July 3, 1951 C. B. JACKSON ET AL 2,558,756

OXYGEN GENERATOR

Filed July 28, 1948 2 Sheets-Sheet 1

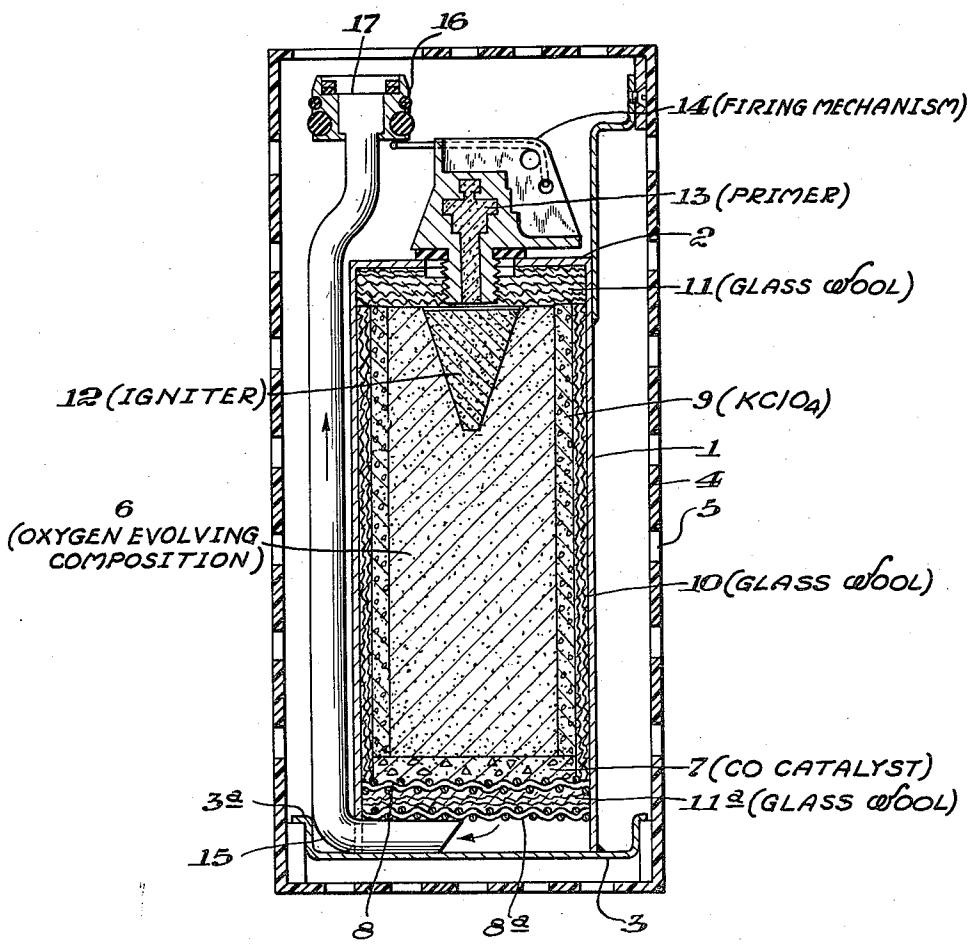


Fig. 1.

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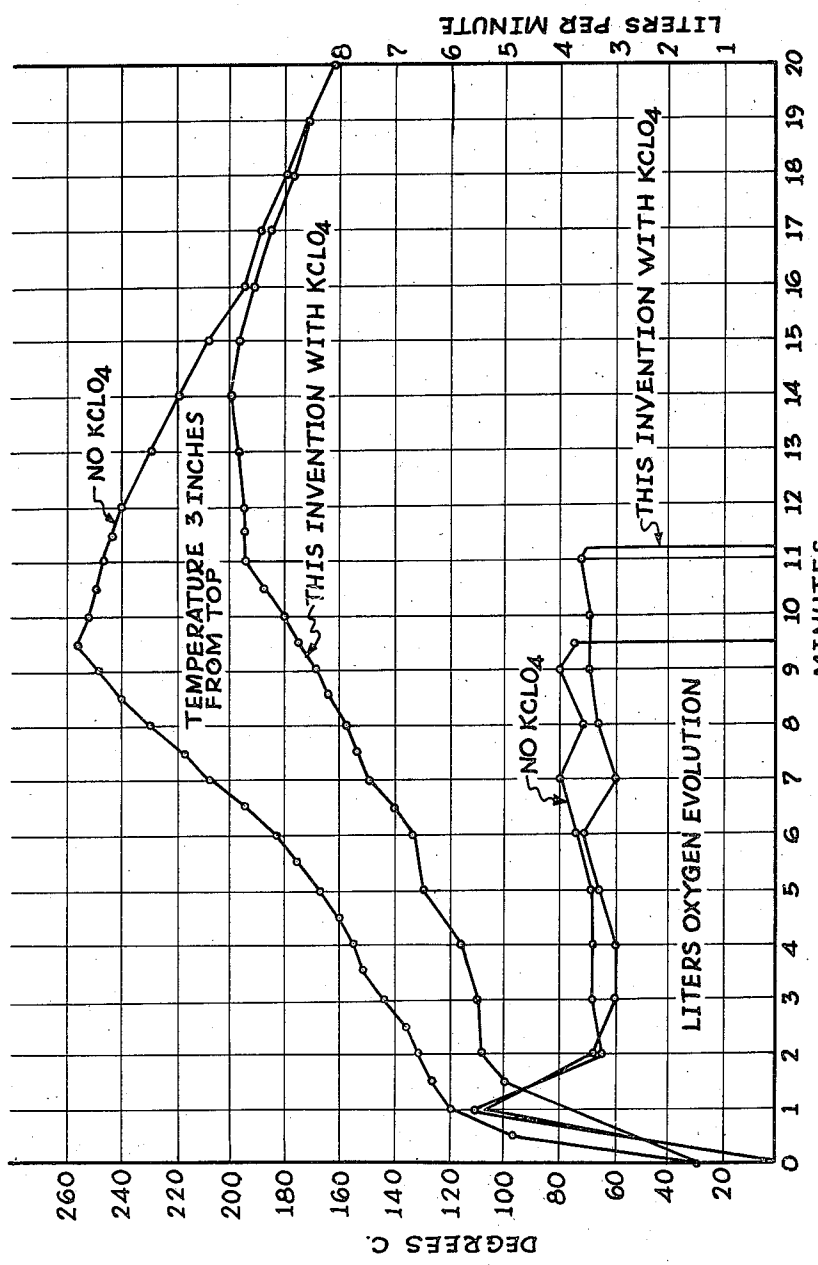


Fig. 2.

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OXYGEN GENERATOR

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7 Claims. (Cl. 23—281)

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This invention relates to oxygen-evolving devices, and more particularly to the so-called oxygen candles.

A source of oxygen for respiration is required for various purposes such, for example, as in high altitude aircraft, in submarines, for breathing apparatus for use in irrespirable atmospheres, in mountain climbing, and for related purposes. Cylinders containing oxygen under pressure are in general unsuited to such purposes, either because the cylinders are objectionably heavy and bulky or because if they are small enough to be carried comfortably and without fatigue, they do not supply oxygen for a desirably long period of time. Also, because of the very high pressure of oxygen in a cylinder, a pressure regulating device is necessary which adds to the weight and complicates the use of the cylinder.

So-called oxygen candles have been developed to give a higher ratio of oxygen supply per unit weight of equipment than is to be had with cylinder oxygen, whereby to avoid the aforementioned disadvantageous nature of the latter type of equipment. Such candles make use of the fact that chlorates, such as sodium chlorate ($NaClO_3$) and potassium chlorate ($KClO_3$), decompose exothermically with evolution of oxygen, for example as follows:

$$2NaClO_3 \rightarrow 3O_2 + 2NaCl + 33{,}000 \text{ cal.}$$

Although this reaction is exothermic, a common practice is to compound the oxygen-evolving chlorate with a material, such as iron powder, that undergoes oxidation with liberation of heat, together with other agents for special purposes, for example, a substance to fix any elemental chlorine that may be formed, and a catalytic material. Commonly these compositions are densely consolidated, most suitably by casting a melt of the chlorate carrying such addition to form bodies of desired shape and size. A typical composition is, by weight, 80 per cent of sodium chlorate, 10 per cent of iron powder (reduced), 6 per cent of powdered glass as a catalyst, and 4 per cent of barium peroxide (BaO_2) to fix chlorine, if any is formed.

These candles are disposed in closed metallic canisters provided with an oxygen outlet and with means for igniting the composition when the candle is to be put in use. Extended experience has shown that the heat developed during the burning of such candles as constructed heretofore is so great as to be objectionable, and even dangerous. Thus, in some instances the walls of the canister may actually become red hot with

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the possibility of injury to a person carrying such a candle, or of ignition of flammable materials. Heretofore this situation has necessitated the use of insulating materials exteriorly of the canister, which is obviously disadvantageous in that the bulk and weight of the candles are thereby increased. Also, such insulation results in accelerated decomposition of the candle composition, which is objectionable because, in general, it is desired that devices of this type supply oxygen for extended periods of time.

An object of the present invention is to provide oxygen candles of the general type just referred to and in the use of which the canister reaches much lower temperatures than was the case with those known prior to this invention, and to do so simply, inexpensively, efficiently, and without material modification of existing structural details.

Another object is to provide such candles which also have longer operating life than heretofore with a given charge of oxygen-evolving composition.

Other objects will appear from the following specification.

The invention will be described with reference to the accompanying drawings in which Fig. 1 is a longitudinal section through a chlorate candle constructed in accordance with the preferred embodiment of the invention, some parts being shown schematically; and Fig. 2 graphs comparing canister wall temperatures and volume of oxygen evolved a sodium chlorate candle constructed in accordance with prior commercial practice with a candle of the same composition but additionally embodying the present invention.

We have discovered, and it is upon this that the present invention is predicated, that the objects of the invention are attained by surrounding at least the body of the oxygen-evolving composition with a substance that undergoes an endothermic effect under the influence of the heat liberated by the reaction, or burning, of the oxygen-evolving composition. In other words, in accordance with the invention we dispose between the candle composition and the wall of its enclosing canister, longitudinally of the candle length, a substance that undergoes change with absorption of heat during progressive burning of the candle composition. Although a number of substances may be used for this purpose, we prefer compounds which under the influence of the heat liberated by combustion of the candle undergo endothermic composition, and most suit-

ably those that evolve oxygen in doing so. Perchlorates, especially those of the alkali metals, serve admirably the preferred embodiment of the invention, and for most purposes we use potassium perchlorate ($KClO_4$).

It is conventional in candles of this type to surround the candle with one or more layers of an inert and heat resistant filtering material for the purpose of separating from the oxygen withdrawn from the canister the particles of sodium chloride that would otherwise appear as a chloride smoke in the oxygen withdrawn from the canister. Glass wool is commonly used for this purpose.

In the preferred embodiment of the invention we disposed a layer of potassium perchlorate, or other substance that undergoes the necessary endothermic effect during burning reaction, or combustion, of the candle, between the candle itself and the glass wool, or equivalent filtering agent, although other modes of surrounding the candle with the perchlorate are, of course, possible, as by placing it between the canister wall and one or more layers of filter agent disposed around the candle composition, or by disposing the perchlorate between layers of the glass wool or equivalent filter material.

Having reference now to Fig. 1, in the embodiment shown the canister comprises a tubular member, most suitably formed from sheet copper or brass, in the form of a cylinder 1 having a top closure 2 and a bottom closure 3 connected to provide gas tight joints. Bottom 3 preferably is in the form of a cup with the upper end of its side wall turned outwardly to provide a flange 3*a* for supporting the canister coaxially within and spaced from the wall of an enclosing envelope 4. Most suitably envelope 4 is formed of one of the well known laminated fabric-synthetic resin materials, and it is provided with perforations 5 for radiation of heat.

Disposed within the canister and spaced annularly from its wall 1 and from its top 2 and bottom 3 is the oxygen evolving composition, or candle, 6. In the embodiment shown it rests upon a layer 7 of catalyst, such as the well known Hopcalite, adapted to oxidize to carbon dioxide (CO_2) any carbon monoxide (CO) that may result from combustion of candle 6. This in turn rests on a copper wire screen 8 spaced from a similar screen 8*a* mounted above bottom member 3.

In accordance with the invention candle 6 is surrounded laterally by a layer 9 of potassium perchlorate or other substance that undergoes an endothermic effect when the candle burns. Interposed between the potassium perchlorate 9 and canister wall 1 is a body 10 of glass wool or equivalent filter agent, in the form of one or more layers. One or more layers of glass wool are preferably disposed over the top of candle 6 and between screens 8 and 8*a*, as indicated at 11 and 11*a*, respectively. The glass wool acts, as noted above, to filter potassium chloride fume from the evolved oxygen.

Combustion of candle 6 is initiated by an ignition composition 12 that is fired by a primer 13 through mechanism indicated generally at 14.

The details of construction of the firing means 14—13—12 as well as the precise make-up of candle composition 6, which preferably is cast to shape and size, are known and constitute no part of the present invention and therefore they require no further detailed illustration or description. However, composition 6 may, by way of example, be in accordance with the typical composition cited above.

The amount of potassium perchlorate, or other substance 9, that reacts endothermically under the heat evolved by combustion of candle 6, or in other words, the width (horizontally of Fig. 1) of the layer 9, will depend upon various factors, including the exact composition of candle 6 and the amount of heat liberated by it per unit of time, the desired maximum temperature that the canister wall is to attain, and the particular endothermic substance that constitutes layer 6. Consequently, it is not possible to state numerical values that are applicable to all situations. Characteristic data indicative of this factor are, however, available from the example given hereinafter.

In the use of a candle in accordance with this invention the reaction, or combustion, of the oxygen-evolving composition 6 is initiated through the action of firing mechanism 14. When composition 6 burns oxygen is released and flows laterally through the filter layer 10 (and perhaps to some extent through layer 11) which removes any KCl fume, and thence toward the bottom of the canister where it meets the layer 7 of CO catalyst. The purified oxygen is withdrawn through a tube 15 that extends through wall 1 of the canister into the space between screen 8*a* and bottom closure 3. At its upper end tube 15 is provided with means 16 for receiving the tube to a face mask. Means 16 is provided, in known manner, with rupturable sealing means 17 that protects candle 6 from atmospheric action until the device is placed in use.

As the composition 6 burns progressively of its length with liberation of oxygen that is withdrawn through tube 15, and with liberation of heat (combustion of Fe, decomposition of chlorate), the heat will tend in large part to flow toward the wall 1 of the canister, with some portion withdrawn by heating of the evolved oxygen. In the past it has been not uncommon for the canister wall to reach temperatures of the order of 250° C., and even to become red hot. However, in a canister in accordance with this invention as the heat travels through the layer 9, i. e., potassium perchlorate in the preferred embodiment, the thermal effect is great enough to cause decomposition of the perchlorate, which absorbs heat to an extent such that the canister wall does not reach so high a temperature as in the case of candles not surrounded by material productive of an endothermic effect. Furthermore, the decomposition of the perchlorate that constitutes the preferred embodiment releases oxygen which thus tends to offset the oxygen loss due to combustion of iron or similar oxidizable agent that may be included in the candle composition. Moreover, the endothermic effect likewise causes the oxygen evolved to be cooler than is the case with conventional candles of this type, which is advantageous where the oxygen is for breathing.

To show the benefits flowing from the invention reference will now be made to comparative tests of candles identical except that one was provided with $KClO_4$ as described above. The candle 6 according to the invention was $1\frac{10}{64}$ inches diameter and 3.5 inches long and was cast from the specific composition cited above. It was mounted in a 0.010 inch thick copper canister 1.75 inches in diameter and 4⅝ inches long. Glass wool layers 10 was $\frac{9}{64}$ inch thick, of 3 grams weight, and the $KClO_4$ layer 9 was $\frac{9}{64}$ inch wide and weighed 40 grams. Layer 7 consisted of 6 grams of "Hopcalite." Temperatures were measured by a

thermocouple in contact with canister wall 1 three inches below the top of the canister. That candle was compared with a candle identical in all respects except that it lacked the layer 9 of $KClO_4$.

The comparative data of the two candles are shown in Fig. 2. These data show clearly the great effectiveness of the present invention in reducing the temperature of the canister wall. As a result of this invention, the evolution of oxygen occurs at a more uniform rate and over a greater period of time, as shown also by Fig. 2. This is due to the fact that by reduction of temperature through the present invention combustion of the candle is retarded and is more uniform.

Although the invention has been described with particular reference to oxygen candles to supply oxygen for breathing purposes, by connecting the element 16 to a face mask, it will be understood that these candles are applicable also to other purposes. Likewise, mixtures of two or more substances that develop the endothermic effect that characterizes the invention may be used. Likewise other canister constructions than that shown may be used, the essence of the invention residing in surrounding the candle composition with $KClO_4$ or equivalent endothermic agent. It may be added that the desired reduction of temperature is not attained if the endothermic substance is incorporated in the candle composition.

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 oxygen generator comprising an elongate canister closed at its ends and provided at one end with an oxygen outlet, a consolidated body of a combustible composition which upon ignition undergoes exothermic reaction with evolution of oxygen disposed in said canister, means associated with said canister for igniting said composion, and a layer of substance that is decomposed endothermically with evolution of oxygen under the heat of reaction of said composition surrounding the exterior of said body between it and the canister wall.

2. An oxygen generator according to claim 1, said substance being a perchlorate.

3. An oxygen generator according to claim 1, said substance being an alkali metal perchlorate.

4. An oxygen generator comprising an elongate canister closed at its ends and provided at one end with an oxygen outlet, a consolidated body of a combustible chlorate composition disposed in said canister, means associated with said canister for igniting said composition, a layer of inert filter medium disposed about the body of said composition, and a layer of substance that is decomposed endothermically with evolution of oxygen under the heat of reaction of said composition surrounding the exterior of said layer between it and the canister wall.

5. An oxygen generator comprising an elongate canister closed at its ends and provided at one end with an oxygen outlet, a consolidated body of sodium chlorate disposed in said canister, means associated with said canister for igniting said composition, a layer of glass wool surrounding the body of said composition, a layer of substance that decomposes endothermically with evolution of oxygen under the heat of decomposition of said chlorate surrounding the exterior of said layer, and a second layer of glass wool disposed between said substance and the canister wall.

6. An oxygen generator according to claim 5, said substance being a perchlorate.

7. An oxygen generator according to claim 5, said substance being potassium perchlorate.

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