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(71) Applicant: **BENDIX LIMITED**
Douglas Road
Kingswood, Bristol BS15 2NL (GB)

(72) Inventor: **Swinton-Clarke, William James Bentinck**
Lower Mill Lodge Newnham Lane
Old Basing Basingstoke Hants, RG24 0AT (GB)

Durrant, Jeremy James
15 isley's Court
Longwell Green Bristol, BS15 7DR (GB)

(74) Representative: **Turner, Alan Reginald**
BENDIX LIMITED Douglas Road
Kingswood, Bristol BS15 2NL (GB)

(54) **Gas compressor apparatus.**

(57) An air compressor is provided with an additional valve (7) in the cylinder head which is operable by a piston (16) in response to a governer signal to connect an extra closed clearance volume (27) to the compression chamber (9) for unloading the compressor.

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Description

Gas Compressor Apparatus

This invention relates to gas compressors and relates more especially but not exclusively to piston and cylinder air compressors in which the ultimate pressure of the delivered compressed air is limited by introducing additional clearance volume.

It has been proposed to limit the output pressure of a compressor by introducing additional clearance volume, such clearance volume either being a fixed volume or alternatively being a volume which is progressively variable. In a particular example of a compressor in which the delivered pressure is limited by added clearance volume, the compressor is provided with a valve having a pressure responsive control member subject to delivered pressure. The control member is biassed by the force of a spring so that the valve remains closed until a pre-determined pressure is reached, it acts on the pressure responsive member to unseat the valve and thereby add a small volume to the clearance volume above the head of the compressor piston. One shortcoming of such an arrangement is that the valve may be so sensitive as to open and close for small fluctuations of the delivered pressure. Indeed, the valve may tend to open and close for each cycle of the compressor piston at times when the delivered pressure is at or near the pre-determined value.

The object of the present invention is to provide improved gas compressor apparatus wherein the foregoing shortcoming is reduced or completely overcome.

According to the present invention there is provided a gas compressor apparatus comprising a compressor with a compression member which reciprocates in a chamber alternately to induce and compress gas for delivery to a receiver through a delivery valve said compressor having a spring-biassed unloader valve co-operable with an opening of said chamber and actuating means operatively linked to the valve member for displacement thereof against the action of the biassing spring in response to a signal from a governor which senses attainment of preset delivered pressure unseating of the unloader valve providing communication between said chamber and an additional volume.

More especially the invention provides gas compressor apparatus comprising a compressor with a compression member which reciprocates in a chamber alternatively to induce and compress gas for delivery to a receiver through a delivery valve said compressor having a spring-biassed unloader valve co-operable with an opening of said chamber characterised by a pressure responsive member operatively linked to the valve member for displacement thereof against the action of a biassed spring in response to signal pressure at an input port from a governer device which senses attainment of preset delivered pressure in the receiver unseating of said unloader valve providing communication between said chamber and an additional enclosed volume.

Preferably said pressure responsive member comprises a stepped member having a first relatively large area subject to pressure signals from said governer and an opposing relatively smaller area subject to pressure in the additional clearance volume.

In order that the invention may be more clearly understood and readily carried into effect, the same will be further described by way of example with reference to the accompanying drawings of which:

Fig. 1 illustrates in sectional view part of an air compressor and system employing the present invention,

Fig. 2 illustrates a modification of the air compressor shown in Fig. 1,

Fig. 3 illustrates an alternative gas compressor employing an alternative form of unloader valve and,

Fig. 4 illustrates a further modification of the gas compressor of Fig. 2 affording reduced overall height.

Referring to the drawing, a reciprocating piston air compressor has a cylinder a fragment of which is indicated at reference 1, having a bore 2 and a piston 3 sealingly slideable therein. The cylinder 1 is provided with a valve plate 4 with delivery and inlet valves 4a and 4b together with a cylinder head assembly comprising a main portion 5 and a cover portion 6 which is separable from 5 for ease of manufacture, assembly and subsequent maintenance of a further poppet valve denoted by reference 7 which operaters as an unloader valve.

The cylinder head has an induction chamber 8 communicating with a region 9 above the piston via the inlet valve 4a and delivered air under pressure from the region 9 passes through the delivery valve 4b to a delivery port 10 for supplying to a receiver comprising a storage reservoir 11. The pressure stored in the reservoir 11 is communicated via a pipe 12 to utilisation means such as a brake system. The pressure in the line 12 is sensed by a governer device 13 which typically is a governer type D2 as marketted by Applicant and described for example in their Technical Pamphlet 4/002. A pressure signal is derivable from the governer 13 and connected to a control input port 14 which communicates with the larger area 15 of a sealingly slideable stepped piston 16 with seals 17 and 18. The region between seals 17 and 18 is vented via a small passage 26 (shown dotted) to atmosphere. The opposing face 19 of the piston 16 is engageable with inward end 20 of a stem 79 of the unloader valve7 which is located in a valve guide 21 and has a head 22 engageable with a seat 23 formed in the cylinder head portion 5 and therefore is located in the compression chamber formed by region 9. The valve 7 is biassed into the closed position shown by a frusto-conical spring 24 acting between the guide 21 and a collet 25 retained on the stem by a sutiable circlip or cotter 29 in an annular groove. Incorporated in the cylinder head assembly there is provided an additional clearance volume by virtue of a region 27 which communicates via apertures 28 in the valve guide 21 and unseated

valve 7, with the region 9 above the piston. The area presented by the head 22 of the valve to the pressure in the region 9 lies between the area of 19 and the area of 15.

The compressor apparatus operates in a conventional manner drawing air in via induction chamber 8 and delivering compressed air via the delivery port 10 into the storage volume of the reservoir 11, chosen in accordance with the utilisation means, and upon attainment of the selected pressure the governer device 13 applies a pressure signal to the control port 14. The pressure delivered by the governer approximates to the pressure in the reservoir and this acts on the upper surface of the piston 16 to thereby urge the valve member against the action of spring 24 and the pressure in chamber 9 acts on the area of 22, such that the valve is rapidly unseated. Opening of this further valve connects the extra clearance volume provided by region 27 with the volume of the chamber 9. The volume of 27 is approximately twenty times the minimum volume of chamber 9, typically 100 cubic centimetres. Under these conditions, the maximum pressure attained in the chamber 9 immediately drops to a value which is appreciably less than the former delivery pressure and pressure in the reservoir 11, so that the compressor now ceases to deliver compressed air. There is then a cyclic pressure fluctuation accompanied by flow of air backwards and forwards via the unseated valve 22 bvetween the regions 9 and 27 as the piston 3 cyclicly varies the volume 9.

In the compressor apparatus described in the foregoing with reference to Fig. 1, there is a possibility of pressure flucations in the compressor chamber 9 of the compressor causing the valve 7 to chatter against its seat whilst the signal pressure at the control port 14 is increasing or decreasing through a small critical band of pressures within which the valve 7 is to be operated either to unload or reinstate the compressor operation. A modification of the arrangement of Fig. 1, designed to reduce or prevent such valve chatter, is illustrated in Fig. 2 in which corresponding passages, ports, volumes and components are given the same reference numerals as those of Fig. 1. The main additional feature of Fig. 2 resides in that the sealingly slideable piston 36 which is of extended length in its upper portion, is provided with two 'O' ring seals 37 and 38. The signal passage from the control signal input port 14 now communicates via an annular region 40 between seals 37 and 28 and a choked flow passage 39 in the piston with the upper area 41 of the extended piston. The portion of the psiton 36 which carries the seal 38 has a somewhat reduced diameter compared with the piston 16 of Fig. 1 and the portion of piston 36 which carries seal 37, in order that it may conveniently be accommodated in a bore 43 formed in a screwed-in closure cap 42 which therefore needs to be of no greater diameter than the closure cap of Fig. 1.

In operation of the compressor arrangement of Fig. 2, assume initially that the compressor is operating to deliver pressure via the delivery port 10to reservoir 11 the pressure in reservoir 11 attains a pressure value which is sensed by the governer 13 as being the preset normal operating pressure for the system which is supplied by the reservoir, the governer 13 communicates a control pressure to port 14. Depending upon the characteristics of the governer and the lengths and diameters of the flow paths involved for the control pressure signal, the pressure applied to the piston 36 may be subject to a progressive increase but since this is applied via choked passage 39 a small volume exists above the area 41 of the piston which, with choked passage 39, is effective to damp the effects of pulsating flow through the valve 7, when the valve is being unseated. Chatter of the head 22 of the valve7 against its seat 23 is, therefore, substantially prevented or reduced. Similarly, during release of signal pressure from port 14, when the governer determines that the compressor is required to go 'on-load' again, the volume of air above the piston area 41 again serves to act against the valve 7, until a sufficient pressure reduction occurs to enable the valve to close completely against its seat 23 under the actyion of spring 24, assisted finally by an upward compression stroke of the compressor piston.

A further embodiment of the invention, as shown in Fig. 3, incorporates a double valve device 50 which seats alternatively against a valve seat 51 within the cylinder head of the compressor or a valve seat 52 provided by the top surface of the valve plate 4. The seat 52 is provided around an aperture 53 alongside the inlet valve passage 54 which communicates via an aperture 55 with the inlet passage 56. The valve member 50 is connected to an operating piston 57 which is urged into the position shown by a spring 58 between piston 57 and a closure cap 59. The annular region 60 provided in the cylinder head between respective seals 61 and 62 is communicated to a control input port, not shown, whereby upon application by the governer of signal pressure to the region 60 the piston 57 is actuated. Upon such actuation of piston 57 the valve member 50 moves upwards against spring 58 to close the passage 55 after opening the passage 53. The effect of this is to close the normal input communication between the input port 56 and passage 54 to connect an additional volume with the compression chamber of the compressor, such additional volume being denoted by reference 63. The compressor is thereby unloaded and runs to alternately compress and expand air in the compression chamber volume supplemented by the volume 63. Upon removal of the governer signal from annular region 60 the valve member 50 reseats in the position shown and the compressor reverts to normal operation.

In each of the arrangements described in the foregoing, the further or unloader valve is operated by an actuating piston which is aligned with and above it whereas for some applications the additional height requirement imposed by the presence of such an actuating piston may be unacceptable. In a further embodiment of the invention, as illustrated in Fig. 4, the height requirement for the actuating piston may be substantially reduced by locating the actuating piston alongside the valve, rather than

above it and arranging a suitable rocker arm linkage between them.

Referring to Fig. 4, wherein similar references are applied to corresponding components already referred to, the actuating piston 66 is sealingly slideable in a cylindrical bore 67 formed in the cylinder head of the compressor alongside the valve 7. The piston 66 is similar to piston 36 of Fig. 2 and the portion including the choked passage 68 includes a recess 72 for a light spring 73 and is sealingly slideable in a suitable plug 69, which closes the lower end of the cylinder 67. A rocker 70 is pivotted on a spindle 71 captive in the cylinder head such that upward movement of the piston 66 acts through the rocker arm 70 against the upper end of the stem 7a of the valve 7 whereby the valve 7 is operable in the same way as described previously, upon application of a governer signal to an annular region 64. Spring 73 prevents unnecessary rattle.

In embodiments such as those of Figs. 1, 2 and 4 when using materials most conventionally used for cylinder heads and valves, it is found that it is preferable to have the periphery of the head (e.g., 22 in Fig. 1)of curved section and the seat which receives it is conveniently frusto-conical. However, other shapes may be employed if desired.

An advantage of unloading a compressor by means such as provided by the invention is that oil carry-over from the compression chamber of the compressor may be minimised by maintaining pressure above the piston 3 even when the compressor is "off load".

Furthermore, by having additional clearance volume, which is connectable by virtue of a valve such as 7 operated by a pressure responsive member controlled by a governer device, the possibility of the valve member being actuated by pressure fluctuation in the chamber 9 is substantially removed. It is also to be seen that a pressure responsive member such as 16, 36 or 66, with its relatively large area subject to the governer signal and its relatively small area subject to the pressure in the additional clearance volume, the latter pressure is unable to affect the action of the said member in a manner which would override the action of the governer.

Although not described herein by way of emobidment it will be appreciated that the governer may if desired be incorporated in the cylinder head or even in part integrated with the actuating means of the unloader valve. Again, the signal which operates the actuating means may be other than a fluid pressure signal, for example, an electrical signal.

Claims

1. Gas compressor apparatus comprising a compressor with a compression member (3) which reciprocates in a chamber (9) alternately to induce and compress gas for delivery to a receiver 11 through a delivery valve (4b) said compressor heaving a spring-biassed unloader valve co-operable with an opening of said chamber (9) characterised by actuating means (16; 36; 57; 66) operatively linked to the valve member for displacement thereof against the action of the biassing spring (24) in response to a signal from a governor which senses attainment of preset delivered pressure unseating of the unloader valve (7) providing communication between said chamber (9) and an additional enclosed volume (7).

2. Gas compressor apparatus comprising a compressor with a compression member (3) which reciprocates in a chamber (9) alternatively to induce and compress gas for delivery to a receiver 11 through a delivery valve said compressor having a spring-biassed unloader valve (7) co-operable with an opening of said chamber (9) characterised by a pressure responsive member (16) operatively linked to the valve member (7) for displacement thereof against the action of a biassing spring (24) in response to signal pressure at an input port (14) from a governer device (13) which senses attainment of preset delivered pressure in the receiver, unseating of said unloader valve (7) providing communication between said chamber (9) and an additional enclosed volume (27).

3. Gas compressor apparatus as claimed in claim 2, characterised by said pressure responsive member having a relatively large area (15) subject to the pressure signal at said input port (14) and a relatively small area (19) communicating with said additional enclosed volume (27).

4. Gas compressor apparatus as claimed in claim 3 characterised by said pressure responsive member (36) having two seals (37 and 38) and the pressure signal being applied via a space (40) between said seals and said relatively large area (41) via a choked passage (39).

5. Gas compressor apparatus as claimed in claim 2, 3 or 4 characterised by said pressure responsive member being algined with the direction of movement of the valve member (7).

6. Gas compressor apparatus as claimed in claim 2, 3, or 4, characterised by the pressure responsive member being linked to thje valve member (7) via a pivotted rocker arm (70, 71).

7. Gas compressor apparatus as claimed in any preceeding claim characterised by the valve member (7) comprising a poppet valve with a head which is movable into said chamber (9) upon separation of the head (22) from its seat (23).

8. Apparatus as claimed in any of claims 1, 2, 4 ,6 or 7, characterised by said unloader valve comprising a double valve which upon actuation thereof closes off a communication between a compressor inlet port (56) and said chamber (9) and opens a communication between said chamber (9) and said additional volume (63).

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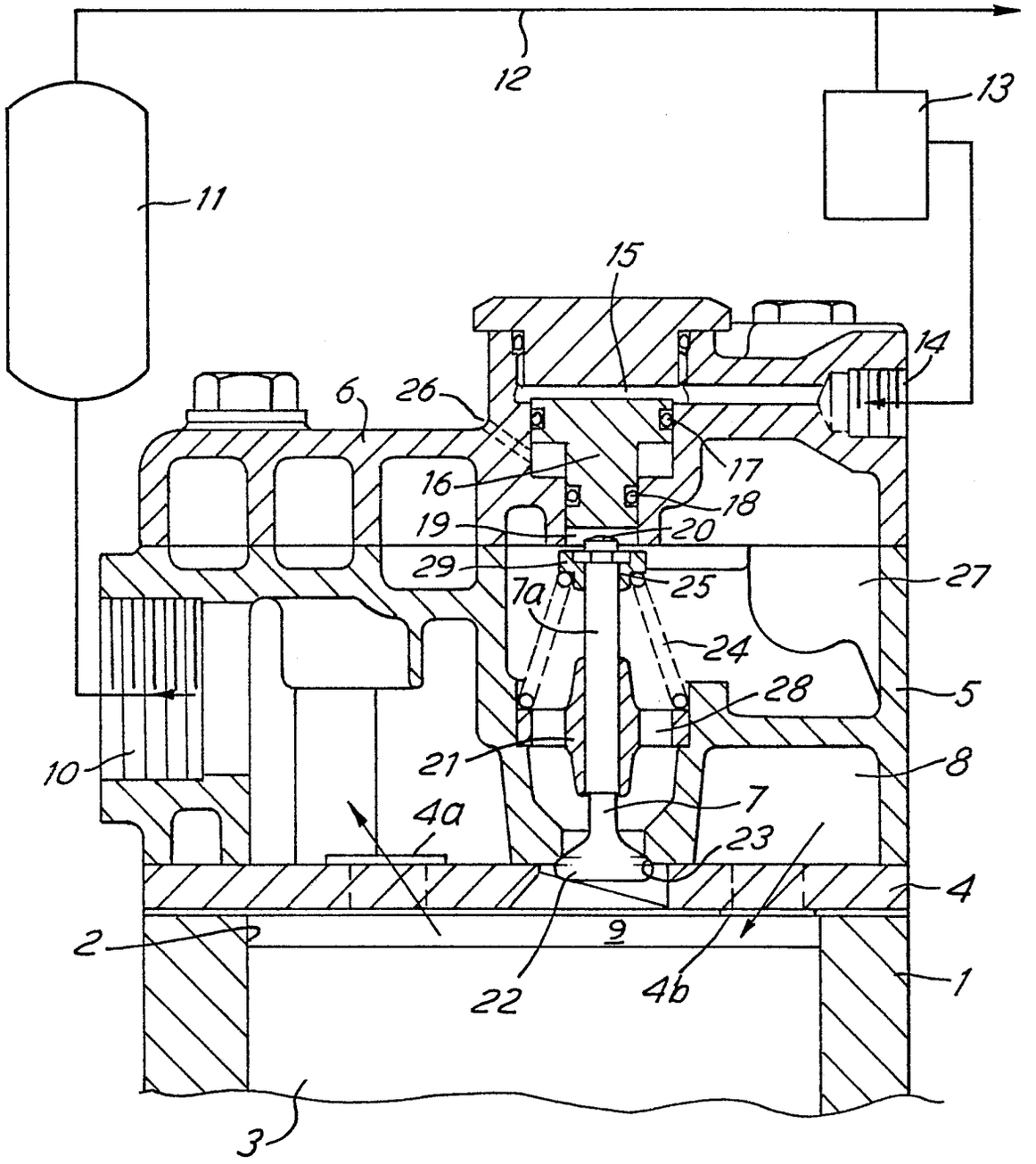

FIG.1

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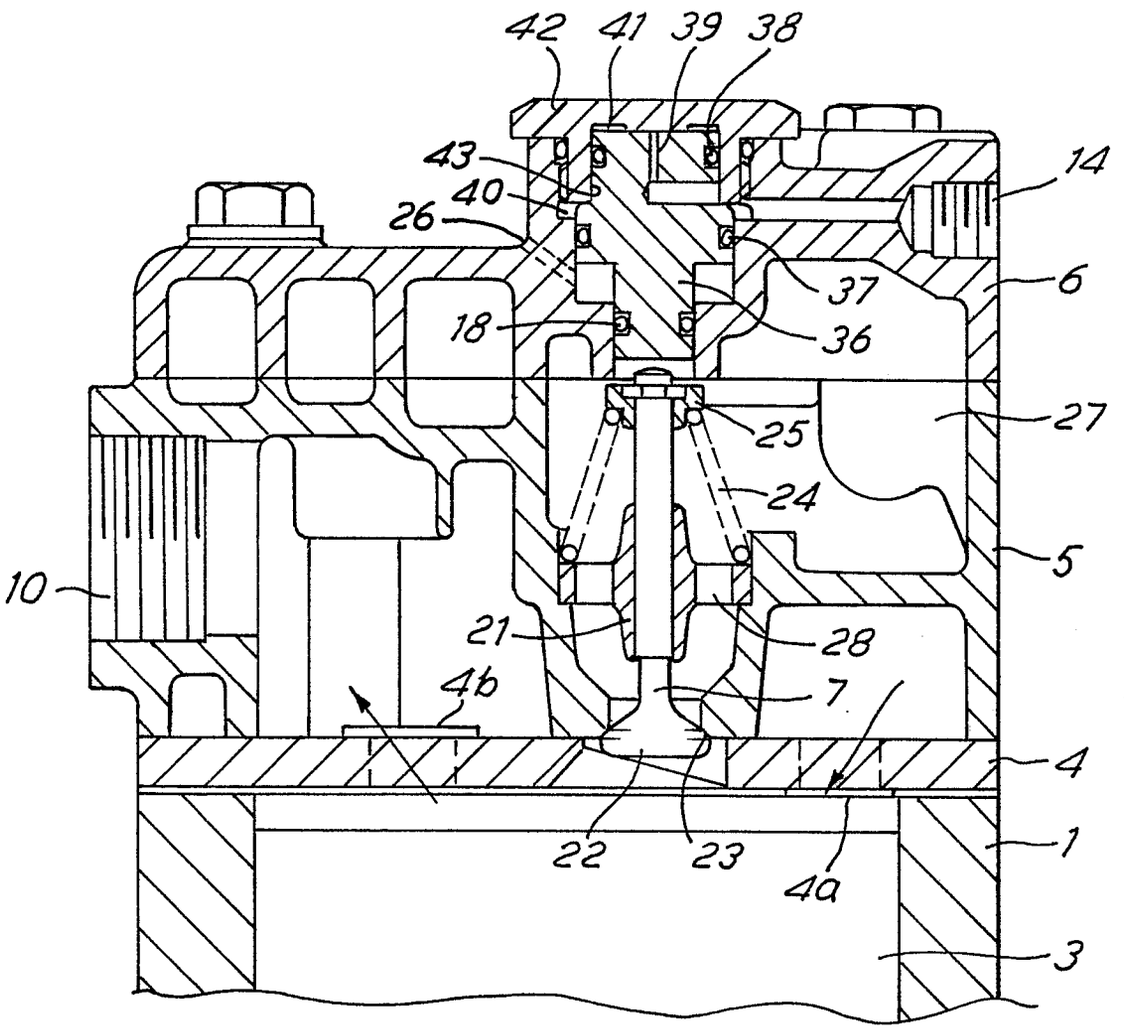

FIG.2

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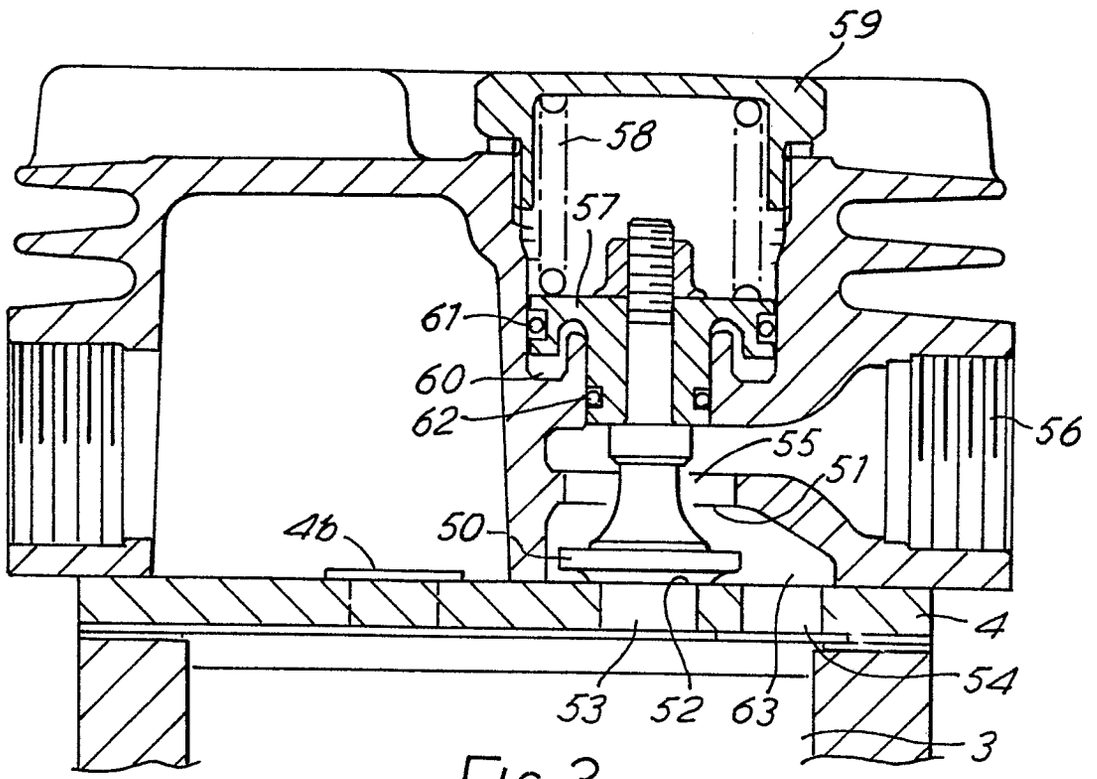

FIG. 3

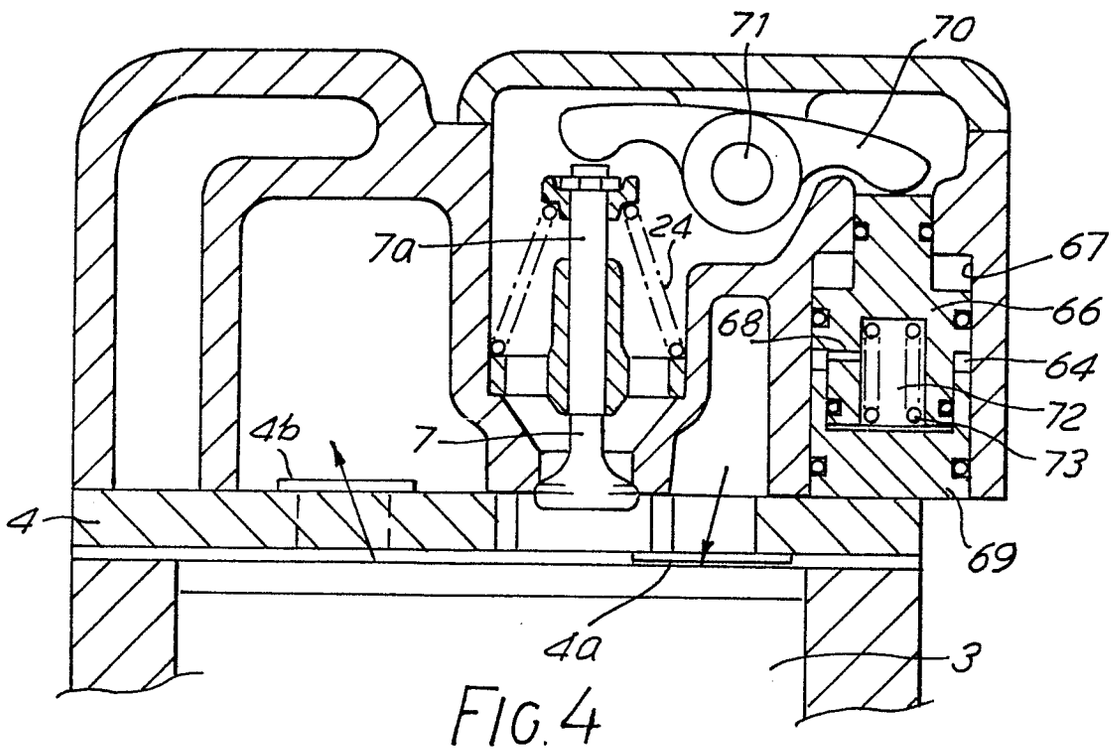

FIG. 4