US00RE40591E

(19) **United States**
(12) **Reissued Patent**
Denyer

(10) **Patent Number: US RE40,591 E**
(45) **Date of Reissued Patent: Dec. 2, 2008**

(54) **ATOMIZER**

(75) Inventor: **Jonathan Stanley H. Denyer**, Chichester (GB)

(73) Assignee: **Profile Respiratory Systems Limited**, West Sussex (GB)

(21) Appl. No.: **09/425,031**

(22) Filed: **Oct. 19, 1999**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **5,687,912**
Issued: **Nov. 18, 1997**
Appl. No.: **08/556,093**
Filed: **Nov. 9, 1995**

(51) **Int. Cl.**
A61M 11/00 (2006.01)

(52) **U.S. Cl.** **128/200.18**; 128/200.21; 239/343; 239/338; 239/366

(58) **Field of Classification Search** ..... 128/200.17, 128/200.18, 200.19, 200.21, 200.22, 200.12; 239/4, 318, 337, 338, 339, 365, 366, 368, 239/370, 371, 423, 424, 424.5, 433, 434; 261/78.1, DIG. 65
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,535,844	A		12/1950	Emerson	
2,785,679	A	*	3/1957	Wullschleger	128/200.18
3,206,175	A	*	9/1965	Boteler	128/200.22
3,302,374	A	*	2/1967	Szekely	96/260
3,398,897	A	*	8/1968	Urbanowicz	239/358
3,467,092	A		9/1969	Bird et al.	
3,516,771	A	*	6/1970	Rendina	239/338 X
3,591,090	A	*	7/1971	Carden	128/200.22
3,630,196	A		12/1971	Bird et al.	
3,658,059	A	*	4/1972	Steil	128/200.21
3,664,337	A	*	5/1972	Lindsey et al.	128/200.18
3,838,686	A		10/1974	Szekely	
3,874,379	A		4/1975	Enfield et al.	
3,990,442	A		11/1976	Patneau	
4,200,093	A	*	4/1980	Camp	128/200.14
4,333,450	A	*	6/1982	Lester	128/200.14
4,368,850	A	*	1/1983	Szekely	239/333
4,429,835	A	*	2/1984	Brugger et al.	239/338
4,566,451	A	*	1/1986	Badewien	128/200.21
4,657,007	A	*	4/1987	Carlin et al.	128/200.21
4,792,097	A	*	12/1988	Kremer, Jr. et al.	239/338
5,054,477	A		10/1991	Terada et al.	
5,165,392	A	*	11/1992	Small, Jr.	128/200.18
5,277,175	A		1/1994	Riggs et al.	
5,301,663	A		4/1994	Small, Jr.	
5,398,714	A		3/1995	Price	
5,503,139	A	*	4/1996	McMahon et al.	128/200.18
5,533,497	A		7/1996	Ryder	
5,533,501	A		7/1996	Denyer	
5,584,285	A		12/1996	Salteg et al.	
5,630,409	A		5/1997	Bono et al.	
6,116,233	A	*	9/2000	Denyer et al.	128/200.18

FOREIGN PATENT DOCUMENTS

DE	3429411	*	2/1986
EP	170715	*	2/1986
EP	0587380		3/1994
EP	627266	*	12/1994
FR	1 070292		7/1954
GB	675524		7/1952

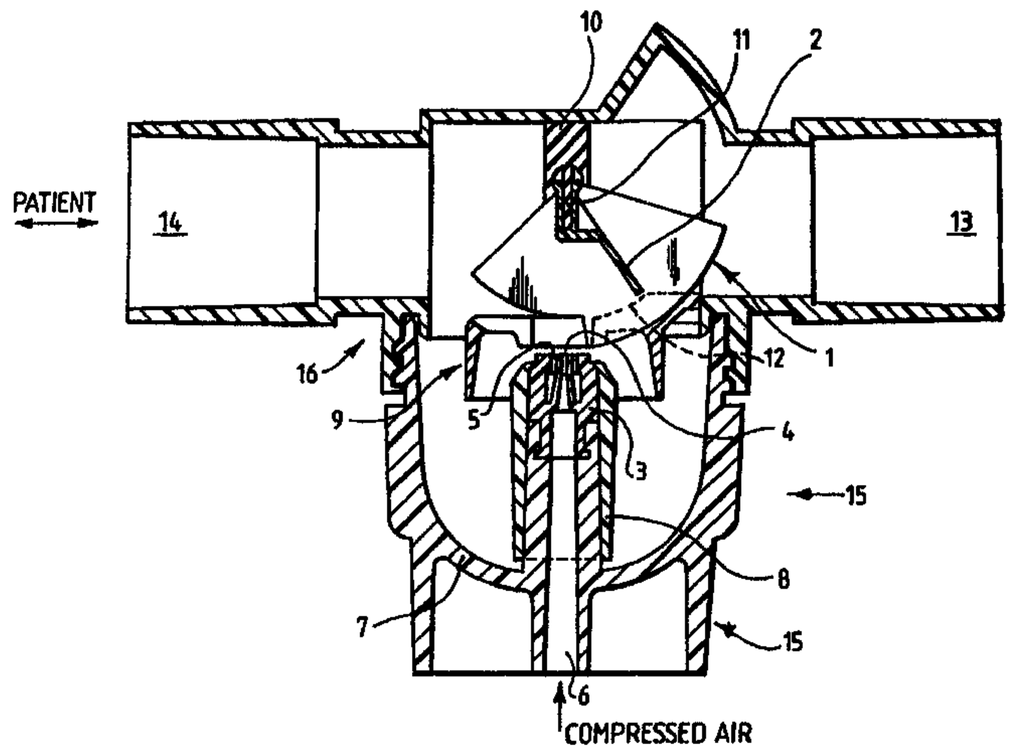
* cited by examiner

Primary Examiner—Steven O Douglas
(74) *Attorney, Agent, or Firm*—Pillsbury Winthrop Shaw Pittman LLP

(57) **ABSTRACT**

An atomizer including a gas exit, an outlet adjacent the gas exit, and a deflector for deflecting gas issuing from the gas exit over the outlet for drawing a substance to be atomized out from one outlet and atomizing the substance in the gas issuing from the gas exit characterised in that the deflector is movable between a first position in the path of the gas issuing from the gas exit for atomization and a second and non-atomizing position.

66 Claims, 7 Drawing Sheets



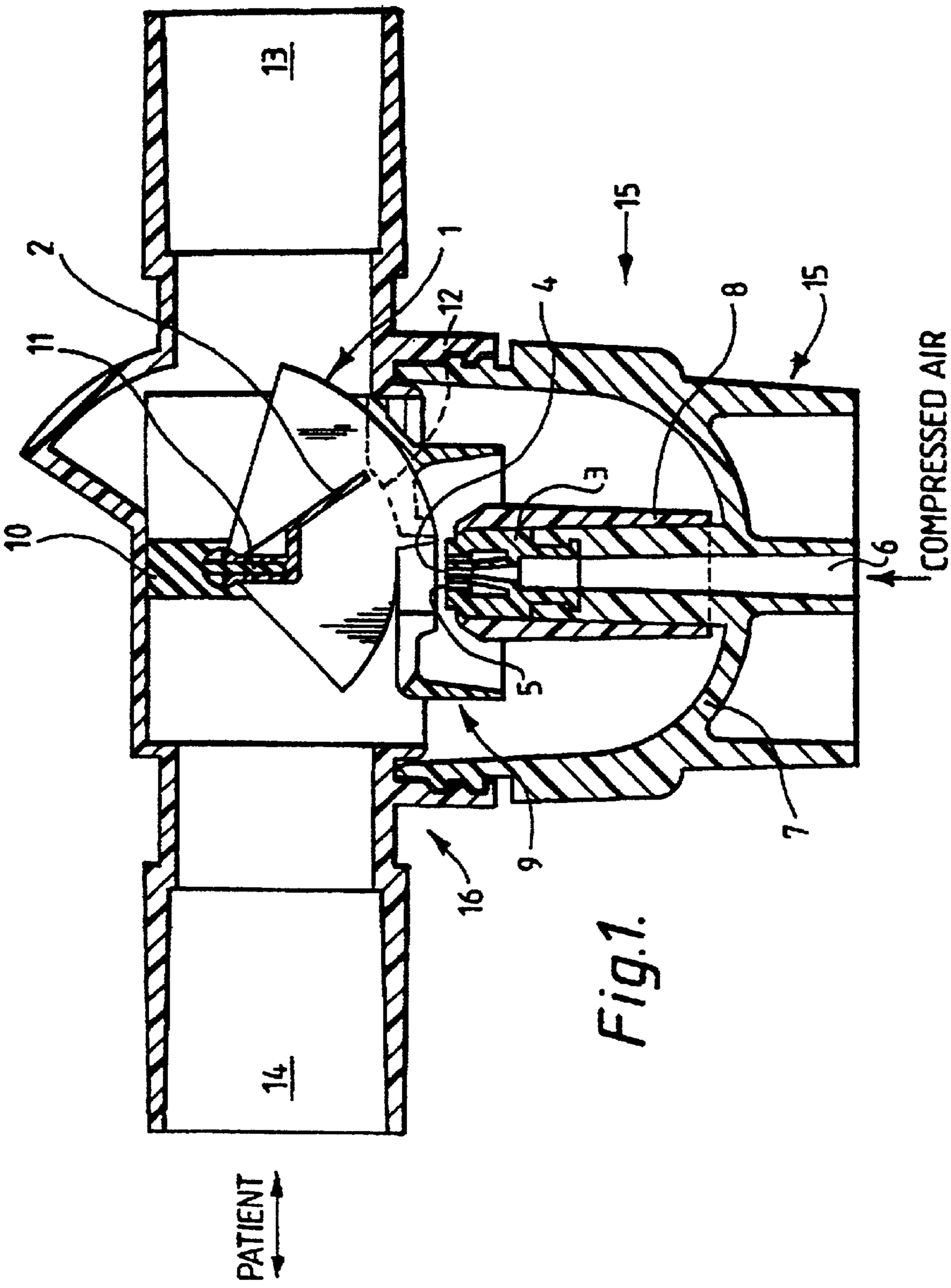


Fig. 1.

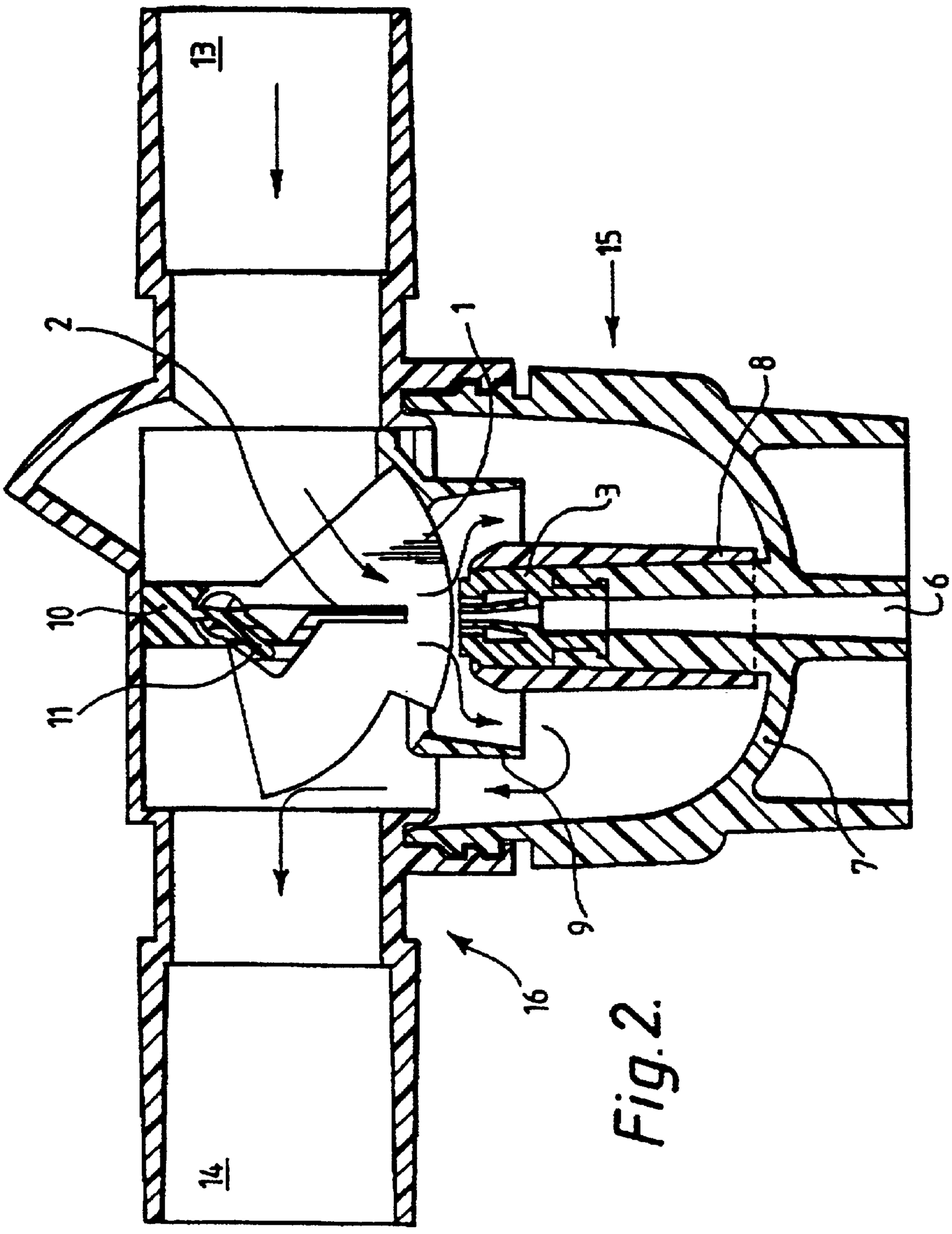


Fig. 2.

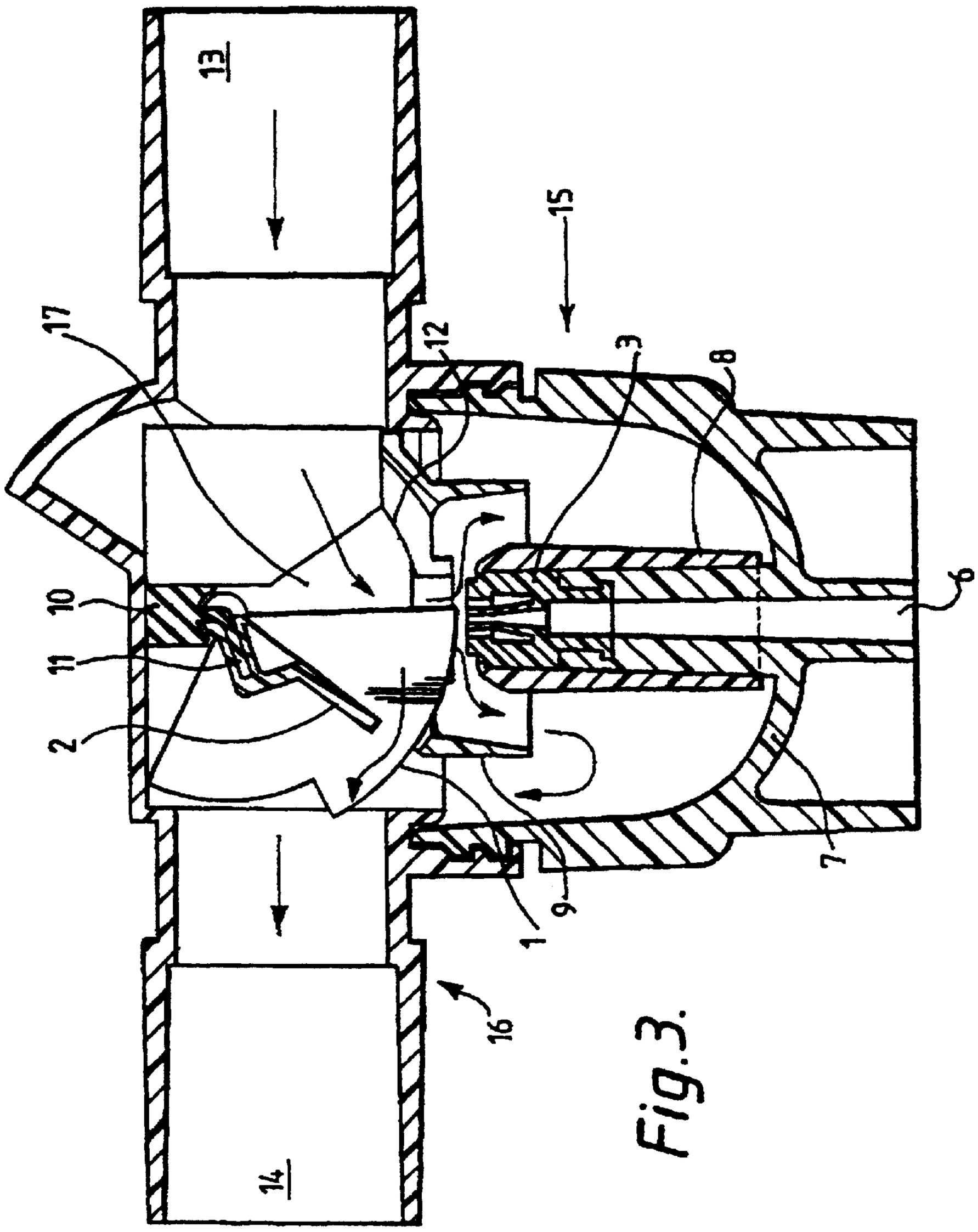


Fig.3.

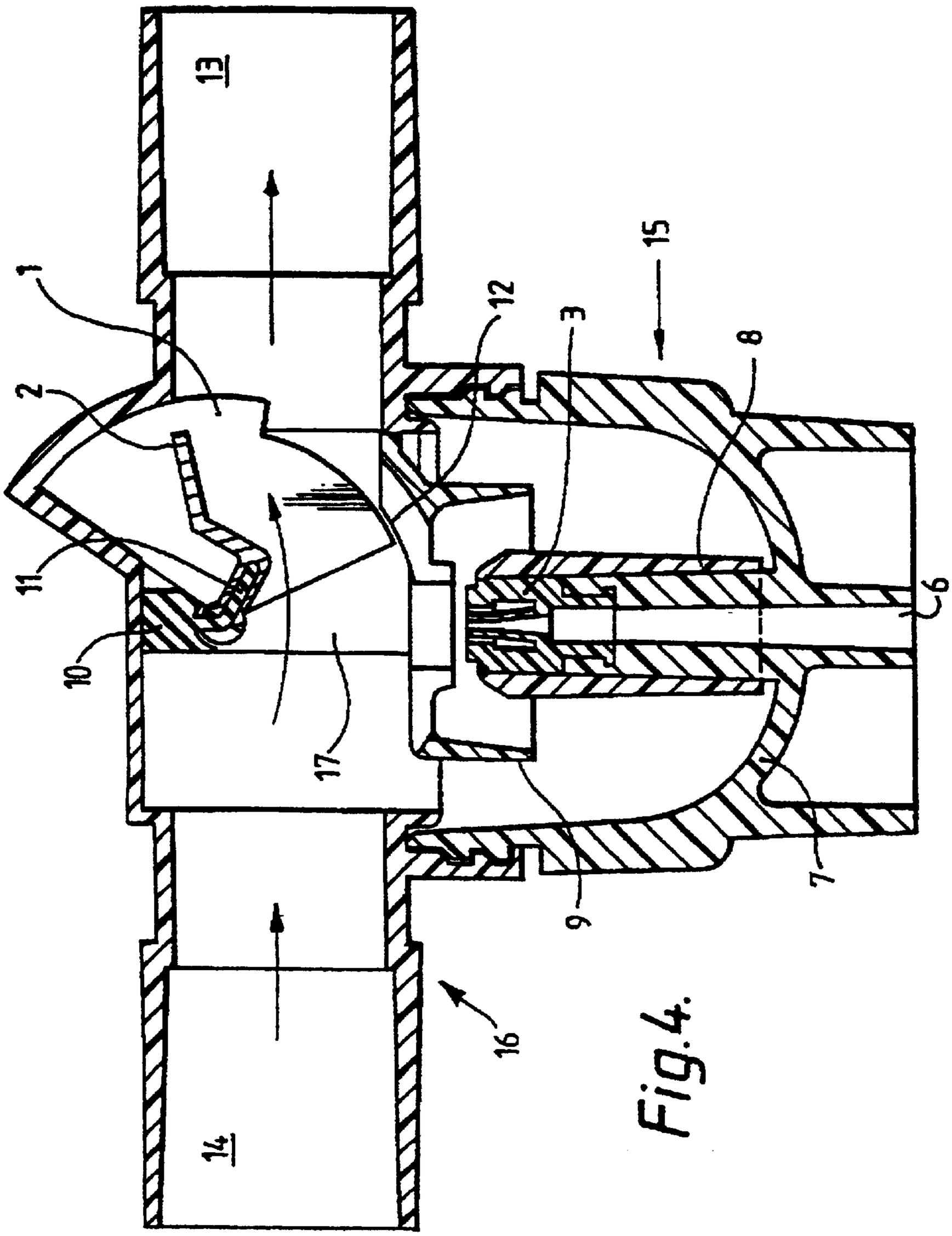


Fig.4.

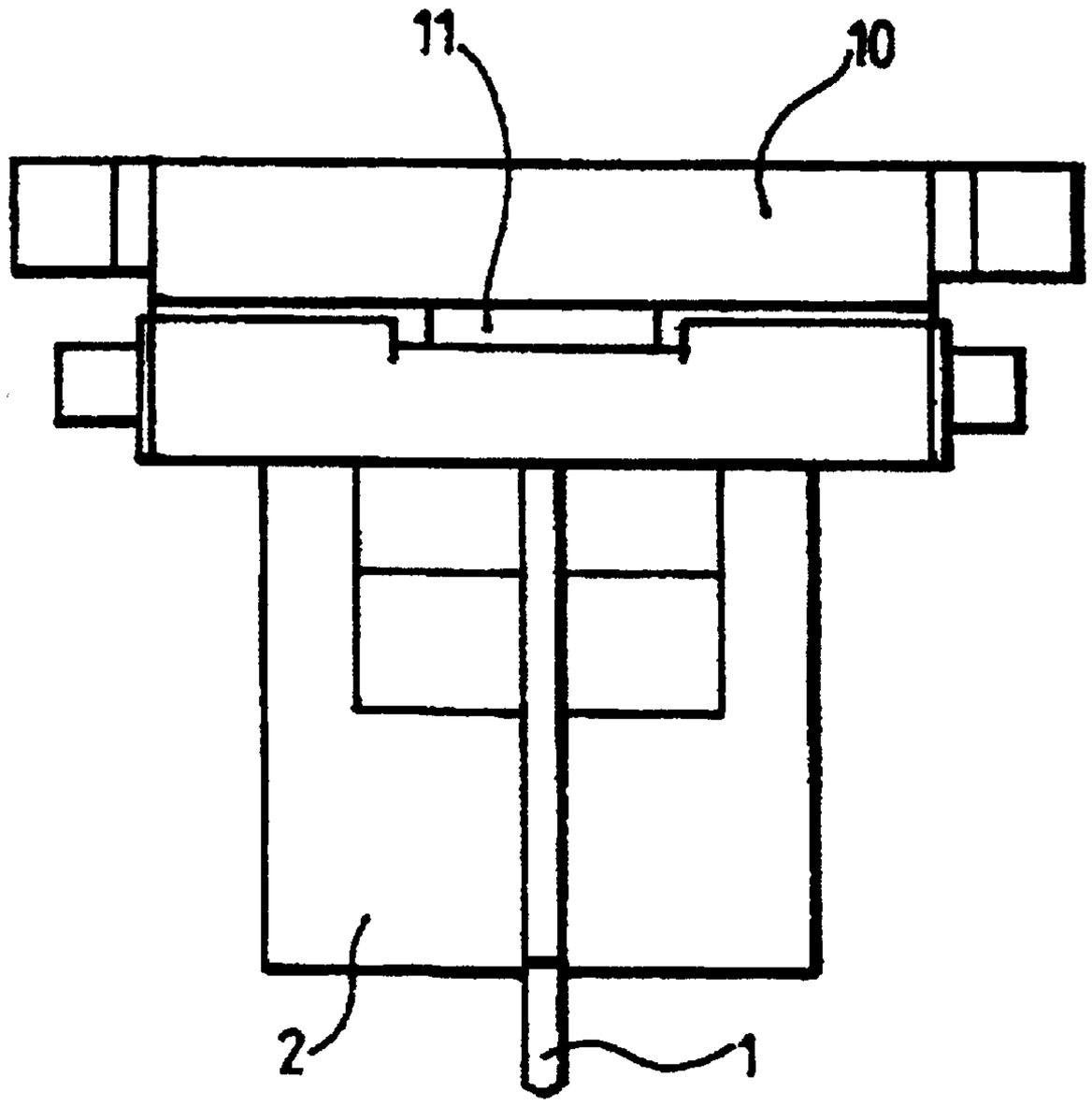


Fig.5.

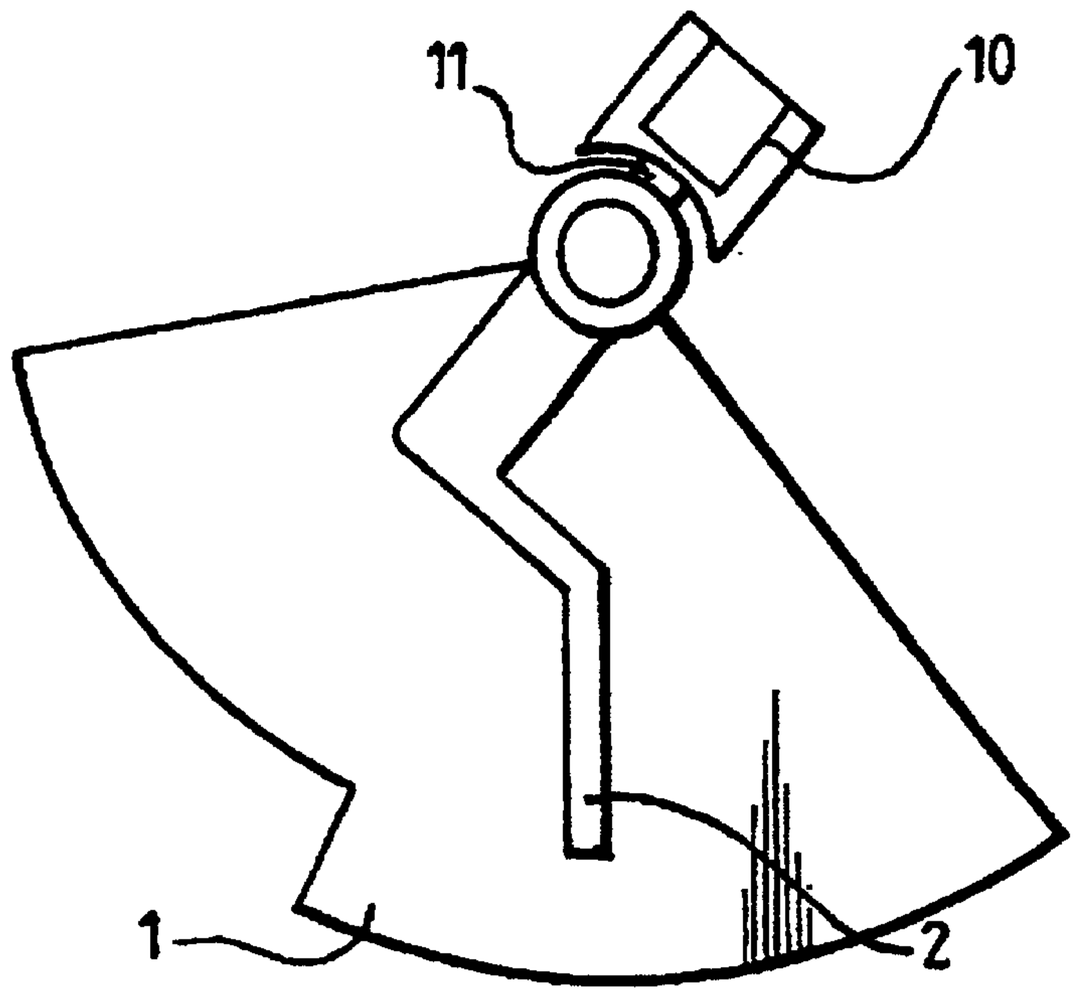
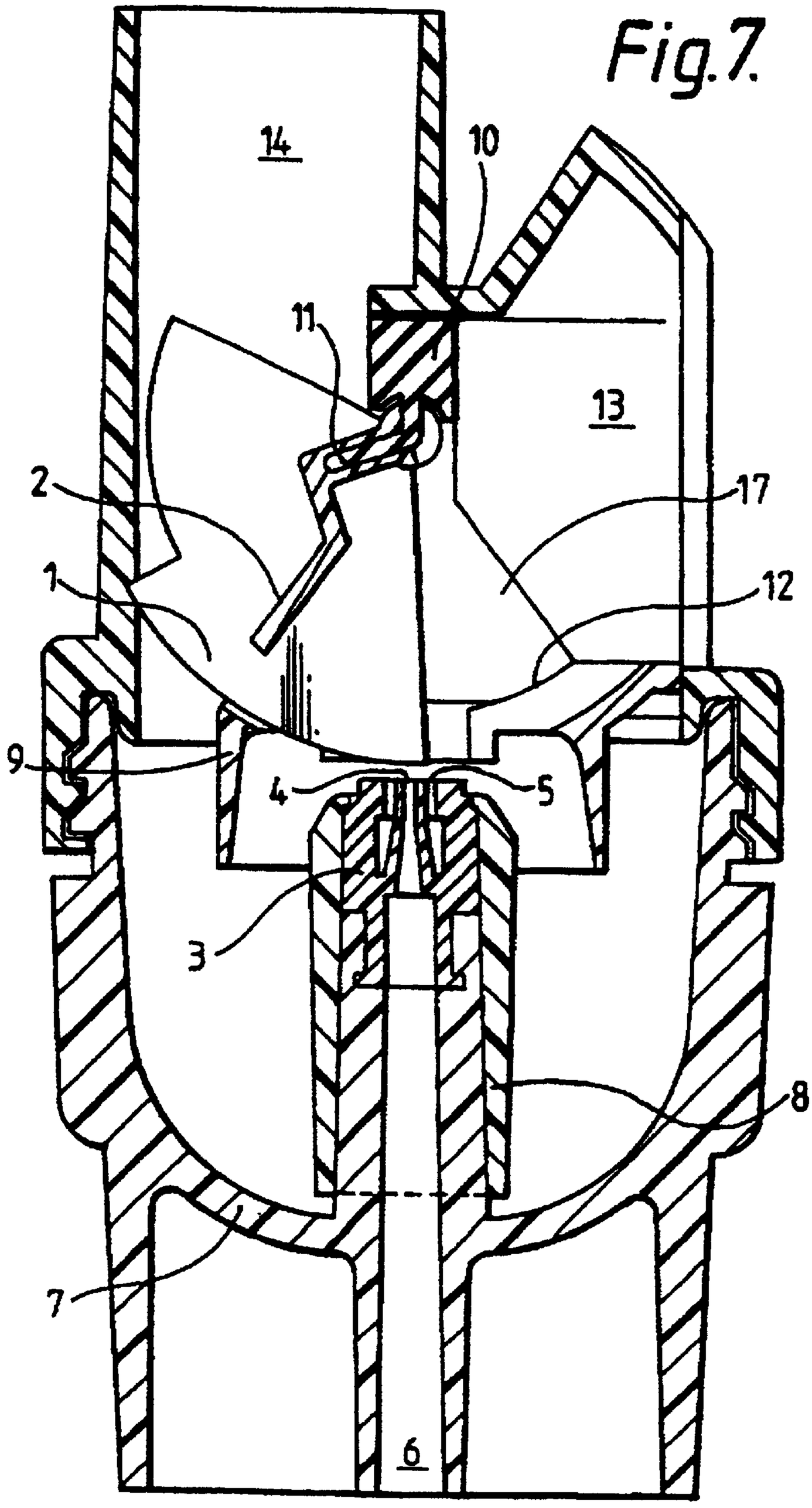


Fig.6.

Fig.7.



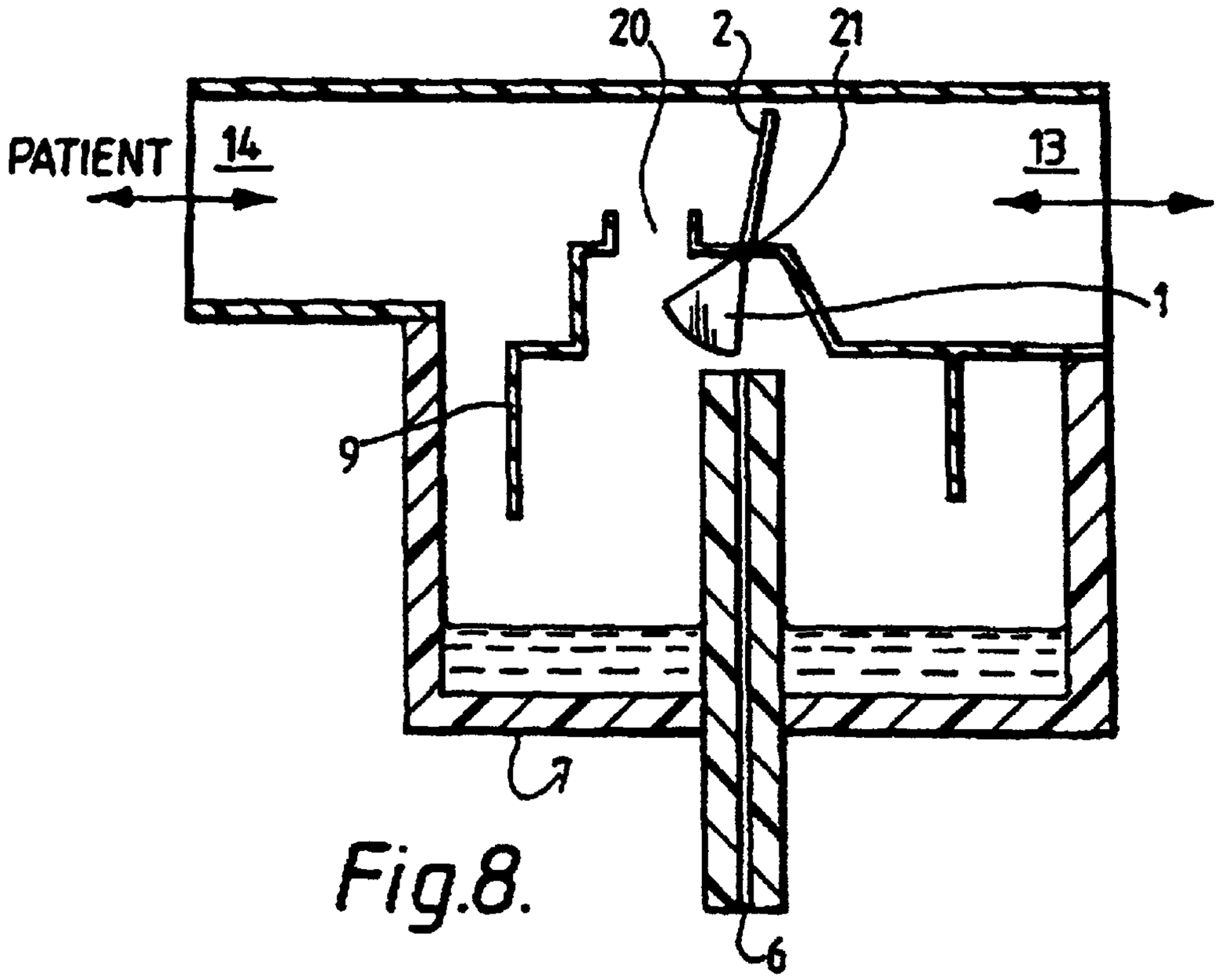


Fig.8.

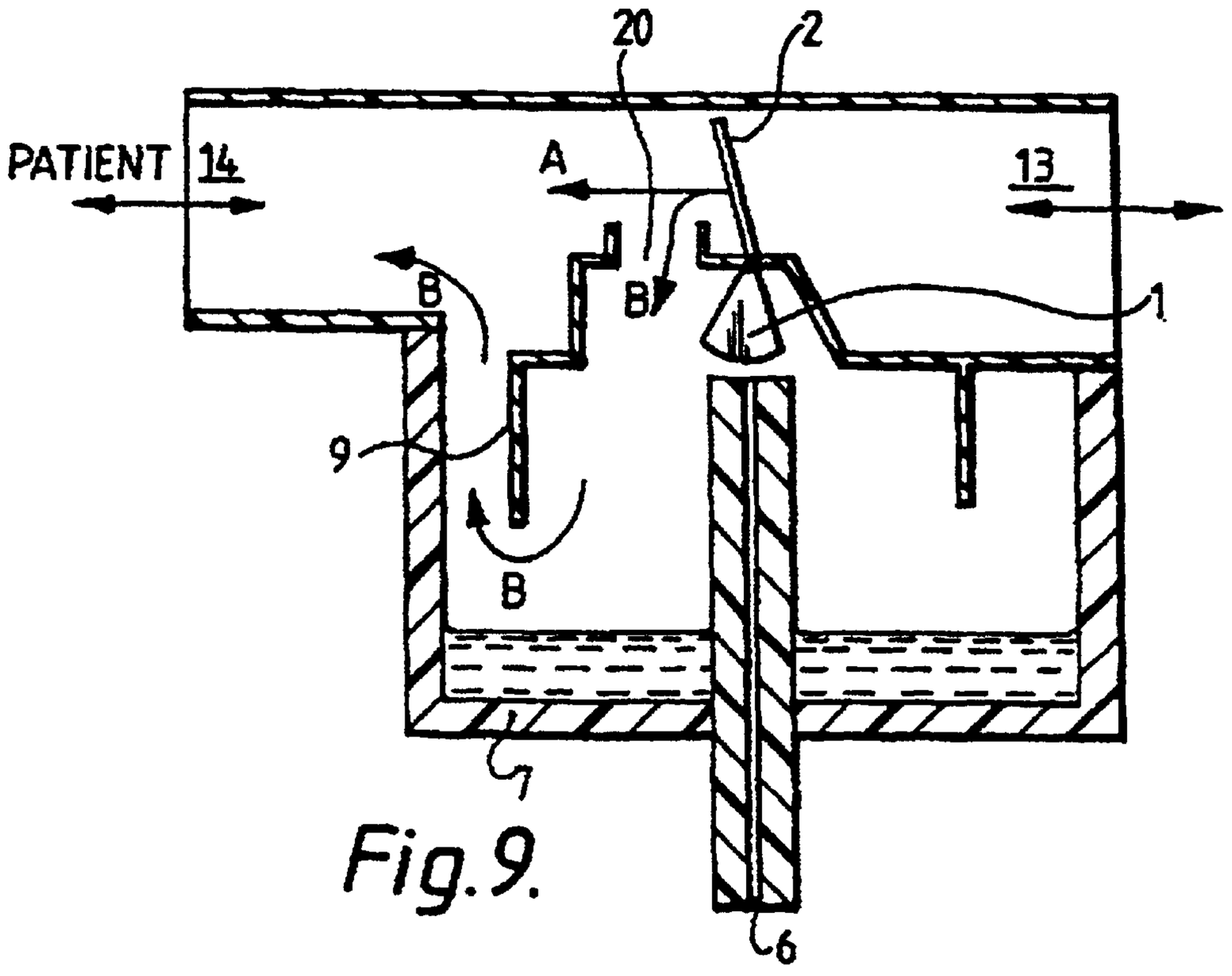


Fig.9.

ATOMIZER

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

More than one reissue application has been filed for U.S. Pat. No. 5,687,912, including U.S. application Ser. No. 12/060,577, filed Apr. 1, 2008, which is a continuation of this reissue application.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to atomizers and, in particular, to atomizers of the type which include a gas exit, at least one outlet in the region of the gas exit and a deflector for deflecting gas issuing from the gas exit across the at least one outlet whereby a substance to be atomized is drawn out of the at least one outlet and atomized. These atomizers atomize liquids or powders into the gas.

Most conventional atomizers of the above type operate continuously whether atomization is required or not. Strictly speaking, when such atomizers, frequently called nebulisers, are used in medical applications, atomization is only required during the inhalation phase of a breathing cycle so that a drug can be administered by deposition in the lungs. In practice a patient usually inhales for about 30 percent of the breathing cycle, consequently, use of a continuously operating atomizer results in a large proportion of the atomized drug being wasted.

Some designs of medical atomizer overcome such wastage by giving the patient a trigger to start the atomization when they begin to inhale. Such a trigger controlled type of atomizer is not satisfactory since the patient must coordinate inhalation with trigger operation.

In one conventional atomizer a gas duct leads gas under pressure to a gas exit, a reservoir for holding the substance to be atomized is formed around the base of the gas duct, and a sleeve placed around the gas duct defines a passageway through which the substance to be atomized may pass to at least one outlet. A fixed deflector in the form of a bar is disposed in line with the gas outlet so that gas issuing from the gas exit is defected so as to pass over the outlet or outlets. The passage of gas over each outlet draws the substance to be atomised from the reservoir, through the passageway to each outlet. The deflected gas atomizes the substance, and atomized particles of the substance are carried away during the inhalation phase of the patient since the patient breathes air or gas in through the atomizer some of the drug is lost while the patient is not inhaling.

Atomizers are used in other applications. For example, powders or liquid may be sprayed from a jet, the liquid or powder being atomized and entrained by a propellant. In conventional sprays, operation is controlled by a valve for releasing propellant. When the valve is released, the spraying operation is stopped and some of the liquid or powder collects in the jet since insufficient propellant has been released. The collected spray either dries to block the jet or is propelled by a re-started spraying operation in large droplets. Where paint is being sprayed, this causes splatter and uneven deposition on a surface to be painted.

It is an object of this invention to reduce at least some of the above disadvantages of the above-mentioned prior art.

The present invention is defined in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are described below by way of example only with reference to the accompanying drawings in which:

FIG. **1** shows a first embodiment of the invention in a relaxed position;

FIG. **2** shows the first embodiment of the invention in a first operational position in which atomization takes place;

FIG. **3** shows the first embodiment of he invention in a second operational position in which atomization takes place;

FIG. **4** shows the first embodiment of the invention in a third operational position in which no atomization takes place;

FIGS. **5** and **6** show one embodiment of the flap valve and gas deflector;

FIG. **7** shows a second embodiment of the invention in a second operational position in which atomization takes place,

FIG. **8** shows a further embodiment of the invention in which the movable baffle bar is located beneath the baffle, and

FIG. **9** shows the further embodiment during inhalation by a patient.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to FIGS. **1** to **4**, an atomizer includes a gas duct **6** which leads gas under pressure to a gas exit **4** within a jet head **3**. The gas duct **6** passes through a wall of a reservoir **7** within which a substance to be atomised is held. A sleeve **8** is disposed around the jet head **3** and the gas duct **6**. Passages are formed between the inner surface of the sleeve **8** and the outer surface of the gas duct **6** for leading the substance to be atomized from the reservoir **7** to outlets **5** in the jet head adjacent to the gas exit **4**. For atomization of the substance to take place, a deflector **1** must be placed in the path of the pressurised gas exiting from the gas exit **4** so that it is redirected to pass directly over the outlets **5**. This flow of pressure air draws the substance to be atomized from the reservoir **7**, through the passage between the sleeve **8** and the gas duct **6** to the outlets **5**. The flow of pressure air atomizes the substance as the substance leaves the outlets **5**.

A downwardly and outwardly shaped baffle **9** is disposed around the jet head **3** to deflect the atomized substance downwards before it is carried away. It is important that the substance is atomized into very fine droplets. In medical applications, the substance to be atomized is a drug for administering to a patient by lung deposition. The finer the droplets, the deeper into the lungs the drug will pass. This maximises the deposition of the drug. Larger droplets collect on the inside of the baffle **9** where they coalesce to drop back down into the reservoir **7**.

The atomizer also includes an air inlet **13** and an air outlet **14**. In the above-mentioned medical application, as a patient inhales, ambient air is drawn into the atomizer through the inlet **13**. The air then passes into the region of the air exit **4** and outlets **5** where droplets are entrained by the inhaled ambient air. The air then passes down under the baffle **9** before passing upwardly and out via the air outlet **14** carrying droplets of the drug to the patient. This action is described in more detail in British Patent application 9219327.5 and U.S. Pat. No. 5,533,501, which are hereby imported into this description in their entirety.

A planar arcuate gas deflector **1** is mounted above the gas exit to be movable about a pivot in that plane. The gas deflector **1** may be disposed across the gas exit **4**, in which case atomization takes place, or may be disposed away from the gas exit **4**, in which case no atomization takes place.

A vane **2** is joined to the deflector bar **1** so as to be pivotally mounted and to move with the deflector bar **1**. The flap **2**

responds to the breathing pattern of a patient by moving around the pivot.

When the apparatus is not in use, the vane assumes the positions shown in FIG. **1** in which the gas deflector is not disposed across the gas exit. The vane forms a partial seal against a curved surface **12** (shown in outline). Even when pressure gas is issuing from the gas exit, no atomization takes place since the deflector is not disposed in the path of the gas.

When a patient inhales, ambient air is drawn into the atomizer through the air inlet **13**. The vane **2** is displaced into the position shown in FIG. **2** permitting and directing the ambient air to pass into the region of the gas exit before being directed downwardly and outwardly around the baffle. The air then escapes via the air outlet **14** to the patient. The displacement of the flap moves the deflector bar into the path of the gas issuing from the gas exit. Atomization therefore begins as soon as the patient begins to breath in. The atomized drug is carried away by the air passing through the atomizer. The vane must move only a few degrees before the deflector bar **1** is brought into position to commence atomization, but must move a few more degrees before breaking the seal between the flap and the curved surface to permit ambient air to enter the nebulizer. This ensures that the deflector is fully in position and atomizing cleanly before the ambient air passes through the atomizer to carry the droplets away.

The deflector extends further from the pivot than the flap so that the deflector can be positioned very close to the gas exit without obstruction from the flap. The curved surface **12** against which the vane seals therefore includes an arcuate slot through which the deflector may pass.

If the patient inhales sharply or quickly, the vane **2** assumes the position shown in FIG. **3** wherein the deflector bar **1** remains in the path of the gas exit so that atomization takes place, but excess air passes directly from the air inlet **13** to the air outlet **14** without entraining the atomized substance. The main reason for this is that the efficiency of entrainment of droplets decreases where air passes through the atomizer too quickly since a proportion of droplets will impact against the walls of the atomizer. A typical optimum flow rate is of the order of twenty five liters per minute.

When the patient exhales, the vane **2** is displaced to a position as shown in FIG. **4** where the deflector is displaced such that it is not in the path of the gas exit. Atomization therefore does not occur, and so no drug is wasted. The vane allows exhaled air to pass directly from the air outlet **14** to the air inlet **13** without having to pass through the atomizing chamber. The combination of the vane **2** and the deflector **1** therefore constitutes a one-way valve.

When the patient is not breathing in or out, the vane **2** is biased towards the position shown in FIG. **1**. The vane **2** and deflector **1** are mounted on a rubber tongue **11** extending from a fixed rubber block **10**. The vane **2** and deflector **1** are therefore resiliently mounted.

The atomizer shown in FIGS. **1** to **4** includes three separable units. A base unit **15** includes the reservoir **7**, the gas duct **6**, the jet head **3** and outlets **5**. The reservoir **7** includes a threaded rim. An upper unit **16** includes three air inlet **13**, and the air outlet **14**. The baffle **9**, sleeve **8**, frame members **17**, the vane **2**, gas deflector **1**, the rubber tongue **11** and the fixed rubber block **10** constitute the third unit. Separation of the third unit permits the atomizer to be more easily cleaned. The vane **2** and gas deflector are connected to the air inlet **13** in the upper unit **16**, and to the baffle **9** since the gas deflector **1** must pass though a slot in the baffle. The sleeve **8** may be part of the base unit **15**, or part of the third unit.

FIGS. **5** and **6** show the vane **2** and deflector **1** mounted on the fixed rubber block and rubber tongue. The rubber tongue **11** is held at the ends by the frame members **17** so that when the tongue **11** is bent by the vane, a load is applied. The vane **2** and deflector **1** are attached directly to the tongue **11** so that they are pivotally displaceable.

FIG. **7** shows a second embodiment of this invention in which the base unit **15** is exactly as described in relation to FIGS. **1** to **4**. The vane **2** and deflector **1** are also mounted as described above. The main difference in this second embodiment is that the air outlet **14** leading to a patient extends vertically from the atomizer as shown in FIG. **7**. Drug laden air does not have to pass around a sharp corner into the air outlet **14** once it has passed around the baffle **9**. Fewer drug droplets will collect on the inner surface of the air outlet **14**.

Referring to FIGS. **3**, **4** and **7**, the lower edge of the vane **2** forms a seal with the curved surface **12** as explained above. The vane **2** also includes two other edges which must be sealed. The vane **2** swings between two vertical wedge-shaped frame members **17** which form a seal so that flow of air to bypass the vane **2** is restricted when the vane **2** is disposed in any of the positions shown in FIGS. **1**, **2** or **7**. In the first and second embodiments shown in FIGS. **1** to **7**, the frame members **17** also act as supports for the fixed rubber block **10**. The frame members **17** may extend from the baffle **9**, from the edge of the curved surface **12** or from the base unit **15**. Where the frame members extend from the edge of the curved surface **12**, the vane **2**, deflector **1** and rubber block **10** are all mounted on the frame members **17** and within the upper unit **16**.

According to another embodiment (not shown), the rubber block **10** is replaced by a metal spring eg, a leaf spring which permits the vane **2** and deflector **1** to be pivotally moveable in the same manner as described in relation to the rubber block **10** and tongue **11**.

In a further embodiment (not shown) the vane **2** is omitted, and the deflector is movable into and out of the stream of gas issuing from the gas exit according to the breathing pattern of a patient. The vane is replaced by a flow sensor which detects when a patient begins to inhale and moves the deflector **1** into the path of gas issuing from the gas exit. In this embodiment the deflector is a bar which is moveable perpendicularly or laterally relevant to the longitudinal extent of the bar.

In another embodiment the deflector **1** is displaceable up and down in line with the gas issuing from the gas outlet. Once the deflector is raised above a certain height, atomization ceases to take place.

In yet a further embodiment, the deflector is not a straight bar, but is of any suitable shape for deflecting the gas across the outlets to cause atomization. The deflector may, for example, be a spherical ball disposed in the path of gas exiting the gas exit. The deflector may be a longitudinal blade movable into the path of the gas in the longitudinal direction of the blade.

In yet another embodiment (not shown) of this invention, the atomizer is used for producing a spray. This spray may be liquid droplets or powder particles. In medical applications, the spray may contain a drug. This spray producing apparatus may be used for producing sprays of paint droplets, perfume droplets or any other suitable liquids or powders. A base unit **15** of FIGS. **1–4** may be used to produce a gas exit **4** and outlets **5** for the substance to be atomized. A moveable deflector **1** is displaceable by a user. The user first activates a compressor which sends gas through the gas duct. For paint spraying, a mechanical compressor may

be used, although this could be substituted for an aerosol propellant. The user then moves the deflector into the path of the gas issuing from the gas exit **4** to start atomization. The propellant then carries the droplets or powder through an outlet jet to form a spray. The user stops atomization before stopping the flow of gas from the gas exit. This keeps the outlet jet clean and free from paint and the like. A two-stage button can be used whereby atomization only takes place when the button is fully depressed while gas issues from the gas exit when the button is only partially depressed.

Under certain conditions, although 95% of the gas issuing from the gas exit **4** is deflected to either side of the deflector bar **1**, a small amount hits the baffle bar depositing the substance to be atomized on the deflector bar **1**. The gas which hits the baffle bar drives the liquid along the baffle bar towards the ends where the liquid can collect on top of the baffle **9** so that it is lost to the atomizer system. The whole dose of medicament is then not available to be administered to the patient. Furthermore, in some arrangements, as the deflector bar is moved out of the flow of gas issuing from the gas exit **4**, the liquid that is running along the edge of the deflector bar **1** is sprayed into the top of the nebulizer where it collects without returning back to the reservoir **7**. Referring now to FIGS. **8** and **9**, the deflector bar **1** is housed entirely within the baffle **9** so that any liquid which collects on the deflector bar merely drips back into the reservoir, or if it is sprayed from the deflector bar by the flow of gas from the gas exit **4**, is collected on the underside of the baffle **9** whereupon it coalesces and drops back down into the reservoir **7**. FIG. **8** shows the nebulizer in a position where the patient is not inhaling. The segment shaped deflector bar **1** is disposed outside the line of gas exiting from the gas exit **4** so that nebulization does not take place. The segment is pivoted at a pivot point **21**, and is also connected to the vane or flap **2**. When a patient inhales, air is drawn into the nebulizer through air inlet **13**, and deflects the vane or flap **2** moving the deflector bar **1** into line with the gas exit thus causing atomization of the substance to occur. For clarity, the outlets **5** and the sleeve **8** are not shown in the Figure. However the jet head is arranged in the same way as described in connection with FIGS. **1** to **7**. The atomization of the substance causes the pressure beneath the baffle **9** to be decreased thereby drawing part of the inhaled air under the baffle **9** as shown by arrow B. The baffle **9** includes an aperture **20** for permitting the flow of air for entraining droplets B to enter beneath the baffle **9**. A proportion of the inhaled air passes directly from the air inlet **13** to the air outlet **14** as shown by arrow A. Once the flow of air for entraining droplets B has passed beneath the baffle **9**, it returns around the outside of the baffle **9** to rejion the through flow of air A. A further advantage of this embodiment is that only a certain volume of air passes under the baffle **9** in a given time. The nebulizer works most effectively when the flow of air for entraining droplets is of the rate of about 25 liters per minute. If this rate of flow of air is much greater than this or much less than this, the effectiveness of entrainment decreases. This means that if the patient inhales sharply, the rate of through flow of air A increases without significantly altering the flow of air for entraining droplets B passing beneath the baffle.

I claim:

1. An atomizer comprising:

a head having a gas exit and at least one outlet adjacent said gas exit;

a deflector for deflecting gas issuing from said gas exit over at least one of said outlets, for drawing a substance to be atomized out from at least one of said outlets and atomizing the substance in the gas issuing from said gas exit; and

said deflector mounted with respect to said head so that said deflector is movable between a first position in which said deflector is adjacent said gas exit and directly in the path of gas issuing from said gas exit so that atomization of the substance takes place, and a second position spaced from said gas exit so that no atomizing takes place.

2. An atomizer as recited in claim **1** further comprising condition responsive means for automatically moving said deflector between said first and second positions in response to a condition.

[3. An atomizer as recited in claim **2** wherein said condition responsive means comprises a vane connected to said deflector and effecting movement of said deflector in response to air pressure conditions acting on said vane.**]**

4. An atomizer as recited in claim **1** wherein said deflector is mounted with respect to said jet head by a pivot, so that said deflector pivots between said first and second positions.

5. An atomizer as recited in claim **1** further comprising a vane for moving said deflector between said first and second positions.

6. An atomizer as recited in claim **5** wherein said deflector comprises a bar connected to said vane.

7. An atomizer as recited in claim **1** further comprising an air inlet and an air outlet providing for the flow of air toward and past said head, said outlet permitting flow of atomized substance to a human.

[8. An atomizer as recited in claim **7** wherein said deflector moves into said first position when air flows from said air inlet to said air outlet.**]**

[9. An atomizer as recited in claim **7** wherein said deflector moves into said second position when air is not flowing from said air inlet to said air outlet.**]**

10. An atomizer as recited in claim **[3]** *2, wherein said condition responsive means comprises a vane connected to said deflector and effecting movement of said deflector in response to air pressure conditions acting on said vane; wherein the atomizer* further **[**comprising**]** *comprises* an air inlet and an air outlet for providing the flow of air to and past said head; and wherein said deflector is biased to said second position and wherein said vane is biased to a position closing said air inlet.

11. An atomizer as recited in claim **10** wherein said vane is positioned to direct a flow of air toward said gas exit when air flows from said air inlet to said air outlet.

12. An atomizer as recited in claim **10** wherein said vane is mounted to allow air flow from said air outlet directly through said air inlet, without passing past said head.

13. An atomizer as recited in claim **10** wherein said vane is mounted so as to allow a proportion of the air flowing from said air inlet to said air outlet to by-pass said head when the air flow rate exceeds a predetermined value.

14. An atomizer as recited in claim **4** wherein said deflector comprises a bar with an arcuate surface.

[15. An atomizer as recited in claim **2** wherein said condition is a human inhaling and exhaling during breathing.**]**

16. An atomizer as recited in claim **[15]** *1,* wherein said deflector is positioned so that during exhaling, exhaled air does not entrian the substance to be atomized.

17. An atomizer as recited in claim **1** further comprising a baffle extending outwardly and downwardly about said gas exit; and wherein said deflector is mounted within said baffle and movable with respect to said baffle.

18. An atomizer comprising:

a head having a gas exit and at least one outlet adjacent said gas exit;

a deflector for deflecting gas issuing from said gas exit over at least one of said outlets, for drawing a substance

to be atomized out from at least one of said outlets and atomizing the substance in the gas issuing from said gas exit;

said deflector mounted with respect to said head so that said deflector is movable between a first position in the path of gas issuing from said gas exit for atomization, and a second, non-atomizing, position; and

a vane for moving said deflector between said first and second positions.

19. An atomizer as recited in claim **18** wherein said deflector is mounted with respect to said head by a pivot, so that said defector pivots between said first and second positions.

20. An atomizer as recited in claim **18** wherein said vane is integral with said deflector.

21. An atomizer as recited in claim **18** wherein said deflector comprises a surface elongated in a first dimension and having a first width; and wherein said vane comprises a surface elongated in a second dimension substantially perpendicular to said first dimension and has a second width much greater than said first width so that said vane moves, and effects movement of said deflector, in response to breathing action by a human.

22. An atomizer as recited in claim **21** further comprising a baffle extending outwardly and downwardly about said gas exit; and wherein said deflector is mounted within said baffle and movable with respect to said baffle.

23. An atomizer comprising:

a head having a gas exit and at least one outlet adjacent said gas exit;

a deflector for deflecting gas issuing from said gas exit over at least one of said outlets, for drawing a substance to be atomized out from at least one of said outlets and atomizing the substance in the gas issuing from said gas exit; and

said deflector pivotally mounted with respect to said head so that said deflector is pivotally movable between a first position in the path of gas issuing from said gas exit for atomization, and a second, non-atomizing, position.

24. An atomizer as recited in claim **23** further comprising a baffle extending outwardly and downwardly about said gas exit; and wherein said deflector is mounted within said baffle and movable with respect to said baffle.

25. Spray forming apparatus comprising:

a housing having an outlet for a spray of atomized substance;

a head mounted within said housing and including a pressuzied gas exit, and at least one outlet adjacent said gas exit;

a deflector for deflecting gas issuing from said gas exit over at least one of said outlets, for drawing a substance to be atomized out from at least one of said outlets and atomizing the substance in the gas issuing from said gas exit; and

said deflector mounted with respect to said head so that said deflector is movable between a first position in which said deflector is adjacent said gas exit and directly in the path of gas issuing from said gas exit so that atomization of the substance takes place, and the atomized substance is sprayed out of said housing outlet, and a second position in which said deflector is spaced from said gas exit so that no atomized substance is sprayed out of said spray outlet.

26. The atomizer of claim 1, further comprising:

an air inlet and an air outlet for providing the flow of air to and past said head, an air passage being defined between the air inlet and air outlet; and

a structure movable relative to the air passage between a first position that at least substantially prevents air flow through the air passage and a second position that permits air flow through the air passage, the structure being constructed and arranged to move between the first and second positions in response to inhalations by a patient,

wherein the deflector is constructed and arranged to move between the first and second positions in response to the inhalations by the patient, and

wherein the deflector is constructed and arranged such that when the patient inhales, the deflector moves into its first position before the structure moves into its second position.

27. The atomizer of claim 26, wherein said structure operatively connects to the deflector for effecting the automatic movement of said deflector between the first and second positions in response to the inhalations by the patient.

28. The atomizer of claim 26, wherein the structure closes the air inlet when in its first position, and opens the air inlet when in its second position.

29. The atomizer of claim 26, wherein the structure seals the air passage when in the first position.

30. The atomizer of claim 26, wherein said structure comprises a flap valve.

31. The atomizer of claim 26, wherein said structure comprises a vane.

32. The atomizer of claim 31, wherein said vane operatively connects to the deflector for effecting the automatic movement of said deflector between the first and second positions in response to the inhalations by the patient.

33. The atomizer of claim 32, wherein the vane is integral with the deflector.

34. The atomizer of claim 26, wherein the deflector is mounted with respect to said head by a pivot, so that the deflector is pivotally movable between the first and second positions.

35. The atomizer of claim 26, wherein the structure is movably mounted with respect to the air inlet by a pivot.

36. The atomizer of claim 26, wherein the structure is biased toward its first position.

37. An assembly comprising:

an atomizer having an atomizing chamber, and an air inlet and an air outlet for enabling flow of air through the atomizing chamber, an air passage being defined between the air inlet and air outlet, the atomizer being constructed to atomize liquid in response to inhalations by a patient; and

a first structure movable relative to the air passage between a first position that at least substantially prevents air flow through the air passage and a second position that permits air flow through the air passage, the first structure being constructed and arranged to be movable between the first and second positions in response to the inhalations by the patient,

wherein the atomizer is constructed such that when the patient inhales, the atomizer begins atomization before the first structure moves into its second position.

38. The assembly of claim 37, wherein the atomizer further comprises:

a pressurized gas outlet disposed in the atomizing chamber; and

a deflector movable relative to the pressurized gas outlet, the movable deflector being constructed and arranged to move between an atomizing position and a non-atomizing position in response to the inhalations by the patient.

39. The assembly of claim 37, wherein the atomizer further comprises:

a pressurized gas outlet disposed in the atomizing chamber; and

a second structure that is movable relative to the pressurized gas outlet, the second structure being constructed and arranged to move between an atomizing position and a non-atomizing position in response to the inhalations by the patient.

40. The assembly of claim 39, wherein the second structure is constructed and arranged such that when the patient completes an inhalation, the second structure moves into the non-atomizing position after the first structure moves into the first position.

41. The assembly of claim 39, wherein the second structure is constructed and arranged such that when the patient's inhalation pressure falls below a predetermined threshold, the second structure moves into the non-atomizing position after the first structure moves into the first position.

42. The assembly of claim 39, wherein the first structure is resiliently biased toward its first position, and the second structure is resiliently biased toward its non-atomizing position.

43. The atomizer of claim 37, wherein the first structure is resiliently biased toward its first position.

44. The assembly of claim 37, wherein the first structure seals the air passage when in the first position.

45. The assembly of claim 37, wherein the atomizer is constructed such that when the patient completes an inhalation, the atomizer stops atomization after the first structure moves into the first position.

46. The assembly of claim 37, wherein the atomizer is constructed such that when the patient's inhalation pressure falls below a predetermined threshold, the atomizer stops atomization after the first structure moves into the first position.

47. An assembly comprising:

an atomizer having an atomizing chamber, and an air inlet and an air outlet for enabling flow of air through the atomizing chamber, an air passage being defined between the air inlet and air outlet, the atomizer being constructed to atomize a liquid in response to inhalations by a patient; and

a first structure movable relative to the air passage between a sealed position that at least partially seals the air passage and an unsealed position that unseals the air passage, the first structure being constructed and arranged to move between the sealed position and the unsealed position in response to the inhalations by the patient,

wherein the atomizer is constructed such that when the patient inhales, the atomizer begins atomizing before the first structure moves into its second position.

48. An assembly comprising:

an atomizer having an atomizing chamber, the atomizer being constructed to atomize liquid in response to inhalations by a patient;

an air inlet fluidly connected to the chamber; and

a first structure movable relative to the air inlet between a first position that at least substantially prevents air flow through the air inlet and a second position that permits air flow through the air inlet, the first structure being constructed and arranged to move between the first and second positions in response to the inhalations by the patient,

wherein the atomizer is constructed such that when the patient inhales, the atomizer begins atomization before the first structure moves into its second position.

49. An assembly comprising:

an atomizer having an atomizing chamber, the atomizer being constructed to atomize liquid in response to inhalations by a patient;

an air inlet fluidly connected to the chamber; and

a first structure movable relative to the air inlet between a sealed position that at least partially seals the air inlet and an unsealed position that unseals the air inlet, the first structure being constructed and arranged to move between the sealed position and the unsealed position in response to the inhalations by the patient,

wherein the atomizer is constructed such that when the patient inhales, the atomizer begins atomization before the first structure moves into the unsealed position.

50. The assembly of claim 49, wherein the atomizer further comprises:

a pressurized gas outlet disposed in the atomizing chamber; and

a second structure that is movable relative to the pressurized gas outlet, the second structure being constructed and arranged to move between an atomizing position and a non-atomizing position in response to the inhalations by the patient,

wherein the second structure is constructed and arranged such that when the patient inhales, the second structure moves into the atomizing position after the first structure moves into the unsealed position.

51. The assembly of claim 50, wherein the second structure is constructed and arranged such that when the patient completes an inhalation, the second structure moves into the non-atomizing position after the first structure moves into the sealed position.

52. The assembly of claim 50, wherein the first structure is resiliently biased toward its sealed position, and the second structure is resiliently biased toward its non-atomizing position.

53. An atomizer comprising:

an atomizing chamber;

a pressurized gas outlet disposed in the atomizing chamber;

an air inlet for enabling flow of ambient air into the atomizing chamber;

an air outlet for enabling flow of air out of the atomizing chamber to a patient;

an air passage defined between the air inlet and air outlet;

a deflector movable relative to the pressurized gas outlet, the deflector being constructed and arranged to move between an atomizing position and a non-atomizing position in response to inhalations by the patient; and

a variable size orifice in the air passage, wherein the orifice is constructed and positioned so as to change in size in response to the inhalations by the patient.

54. The atomizer of claim 53, further comprising a structure movable relative to the air passage between a first position that at least substantially prevents air flow through the air passage and a second position that permits air flow through the air passage, the structure being constructed and arranged to be movable between the first and second positions in response to the inhalations by the patient.

55. The atomizer of claim 53, wherein the orifice is constructed and positioned to increase in size during atomization.

56. A method of atomizing liquid with an atomizer comprising an atomizing chamber, a pressurized gas outlet disposed in the atomizing chamber, an air inlet extending from an ambient environment to the atomizing chamber, a variable size orifice disposed in the air inlet, an air outlet fluidly connected to the atomizing chamber, and a deflector movable relative to the pressurized gas outlet, the method comprising:

moving the deflector from a non-atomizing position to an atomizing position in response to an inhalation by a patient of air through the air outlet; and

varying the size of the orifice in response to the inhalation.

57. The method of claim 56, further comprising:

increasing the size of the orifice in response to the inhalation;

reducing the size of the orifice in response to completion of the inhalation; and

moving the deflector from the atomizing position to the non-atomizing position in response to the completion of the inhalation.

58. The method of claim 56, wherein the method further comprises, after moving the deflector to the atomizing position, increasing a size of the orifice in response to the inhalation by the patient.

59. The method of claim 58, further comprising:

reducing the size of the orifice in response to completion of the inhalation; and

after reducing the size of the orifice, moving the deflector from the atomizing position to the non-atomizing position in response to the completion of the inhalation.

60. A method of atomizing liquid with an atomizer comprising an atomizing chamber, and an air inlet and an air outlet for enabling flow of air through the atomizing chamber, an at least partially sealable air passage being defined between the air inlet and air outlet, the method comprising, sequentially:

(a) starting atomization of the liquid by the atomizer in response to a patient inhaling through the air outlet;

(b) after starting atomization, unsealing the air passage; and

(c) passing air from the air inlet to the air outlet to carry atomized liquid through the air outlet.

61. The method of claim 60, wherein unsealing the air passage comprises unsealing the air passage in response to the inhaling by the patient.

62. The method of claim 61, wherein:

the atomizer further comprises a first structure movable relative to the air passage between a sealed position that at least partially seals the air passage and a first unsealed position that unseals the air passage; and

the step of unsealing the air passage comprises moving the first structure from the sealed position to the first unsealed position.

63. The method of claim 62, wherein:

the atomizer further comprises a pressurized gas outlet disposed in the atomizing chamber, and a deflector movable relative to the pressurized gas outlet between an atomizing position and a non-atomizing position; and

the step of starting atomization of the liquid comprises moving the deflector into the atomizing position to cause atomization of the liquid.

64. The method of claim 62, wherein:

the atomizer further comprises

a pressurized gas outlet disposed in the atomizing chamber; and

a second structure that is movable relative to the pressurized gas outlet, the second structure being constructed and arranged to move between an atomizing position and a non-atomizing position in response to the inhalations by the patient, and

the step of starting atomization of the liquid comprises moving the second structure into the atomizing position.

65. The method of claim 64, further comprising, after (c), sequentially:

(d) moving the first structure from the first unsealed position to the sealed position to at least partially seal the air passage in response to completion of an inhalation by the patient; and

(e) moving the second structure into the non-atomizing position in response to the completion of the inhalation by the patient.

66. The method of claim 65, further comprising, after (e):

(f) moving the first structure from the sealed position to a second unsealed position that unseals the air passage in response to an exhalation by the patient.

67. The method of claim 64, further comprising, after (c), sequentially:

(d) moving the first structure from the first unsealed position to the sealed position to at least partially seal the air passage in response to the patient's inhalation pressure falling below a first predetermined threshold; and

(e) moving the second structure into the non-atomizing position in response to the patient's inhalation pressure falling below a second predetermined threshold.

68. The method of claim 61, further comprising, after (c), sequentially:

(d) at least partially sealing the air inlet in response to completion of an inhalation by the patient; and

(e) stopping atomization of the liquid into the atomizing chamber in response to the completion of the inhalation by the patient.

69. The method of claim 68, further comprising, after (e), repeating (a) through (e) in response to another inhalation by the patient.

70. A method of atomizing liquid with an atomizer having an atomizing chamber, an air inlet and an air outlet for enabling flow of air through the atomizing chamber, an air passage defined between the air inlet and air outlet, and a structure disposed in the air passage in a first position that at least substantially prevents air flow through the air passage, the method comprising, sequentially:

(a) starting atomization of the liquid by the atomizer in response to a patient inhaling through the air outlet;

(b) moving the structure into a second position in response to the inhaling by the patient, the second position permitting air flow through the passage; and

(c) passing air from the air inlet to the air outlet to carry atomized liquid through the air outlet.

* * * * *