# United States Patent [19]

**Milnes et al.**

[11] **3,799,185**

[45] **Mar. 26, 1974**


[54] **BREATHING VALVE**


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[73] Assignee: **Kohler Co.**, Kohler, Wis.



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[21] Appl. No.: **268,432**

[52] **U.S. Cl.**..... **137/102,** 137/512.2, 251/121

[51] **Int. Cl.**..... **F16k 15/14**

[58] **Field of Search**.... 137/63 R, 102, 512.2, 512.3, 137/512.15, 614.2, 613; 128/142.2, 142, 146.5, 2.08; 251/121, 34 S; 272/57 F



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,954,793 | 10/1960 | Seeler | 137/63 R |
| 3,232,304 | 2/1966 | Koester | 137/512.2 |
| 2,966,917 | 1/1961 | Bloom | 137/63 R |
| 2,982,306 | 5/1961 | Fitzgibbon | 137/625.64 |
| 1,044,367 | 11/1912 | Evans | 272/57 F |



*Primary Examiner*—William R. Cline

*Attorney, Agent, or Firm*—Allan W. Leiser; Arthur H. Seidel



[57] **ABSTRACT**

A breathing valve of the type having concentric inhalation and exhalation valves has an exhaust passage with tapered inlet ports that provide a variable orifice to minimize flutter. Flutter is further reduced by having the exhalation valve mounted on an unsupported rubber sleeve that can flex to accommodate pressure variations, and by a mushroom inhalation valve that has a U-shaped flex ring with its open end facing the inhalation chamber so that the periphery of the valve lifts as a whole. A modified version of the valve for respiratory use includes a control ring operable to progressively open and close the exhaust passage, another modified version for use in anesthesia includes a collector shroud that encloses the exhaust passage and is connectable to a discharge line, and a third modified version includes both the ring and shroud.


**5 Claims, 10 Drawing Figures**

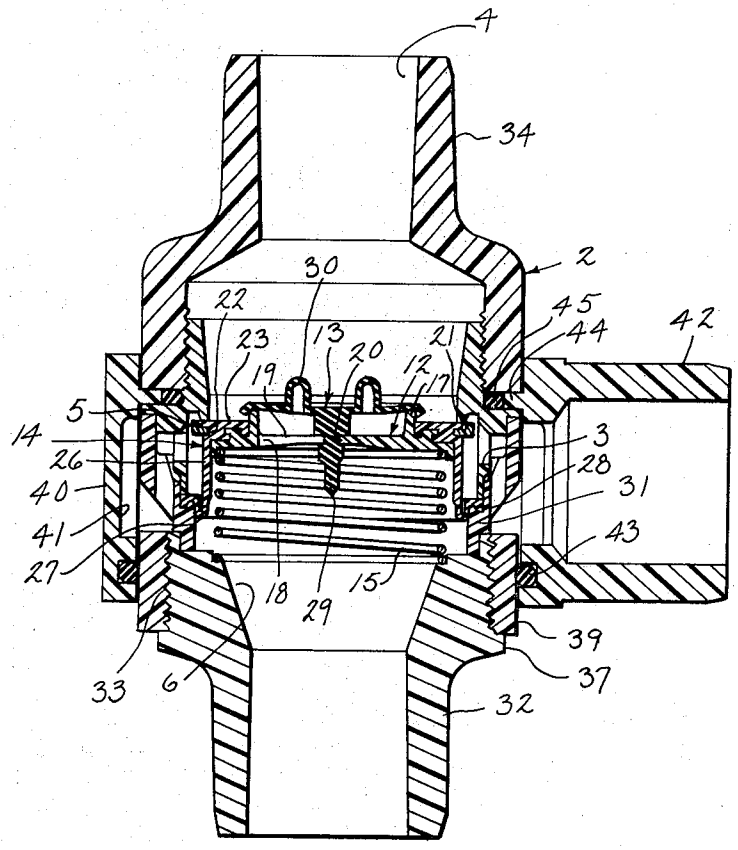

Fig. 1

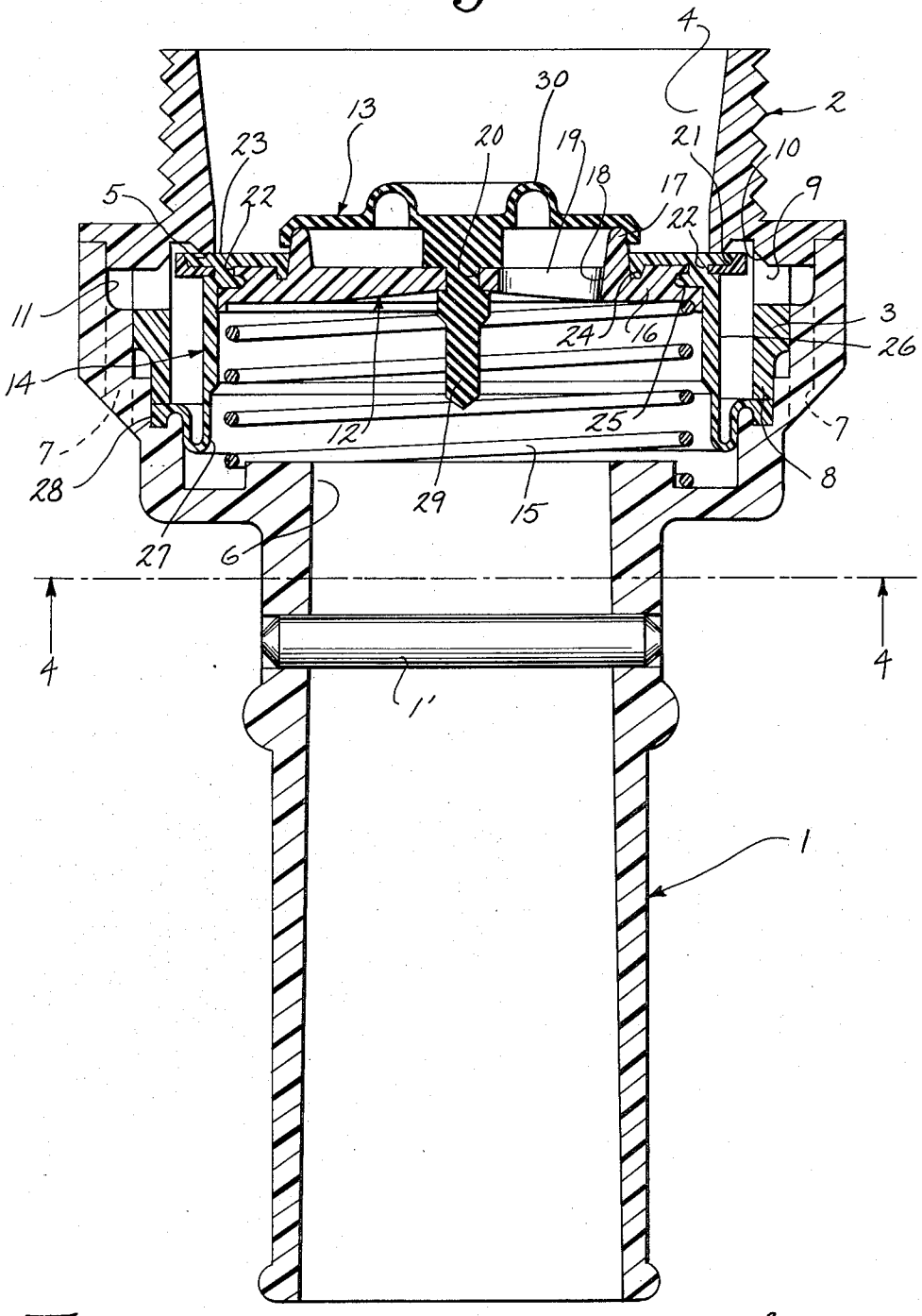
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Fig. 6

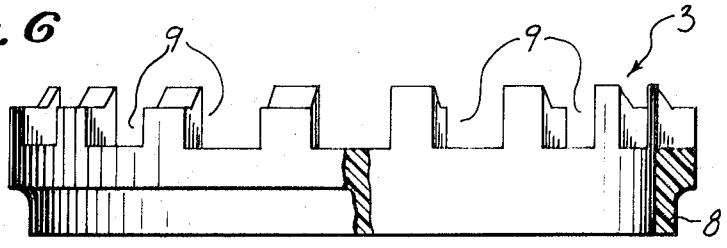
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Fig. 2

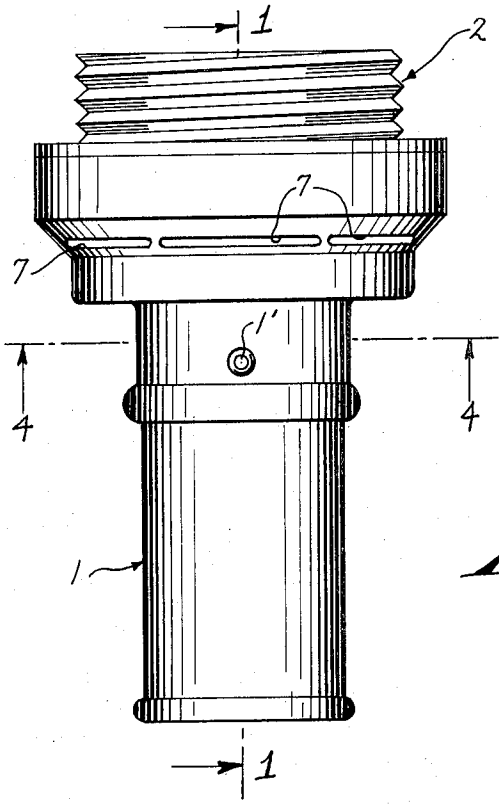



Fig. 3

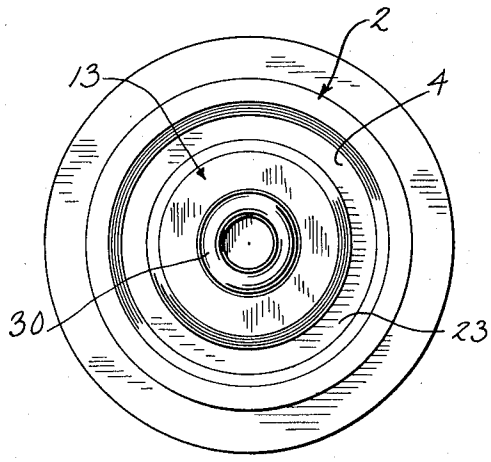
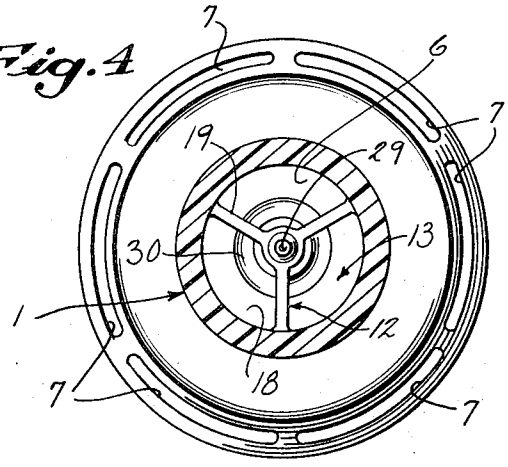



Fig. 4



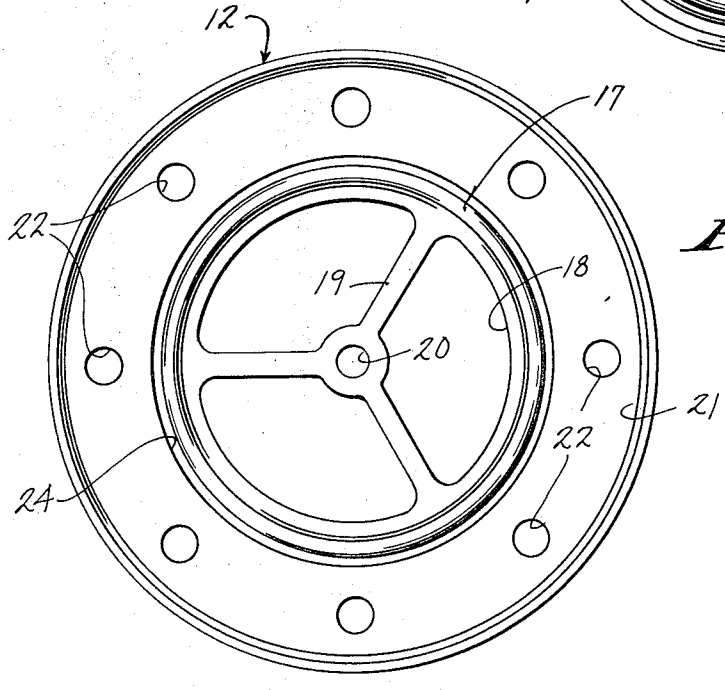




Fig. 5

Fig. 1

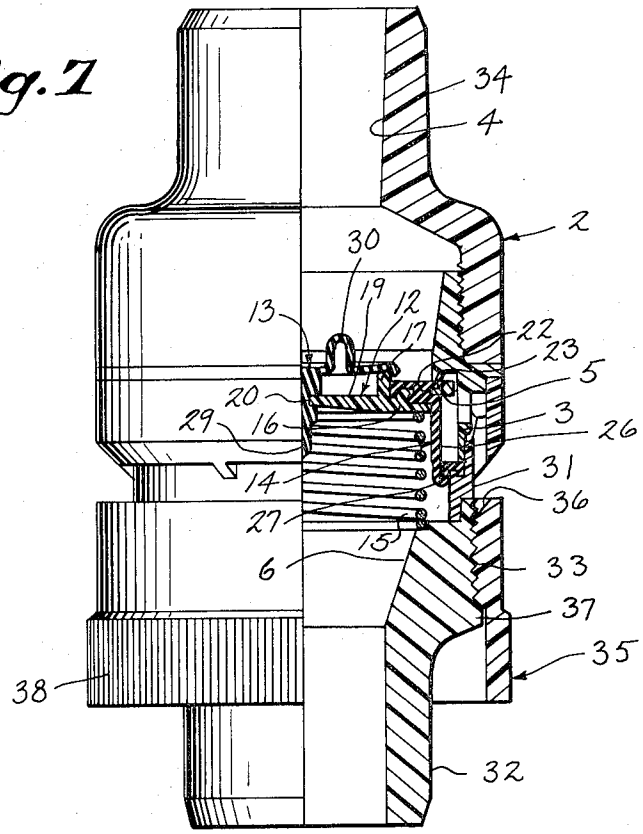

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Fig. 10

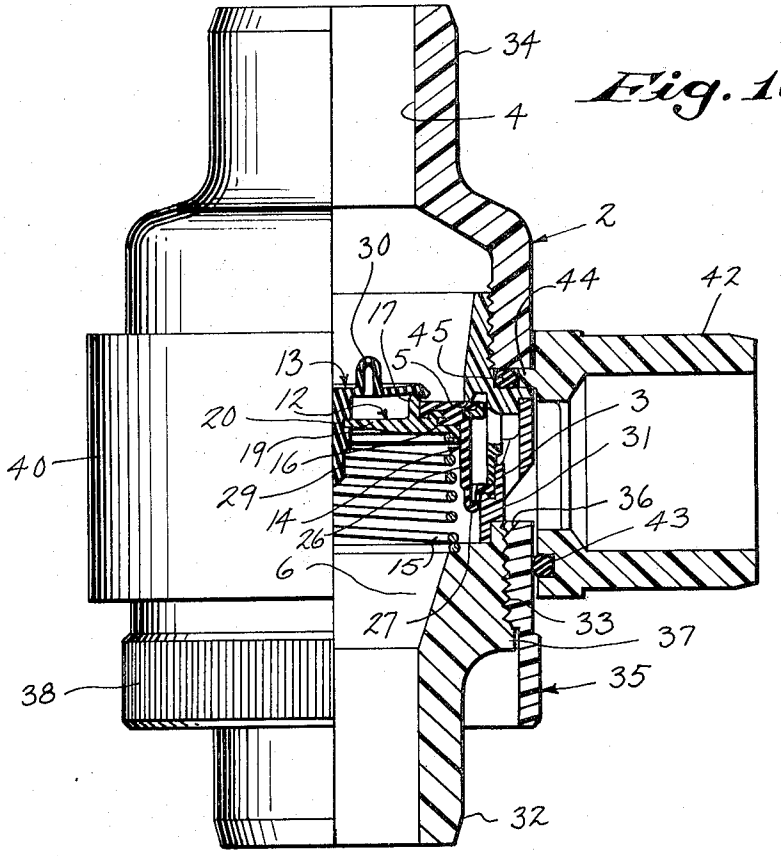
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Fig. 8

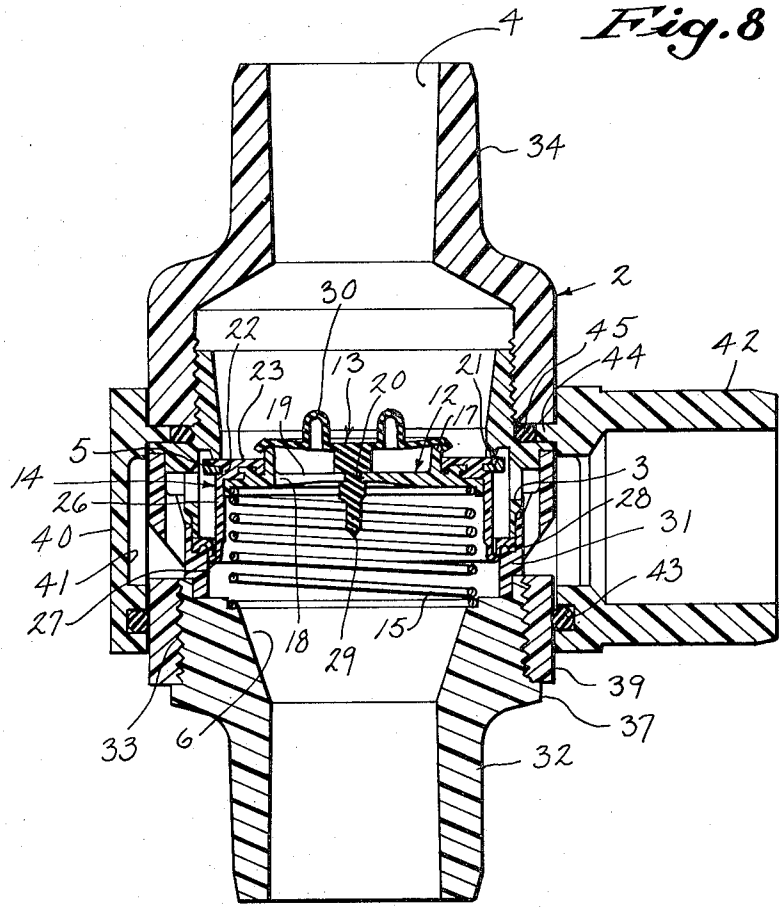
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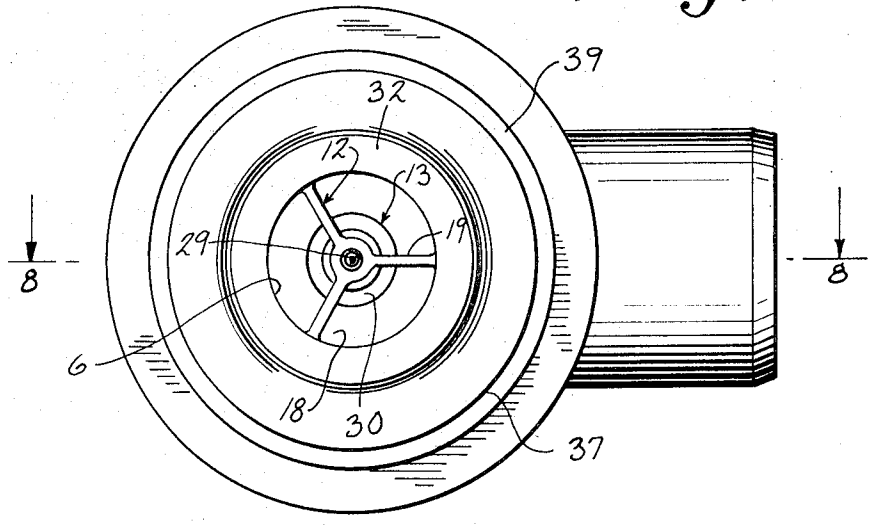
Fig. 9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# BREATHING VALVE

## BACKGROUND OF THE INVENTION

This invention relates generally to breathing valves of the type having concentric exhalation and inhalation valves, this type of valve being shown, for example, in U.S. Pat. No. 3,342,200, issued Sept. 19, 1967. While such valves have been extensively used for flyers' oxygen masks, prior designs have not been satisfactory in all respects, particularly with regard to simplicity of construction and the elimination of undesirable fluttering. Further, valves of this type have not heretofore been designed for use in certain specialized medical and similar applications.

## SUMMARY OF THE INVENTION

It is the general object of this invention to provide an improved basic valve of the contemplated type, and also to provide modified versions for medical and similar uses.

One specific object is to provide a basic valve that includes an exhaust passage with tapered inlet ports to provide a variable orifice and thus minimize flutter. Another purpose is to provide a valve in which the exhalation valve disc is mounted on an unsupported sleeve of resilient material which can flex to accommodate pressure variations. Still another object is to provide a mushroom inhalation valve with a flex ring that is inverted from normal past orientation to provide for improved action. Another object is to provide a valve which can be adapted for use with an exhalation control ring and/or an exhaust collector shroud for medical and related uses. It is also an object of the invention to provide a highly effective, improved valve of the type contemplated which is still relatively simple and inexpensive, and in which several forms can use common parts. Other features, objects and advantages will appear from the description to follow.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an enlarged view in cross section through the plane **1—1** shown in FIG. **2** and showing a basic valve formed according to the invention incorporated in an oxygen mask valve,

FIG. **2** is a side view in elevation of the valve of FIG. **1**,

FIG. **3** is a top plan view of the valve of FIG. **1**,

FIG. **4** is a view in cross section through the plane **4—4** shown in FIG. **2**,

FIG. **5** is an enlarged top plan view of an exhalation valve disc for the valve of FIG. **1**, the disc being shown as it appears prior to a molding operation,

FIG. **6** is an enlarged side view, partially broken away, showing a guide ring in the valve of FIG. **1**,

FIG. **7** is a side view, partially broken away, showing a basic valve capsule, similar to the valve of FIGS. **1–6**, incorporated in a respiratory valve having an exhalation control ring,

FIG. **8** is a view in cross section, through the plane **8—8** shown in FIG. **9**, showing a valve capsule like that shown in FIG. **7** incorporated in a combination respiratory-anesthesia valve having a collector shroud,

FIG. **9** is a bottom plan view of the valve of FIG. **8**, and

FIG. **10** is a side view, partially broken away, showing the valve capsule of FIGS. **7–9** incorporated in a combination respiratory-anesthesia valve having an exhalation control ring and a collector shroud.



## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The valve shown in FIGS. **1–6** includes a housing made up of three basic parts — an inhalation chamber section **1**, an exhalation section **2**, and a guide ring **3**, all preferably formed of a rigid thermoplastic material capable of withstanding large temperature variations. A reduced portion at the lower end of the section **2** as it is seen in FIG. **1** is received in the open upper end of the section **1** with a tight fit, and the ring **3** is held captive between them. The sections **1** and **2** are preferably joined together permanently by ultrasonic welding, which is a convenient method of manufacture and which also allows the unit to meet military specifications which require that valves of this type not be capable of being disassembled for repair. It is a particular feature of the invention that the housing can be formed from only three parts, as opposed to the complex assemblies found in some prior valves.

The exhalation section **2** defines an exhalation chamber **4** which is on the mask or user's side of the valve, and it is externally threaded so that it can receive conventional clamping ring (not shown) for attaching the valve to an oxygen mask, or so that it can be connected to other elements to be described. The inner or lower end of the exhalation chamber **4** is shaped to define an upstanding exhalation valve seat **5** which faces the inhalation chamber to be described.

The inhalation section **1**, which is elongated and provided with a cable retention pin **1'**, can be connected to an oxygen supply tube (not shown) in conventional fashion. It defines an inhalation chamber **6** which is on the supply side of the valve, and has a stepped upper end provided with a series of circumferentially spaced, axially extending openings **7** which open from the exhalation chamber side of the valve and serve as exit ports for an exhaust passage to be described.

The guide ring **3**, which is seen most clearly in FIG. **6**, has a substantial axial length, and includes a reduced lower portion **8** which is received in a corresponding recess in the housing section **1** with a relatively tight fit. Approximately the upper axial half of the ring **3** is cut out to define a series of circumferentially spaced slots **9**, which serve as entry ports for an exhaust passage as will be described. As can be seen in FIGS. **1** and **6**, the upper outer edge of the ring **3** is cut away along a line that is tapered at its radially inner end and horizontal at its radially outer end, and the exhalation housing section **2** has a matching configuration. As a result of this, the upper, radially innermost edges **10** of the slots **9** are outwardly tapered from top to bottom to provide a variable orifice as will be described below. The tapered edges **10** define the upper or exhalation chamber ends of the slots **9** and are approximately at the level of the exhalation seat **5**; and the lower ends of the slots **9** are substantially spaced therefrom.

As can be seen in FIG. **1**, the housing sections **1** and **2** are shaped to define an annular space **11** which lies between and is in communication with both the slots **9** and the openings **7**. The slots **9** and openings **7** and the space **11** together define an annular, outwardly opening exhaust passage downstream of the exhalation chamber **4** for air or gases moving therefrom. To avoid undesirable back pressures which might result in flut-

tering, the total effective area of the space **11** is made greater than the total effective area of the slots **9**, and the total effective area of the openings **7** is made greater than that of the space **11**.

A concentric inhalation-exhalation valve assembly is supported in the housing and separates the exhalation and inhalation chambers **4** and **6**. The valve assembly comprises an exhalation valve disc **12**, a mushroom-type inhalation check valve **13**, a cylindrical sleeve **14**, and a compression bias spring **15**.

The sleeve **14** is of a suitable substantially impervious, resilient material, such as silicon rubber, which is not affected by the temperature variations likely to be encountered in use; and is preferably formed with the disc **12** in a single molding operation which also provides a seating surface for the disc **12**. The disc **12** includes a generally horizontal peripheral portion **16** and an upstanding inhalation valve seat **17** which is concentric with the disc **12** as a whole and faces the exhalation chamber **4**. The seat **17** surrounds an inhalation port **18** which affords communication between the exhalation and inhalation chambers **4** and **6**, and a spider **19** spans the port **18** to provide a central support opening **20**. Radially outwardly of the seat **17**, the upper or exhalation chamber side of the peripheral portion **16** is recessed to define a shallow trough **21** which extends almost to its outer edge. A circumferentially spaced series of openings **22** extend through the bottom of the trough **21**. The sleeve **14** is molded in conjunction with the valve disc **12**. In the course of this process the rubber material flows through the openings **22** onto the peripheral portion **16**, and fills the trough **21**, thereby forming a highly effective sealing surface **23** which extends radially beyond and is engageable with the exhalation seat **5**. The peripheral portion **16** is shaped to define an axially opening groove **24** and a radially opening groove **25** into which the rubber material flows during molding to lock the molded rubber securely in place.

The sleeve **14** comprises a relatively thicker body portion **26**, a relatively thinner bight portion **27**, and a thickened bead **28**. The bead **28** is received in a corresponding annular groove formed in the housing section **1** and is held in place by the guide ring **3**, as the result of which the inhalation chamber **6** is sealed off from the exhaust passage and the exhalation chamber **4** except for communication allowed by the port **18**. The bight portion **27** allows the exhalation valve disc **12** to move axially between a closed position shown in FIG. **1** in which it is against the seat **5** and an open position in which it is moved downwardly and is away from the seat **5**. The guide ring **3** is spaced relatively close to the periphery of the disc **12** and thus serves to guide it in this movement. It is an important feature of the invention that the sleeve **14** is formed of a resilient material and is substantially unsupported along its entire axial length. As a result, it is capable of flexing radially inwardly and outwardly to compensate for relative pressure variations in the inhalation chamber **6**, thus minimizing fluttering, the thickened body portion **26** serving to prevent excessive flexing or bulging. This construction is quite different from usual constructions in which there is a rigid sleeve or skirt formed with or fixed to the exhalation valve disc and connected to the inhalation side by a flexible ring.

The bias spring **15** is seated between the inhalation section **1** and the underside of the disc **12**, and serves to bias the disc **12** toward its closed position. This is preferably a relatively light spring to minimize breathing effort.

The inhalation valve **13** is also formed of a resilient, substantially impervious, temperature resistant material such as silicon rubber, and includes a grooved stud **29** which is tightly received in the opening **20** to centrally support the valve **13** concentric with the seat **17**. The peripheral portion of the valve **13** extends across the seat **17** and is turned downwardly at its outermost edge. The valve **13** is shaped to define a U-shaped concentric flex ring **30** which is intermediate between its center and periphery. It is important to note that the open end of the flex ring **30** faces the inhalation chamber **6**, this being inverted from usual flex ring orientation in valves of this type. As a result of this arrangement, the entire periphery of the valve **13** tends to lift as a unit to avoid the edge fluttering which often results with usual constructions. The valve **13** is self-biased because of its resilient nature toward the closed position shown in FIG. **1** in which its periphery is against the seat **17** and the inhalation port **18** is thus closed off. In the event of relatively higher pressure in the inhalation chamber **6**, however, the periphery of the valve **13** will be lifted off the seat **17** thus allowing communication between the inhalation chamber **6** and the exhalation chamber **4**. If the pressure in the chamber **4** is relatively higher, the valve **13** will only be forced more tightly against the seat **17**.

As shown in FIG. **1**, the valve is in a normal position with both the inhalation valve **13** and the exhalation valve disc **12** in closed positions, so that there is no communication between the exhalation chamber **4**, the inhalation chamber **6** and the exhaust passage. When the user inhales, there will be a relatively lower pressure in the exhalation chamber **4**, and the correspondingly higher relative pressure in the inhalation chamber **6** will cause the periphery of the valve **13** to be lifted off the seat **17** to allow oxygen or other gas to flow toward the user. The relatively higher pressure in the chamber **6** will cause the exhalation valve disc **12** to be held tightly against its seat during inhalation, thus closing off the exhaust passage. When the user exhales, there will be a relatively higher pressure in the chamber **4** which will hold the inhalation valve **13** closed but act against the exhalation valve disc **12** to move it downwardly toward open position, thus allowing communication between the chamber **4** and the exhaust passage. The outer edge of the disc **12** is relatively close to the slots **9** and approximately at the level of the edges **10** when it is closed; and as the disc **12** moves downwardly in an opening action it will first expose the tapered upper edges **10** of the slots **9**, and as it moves further downwardly the slots **9** will be progressively uncovered to provide a variable orifice proportional to the pressure differential between the chambers **4** and **6**, which has proven very important in overcoming fluttering.

The slots **9** extend axially far enough so that their lower ends are approximately at the level of the edge of the disc **12** when the disc **12** is at its maximum open position. The tapered edges **10** at the upper ends of the slots **9** are extremely important during initial opening movement in avoiding the usual orifice effect of a rapid initial increase in flow and in preventing fluttering. In the embodiment shown, it has been found desirable to hold the taper to 30° plus or minus only one-half degree, although different tapers might be desirable with

other configurations. The exhaled gases which enter the slots 9 pass through the space 11 and out the openings 7, and as indicated above the progressively increasing effective areas prevent back pressures as the gases expand.

Another important feature of the embodiment shown is the fact that the exhalation valve disc 12 extends substantially radially beyond the seat 5. This provides a second stage pressure area which is acted on as soon as the disc 12 opens in response to a higher pressure in the chamber 4 to insure that the disc 12 will move far enough to be fully opened.

While the valve shown is generally similar to previously known valves of this type, it is as a result of the features discussed above extremely efficient and operates with virtually no fluttering. It comprises only a relatively small number of parts as opposed to prior valves so that it is relatively simple and inexpensive. The valve shown is particularly suited for use as an oxygen mask valve since military specifications generally require that such valves not be capable of being disassembled for repair, and this is assured by the welded connection between the sections 1 and 2. By the use of suitable plastic materials and silicon rubber, the valve can easily be made to withstand the great range of temperatures expected to be encountered in such use.

In FIGS. 7–10, the basic valve construction of FIGS. 1–6 is shown incorporated in three modifications suitable for medical and similar applications. The basic valve construction in all three cases is substantially identical to that of the embodiment of FIGS. 1–6, but the housing construction is modified by the substitution of a shorter inhalation housing section 31 for the elongated section 1 shown in FIGS. 1–6, the section 31 being substantially identical to the section 1 except that its lower end has been shortened and shaped to receive an extension. An extension 32 is welded onto a reduced end portion of the section 31 and is adapted to be connected to a supply (not shown). The extension 32 defines the seat for the spring 15, and is externally threaded at 33 for purposes that will be described. An exhalation extension 34 is threaded onto the exhalation housing section 2 and is adapted to be connected to a mask or the like (not shown). These elements together define a basic valve capsule, and it is an important feature of the invention that the same capsule can be used for all three of the specialized embodiments to be described.

FIG. 7 shows the basic valve modified for use as a respiratory valve provided with an exhalation control ring so that a controlled exhalation back pressure can be developed. It is often desirable for medical purposes to be able to establish such a back pressure, for example to prevent lung collapse. To this end, the basic valve capsule is fitted with an axially extending control ring 35 which is threaded onto the extension 32 to be movable toward and away from the exhalation openings 7. The upper inner edges 36 of the ring 35 is tapered to match the configuration of the section 31 at the exit ends of the openings 7, and the ring 35 is thus able to close off the exhaust passage completely or allow it to be opened to a finely controlled degree to establish the desired back pressure.

The extension 32 is provided with an outwardly extending annular flange 37 immediately below the threads 32, and this is engageable with the internal threads of the ring 35 to limit downward movement of the latter as seen in FIG. 7, upward movement obviously being limited by engagement with the housing section 31. The ring 35 is thus trapped in place, and must be threaded onto the extension 32 before the latter is welded onto the housing section 31. The ring 35 includes a radially enlarged lower portion 38 which extends over the flange 37 and is knurled on its outer surface for manual adjustment of the ring 35.

FIGS. 8 and 9 show the basic valve capsule modified to provide a respiratory-anesthesia valve for use in anesthesia or other applications in which it is necessary to collect exhaled air or gases for disposal, analysis, or the like. In this embodiment, the control ring 35 is replaced by a threaded spacer ring 39, which may be ultrasonically welded or otherwise fixed to the extension 32, and a collector shroud 40 is provided which encloses the outer end of the openings 7, or the exhaust passage. The shroud 40 defines a continuous annular collector passage 41 which surrounds the entire valve capsule and leads to an outlet stub 42 that is adapted to be connected to a suitable discharge line (not shown). The lower end of the shroud 40 as seen in FIG. 8 is large enough to slide over the spacer ring 39, and an O-ring 43 mounted in a recess in the shroud 40 provides an airtight seal therebetween. The upper end of the shroud 40 is provided with an inwardly extending annular flange 44 which extends and is trapped between the housing section 2 and the exhalation extension 34; and an O-ring 45 defines an airtight seal between the elements 2, 34 and 40. Obviously, the shroud 40 must be put over the valve capsule from the top as seen in FIG. 8 before the extendion 34 is threaded in place and after the spacer 39 is put in place.

FIG. 10 shows the basic valve capsule modified to provide a respiratory-anesthesia valve having both a control ring and a collector shroud. This embodiment is essentially identical to that of FIGS. 8 and 9, including the shroud 40, but the control ring 35 is used instead of the spacer ring 39, as the result of which a back pressure can be established. The O-ring 43 provides an airtight seal notwithstanding the relative axial movement of the ring 35.

From the preceding showings and description it can be seen that this invention provides a greatly improved basic breathing valve which is highly effective and free from flutter, and also a valve that is adaptable to a wide variety of applications while remaining relatively simple and inexpensive, particularly insofar as common parts can be used for a number of embodiments. While preferred embodiments of the invention have been shown and described, however, it will be obvious that various modifications might be made without departure from the spirit of the invention. The invention is not, therefore, intended to be limited by the showing herein or in any other way except insofar as may specifically be required.

We claim:

1. In a breathing valve of the type comprising: a housing defining an inhalation chamber on the supply side, an exhalation chamber on the user side that terminates at its inner end in an annular exhalation valve seat facing the inhalation chamber, and an outwardly opening annular exhaust passage downstream of the exhalation chamber; an exhalation valve disc on the inhalation chamber side of the exhalation valve seat that is movable between a closed position where its periphery engages the seat to close off the exhalation chamber from

the exhaust passage and an open position where it is spaced from the exhalation valve seat to allow communication between the exhalation chamber and exhaust passage, the exhalation valve disc being biased toward closed position; a cylindrical sleeve connected between the periphery of the inhalation chamber side of the exhalation valve disc and the housing to seal off the inhalation chamber from the exhalation chamber and the exhaust passage, said sleeve being capable of accommodating axial movement of the exhalation valve disc; an inhalation port extending through the exhalation valve disc within the area circumscribed by the exhalation valve seat; and an inhalation check valve that is adapted to open and close the inhalation port to allow communication only from the inhalation chamber to the exhalation chamber;

the improvement wherein:

the housing includes a cylindrical guide wall that relatively closely surrounds the edge of the exhalation valve disc to guide the same in its axial movement; and the exhaust passage includes a series of slots defining inlet ports leading through the guide wall, the slots being of substantial axial length and extending from upper ends that are approximately at the level of the exhalation valve disc when the same is in closed position to lower ends that are approximately at the level of the edge of the exhalation valve disc when the same is in maximum open position, the upper inner edge portions of the slots being out-wardly tapered from top to bottom.

**2.** A breathing valve according to claim **1** wherein: the exhaust passage terminates at its outer end in a portion that lies in parallel to the length of the housing; and there is a control ring surrounding the exterior of the housing and threadedly mounted thereon to be axially movable toward and away from the outer end portion of the exhaust passage to progressively close and open the same.

**3.** A breathing valve according to claim **2** wherein: there is an annular collector shroud fixed to the exterior of the housing that encloses the outer end portion of the exhaust passage and defines a collector passage leading to an outlet; and the control ring extends axially through the shroud with an airtight seal therebetween.

**4.** In a breathing valve of the type comprising: a housing defining an inhalation chamber on the supply side, an exhalation chamber on the user side that terminates at its inner end in an annular exhalation valve seat facing the inhalation chamber, and an outwardly opening annular exhaust passage downstream of the exhalation chamber; an exhalation valve disc on the inhalation chamber side of the exhalation valve seat that is movable between a closed position where its periphery engages the seat to close off the exhalation chamber from the exhaust passage and an open position where it is spaced from the exhalation valve seat to allow communication between the exhalation chamber and exhaust passage, the exhalation valve disc being biased toward closed position; a cylindrical sleeve connected between the periphery of the inhalation chamber side of the exhalation valve disc and the housing to seal off the inhalation chamber from the exhalation chamber and the exhaust passage, said sleeve being capable of accommodating axial movement of the exhalation valve disc; an inhalation port extending through the exhalation valve disc within the area circumscribed by the exhalation valve seat; and an inhalation check valve that is adapted to open and close the inhalation port to allow communication only from the inhalation chamber to the exhalation chamber;

the improvement wherein:

the exhaust passage terminates at its outer end in a portion that lies parallel to the length of the housing; and there is a control ring surrounding the exterior of the housing and threadedly mounted thereon to be axially movable toward and away from the outer end portion of the exhaust passage to progressively close and open the same.

**5.** A breathing valve according to claim **4** wherein: there is an annular collector shroud fixed to the exterior of the housing that encloses the outer end portion of the exhaust passage and defines a collector passage leading to an outlet; and the control ring extends axially through the shroud with an airtight seal therebetween.

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