(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 582 419 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **93305888.5**

(51) Int. Cl.[5] : **A62B 9/02**

(22) Date of filing : **26.07.93**

(30) Priority : **07.08.92 GB 9216860**

(43) Date of publication of application :
09.02.94 Bulletin 94/06

(84) Designated Contracting States :
DE ES FR GB IT

(71) Applicant : **SABRE SAFETY LIMITED**
Ash Road
Aldershot Hampshire, GU12 4DE (GB)

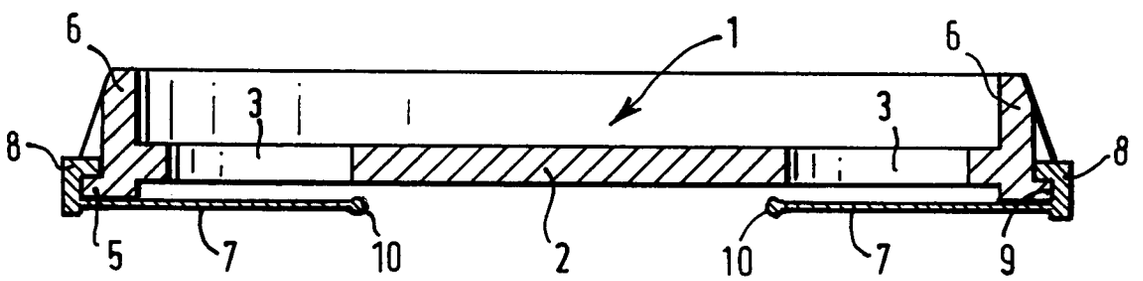
(72) Inventor : **Tatarek-Gintowt, Andrew Richard Thomas**
27 Northbrook Road
Aldershot, Hampshire GU11 3HE (GB)

(74) Representative : **Boydell, John Christopher et al**
Stevens, Hewlett & Perkins 1 Serjeants' Inn
Fleet Street
London EC4Y 1LL (GB)

(54) A valve for use with breathing apparatus and breathing apparatus incorporating the valve.

(57) A valve for use with breathing apparatus the valve comprising a rigid circular disc (1) having a solid central area (2) and a plurality of apertures (3) between the solid central area (2) and the circumference of the disc (1), and a valve member (7) which is an annular member of elastomeric material, the valve member (7) being secured over a circumferential edge of the disc (1) such that the annular valve member (7) is under tension and, in the absence of a pressure difference between opposite surfaces of the annular valve member (7) tending to move the annular valve member (7) away from the disc (1), the annular valve member (7) is maintained in a plane covering the apertures (3) in the disc (1). The valve is shown in use in breathing apparatus as an inhale valve in conjunction with a demand valve, but may also be used as an exhale valve.

FIG.1



EP 0 582 419 A1

This invention relates to a valve for use with breathing apparatus and to breathing apparatus incorporating the valve. The valve according to the present invention is capable of use as either an inhale valve or an exhale valve.

It is common practice in breathing apparatus to use simple flap valves as both inhale valves and exhale valves. Such flap valves consist of a central stem carrying a flexible essentially flat rubber disc which is capable of sealing against a surrounding surface when the stem of the valve member is placed substantially centrally in an aperture in the surface and an applied pressure difference directs the flexible disc towards the surface. The rubber disc will flex away from the surface and permit gas flow through the aperture when an opposite pressure difference exists across the disc. The rubber disc may be formed with corrugations.

However such known flap valves are liable to open partially in the absence of a pressure difference urging the disc into sealing contact with the surface surrounding the aperture. This tendency gives rise to disadvantages when a flap valve is used as the external inhale valve in breathing apparatus to be used in conditions where foreign matter may come into contact with the inhale valve. This applies particularly in the medical field where the breathing apparatus is liable to be contaminated by foreign matter such as sweat, spit or vomitus, and the contaminant may enter through the aperture into the valve mechanism or the interior of the breathing apparatus.

According to the present invention there is provided a valve for use with breathing apparatus, the valve comprising a rigid circular disc having a solid central area and a plurality of apertures between the solid central area and the circumference of the disc, and a valve member which is an annular member of elastomeric material, the valve member being secured over a circumferential edge of the disc such that the annular valve member is under tension and, in the absence of a pressure difference between opposite surfaces of the annular valve member tending to move the annular valve member away from the disc, the annular valve member is maintained in a plane covering the apertures in the disc.

The annular valve member may be maintained in contact with the solid central area of the disc. Such contact may be obtained by providing an angularly projecting lip on the free inner edge of the annular valve member or by so constructing the valve that the tensioned annular valve member naturally engages the solid central area of the disc.

Conveniently the circumferential edge of the disc is an outwardly projecting rim on the disc and the valve member is formed with an integral peripheral flange defining an inwardly facing channel, the valve member being secured to the disc by engagement of the rim of the disc in the said inwardly facing channel. The outwardly projecting rim of the disc may be displaced laterally relative to the solid central area of the disc.

In one embodiment of the present invention which will be described the disc has a peripheral flange which includes the rim and which has a circumferential recess of which the rim forms a wall, the flange on the valve member engaging in the circumferential recess.

Conveniently the apertures in the rigid disc are circular apertures the centres of which are all at the same radial distance from the centre of the disc.

The valve member may be made of silicone rubber or other suitable resiliently flexible material.

The present invention also comprehends breathing apparatus comprising means for supplying breathing gas from a source thereof to a gas delivery means for delivering breathing gas to a user, the means for supplying breathing gas including a demand valve for passing breathing gas from the source in response to a reduction of pressure on inhalation by the user, and an inhale valve located between the demand valve and the gas delivery means, the inhale valve being a valve according to the present invention as recited in the preceding paragraphs arranged such that the annular valve member moves away from the disc in response to inhalation by the user.

In breathing apparatus in accordance with the present invention the demand valve preferably includes a main valve and a pilot valve, the pilot valve comprising first and second chambers separated by a pivotally mounted diaphragm, the first chamber being connected to the inhale valve and the second chamber being connected to atmosphere, a reduction in pressure in the first chamber at the commencement of inhalation causing pivotal movement of the diaphragm to open a pilot jet communicating with the first chamber with consequential opening of the main valve to pass breathing gas from an outlet of the main valve over the solid central area of the disc on the opposite side of the disc to that over which the annular valve member is tensioned, the breathing gas also passing over an aperture defined by a cylindrical member, and the aperture communicating with the first chamber whereby an increase in the rate of breathing gas drawn through the inhale valve results in further pivoting movement of the diaphragm thereby further opening the main valve and substantially preventing an increase in the inhalation resistance of the demand valve as the rate of flow of breathing gas through the demand valve increases.

In the embodiment of this aspect of the present invention which will be described the breathing gas passes over a pair of apertures each defined by a cylindrical member and each aperture communicating with the first chamber, and the cylindrical members are located on either side of the outlet of the main valve.

The present invention will be further understood from the following detailed description of preferred embodiments thereof which is made, by way of example, with reference to the accompanying drawings, in which

Figure 1 shows in cross-section a first embodiment of a valve in accordance with the present invention

Figure 2 shows in cross-section another embodiment of a valve in accordance with the present invention

Figure 3 is a cross-sectional view through a demand valve incorporating an inhale valve in accordance with the present invention,

Figure 4 is a cross-sectional view of the arrangement of Figure 3 taken along the line IV-IV of Figure 3 and illustrating a means for maintaining an inhalation resistance substantially independent of the rate of gas flow through the inhale valve, and

Figure 5 is a cross-sectional view, similar to Figure 4, of a modified form of valve according to the present invention suitable for use in forcing breathing gas into a patient's lungs.

In the drawings the same or similar parts are designated by like reference numerals.

Referring to Figure 1 of the accompanying drawings there is shown a valve comprising a rigid circular disc 1 of a plastics material such as polysulphone or acetal. The disc 1 has a solid central area 2 and, around the solid central area 2, a series of circular apertures 3, 3 the centres of which are all at the same radial distance from the centre of the disc. The disc 1 is formed with an outwardly extending rim 5 displaced laterally relative to the solid central area 2 of the disc 1, the rim 5 being of lesser thickness than the body of the disc which includes the solid central area 2. The disc 1 also includes a flange 6 which is substantially perpendicular to the plane of the disc 1 and which extends from the disc 1 in the opposite direction to the direction of lateral displacement of the rim 5.

The valve illustrated in Figure 1 further includes a valve member 7 consisting essentially of a resiliently flexible annulus formed, for example, of silicone rubber. The inner edge 10 of the annular valve member 7 defines an aperture of a smaller diameter than the solid central area 2 of the disc 1.

Formed integrally with the annular valve member 7 is a flange 8 which defines an inwardly facing channel 9. The annular valve member 7 is secured over the rim 5 which is the circumferential edge of the disc 1 by engaging the rim 5 in the inwardly facing channel 9 defined by the flange 8 of the annular valve member 7 so that the annular valve member 7 is held in tension on the disc 1.

The tension in the annular valve member 7 results in the annular valve member 7 being maintained in the planar position illustrated in Figure 1 in the absence of a significant pressure difference between opposite surfaces of the annular valve member 7.

The rim 5 of the disc 1 may alternatively be arranged such that the surface of the rim 5 over which the annular valve member 7 is tensioned is in the same plane as the adjacent surface of the solid central area 2. The free inner edge 10 of the annular valve member 7 will then contact the surface of the solid central area 2 of the disc 1.

An alternative embodiment of a valve in accordance with the present invention is illustrated in Figure 2. The valve of Figure 2 differs from the valve of Figure 1 in the means of securing the annular valve member 7 to the disc 1 and in the provision at the free inner edge of the annular valve member 7 of a continuous angularly projecting lip 11 ensuring contact between the annular valve member 7 and the solid central area 2 of the disc 1 in the absence of a significant pressure difference across the annular valve member 7.

The disc 1 illustrated in Figure 2 has its flange 6 formed with a circumferential recess 12 adjacent the rim 5 so that the rim 5 constitutes a wall of the circumferential recess 12. The flange 8 on the annular valve member 7 then engages over the rim 5 and into the recess 12, the projection on flange 8 being shaped to fit precisely into the recess 12.

The valve of either Figure 1 or Figure 2 may advantageously be used as an inhale valve in conjunction with a demand valve in breathing apparatus for supplying breathing gas, for example oxygen, to a user such as a patient. Figures 3 and 4 show part of one embodiment of breathing apparatus incorporating the valve of the present invention with a pilot-operated demand valve.

Referring to Figures 3 and 4 of the accompanying drawings breathing gas from a suitable source, for example a piped hospital gas supply, is fed to a channel 21 which is an inlet channel of a main valve and which is terminated by a valve member which is a resilient disc 22. The disc 22 has a small central aperture 23 through which gas passes to a channel 24 and a pilot jet 25 which is normally closed by a pivotally mounted diaphragm 26 which constitutes a partition separating a first chamber 27 from a second chamber 28. The second chamber 28 is connected to atmosphere by an aperture 29 and the diaphragm 26 is biased by springs (not shown) to keep the pilot jet 25 closed.

The main valve has an outlet 31 to which breathing gas is supplied from channel 21 via apertures 32 when the resilient disc 22 is caused to bow away from its valve seat when the pilot jet 25 is opened.

An inhale valve essentially similar to the valve described with reference to Figure 1 is mounted adjacent the outlet 31 from the main valve so that breathing gas passing through the main valve strikes the solid central area 2 of the disc 1 of the inhale valve.

As shown more particularly in Figure 4 a pair of

cylindrical members 35 and 36 define apertures leading to the first chamber 27 . The cylindrical members 35 and 36 are located on diametrically opposite sides of the outlet 31 from the main valve and the cylindrical members 35 and 36 are situated so that the apertures defined thereby partially overlap the solid central area 2 of the disc 1 of the inhale valve and are relatively closely spaced from the solid central area 2.

The breathing apparatus illustrated in Figures 3 and 4 further includes a passage 38 leading to a mouthpiece or face mask used by a wearer such as a patient and further includes an exhale valve 39 which is a flap valve constituted by an annulus located in a recess 40 in the external surface of the wall which defines the passage 38.

In Figure 4 of the accompanying drawings the breathing apparatus is shown in the inhale mode in the right half of the drawing and in the exhale mode in the left half of the drawing.

In operation at the commencement of inhalation there is a reduction in pressure in passage 38 which is communicated through the inhale valve to the first chamber 27 as a result of which the diaphragm 26 pivots about pivots 37 to open the pilot jet 25 thus permitting the resilient disc 22 to bow away from the valve seat 30 and allowing breathing gas to flow from the channel 21 through the ports 32 and through the outlet 31. The breathing gas then strikes the solid central area 2 of the disc 1 of the inhale valve and flows outwardly past the apertures defined by the cylindrical members 35 and 36, the outward flow being restrained by the flange 6 on the disc 1 and the chamber defined thereby adjacent to the apertures 3, 3 etc. in the disc 1. The pressure difference thus created across the annular valve member 7 causes the annular valve member 7 to flex away from the disc 1 against the tension in the annular valve member 7 enabling breathing gas to flow through the passage 38 for use as shown at 41 in Figure 4.

As the rate of flow of breathing gas past the apertures defined by the cylindrical members 35 and 36 increases this gas flow will effect a further reduction in pressure in the first chamber 27 by the Bernoulli effect. The diaphragm 26 is thus caused to pivot further, enabling the resilient disc 22 to bow further and a greater volume of breathing gas to pass through the main valve. The provision and location of the apertures defined by the cylindrical members 35 and 36 and communicating with the first chamber 27 of the pivot valve enable a substantial equalisation of resistance to inhalation to occur over a wide range of gas flows to the patient or other user of the breathing apparatus.

Exhale valve 39 remains closed throughout inhalation. However, when the patient or other wearer of the breathing apparatus exhales, the annular valve member 7 resumes its normal position closing apertures 3, 3, as shown on the left half of Figure 4, and the exhale valve 39 opens permitting exhaled gases to pass freely to atmosphere.

If breathing apparatus in accordance with the present invention is to be used in forcing breathing gas into a patient's lungs, for example in artificial respiration, the construction of the apparatus should be such that, when the annular valve member 7 is flexed away from the disc 1 by the gas under pressure, the annular valve member 7 contacts a continuous surface and prevents escape of gas via the exhale valve 39.

This effect may be achieved by modifying the construction of the apparatus of Figure 4 to reduce the distance D between the upper end of the wall which defines passage 38 and the plane in which the annular valve member 7 is tensioned in the absence of a pressure difference across it.

Alternatively the effect may be achieved as illustrated in Figure 5 of the accompanying drawings by using, in order to define passage 38, a tube 42 which extends upwardly well beyond the level at which the exhale valve 39 is mounted to the external surface of the tube 42. When the annular valve member 7 is forced open under applied gas pressure, as shown in the right-hand half of Figure 5, the annular valve member 7 contacts the upper edge of tube 42 and prevents the applied gas from opening the exhale valve 39 with the result that all the applied breathing gas is forced into the patient's lungs.

The use of an inhale valve according to the present invention in breathing apparatus such as that described with reference to Figures 3, 4 and 5 impedes any foreign matter or contaminants from passing through the inhale valve into the apertures defined by the cylindrical members 35, 36 and the interior mechanisms of the demand valve. The presence of the cylindrical members 35, 36 is a further obstacle to contaminants entering chamber 27 of the pilot valve.

Variations in the flow/inhalation resistance characteristic can be made by using differently constructed discs 1 having different heights H for the flange 6 and using different heights for the distance which the cylindrical members 35 and 36 extend from the horizontal wall of the housing towards the disc 1.

Although the method of substantially equalising the resistance to inhalation over a range of rates of gas flow has been described in connection with a particular breathing apparatus, the method may be used in other breathing apparatus. The method may also be used to produce another desired flow/inhalation resistance characteristic.

According to this aspect, therefore, the present invention also comprehends breathing apparatus comprising means for supplying breathing gas from a source thereof to a gas delivery means for delivering breathing gas to a user, the means for supplying breathing gas including a demand valve and an inhale valve, the demand valve having a chamber containing

a diaphragm which is movable in response to a reduction of pressure in the chamber on inhalation by the user for causing breathing gas to be passed from the source through an outlet from the demand valve and thence through the inhale valve to the user, the inhale valve having a solid central area and circumferential apertures which are normally closed but which open to permit passage of inhale gas, the outlet from the demand valve being located adjacent the solid central area of the inhale valve so that gas flows over the solid central area substantially parallel thereto, and at least one cylindrical member, which defines an aperture leading to the chamber of the demand valve which contains the diaphragm, being located adjacent the gas flow over the solid central area of the inhale valve whereby an increase in the rate of breathing gas drawn through the inhale valve results in further movement of the diaphragm to open the demand valve further and moderate any increase in the inhalation resistance of the demand valve as the rate of flow of breathing gas through the demand valve increases. The arrangement may be selected to prevent any substantial increase in the inhalation resistance of the demand valve with increase in the rate of flow of breathing gas.

The demand valve used in this aspect of the invention may be a simple demand valve, or a pilot-operated demand valve. The only restriction on the type of demand valve is that the demand valve must incorporate a diaphragm controlling movement of a valve member such that the movement of the valve member to open the demand valve is generally proportional to the movement of the diaphragm.

Claims

1. A valve for use with breathing apparatus, the valve comprising a rigid circular disc having a solid central area and a plurality of apertures between the solid central area and the circumference of the disc, and a valve member which is an annular member of elastomeric material, the valve member being secured over a circumferential edge of the disc such that the annular valve member is under tension and, in the absence of a pressure difference between opposite surfaces of the annular valve member tending to move the annular valve member away from the disc, the annular valve member is maintained in a plane covering the apertures in the disc.

2. A valve according to Claim 1 wherein, in the absence of the said pressure difference, the annular valve member is maintained in contact with the solid central area of the disc.

3. A valve according to Claim 1 or Claim 2 wherein the circumferential edge of the disc is an outwardly projecting rim and the valve member is formed with an integral peripheral flange defining an inwardly facing channel, the valve member being secured to the disc by engagement of the rim of the disc in the said inwardly facing channel.

4. A valve according to Claim 3 wherein the rim of the disc is displaced laterally relative to the solid central area of the disc.

5. A valve according to Claim 3 or Claim 4 wherein the disc has a peripheral flange which includes the rim and which has a circumferential recess of which the rim forms a wall, the flange on the valve member engaging in the circumferential recess.

6. A valve according any one of the preceding Claims wherein the apertures in the rigid disc are circular apertures the centres of which are all at the same radial distance from the centre of the disc.

7. A valve according to any one of Claims 1 to 6 wherein the valve member is made of silicone rubber.

8. Breathing apparatus comprising means for supplying breathing gas from a source thereof to a gas delivery means for delivering breathing gas to a user, the means for supplying breathing gas including a demand valve for passing breathing gas from the source in response to a reduction of pressure on inhalation by the user, and an inhale valve located between the demand valve and the gas delivery means, the inhale valve being a valve according to any one of the preceding claims arranged such that the annular valve member moves away from the disc in response to inhalation by the user.

9. Breathing apparatus according to Claim 8 wherein the demand valve includes a main valve and a pilot valve, the pilot valve comprising first and second chambers separated by a pivotally mounted diaphragm, the first chamber being connected to the inhale valve and the second chamber being connected to atmosphere, a reduction in pressure in the first chamber at the commencement of inhalation causing pivotal movement of the diaphragm to open a pilot jet communicating with the first chamber with consequential opening of the main valve to pass breathing gas from an outlet of the main valve over the solid central area of the disc on the opposite side of the disc to that over which the annular valve member is tensioned, the breathing gas also passing over

an aperture defined by a cylindrical member, and the aperture communicating with the first chamber whereby an increase in the rate of breathing gas drawn through the inhale valve results in further pivoting movement of the diaphragm thereby further opening the main valve and substantially preventing an increase in the inhalation resistance of the demand valve as the rate of flow of breathing gas through the demand valve increases.

10. Breathing apparatus according to Claim 9 wherein the breathing gas passes over a pair of apertures each defined by a cylindrical member and each aperture communicating with the first chamber, and the cylindrical members are located on either side of the outlet of the main valve.

11. Breathing apparatus comprising means for supplying breathing gas from a source thereof to a gas delivery means for delivering breathing gas to a user, the means for supplying breathing gas including a demand valve and an inhale valve, the demand valve having a chamber containing a diaphragm which is movable in response to a reduction of pressure in the chamber on inhalation by the user for causing breathing gas to be passed from the source through an outlet from the demand valve and thence through the inhale valve to the user, the inhale valve having a solid central area and circumferential apertures which are normally closed but which open to permit passage of inhale gas, the outlet from the demand valve being located adjacent the solid central area of the inhale valve so that gas flows over the solid central area substantially parallel thereto, and at least one cylindrical member, which defines an aperture leading to the chamber of the demand valve which contains the diaphragm, being located adjacent the gas flow over the solid central area of the inhale valve whereby an increase in the rate of breathing gas drawn through the inhale valve results in further movement of the diaphragm to open the demand valve further and moderate any increase in the inhalation resistance of the demand valve as the rate of flow of breathing gas through the demand valve increases.

12. Breathing apparatus according to Claim 11 wherein the further movement of the diaphragm to open the demand valve is selected to prevent any substantial increase in the inhalation resistance of the demand valve with increase in the rate of flow of breathing gas.

FIG.1

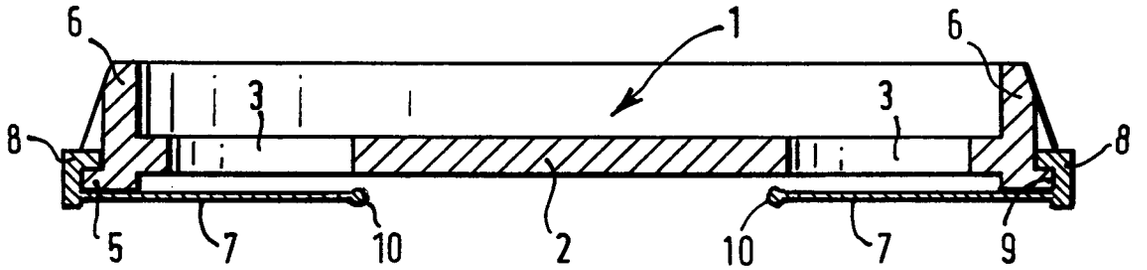


FIG.2

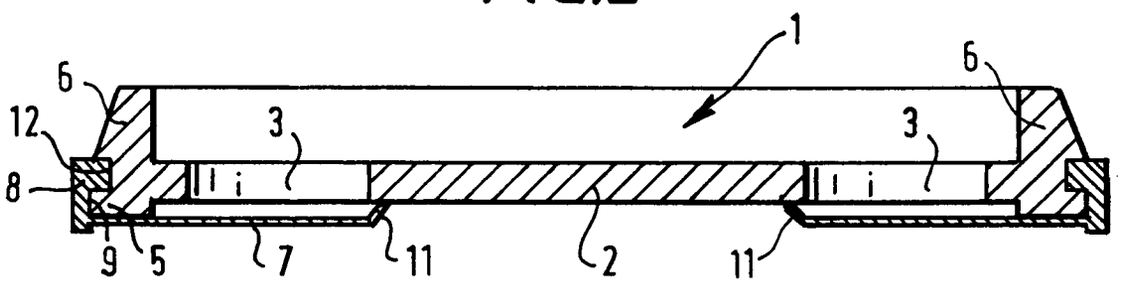


FIG.3

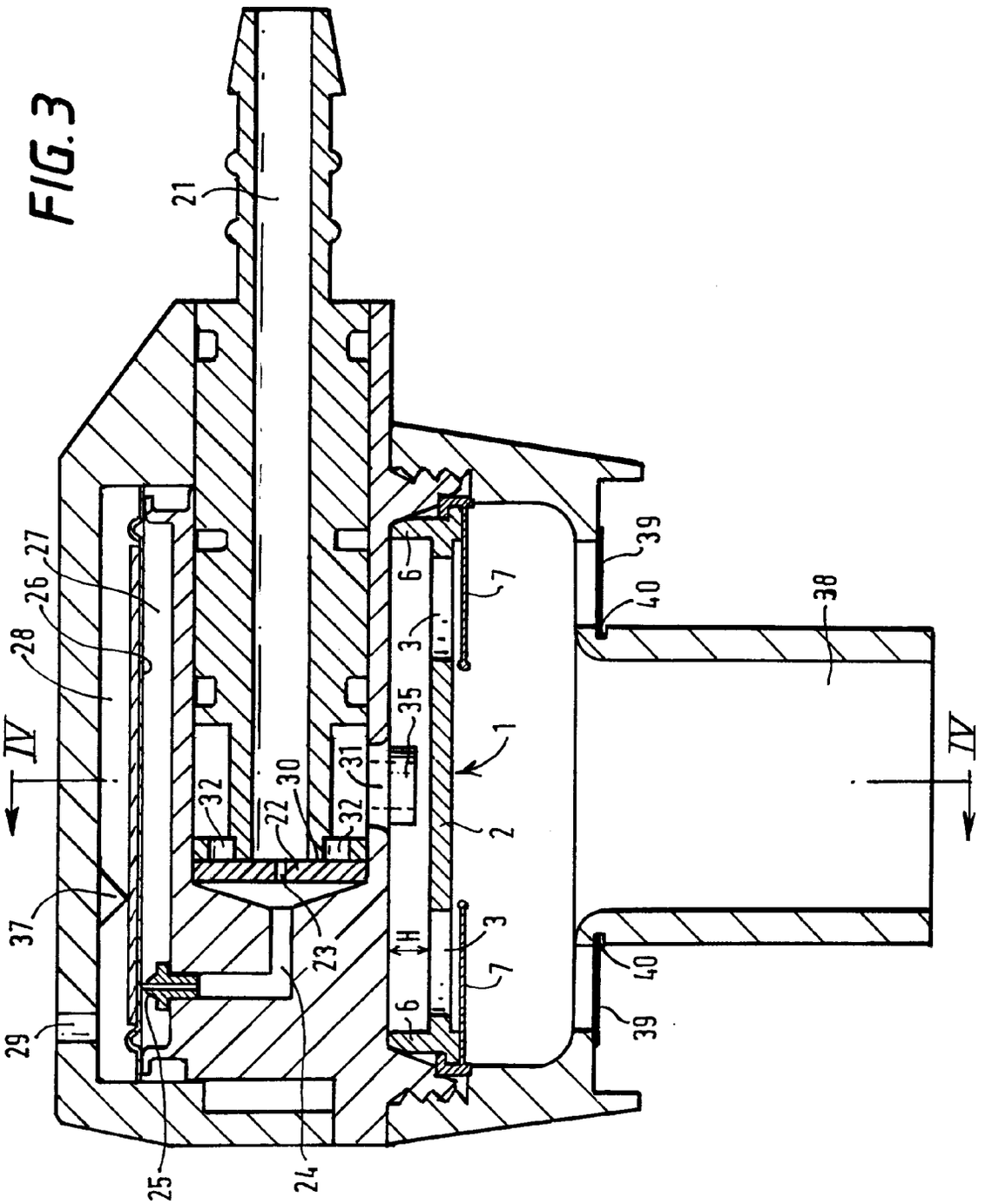


FIG. 4

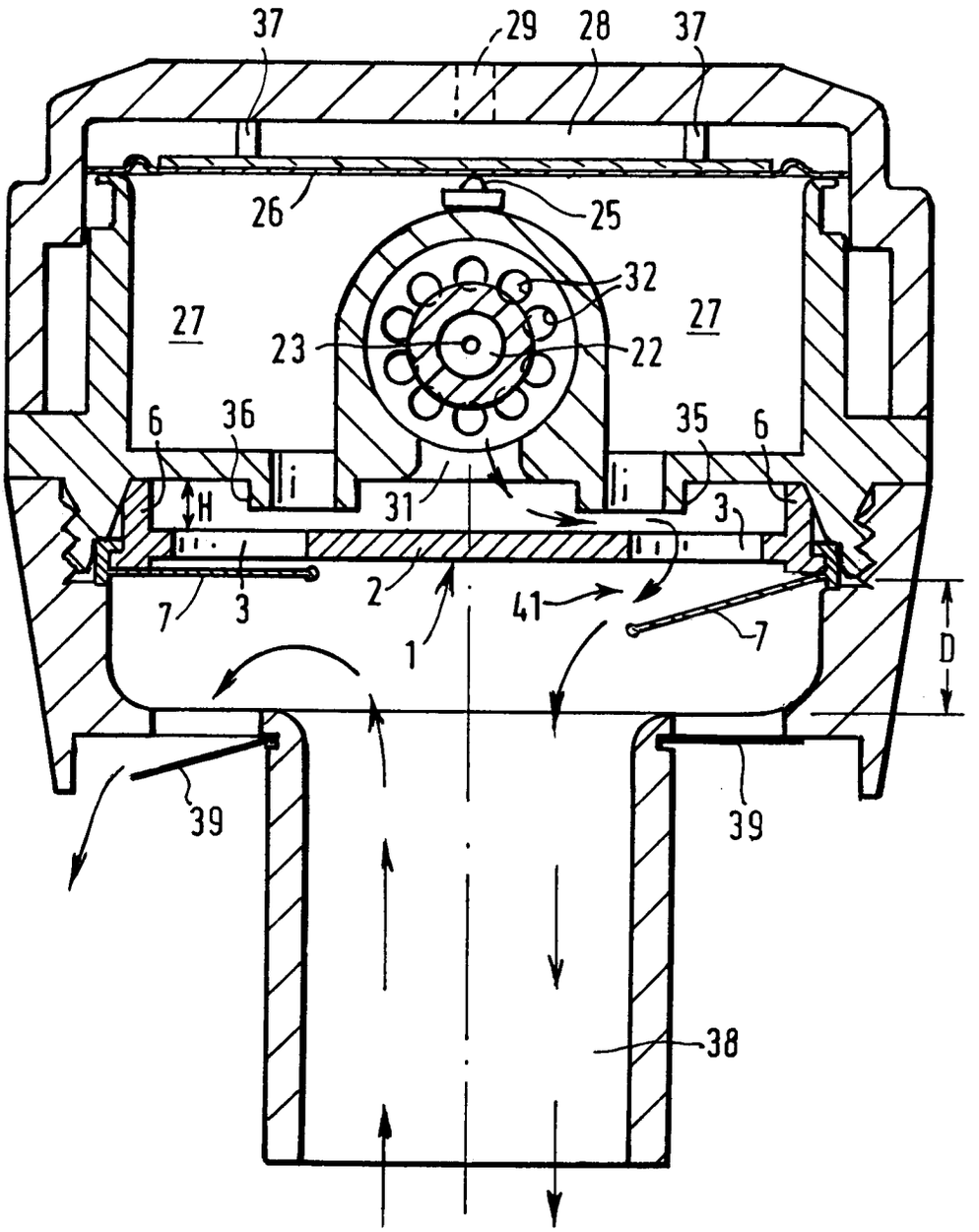
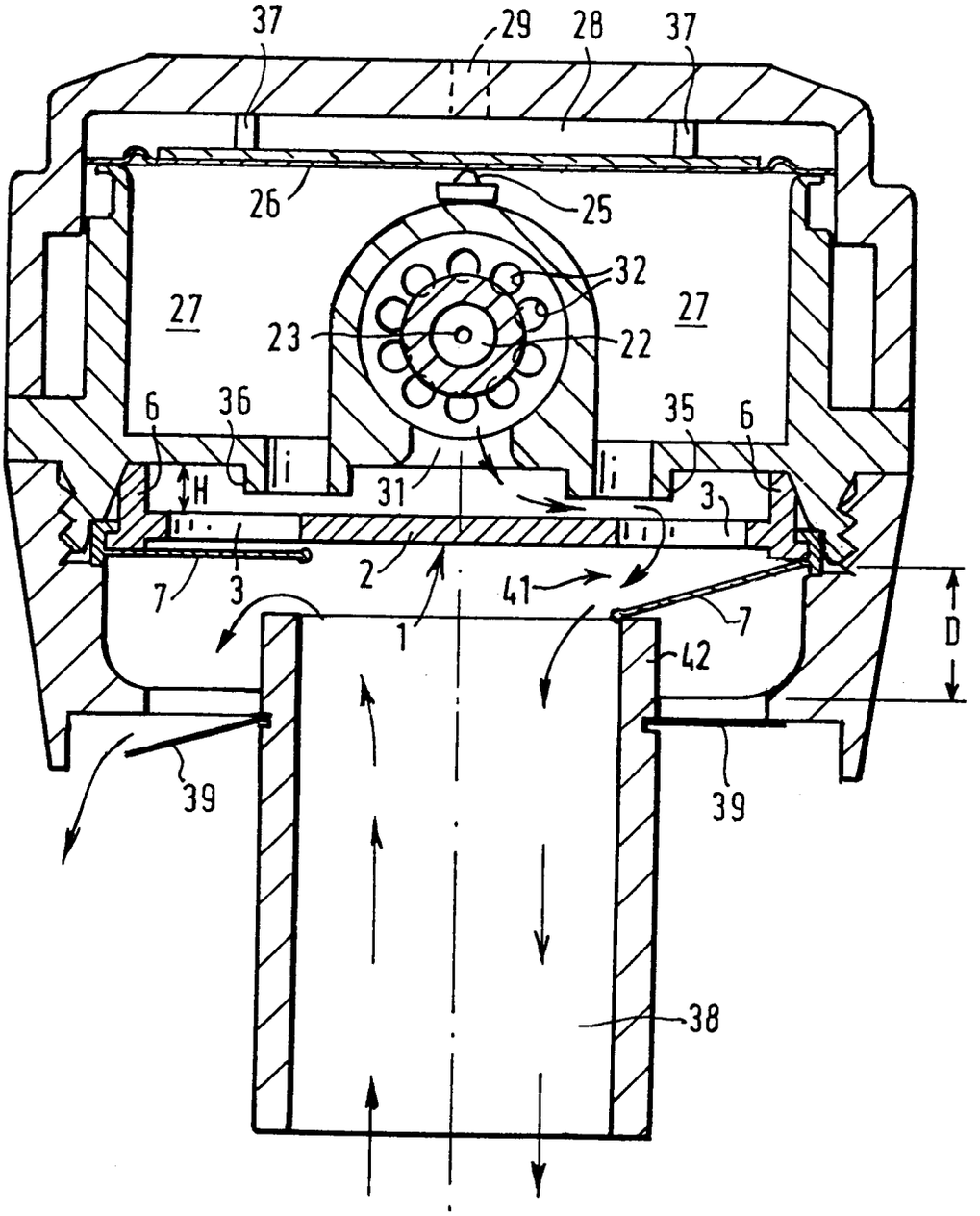


FIG. 5



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 5888

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X Y A	US-A-2 640 481 (CONLEY) * column 4, line 25 - line 63 * * column 6, line 21 - line 42; figures 4,10 *	1,2,6 7 3-5,8-12	A62B9/02
Y A	US-A-4 428 392 (JONES) * column 3, line 27 - line 28 * * column 3, line 46 - line 48; figure 3 *	7 8-12	
A	EP-A-0 260 021 (JACKSON) * the whole document *	8-12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5) A62B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 November 1993	SIDERIS, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)