

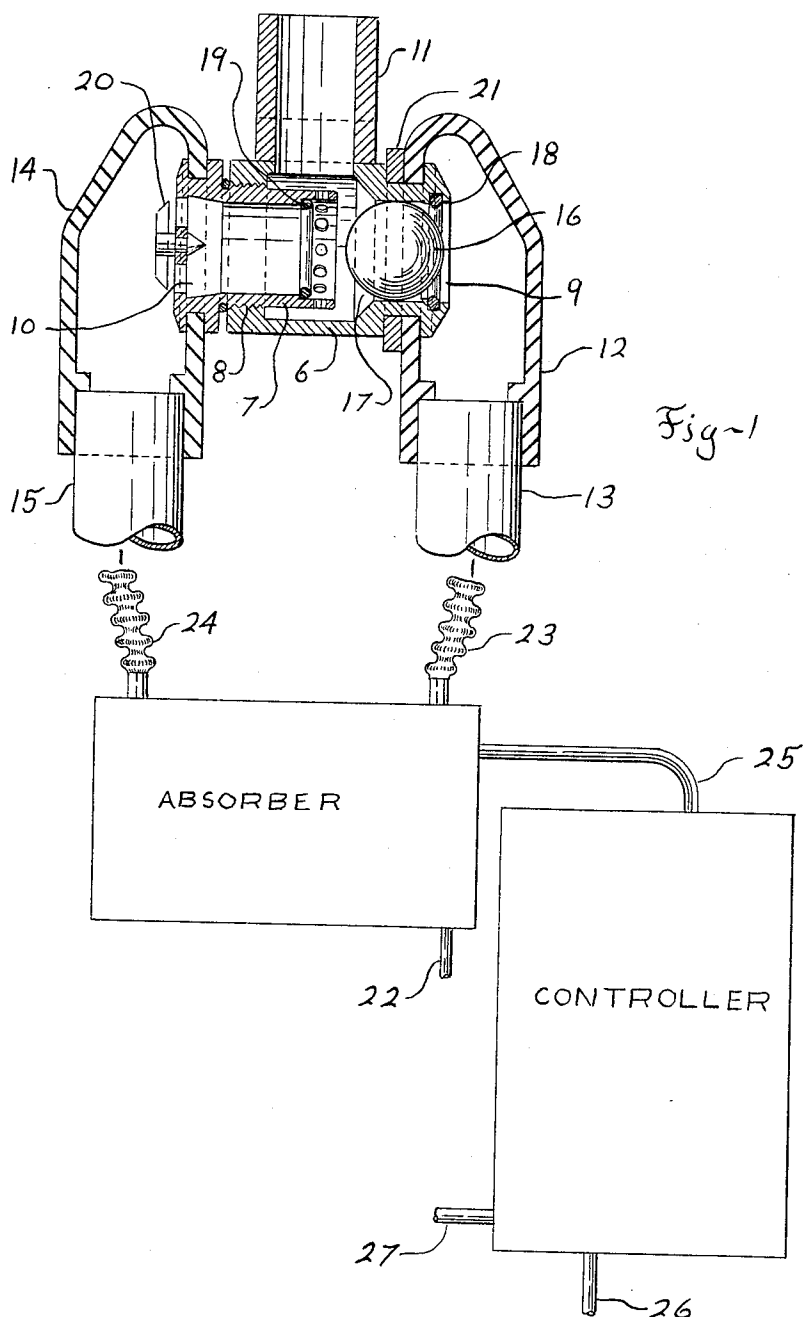
Oct. 18, 1966

J. O. ELAM
BREATHING VALVE

3,279,487

Filed Dec. 30, 1963

2 Sheets-Sheet 1



INVENTOR.
James O. Elam
BY
Spencer & Leckner
ATTORNEYS

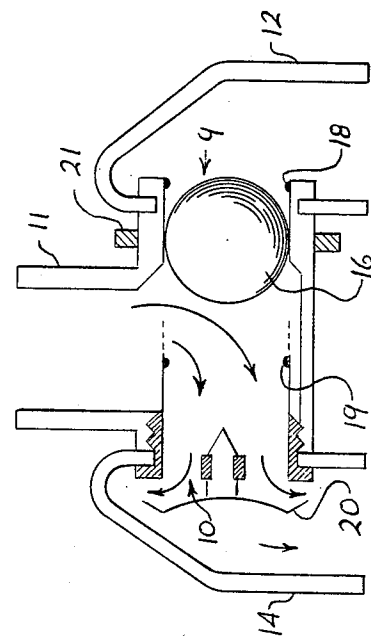
Oct. 18, 1966

J. O. ELAM
BREATHING VALVE

3,279,487

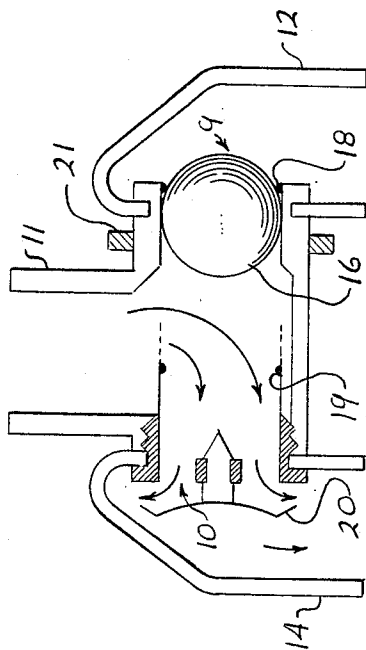
Filed Dec. 30, 1963

2 Sheets-Sheet 2



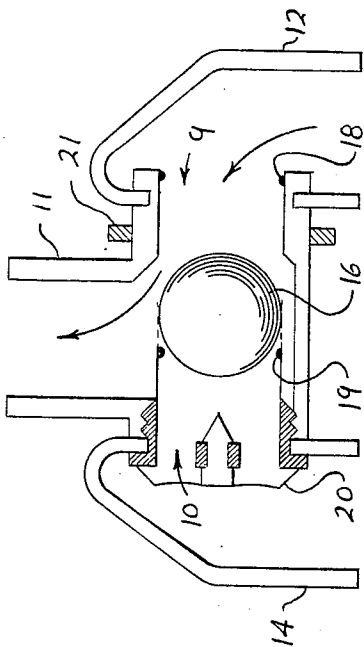
SPONTANEOUS EXPIRATION

Fig-3



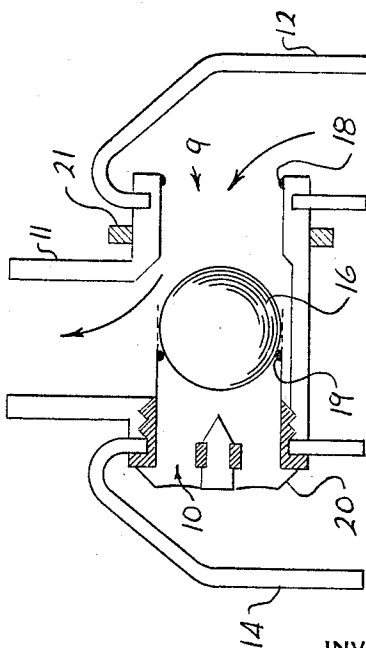
NEGATIVE PRESSURE EXPIRATION

Fig-5



SPONTANEOUS INSPIRATION

Fig-2



POSITIVE PRESSURE INSPIRATION

Fig-4

INVENTOR
James O. Elam
BY
Symon & Lechman
ATTORNEYS

1

3,279,487

BREATHING VALVE

James O. Elam, % Roswell Park Memorial Hospital,
616 Elm St., Elma, N.Y.

Filed Dec. 30, 1963, Ser. No. 334,319

7 Claims. (Cl. 137-63)

This invention relates to breathing equipment and is particularly concerned with what may be termed a breathing valve, i.e., a valve assembly through which inspiration as well as expiration of the patient occurs, the valve providing automatically for the flow of inspiratory gases through one channel and for the flow of expiratory gases through another channel.

There are a number of different general types of breathing apparatus or equipment and it is an important object of the present invention to provide a breathing valve which is adapted for use with many different kinds of breathing equipment.

For example, one form of breathing equipment comprises a simple so-called resuscitator incorporating a manually squeezable bag for forcing air into the patient's lungs. In equipment of this type, it is desirable that the mouthpiece or mask adapted to be applied to the patient be connected with the bag in such manner that air will flow from the bag to the patient, but that the gases exhaled by the patient shall not return into the bag but shall be discharged externally thereof. The breathing valve of the present invention is adapted to be employed with this type of equipment and provides for the desired flow of breathing gases to the bag from the patient and from the patient to a point of discharge externally from the bag.

In certain other forms of breathing equipment used for various purposes including anesthesia, the patient's voluntary or spontaneous inspiration and expiration are relied upon, although it is still of importance to provide for channeling of the inspiratory gases and expiratory gases to different points or through different connections. The breathing valve of the present invention is adapted also to meet the requirements of this type of breathing equipment.

Still further, in certain types of breathing equipment the equipment itself induces at least positive pressure inspiration, and passive expiration or negative pressure expiration, here again it being of importance to maintain a separation between the inspiration gases and the expiration gases. The breathing valve of the present invention is also adapted to meet the requirements of this type of equipment.

It is a further object of the invention that the breathing valve be arranged to meet various of the requirements such as those noted above without requiring any change in the breathing valve itself.

Another object of the invention is to provide an improved breathing valve the action of which is not influenced by gravity so that the breathing valve may be placed in any position without altering the operation thereof.

According to another feature of the invention a breathing valve is provided in which a movable ball member is visible through a transparent valve body wall, thereby providing a visual monitoring of the patient's breathing. This is of especial importance in connection with the administration of anesthesia with equipment including a manually compressible bag for assisting inspiration by the patient. In the anesthetized patient who may be nearly paralyzed, the moving valve member provides a means of detection of extremely small inspiratory effort and

2

affords, thereby, a visible signal for the physician to manually compress the bag. This makes possible synchronization of the inflation of the lungs of the patient in precise rhythm with the patient's own weak effort.

How the foregoing and other objects and advantages are attained will appear more fully from the following description of the accompanying drawings illustrating a preferred embodiment of the invention and in which:

FIGURE 1 is a sectional view of a breathing valve constructed according to the present invention, this view also diagrammatically illustrating the association of the valve with one particular form of breathing equipment, for instance of the type adapted to effect positive pressure inspiration and also negative pressure or passive expiration;

FIGURE 2 is a somewhat diagrammatic sectional view of the breathing valve of the invention illustrating the valve parts during spontaneous inspiration by a patient;

FIGURE 3 is a view similar to FIGURE 2 but illustrating the valve parts during spontaneous expiration by the patient;

FIGURE 4 is a view similar to FIGURE 2 but illustrating the position of valve parts during positive pressure inspiration of a patient; and

FIGURE 5 is a view similar to FIGURE 3 but illustrating valve parts during negative pressure expiration of the patient.

In the preferred embodiment herein illustrated, the valve body is made up of two generally cylindrical parts, including an outer cylindrical member 6 and an inner cylindrical member 7 telescoped in the outer member and threaded therein as indicated at 8. Toward opposite ends of the telescoped members 6 and 7 there are ports or portage, the port 9 at the end of the member 6 comprising the inspiratory port and the port 10 at the end of the member 7 comprising the expiratory port. In the central region of the assembly the side wall of the member 6 is provided with a port with which the connection 11 is associated, this latter connection being adapted to be associated with the mask, mouthpiece, tracheal fitting or the like adapted to be associated with the patient.

Externally the valve member 6 is provided with a groove adapted to cooperate with a rubber fitting 12 by means of which an inspiratory connection 13 may be associated with the valve body. Similarly, at the opposite side of the device, the member 7 is grooved to cooperate with the rubber fitting 14 with which an expiratory connection 15 is associated.

A ball valve 16 is arranged within the valve chamber interiorly of the parts 6 and 7 and is adapted to move axially therein to effect various of the control functions of the valve. The member 6 is provided with a portion of reduced diameter indicated at 17, adjacent to the port 9, this portion being only very slightly larger than the diameter of the ball 16 so as to provide what might be termed a raceway in which the ball is caused to move in one direction or another upon even very slight flow or pressure differentials. A ball seat, advantageously in the form of a rubber O ring 18 is arranged adjacent to the port 9 and is engageable by the ball 16 to close the port 9. Similarly the member 7 carries a valve seat in the form of a rubber O ring 19 which is engageable by the ball when it moves in the opposite direction so as to close the port 10.

A flexible, for instance rubber, check valve 20 is mounted at the left end of the member 7 as viewed in FIGURE 1 in position to provide for closure of the port 10 under

the influence of an increase in pressure entering through connection 15. This check valve 20 opens freely upon increase in pressure in the interior of member 7 or the port 10.

Attention is now called to the fact that in the preferred embodiment of the invention, both of the valve body parts 6 and 7 are composed of nonmagnetic material. Most advantageously member 6 is of a transparent nonmagnetic material, such as various plastics, for instance polymethylmethacrylate. The member 7 is advantageously made of plastic or of a nonmagnetic metal, such as aluminum.

The invention also contemplates the employment of a ball valve 16 composed of magnetic material, for instance nickel or ferrite or iron particles imbedded in a plastic vehicle and because it is contemplated according to the invention that the ball valve shall have very low mass and inertia, the ball is advantageously made hollow. The position of the magnetic ball is influenced by the permanent magnet ring 21 which is disposed externally of the valve body member 16 in the region in which the ball race 17 is provided. This ring 21 thus lies between the patient's breathing port and connection 11 on the one hand, and the port 9 and the valve seat 18 on the other hand. The ring 21 tends to maintain the ball in the plane of the ring, and this is true regardless of the position of the valve assembly, in view of which the valve assembly is substantially unaffected by gravity regardless of the position in which it is mounted or held.

It is desirable in order for the purpose of avoiding undesired magnetic fields in the region of the ball that all of the parts of the valve assembly be composed of nonmagnetic material except for the ball itself and the ring 21. The making of the inner valve body member 7 of nonmagnetic metal or plastic serves this purpose, as does also the making of the body part 6 of plastic. Connection 11 which is adapted to be associated with the patient is also desirably made of nonmagnetic material, for instance a plastic such as that of which the member 6 is composed. The connection 11 may be adhesively secured to the member 6.

The fittings 12 and 14 and also the O rings 18 and 19, as well as the valve 20, all being made of rubber or a plastic such as polytetrafluoroethylene, will of course not influence the action of the magnetic ball 16.

In FIGURE 1 the breathing valve of the invention is illustrated as being associated with breathing equipment including an absorber diagrammatically illustrated, this absorbed having provision for introduction of an anesthetic gas at 22. As is well known, an absorber of this type provides for recirculation of the gases after passing through the absorber, but the inspiratory and expiratory connections 13 and 15 are of course separately connected with the absorber, for instance by flexible conduits 23 and 24. The breathing equipment shown in FIGURE 1 further diagrammatically illustrates a controller for a connection 25 with the absorber and having also an air or oxygen intake 26 and a discharge or exhaust port 27, all of these parts and connections being here illustrated purely diagrammatically as they form no part of the present invention per se. They do, however, illustrate a manner of use of the breathing valve of the invention and in the illustrative example it is assumed that the equipment diagrammatically shown in FIGURE 1 may alternatively be operated either in a manner relying upon the patient's spontaneous effort to effect inspiration and expiration or upon action of the controller to provide positive pressure inspiration and negative pressure expiration.

The diagrams of FIGURES 2 and 3 illustrate the position of the valve parts during spontaneous breathing by the patient, and the diagrams of FIGURES 4 and 5 illustrate the positively controlled inspiration and expiration of a patient.

Referring first to FIGURE 2, it will be noted that this represents spontaneous inspiration and in this condition

the resultant pressure reduction in the patient's breathing connection 11 causes the ball valve to shift partway to the left so that the breathing gases may enter from the fitting 12 at the inspiratory side of the device. At this time there would be a tendency to retain the check valve 20 in closed position so that the patient would not receive air or gases from the fitting 14 at the expiratory side of the valve. From FIGURE 2 it will be noted that the ball valve 16 is displaced from the plane of the magnetic ring 21, but is not necessarily displaced all the way to the seat 19, and seating of the valve at that point is not needed because of the action of the check valve 20.

Upon spontaneous expiration, the valve parts assume the positions illustrated in FIGURE 3. Here the ball valve 16 has been displaced slightly to the right, although not necessarily tightly fitted against the O ring 18, and the expiratory gases readily pass into the valve chamber and past the check valve 20 into the expiratory connection 14. Because of the very close tolerance between the valve 16 and its raceway toward the right hand end of the assembly, no significant quantity of expiratory gases will enter the inspiratory fitting 12.

Turning now to the illustrations of FIGURES 4 and 5, it will be noted that during positive pressure inspiration, the pressure entering the valve assembly through the connection 12 will displace the ball valve 16 to the left sufficiently to seat against the O ring 19 and thus prevent loss of pressure past the check valve 20 and into the expiratory fitting 14. The inspiratory gases under positive pressure will of course enter the patient's breathing connection 11 and supply the patient with the desired breathing gases. From FIGURE 5, during negative pressure expiration, it will be seen that the negative pressure induced in the expiratory fitting 14 will result in opening of the check valve 20 and withdrawal of expiratory gases from the patient from the patient's connection 11. At this time the ball valve 16 will be caused to move to the right sufficiently to fit against the O ring 18 because the negative pressure is also present at the opposite side of the ball valve, being applied thereto through the fitting 12 which also communicates with the absorber and thus ultimately with the controller which at this time is establishing a negative pressure in the breathing circuit.

Another feature of advantage of the breathing valve is that the arrangement causes the ball valve to cycle substantially in the manner described above even with the check valve 20 removed, which may readily be done merely by pulling the rubber valve and its mounting stem out of the central mounting socket provided. This functioning is effected by a difference in resistance to gas flow which is present in the valve between the points or ports 11 and 10 on the one hand, as compared with the resistance to flow between the ports or points 11 and 9 on the other hand. During flow of gas into the patient the resistance through the port 9 is less than that through the port 10, causing lower pressure at port 10 and thereby causing the ball to move toward seat 19. Since the internal pathway is larger between ports 11 and 9 the initial flow of a very small amount of gas through this path reduces the pressure at port 9 below that at port 10 and causes the ball to move toward seat 18.

It will also be readily apparent that for use with a simple type of resuscitator, such as that mentioned toward the beginning of the specification, providing for positive pressure inspiration but for spontaneous expiration, the conditions prevailing will correspond essentially to those represented by FIGURES 4 and 3, respectively. In such a situation it may not even be necessary to retain the fitting 14 or at least any extended connection therefrom, the expiratory gases merely being discharged past the check valve 20 to atmosphere. In this use, i.e., with a simple resuscitator, the bag or bulb would of course be connected with the inspiratory fitting 12. In this use with a resuscitator, the check valve 20 may be eliminated

5

without destroying the desired valving action of the ball valve. The elimination of the check valve for such resuscitator use constitutes a safety feature because, in the event the resuscitator ceased operation, a recovering patient could nevertheless breathe spontaneously by inhaling air through the port 10.

In all of the uses described above it will be noted that the ball valve 16 partakes of at least some motion during inspiration and expiration by the patient. Since this ball valve is readily visible through the transparent wall of the valve body part 6, the ball provides an effective visible means of monitoring the patient's breathing. With a ball valve of light weight as is contemplated, the ball is so sensitive to flow and pressure fluctuations that the ball will frequently afford the anesthetist or other operator with a clear indication of the patient's breathing, even where the breathing is so slight as not to be readily detectable by observing the patient himself.

According to the invention the breathing valve provided is also adaptable virtually universally to breathing equipment without any alteration or adjustment in the parts. The construction of the breathing valve is also of advantage as it permits of ready fabrication of the parts as well as convenient assembly and disassembly for purposes of cleaning, sterilization and the like.

I claim:

1. A valve for use with breathing equipment comprising a valve body of nonmagnetic material and having a generally cylindrical valve chamber therein with inspiratory and expiratory ports communicating with the chamber toward opposite ends thereof and with a patient's breathing port communicating with the chamber intermediate the inspiratory and expiratory ports, a ball valve in the chamber and comprising magnetic material, a ball seat around the inspiratory port engageable by the ball to close the inspiratory port, a ball seat around the expiratory port engageable by the ball to close the expiratory port, a check valve associated with the expiratory port and positioned to prevent flow through the expiratory port toward the patient's breathing port, and magnetic means disposed around the valve body externally thereof for urging the ball toward a position intermediate the patient's breathing port and the ball seat around the inspiratory port substantially arresting flow therethrough.

2. A valve according to claim 1 in which the valve body comprises transparent nonmagnetic material at least in a region between the ball seats to provide for visual observation of the ball and thus visual monitoring of the patient's breathing.

3. A valve for use with breathing equipment comprising a valve body including a part of nonmagnetic material and having a cylindrical valve chamber therein with an inspiratory port communicating with the chamber toward one end thereof and with a patient's breathing port communicating with the chamber through the side wall of the chamber, the valve body including another cylindrical part having a cylindrical valve chamber therein communicating with the first chamber and having an expiratory port toward its end opposite to the inspiratory port, a ball valve movable in said chambers and comprising magnetic material, a ball seat around the inspiratory port engageable by the ball to close the inspiratory port, a ball seat around the expiratory port engageable by the ball to close the expiratory port, a check valve associated with the expiratory port and positioned to prevent flow through the expiratory port toward the patient's breathing port, and magnetic means disposed around the first part of the valve body externally thereof for urging the ball toward a position intermediate the patient's breathing port and the ball seat around the inspiratory port substantially arresting flow therethrough.

4. A valve for use with breathing equipment comprising a valve body made of two partially telescoped

6

cylindrical members cooperating to define a valve chamber, the chamber having an inspiratory port toward one end thereof, an expiratory port toward the other end thereof and a patient's breathing port through the side wall thereof between the inspiratory and expiratory ports, both of the telescoped members being composed of nonmagnetic material and at least the outer of the telescoped members being transparent, a magnetic ball valve movable in said chamber, a ball seat around the inspiratory port engageable by the ball to close the inspiratory port, a ball seat around the expiratory port engageable by the ball to close the expiratory port, a check valve associated with the expiratory port and positioned to prevent flow through the expiratory port toward the patient's breathing port, and magnetic means disposed around the valve body externally thereof and concentrated in a plane intermediate the patient's breathing port and the ball seat around the inspiratory port for urging the ball valve to a position in said plane substantially arresting flow therethrough.

5. A valve for use with breathing equipment comprising a valve body of nonmagnetic material and having a generally cylindrical valve chamber therein with inspiratory and expiratory ports communicating with the chamber toward opposite ends thereof and with a patient's breathing port communicating with the chamber intermediate the inspiratory and expiratory ports, a ball valve in the chamber and comprising magnetic material, the portion of the valve chamber in the region between the inspiratory port and the patient's breathing port being of diameter closely approximating that of the ball valve, a ball seat around the inspiratory port engageable by the ball to close the inspiratory port, a ball seat around the expiratory port engageable by the ball to close the expiratory port, a check valve associated with the expiratory port and positioned to prevent flow through the expiratory port toward the patient's breathing port, and magnetic means disposed around the valve body externally thereof in the region of said portion of the valve chamber for urging the ball toward a position intermediate the patient's breathing port and the ball seat around the inspiratory port substantially arresting flow therethrough.

6. A valve for use with breathing equipment comprising a valve body of nonmagnetic material and having a generally cylindrical valve chamber therein with inspiratory and expiratory ports communicating with the chamber toward opposite ends thereof and with a patient's breathing port communicating with the chamber intermediate the inspiratory and expiratory ports, a ball valve in the chamber and comprising magnetic material, the portion of the valve chamber in the region between the inspiratory port and the patient's breathing port being of diameter closely approximating that of the ball valve and being formed of transparent material providing for observation of the ball valve therein, and the adjoining portion of the chamber with which the patient's breathing port communicates being of diameter considerably larger than the ball valve, a ball seat around the inspiratory port engageable by the ball to close the inspiratory port, a ball seat around the expiratory port engageable by the ball to close the expiratory port, and magnetic means disposed around the valve body externally thereof in the region of the portion of the chamber of diameter approximating that of the ball valve for urging the ball valve toward a position intermediate the patient's breathing port and the ball seat around the inspiratory port substantially arresting flow therethrough.

7. A valve for use with breathing equipment comprising a valve body of nonmagnetic material and having a generally cylindrical valve chamber therein with inspiratory and expiratory ports communicating with the chamber toward opposite ends thereof and with a patient's breathing port communicating with the chamber intermediate the inspiratory and expiratory ports, a ball valve in the chamber and comprising magnetic material, the

7

portion of the valve chamber in the region between the inspiratory port and the patient's breathing port being of diameter closely approximating that of the ball valve and being formed of transparent material providing for observation of the ball valve therein, a ball seat around the inspiratory port engageable by the ball to close the inspiratory port, a ball seat around the expiratory port engageable by the ball to close the expiratory port, and magnetic means for urging the ball valve to a position intermediate the patient's breathing port and the ball seat around the inspiratory port substantially arresting flow therethrough.

5

10

8

References Cited by the Examiner

UNITED STATES PATENTS

2,700,395	1/1955	Young	251—65 X
2,811,979	11/1957	Presnell	251—65 X
3,063,461	11/1962	Rudolph	137—64
3,107,669	10/1963	Gross	128—142

FOREIGN PATENTS

914,086	6/1954	Germany.
---------	--------	----------

WILLIAM F. O'DEA, *Primary Examiner.*R. GERARD, *Examiner.*