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Churchill et al.

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[45] **May 29, 1973**

[54] **OXYGEN GENERATOR CELL**

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[21] Appl. No.: **143,853**

[52] **U.S. Cl.** ....**23/281**, 23/252 R, 102/57, 128/191, 128/203, 222/3, 423/579

[51] **Int. Cl.** **B01j 7/00**

[58] **Field of Search**......................23/281, 284, 252; 102/57; 128/191, 203

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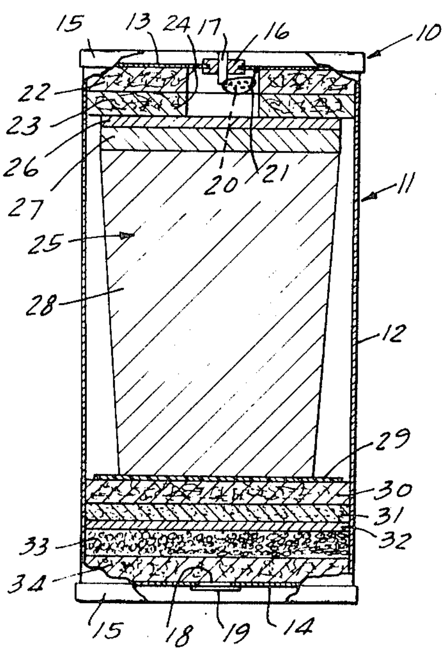
[57] **ABSTRACT**

Chemical oxygen generators in the form of disposable tin plated steel cans housing a chlorate candle, a starter, and filters where needed to remove contaminants and also serve as shock absorbing means. The cans have oxygen delivery outlets and starter actuators which can be at one end of the can or separated at both ends of the can. The preferred oxygen generating chemical is sodium chlorate, the decomposition of which is catalyzed by sodium peroxide.

14 Claims, 11 Drawing Figures



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SHEET 1 OF 3

Fig. 1

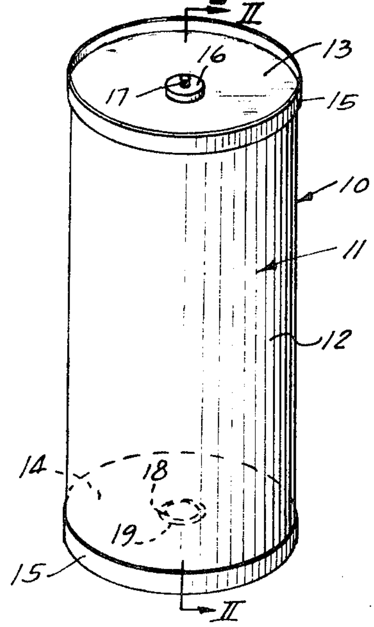

Fig. 4

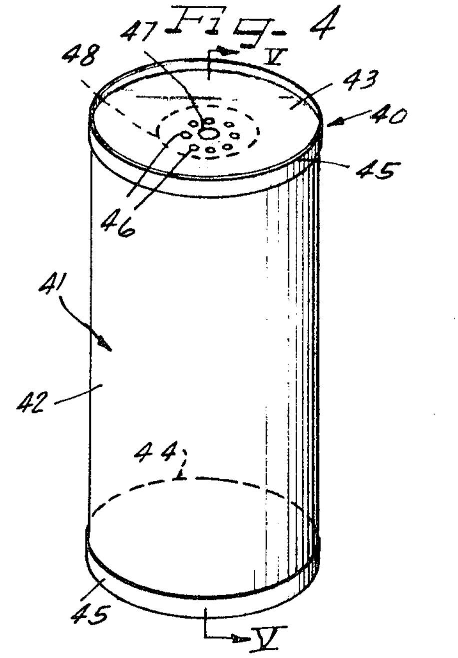

Fig. 2

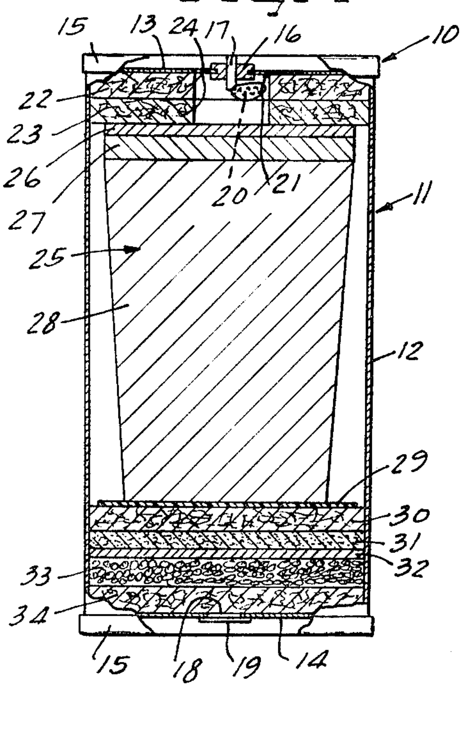

Fig. 3

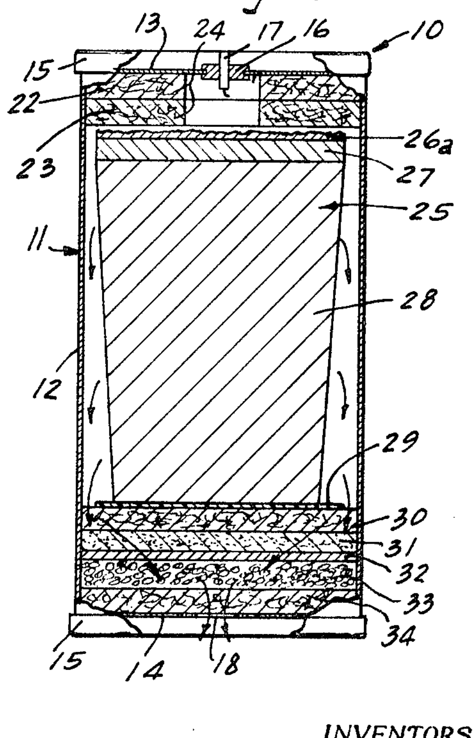

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Fig-5

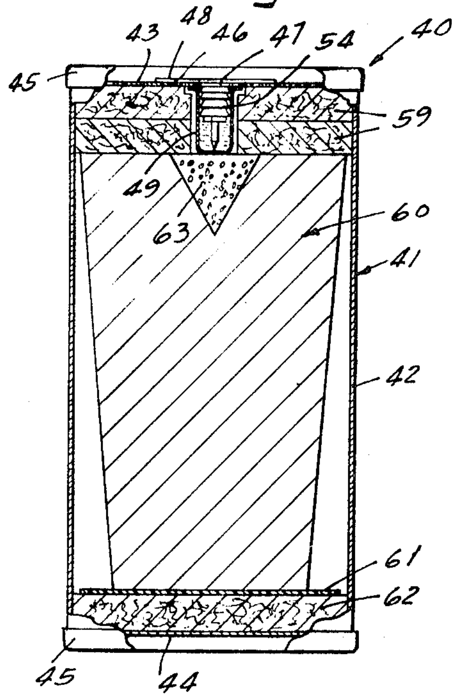

Fig-6

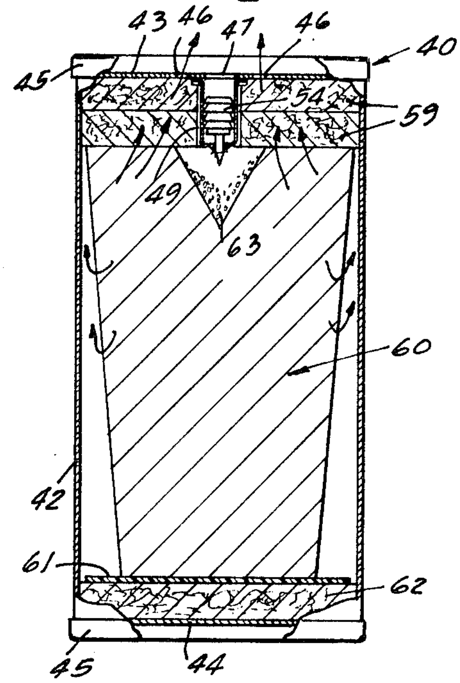

Fig-7

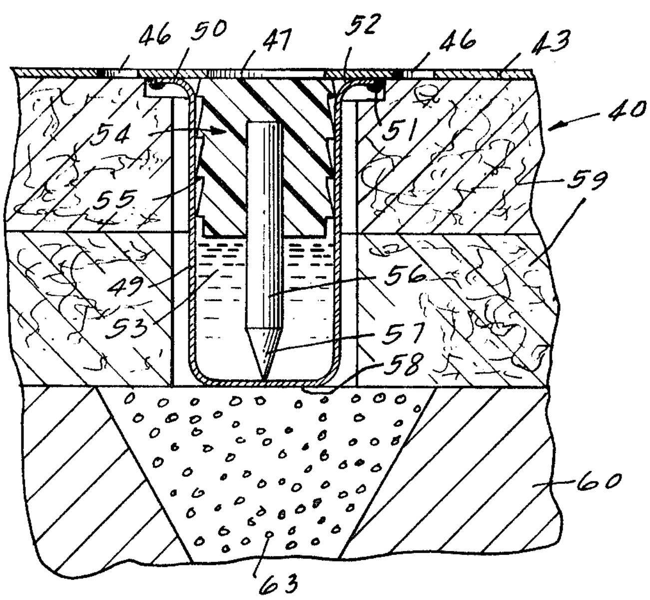

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Fig. 8

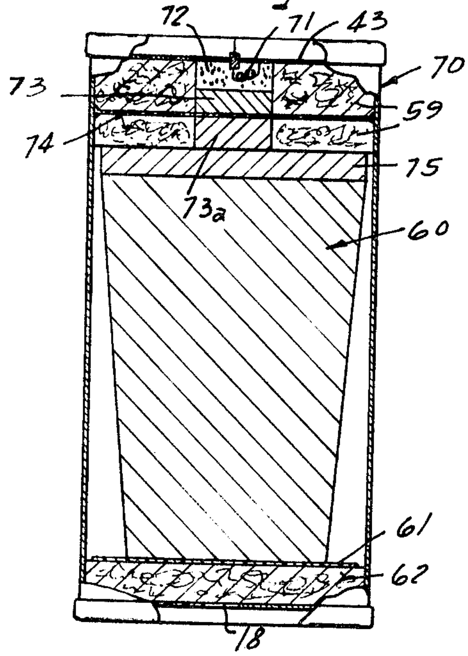


Fig. 10

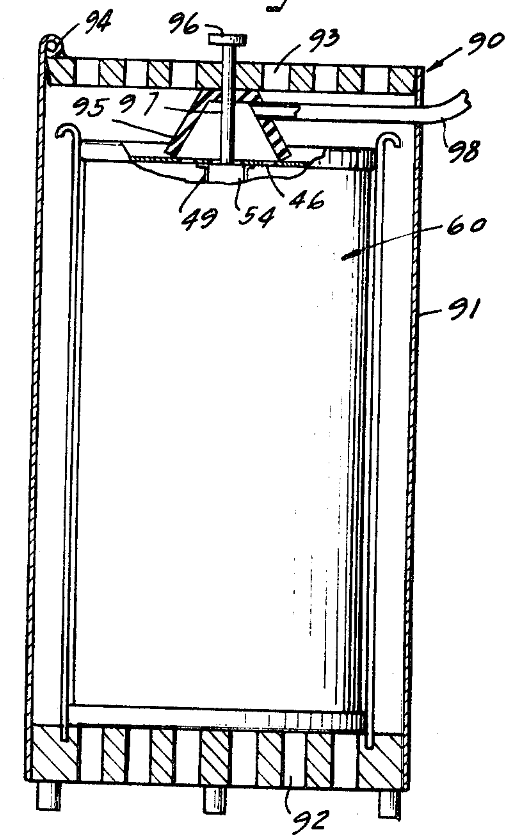


Fig. 9

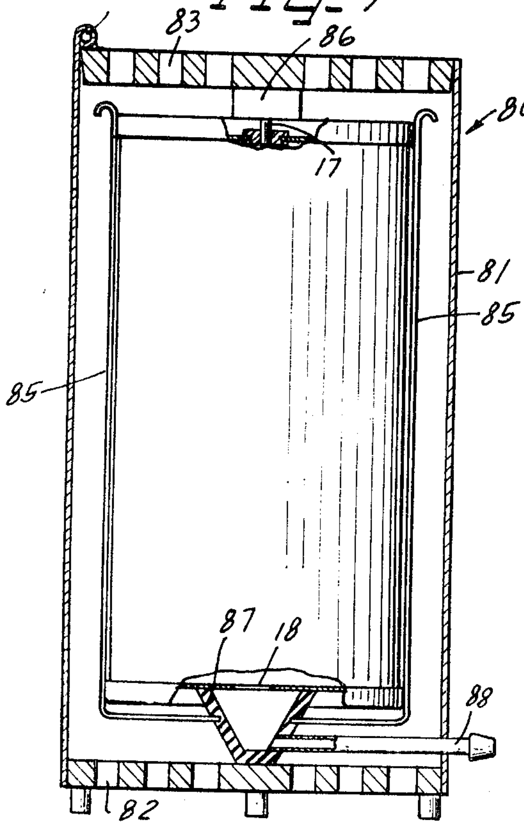
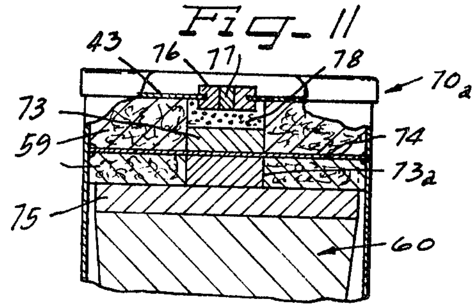


Fig. 11



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OXYGEN GENERATOR CELL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the art of chemical oxygen generators and is particularly concerned with the use of conventional thin-walled tin plated steel cans as housings for chlorate candle type oxygen generators having a formulation which will maintain a self sustaining low temperature reaction which will not damage the cans.

2. Description of the Prior Art

Chemical oxygen generators are known in the prior art as for example in the Geffroy et al. U.S. Pat. No. 2,775,511 dated Dec. 25, 1956; the Jackson et al. U.S. Pat. No. 2,558,756 dated July 3, 1951; and the Moni et al. U.S. Pat. No. 3,276,846 dated Oct. 4, 1966. These generators operate at high temperatures and are expensive and cumbersome. It is not economically feasible to discard them after use and they are not adapted for instantaneous use after a long shelf life.

SUMMARY OF THE INVENTION

The present invention now provides chemical oxygen generators in the form of sealed non-pressured disposable tin cans capable of being actuated to instantly generate oxygen suitable for breathing at a steady low pressure rate for a predetermined time period.

The preferred embodiments of this invention include conventional tin cans of standard sizes selected to deliver sufficient oxygen for breathing over a predetermined time period and housing a chlorate candle, an igniter for the candle, and an activator for the igniter. The activator may take the form of a nichrome wire heated to ignite a pyrotechnic mixture, a percussion cap or a chemical injected into the starter material. The chlorate candle preferably is tapered to provide a decreasing reaction area as the reaction progresses, thereby maintaining a steady delivery rate and the chlorate candle is preferably clamped between shock absorbing filters which are also effective to filter out contaminants.

In one preferred form of the invention, one end of the can has an insulated contact point extending therefrom connected to a nichrome bridge wire grounded in the can. When the contact point receives an electrical charge from a battery, the nichrome wire is heated to ignite a pyrotechnic starter for the chlorate candle.

In another preferred form of the invention, one end of the can has a metal thimble suspended therefrom partially filled with a starting chemical and slidably supporting a sealing piston from which depends a piercing point. When the piston is depressed in the thimble, the pin punctures the end wall of the thimble and the piston injects the chemical into starter material on the candle.

The oxygen generating cans of this invention have outlet orifices in an end thereof which are conveniently covered by an overlying seal in a dispensing unit to deliver the oxygen to a canula or breathing mask.

An important feature of the invention is the low cost of mass producing the oxygen generator cans of this invention and the long shelf life of the cans without loss of oxygen generating capacity or danger of exploding. The cans are easily sealed by pressure sensitive impervious tapes, will not freeze, and cannot be activated even at very high temperatures until properly triggered.

It is then an object of this invention to provide safe disposable chemical oxygen generator cans with self-contained starters.

Another object of this invention is to provide an oxygen generator cell capable of delivering oxygen suitable for breathing at a controlled steady rate and sufficiently inexpensive to be discarded after use.

A still further object of this invention is to provide a lightweight, convenient oxygen generating canister having a long safe shelf life, capable of being instantly triggered for use and inexpensive enough to be discarded after use.

A specific object of this invention is to provide an oxygen generator cell in the form of a conventional tin can having an easily sealed delivery orifice and an externally actuated starter.

Another object of the invention is to provide a chlorate candle oxygen generator housed in a conventional tin can and protected against shock by end filter pads.

A further specific object of this invention is to provide a chlorate candle of tapered configuration in a standard tin can having a delivery orifice at one end thereof and an igniter chemical initiating decomposition of the large end of the candle with the taper of the candle developing a diminishing reaction area to maintain a steady oxygen delivery rate as the reaction progresses at increasing temperatures.

Another specific object of this invention is to provide an oxygen generator cell easily dropped into a dispensing unit and activated to deliver medically pure oxygen to a canula or oxygen mask.

Other and further objects of this invention will be apparent to those skilled in this art from the following detailed description of the annexed sheets of drawings, which by way of preferred examples illustrate several embodiments of this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one form of oxygen generator cell of this invention;

FIG. 2 is a vertical cross-sectional view along the line II—II of FIG. 1;

FIG. 3 is a view similar to FIG. 2 but illustrating the condition of the cell after ignition and during oxygen generation;

FIG. 4 is a perspective view similar to FIG. 1 but illustrating another form of the cell of this invention;

FIG. 5 is a cross-sectional view taken along the line V—V of FIG. 4;

FIG. 6 is a view similar to FIG. 5 but illustrating the condition of the cell after ignition and during oxygen generation;

FIG. 7 is an enlarged fragmentary cross-sectional view of the thimble and plunger detail of the unit of FIGS. 4–6;

FIG. 8 is a vertical cross-sectional view similar to FIGS. 2 and 5 but illustrating another modification of the cell;

FIG. 9 is a somewhat diagrammatic sectional view with parts in elevation illustrating the manner in which the units of FIGS. 1–3 or 8 may be mounted in a dispensing apparatus for discharging oxygen to the inlet tube of an oxygen mask or the like;

FIG. 10 is a view similar to FIG. 9 but illustrating the manner in which the unit of FIGS. 4–7 may be mounted in the dispensing apparatus;

FIG. 11 is a fragmentary cross-sectional view of another form of igniter for the generator cells of this invention.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

The unit 10 of FIGS. 1 to 3 includes a tin-plated steel can 11 having a cylindrical body 12, a flat circular lid 13 and a flat circular bottom 14 sealed to the cylindrical body with the conventional rolled peripheral edges or rims 15. The can 11 may be of any convenient size to house a predetermined supply of oxygen generating chemicals. A preferred can size is 2 inches in diameter and 4 inches in length.

The lid 13 has a central aperture closed by an electrical insulator plug 16 having a contact pin 17 extending through the center thereof. The bottom 14 of the can has a circular central aperture 18 providing an outlet orifice. A sealing cover 19 composed of pressure sensitive impervious tape or label material is cemented over the orifice 18 and can be easily peeled from the bottom face of the end wall 14 to expose the orifice for use.

As shown in FIG. 2, the contact pin 17 has one end of a bridge wire 20 soldered thereto inside of the can, while the other end of the wire 20 is soldered to the inner face of the lid 13. This wire 20 is composed of electrical resistance material that will heat up when current is flowed therethrough. Nichrome wire is satisfactory.

A bead 21 composed of pyrotechnic chemicals is placed on the wire 20 to insure rapid ignition when the wire is heated. A mixture of zirconium, nickel and potassium perchlorate is useful and only a small amount need be used to provide an "electric match" causing ignition when current flows through the bridge wire 20.

A pair of ceramic mats 22 and 23 composed of fiberglass or the like inert felt-like material surround the "electric match" and have apertures 24 therethrough freely embracing the "electric match." The mats are somewhat resilient and have good heat insulation properties.

An oxygen generating pellet 25 underlies the mat 23 and has a generally inverted frusto-conical configuration. The pellet 25 has a top layer 26 of "first fire" material overlying a slower burning pyrotechnic material layer or "cone" 27 which in turn overlies the main chlorate candle body 28. The layer 26 is relatively thin and may be composed of a conventional first fire zirconium/barium chromate mixture containing about 21 percent zirconium by weight. Some of this same mixture 26 may fill or partially fill the apertures in the mats 22 and 23. The "first fire" mixture ignites the "cone" 27 which may have the following composition:

iron powder	20% by weight
$NaClO_3$	42% by weight
Na_2O_2	8% by weight
Fe_2O_3	14% by weight
Cu_2O	12% by weight
Super-floss (product of Johns-Manville, New York, N.Y.	4% by weight

The main chlorate candle body 28 is composed of an intimate mixture of sodium chlorate ($NaClO_3$) and a sodium oxide catalyst, preferably sodium peroxide, although sodium monoxide may be used in place of some of the peroxide since it will oxidize to the peroxide. The catalyst content is controlled to regulate the burning rate of the candle and may widely vary from 0.5 to 20 percent by weight. The entire pellet 25 is compressed into a solid self-sustaining inverted frusto-conical shape with the small end at the bottom to decrease the area of the burning front as temperature increases during the burning of the candle, thereby maintaining a steady oxygen generating rate.

The maximum temperature developed during the burning of the candle is well below any temperature that would weaken the can or cause a fire hazard. Heretofor chlorate candles contained added fuels such as iron, charcoal, magnesium and the like to maintain the reaction and commercial "tin cans" could not be used as housings because they would not withstand the reaction temperatures. Maximum operating temperatures of 400° F. or less are now provided.

The small end of the pellet 25 rests on a thin mica disk 29 loosely fitted in the can above the bottom wall 14 thereof and another ceramic mat 30 which underlies this mica disk and in turn overlies a layer of sodium peroxide 31 bottomed by a thin ceramic mat 32. A layer of odor absorbing pellets 33 underlies the layer 31. The pellets 33 can be "Purafil" (a product of Marbon Chemical Co., Washington, W. Va.). Another filter mat 34 underlies the pellets 33 and rests on the bottom 14 of the can covering the orifice 18. Glass wool is a suitable material for the filter mats.

From the above description, it will be understood that the oxygen generating pellet 25 is clamped between the ends of the can on resilient filter mats effective to protect the candle against shock and maintain it centered in spaced relation from both the top and bottom of the can.

As shown in FIG. 3, when the "electric match" is fired, the first fire layer 26 burns away leaving some ash 26*a* and ignites the cone 27 which burns rather slowly to maintain a reaction temperature for the sodium chlorate candle body 28. The candle will react downwardly, releasing oxygen to flow as indicated by the arrows around the mica disk 29 and through the stack of ceramic mats and filter layers to discharge out of the orifice 18. The seal cover 19 for the orifice 18 is, of course, removed.

It should be understood that the sodium chlorate/oxide candle yields pure oxygen and the filter material removes any contaminants that might initially be formed from the starting materials.

The oxygen generating unit 40 of FIGS. 4 to 6 is also housed in the same "tin can" type housing 41 as the unit 10. The housing 41 has a cylindrical main body 42 with a flat disk top 43 and an imperforate flat disk bottom 44. The conventional sealing rims or beads 45 connect the cylindrical body with the top and bottom.

A ring of small diameter holes 46 are formed through the lid 43 surrounding a central large diameter hole or opening 47 and a pressure sensitive sealing cover 48 is adhesively secured to the top of the lid 43 overlying the holes 46 and 47.

As shown in FIGS. 5 to 7, an open topped, closed bottom metal thimble 49 mates with the central hole 47 in the lid 43 and has an out-turned flange 50 soldered or brazed to the underface of the lid in sealed relation as at 51.

As shown in FIG. 7, the thimble 49 is of slightly larger diameter than the hole 47 so that the peripheral margin of the hole 47 will overlie the open top mouth 52 of the thimble. The cylindrical side wall of the thimble is of a desired length to house a sufficient amount of ignition inducing chemical 53 under a plunger or piston 54 slidable in the thimble and having sealing ribs 55 sealingly engaging the cylindrical wall of the thimble. A pin 56 with a pointed end is anchored in the piston 54 and depends therefrom with its point 57 resting on the relatively thin bottom 58 of the thimble. When the piston 54 is depressed in the thimble, the pin will puncture the thin bottom 58 and the piston head or plunger will eject the fluid 53 into the upper portion of the housing 41 releasing the chemical for its function in igniting the candle, as will be more fully hereinafter described.

As shown in FIGS. 5 and 6, the thimble 49 is surrounded by a pair of ceramic mats 59 composed of fiberglass, glass wool or the like and these mats in turn overlie the main pellet body 60 of the oxygen generating candle. This pellet 60, like the pellet 25 of the FIG. 1 to 3 embodiment, is of inverted frusto-conical shape with the small end thereof resting on a thin mica disk 61 which in turn overlies another ceramic mat 62 resting on the bottom 44 of the can.

The pellet itself has a central cone 63 of material that will react with fluid ejected from the thimble 49 to generate heat sufficient for igniting the main oxygen generating body 64 of the pellet.

The starting cone 63 is composed of a loose powder mixture of sodium iodate ($NaIO_3$), sodium monoxide (Na_2O) and barium perchlorate $Ba(ClO_4)_2$. The iodate constitutes about one-half of the mixture, the sodium oxide about 35% of the mixture, and the barium perchlorate the balance. This formulation may be varied using calcium perchlorate $Ca(ClO_4)_2$ in place of the barium and adding around 10 percent of zinc peroxide. In general, the cone 63 can be composed of from 10–85 percent by weight of an alkali metal or alkaline earth metal iodate from 10–70 percent of sodium monoxide, and from 10–70 percent of an auxiliary oxidizer such as calcium or barium perchlorate, zinc peroxide and the like.

The fluid 53 for igniting the cone 63 may be water, which will initiate an exothermic reaction of the iodate mixture developing sufficient heat to ignite the body material 64 of the chlorate candle pellet 60. From 10–20 grams of the iodate mixture are sufficient to ignite the candle body 64 and only about 0.1 cc of water is needed to activate the cone. A freezing depressant such as calcium chloride may be added to the water.

It will be noted that no chemical filtration is used in the water activated unit 40 since the chemical starting material does not produce contaminants.

The water activated unit 40 of FIGS. 4 to 6 may be modified as shown in FIG. 8 to provide for electric match ignition in place of water ignition. In FIG. 8, the unit 70 has the same components as the unit 40 and identical parts have been marked with the same reference numerals. The unit 70 like the unit 10 has a bottom outlet orifice 18. In place of the thimble 49, an electric match bridge wire arrangement 71 is provided similar to the electric match arrangement of FIGS. 1 to 3. The match is surrounded by a first fire mixture of zirconium and barium chromate 72. Plugs of iodate ignition mixtures 73 and 73*a* underlie the first fire material and are separated by a thin copper foil barrier 74. The iodate ignition cone 75 overlies the generator body 69. The copper foil barrier serves to prevent contaminants from the electric match and first fire material from entering the oxygen generating zone of the can 70. The first fire material and the plug of the iodate mixture overlying the copper foil will heat the foil sufficiently high to ignite the underlying iodate ignition cone 75.

In still another modification the unit 70 may be revised as in FIG. 11 where a unit 70*a* is partially shown as having a percussion cap igniter in place of the electric match type igniter. In FIG. 9 a heavy central brass washer 76 is spun into the center of the lid 43 and has a percussion cap 77 pressed into its aperture. This cap when struck by a pin will ignite the underlying first fire material 78 which may be first fire or the iodate plugs of the unit 70. The candle 60 underlying the ignition cone 75 will discharge oxygen through a bottom outlet 18 as in the unit 70.

As shown in FIG. 9, the unit 10 of FIGS. 1 to 3 may conveniently be dropped into an oxygen dispensing apparatus 80 which has an upright cylindrical side wall 81 with a perforate bottom 82 and a perforate lid 83 hinged to the body 81 at 84. The bottom 82 carries upwardly projecting wire guide fingers 85 into which the unit 10 may conveniently be dropped and held in position in spaced relation from the side wall 81 in the unit 80. The cover 83 carries an ignition contact member 86 engaging the contact point 17 of the unit when the lid is closed. The orifice 18 in the bottom of the unit 10 is surrounded by a rubber lip seal 87 discharging to an outlet tube 88 which may be connected with an oxygen mask or the like. When electric current is flowed through the contact point 86 to ignite the unit 10, oxygen will flow from the outlet 18 into the tube 88 with the can sealingly clamped against the resilient support 87 by the lid 83. Of course, the sealing cover 19 is previously removed from the orifice 18. The apparatus 80 of FIG. 9 will also accommodate the modified unit 70 of FIG. 8 and has a battery charged electrical circuit for energizing the contact point 86 to fire the electric match.

The apparatus 80 can be modified to accommodate the unit 70*a* by replacing the contact 86 with a percussion cap striking pin.

The apparatus 90 of FIG. 10 will accommodate the chemical actuated unit 40 of FIGS. 4–6 and it has a cylindrical side wall 91 with a perforate bottom 92 and a perforate hinged lid 93 connected to the top of the body 91 by a hinge 94. The lid 93 has a resilient lip seal 95 depending therefrom adapted to surround the orifices 46 in the top of the unit 60. A push-button 96 is carried by the lid 93 and has a depending pin 97 to engage the plunger 54 forcing its pin to puncture the thimble 49 and inject the chemical fluid into the ignition cone 63. The lip seal arrangement 95 discharges into the feed tube 98 of an oxygen mask or the like.

It will be understood that the receivers 80 and 90 of FIGS. 9 and 10 are illustrative only of the type of receiver or dispensing apparatus that can be used to dispense the gas from the units of this invention.

The oxygen generators of this invention operate at sufficiently low temperatures so that no fire hazards are involved and inexpensive "tin can" housings can be used. The oxygen producing candle is shock insulated on mats in the can and chemical filters or separators are provided in the can if the starting materials yield some gaseous contaminants or are eliminated if the starter materials do not contaminate the oxygen. Thus only pure oxygen is discharged.

We claim as our invention:

1. A gas generator cell which comprises a conventional tin-plated steel can having an outlet orifice in

one end thereof, a seal closing said orifice, a fuel free chlorate candle body composed of sodium chlorate and a sodium oxide catalyst effective to generate oxygen at temperatures well below those effective to weaken the can or cause a fire hazard, resilient mats clamping the candle body between the ends of the can in spaced relation from the can sidewall and providing an unfilled space between the candle body and sidewall, said candle body having a varying cross-sectional area along its length sized and shaped to maintain a steady oxygen generating rate as burning progresses along the length of the body, ignition material in one end of the can for igniting the candle, and means in the can activated from outside of the can to ignite the ignition material for initiating generation of oxygen by the candle to flow through said space between the candle and side wall of the can and through a resilient mat to the outlet oriface in the end of the can.

2. The cell of claim **1** wherein the means for igniting the ignition material is an electric match.

3. The cell of claim **1** wherein the ignition material for the candle is activated by water and the means for igniting the ignition material is a device for releasing water to the ignition material.

4. The cell of claim **1** wherein the means for igniting the ignition material is a percussion pellet in the can.

5. The cell of claim **1** wherein the orifice in an end of a can is a ring of spaced holes and the means for igniting the ignition material is surrounded by said ring of holes.

6. A disposable oxygen generating cell which comprises a conventional metal can having an outlet in an end thereof and a chlorate candle activator in an end thereof, a chlorate candle body clamped in the can between the ends thereof and spaced from the side of the can to provide therebetween a passage along the length of the candle body for flow of oxygen from the candle to the outlet, an ignition material cone at one end of the candle, means in the can activated from outside of the can to ignite the ignition cone for burning the candle to discharge oxygen through said passage to said outlet, and said candle body being sized and shaped to deliver oxygen at a steady rate as burning progresses through the length of the candle.

7. A disposable oxygen generating cell adapted to be dropped into a dispensing receiver for feeding oxygen to a tube which comprises a conventional tin plated steel can, a compressed fuel free sodium peroxide catalyzed chlorate candle pellet in the can releasing oxygen by catalytic decomposition at low temperatures, resilient filter mats overlying the ends of the pellet in the can clamping the pellet between the ends of the can in fixed relation to the can, water activated ignition material on one end of the pellet, a water filled container in said can in sealed adjacent relation to said ignition material, and means actuated from outside of said can for piercing said container to release water to said ignition material for activating the pellet to generate oxygen.

8. An oxygen generator cell which comprises a metal can having a top lid with a depending thimble, a plunger having peripheral ribs sealingly slidable in the thimble, a piercing needle depending from the plunger effective to pierce the bottom of the thimble when the plunger is depressed, said thimble and plunger adapted to confine fluid material therebetween to eject the fluid through the pierced end of the thimble into the can, an oxygen generating candle in the can having an ignition cone adapted to received said fluid from the pierced thimble, and discharge orifice means in the can for releasing oxygen generated by the candle.

9. The canister of claim **6** wherein the candle is clamped between resilient ceramic mats in the central portion of the can and held is spaced relation from the side wall of the can.

10. The canister of claim **6** wherein the material for igniting the candle is water initiated and the activator is a water filled container for releasing water to the material.

11. The canister of claim **6** wherein said outlet is covered by a removable seal.

12. The canister of claim **6** wherein both the outlet and the activator are in one end of the can.

13. The canister of claim **6** wherein the outlet and the activator are in opposite ends of the can.

14. An oxygen generator cell which comprises a metal can having a top lid with a depending thimble, a plunger slidable in the thimble, a piercing needle depending from the plunger effective to pierce the bottom of the thimble when the plunger is depressed, said thimble and plunger adapted to confine fluid material therebetween to eject the fluid material through the pierced end of the thimble into the can, an oxygen generating chlorate candle in the can, ignition material on one end of the candle adapted to be ignited by fluid received from the pierced thimble, and a ring of holes surrounding the thimble providing a discharge outlet for oxygen generated by the candle.

* * * * *