotor assembly comprising: a casing; a rotor which forms a compression chamber inside the casing and rotates inside the casing for drawing in, compressing and discharging a gas; the casing having an opening in a rotational angular range which includes a latter half of a compression stroke of the rotor, and a passageway for communicating the compression chamber with a discharge pipe via the opening; and switching means arranged in the passageway for opening and closing the passageway in dependence upon discharge pressure produced by the compression stroke and supercharging pressure inside the discharge pipe.

The exhaust pressure regulating mechanism of the invention is simple in structure and does not require to be machined to a high precision. Outstanding effects can be obtained through a simple structure merely by boring a hole in the casing of the conventional assembly to form a valve chamber and arranging a valve within the valve chamber. In accordance with a first embodiment of the invention, the object of the invention is attained by a very simple structure in which the valve is subjected to back pressure by a return spring.

The exhaust pressure regulating mechanism of the invention can be manufactured at low cost.

PREFERRED EMBODIMENTS

In a preferred embodiment, the switching means comprises a valve seat formed in the casing at a peripheral portion of the opening, a valve body which moves axially of the opening so as to be capable of closing off the opening in cooperation with the valve seat, and a return spring for urging the valve body toward the valve seat.

The valve body has an exhaust pressure receiving surface shaped to conform to the opening.

The valve body comprises a plate having a first surface forming the exhaust pressure receiving surface and a second surface forming a supercharging pressure receiving surface, the exhaust pressure receiving surface having a peripheral portion which is seated and unseated on the valve seat, the valve body being moved directly axially of the opening substantially by a pressure difference between the exhaust pressure and supercharging pressure.

The switching means comprises a valve seat formed in the casing at a peripheral portion of the opening, a valve body movable to close off the opening in cooperation with the valve seat, an actuator for moving the valve body axialy of the opening, thereby opening and closing the opening, a first sensor for sensing the exhaust pressure, a second sensor for sensing the supercharging pressure, and a controller which receives output signals from the first and second sensors for controlling the actuator.

The actuator includes a return spring for urging the valve body toward valve seat.

The valve body has an exhaust pressure receiving surface shaped to conform to the opening.

The valve body comprises a plate having a first surface forming the exhaust pressure receiving surface and a second surface forming a supercharging pressure receiving surface, the exhaust pressure receiving surface having a peripheral portion which is seated and unseated on the valve seat, and the valve body being moved axially of the opening substantially by a pressure difference between the exhaust pressure and supercharging pressure.

The actuator comprises an electromagnetic solenoid, the first and second sensors comprise respective pressure sensors for outputting first and second electric signals in dependence upon the pressures sensed, and the controller compares the first and second electric signals, produces a valve actuating signal in dependence upon the result of the comparison and applies the valve actuating signal to the actuator.

The rotor comprises an outer rotor which rotates so as to separate from the casing in a gas suction stroke, contact the casing in a gas compression stroke and separate from the casing in a gas discharge stroke, and an inner rotor disposed within the outer rotor eccentrically with respect thereto for rotating while maintaining a seal at all times, the axial direction of the opening coinciding with the direction of a radius of a circle circumscribed by rotation of the outer rotor.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view illustrating a first embodiment of a rotor assembly according to the present invention;

Fig. 2 is a sectional view illustrating a second embodiment of a rotor assembly according to the present invention;

Figs. 3 and 4 are P-V diagrams;

Fig. 5 is a view of a system having an engine equipped with a supercharger;

Fig. 6 is a view illustrating a peripheral mechanism;

Figs. 7 and 8 are sectional views of a rotor assemblies having conventional exhaust pressure regulating mechanisms; and

Fig. 9 is a sectional view illustrating a rotor assembly which does not have an exhaust pressure regulating mechanism.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will now be described with reference to the drawings.

Fig. 1 is a sectional view illustrating a first embodiment of a rotor assembly according to the present invention.

A rotor assembly 1 according to the invention includes a casing 2 and two-vaned rotors, namely an inner rotor 3 and an outer rotor 4, arranged within the housing 2. The two-vaned rotors 3, 4 rotate at equal angular speeds about respective rotary shafts 5, 6. The casing 2 is formed to include a suction port 7 and a discharge port 8.

When the inner and outer rotors 3, 4 rotate, they do so while in close contact with each other to form a seal. Formed between the rotors 3, 4 and the inner wall of the casing 2 is a working space which undergoes a volumetric change as the rotors 3, 4 rotate. A compression working chamber 12 is formed by the compression stroke of the rotors when the rotors rotate. The casing 2 is provided with an opening 9 within the rotational angle range of the compression working chamber 12, which range includes at least the latter half of the compression stroke. Numeral 11 denotes a discharge pipe communicating the discharge port 8 with the engine intake side, not shown. The casing 2 is also formed to include a passageway 10 communicating the discharge pipe 11 and compression working chamber 12 via the opening 9. The passageway 10 includes a passageway segment 10a in which switching means, namely valve means 13, is provided for opening and closing the passageway 10. The valve means 13 comprises a valve 15 and a backing spring 16. The valve 15 slides radially in the passageway segment 10a, which forms a cylindrically shaped projection 14. The spring 16 is arranged between the valve 15 and a cover member 17 fixedly secured to the projection 14 and urges the valve 15 in the radial direction toward the opening 9.

The valve 15 has a disk-shaped configuration the outer diameter whereof is slightly smaller than the inner diameter of the cylindrical passageway segment 10a and is arranged in the passageway segment 10a so as to be slidable radially of a circle defined by rotation of the outer rotor 4. The opening 9 has a diameter smaller than the inner diameter of the passageway 10a, so that a step 23 is formed between the passageway 10a and the opening 9. The step 23 defines the valve seat of the valve 15, which is urged against the valve seat or step 23 by the spring 16. The surface of the valve seat and the surface of valve 15 urged into contact with the valve seat are subjected to surface machining so that a sufficient seal is maintained between the valve and the valve seat.

In order to permit the valve 15 to be opened and closed at high speed, it is preferred that the weight of the valve be very low and that the spring 16 having a very low spring constant.

When the relation $P_1 > P_2$ holds, the valve 15 moves in the opening direction to establish the relation $P_1 = P_2$. The valve 15 closes when the relation $P_1 < P_2$ prevails. The valve 15 begins to move in the opening direction from the moment the exhaust pressure P_1, which increases during the compression stroke due to rotation of the rotors 3, 4, coincides with the supercharging pressure P_2. The relation $P_1 = P_2$ is established when the valve 15 opens.

Though balance between the pressures on the primary and secondary sides is achieved merely by the valve 15 retracting slightly from the valve seat, it is preferred that the valve have a pressure receiving surface large enough to assure operation in response even to a slight pressure difference.

Fig. 2 is a sectional view illustrating a second embodiment of a rotor assembly according to the present invention, in which portions similar to those shown in Fig. 1 are designated by like reference characters and need not be described again.

In the present embodiment, the valve 15 is opened and closed by an actuator 21 and a controller 22 for controlling the actuator 21. In other aspects, this embodiment is identical with the first embodiment.

The actuator may comprise electrical means, hydraulic means or means which employ compressed air and/or exhaust negative pressure, by way of example. In the present embodiment, however, a solenoid arrangement is adopted owing to its simple structure and mounting ease.

Pressure signals P_1, P_2, which are produced by pressure gauges (not shown) for detecting the pressures in the compression chamber 12 and discharge pipe 11, respectively, are inputted to the controller 22, where the pressure signals P_1, P_2 are compared. When a difference develops between these two signals, the controller 22 sends the actuator 21 a signal for actuating the valve 15. In response to the signal from the controller 22, the solenoid constituting the actuator 21 is actuated, thereby opening the valve 15 to establish the relation $P_1 = P_2$.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

A rotor assembly used in an automobile supercharger includes a casing in which a rotor rototes to draw in, compress and discharge a gas. The casing and the rotor define a compression chamber, and the casing is provided with an opening over a rotational angular range of the compression chamber which includes the latter half of the rotor compression stroke, and with a passageway for communicating the compression chamber with a discharge pipe via the opening. Switching means are arranged in the passageway for opening and closing the passageway in dependence upon discharge pressure produced by the compression stroke and supercharging pressure inside the discharge pipe.

Claims

1. A rotor assembly comprising:

a casing;

a rotor which forms a compression chamber inside said casing and rotates inside said casing for drawing in, compressing and discharging a gas;

said casing having an opening in a rotational angular range which includes a latter half of a compression stroke of said rotor, and a passageway for communicating said compression chamber with a discharge pipe via said opening; and

switching means arranged in said passageway for opening and closing said passageway in dependence upon discharge pressure produced by the compression stroke and supercharging pressure inside the discharge pipe.

2. The rotor assembly according to claim 1, wherein said switching means comprises:

a valve seat formed in said casing at a peripheral portion of said opening;

a valve body which moves axially of said opening so as to be capable of closing off said opening in cooperation with said valve seat; and

a return spring for urging said valve body toward said valve seat.

3. The rotor assembly according to claim 2, wherein said valve body has an exhaust pressure receiving surface shaped to conform to said opening.

4. The rotor assembly according to claim 3, wherein said valve body comprises a plate having a first surface forming said exhaust pressure receiving surface and a second surface forming a supercharging pressure receiving surface, said exhaust pressure receiving surface having a peripheral portion which is seated and unseated on said valve seat, said valve body being moved directly axially of said opening substantially by a pressure difference between the exhaust pressure and supercharging pressure.

5. The rotor assembly according to claim 1, wherein said switching means comprises:

a valve seat formed in said casing at a peripheral portion of said opening;

a valve body movable to close off said opening in cooperation with said valve seat;

an actuator for moving said valve body axialy of said opening, thereby opening and closing said opening;

a first sensor for sensing the exhaust pressure;

a second sensor for sensing the supercharging pressure; and

a controller which receives output signals from said first and second sensors for controlling said actuator.

6. The rotor assembly according to claim 5, wherein said actuator includes a return spring for urging said valve body toward said value seat.

7. The rotor assembly according to claim 5, wherein said valve body has an exhaust pressure receiving surface shaped to conform to said opening.

8. The rotor assembly according to claim 7, wherein said valve body comprises a plate having a first surface forming said exhaust pressure receiving surface and a second surface forming a supercharging pressure receiving surface, said exhaust pressure receiving surface having a peripheral portion which is seated and unseated on said valve seat, said valve body being moved axially of said opening substantially by a pressure difference between the exhaust pressure and supercharging pressure.

9. The rotor assembly according to claim 5, wherein said actuator comprises an electromagnetic solenoid, said first and second sensors comprise respective pressure sensors for outputting first and second electric signals in dependence upon the pressures sensed, and said controller compares the first and second electric signals, produces a valve actuating signal in dependence upon the result of the comparison and applies the valve actuating signal to said actuator.

10. The rotor assembly according to claim 2, wherein said rotor comprises:

an outer rotor which rotates so as to separate from said casing in a gas suction stroke, contact said casing in a gas compression stroke and separate from said casing in a gas discharge stroke; and

an inner rotor disposed within said outer rotor eccentrically with respect thereto for rotating while maintaining a seal at all times;

the axial direction of said opening coinciding with the direction of a radius of a circle circumscribed by rotation of said outer rotor.

Fig. 1

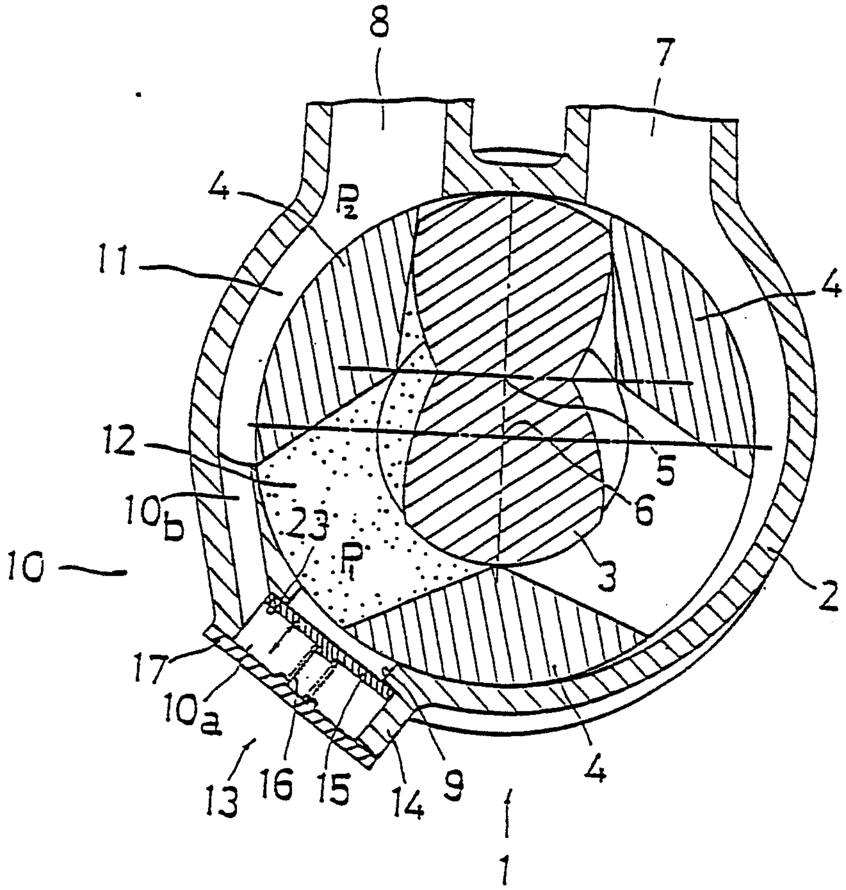

Fig. 2

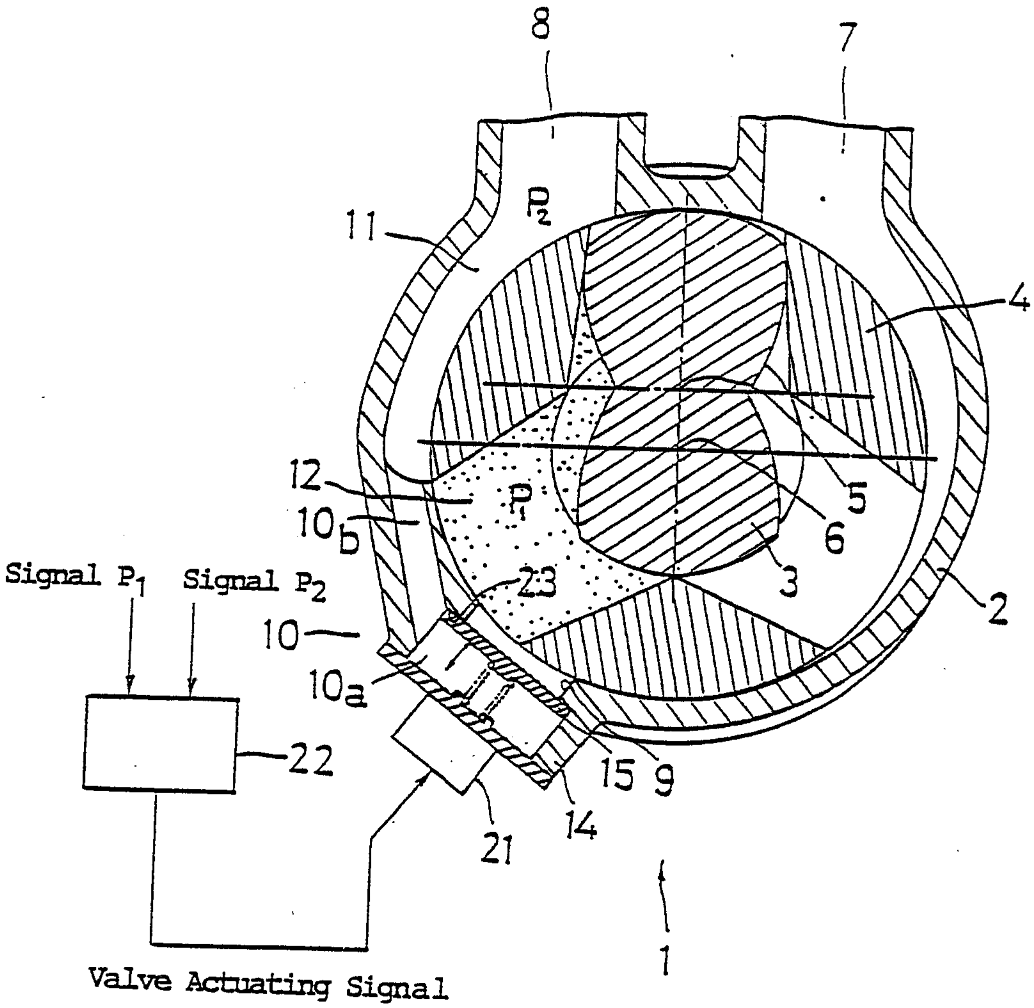
8
7
P2
11
4
12
P1
5
10b
6
Signal P1
Signal P2
3
23
2
10
10a
22
15
9
14
21
1
Valve Actuating Signal

Fig. 3

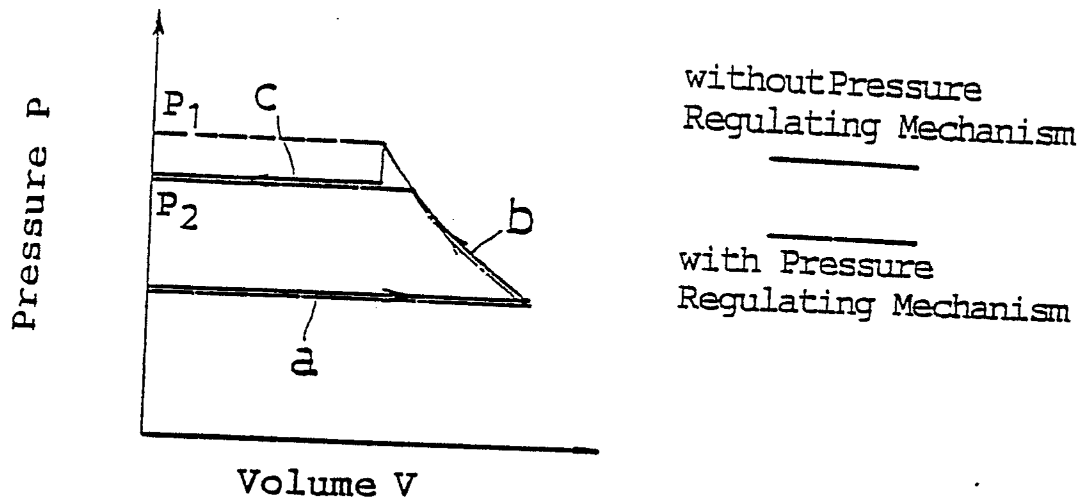
Pressure P
P1
C
P2
b
a
Volume V
without Pressure
Regulating Mechanism
with Pressure
Regulating Mechanism

Fig. 4.

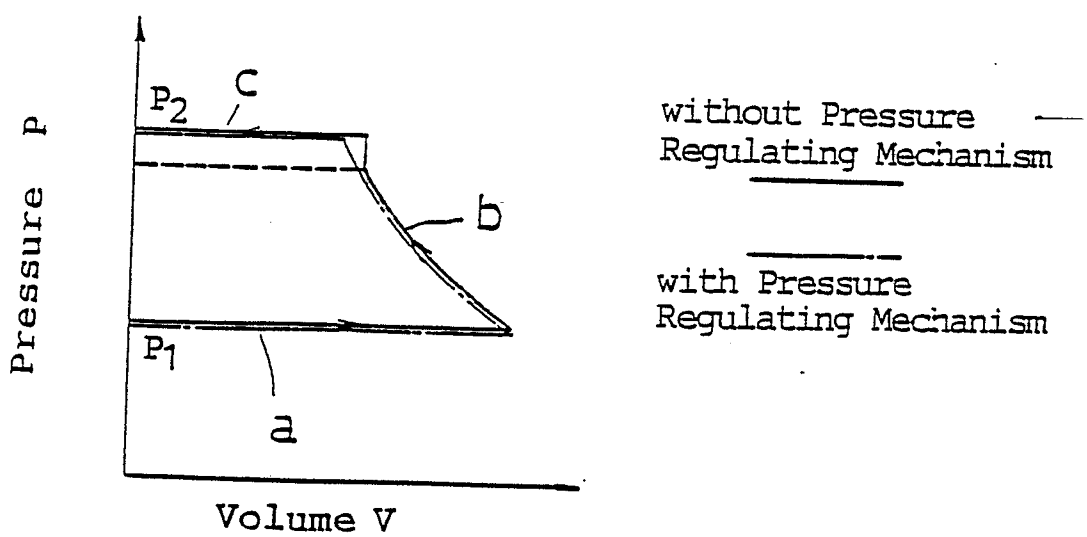
Pressure P
P2
C
b
P1
a
Volume V
without Pressure
Regulating Mechanism
with Pressure
Regulating Mechanism

Fig.5

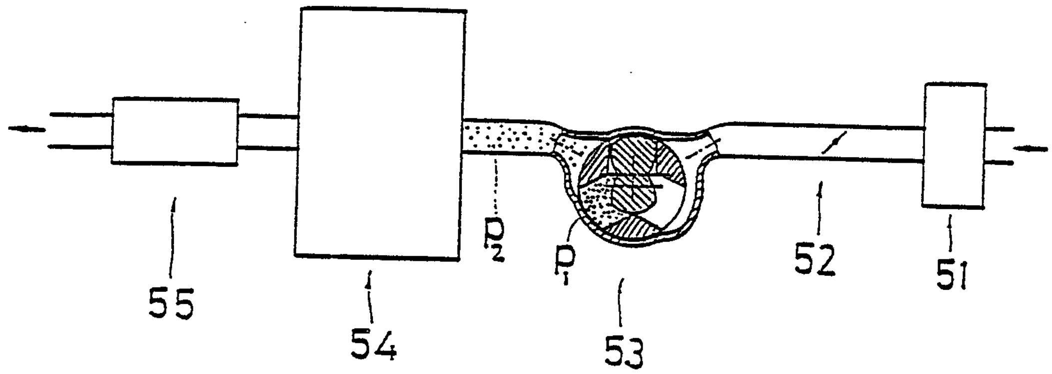

Fig.6

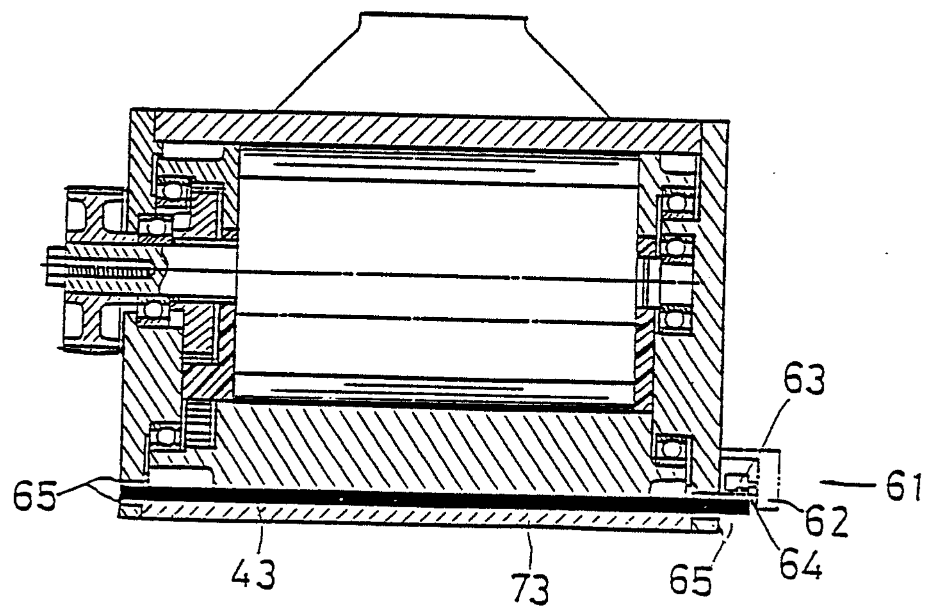

Fig. 7

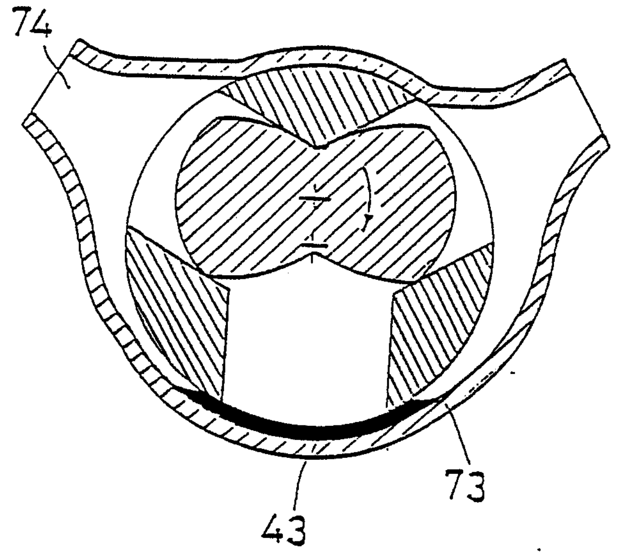

Fig. 8

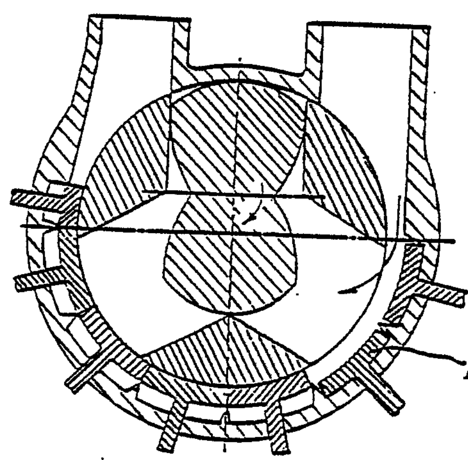

Fig. 9