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SYSTEM FOR INTERMITTENTLY DISPENSING OXYGEN OR OTHER  
GAS SUITABLE FOR BREATHING  
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3,400,712

Fig. 1.

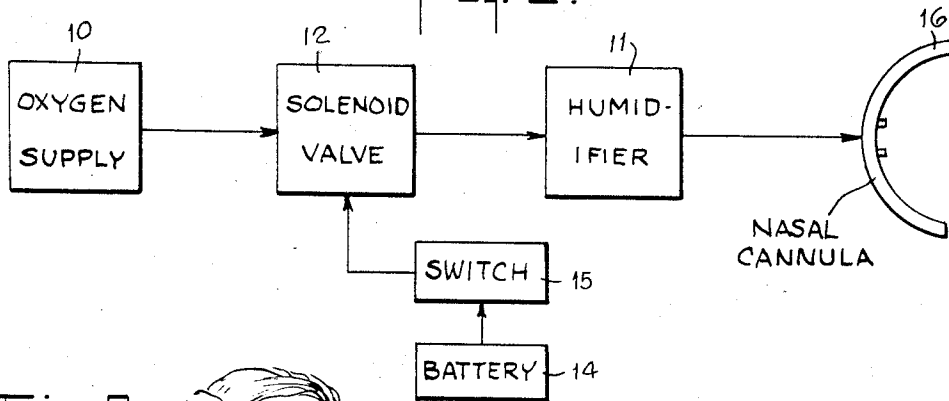


Fig. 2.

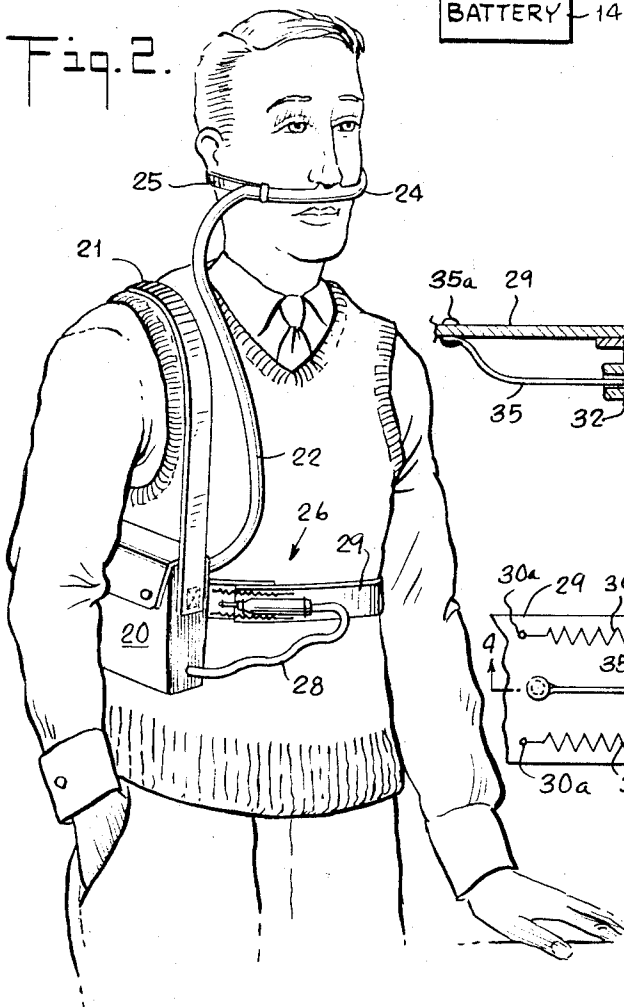


Fig. 4.

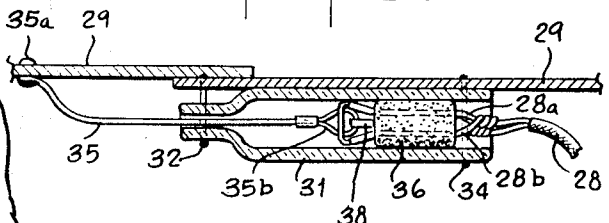
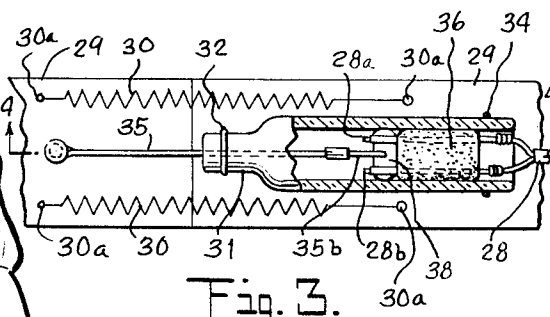


Fig. 3.



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**SYSTEM FOR INTERMITTENTLY DISPENSING  
OXYGEN OR OTHER GAS SUITABLE FOR  
BREATHING**

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**ABSTRACT OF THE DISCLOSURE**

A portable, self-contained apparatus useful for dispensing a gas such as oxygen. In the operation of this device the gas or oxygen is dispensed only when the person wearing the device is inhaling. When the person wearing the device exhales, the supply of oxygen is interrupted. This is accomplished by including in the device adapted to be worn on the person, along with the oxygen supply, an oxygen flow control means and the oxygen dispensing means which may be a nasal cannula connected with the oxygen source via the oxygen flow control means by means of a conduit, an actuating means responsive to the torso body movement of the person wearing the device. The actuating means comprises a belt and a switch with a lost motion connection between the belt and the switch, the switch being operatively connected to the oxygen flow control means which may be a solenoid valve. When the person wearing the device inhales the resulting torso body movement operates the switch so as to open the oxygen flow control means to supply oxygen to the oxygen dispensing means. When, however, the person wearing the device exhales the resulting torso body movement causes the switch to open to shut off the oxygen flow control means thereby interrupting the supply of oxygen to the oxygen dispensing means. The device of this invention does not restrict normal body movement or activity of the person wearing the same and leaves the face of the wearer exposed and the nose and any other face part of the wearer substantially unrestricted.

This invention relates to a system or device or apparatus for dispensing oxygen or other gas suitable for inhalation. More particularly, this invention relates to a portable system or device for intermittently dispensing oxygen for breathing. Still more particularly, this invention relates to a system or apparatus capable of being worn on the person and for dispensing intermittently oxygen for breathing.

In accordance with one embodiment, this invention is directed to a portable oxygen supply apparatus useful for intermittently supplying oxygen for breathing. In accordance with another embodiment this invention is directed to a method or technique for supplying oxygen for breathing. In accordance with yet another embodiment this invention is directed to a technique of oxygen therapy particularly useful for an emphysematous person. In accordance with yet another embodiment this invention is directed to a system for training or aiding in proper breathing control, particularly useful in emphysema therapy involving the supply of oxygen for breathing.

Various systems, devices and techniques are known for supplying oxygen for breathing. Also, it is known to provide a portable oxygen dispensing apparatus for supplying oxygen or to supplement the supply of oxygen for breathing purposes. Such systems and techniques heretofore have usually involved supplying oxygen continuously. For example, such systems and techniques heretofore have involved continuously supplying oxygen for breathing, both during inhalation and exhalation. Supplying oxygen for breathing purposes when the person is ex-

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haling is wasteful since unless confined or channeled or captured by suitable means, which means would be cumbersome, the oxygen supplied for breathing during exhalation would be wasted. Despite this situation portable oxygen dispensing means known heretofore supply oxygen substantially continuously for breathing. This has necessitated the use of a relatively large capacity oxygen source. Since oxygen is normally gaseous and has a low boiling point, strong and heavy containers must be employed to contain the oxygen. This has contributed substantially to the weight of the portable oxygen breathing apparatus and to the effort and discomfort of the person carrying the same. Also, obviously, such systems and technique for supplying oxygen for breathing in a manner

Further, when oxygen is supplied continuously, such as by means of a nasal cannula or the like, the continuous supply of oxygen, particularly over a long period of time, may have an irritant effect upon the mucous membranes and the like in contact therewith. This irritant effect can to some extent be mollified by humidifying the oxygen.

It is an object of this invention to provide a relatively lightweight, easily carried, portable system for dispensing oxygen.

Another object of this invention is to provide a relatively lightweight, simple, portable system for dispensing oxygen intermittently and on demand.

Another object of this invention is to provide a technique for supplying oxygen for breathing in a manner particularly useful for an emphysematous person or in oxygen therapy for emphysema.

Yet another object of this invention is to provide a portable oxygen supply system adapted to be worn on the person and providing a longer useful life for a given amount of oxygen contained in the system as compared with other known comparable portable systems which continuously dispense oxygen.

Still another object of this invention is to provide a portable system adapted to be worn on the person for the supply of gaseous oxygen for breathing purposes wherein the face of the person wearing the same is free and exposed save for a nasal cannula or the like for the supply of the dispensed oxygen and wherein the freedom of movement of the person, including use of nose or mouth, wearing the system is substantially unrestricted.

Still another object of this invention is to provide an oxygen supply system adapted to be worn on the person for the supply of oxygen for breathing purposes via the nose or mouth and only when the person is inhaling, the mouth or nose not being necessarily sealed to the system during use.

How these and other objects of this invention are achieved will become apparent in the light of the accompanying disclosure made with reference to the accompanying drawings wherein:

FIG. 1 schematically illustrates major elements of the oxygen supply system in accordance with this invention;

FIG. 2 shows a disposition and arrangement of the system or device in accordance with this invention when worn on the person;

FIG. 3 is a plan view in partial cross section of a switching or actuating element useful in the system or apparatus of this invention; and wherein

FIG. 4 is a cross sectional view taken through lines 4—4 of FIG. 3.

In at least one embodiment of the practice of this invention at least one of the foregoing objects will be achieved.

In accordance with this invention there is provided a system and/or apparatus wherein oxygen or other gas suitable for breathing is dispensed or delivered intermittently on demand. More particularly in accordance

with this invention there is provided a system and/or apparatus wherein oxygen or other gas suitable for breathing is dispensed intermittently and on demand only when the person employing said system and/or apparatus is inhaling, the supply of oxygen or other suitable gas being interrupted or shut off during exhaling.

As indicated schematically in the accompanying drawings, and with particular reference to FIG. 1 thereof, the system and/or apparatus in accordance with this invention comprises an oxygen supply or tank 10, such as an oxygen tank together with conventional pressure reduction and flow control valves and equipment. Optionally, there is associated with the system a humidifying device or humidifier 11 for humidifying the gaseous oxygen issuing from oxygen supply 10 just before it is dispensed to the user. The dispensed gaseous oxygen is arranged to flow through a suitable valving device, such as solenoid valve 12. Solenoid valve 12 is adapted to be opened or closed to permit the flow or interruption of the flow of oxygen therethrough depending upon whether or not solenoid valve 12 is opened or closed.

Operation of the solenoid valve 12 is effected by means of a suitable electrical power source, such as battery 14, and actuating mechanism or switch 15. When switch 15 is closed solenoid valve 12 is actuated to open and to permit the flow of gaseous oxygen to a suitable dispensing means, such as nasal cannula 16. When switch 15 is opened the flow of current from battery 14 to solenoid valve 12 is interrupted and solenoid valve 12 closed thereby shutting off the flow of oxygen to nasal cannula 16.

It is a feature of this invention that actuating mechanism or switch 15 is operated so that oxygen is supplied to nasal cannula 16 intermittently and on demand during inhaling and only when the person wearing or employing the system and/or apparatus of this invention is inhaling. By adapting solenoid valve 12 to dispense oxygen to the nasal cannula only when the person using the system and/or apparatus of this invention is inhaling, a substantial saving in oxygen consumption is realized since all the oxygen dispensed and flowing through solenoid valve 12 and nasal cannula 16 is consumed by the person inhaling. There is no oxygen flowing through solenoid valve 12 and nasal cannula 16 when the person employing the system and/or apparatus of this invention is exhaling or commences to exhale, with resulting wasting of any oxygen which is dispensed during exhaling. In accordance with this feature of the invention oxygen only flows through solenoid valve 12 and the dispensing means, nasal cannula 16, when the person employing the system and/or apparatus of this invention commences to inhale and during inhaling. When the person stops inhaling and commences to exhale the flow of oxygen through solenoid valve 12 and nasal cannula 16 is immediately interrupted.

Importantly there is also a safety feature associated with the use of this device in oxygen therapy. Since the oxygen, as dispensed, is inhaled and consumed immediately, there is substantially no tendency for oxygen to accumulate and concentrate in the immediate surroundings of the user thereby avoiding fire and explosion hazards usually associated with conventional oxygen therapy.

Referring now to FIG. 2 of the drawings which illustrates generally the portable oxygen dispensing system and/or apparatus of this invention and how it may be adapted to be worn on the person, there is illustrated a container 20 suspended from one shoulder of the person wearing the same by means of shoulder strap 21. Container 20 is provided with an oxygen source, such as a small oxygen tank, together with an associated humidifying device and battery and solenoid valve, all not shown but suitably disposed within container 20. Conduit 22, such as a flexible plastic tubing, leads from container 20 to nasal cannula 24 which is held in place

on the face of the person by means of adjustable strap 25. Flexible tubing or conduit 22 is in fluid communication with the oxygen source within container 20 and the humidifying device and solenoid valve therein for the transmission and dispensing of the oxygen to nasal cannula 24.

The solenoid valve within container 20 is actuated by means of a switch, generally indicated by reference numeral 26, which is in electrical contact with the battery and solenoid valve within container 20 by means of wire or conductor 28.

As illustrated in FIG. 2 switch 26 is positioned and adapted to be worn on the torso of the person by means of belt 29 which encircles the body of the person wearing the same at the waist, below the rib cage, in substantially the usual belt-wearing position. The system and/or apparatus of this invention employed as illustrated in FIG. 2 of the drawings is specially suited to promote diaphragmatic breathing of the person wearing the same. If desired, however, the belt may be worn to encircle the chest if thoracic breathing is predominant. In normal persons breathing is both thoracic and diaphragmatic.

More particularly, in diaphragmatic breathing the diaphragm, during inhalation, descends. Upon descension the diaphragm tends to draw air into the lungs while at the same time causing the abdomen to expand. At the conclusion of diaphragmatic inhalation the diaphragm ascends thereby tending to expel air from the lungs and causing the abdomen to contract. Switch 26 is effective, upon inhalation and expansion or enlargement of the abdomen as the diaphragm descends, to dispense oxygen via tubing 22 and nasal cannula 24 to the person breathing and to shut off the flow of oxygen as the person commences to exhale as the diaphragm ascends with resulting contraction of the abdomen.

This disposition and arrangement for supplying and interrupting the supply of oxygen through diaphragmatic breathing is particularly advantageous for an emphysematous person since an emphysematous person is encouraged to breath diaphragmatically. The system and/or apparatus of this invention, since it can be employed to be operative exclusively with diaphragmatic breathing, can be employed to encourage diaphragmatic breathing and, in use, to award the person properly breathing diaphragmatically with a draught of oxygen. If the person employing the device and/or apparatus of this invention does not properly breath, i.e. does not breath enough diaphragmatically, no oxygen is supplied. Therefore, the person employing the system and/or apparatus of this invention is more conscious and aware of diaphragmatic breathing and the necessity of diaphragmatic breathing if oxygen is to be supplied. This arrangement and disposition, as indicated hereinabove, is particularly valuable for an emphysematous person.

Referring now to FIGS. 3 and 4 which illustrate in greater detail a switch suitable for use in a system and/or apparatus of this invention, as illustrated therein ends of belt 29 are expandably held together by means of springs 30. Belt 29 is adapted, as illustrated, to encircle the wearer and is fastened to the wearer by means of an adjustable buckle, not shown. Springs 30 are fastened to belt 29 by suitable means, such as rivets 30a. The switch is made up of an outer, bottle-shaped shell or body 31 of suitable material, such as glass or plastic. The necked-down or neck portion of switch body 31 is fastened to belt 29 by means of clip 32 and the cylindrical portion of switch body 31 is fastened to belt 29 by means of clip 34.

A stiff member 35, such as a stiff wire, is fastened at one end to belt 29 by means of rivet 35a. The other end of stiff wire 35 is disposed within switch body 31, stiff wire 35 being slidably fitted within the neck portion thereof. The other end of stiff wire 35 is formed into loop 35b. Wire or conductor 28 is disposed to pass through cylinder plug or body 36 slidably disposed within switch body 31. Desirably, plug 36 is made of insulating material and

fairly closely fitted within switch body 31 for a snug fit and so that sufficient friction is present between plug 36 and switch body 31 such that plug 36 does not tend to chatter or move therein unless positively moved by wire 35.

Metallic wire elements 28a and 28b of conductor 28 enter one end of and are separated within plug 36 and pass therethrough. At the other end of plug 36 the insulating material is stripped from elements 28a and 28b and the bare metallic electrically conducting elements exposed. Bare metallic elements 28a and 28b of conductor 28 are exposed to form two separate loops. Disposed within loops 28a and 28b is bar 38 of suitable electrically conductive material, such as copper. Bar 38 is fastened or connected to stiff wire 35 with the result that stiff wire 35 at loop portion 35b thereof together with bar 38 forms a lost motion-type connection with respect to plug 36 via looped elements 28a and 28b.

In operation, and in the manner as illustrated in FIG. 2, as the person wearing the apparatus in accordance with this invention inhales diaphragmatically the abdomen expands. Upon expansion of the abdomen, belt 29 is expanded against springs 30 and stiff wire 35 moves bar 38 into contact with bare metallic elements 28a and 28b of conductor 28 thereby forming an electrical connection therebetween and closing the circuit permitting actuation and opening of the solenoid valve to dispense oxygen via tubing 22 to nasal cannula 24 for inhalation. Upon continued expansion of the abdomen during diaphragmatic breathing plug 36 with conductor 28 and its associated components moves within switch body 31 toward the neck end of switch body 31 under the urging or pull of stiff wire 35.

Upon completion of inhalation, still breathing diaphragmatically, and at the start of exhalation, the abdomen contracts with the result that belt 29 also contracts. As belt 29 contracts and under the urging of springs 30, bar 38 which is fastened to stiff wire 35 is moved out of contact with metallic elements 28a and 28b and is pushed against plug 36 as stiff wire 35 moves plug 36 away from the neck end of switch body 31. It is thus seen that by virtue of the lost motion-type connection between stiff wire 35 and plug 36 electrical contact is made and broken so as to actuate the solenoid valve and dispense oxygen to the person for inhaling diaphragmatically or exhaling diaphragmatically.

During inhalation and upon expansion of belt 29 stiff wire 35 pulls copper bar 38 to contact elements 28a and 28b to complete the circuit by electrically joining elements 28a and 28b. At the end of inhalation, as the abdomen contracts, stiff wire 35 moves bar 38 out of contact with elements 28a and 28b pressing bar 38 against plug 36 and moving plug 36 backwards within switch body 31. As bar 38 is moved out of contact with elements 28a and 28b the circuit is broken and the solenoid valve closed thereby preventing the flow of oxygen to the nasal cannula during the period of exhalation when oxygen is not required and would be wasted.

It is thus seen that there is provided in accordance with this invention a switch operative to actuate or to open a solenoid valve to permit the flow of oxygen during inhalation only and to close the solenoid valve and to prevent the flow of oxygen when exhalation is commenced. The switch employed in the apparatus in accordance with this invention is motion sensitive and can be made such that upon the slightest expansion or contraction of the chest or abdomen, an electrical connection is made to permit oxygen to be dispensed through the solenoid valve during inhalation and to break the electrical connection, thereby interrupting the flow of oxygen during exhalation.

Although this invention has been described in particular with respect to switch 26 of special construction as illustrated in FIGS. 3 and 4 other switches effective upon diaphragmatic inhalation to dispense oxygen and effective

upon diaphragmatic exhalation to interrupt the supply of oxygen, all in the manner described in accordance with this invention, are suitable. Such switches may be mechanical, electromechanical, electrical, magnetic, and combinations thereof in operation.

Further, although this invention has been described in connection with a portable system, such as one capable of being worn on the person, it is pointed out the oxygen supply source may be from a central source of large capacity and even remote from the person. The benefits of this invention are still obtainable in such a situation since the actuating means attached to the person is effective to supply and dispense the oxygen from this central source only when the person is inhaling.

As will be apparent to those skilled in the art in the light of the foregoing disclosure, many substitutions, alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof.

I claim:

1. Portable apparatus useful for oxygen therapy and capable of being worn on the person, the apparatus permitting freedom of movement of the person wearing the apparatus and leaving the face exposed and the nose and mouth of the person wearing the apparatus substantially unrestricted, comprising a source of oxygen, oxygen flow control means, an electrical circuit comprising an electric circuit means, a source of electrical power to operate through said electrical circuit said oxygen flow control means, oxygen dispensing means, a conduit in fluid communication with said oxygen source and said oxygen dispensing means for supplying oxygen to the person wearing said apparatus, said oxygen flow control means being disposed in association with said conduit to permit the flow or the interruption of the flow of oxygen through said conduit, actuating means to actuate said oxygen flow control means, said actuating means comprising a belt adapted to encircle the torso of the person wearing said apparatus and to expand and contract with the torso body movement of the person wearing said apparatus, said electric circuit means being carried on said belt and adapted to permit the supply of electrical power via said electrical circuit from said electrical power source to said oxygen flow control means when said circuit means is closed to operate said oxygen flow control means to permit the flow of oxygen therethrough and to interrupt the flow of oxygen through said oxygen flow control means when said circuit means is opened, said circuit means being adapted to be opened or to be closed by means of a lost motion connection between said belt and said circuit means depending upon the torso body movement of the person wearing said apparatus, said lost motion connection comprising a stiff member fixed at one end to said belt and carrying at the other end means to complete and close said circuit means, said lost motion connection being effective upon expansion of said belt to move said stiff member in one direction to bring said means carried at the other end of said stiff member into contact with and to complete and close said circuit means and upon continued expansion of said belt to maintain said means in contact with said circuit means and to move said circuit means in said one direction, said stiff member being adapted to immediately move said means carried at the other end of said stiff member out of contact with and away from and to open said circuit means upon contraction of said belt and being adapted to maintain said means carried at the other end of said stiff member out of contact with said circuit means and to move said circuit means in said other direction upon continued movement of said stiff member in said other direction due to continued contraction of said belt.

2. Apparatus in accordance with claim 1 wherein said oxygen flow control means is a solenoid valve.

3. Apparatus in accordance with claim 1 wherein said

oxygen flow control means is a solenoid valve and wherein said oxygen dispensing means is a nasal cannula.

4. Apparatus in accordance with claim 1 wherein said oxygen flow control means is a solenoid valve, wherein said oxygen dispensing means is a nasal cannula and including a humidifying means effective to humidify the oxygen flowing from said oxygen source to said nasal cannula.

5. Apparatus in accordance with claim 1 wherein said source of oxygen, said oxygen flow control means and a portion of said conduit are provided within a container adapted to be worn on the person.

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