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| [45] | Patented | Dec. 28, 1971 |

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|-----------|---------|----------------------|-----------|
| 3,419,029 | 12/1968 | Straub | 137/81.5 |
| 2,887,104 | 5/1959 | Sovinsky et al. | 128/29 |
| 2,966,917 | 1/1961 | Bloom | 137/512.2 |

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- [54] RESPIRATORY VALVE OF NONREBREATHING
TYPE FOR USE IN ANAESTHESIA APPARATUS
10 Claims, 8 Drawing Figs.**

- [52] **U.S. Cl.**..... **128/188,**
137/512.2, 137/525
[51] **Int. Cl.**..... **A61m 17/00**
[50] **Field of Search**..... 137/63 R,
102, 525, 512.2, 512.3; 128/188, 142.2, 142, 186,
187, 189-213, 145.5, 145.6, 145.7

- [56] **References Cited**
UNITED STATES PATENTS

- | | | | |
|-----------|---------|----------------|-----------|
| 2,954,793 | 10/1960 | Seeler..... | 137/64 |
| 3,219,030 | 11/1965 | Bartlett | 128/145.5 |

ABSTRACT: This respiratory valve of nonrebreathing type consists of a one-way inspiratory valve for gas coming from the gas-feeding mouth and an expiratory valve capable to close gas exhaust induction holes in an expiratory valve seat when pressed by the spring, both provided in a valve casing which includes at one end a gas-feeding mouth connected with an anesthesia apparatus and at the other end a delivery mouth to be connected with a patient. When the patient inhales the inspiratory valve opens while the expiratory valve closes so that the anesthetic gas is fed to the patient from the apparatus, and when the patient exhales the inspiratory valve closes while the expiratory valve opens to release the breathing out into the open.

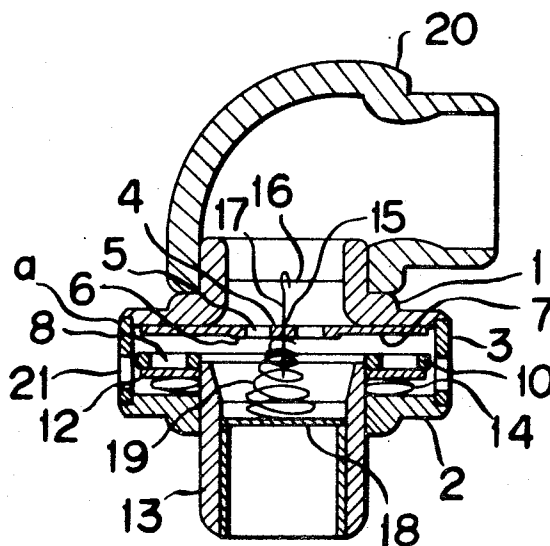


FIG. 1

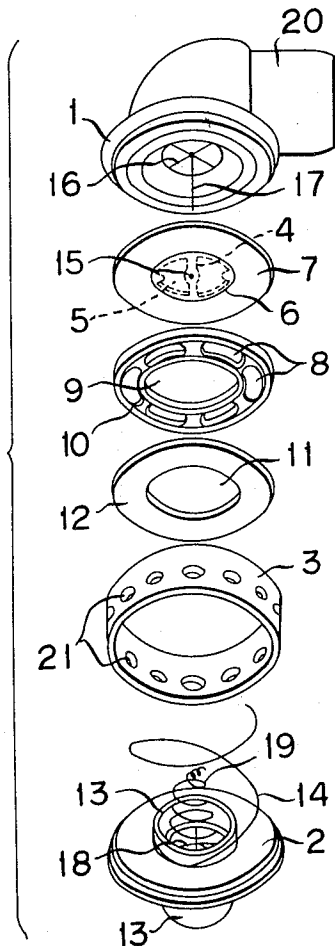


FIG. 2

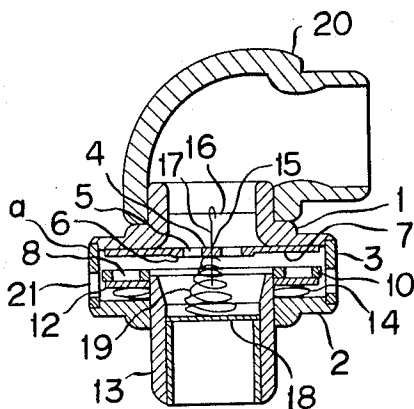


FIG. 3

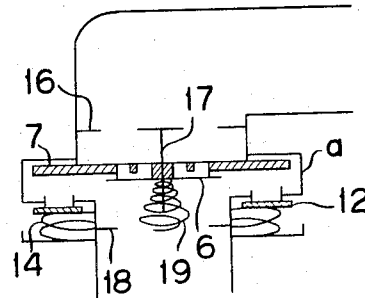
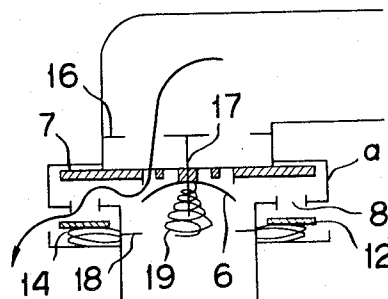


FIG. 4



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FIG. 5

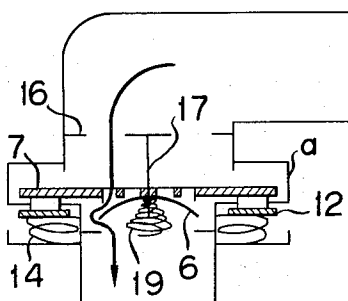


FIG. 6

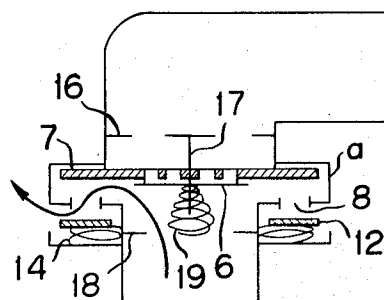


FIG. 7

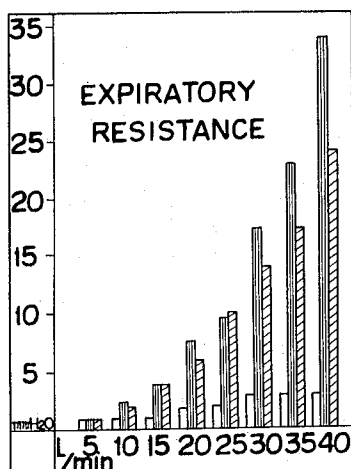
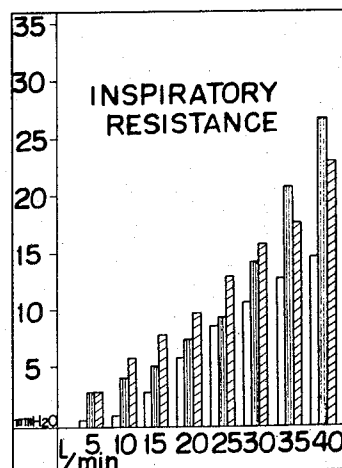


FIG. 8




 (A) (B) (C)

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RESPIRATORY VALVE OF NONREBREATHING TYPE FOR USE IN ANAESTHESIA APPARATUS

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to an improved respiratory valve assembly for use in the anesthesia apparatus, utilized during the surgical operation, as of a real nonrebreathing type, by which the anesthetic gas is fed to the patient by inhalation without permitting it to circulate.

2. Description of the Prior Art

The conventional respiratory valve of similar type comprises mostly two different types, the first is the type wherein the center shaft of a rubber valve is inserted and fixed in the center hole of a metal valve seat perforated with a multiple holes, the second is the type wherein a guide pin installed in the gas-feeding mouth is fitted into a receiving tube of a slide valve for inhalation, said slide valve being pressed by the spring, and a bearing hole provided in the gas exhaust mouth is fitted with a valve rod of the slide valve capable to close said mouth on inhalation, and said slide valve is being pressed by the spring. The drawbacks of these conventional respiratory valves are: in the first type, because of its greater contact area between the valve and the valve seat and also because of the rubber-made valve components, the elastic resistance is greater either on inhalation or on exhalation, and further due to the moisture exhausted on exhalation the resistance of the valve parts becomes greater thus causing total resistance to become greater. In the second type, in addition to the frictional resistance between the receive tube of the slide valve and the guide pin, the elastic resistance works on inhalation, and on exhalation the elastic resistance of the spring works in addition to the frictional resistance between the valve rod of the slide valve and the bearing provided within the gas exhaust mouth, rendering total resistance greater. These drawbacks either in the first or the second type make this inhalation anesthesia apparatus unfit in use particularly for infants and further makes the apparatus uneconomically large in dimension.

The object of this invention is to provide an improved respiratory valve assembly particularly for use in the anesthesia apparatus in which the resistance on inhalation is minimized by using an inspiratory valve made of a plastic film.

The object of this invention is to provide an improved inspiratory valve assembly in which the resistance on inhalation and exhalation is minimized by decreasing the friction area between the inhalation and exhalation valves and their respective valve seats. A further object of this invention is to provide an improved inspiratory valve assembly made in a compact size. A still further object of this invention is to provide an improved inspiratory valve assembly compatible with the use for adult as well as infant, who has a much smaller respiration volume than the adult, by minimizing the resistance during breathing and also by reducing its dead space.

A still further object of the present invention is to provide an improved respiratory valve assembly capable of permitting forward leak (discharging of an excess of the supplied gas into the air) in order to make the amount of gas as supplied to a patient equivalent to the patient's inhaling capacity.

SUMMARY OF THE INVENTION

A respiratory valve, as herein disclosed, of this invention consists of a valve box or housing having on one side a gas-feeding mouth or an opening through which the gas is fed to the patient, on the other side a gas-feeding valve in the form of one-way valve for the gas coming from the gas-feeding mouth which is closed when pressed by the spring and said gas-feeding valve being equipped with a film valve fixed in the hole perforated in a part of the same, an expiratory valve seat disk perforated with an exhaust gas induction port or hole at the bottom, and annual expiratory valve disk capable to close the exhaust gas induction hole of the expiratory valve seat disk when pressed by the spring, all being installed in the valve box

in the way they have contact area as small as possible, and further the expiratory valve seat disk is fixed to the valve box, and the inspiratory valve and annular expiratory valve disk are installed in the valve box in the manner capable to slide freely, and further the opening for feeding gas to patient is installed to open in the space between the expiratory valve seat disk and the inspiratory valve from the side of the annular expiratory valve disk, and an exhaust gas hole is perforated in the valve box from the expiratory valve seat disk to the side contacting the patient.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a slant view of the component parts of an embodiment of this invention.

FIG. 2 is a front view showing a longitudinal section of the embodiment in FIG. 1 when assembled.

FIG. 3 gives a diagram showing a longitudinal section of the embodiment in FIG. 1 and illustrating a condition not working.

FIG. 4 does the same as FIG. 3 but illustrating a condition when gas is supplied while the opening to the patient is closed.

FIG. 5 does the same as FIG. 3 but illustrating a condition when the patient inhales.

FIG. 6 does the same as FIG. 3 but illustrating a condition when the patient exhales.

FIGS. 7 and 8 give bar graphs of the exhalation and inhalation resistances in a valve of this invention A, in comparison with those of two conventional valves, B and C.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, an upper mouthpiece element 1 connected with a gas-feeding tube has a cylindrical portion in the center being fitted on its periphery with an anesthetic gas-feeding tube 20 and the inner opening is fitted with two filaments 16 pitched crisscross and at the intersection is fixed one end of a guide pin 17. An inspiratory valve 7 has openings 5 in the center and is provided with a valve seat 4 extending in diametrical direction having a pinhole 15 in the center and said valve seat 4 is affixed with a film valve 6 made of a plastic material to seal valve opening 5. An expiratory valve seat 10 has a plurality of exhaust gas induction ports or holes 8 in the inner periphery and a circular opening 9 in the center. An expiratory valve 12 is formed as an annular ring having a circular opening 11 in the center. Cylindrical ring 3 is provided with a plurality of exhaust gas outlets 21 perforated at the position close to the bottom. Lower mouthpiece element 2 for delivery to the patient is fitted with a tube 13 for serving the patient being inserted in the opening provided in the center of said mouthpiece 2; said tube 13 is equipped in the periphery with a spiral spring 14, the opening of said tube is fitted with two filaments pitched crisscross 18 and at the intersection one end of the spiral spring 19 is fixed.

In FIG. 2 showing the assembled components of said embodiment, it is seen that a valve housing is composed of the mouthpiece element 1, the mouthpiece 2 for delivery to the patient and the cylindrical ring 3. And this valve accommodates therein the inspiratory valve 7, the expiratory valve seat 10, and the expiratory valve 12 in this order starting from the gas-feeding mouth. In this assembly, the periphery of the expiratory valve seat 10 is fixed to the inner wall of the cylindrical ring 3 and the peripheral edge of the top of the tube 13 inserted into the opening of the mouthpiece 2 is fixed to the peripheral edge of the circular opening 9 of the expiratory valve seat 10. The inspiratory valve 7 and expiratory valve 12 are installed in such a way as they can freely move on respective sides of gas feeding or delivery, and the contact area when in contact with the expiratory valve seat 10 is minimized as much as practicable, and the expiratory valve 12 closes exhaust gas induction holes 8 at all time by the pressing force of the spiral spring 14, and inspiratory valve 7 has a valve seat 4 with a guide pinhole 15 perforated in the center, and in which a guide pin 17 is playably fitted and one end of the guide pin is

fixed at the intersection of two crossing filaments 16 pitched over the opening of the anesthetic gas-feeding mouth 1 and the reverse side of the inspiratory valve 7 with the guide pin 17 protruding therefrom lightly contacts and guides the spiral spring 19, one end of which is fixed to the intersection of two filaments 18 pitched crisscross at the opening of the tube 13 and thereby the valve opening 5 and the mouthpiece element 1 are kept always closed.

Like FIG. 2, FIG. 3 shows just as FIG. 2 respiratory valves of this invention in contact with neither anesthesia apparatus nor the patient. FIG. 4 illustrates that, if an anesthetic gas is supplied through a gas-feeding tube 20 in an amount exceeding the inhaling capacity of a patient, or if an anesthetic gas is supplied while the gas feeding and exhausting tube 13 is closed, an excess of said gas, or the whole of supplied gas is discharged in the open air by the opening of thin-film valve disk 6 of the inspiratory valve disk 7 and then the opening of annular expiratory valve disk which is pressed down against the force of spring 14, resulting in forward leak of the excess gas. The excess of supplied gas is discharged through the openings 5 of said inspiratory valve disk, and then through exhaust gas induction ports 8 and exhaust gas outlets 21.

FIG. 5 shows how the expiratory valve 12 is lifted by the force of the spring 14 when the patient inhales anesthetic gas from the feeding and exhausting tube 13, closing thereby the exhaust gas induction holes from the lower side, and at the same time how the inspiratory valve 7 is also lowered by means of the gas-feeding pressure and the inhalation pressure of the patient, counteracting the force of the spring 19 and it also closes the upper surface of the exhaust gas induction holes 8 with its lower peripheral surface and furthermore the film valve 6 is opened and then the anesthetic gas is inhaled by the patient.

FIG. 6 shows how inspiratory valve 7 closes mouthpiece element 1 by the lifting pressure of the spring 19 and the exhalation pressure, when the patient exhales, and also the valve opening 5 of the film valve 6 is closed by the exhalation pressure of the patient and at the same time the expiratory valve 12 opens the exhaust gas induction holes 8 of the expiratory valve seat 10 by counteracting the elastic force of the spring 14 so as to discharge the exhalation gas from the patient into the open through the exhaust gas induction holes 8 and exhaust gas outlet 21.

In accordance to the embodiment of this invention, said valve assembly repeats the aforesaid operation effectively and continuously by means of the respiration of the patient: since the inspiratory valve 7 is set up as a duplex one, such that the valve itself closes the gas-feeding mouth by being pressed by the spring 19 into contact with the mouth and further it has a film valve in its center, so far as the elastic force of the spring 19 is preset to an extent capable to release the inspiratory valve 7 from the gas-feeding mouth by the inhalation of the patient, even when, for example, the film valve 6 happens to stick to inspiratory valve 7 due to the moisture in patient inhalation, the inspiratory valve 7 can open the gas-feeding mouth by the inhalation of the patient so as to enable the patient to inhale anesthetic gas through the periphery of the inspiratory valve. Once the inhalation pressure of the patient rises up to an extent that the inspiratory valve comes into contact with the expiratory valve seat 10 by a slight resistance differential, the film valve 6 also gets open and thereby the inhalation resistance can be reduced to the minimum.

On the other hand, the elastic force of the spring 14 for lifting the expiratory valve 12 is preset to an extent capable only to open the exhaust gas induction holes 8 by the exhalation pressure with ease, during exhalation phase, the inspiratory valve 7 can close the gas-feeding mouth, and the film valve 6 can close its valve opening by both of the slight exhalation pressure of the patient and the elasticity of the spring 19, and the the expiratory valve 12 opens the exhaust gas induction holes 8 and thus the expiration even with very slight pressure can be discharged to the open through the exhaust gas induction holes 8 and the exhaust gas outlet 21, whereby the expiration resistance can be significantly reduced.

The spring 19 thus exerts sufficient force on the valve 7 to normally maintain it in the upper position illustrated in FIG. 6 so long as the pressure of the fluid within the intake does not substantially exceed the pressure of the fluid within the chamber defined by the ring 3. However, when the patient inhales, then the pressure within the chamber is less than the pressure within the mouthpiece 20 so that, when a predetermined minimum pressure differential exists across the valve member 7, then the pressure acting on the upper area of the valve 7 is able to overcome the force of spring 19 and move the valve 7 into the position whereby same closes the ports 8 as illustrated in FIG. 5. Further, the pressure differential across valve 7 also causes the film valve 6 to elastically deform to permit gas to be supplied to the patient through the tube 13. When the patient begins to exhale, the pressure within the chamber and within the pipe 13 increases until the desired minimum pressure differential no longer exists, whereupon the pressure of the gas within the pipe 13, in conjunction with the force of spring 19, causes valve 6 to close and causes valve 7 to return to its upper position. The pressure of the exhaust gas then causes valve 12 to move downwardly into its open position in opposition to the urging of spring 14.

In situations where an excess quantity of gas is supplied to the mouthpiece 20, after the valve 7 has moved into the lower position illustrated in FIG. 5, then the excess gas will flow through the open film valve 6 and cause the pressure within the pipe 13 to increase so that the pressure of the supply gas in mouthpiece 20 no longer exceeds the pressure of the gas within pipe 13 by the desired predetermined minimum differential. This pressure buildup within pipe 13 again causes the valve 7 to move into its upper position, whereupon the pressure level of the gas within the pipe 13 is again of sufficient magnitude to cause the valve 12 to open.

While there is no set ratio or relationship between the magnitudes of the force generated by the springs 19 and 18, inasmuch as the force of these springs is designed in accordance with the effective area over which the gas acts, nevertheless the system is preferably designed so that the spring 14 will maintain the valve 12 in its closed position whenever the pressure of the gas within the pipe 13 is less than a predetermined maximum. This predetermined maximum value is greater than the pressure which exists in pipe 13 during inhaling, whereupon the valve 12 thus remains closed during the inhaling phase of the cycle. However, during exhaling, or when excess gas is supplied to the pipe 13, the pressure of the gas within pipe 13 exceeds this predetermined maximum so that the gas is able to move the valve 12 to the opened position to permit discharge of the gas. The spring 19, on the other hand, is designed to permit movement of the valve 7 in opposition to the urging of the spring whenever the predetermined minimum pressure differential exists between the gas within mouthpiece 20 and pipe 13, thereby permitting gas to flow from mouthpiece 20 into pipe 13.

The respiration resistance is further reduced because the contact area between the expiratory valve seat, inspiratory valve, and the expiratory valve is minimized as small as possible.

Furthermore, the respiratory valve of this invention is made in a compact structure and the dead space can be reduced to the minimum. Another advantage of this respiratory valve is that this valve is compatible for use with the infant and the adult without troublesome selection of valves with different operability, since this valve can work even with the slight respiration of the infant.

FIGS. 7 and 8 show bar graphs illustrating the results of exhalation and inhalation resistance tests conducted with the embodiment A of this invention together with two other ones of conventional type B and C, and the ordinate representing hydraulic pressure resistance, mm.H₂O while the abscissa representing the flow rate per minute, l./min.

As evident from the above graphs, the embodiment A of this invention shows resistance far smaller than those of conventional ones. Meanwhile, the dead space occupied by a valve of this invention comes to be about 4 cm.³ and the conventional

ones usually come to 9 to 11.5 cm.³, so that it is only from one-half to one-third of the conventional ones.

What is claimed is:

1. A respiratory valve assembly of the nonbreathing type for use in an anesthesia apparatus, comprising:

a valve housing having an internal valve chamber and an inlet passage, one end of said inlet passage communicating with said chamber and the other end of said inlet passage being connectable to a gas-feeding source;

said housing further having a flow passage therein, one end of said flow passage communicating with said chamber and the other end of said flow passage being adapted for communication with a patient's mouth;

said housing still further including a discharge passage having an inlet end communicating with said chamber and an outlet end communicating with a location disposed externally of said housing;

first one-way check valve means biased to a normally closed position and coacting with said inlet passage for permitting flow of gas through said inlet passage into said chamber when the pressure in said inlet passage exceeds the pressure in the chamber by a predetermined amount, said first one-way check valve means preventing flow of gas in the opposite direction;

second one-way check valve means biased to a normally closed position and coacting with said discharge passage for permitting flow of gas from said chamber into said discharge passage whenever (1) exhaust gases are supplied to said chamber through said flow passage due to exhaling and (2) excess inlet gases are supplied to said chamber through said inlet passage, said second one-way check valve means including first biasing means for opening said second one-way check valve means only when the pressure in said chamber downstream of said first one-way check valve means exceeds a predetermined maximum; and

control valve means including a movable control valve member coacting with said discharge passage for preventing flow of gas from said chamber into said discharge passage when said first check valve means is open and gases are flowing from said inlet passage into said flow passage, said control valve means including second biasing means for moving said control valve member to an open position when the pressure in the inlet passage exceeds the pressure in the chamber by said predetermined differential and the pressure within said chamber exceeds said predetermined maximum for permitting excess inlet gases supplied to said chamber through said inlet passage to be discharged through said discharge passage.

2. A valve assembly according to claim 1, wherein said control valve member is movably disposed in said chamber and said second biasing means comprising spring means urging said control valve member into a first position, said control valve member being movable from said first position to a second position preventing communication between said chamber and said discharge passage in response to flow through said inlet passage; and

said first one-way check valve means including a first valve member disposed within said chamber and mounted for movement relative to said control valve member, said first valve member being normally maintained in a closed position for preventing flow from said inlet passage to said chamber and being movable to an open position in response to said predetermined pressure differential thereacross for permitting flow from said inlet passage into said chamber and through said discharge passage when said control valve member is in said first position.

3. A valve assembly according to claim 1, wherein said control valve member comprises a rigid platelike valve member movably disposed within said chamber and said second biasing means comprising spring means resiliently urging said platelike valve member toward one end position; and

said second one-way check valve means including a rigid platelike valve member and said first biasing means comprising spring means normally urging same to a closed position.

4. A valve assembly according to claim 1, wherein said valve housing includes means defining first and second opposed valve seats, said first valve seat being disposed in surrounding relationship to said one end of said inlet passage, and said second valve seat being disposed in surrounding relationship to the inlet end of said discharge passage; and

said valve member being disposed within said chamber and movable between a first position wherein said control valve member is in seating engagement with said first valve seat and a second position wherein said control valve member is in seating engagement with said second valve seat, and second biasing means comprising resilient means urging said control valve member toward said first position.

5. A valve assembly according to claim 4, wherein said housing includes a seat member having said discharge passage extending therethrough, said second one-way check valve means comprising a check valve member movably mounted on said housing, and said first biasing means comprising spring means resiliently urging said check valve member into seating engagement with said seat member for closing one end of said discharge passage, and said control valve member being adapted to sealingly contact a further surface of said seat member for closing the other end of said discharge passage when said control valve member is moved to said second position.

6. A valve assembly according to claim 4, wherein said first one-way check valve means includes an opening extending through said control valve member and communicating with said inlet passage and a first valve member mounted on and movable relative to said control valve member for normally closing said opening, said first valve member being movable to an open position so as to uncover said opening in response to the flow of gas through said inlet passage.

7. A valve assembly according to claim 6, wherein said control valve member comprises a rigid platelike disk provided with a plurality of openings in the center thereof, and said first valve member comprises a thin flexible plastic disk fixedly secured to said platelike disk substantially adjacent the center thereof and disposed for normally overlapping and closing said plurality of openings.

8. A valve assembly according to claim 6, wherein said housing includes means defining a third valve seat in surrounding relationship to a portion of said discharge passage, and said second one-way check valve means includes a second movable valve member and said first biasing means comprising resilient means coacting with said second valve member for normally urging same into seating engagement with said third valve seat.

9. A valve assembly according to claim 6, wherein said housing is comprised of first and second housing members having first and second flange portions, respectively, which are spaced from one another, with said inlet passage and said flow passage being provided in said first and second housing members, respectively, and said passages being substantially coaxially aligned;

said housing further including a cylindrical ringlike member extending between and fixedly secured to said first and second flange portions, and a seat member disposed axially between said first and second flange portions and fixedly secured to at least one of said second housing member and said ringlike member, whereby said seat member and said first flange portion define said chamber therebetween, and said seat member and said second flange portion defining a compartment therebetween with said compartment comprising a portion of said discharge passage; and

said discharge passage includes a first plurality of ports extending through said seat member to provide communica-

tion between said chamber and said compartment, and a second plurality of circumferentially spaced ports extending through said ringlike member for providing communication between said compartment and said external location.

10. A valve assembly according to claim 9, wherein said second one-way check valve means comprises an annular ringlike valve member movably disposed within said compart-

ment, and said first biasing means comprising spring means resiliently urging said ringlike valve member into seating engagement with said seat member for closing said first plurality of ports, and said control valve member being adapted to sealingly contact the opposite side of said seat member for closing said first plurality of ports when said control valve member is moved to said second position.

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