March 30, 1971 R. M. BOVARD 3,573,001

OXYGEN GENERATOR

Filed April 3, 1967 2 Sheets-Sheet 1

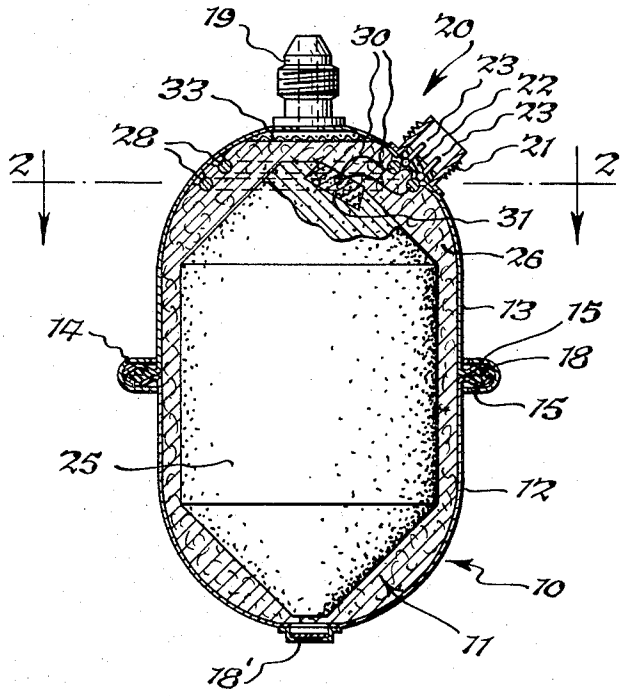


Fig. 1.

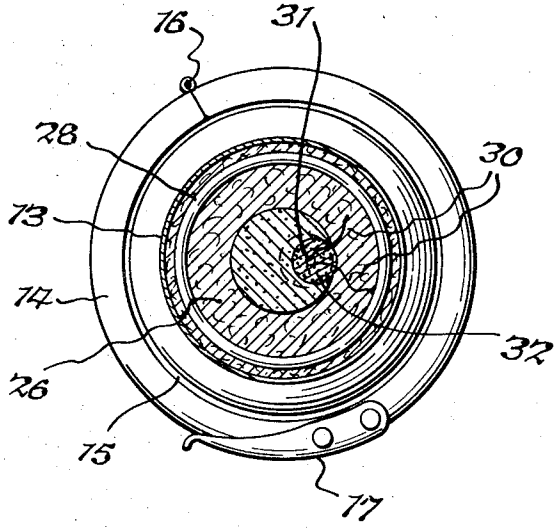


Fig. 2.

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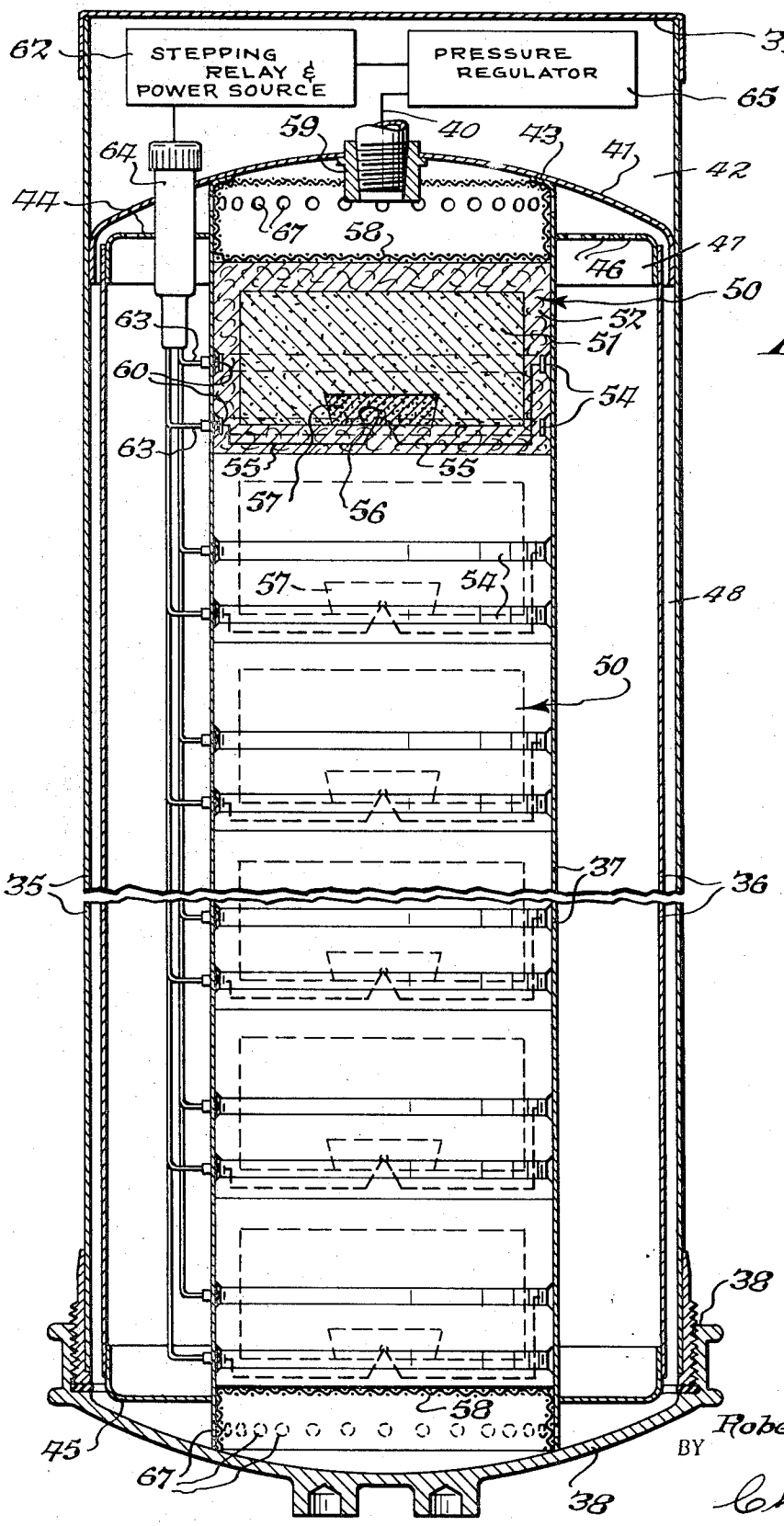


Fig. 3.

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OXYGEN GENERATOR

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U.S. Cl. 23—281 8 Claims

ABSTRACT OF THE DISCLOSURE

A solid state, oxygen evolving body is encased within a stable, shape-sustaining envelope serving as a filter, insulator and coolant for the body when the latter burns, the body and envelope forming a recharging candle unit for insertion and withdrawal from a canister. An electrical ignitor including contact rings mounted about the envelope and an ignition area imbedded within the candle in contact with the rings is carried by the recharging unit and an ignitor actuator having contacts is carried by the canister, the contacts and contact rings contacting one another in all angular positions of the rechargeable unit relative to the canister. In a modification, the rechargeable units are stacked in a sleeve having contacts spaced therealong and engaging the contacts of the individual units. A pressure regulator controls a stepping relay which sequentially ignites the units. A reservoir is provided around the sleeve. A cooling path for the evolved oxygen is provided between the reservoir and an outer casing.

BACKGROUND OF THE INVENTION

This invention relates to solid state, chemical, oxygen generators.

Oxygen evolving chlorate candles are known, and offer certain advantages over cylinders of oxygen under pressure. However, they burn with an intense heat and require an insulated canister. If the canister is not readily reusable when the candle is spent, the economics involved can become unfavorable.

SUMMARY OF THE INVENTION

A primary object of this invention is to provide an insulated oxygen candle capable of storage and handling as a self-contained unit.

Another object of this invention is to provide a rechargeable oxygen generator having one or more candle units.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a single candle rechargeable generator of the invention;

FIG. 2 is a cross sectional view thereof taken about on line 2—2 of FIG. 1; and

FIG. 3 is a longitudinal sectional view of a multiple candle rechargeable generator of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, there is shown a preferred form of a rechargeable single candle oxygen generator of the present invention comprising a generally cylindrical outer canister or container **10** and an oxygen generating unit **11**. Canister **10** is fabricated in the form of a pair of container half-sections **12** and **13** releasably joined together in opposed relation by a ring **14** which is generally U-shaped in cross section and which clamps about a pair of annular flanges **15** projecting radially outwardly from the respective open ends of container sections **12** and **13**. Clamping ring **14** comprises a pair of half-ring segments pivoted together at **16** and having an overcenter

toggle **17** (FIG. 2) releasably connecting their free ends, whereby canister sections **12** and **13** can be separated one from the other. The abutting faces of flanges **15** are annularly recessed and a suitable sealing ring **18** is located in the registering recesses to provide an air tight joint between container sections **12** and **13**.

Canister section **12** has a relief valve **18'** located at its closed end and canister section **13** carries an externally threaded outlet nipple **19** at its closed end adapting canister **10** for connection to a conduit, not shown, for transmiting the oxygen evolved from oxygen generating unit **11** to a user thereof. An electrical connection **20** is provided for igniting unit **11** and comprises a nipple **21** suitably secured on the closed end of canister section **13** adjacent but axially spaced from outlet **19**. A disk **22** of electrical insulating material is secured within the base of nipple **21** over an opening through canister section **13**. A pair of electrically conductive prongs **23** extend through disk **22** with their inner ends projecting slightly beyond the inner face of canister section **13** and their outer ends projecting within nipple **21**, the latter being adapted to receive an electrical connector, not shown.

Oxygen generating unit **11** comprises an inner body **25** capable of evolving oxygen upon burning. Composition **25** consists of a consolidated body having uniformly distributed therethrough an alkali metal chlorate or perchlorate which generates oxygen upon combustion, a finely divided oxidizable material such as iron powder or carbon for burning and supplying part of the heat needed for combustion, a binder such as inorganic glass fibers or steel wool for holding the mass together and aiding in the even decomposition of the chlorate or perchlorate, and barium peroxide or like chlorine fixes for chemically eliminating traces of chlorine gas released during thermal breakdown of the chlorate or perchlorate. Such oxygen candle compositions are known and form no part of the present invention per se. In the illustrated form, composition **25** is press-molded or cast to form a cylinder having truncated cones projecting from the opposite ends thereof.

Candle body **25** is encased within a heat insulating envelope **26** of filter medium, and it is a particular feature of my invention that body **25** and envelope **26** comprise a self-contained candle unit which can be handled and stored as such. Envelope **26** can be formed, for example, of fiber glass impregnated with a silicate or other hardening agent in an amount sufficient to make the envelope shape sustaining in the desired form which, in the illustrated embodiment, generally corresponds to the interior dimensions of canister **10**. Candle unit **11** thereby has a releasably snug fit within canister **10**. A pair of axially spaced conductor rings **28**, preferably formed of copper, are imbedded about an end portion of filter-insulator housing **26** with their outer exposed peripheries lying substantially flush with the surface of material **26**. Rings **28** are axially spaced from the end of unit **11** so that they register with and engage prongs **23** when unit **11** is fully inserted within canister section **12** as shown in FIG. 1. A pair of leads **30** are connected to rings **28** and pass inwardly through the filter and insulator envelope **26** to terminate in a resistance or heating element **31** imbedded within an ignition area **32** formed in one of the truncated cone-shaped ends of body **25**. Ignition area **32** comprises the foregoing composition enriched with a metal powder, such as iron, to provide a concentrated area of intense heat when ignited by heating element **31**. A filter screen **33** is secured about canister section **12** directly adjacent outlet **19**.

When a current source is applied across prongs **23**, a circuit including rings **28** and leads **30** is energized to heat resistance element **31** and thereby ignite the enriched composition in ignition area **32**. The intense heat thus

generated ignites composition 25 whereby oxygen is generated and flows through filter-insulator shell 26 and screen 33 and out through outlet 19. Envelope 26 filters the liberated oxygen, and insulates canister 10 from the heat of combustion.

When body 25 is completely burned or spent, clamp ring 14 is released and canister sections 12 and 13 separated. The spent candle unit 11 is withdrawn from either of the canister sections, as the case may be, and a fresh unit 11 is inserted with the end thereof mounting the exposed conductor rings 28 applied within canister section 13 so that rings 28 register against the inner ends of prongs 23. Thus canister 10 can be re-used many times over merely by withdrawing a spent unit 11 and replacing the same with a fresh unit 11, the snug fit and registry of the latter within canister 10 being assured by the shape sustaining nature of the filter-insulator 26 of the recharging units. Significantly, the cylindrically shaped recharging units 11 can be inserted in canister 10 without regard to the relative angular positions of either the units 11 or canister 10 since rings 28 will always bear against the inner ends of prongs 23 for all angular positions of the one relative to the other. While an electrical ignitor is shown, the candle unit 11 can be ignited by other means known in the art.

Other suitable materials, such as the high temperature silica insulation sold by the Carborundum Company under the name "fibre-fax" can be used for envelope 26, the important factor being physical stability and the ability of the envelope to retain its shape independently of the canister. Also, envelope 26 can contain an endothermic material, such as potassium chlorate, which reacts to the heat of combustion and cools the oxygen liberated upon burning body 25. Such cooling agent also evolves oxygen, and can be incorporated in or on the envelope.

Referring to FIG. 3 there is shown a multiple candle rechargeable solid state chemical oxygen generator comprising an elongated outer cylindrical housing 35, an intermediate cylindrical casing 36 and an inner cylindrical sleeve 37. Housing 35 has a base plate 38 threaded on its lower end, a cap 39 closing its upper end, and an intermediate plate 41 axially spaced from cap 39 and forming therewith a chamber 42, the upper end of sleeve 37 being suitably secured to plate 41 at 43. Intermediate casing 36 is substantially coextensive with sleeve 37 and has annular end plates 44 and 45 mounting the same concentrically about sleeve 37. Upper end plate 44 has a plurality of axial openings 46. Lower end plate 45 is closed.

Inner sleeve 37 contains a plurality of cylindrical oxygen generating units 50 stacked one on top of another. While a total of six such units are shown, either a greater or a lesser number can be utilized. Each unit 50 is self-contained, in the manner of unit 11 in FIG. 1, and comprises a consolidated inner body of oxygen evolving composition indicated at 51 which can be identical to composition 25 of FIGS. 1 and 2 and which is press-molded or cast to form a cylindrical disk or charge. Composition 51 is encased within a heat insulating envelope 52 of filter material such as fiber glass impregnated with a silicate or other hardening agent to impart stability to the envelope and make the same shape-sustaining in the substantially cylindrical form shown. Envelope 52 is like envelope 26 of FIG. 1, and provides a snug fit slidable within sleeve 37. Each oxygen evolving unit 50 has a pair of axially spaced electrically conductive rings 54, preferably formed of copper, imbedded about its periphery with the outer exposed surfaces thereof slightly recessed from the cylindrical surface of unit 50. A pair of leads 55 extend through filter-insulator 52 to connect rings 54 with a resistance-heating element 56, the latter being located in a central, truncated cone-shaped, ignition area 57 of reduced diameter imbedded in the lower face of cylindrical oxygen evolving body 51. Ignition area 57 comprises a composition like that of body 52 and enriched with metal powder, such as iron, to provide a concentrated area of intense heat adjacent composition 52 when ignited by heating element 56.

A pair of rigid, cup-shaped screen elements 58 are located at the upper and lower ends of sleeve 37, their respective faces bearing against the upper and lowermost units 50 and their ends engaging plates 41 and 38. Units 50 are thus clamped between screen elements 58 by base plate 38 whereby units 50 are spaced a predetermined distance from plate 41. Screens 58 also serve to filter the evolved oxygen prior to its passage through conduit 40 in an outlet 59 formed through plate 41. A plurality of paired axially spaced contacts 60 are spaced along sleeve 37 and project slightly inwardly thereof to bear against and make electrical contact with rings 54, the axial spacing of the individual pairs of contacts 60 and the axial spacing between adjacent pairs of contacts 60 being such as to correspond with the axial spacing of the rings 54 on each unit 50 and the axial spacing between adjacent pairs of rings 54 on stacked units 50 respectively whereby paired rings 54 of each unit 50 register with corresponding paired contacts 60.

A control circuit for sequentially igniting oxygen candle units 50 is provided and comprises a stepping relay and power source 62, paired contacts 60 being connected to stepping relay via paired leads 63 and a plug 64. A pressure regulator 65 located in chamber 42 and communicating with outlet conduit 40 is arranged in controlling relation to stepping relay 62, both pressure regulator 65 and stepping relay 62 and the controlling arrangement of the former relative to the latter being conventional and per se no part of my invention. Suffice it to say that pressure regulator 65 indexes the stepping relay 62 to provide current through successive paired leads 63 in response to the successive sensing of outlet pressures below a predetermined pressure, whereby oxygen evolving units 50 are sequentially ignited as needed.

In use, the power source is activated by a suitable switch, not shown, and energizes a circuit through the lowermost pair of leads 63, their associated contacts 60, the rings 54 of the lowermost oxygen candle unit 50, and leads 55 thereof to heat resistance element 56 and thereby ignite ignition area 57, which, in turn, ignites oxygen evolving composition 51. Note that both ends of sleeve 37 have a plurality of lateral openings 67 and are in open communication with one another through an annular passage 48 between casing 36 and housing 35. The oxygen thus generated passes outwardly through filter-insulator envelope 52 and passes downwardly through sleeve 37, outwardly through openings 67 at the lower end of sleeve 37 and into openings 67 at the upper end of sleeve 37 via passage 48 to outlet 59. Excess oxygen flows through openings 46 in the storage reservoir 47 provided between sleeve 37 and inner casing 36. Casing 36 not only defines reservoir 47, but also defines a path for the evolved oxygen along the inner wall of outer casing 35, thereby cooling the evolved oxygen as it passes to outlet 40.

In the event that the pressure of the evolved oxygen drops below a predetermined pressure, pressure regulator 65 indexes stepping relay 62 to complete an energizing circuit to the heating element 56 of the next adjacent oxygen evolving unit 50 via its corresponding paired leads 63, contacts 60, rings 54 and leads 55. Element 56 of this next adjacent unit 50 ignites its associated ignition area 57 and oxygen evolving composition 51 whereby the oxygen generated therefrom passes axially through its associated filter 52 and through the filter 52 of the spent unit or units via passage 48 to outlet 59 and into reservoir 47 as before.

In like manner, additional units 50 are sequentially ignited as needed. If additional oxygen is not needed, ignition is stopped either manually or automatically and unburned candle units 50 remain available for subsequent use.

Insulating envelopes **52** insulate reservoir **47** from the heat of combustion. They also insulate adjacent candle units from each other. As noted in connection with envelope **26** of FIG. 1, they can contain an endothermic material, such as potassium chlorate, for cooling the evolved oxygen.

Significantly, when candle units **50** are burned or spent, the oxygen generator can be recharged with fresh units **50**. By unthreading base plate **38** from the lower end of housing **35**, the spent units **50** as well as both screen elements **58** can be withdrawn by sliding the same outwardly through the lower end of sleeve **37**. Fresh recharging units **50** and filter screen **58** can be inserted through the lower end of sleeve **37** to form the stacked configuration substantially as shown, the recharging units being inserted with their ignition areas **57** facing the open end of sleeve **37**. When the proper number of units are inserted and base plate **38** is threaded on the end of housing **35** to clamp screens **58** and units **50** between plates **38** and **41**, it is seen that paired rings **54** of the inserted units **50** will register with the associated paired contacts **60**. As in the previous form, the cylindrically shaped recharging units **50** can be inserted within sleeve **37** without regard to the relative angular positions of either units **50** or sleeve **37** since rings **54** will always bear against contacts **60**. It is a simple matter to replace one or more of the units **50**, as required.

Thus, it is seen that my invention fully accomplishes its intended objects. While I have described two embodiments in detail, that has been done by way of illustration only, it being intended that the scope of my invention be defined by the appended claims.

What I claim as new is:

1. A rechargeable oxygen generator comprising a canister formed of a pair of cup-shaped sections assembled in opposed relation and having annular flanges projecting outwardly from the respective open ends of said sections, clamping ring means for securing said flanges together to hold said canister sections in assembled relation, means releasably connecting said ring means in clamping engagement with said flanges, an oxygen outlet from said canister, a body of combustible material capable of evolving oxygen disposed in said canister, an envelope of heat insulating filter material surrounding said body, said envelope and said body comprising a shape sustaining candle unit insertable in and removable from said canister sections upon disassembly of said sections, whereby said generator can be recharged by replacing a used candle unit with an unused one, said candle unit having a shape corresponding to the interior dimensions of said canister for releasable sug-fitting engagement therein; ignitor means

carried by said unit, and ignitor actuator means carried by one of said casing sections, said actuator means having operative connection with said ignitor means upon assembly of said body envelope unit in said one casing section regardless of the relative angular orientation thereof.

2. An oxygen generator as set forth in claim **1**, wherein said envelope completely encloses said body.

3. An oxygen candle as set forth in claim **1**, wherein said envelope is impregnated with a substance which undergoes an endothermic reaction to combustion of said body for cooling the evolved oxygen.

4. A candle as set forth in claim **3**, wherein said last-named substance also evolves oxygen during said endothermic reaction.

5. A rechargeable oxygen generator comprising an elongated canister, at least two discrete candle units disposed in series relation within said canister, each of said units comprising a body of combustible material capable of evolving oxygen and a heat insulating envelope completely enclosing said body, said envelope and said body having sufficient integrity to comprise units capable of independent handling and storage, said units being separately insertable in and removable from said canister for replacing spent units with fresh ones, and separate means for independently igniting said units.

6. A generator as set forth in claim **5**, wherein said canister is enclosed within a housing defining an oxygen storage reservoir around said canister.

7. A generator as set forth in claim **6**, wherein said separate ignition means comprise pressure responsive switching means for sequentially igniting said units.

8. A generator as set forth in claim **6**, wherein said reservoir defining housing is enclosed within an outer casing spaced therefrom, said housing and said casing defining a passage for the evolved oxygen.

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U.S. Cl. X.R.

23—221; 102—39, 46, 70.2; 220—55, 3; 252—186