Oct. 4, 1966 J. C. MATCHETT 3,276,462

DEMAND TYPE OXYGEN VALVE

Filed Nov. 26, 1962

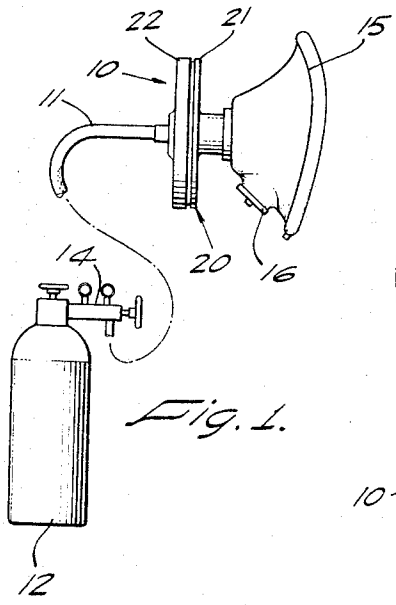


Fig. 1.

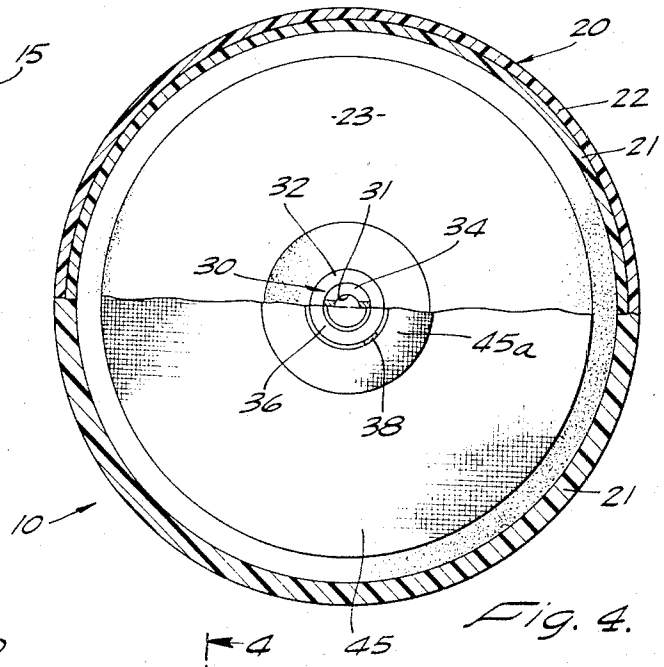


Fig. 4.

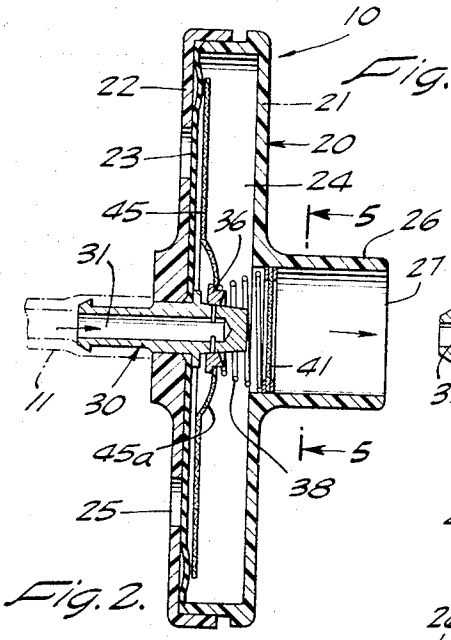


Fig. 2.

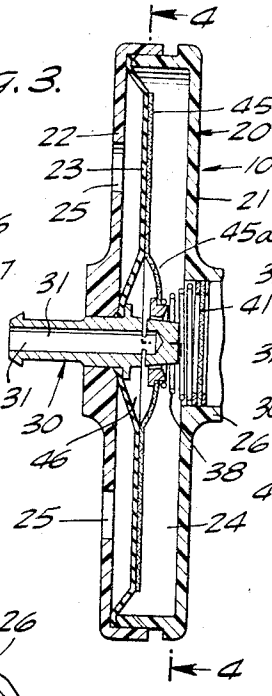


Fig. 3.

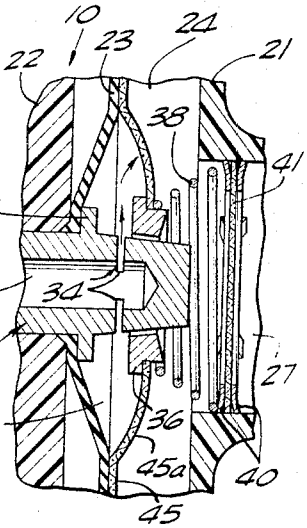


Fig. 6.

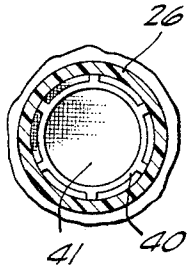


Fig. 5.

INVENTOR.
JOHN C. MATCHETT
BY
Paul A. Weilein
ATTORNEY

United States Patent Office

3,276,462

Patented Oct. 4, 1966

3,276,462

DEMAND TYPE OXYGEN VALVE

John C. Matchett, 6613 Glorywhite, Lakewood, Calif.

Filed Nov. 26, 1962, Ser. No. 239,955
9 Claims. (Cl. 137—64)

The present invention relates generally to oxygen therapy equipment and more particularly to a demand type valve regulating the flow of oxygen or other gas to a mask or the like in response to the breathing requirements of a person using the mask.

The present type of valve is known as a demand type valve as opposed to a constant flow valve or a valve such as is used in a resuscitator. In a constant flow system the oxygen mask is constantly flooded with oxygen or other gas being administered from a suitable source and under a slight pressure, some systems also including a breathing bag which serves as an intermediate reservoir. Systems of this constant flow type have the disadvantage that the oxygen is flowing constantly and, therefore, much of it is wasted. Probably less than half of the oxygen is actually inhaled and thereby used, the rest being wasted to the atmosphere through the exhaust valve in the mask. This is necessarily costly. Also, the user must exhale against the incoming positive pressure of the oxygen. This may be objectionable to the user when weak, since constant breathing against a pressure, even though slight, becomes very tiring.

The resuscitator apparatus bears little resemblance to the present invention because it forces oxygen into the lungs under a precise pressure and then draws the air out of the lungs as a result of the operation of mechanical means over a fixed cycle. There is in this case no response to the normal breathing of the user.

A demand type system for supplying oxygen to a user has several advantages. In the first place, the wasted oxygen is reduced to a minimum because substantially all of the oxygen supplied to the mask is inhaled and thus passes into the lungs before being exhausted to the atmosphere.

Another advantage is that the user does not have to exhale against an existing pressure. Thus, the use of the mask imposes no appreciable burden upon a patient and a substantially normal breathing cycle is possible. Also, the user does not reinhale a large portion of his own breath with each cycle, because the interior volume of the mask is not as large as in the case of a constant flow mask or a system having a breathing bag as a reservoir.

A further advantage of the demand type system is that a face mask can be applied and used instantly without the necessity of having to turn valves on and adjust flow controls. This greatly simplifies the operation of the system in the hands of an unskilled user or attendent.

The critical component of the demand type system of supplying oxygen is the valve. The characteristics of the demand type valve make the system distinctive and satisfactory operation of the system depends entirely upon the proper functioning of the valve. In spite of the advantages of the demand type system, there are relatively few demand type valves available for users. many of them are relatively costly because of their complex structure and, therefore, are sometimes difficult to operate properly and generally in need of costly adjustment to maintain them in proper operating condition. The ordinary unskilled user or attendent not trained in the use of these valves would be unable to use them satisfactorily.

Thus it is a general object of the present invention to provide a demand type valve of novel design which is

greatly simplified in its construction and is therefore inexpensive to manufacture.

It is also an object of the invention to provide a demand type valve which is simple in operation so that unskilled and untrained people can use the valve without difficulty and without the necessity of constant adjustment or maintenance operations on the valve to keep it in operating condition.

A further object of the invention is to provide a demand type valve which is lightweight in construction and therefore is easily moved to open position and back to closed position in which latter position it securely closes the inlet port, the movements requiring such little force that the valve is extremely sensitive to the breathing demand of the user.

These objects of the invention have been achieved in a demand type oxygen valve by providing a housing having an interior space, a flexible diaphragm within the housing which forms in cooperation with the housing a chamber of which one wall is the diaphragm, the diaphragm being exposed at one side to fluid pressure in the chamber and at the other side to atmospheric pressure and yielding to the pressure of the fluid media at opposite sides thereof, means for introducing a gas under pressure into the chamber including a discharge port opening into the chamber, means providing a passage from the chamber to the user of the regulator, a movable valve member which is normally biased to a position closing said port to prevent entry of gas into the chamber, and means periodically coupling the valve means to the diaphragm and movable thereby to move the valve means in opposition to the biasing means to a position opening said port in response to fluid pressure exerted on the diaphragm.

Other objects and advantages of the invention will be hereinafter described or will become apparent to those skilled in the art, and the novel features of the invention will be defined in the appended claims.

Referring to the drawings:

FIG. 1 is a schematic view of a demand type oxygen supply system in which is incorporated a demand type valve construction according to the present invention;

FIG. 2 is a median longitudinal section through the demand type valve of the present invention, with the valve in closed position;

FIG. 3 is a section similar to FIG. 2 showing the valve is open position;

FIG. 4 is a transverse section on line 4—4 of FIG. 3;

FIG. 5 is a fragmentary transverse section on line 5—5 of FIG. 2; and

FIG. 6 is an enlarged fragment of FIG. 3 showing especially the discharge port and the movable valve member in open position.

Referring now to the drawing, and especially to FIGS. 1 and 2, it will be seen that the demand type valve of the present invention is indicated generally at **10**. It is shown in FIG. 1 in a complete oxygen supply system in which oxygen is supplied to the valve through a hose or tubing **11** connected to the inlet side of the valve and also to any suitable source of gas under pressure, such as tank **12**. Gas is held in the tank under a relatively high pressure, normally reaching values as high as 2000 p.s.i., the pressure at the outlet from the tank being reduced by a reducing valve **14** to a substantially lower pressure, normally under 50 p.s.i. and usually in the neighborhood of 25–30 p.s.i. It will be realized that the source of oxygen or other gas is not limitative upon the present invention as it is common practice nowadays for hospitals to be piped with gas supply systems having outlets at bedside, with which valve **10** may be used.

In FIG. 1 the demand valve is shown as being mounted

directly upon face mask **15** which has an exhaust valve **16** of any suitable type. The construction of the mask and its exhaust valve are not described herein, since they constitute no part of the present invention and various products for this purpose are widely known.

From FIG. 2 it will be seen that the demand valve **10** comprises a housing **20** of circular outline (FIG. 4) made in two parts **21** and **22**. The two parts of the housing are preferably molded from some lightweight material, for example a synthetic resin or plastic, and they define between them an interior space.

Located within housing **20** is a flexible diaphragm **23** which typically and preferably is confined around its entire periphery by being clamped between the two housing sections **21** and **22** to hold the diaphragm in place. It will thus be seen from reference to FIGS. 2 and 3 that the diaphragm in cooperation with the housing, and more especially that portion of the housing represented by housing section **21**, forms an interior chamber **24** one side of which is the flexible diaphragm. The diaphragm is thus exposed fully at one side to the pressure of the fluid medium in chamber **14**. A plurality of openings **25** in housing section **22** expose the other side of the diaphragm to the pressure of the atmosphere. The diaphragm is very thin and flexible so that it yields easily to pressures of fluid media at the opposite sides of the diaphragm.

At one side of the housing is collar **26** which is hollow and serves as means providing a passage from chamber **24** to the user of the regulator. The internal passage through collar **26** is preferably of substantial diameter in order to minimize resistance to air flow through it and also of a size to fit around a projection on mask **15** so that valve **10** can be mounted directly onto mask **15** in communication with the interior of the mask.

The means for introducing the oxygen or any other gas under pressure into chamber **24** takes the form of a hollow, rigid core member **30** having a longitudinally extending passage **31**. The inner end of passage **31** is closed except for the discharge port to be described. The outer end of passage **31** is open to receive oxygen or other gas when hose **11** is attached to the projecting end of the core **30**. Core **30** is a press fit in the wall of the housing provided by housing section **22**.

It will be noted that internally of the housing core **30** is provided with an annular shoulder **32**, shown particularly in FIG. 6. This shoulder around the core engages diaphragm **23** on the inner face thereof, that is, the face exposed to chamber **24**, and confines the diaphragm centrally between shoulder **32** and the opposing portion of housing **20**. Thus, core **30** extends through diaphragm **23** centrally thereof to terminate inside the housing, preferably within chamber **24**, and the core provides a gas passage from the exterior of the demand valve to the interior chamber **24**.

As will be seen from FIG. 6 particularly, the outside surface of the terminal section of core **30** is tapered or frusto-conical in shape. In this tapered portion of the core there are two oppositely disposed, radially extending slots **34** which cut through the wall of the core and provide a pair of gas discharge ports **34** communicating between passage **31** inside the core and chamber **24** inside the housing. When ports **34** are open as in FIGS. 3 and 6, gas can flow freely from passage **31** through ports **34** into the housing chamber and thence out through passage **27** in collar **26** to mask **15**.

To shut off the flow of oxygen when there is no demand for it, movable valve member **36** is provided which is movable to a position covering ports **34** in order to close them to the discharge of gas, as indicated in FIG. 2. Valve member **36** is annular in configuration and the inner wall of the central opening is tapered to conform to the taper of the terminal section of core **30**. Thus, there is a wedging effect as the valve member moves toward the larger diameter of the tapered section of the core member which causes the valve member to stop at a proper position to cover ports **34** and to tightly engage the exterior surface of the core in order to prevent leakage of gas through the ports.

Valve member **36** is normally biased to the closed position of FIG. 2 by a very lightweight spring **38** which bears at one end against the valve member and at the other end against a suitable fixed abutment. In this embodiment of the invention, this abutment is provided by a lock ring **40** in passage **27**. The construction of the lock ring is shown in detail in FIG. 5 from which it will be seen that ring **40** comprises an annular member with a plurality of radially extending tabs which engage the wall of passage **27** and anchor the ring in place. It is preferred to use two such rings in the passage to hold between them screen filter **41**. Any other suitable abutment means, for example an annular shoulder on the housing, may be employed if desired.

In order to move the valve member **36** to a position in which discharge ports **34** are uncovered, means are provided for periodically coupling the valve means to the diaphragm. Such coupling means operates to move the valve member to the open position in response to user demand which causes a drop in pressure in chamber **24** that in turn causes movement of diaphragm **23** away from housing section **22** and in a direction to reduce the volume of chamber **24**. The coupling means comprises disc shaped pressure plate **45** mounted upon and movable with the movable valve member **36**. As shown in FIGS. 3 and 4, when certain pressure conditions exist in the fluid media surrounding diaphragm **23**, the diaphragm engages pressure plate **45** and moves it from the position of FIG. 1 to the position of FIG. 3 in opposition to the force exerted by spring **38**. This movement of pressure plate **45** carries with it valve member **36** which is thereby moved from the closed position to the open position in which ports **34** are uncovered.

Pressure plate **45** has a gas pervious central section **45***a* through which gas issuing from ports **34** can flow to enter the valve chamber **24**. A simple and preferred manner of providing a perforate or gas pervious central section for the plate is to make the entire plate of a wire cloth screen or similar material, although it will be realized that the invention is not necessarily limited thereto since other constructions may be employed to permit gas flow through the central section **45***a* which immediately surrounds valve member **36**.

As clearly shown in the drawings, the central section **45***a* of the pressure plate is concave on the side facing the diaphragm so that contact between the diaphragm and the pressure plate is prevented over the central area. This construction is provided since gas ports **34** are located between the diaphragm and the pressure plate when the valve is in the open position and this construction makes it possible for the gas to escape from the space **46** between the diaphragm and pressure plate and immediately surrounding core **30** by passing through the pressure plate into chamber **24**. From chamber **24** the gas leaves through passage **27** to enter mask **15**.

Having described the construction of my improved demand type oxygen valve, its operation will now be reviewed briefly. The valve is normally closed with the parts in the position as shown in FIG. 2. Annular valve member **36** covers ports **34**, being moved to this position under the pressure exerted by spring **38**. Diaphragm **23** is not normally in engagement with pressure plate **45**.

When the patient inhales, the pressure within mask **15** drops below atmospheric. This pressure drop is communicated quickly through passage **27** to valve chamber **24**. Diaphragm **23** is very highly sensitive to a pressure differential in the fluid media at the two sides of the diaphragm, and the pressure in chamber **24** being lower than atmospheric causes the atmospheric pressure entering through openings **25** in the housing wall to move the diaphragm to the right as viewed in the figure.

This movement of the diaphragm causes it to engage pressure plate **45** and carry the pressure plate to the right, moving valve member **36** away from ports **34**, as shown in FIG. 3. Oxygen or other gas can now leave core **30** through ports **34**, as previously described and reaches the patient through passage **27**. As long as the user inhales, there is maintained a pressure differential on the diaphragm that holds it in the position of FIG. 3 with port **34** open.

Upon exhaling, the pressure within mask **15** and also chamber **24** normally becomes higher than atmospheric. The fluid pressure differential upon diaphragm **23** is now in a direction to return diaphragm **23** to the position of FIG. 2. Freed from engagement with the diaphragm, valve member **36** and pressure plate **45** are returned to the closed position of FIG. 1 by the force of spring **38**.

The valve is designed to return to a normally closed position when the fluid pressure in chamber **24** is equal to atmospheric. The fluid pressure differential is then zero, and the diaphragm assumes a normal position out of engagement with the pressure plate. The valve member is now subject only to the influence of spring **38**, and the force of the spring is adequate to close the valve. It is thus evident that the valve is opened in response to a fluid pressure differential in one direction on the diaphragm, but the valve is closed by the spring upon disappearance of that differential.

This construction offers several advantages of importance. It permits a very lightweight construction with the result that diaphragm **23** and the pressure plate can be moved with very low pressure differentials and thus they are extremely sensitive to the pressure changes created by the normal inhalation and exhalation of the used. This sensitivity makes the valve so responsive to the demands of the patient that the patient feels substantially no restriction upon his breathing.

The tapered external surface of core **30** in the vicinity of ports **34** and the corresponding taper on the internal bore through valve member **36**, creates a valve construction that is highly effective. The taper of the engaging surfaces causes the valve to close securely in a position covering ports **34**. Yet, when the valve member is moved away from ports **34**, it is free of the core and therefore movement of the pressure plate is not impeded or retarded in any way by frictional drag of the valve member on the core. This facilitates the lightweight construction and improves the sensitivity of the device. Upon closing, the tapered surfaces give a self-centering action to the valve member so that no guides or supporting elements are required to guide the valve as it moves between open and closed positions. These characteristics all contribute not only to the simplicity of the device by eliminating as many parts as possible, but also contribute to reliability in operation.

While specific structural details have been shown and described, it should be understood that changes and alterations may be resorted to without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. In a demand type oxygen valve, the combination comprising: a housing having an interior space; a flexible diaphragm in said housing forming in cooperation with the housing a chamber, the diaphragm being exposed at one side to atmospheric pressure and yielding to pressure of fluid media at opposite sides thereof; a hollow, rigid core extending through a housing wall and the diaphragm centrally thereof; means cooperable with said core and said wall to anchor the diaphragm to said wall at the core, said core having a port opening between the ends thereof into said chamber; means providing a passage from said chamber to a user of the demand type valve; an annular valve member surrounding and movable relative to the core and movable to a position covering said port in the core to prevent entry of gas into the chamber; means biasing said valve member toward said position covering the port; and means engageable by the diaphragm and movable thereby to move the valve means in opposition to the biasing means to a position uncovering the port in response to fluid pressure on the diaphragm.

2. In a demand type oxygen valve, the combination as in claim 1 in which the core has a frusto-conical surface at the position of the port and which serves as stop means limiting said valve member to a position closing said port.

3. In a demand type oxygen valve, the combination comprising: a housing having an interior space; a flexible diaphragm in said housing forming in cooperation with the housing a chamber, the diaphragm being exposed at one side to atmospheric pressure and yielding to pressure of fluid media at opposite sides thereof; a hollow, rigid core extending through a housing wall and the diaphragm centrally thereof; means on said core for engaging and holding a portion of said diaphragm against said wall to anchor the diaphragm to the housing at the core, said core having in its side periphery a port opening into said chamber; means providing a passage from said chamber to a user of the demand type valve; an annular valve member surrounding and movable axially relative to the core and movable to a position covering said port in the core to prevent entry of gas into the chamber; means biasing said valve member toward said position covering the port; and a disc mounted on the valve means and movable therewith, said disc having a central gas-pervious portion that is concave facing the diaphragm, the disc radially outwardly of said central portion being engageable by the diaphragm to be moved thereby in response to pressure of fluid media on the diaphragm to a position in which the valve means uncovers the port and permits gas to enter said chamber.

4. A demand type gas valve unit comprising: a housing; a diaphragm in said housing; said diaphragm having a central portion and a peripheral portion; means fixing said central portion to a wall of said housing; means fixing said peripheral portion to said housing to form within the housing a chamber; said diaphragm having between said central and peripheral portions a flexible portion disposed to move in a circular pattern relative to said wall in response to fluid pressures on opposite sides thereof; said wall having an opening exposing one side of said flexible portion to atmospheric pressure; a tubular gas introducing member extended through said wall and said central portion and having a port opening on the side of said introducing member into said chamber; said housing providing a passage for affording communication of a user of the valve unit with said chamber; a valve element surrounding and axially movable relative to said member to open and close said port; means biasing said valve element toward port closing position; stop means embodied in said valve element and said tubular member for limiting movement of said valve element to the position for closing said port; and means in said chamber operable in response to fluid pressure effected movements of said flexible portion and said diaphragm for moving said valve element to open said port.

5. A demand type gas valve unit comprising: a housing; a diaphragm in said housing; said diaphragm having a central portion; and a peripheral portion; means fixing said central portion to a wall of said housing; means fixing said peripheral portion to said housing to form within the housing a chamber; said diaphragm having between said central and peripheral portions a flexible portion disposed to move in a circular pattern relative to said wall in response to fluid pressures on opposite sides thereof; said wall having an opening exposing one side of said flexible portion to atmospheric pressure; a gas introducing member extended into said housing and having an outlet port which opens into said chamber; said housing having means forming a passage for affording communication of a user of the valve unit with said chamber; said member having a tapered exterior surface through which said port extends; a valve element movable on said member to open

and close said port and having a surface tapered to conform to and engage said tapered surface of said member so as to wedge against said member when in port closing position; means biasing said valve element toward port closing position; and means in said housing operable in response to movement of said diaphragm to move said valve element to open said port.

6. A demand type gas valve unit comprising: a housing; a diaphragm mounted in said housing to form therewith a chamber; said diaphragm having a first portion and a second portion both fixed against movement relative to walls of the housing and defining between said first and second portions a flexible portion disposed to move in opposite directions relative to said walls in response to fluid pressures on opposite sides thereof; said housing having an opening in a wall opposite the side of said flexible portion that is disposed exteriorly of said chamber to expose said side to atmospheric pressure; said housing having means providing a passage leading from the exterior of the housing into said chamber; a tubular gas introducing member extending through said wall and said second portion of said diaphragm and having a port opening into said chamber; said member having a tapered exterior surface through which said port extends; a valve element surrounding said member and movable thereon to open and close said port; said valve element having a tapered surface for engaging and wedging said valve element on said member when said valve element closes said port; means biasing said valve element toward port closing position; and means operable to move said valve element to open said port responsive to fluid pressure effected movements of said flexible portion of said diaphragm.

7. In a demand type oxygen valve, the combination comprising: a housing having an interior space; a flexible diaphragm in said housing forming in cooperation with the housing a chamber, the diaphragm being exposed at one side to atmospheric pressure and yielding to pressure of fluid media at opposite sides thereof; means introducing a gas under pressure into the chamber including a port opening into the chamber; means cooperable with said gas introducing mans and a wall of said housing for immovably holding a portion of said diaphragm against said wall around said gas introducing means; means providing a passage from said chamber to a user of the valve; movable valve means moving to a position closing the port to prevent entry of gas into the chamber; means biasing the valve means toward said closed position; and a pressure plate mounted on the valve means and movable therewith, said pressure plate being engageable by the diaphram to be moved thereby to open said port in response to fluid pressure on the diphragm; said diaphragm normally assuming a position out of engagement with said pressure plate and, in response to a fluid pressure differential created by a subatmospheric pressure in said chamber, will move into engagement with the pressure plate to open the valve.

8. In a demand type oxygen valve, the combination comprising: a housing having an interior space; a flexible diaphragm in said housing forming in cooperation with the housing a chamber, the diaphragm being exposed at one side to atmospheric pressure and yielding to pressure of fluid media at opposite sides thereof; means introducing a gas under pressure into the chamber including a port

opening into the chamber; means cooperable with said gas introducing means and a wall of said housing for immovably holding a portion of said diaphragm against said wall around said gas introducing means; means providing a passage from said chamber to a user of the valve; movable valve means moving to a position closing the port to prevent entry of gas into the chamber; means biasing the valve means toward said closed position; and a pressure plate mounted on the valve means and movable therewith, said pressure plate being engageable by the diaphragm to be moved thereby to open said port in response to fluid pressure on the diaphragm; said means for introducing gas into said chamber being a tubular member and having a radially extending slot forming a port in the peripheral surface of the tubular member; said movable valve means including an annular member surrounding and movable axially of said tubular member.

9. In a demand type oxygen valve, the combination comprising: a housing having an interior space; a flexible diaphragm in said housing forming in cooperation with the housing a chamber, the diaphragm being exposed at one side to atmospheric pressure and yielding to pressure of fluid media at opposite sides thereof; a hollow, rigid core extending through a housing wall and the diaphragm centrally thereof; means on said core for engaging and holding a portion of said diaphragm against said wall to anchor the diaphragm to the housing at the core, said core having in its periphery a port opening into said chamber; means providing a passage from said chamber to a user of the demand type valve; an annular valve member surrounding and movable axially relative to the core and movable while surrounding said core to prevent entry of gas into the chamber; means biasing said valve member toward said position covering the port; and a disc mounted on the valve means and movable therewith, said disc having a central gas-pervious portion that is concave facing the diaphragm, the disc radially outwardly of said central portion being engageable by the diaphragm to be moved thereby in response to pressure of fluid media on the diaphragm to a position in which the valve means uncovers the port and permits gas to enter said other chamber; said diaphragm normally assuming a position out of engagement with said disc and, in response to a fluid pressure differential created by a subatmospheric pressure in said chamber, will move into engagement with said disc to open the valve.

References Cited by the Examiner

UNITED STATES PATENTS

2,746,479	5/1956	Krow	137—505.25 X
2,918,079	12/1959	Krow	137—505.25 X
2,926,683	3/1960	Windsor	137—63
3,020,926	2/1962	Browning	137—508 X

FOREIGN PATENTS

590,096	7/1947	Great Britain.

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

M. CARY NELSON, MARTIN P. SCHWADRON, *Examiners.*

J. DEATON, R. GERARD, *Assistant Examiners.*