United States Patent [19]

Diedrich et al.

[11] **3,794,072**

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

[54] **OXYGEN DILUTER DEVICE**

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[73] Assignee: **Hudson Oxygen Therapy Sales Company**, Temecula, Calif.

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[52] **U.S. Cl.** **137/604,** 128/209

[51] **Int. Cl.** **F16k 15/00**

[58] **Field of Search** ... 128/209, 210, 197, 205, 185, 128/194, 145 R, 145.5–145.8; 137/604; 239/427.3, 428.5, 419.5

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Assistant Examiner—Lee S. Cohen
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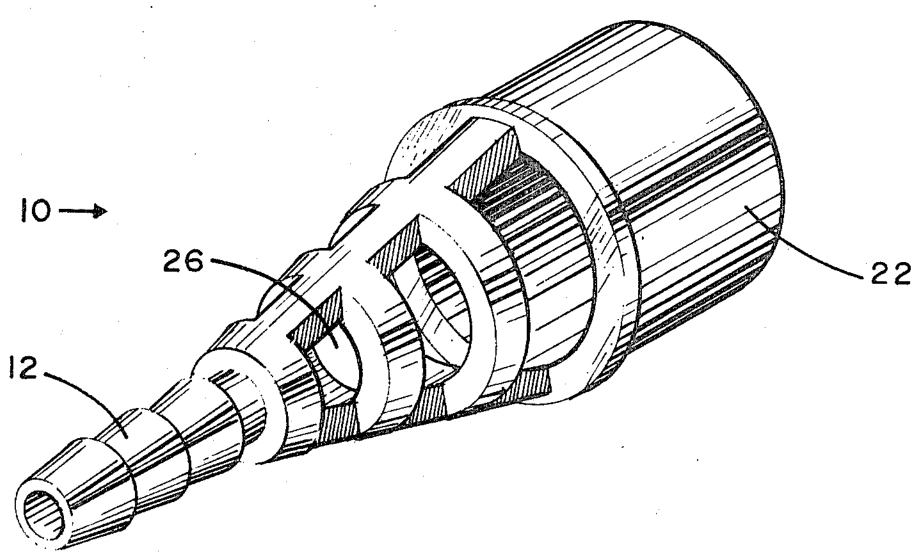
[57] **ABSTRACT**

An improved device for controlling oxygen concentration delivered to an oxygen mask comprises a nozzle portion disposed at one end for attaching an oxygen delivery tube, a hollow gas delivery portion at the opposite end for directing gas to an oxygen mask and a tunnel portion disposed between the nozzle and gas delivery portion having support bars extending between the nozzle and delivery portions and a plurality of spaced arcuate ribs secured along the bars between which ribs are defined a plurality of air entrainment ports through which atmospheric air is drawn for diluting a stream of oxygen passing along the tunnel. Air restriction closure members are secured between the ribs selectively closing one or more of the ports for metering air entrainment and oxygen concentration delivered to the mask.

4 Claims, 10 Drawing Figures



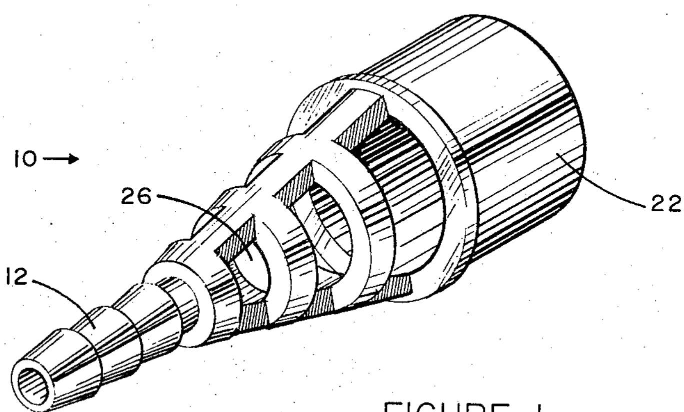


FIGURE 1

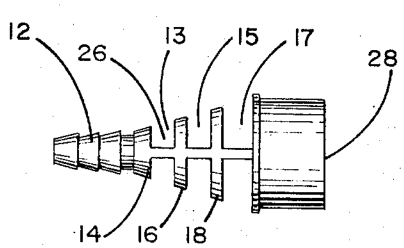


FIGURE 2

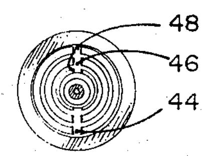


FIGURE 3

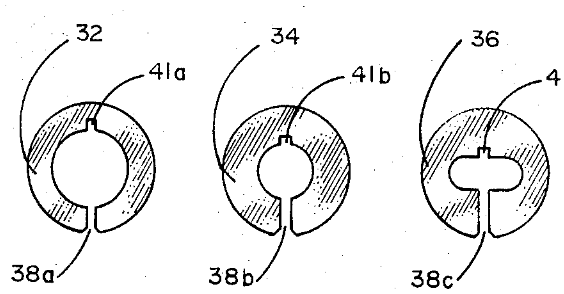


FIGURE 4

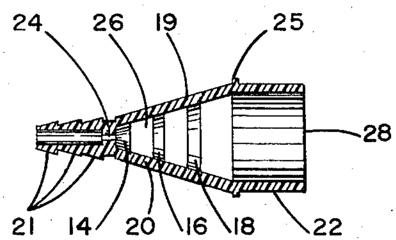


FIGURE 5

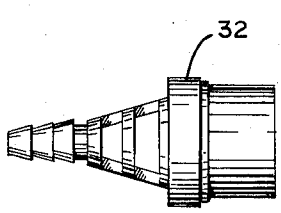


FIGURE 6

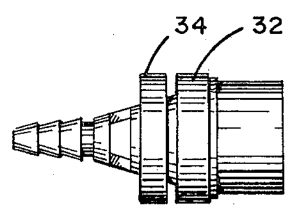


FIGURE 7

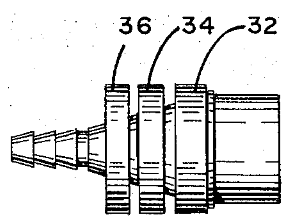


FIGURE 8

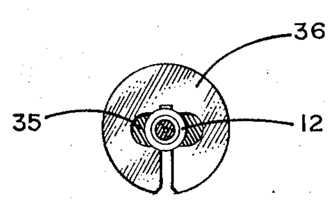


FIGURE 9

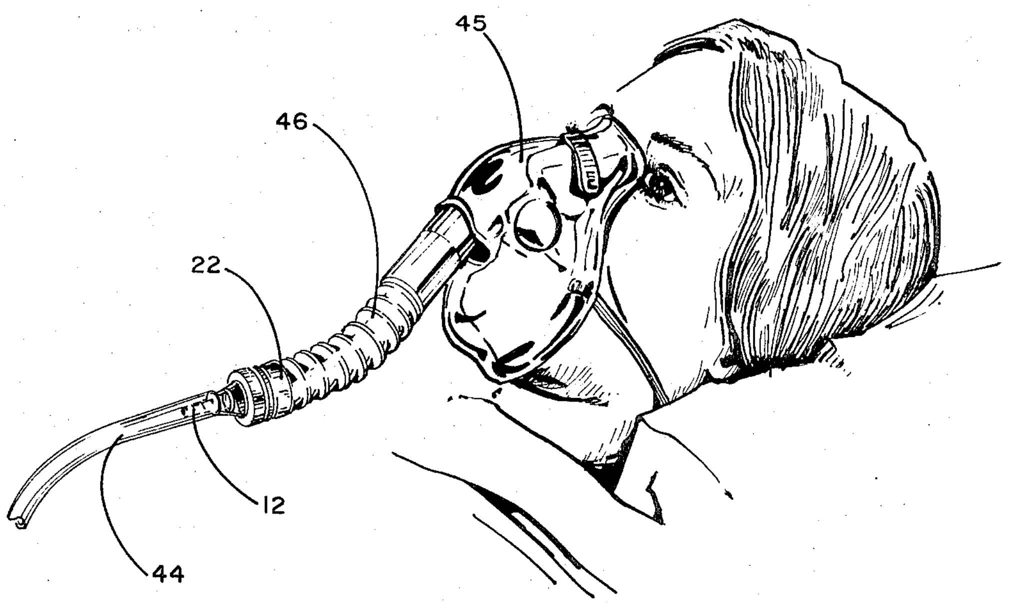


FIGURE 10

OXYGEN DILUTER DEVICE

BACKGROUND OF THE INVENTION

A number of devices for diluting the concentration of oxygen supplied to patients receiving inhalation therapy have been proposed. Such prior art devices usually include a nozzle for securing an oxygen supply tube and an enlarged apertured venturi tunnel portion into which the oxygen is directed from the nozzle. Normally, large bore tubing is attached between the apertured venturi portion and an oxygen mask secured on a patient for delivery of the oxygen enriched gas.

As the high flow of oxygen passes from the nozzle into the enlarged tunnel, a partial vacuum in the vicinity of the oxygen stream is created which stream becomes entrained and diluted with room air drawn through the orifices. The problem with such prior art diluter devices is that the orifices communicating between the venturi chamber and room atmosphere supply only a single oxygen dilution ratio at a specified oxygen flow rate. However, for different patients, different dilutions may be desired to provide different oxygen concentrations, for example, 24, 28, 35 and 40 percent with each of these concentrations requiring separate units having different sized orifices in order to achieve different dilutions. In other words, since one unit will provide only a single oxygen concentration, to have a range of diluters on hand, four separate units must be purchased, obviously increasing costs and storage and handling requirements. Moreover, even though the diluters are intended as disposable units to avoid contamination from patient to patient, where a single patient requires differing oxygen concentrations, it will be necessary to provide different individual diluters.

SUMMARY OF THE INVENTION

It is to the elimination of the above noted disadvantages that the present invention is directed. The device incorporates an improved dilution chamber which can be altered to give the full range of usual oxygen concentrations required for most patients. The device, intended to be used in combination with an oxygen mask includes a nozzle portion for securing an oxygen delivery tube. Extending from one end of the nozzle, opposite the end for attaching the oxygen delivery tube, is a gas metering tunnel portion comprising a plurality of spaced arcuate ribs between which ribs are defined a plurality of dilution ports. The ribs are attached to and suspended between a pair of oppositely disposed bars or rods which bars are attached between the nozzle portion and a hollow gas delivery portion the latter which directs the diluted oxygen to an oxygen mask. The device also includes a plurality of closure members for selectively closing one or more of the air entrainment ports as desired for varying the amount of entrained atmospheric air entering the mixing chamber and concomitantly the oxygen concentration delivered to the patient. The closure members may be inserted or removed as desired so that the varying oxygen concentrations may be achieved with a single device without the requirement of utilizing separate diluter devices to achieve differing oxygen concentrations as has been necessitated by prior art devices known heretofore.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged perspective view of the device of the invention;

FIG. 2 is a top plan view of the device shown in FIG. 1;

FIG. 3 is a front elevational view of the device of FIG. 1;

FIG. 4 is a front elevational view of closure members;

FIG. 5 is a side sectional view of the device;

FIG. 6 is a side elevational view of the device showing a first closure member inserted;

FIG. 7 is a side elevational view of the device showing first and second closure members inserted;

FIG. 8 is a side elevational view of the device showing all three closure members inserted;

FIG. 9 is a front elevational view with all closure members inserted; and

FIG. 10 is a perspective view illustrating the device as normally used in combination with an oxygen mask and tubing.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, there is shown an oxygen dilution device 10 of the invention having a forward end nozzle portion 12 and a rearwardly disposed gas delivery portion 22. Intermediate between these two portions is a gas metering tunnel portion 26 through which an oxygen stream flows from the nozzle portion to the gas delivery portion.

Referring also to FIGS. 2 and 5, gas metering tunnel portion 26 is defined between rods 19 and 20, which are disposed on each side of the tunnel portion, and between arcuate ribs 14, 16 and 18. Each of the arcuate ribs extend circumferentially around tunnel portion 26 and are secured to both rods 19 and 20. It will be noted that the ribs are substantially parallel and lie substantially normal to the central axis of tunnel portion 26 and along which axis gas flowing between nozzle portion 12 and gas delivery portion 22 travels. Between adjacent ribs and rib 18 and the gas delivery portion are defined a plurality of ports 13, 15 and 17 through which ports atmospheric air is directed for entrainment with and dilution of oxygen flowing through tunnel portion 26.

Hollow nozzle portion 12 provides a conduit through which oxygen is directed. The size or diameter of the hollow interior of the nozzle portion is not particularly critical. However, as shown in FIG. 5, preferably before communicating with tunnel portion 26, the nozzle portion interior includes a restricted or relatively narrow passageway 24. Accordingly, gas flowing through the passageway 24 and entering tunnel portion 26 will be in the form of a high velocity stream the effect of which stream, entering the significantly larger diameter tunnel portion 26, causes a partial vacuum. According to the venturi principle, atmospheric gas in the immediate vicinity of the tunnel portion will be entrained through open ports 13, 15 and 17 to combine with the oxygen stream and thereby dilute its concentration. Thereafter, the diluted oxygen stream travels through hollow gas delivery portion 22 and exits through open end 28. With two or more ports open, the air entrainment effect may actually be described as a cascading venturi principle since dilution of the oxygen stream passing along the tunnel portion is carried out in successive stages from one port to the next.

Exteriorly disposed on the forward end of nozzle portion 12 are a plurality of frustoconical segments 21 for securing an oxygen supply tube. Preferably, the first end segment has a smaller maximum diameter than the adjacent segment so that the segments have maximum diameters increasing from forward to rear and provide an adaptor for attaching oxygen tubing of varying sizes. However, such features are not critical and are merely for convenience.

Hollow gas delivery portion **22** is preferably annular so that the circumferential exterior thereof may be easily fitted into a circular receiving orifice of an oxygen mask or large bore tubing end for delivery of oxygen. A flange **25** is preferably located around the outer gas delivery portion surface to act as as a stop for limiting the extent to which the device extends within tubing or mask opening or orifice. Other equivalent means may be used for that purpose. However, it should also be appreciated that the exterior shape as well as the hollow interior of gas delivery portion **22** is not particularly critical so long as it can be received and secured with an oxygen mask or tubing to form a substantially gas tight seal at the receiving orifice as will be appreciated by those skilled in the art.

Observing also FIG. **4,** a plurality of air restricting closure members **32, 34** and **36** are used for closing gas entrainment ports **13, 15** and **17** (FIG. **2**) in order to achieve varying oxygen concentrations as required. The closure members are preferably in the shape of a disc corresponding to the arcuately shaped ribs **14, 16** and **18** but which discs have a larger or greater outside diameter so that they may be relatively easily grasped by an operator for removal or insertion along tunnel portion **26.** The center area of each of the discs is also hollow and preferably does not interfere or project into the interior of tunnel portion **26** to avoid deflection of the air stream passing therealong. The disc centers are also preferably axially aligned along the central axis extending through tunnel portion **26.** The air restriction discs also are each provided with a slot **38***a*, **38***b* and **38***c* through which one of the rods **19** or **20** is guided and the other rod received in securing the discs. Notches **41***a*, **41***b* and **41***c* are also present in which one of the rods is received in further stabilizing secured discs.

In securing a disc, it is simply placed on the device so that a disc will fill or stopper one of the ports. A disc is secured by passing rod **19** through a slot (**38***a*) and pressing the disc in place until rod **20** is received in slot **38***a* and rod **19** is received in notch 41a.

Observing also FIGS. **6, 7** and **8,** it will be noted that disc **32** not only has a larger hollow center than discs **34** or **36** but that the latter discs are respectively thinner. Thus, the thickness of each disc corresponds to the width of the ports in which the respective disc fits and preferably all are different so that each disc will fit only one port. For this purpose not only may the port sizes (distance between adjacent ribs) be different, but the width of rods **19** and **20** between adjacent ribs as well as corresponding disc slot and notch sizes may vary. Such a feature will prevent an inexperienced operator from inadvertently placing the wrong disc on the wrong port. This feature is further noted in observing FIG. **3** in which rod portions **44, 46** and **48** between adjacent ribs are progressively smaller in both length and width. Correspondingly, observing FIG. **5,** the distance across slots **38***a*, **38***b* and **38***c* and notches **41***a*, **41***b* and **41***c* are progressively smaller.

It should be appreciated that the device may have a different shape as may the closure members. For example, rather than the ribs and rods forming a generally frustoconical outline, ribs may be formed with similar modification of the closure member shape in rectangular, square, or other forms. Moreover, the discs may be color coded to further distinguish them. Such modifications will be evident to those skilled in the art without departing from the purview of the invention.

In operation, the device is utilized and functions as follows:

Observing FIG. **10,** oxygen supply tubing **44** is secured to nozzle portion **12** and gas delivery portion **22** is inserted and received in the end of oxygen delivery tube **46.** The delivery tubing is connected to oxygen mask **45** which is secured to a patient as shown. Alternatively, the device may be secured directly to an oxygen mask thereby eliminating delivery tubing if desired. The operator or therapist then selects the desired oxygen concentration to be delivered to the patient, for example, 24 percent, 28 percent, 35 percent or 40 percent. Where 24 percent oxygen is to be delivered to the patient, none of the discs are inserted on the device so that all three of gas entraining ports **13, 15** and **17** are open as shown in FIGS. **1, 2** and **5.** Accordingly, at an oxygen flow rate of for example, 4 liters per minute the air entrained through the ports provide an oxygen-atmospheric air mixture of about 24 percent oxygen concentration delivered to the patient. For a 28 percent oxygen concentration, disc **32** is inserted as shown in FIG. **6** closing appropriate oxygen entraining port. At the same flow of 4 liters per minute through the oxygen supply tubing an oxygen concentration of 28 percent delivered to the patient will be achieved. For 35 percent oxygen concentration, two of the restriction discs are secured as shown in FIG. **7** and in order to increase total flow to the patient, oxygen flow is increased, for example, to eight liters per minute. With a third disc inserted to close all of the air entraining ports as shown in FIG. **8,** 40 percent oxygen concentration will be delivered to a patient.

Observing also FIG. **9,** it will be noted that disc **36** has an oblong hollow center so that there is a vent opening **35** adjacent nozzle portion **12.** Thus, even all closure members secured some air will be entrained through the vent in order to avoid delivery of unduly high oxygen concentrations. The size of such a vent opening of course, may be varied to achieve any maximum oxygen concentration desired.

Again, the shape of the ribs of the device of the invention is not particularly critical and rather than being arcuate, they may be rectangular, square or some other shape, so long as the air entraining tunnel portion is not adversely affected. Further, the port sizes and shapes may be varied as well as the number of ports incorporated in such a device to achieve a series of different oxygen concentrations as will be appreciated by those skilled in the art. Although the closure members are shown as slotted and notched so that they may be easily fitted over and secured on the rods which extend between the forward-most rib and the forward end of gas delivery portion **22,** other design characteristics which achieve the same purpose are intended to be within the purview of the invention.

It will be appreciated that the device of the invention provides varying oxygen concentrations on a single unit without the requirement of having different devices for each different oxygen concentration desired as have the corresponding prior art devices. Accordingly, a single device of the invention can be used on a single patient whereby varying oxygen concentrations may be selected by simply inserting or removing one or more of the closure members when the unit is to be used as previusly described. These as well as other advantages will be evident to those skilled in the art.

I claim:

1. A device for diluting an oxygen stream delivered to a patient comprising:

a. a nozzle portion disposed at one end for attaching an oxygen supply tube;

b. a hollow gas delivery portion at the opposite end for directing gas to the patient;

c. a hollow tunnel portion extending between the nozzle and gas delivery portions including a pair of oppositely disposed rods extending between said nozzle and gas delivery portions and a plurality of arcuate and parallel ribs secured around both sides of said rods and spaced therealong whereby a tunnel is defined interiorly of said ribs and rods and a plurality of ports are defined between said ribs; and

d. a closure member for each port for being selectively secured on said device to close at least a portion of a respective port whereby an oxygen stream flowing through the tunnel portion is mixed and diluted with entrained air entering through one or more open ports.

2. The device of claim 1 wherein said closure members comprise air restriction discs each of which is shaped to substantially occlude one of said ports.

3. The device of claim 1 wherein said nozzle portion includes a restricted passageway for creating a high velocity oxygen stream directed into said tunnel portion.

4. The device of claim 3 wherein said device has three of said ports and closure members and wherein with all three of said closure members secured an oxygen concentration of about 40 percent is delivered at a flow rate of 8 liters per minute, with two of said closure members secured an oxygen concentration of about 35 percent is delivered at 8 liters per minute flow, with one of said closure members secured an oxygen concentration of about 28 percent is delivered at 4 liters per minute flow, and with no closure members secured and all ports open an oxygen concentration of about 24 percent is delivered at 4 liters per minute flow.

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