May 13, 1969 M. J. McGOFF ET AL 3,443,906

AIR REGENERATION UNIT

Filed Oct. 19, 1965 Sheet 1 of 2

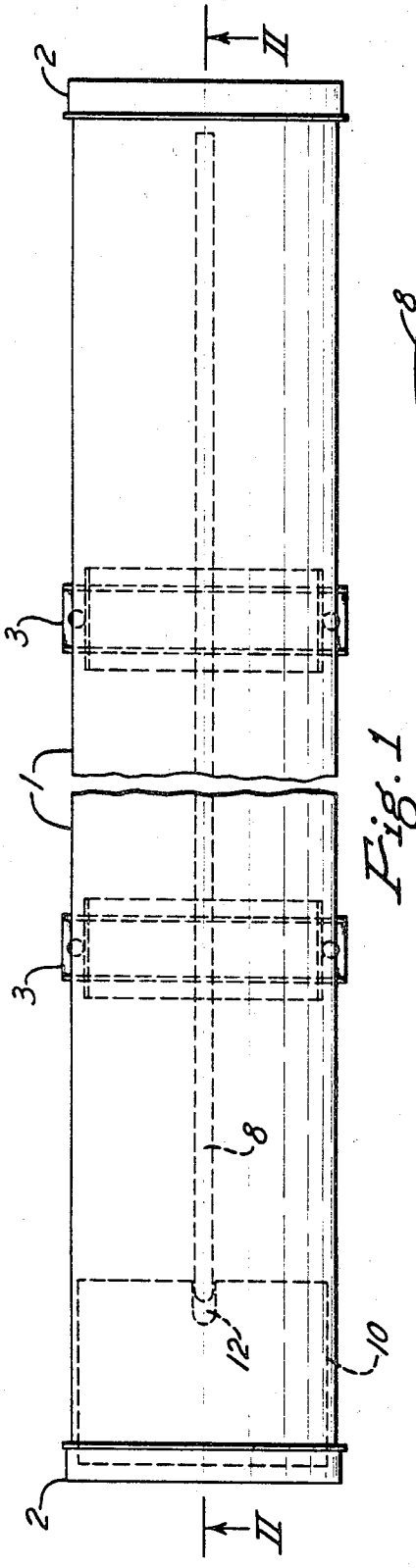


Fig. 1

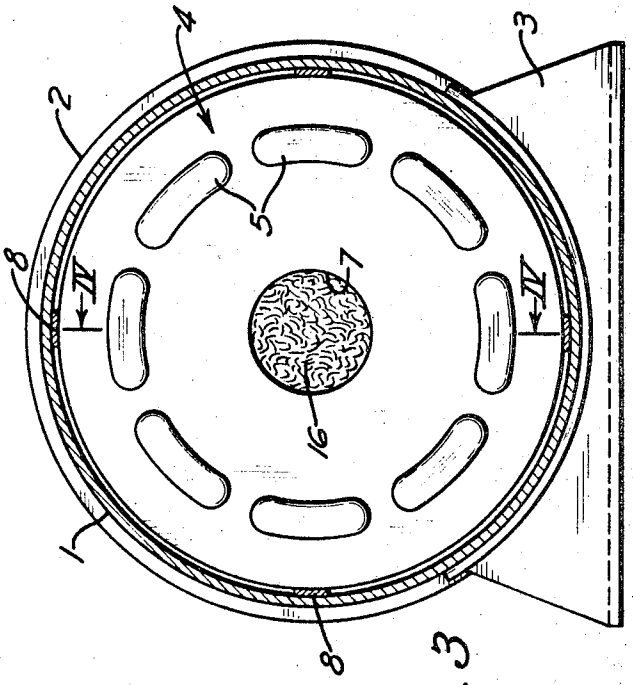


Fig. 3

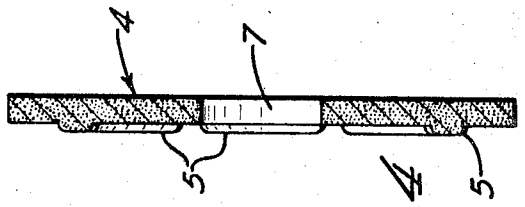


Fig. 4

INVENTORS.
MILES J. McGOFF
JOHN W. MAUSTELLER
CHARLES H. STAUB

BY Brown, Critchlow, Flick & Peckham.
ATTORNEYS.

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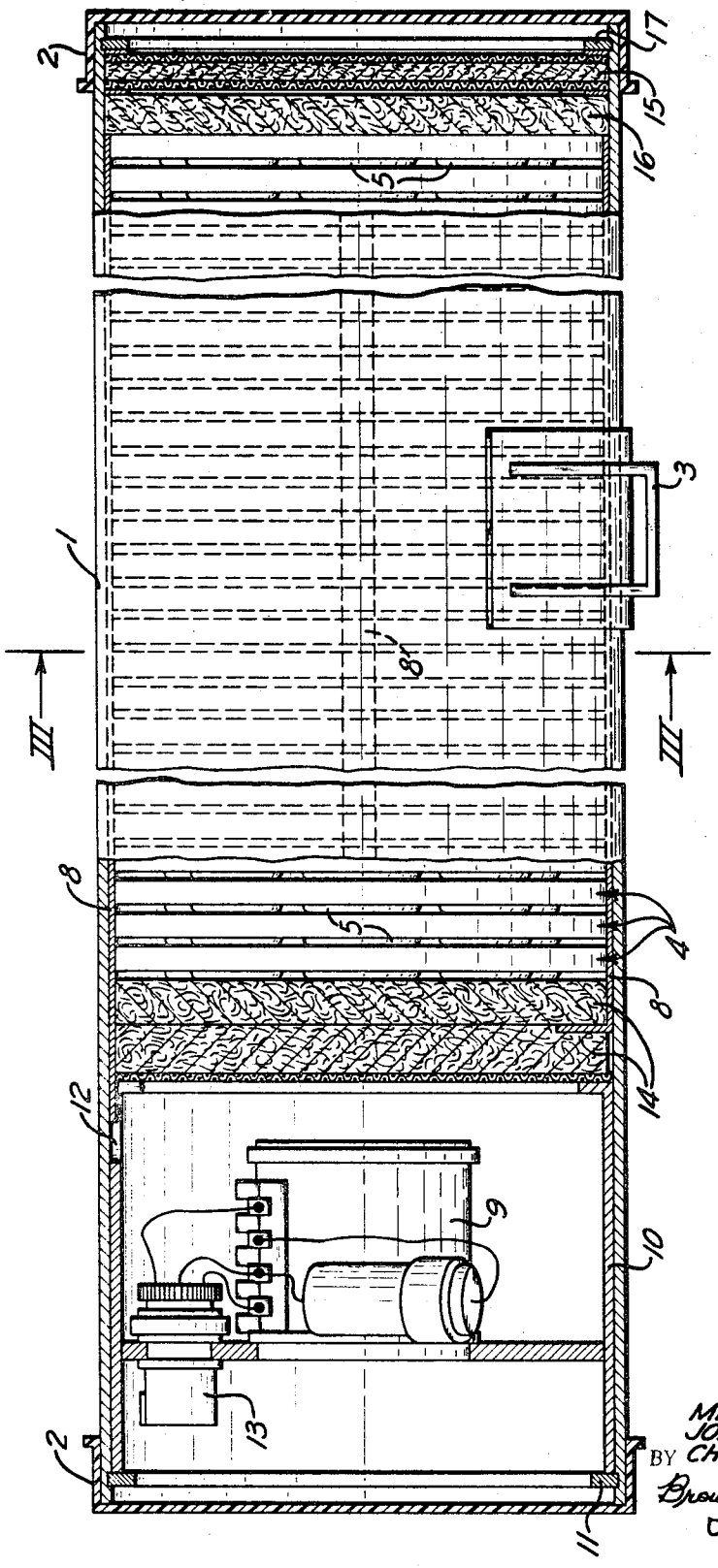


Fig. 2

INVENTORS.
MILES J. McGOFF
JOHN W. MAUSTELLER
BY CHARLES H. STAUB
Brown, Critchlow, Flick & Peckham.
ATTORNEYS.

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3,443,906

AIR REGENERATION UNIT

Miles J. McGoff, Warrendale, John W. Mausteller, Evans City, and Charles H. Staub, Pittsburgh, Pa., assignors to MSA Research Corp., Pittsburgh, Pa., a corporation of Pennsylvania

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U.S. Cl. 23—281 8 Claims

ABSTRACT OF THE DISCLOSURE

An air regeneration unit for use in a chamber containing a human being has a tubular housing open at its ends and contains a stack of closely spaced rigid alkali metal superoxide discs provided with a central passage formed by openings through them. Circumferentially spaced means around the discs form outer passages. Air is circulated through the housing through all of these passages and between the discs so that carbon dioxide will be removed and oxygen will be evolved.

It is well known that alkali metal superoxides; i.e., potassium superoxide and sodium superoxide, absorb carbon dioxide and evolve oxygen. Potassium superoxide is especially useful for this purpose and has been employed in respiratory equipment connected with breathing masks. Moisture in the exhaled air accelerates the production of oxygen.

It is among the objects of this invention to provide an air regeneration unit, which is unconnected to a breathing mask, which can be used to regenerate air in a confined chamber, which does not overgenerate oxygen, which does not liberate dust, which is simple in construction, which is compact and lightweight, and which is highly effective.

In accordance with this invention the air regeneration unit includes a tubular housing that is open at its opposite ends while being used. This housing contains a stack of closely spaced alkali metal superoxide discs provided with an axial passage through them. Circumferentially spaced means around the discs form passages between the housing and discs that extend lengthwise of the housing. Air is positively circulated through the housing through these passages and also passes radially between the discs. As exhaled air flows through the housing, carbon dioxide is absorbed by the discs and oxygen is liberated.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which

FIG. 1 is a plan view of our unit;

FIG. 2 is an enlarged, fragmentary side view mostly broken away in section;

FIG. 3 is a cross section taken on the line III—III of FIG. 2; and

FIG. 4 is a cross section of one of the chemical discs, taken on the line IV—IV of FIG. 3.

Referring to the drawings, a tube **1** made of any suitable material has open ends which may be closed by friction caps **2** until the unit is ready for use. Mounting brackets **3** are fastened to the tube for attaching it to a suitable support in any position. As shown in FIG. 2, the tube contains a stack of discs **4** that are formed from compressed alkali metal superoxide, either potassium superoxide or sodium superoxide, but preferably the former. The stack of discs is not quite as long as the tube and is spaced inwardly from its opposite ends. The individual discs are spaced apart slightly, which can be done conveniently by molding projections **5** on one side of each disc. The preferred thickness of each cake or

disc is about 3/16". If it is less than about 1/8" thick the disc is somewhat friable, while if it is more than about 3/8" thick the utilization of the chemical is reduced drastically. The discs may be about 4 inches in diameter and spaced apart about 1/16". Enough discs must be used to provide sufficient surface area for liberation of the amount of oxygen necessary for the period that the unit is to be used.

To permit air to flow through the discs, they are provided with central openings **7** to form a central passage through the stack. It is best to have the openings axially aligned although they could be staggered but that would increase the pressure drop. It also is important that air flowing through the housing should pass around the discs. For this purpose, circumferentially spaced members are provided around the discs that will form passages between them and the housing extending lengthwise of the tube. The spacing means may be integral radial projections of the discs, or three or four equally spaced thin strips **8** of metal or other material extending lengthwise of the inside of the housing and preferably attached to it. Consequently, when air is forced through the tubular housing, it will flow through the central passage in the stack of discs and also along the outside of the stack. The air also will flow radially between the discs. The result is that all surfaces of the discs are continually exposed to the passing air so that maximum use is made of the superoxide.

For circulating the air through the tubular housing, an electric fan **9** may be mounted in one end of it. Such a fan may be secured in a short tubular casing **10** that fits snugly inside one end of the housing, where it is held by a removable split spring ring **11** seated in a groove in the housing. The side wall of the casing may be provided at its inner end with a notch **12** for receiving the adjoining end of one of the spacer strips **8** to prevent any tendency of the fan casing to turn in the tube. An electric plug **13** is mounted in the housing for connecting the fan with an outside electric power source. A debris trap may be provided at the fan end of the stack of discs by clamping one or more compressible wire mesh pads **14** between the inner end of the fan casing and the adjoining end of the stack. A dust filter **15** and mesh pad **16** are inserted in the opposite end of the tube in engagement with that end of the stack of discs. This filter is held in place by a removable spring retaining ring **17**, so everything in the tube is clamped between the two spring rings and will not be affected by vibration or jolts. By removing the spring rings, an exhausted stack of chemical discs can be removed from the tube and replaced by a new stack.

Overgeneration of oxygen is common with fresh potassium superoxide apparatus, because the KO_2 reacts with both CO_2 and water vapor to produce oxygen. The oxygen produced by the reaction with the water vapor is in excess of that required by the subject breathing the regenerated air. Such overgeneration is an initial effect only because, after partial expenditure of the chemical, some of the CO_2 is captured by the KOH, which is produced by reaction of water vapor with KO_2, and does not generate any oxygen. In the present invention, however, the compressed cakes or discs are less sensitive to water, whereby the reaction of KO_2 with water vapor is reduced without diminishing the reaction with CO_2. Consequently, overgeneration of oxygen is reduced and the reaction rate remains nearly uniform.

Since a superoxide will continue to absorb carbon dioxide even after most of the oxygen has been evolved, by using a long tube filled with a stack of superoxide discs the air is conditioned by the partially exhausted discs at the entrance end of the tube.

By pressing the KO_2 into solid discs, more oxygen

evolution and CO_2 absorption capability per unit volume has been achieved, since the density of the solid form is twice that of the granular form. The density may be as high as from ½ to ⅔ of theoretical, whereas before this invention it has been approximately ⅓ of theoretical. The solid, denser form represented by these discs contributes to more storage of oxygen per unit volume. The use of solid cakes of chemical reduces the space required and the weight of the unit. Further weight savings are gained because of the self-supporting properties of the discs. The rigid cakes resist dusting associated with abrasion, and by making them circular they offer fewer edges at which dust can form. Because of the central passage through the stack of discs, the outside passages around the stacks and the radial passages between the discs, our unit has a low pressure drop.

It has been found that a tube about 32" long and 4" in diameter containing 110 cakes of potassium superoxide, so that the chemical bed is about 27" long and has a surface area of about 1450 square inches, will regenerate air at a rate that will sustain one person in a 150 cubic foot space capsule for one 24-hour day with the air flowing through the unit at about 9 cubic feet a minute. Of course, this unit can be used either as a primary respiratory life support system or as an emergency life support system.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. An air regeneration unit comprising a tubular housing open at its ends, a stack of closely spaced rigid alkali metal superoxide discs in said housing provided with a central passage therethrough formed by openings through the discs, the discs forming the wall of said passage, circumferentially spaced means around the discs forming outer passages between the housing and discs extending lengthwise of the housing, the peripheries of the discs forming walls of said outer passages, and means for circulating air through the housing through all of said passages and between the discs.

2. An air regeneration unit according to claim 1, in which said circumferentially spaced means are narrow strips extending lengthwise of said stack from end to end thereof.

3. An air regeneration unit according to claim 1, in which the density of each of said discs is more than half of theoretical.

4. An air regeneration unit according to claim 1, including removable sealing caps mounted on the ends of said housing before use of said unit.

5. An air regeneration unit according to claim 1, in which said air-circulating means is a fan mounted in one end of the housing.

6. An air regeneration unit according to claim 5, including a tubular casing containing the fan and slidably mounted in said end of the housing, and means removably holding the casing in the housing.

7. An air regeneration unit comprising a tubular housing open at its ends, a stack of rigid alkali metal superoxide discs in said housing provided with a central passage therethrough formed by openings through the discs, the discs forming the wall of said passage, each of said discs being provided at one side with integral projections spacing it from the adjoining disc, circumferentially spaced means around the discs forming outer passages between the housing and discs extending lengthwise of the housing, the peripheries of the discs forming walls of said outer passages, and a fan in one end of the housing for circulating air through the housing through all of said passages and between the discs.

8. An air regeneration unit according to claim 1, in which said discs are between one-eighth and three-eighths inch thick.

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MORRIS O. WOLK, *Primary Examiner.*

R. E. SERWIN, *Assistant Examiner.*