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(54) Vibratory apparatus for ejecting items

(57) A scrap ejector comprises a pneumatic motor imparting a vibratory motion by means of a first piston that is arranged to reciprocatingly slide within a first cavity of an outer body owing to the action of an elastic spring or an adjustable, but substantially constant pneumatic force acting on a side of said piston, and a pulsed pneumatic force acting on the other side thereof. This pulsed force is obtained by applying a pneumatic pressure onto said other side of the piston, while alternately cutting off and re-establishing said second force by means of a valve arrangement based on a second piston adapted to slidably reciprocate within a respective cavity, wherein the opening and closing stroke of this second piston for applying and exhausting the pressure acting upon said first piston is controlled, i.e. actuated in a direct manner in one direction, and in an indirect manner in the opposite direction, by the same reciprocating displacement of said first piston.

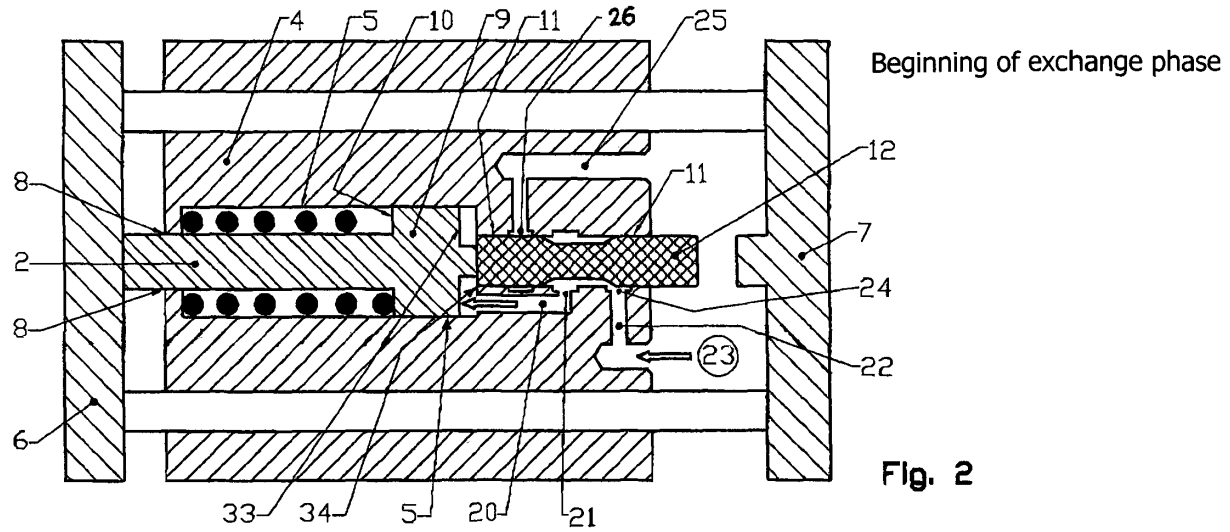

Fig. 2

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Description

[0001] The present invention refers to an apparatus for generally displacing items that are laid down onto a collecting tray or into a collecting container, by imparting a vibratory motion to said tray or container in a generally horizontal or inclined direction, wherein this apparatus will be generally and conventionally referred to as a scrap ejector in the description that follows hereinbelow.

[0002] Various kinds of scrap ejectors are known in the art; for instance, a scrap ejector is known from the disclosure in the Italian patent application No. PN2001A000087, which makes use of an improved and balanced type of connection of a pneumatic motor to a container so as to impart a vibratory motion to said container. However, no indication is given in said patent as far as the type and mode of operation of said pneumatic motor are concerned.

[0003] Known from the disclosure in US 4,192,419 is an oscillating material conveyor based on a reciprocating motion in a horizontal direction, which makes use of both suitably pressure-adjusted fluid means and elastic spring means to bring about said reciprocating motion. The main purpose of the invention described in this patent publication is to obtain a motion in which acceleration is closely controlled in accordance with the position of the conveyor. Now, owing to such requirement, the means used to move the conveyor are necessarily quite complicated, and therefore quite expensive altogether, this limitation being on the other hand of no practical avail in all those cases implying driving systems for simple, low-cost and reliable scrap conveyors that do not involve any particular requirement as far as motion or displacement acceleration is concerned.

[0004] Known from the disclosure in US 5,467,859 is a scrap ejector, the movement of which is based on a pair of mutually opposing pistons that ensure the required reciprocating motion; the compressed air or gas is let into the two chambers, in which said two pistons are slidably arranged, through a complex valve arrangement actuated by the movement of the two pistons themselves or the members connected thereto. While clearly advantageous, since it does not make use of elastic springs that are subject to wear and breakdown, this arrangement has anyway a couple of specific drawbacks deriving from the fact that it requires the use of two pistons, along with the related chambers and the mechanical members and parts associated therewith, instead of just a single piston as required in prior-art solutions of this kind. Furthermore, the auxiliary piston moving crosswise, i.e. transversally relative to the main pistons is driven via a cam system based on a rubbing action, and this fact is largely known to be the cause of not only a quite rapid wear-down, but also a power loss, due to a greater usage of force, that unavoidably leads to slowed-down operating rates.

[0005] Known from the US patent publication No. 4,593,603 is a scrap ejector that makes again use of two distinct pistons to bring about the required reciprocating, i.e. oscillating movement, which in this case is an asymmetrical one, in the sense that the oscillation speed in one direction is different from the oscillation speed in the opposite direction and, in particular, the speed in a travel direction is slower, while its acceleration is however caused to increase in a controlled gradual manner, whereas the speed in the other travel direction is higher.

[0006] Even this solution, however, implies a quite complicated construction, since the two pistons and the related chambers have different diameters so as to be able to generate different forces. Furthermore, the valve arrangement used is still more complex owing to the need for it to ensure said speed control in the slower travel motion.

[0007] It would therefore be desirable, and it is actually a main object of the present invention, to provide a solution enabling a scrap ejector to be made, which is capable of doing away with the various drawbacks of prior-art solutions as described above and, in particular, is simple and capable of operating in a reliable manner, and which, in a particular embodiment thereof, is also capable of operating in an asymmetrical mode of operation.

[0008] These aims, along with other features of the present invention, are reached in scrap ejectors of the kind provided with a pneumatic motor as described and recited in the appended claims. Features and advantages of the present invention will anyway be more readily and clearly understood from the description that is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figures 1 and 1A are perspective views with and without slide, respectively, of the construction structure of a scrap ejector according to the prior art;
- Figure 2 is a simplified view of a horizontal planar section of a scrap ejector according to the present invention, in a first operating stage thereof;
- Figure 3 is a simplified cross-sectional view of some parts forming g the apparatus illustrated in Figure 2;
- Figure 4 is a view of the parts shown in Figure 3 according to the section "s" in the same Figure;
- Figures 5 and 6 are views of two different embodiments of a detail of the apparatus shown in the preceding Figures;
- Figures 7 to 9 are horizontal planar cross-sectional views of the positions of the various functional members and parts in three different operating states thereof following the one shown in Figure 2, respectively;
- Figures 10 and 11 are views of two respective different embodiments of the present invention; and

- Figure 12 is a view of a further different embodiment of the present invention.

[0009] With reference to Figure 1, a scrap ejector according to the prior art comprises a pneumatic motor 1, a rod 2 that is driven into an axial motion by said motor and is connected to a drive plate 6, which is in turn connected to a sliding plate or, more simply, slide 3 that carries the pan or container (not shown) onto or into which the items to be removed are collected.

[0010] Said drive plate 6 may be firmly joined, by means of two tie rods 41 and 42, to a second drive plate 7 separated from the first one, so as to enlarge the resting base for the slide 3.

[0011] According to the present invention, said pneumatic motor 1 comprises an outer body 4, from an aperture of which said rod 2 is able to come out.

[0012] With reference to Figure 2, within this outer body 4 there is provided a first cylindrical cavity 5, which is in communication with said aperture 8 and, furthermore, accommodates a first piston 9 connected with a face 10 thereof to the inward end portion of said rod 2.

[0013] In the outer body 4 there is provided a second cylindrical cavity 11, which is arranged so as to connect said first cavity 5 with the exterior of said outer body 4 on the opposite side of the aperture 8. In this second cylindrical cavity 11 there is accommodated a second piston 12 adapted to slidably displace therein in a substantially sealed, i.e. fluid-tight manner, except for the cases that will be described further hereinbelow, so that said second piston substantially behaves as a shutter as regards its own cavity 11.

[0014] The crosswise dimensions of said first and second cavities, and therefore the pistons 9 and 12 associated thereto, are such that the first cavity 5 has a cross-section area B that is larger than the cross-section area A of the second cavity 11, as this is illustrated schematically in Figures 3 and 4.

[0015] In practice, in the plane "s", where said two cavities join each other with the planar faces thereof, the face of the second cavity 11 fits into the face of the first cavity 5.

[0016] In the preceding description, said cavities and the related pistons have been described as cylindrical elements. Now, such indication is usually given while implying that the talk is about circular cylinders; in this particular case, however, it should be specially noticed that these cylindrical figures must be understood in the broadest meaning thereof, i.e. as formed by the movement, that may not be a circular one, of a segment that moves constantly parallel to and about a fixed segment or axis.

[0017] On the surface of the second piston 12 are provided two grooves 15 and 15 that are so sized and arranged as to ensure that, in any position whatsoever of the piston 12 within the related cavity 11, they communicate with each other.

[0018] This requirement can be complied with in a number of manners: a first manner is to provide a single annular groove 14 in the outer surface of the piston 12, so that said two distinct6 grooves can be considered as being simple sub-portions of said single annular groove 14, as this is symbolically illustrated in Figure 5; or between said two physically and actually separated grooves 14 and 15 there is provided a through-conduit 19 that connects them to each other in a permanent manner, as this is best illustrated in Figure 6.

[0019] There are three distinct conduits provided in the outer body 4, wherein a first conduit 20 connects the chamber of the first cavity 5, as also comprised between said two pistons 9, 12, with a first port 21 provided in the surface of said second cavity 11; a second conduit 22 connects a source of compressed gas 23, usually compressed air, with a second port 24, which is also provided in the outer surface of the same second cavity; and a third conduit 25 connects the outside withy a third port 26 that is again provided in the surface of said second cavity 11.

[0020] Furthermore, the first two ports 21 and 24 are so positioned and spaced from each other as to enable the second piston 12 can move into both:

- a first position (Figure 2), in which said two ports 21 and 24 are connected to each other via the groove 14, while the third port 25 is on the contrary closed by the surface of the second cavity 11, and
- a second position (Figure 8), in which the first port 21 is still open into the first groove 14, while the second port 24 is plugged by the second piston and the third port 26 associated to the third conduit 25 is set into communicating with said second groove 15.

[0021] Furthermore, by means of tie rods 41, 42 the drive plate 6 is rigidly connected to the second plate 7, which is so sized and arranged, relative to the second piston 12, as to ensure that, when said rod 2 is pushed outwards, the second plate 7 pushes in turn the outer portion of said second piston 12 towards the interior of the outer body 4, owing to said rod 2, said first plate 6, said tie rods 41, 42 and said second plate 7 being appropriately linked together.

[0022] It can however be readily appreciated that the correct arrangement and sizing of both stationary and movable elements and members involved relative to each other must be such as to enable the following four operating modes, which shall be referred to as settings hereinbelow, to occur in an orderly and mutually exclusive manner, wherein to each such setting there correspond a respective univocal combination of the positions of the two movable members, i.e.:

- assembly comprised of rod, first piston 9, movable plates, etc.,
- second piston 12.

First setting (Figure 2): the second piston lies in the aforedefined position, while the first piston is in contact with

the second piston with the respective opposite faces 33 and 34 thereof. In such situation, a flow of gas under pressure from said source 23 flows through said second conduit and into the portion of the first cavity that is comprised between the two pistons via said second port 24, said groove 14 and said first port 21; the third port 26 is plugged by the second piston 12. The pressure of the gas filling the first cavity then urges the first piston 9 into starting its movement in the first stroke direction thereof.

Second setting (Figure 7): said first piston 9 reaches a position of its stroke, in which the second plate 7 is abutting against the protruding portion of the second piston 12, but does not push it yet.

Third setting (Figure 8): the first piston continues its stroke until causing the second plate to push the second piston 12 so as to cause the latter to move into the second afore-defined position. In this situation, the second conduit 22 has its port 24 plugged by the second piston, whereas the first conduit 20 continues to be connected, i.e. communicating with the groove 14, and the third port 26 of the third conduit 25 is cleared so as to enable access to be gained to the second groove 15; the flow of compressed gas is stopped and the compressed gas that is present in the cavity between the two pistons is exhausted outside via the flowpath comprising the first conduit 20, the first groove 14, the connection 19 between the two grooves 14 and 15, the second groove 15 and, finally, the third outwardly open conduit 25.

[0023] As a result, since no pressure exists within the cavity between the two pistons, the first piston 9 stops moving, thereby putting an end to the first stroke distance thereof.

[0024] In addition, an elastic spring 30, which is suitably provided in the remaining portion (not comprised between the pistons) of the first cavity, and which is no longer contrasted by the pressure acting upon the first piston at this point, starts urging the latter into moving in the opposite direction.

Fourth setting (Figure 9): said first piston continues moving in the opposite direction, until the face 33 thereof comes into abutting against the face 34 of the second piston, thereby pushing it inwards, i.e. towards the interior of the respective cavity thereof, while the second conduit 22 continues to be plugged.

[0025] From this moment on, the process goes on with the first piston 9 that keeps moving to eventually push the second piston 12 into the initial position thereof and, when this position is eventually reached, the third conduit 25 is plugged again and the second conduit 22 is opened again, thereby restoring the initial conditions of the first setting, from which the cycle then starts again to go on in an iterative and automatic manner.

[0026] At this point, it can therefore be fully and readily appreciated that, in practice, the motion of the whole apparatus is substantially due to the reciprocating movement of the first piston, which is alternately exposed to a pneumatic force on a side and an opposite force (the spring 30) on the other side, thereby behaving like a double-acting piston.

[0027] As a result, the need of having two distinct pistons working alternately in the opposite direction can be advantageously done away with, since - according to the present invention - the first piston 9 performs and ensures both alternating movements in opposite directions.

[0028] Various improvements are furthermore allowed for within the scope of the present invention. So, for instance, and with reference to Figure 10, the cavity 45 - instead of being partially occupied by the spring 30 - is allowed to communicate, via a suitable channel 47, with a source of compressed gas (not shown), so that the elastic countering action of the elastic spring 30 is in this case replaced with the pressure exerted by said compressed gas against the opposing face 10 of the first piston lying therebehind. The advantage of such solution lies in the elimination of the spring 30, along with the largely known drawbacks connected therewith. In practice, the spiral spring 30 is replaced by the pneumatic force acting upon the face 10 of the first piston, thereby providing a gas spring of a conventional kind.

[0029] A further improvement is obtained if the pressure in said cavity 45 is conveniently ensured by simply "tapping", i.e. drawing off pressure from the second conduit 22, from which there departs a channel 48, as this is symbolically illustrated in Figure 11.

[0030] In this case, the pressure in the cavity 45 must of course be strictly prevented from dropping for any reason whatsoever, since this would affect the functionality of the above-described gas spring. To this purpose, a check valve 49 is fitted in said conduit 48 to prevent the pressure in the cavity 45 from being released, in particular in the transient phase between the third and the fourth setting.

[0031] It can further be readily appreciated that the pressure acting on the side 10 of the first piston 9 will under no circumstance be sufficient, i.e. rise to a value enabling it to overcome the force being exerted upon the piston 9 by the pressure acting against the opposite face 33, since, while the pressures on the two faces are the same, the surface area of the face 10 is clearly smaller than the surface area of the face 33, due to the presence of the rod 2, on which no pressure is in fact exerted.

[0032] Anyway, in order to do away with the risk that, in the initial phase, the pressure onto the first piston proves inadequate, owing to the two pistons being "squeezed" against each other to such an extent as to prevent the gas from being able to act against the first piston itself, between the two pistons there is provided a small spacing member 32, having an appropriately reduced diameter, preferably either on the face 33 of the first piston or the face 34 of the second piston 12.

[0033] Finally, in view of ensuring a specifically asymmetrical operation of the scrap ejector, i.e. a feature that is particularly desired or even plainly necessary in a number of applications, said second conduit 22 and/or said third conduit 25 are provided with appropriate flow control valves 50, 51, which are adapted to be operated

selectively so as to be able to deliver a flow of gas at such pressure and rate as to bring about differing velocities in accordance with the actual operating needs (Figure 12).

[0034] In a broader sense, the asymmetry in the operation of the scrap ejector may of course be ensured through a number of different means, and combinations thereof, i.e. by selecting and calibrating in an appropriate manner - as all those skilled in the art are anyway fully capable of doing - said elastic spring 30, the ratio of the cross-section area of the rod 2 to the cross-section area of the first piston 9, the adjustment or setting of either one or both said valves 50, 51 in the respective second conduit 22 and third conduit 25 thereof, as the case may be.

[0035] Again with reference to Figure 12, a further simplification may be easily introduced in any of the above-described embodiments of the present invention if the conduits 47 and 48 delivering compressed gas into the cavity 45 are fully eliminated, while providing the same cavity 45 in a fluid-tight construction, possibly pre-loaded with an initial bias pressure of such a value as to cause the first piston 9 to move back against the second piston 12 as soon as the third conduit 25 is put in connection, i.e. is set into communicating with the portion of said first cavity 5 comprised between the two pistons.

[0036] This solution stands out for its simplicity and functional reliability, further to being favoured by the fact that the current technology is such as to enable pneumatic springs - as is the case of the above-described solution - to be used, which are really capable of performing in an unaltered manner at a high level through millions and millions of operating cycles.

Claims

1. Scrap ejector, comprising:

- a pneumatic motor (1) driving a rod (2) into an axially reciprocating motion,
- one or more drive plates (6, 7) attached to said rod (2) or adapted to move jointly therewith,
- a slide-like plate (3) that is firmly joined to said drive plate(s),

characterized in that said pneumatic motor comprises:

- an outer body (4) that is provided internally with a first cylindrical cavity (5), in which there is accommodated a portion of said rod, and
- an aperture (8), which connects said first cavity (5) with the outside, and through which said rod (2) is able to slidably pass,
- a first piston (9), which is arranged to slide in a fluid-tight manner within said first cavity, and which is connected, with a face (10 thereof, with the inward-facing end portion of said rod (2),
- a second cylindrical cavity (11) that is provided in said outer body (4) on the opposite side of said aperture (8), and that allows said first cavity to be set into communicating with the outside,
- wherein the surface of said second cavity (11), at the common coupling intersection (s) in said first cavity, has an area (A) that is smaller than the area (B) of the surface of said first cavity (5) at the same common coupling intersection (s),
- a second piston (12) that is at least partially accommodated in said second cylindrical cavity (11), and that is adapted to slidably reciprocate within such cavity, said second piston being physically distinct from said first piston (9).

2. Scrap ejector according to claim 1, **characterized in that**, on two distinct and different portions of the cylindrical surface thereof, said second piston is provided with two respective grooves (14, 15), which are so arranged as to be able to communicate with each other (19) in any position whatsoever of the second piston within said second cavity.

3. Scrap ejector according to claim 2, **characterized in that** in said outer body (4) there are provided:

- a first conduit (20) that connects the chamber being substantially defined between said first cavity (5)
- and said first piston (9),
- and said second piston (12), with a first port (21) in the cylindrical wall of said second cavity (11),
- a second conduit (22) that connects a source of gas (23) at a selectively controllable pressure with a second port (24) in the cylindrical wall of said second cavity,
- and a third conduit (25) that connects the outside with a third port (26) in the cylindrical wall of said second cavity, wherein said first port (21) of said second cavity is situated in a position that is closer to said first piston than the position of said second port (24).

4. Scrap ejector according to claim 3, **characterized in that** said second piston, said respective grooves thereof and said three conduits are so positioned and sized as to enable said second piston to move into:

- a first position, in which said first conduit (20) is set in communication with said second conduit (22) via a first one (14) of said grooves, and the port (26) of said third conduit (25) is plugged by the outer cylindrical surface of said second piston (12),
- a second position, in which said first conduit

(20) keeps being connected with said first groove (14), and the port (24) of said second conduit is plugged by the outer cylindrical surface of said second piston (12), and said third conduit (25) is set in communication with the second one (15) of said two grooves (14, 15).

5. Scrap ejector according to claim 4, **characterized in that** said drive plates (6, 7) are adapted to move into four distinct settings, and said two pistons (9, 12) are adapted to move into said respective positions, wherein:

- in the first setting (Figure 2), said first piston is substantially in contact with said second piston, which is in the respective first preceding position,
- in the second setting (Figure 7), said drive plates are displaced so that said first piston is moved to the farthest position from said second piston, which remains in the preceding position,
- in the third setting (Figure 8), said plates are further displaced in the preceding direction, thereby causing said second piston to move into the second position thereof,
- in the fourth setting (Figure 9), said plates (6, 7) have moved back to a position in which said first piston is again in contact with said second piston, which remains in the preceding second position thereof.

6. Scrap ejector according to any of the preceding claims, **characterized in that** in the portion of said first cavity (5) accommodating said rod (2) there is arranged an elastic spring (30) that is adapted to act against said first piston (9).

7. Scrap ejector according to any of the claims 1 to 5, **characterized in that** the portion (45) of said first cavity (5) accommodating said rod (2) is provided in a sealed construction and is kept at an adequate pressure so that said portion (45) and said first piston (9) perform as a pneumatic spring relative to each other.

8. Scrap ejector according to any of the claims 1 to 5, **characterized in that** the portion (45) of said first cavity (5) accommodating said rod (2) is connected to a suitable supply channel (47) connected to a source of compressed gas.

9. Scrap ejector according to claim 7, **characterized in that** said supply channel is a connection channel (48) between said first cavity containing the rod and said second conduit (22) connected to said source of gas under controllable pressure (23), a suitable check valve (49) being preferably fitted in said connection channel (48).

10. Scrap ejector according to any of the preceding claims, **characterized in that** between said first and said second piston (9, 12) there is provided a spacing member (32) that is adapted to prevent the respective, mutually opposing surfaces of said pistons from coming into contact with each other, said spacing member being firmly attached to or integrally provided either on the face (33) of said first piston (9) or on the opposite face (34) of said second piston (12).

11. Scrap ejector according to any of the claims 3 to 10, **characterized in that** in said second conduit (22) and/or said third conduit (25) there are provided respective selectively adjustable flow control means (51, 52).

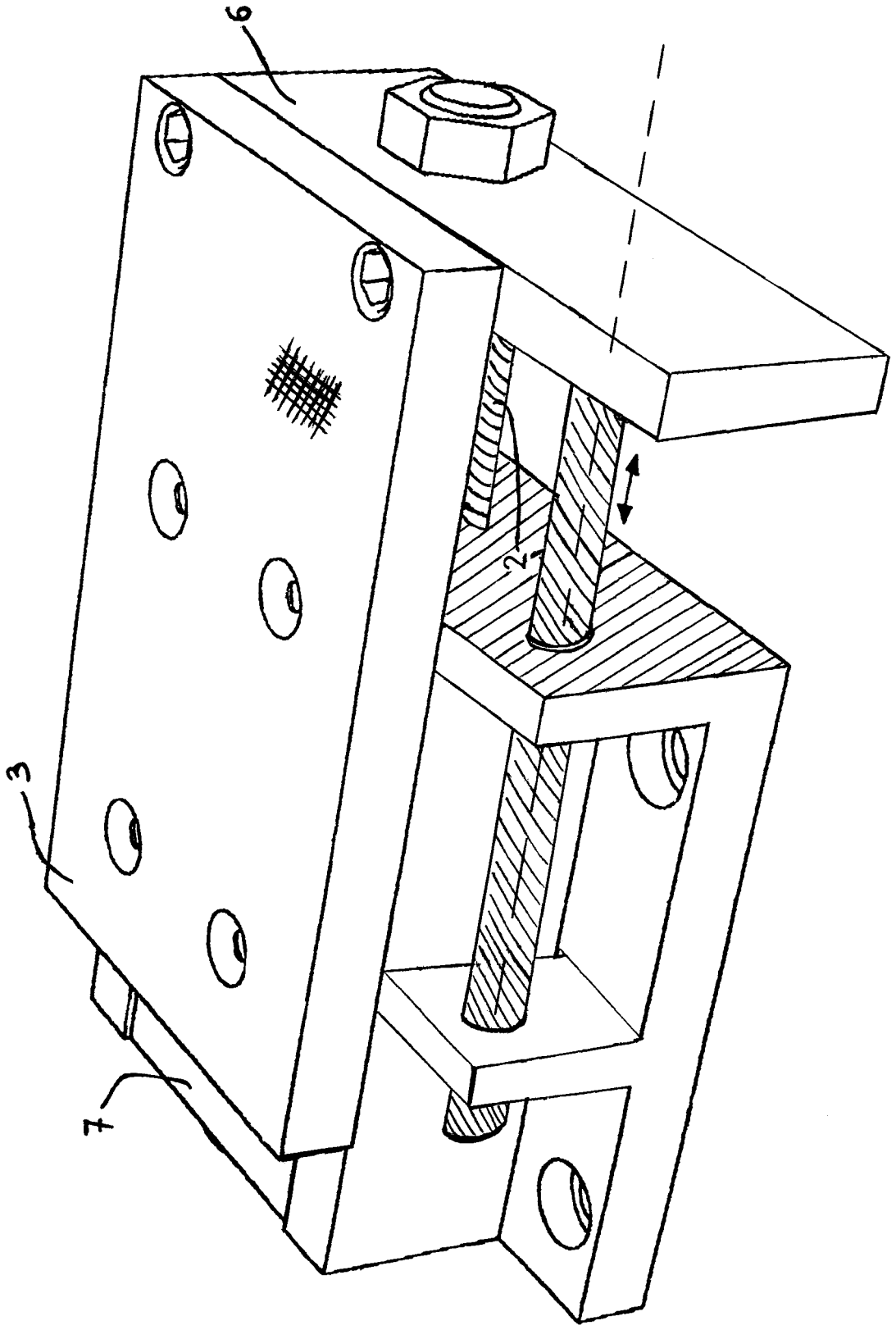

FIG. 1

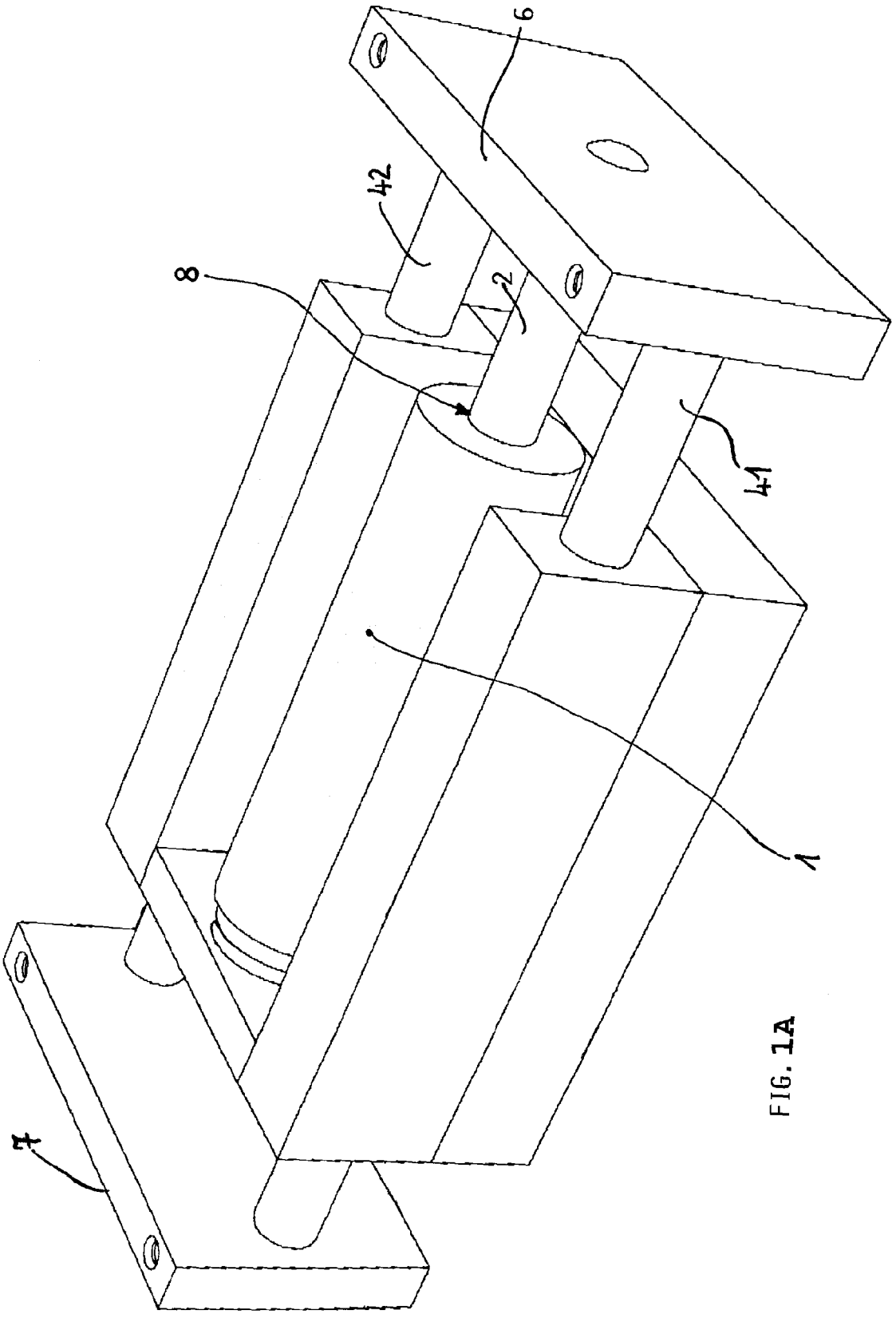

FIG. 1A

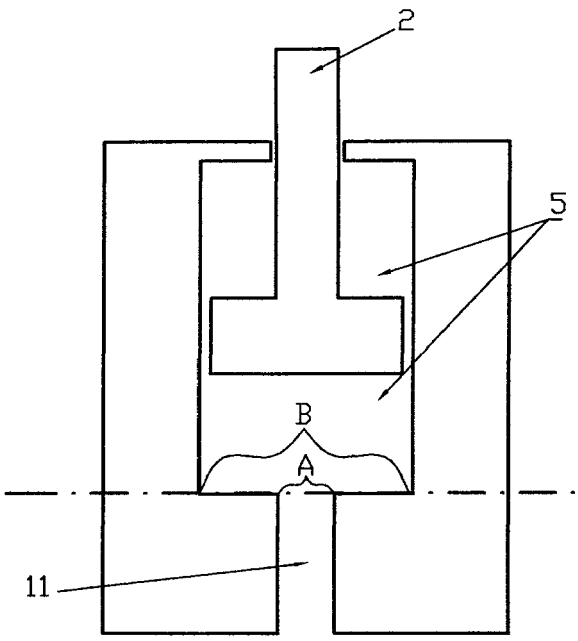

Fig. 3

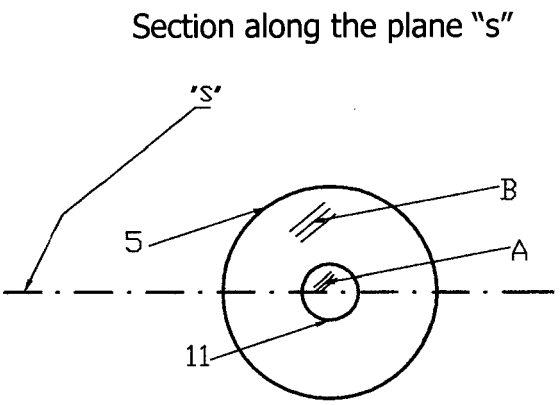

Fig. 4

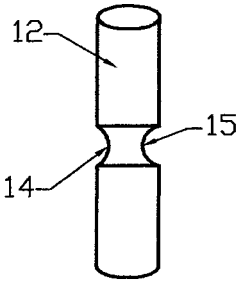

Fig. 5

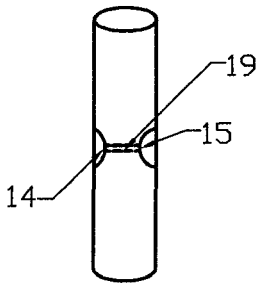

Fig. 6

Beginning of exchange phase

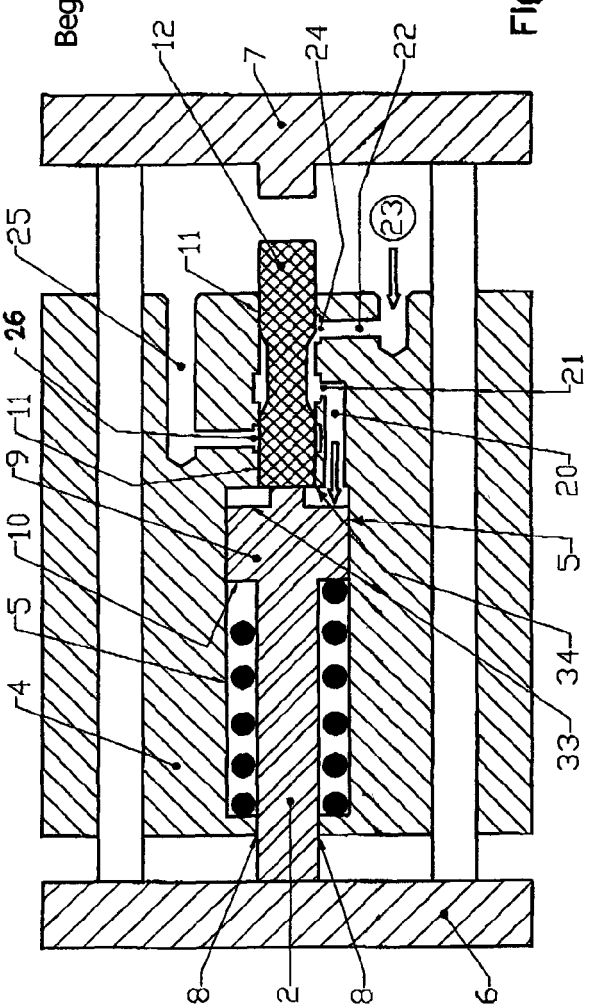

Fig. 2

End of exchange phase

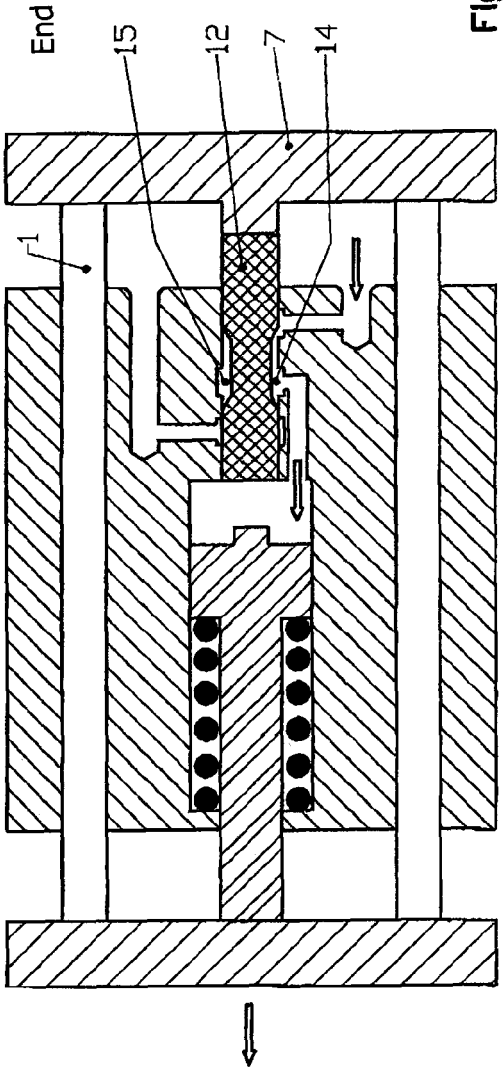

Fig. 7

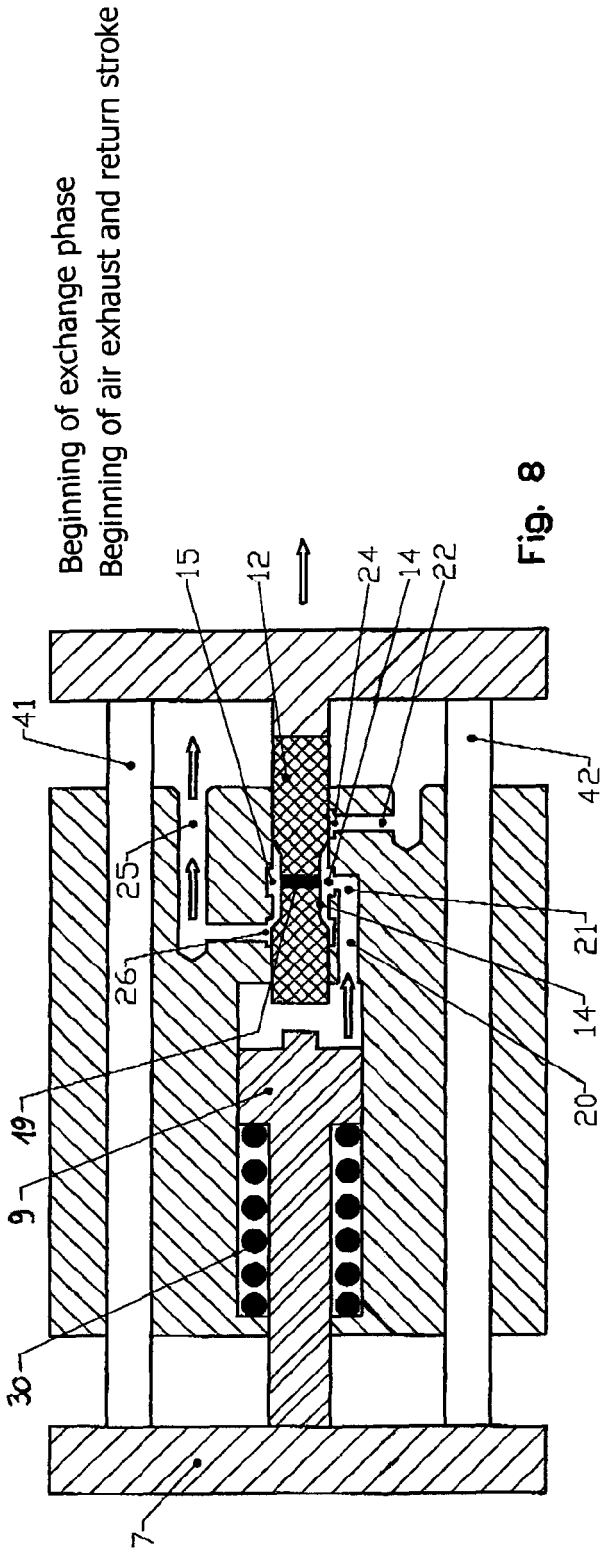
Beginning of exchange phase
Beginning of air exhaust and return stroke
15
12
24
14
22
41
42
25
21
26
14
19
20
9
30
7

Fig. 8

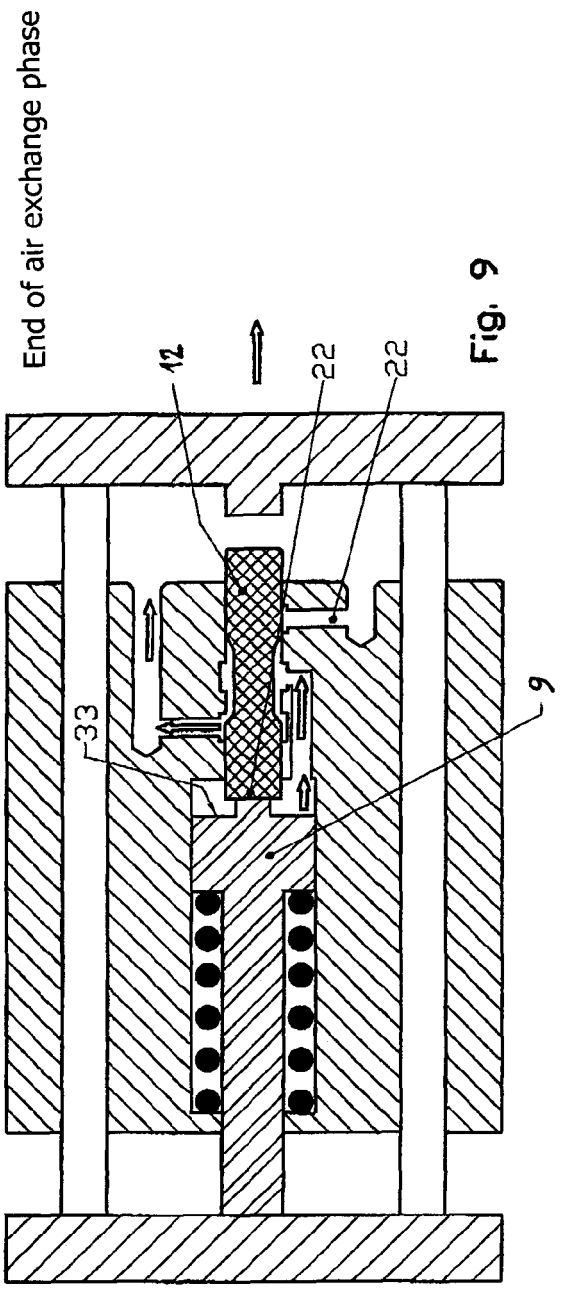
End of air exchange phase
12
22
22
33
9

Fig. 9

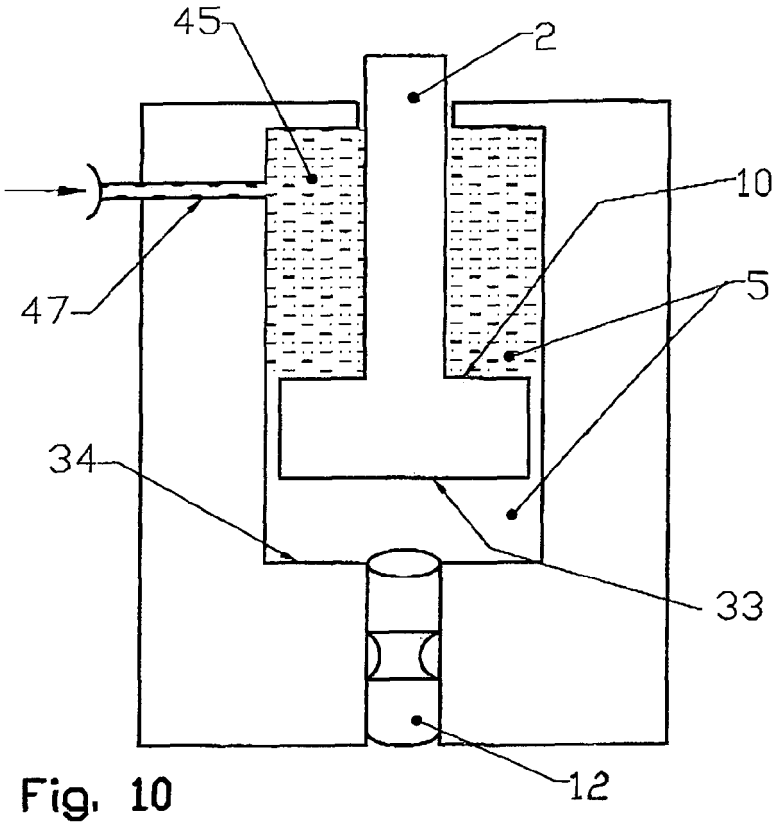

Fig. 10

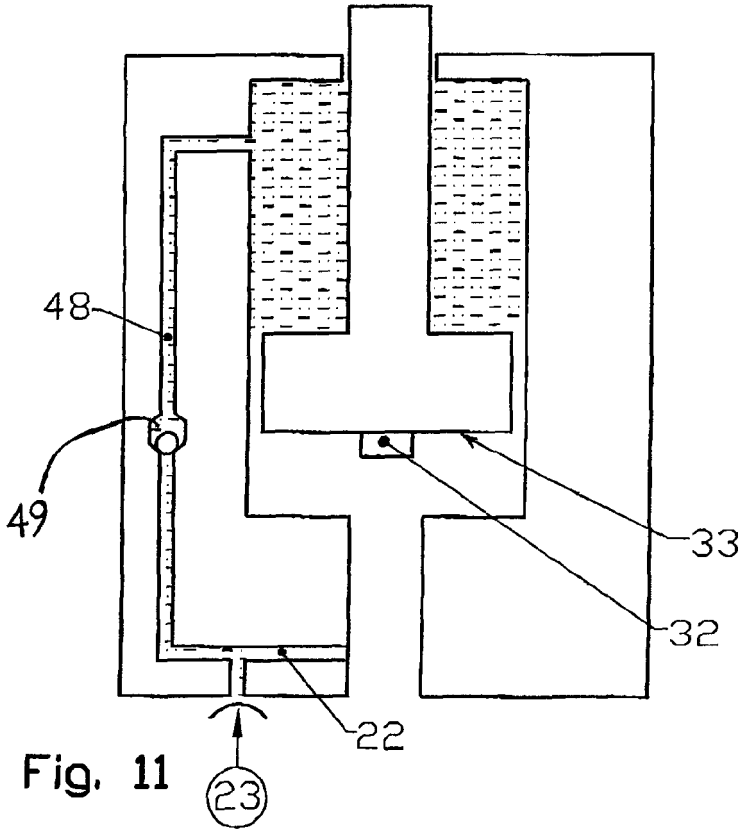

Fig. 11

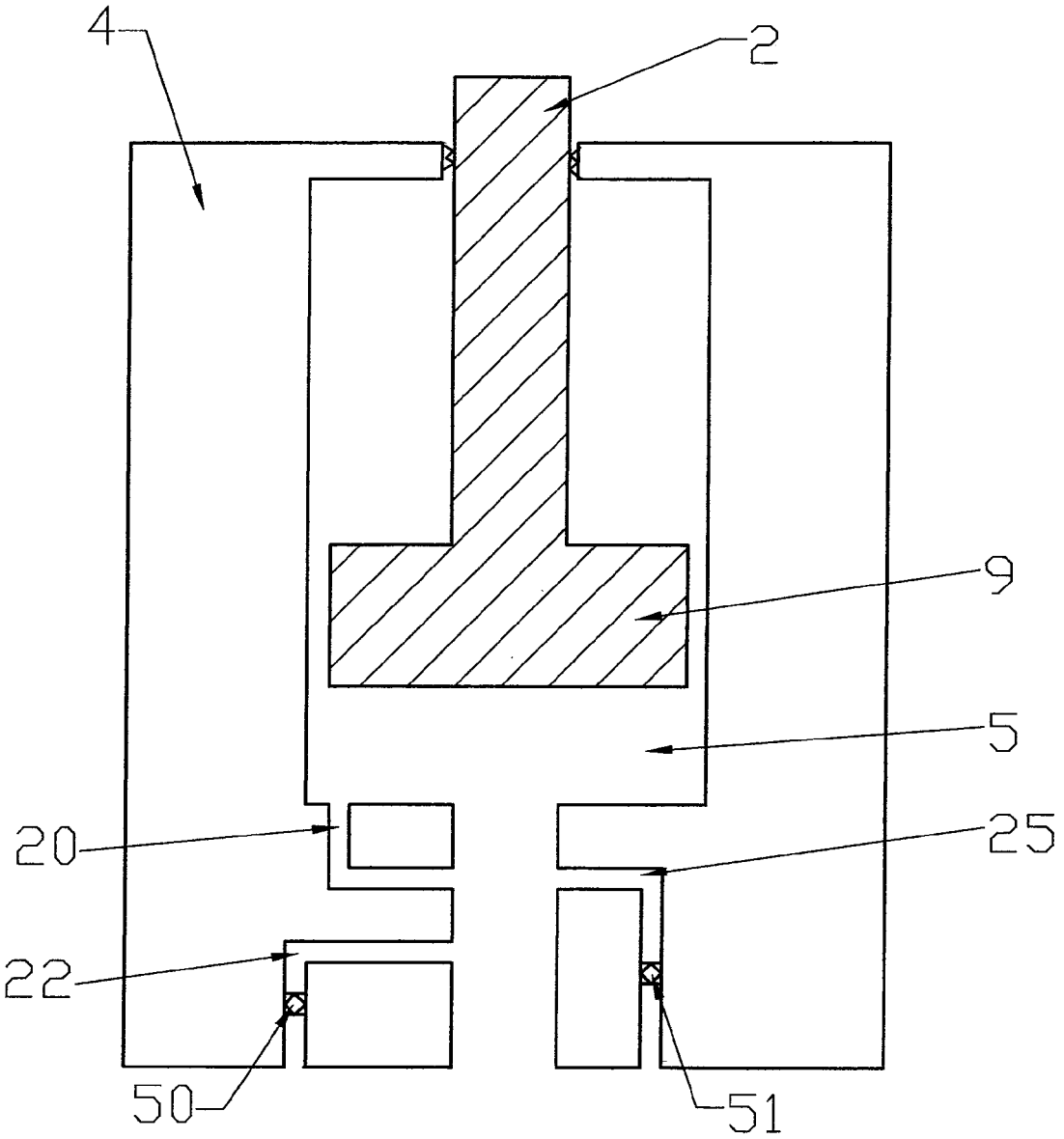

Fig. 12