July 16, 1963 A. M. RUSSELL 3,097,642

FACE MASK

Filed Aug. 21, 1956 3 Sheets-Sheet 1

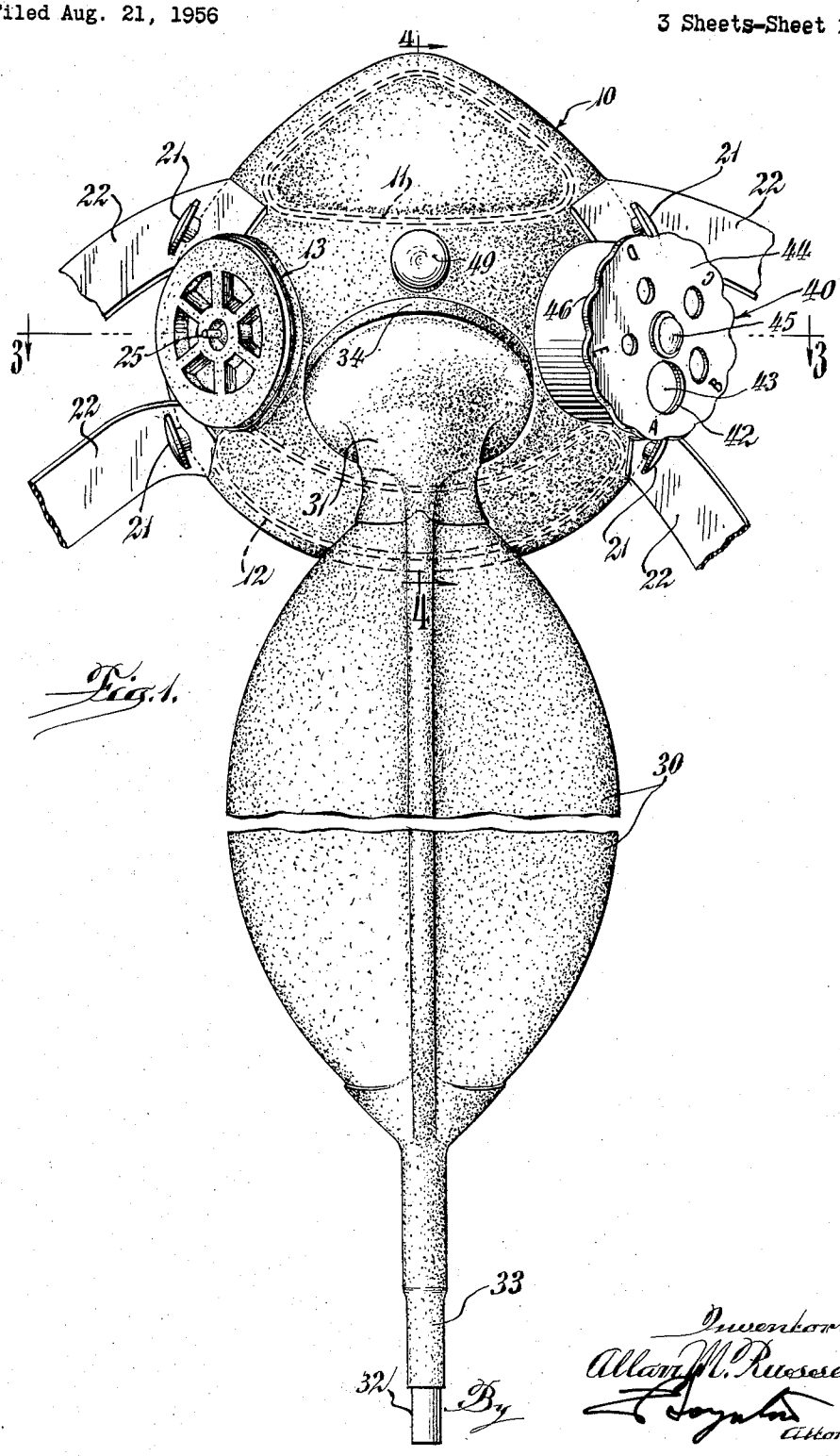

Fig. 1.

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July 16, 1963 A. M. RUSSELL 3,097,642

FACE MASK

Filed Aug. 21, 1956 3 Sheets-Sheet 2

Fig. 2.

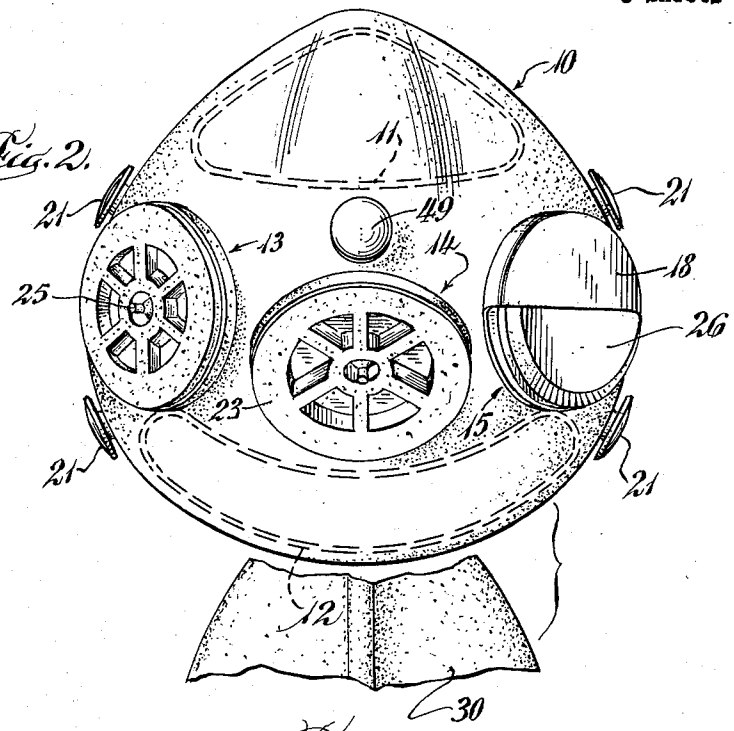
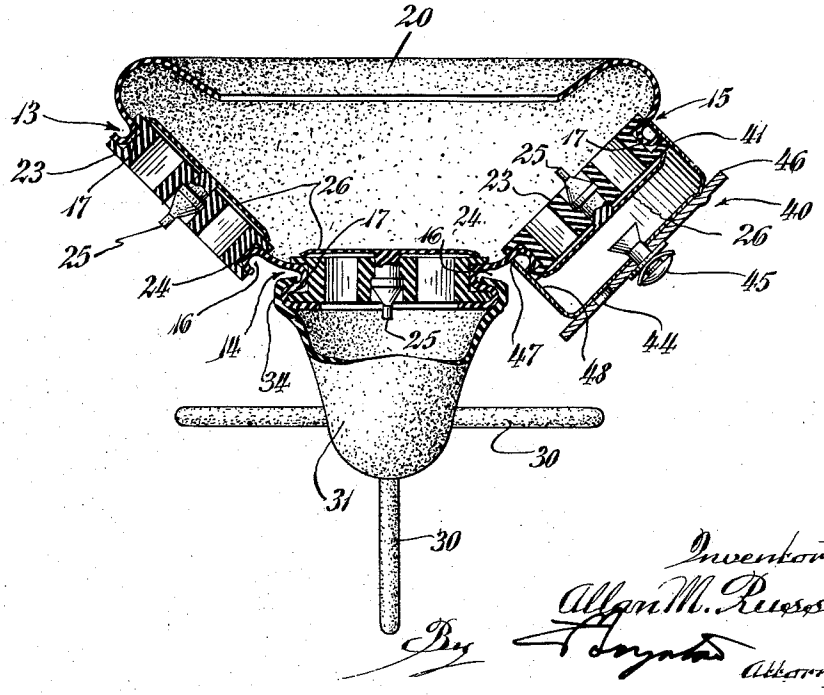


Fig. 3.



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FACE MASK

Filed Aug. 21, 1956 3 Sheets-Sheet 3

Fig. 5.

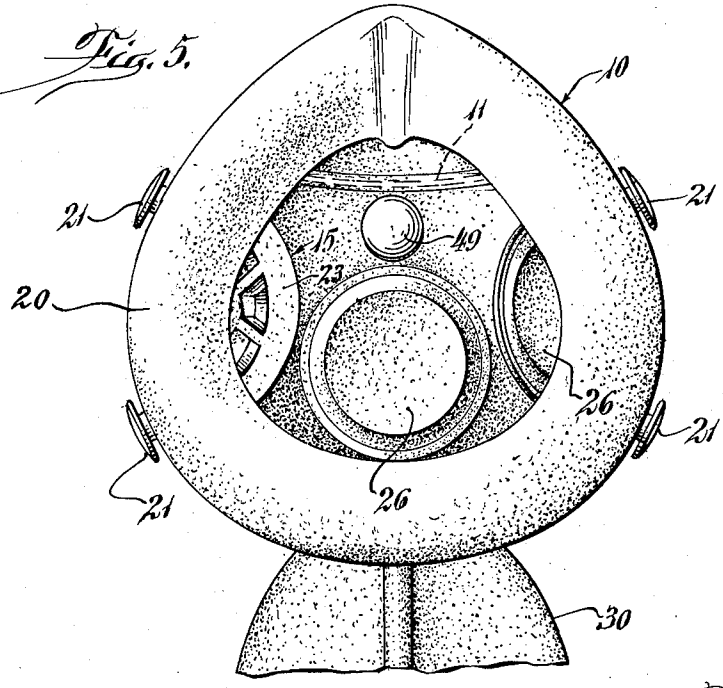


Fig. 4.

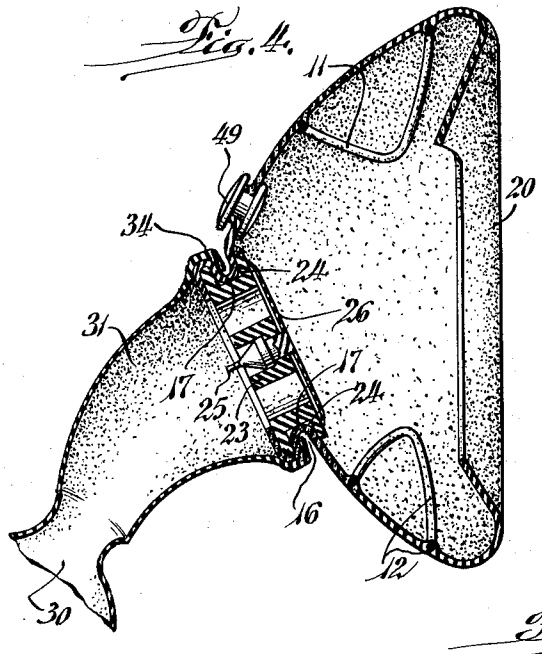
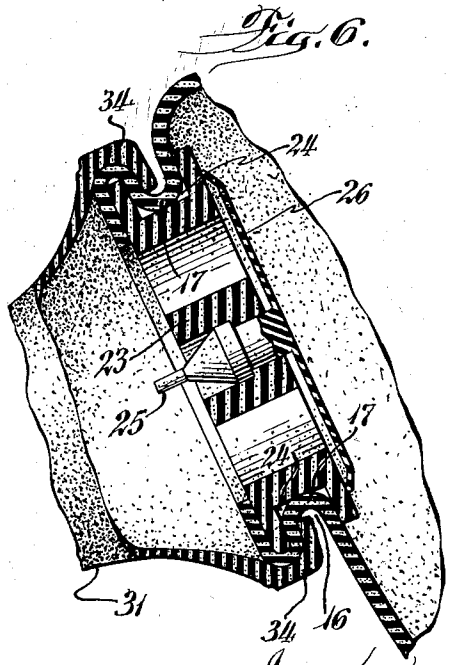


Fig. 6.



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FACE MASK

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4 Claims. (Cl. 128—146)

This invention relates in general to face masks for the administration of gaseous fluids. More particularly it relates to an improved face mask for use either as a conventional rebreathing mask, a reservoir type mask, a positive pressure mask, or a non-reservoir large volume direct flow mask, all providing high oxygen concentrations. This mask is adapted for use either with a continuous flow of gaseous fluids or with gaseous fluids regulated for flow on demand or inspiration only. More specifically, this versatility is achieved through significant discoveries in both the construction of the mask body and apparatus for use in combination with the mask body.

Generally, face masks for the administration of gaseous fluids of the reservoir or rebreathing type are equipped with a reservoir bag or bag for applying rebreathing techniques secured to the mask body by means of a separate rigid intervening connector. In order to achieve the necessary coupling and gas seal between the connector and the bag, a metal ring clamp, band, or wire necessitating tightening with tools such as a screw driver or pliers is usually required. Attachment of the bag to the mask body by such an arrangement is apt to cause or promote cracking and deterioration of the bag material in the area of contact between it and the connector, resulting obviously in an appreciable shortening of the useful life of the bag.

In addition, the manner in which a bag is connected to a mask body by such conventional means renders its removal for sterilization purposes most difficult. Moreover, the construction of many heretofore available masks did not lend itself to compact storage, usually necessary in portable emergency units or airborne compartments, and certainly desirable in hospital equipment rooms.

In more specialized uses of face masks for the administration of gaseous fluids, such as, for example, the treatment of obstructive dyspnea, edema of the lungs, or congestive heart failure, to name a few, it has been found expedient to induce pressure in the lungs by providing resistance to expiration. This is customarily accomplished in a single purpose mask by securing a positive pressure valve to the mask body in much the same manner as the conventional reservoir bag or bag for applying rebreathing techniques is secured. Such valves are usually cumbersome, and their installation or removal while the mask is in use is difficult, if not impossible. This results in an interrupted flow of gaseous fluids to the wearer while the conversion is taking place.

To the end of providing a face mask which eliminates these disadvantages, extensive research has been conducted, and as a result a face mask has been devised which, in combination with a detachable reservoir bag or bag for applying rebreathing techniques and a removable positive pressure valve, overcomes the stated shortcomings of conventional equipment.

It is accordingly one of the principal objects of this invention to provide in combination a face mask and detachable reservoir bag or bag for applying rebreathing techniques that eliminates an intervening connector and clamp, band, or wire and at the same time maintains a snug frictional engagement and gas seal between the mask body and bag.

Another object of this invention is to provide in combination a face mask and a separable reservoir bag or bag for applying rebreathing techniques which are readily

attached or detached without the use of tools thus simplifying variation in methods of administering gaseous fluids using the same face mask, and facilitating sterilization and compact storage.

Still another object of this invention is to provide in combination a face mask and a removable, simple positive pressure valve which efficiently avails selective and variable positive pressures within the lungs, accomplished by merely slipping in place the pressure valve over the exhalation valve turret of the mask body, and which enables switching to and from normal administration of gaseous fluids without interruption in flow.

A feature of the invention resides in the manner in which the various pliable members are formed, in which certain of said members are stiffened without loss of resiliency, and in the trimming or forming of certain portions of the mask body to achieve snug frictional engagement with other components of the mask combination.

These and additional objects and advantages will become more readily apparent as the following description proceeds, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a front view in perspective of the face mask and attached bag and positive pressure valve.

FIG. 2 is a front elevational view of the face mask body with the bag and positive pressure valve removed.

FIG. 3 is a sectional view taken along line 3—3 of FIG. 1.

FIG. 4 is a longitudinal sectional view taken along line 4—4 of FIG. 1.

FIG. 5 is a rear elevational view of the face mask and a portion of the bag.

FIG. 6 is an enlarged view illustrating the manner in which the bag is attached about the inlet turret, the latter having its inlet valve in place.

Referring now to the drawings and particularly FIGS. 1 and 2, the face mask is provided with a mask body **10** preferably of a soft, pliable material such as latex rubber. The mask body **10** has an oral and nasal section in which are embedded two malleable metal members **11** and **12** preferably in the form of wire loops. The members **11** and **12** not only provide stiffening means for the pliable material of the mask body **10**, but enable it to be conformed to the facial configurations of the wearer, and to be maintained in any desired position in such facial areas where adjustment is most generally required.

Three turrets **13**, **14**, **15** are provided in the vicinity of the oral and nasal sections of the mask body **10**. These turrets are formed preferably of the same material as the mask body **10** and integral therewith. The side walls of the turrets **13**, **14**, and **15** are reduced or constricted to form an annulus or groove **16** on one side and a valve body receiving wall **17** on the other side, the function of which will be considered in greater detail later. Each of the turrets **13**, **14**, and **15** is trimmed or formed to provide a central opening. Additionally, one of the turrets, utilized for exhalation, may be provided with a deflector **18**. This deflector is formed preferably integral with the side walls of turret **15** and preferably encloses the top portion of the turret opening. It serves to deflect exhalation downward, thereby preventing interference with the sight, or fogging of eyeglasses or goggles of the wearer of the mask.

In addition, the mask body **10** is formed to provide a face engaging flange **20** (see FIGS. 3, 4, and 5), which is trimmed or formed to allow a sufficient opening to freely receive the mouth and nose of the wearer. Studs or buttons **21**, in spaced relation to one another on the mask body **10**, are also provided to receive head straps **22** which hold the face mask on the wearer. For a

more detailed description of such elements as embedded members **11** and **12**, the deflector **18**, the face engaging flange **20**, and the head straps **22**, reference may be had to my copending application Serial Number 303,030, filed August 7, 1952, now Patent No. 2,818,861, for Oxygen Mask, of which application this application is a continuation in part.

Referring again to the turrets **13**, **14**, and **15**, a valve body **23**, preferably of spoked wheel-like construction and of a resilient material, but in any event considerably stiffer in character than the material of the mask body **10**, is disposed in the central opening of each of the turrets. The valve bodies **23** are provided with an annular groove **24** adapted to engage the valve body receiving wall **17** of the turrets **13**, **14**, and **15** (see FIG. 3). The valve bodies **23** are thus retained in snug and gas sealing engagement with the mask body **10**. The stiffer character of the material of the valve bodies **23** provides added stiffening means for the soft, pliable material of the mask body **10** intermediate the embedded members **11** and **12**.

Each of the valve bodies **23** has a central opening through which a tab **25** of a resilient flap-like check valve **26** may be drawn and secured, the direction in which the tab **25** is drawn determining the direction of flow desired to be checked.

The turrets **13** and **15**, and their included valve bodies **23** and valves **26** are for emergency or excess demand inhalation, and exhalation, respectively. The central turret **14** being most directly situated with respect to the oral and nasal passages of the wearer is generally utilized for introduction and inhalation of gaseous fluids. The position of the turrets with relation to each other and their arrangement on the mask body **10** are, of course, subject to variation. The disposition illustrated, however is preferred.

Referring again to the mask body **10**, the preferred embodiment is illustrated with a bag **30** attached to the turret **14**. The bag **30** is preferably made of the same lightweight, flexible material as the mask body **10** but with a thinner wall, and is provided with an arched neck **31** to direct the bag away from bed clothing or clothing of the wearer and to permit free movement of the bag relative to mask body **10**. The bag **30** has a tube **32** inserted at its lower or pendant inlet end **33** whereby gaseous fluids such as oxygen are directed into the bag from a gas source (not shown). This tube insures the inlet remaining open in the event the bag is pulled or twisted. The tube **32** is inserted into the bag **30** a sufficient distance to prevent inundation of the inner end (not shown) by condensate settling out of exhaled gaseous fluids and deposited in the pendant end of the bag.

The necked end of the bag **30** is provided with a formed resilient ring **34**, preferably integral therewith and of the same material as the bag **30** (see FIGS. 1, 3, 4, and 6). The ring **34** is adapted to be stretched about the turret **14** and snapped into position in the annulus or groove **16** of turret **14**.

In the preferred embodiment illustrated the material forming turret **14** which houses inlet valve body **23** is formed or trimmed to completely cover the rim only of the valve body. When the ring **34** of the bag **30** is snapped into position as described, a snug frictional engagement and seal is effected between the bag **30** and the turret **14**. Due to snug contact between the members of like or similar materials, slippage is prevented and wear is substantially eliminated. Moreover, forces exerted on or by the bag **30** are evenly distributed to the mask body **10**, and not on the rim of the valve body **23**, thus preventing the latter from becoming dislodged.

The construction of the necked end of the bag **30** and the turret **14** as described, notwithstanding the snug seal formed therebetween, permits ready detachment of the bag from the mask body **10**. It is only necessary to apply thumb pressure to the ring **34**. Thus detachment of the bag **30** after use, and sterilization can be easily accomplished.

An added advantage is that the bag **30** can be detached and folded for compact storage within the mask body **10**. This is particularly advantageous when the face mask is used for high altitude flying or with portable emergency units.

As stated earlier, the face mask is adapted for a wide variety of uses. Its versatility of application in reservoir and rebreathing techniques for administering gaseous fluids centers about the bag **30** and the check valve **26**, attached to valve body **23** housed in turret **14**. With the check valve **26** in the position illustrated in FIGS. 4, 5, and 6 the bag **30** serves only as a reservoir for incoming gaseous fluids. The gas, such as oxygen for example, directed into the bag from a source thereof, is available in substantial volume, as determined by the volume of bag **30**, for inhalation by the wearer through the valve **26**. Exhalation into the bag is prevented by the valve **26**. This technique results in a high concentration of gaseous fluids constantly available in the bag **30** for inhalation and thus the term "reservoir" technique.

To use the face mask for rebreathing purposes, the check valve **26** is readily removed from valve body **23**, housed in turret **14**. Thus, on exhalation, a portion of the exhaled gaseous fluids passes into the bag where it mixes with the gas in the bag **30** obtained from a source (not shown). This mixture of previously exhaled gas and gas, such as oxygen from the source, is inhaled by the wearer on inspiration. This technique for administering gaseous fluids produces favorable therapeutic results in those circumstances where such procedure is indicated.

Still another technique possible with applicant's mask is in the administration of gaseous fluids by the non-reservoir large volume direct flow method. To convert the face mask for such use it is necessary only to detach the bag **30** from the mask body **10** and then remove the valve body **23** and its check valve **26** from turret **14**. One end of a section of large bore tubing of suitable diameter and provided with a ring similar to ring **34** is inserted into the opening of turret **14** or about the turret depending on the size of the tubing employed and as desired. The other end is connected to a gas source. Gaseous fluids of desired concentration and volume are then directed to the wearer.

The emergency demand inhalation turret **13** is provided for demand inhalations, such as are comomn in cardiac cases or if for any reason there should be a substantial decrease or stoppage in flow of gaseous fluids from the gas source to the wearer of the face mask. The emergency demand inhalation turret valve **26** in the turret **13** opens under such inspiratory conditions for inspiration from the atmosphere.

The exhalation valve **26** housed in the turret **15** opens in response to exhalation pressures and acts generally as the main vent for the face mask.

For purposes of utilizing positive pressure techniques a positive pressure valve **40** may be mounted over the turret **15** housing the exhalation valve (see FIGS. 1 and 3). Such a valve is desirable in those special circumstances where it is necessary to produce variable pressures within the lungs to reduce the tendency of the pulmonary capillaries to filter serum through their walls into the alveolar spaces. The pressure in the pulmonary capillaries is small, and a therapeutic result may be achieved with pressures as little as one centimeter of water applied to the outside of the capillary wall. The pressure valve **40** is adapted for use in combination with the face mask to produce such pressures varying from 0 to 4 centimeters of water.

The pressure valve **40** preferably has a cup-shaped housing **41** made of a lightweight, durable material such as aluminum. The peripheral wall of the valve **40** is preferably marked or labeled with the word "top" to indicate the operative position in which it is to be mounted with

respect to the mask body as worn. The base **42** of the housing **41** is provided with an opening or port **43** to permit passage of exhaled gaseous fluids. A rotatable disc **44** preferably having five openings graduated in size, the largest of which is equal in size or smaller than the opening **43** in the base **42** of the housing **41**, is rotatably secured to the housing by a pin or rivet **45**. The graduated openings are suitably spaced on the disc **44** and are adapted to singly register with the opening **43** for any desired setting of the disc **44**. The disc **44** is further preferably provided with a lobate edge **46** for easy manipulation, and indexing means (not shown) are provided between the valve housing **41** and the disc **44** to maintain the latter in any selected position.

When positive pressure within the lungs is required, the pressure valve **40** is installed by mounting it over turret **15** housing the outlet or exhalation valve. This can be easily accomplished either while the face mask is worn or before it is placed on an individual. The cupped edge **47** of the valve **40** contacts the mask body **10** when the valve **40** has been properly mounted. The valve **40** is held in position on turret **15** by the snug sealing engagement of the inner peripheral wall **48** of the valve **40** and the material forming the turret **15** (see FIG. 3).

The pressure valve **40** operates on the principle that when expiration takes place through a constricted opening, a positive or back pressure is produced within the lungs due to the inability of exhaled gaseous fluids to escape to atmosphere in normal volume. The five graduated openings labeled A, B, C, D, and E on the disc **44** are calibrated to produce pressures within the lungs corresponding approximately to 0, 1, 2, 3, or 4 centimeters of water, respectively. When the largest opening labeled A is in register with the opening **43**, there is little or no pressure during exhalation. The smallest opening labeled E, on the other hand, will provide a pressure of approximately 4 centimeters of water within the lungs. The degree of resistance to exhalation of gaseous fluids is varied, of course, subject to each individual's physiological requirements and condition.

To assist in determining the amount of pressure being administered to any given individual, a dual purpose opening normally closed by a button or stud **49**, is located in the central section of the mask body **10**. This permits admittance of one end of a piece of tubing into the mask body **10** while the other end is placed in a simple water manometer. In this manner the pressure being produced within the lungs can be measured more accurately. Once the prescribed pressure has been established, the desired setting can then be made with disc **44**. Another function of the opening is to provide means for admitting a duodenal drainage tube while the wearer is undergoing inhalation therapy.

It will be apparent that applicant's face mask has extreme versatility of application, not only in hospitals and emergency units, but in high altitude flying. Its simplicity of operation and its relative inexpensiveness are added features of this valuable development. Certain modifications in construction of applicant's face mask, and apparatus used in combination therewith, will be suggested to those skilled in the art. All such modifications come within the spirit of this invention are intended to be included within its scope as best defined by the appended claims.

I claim:

1. Apparatus for the administration of gaseous fluids, comprising a mask adapted to enclose the oral and nasal passages and formed of soft, pliable material, said mask being provided with a thin flexible face engaging flange of substantial breadth and means comprising a wire loop embedded in said mask having at least a portion thereof extending to an intermediate area of the mask adjacent the oral and nasal passages for adjustably conforming the mask in the areas of the oral and nasal passages to insure its engagement with the face, a plurality of turrets in said mask in the area of the nasal and oral passages, each of said turrets being provided with an opening, stiffening means in said turret openings, a check valve in at least one of said turret openings, and adjustable means removably mounted over one of said turrets to provide preselected resistance to exhalation of gaseous fluids while at all times permitting exhalation therethrough, comprising valve means including means forming a series of constricted openings graduated in size, said valve means being arranged to permit exhalation through a selected one of said constricted openings.

2. Apparatus for the administration of gaseous fluids, comprising a mask adapted to enclose the oral and nasal passages and formed of soft, pliable material, said mask being provided with a thin flexible face engaging flange of substantial breadth and means comprising a wire loop embedded in said mask having at least a portion thereof extending to an intermediate area of the mask adjacent the oral and nasal passages for adjustably conforming the mask in the areas of the oral and nasal passages to insure its engagement with the face, a plurality of turrets in said mask in the area of the oral and nasal passages, each of said turrets being provided with an opening, and at least one of said turrets being formed to provide an annulus, stiffening means in said turret openings, a check valve arranged to form an inlet valve in at least one of said turret openings, and a reservoir bag having means including a ring formed integral therewith adapted to be received in said annulus, said reservoir bag being detachably secured about said turret formed to provide an annulus with said ring in engagement with said annulus, whereby a snug frictional engagement and a gas seal are achieved.

3. In apparatus for administration of gaseous fluids, a mask adapted to enclose the oral and nasal passages, said mask having a face engaging portion, and means comprising a wire loop embedded in said mask having at least a portion thereof extending to an intermediate area of the mask adjacent the oral and nasal passages for adjustably conforming the mask in the areas of the oral and nasal passages to insure its engagement with the face, a turret in said mask in the area of the oral and nasal passages, said turret having an opening, a check valve in said turret opening for exhalation of gaseous fluids, said check valve permitting exhalation through said turret opening but substantially preventing inhalation therethrough, and valve means removably mounted on said turret to provide preselected resistance to exhalation of gaseous fluids comprising, a housing one portion of which is open, said housing having a single port communicating with said open portion to permit passage of gaseous fluids, and means provided with a plurality of openings of predetermined different areas adjustably attached to said housing over said port, said means provided with a plurality of openings being adjustable with respect to said housing to place at all times a selected one of said openings of said different predetermined areas in register with said port to provide a pre-selected resistance to exhalation of gaseous fluids.

4. A gas impervious bag for connection to a face mask to provide a container for gaseous fluids comprising an inflatable portion an end of which is adapted for connection to a source of gaseous fluids other than gaseous fluids derived from exhalation, a tube inserted into said end of the inflatable portion, said tube being inserted a sufficient distance into said inflatable portion to prevent inundation of its inner end by condensate settling out of exhaled gaseous fluids received within the bag, said tube additionally insuring that there is no stoppage of flow of gaseous fluids from said source due to pulling or twisting of said bag in the region of its connection to said source of gaseous fluids, said inflatable portion being capable of receiving and retaining variable volumes of gaseous fluids, an arched neck integral with said inflatable portion and resilient means including a ring continuous

with said arched neck adapted to be manually stretched about a groove inlet turret of a face mask and snapped into engagement with the groove and thereafter to detachably retain said bag in snug frictional engagement and gas sealed relationship with said face mask.

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