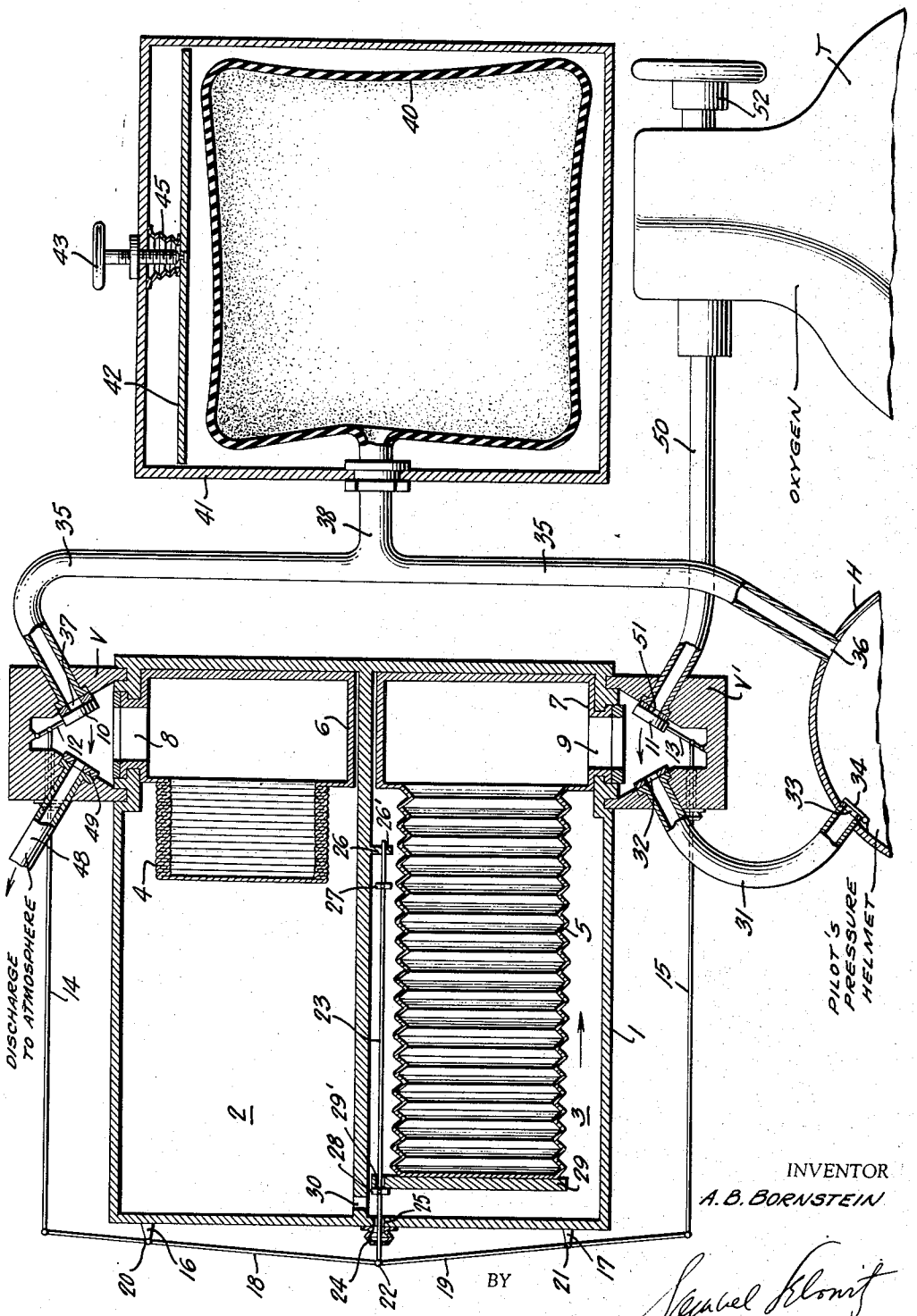
June 21, 1955 A. B. BORNSTEIN 2,711,170

OXYGEN BREATHING APPARATUS

Filed March 18, 1954



United States Patent Office

2,711,170

Patented June 21, 1955

2,711,170

OXYGEN BREATHING APPARATUS

Alfred B. Bornstein, Silver Spring, Md.

Application March 18, 1954, Serial No. 417,137

8 Claims. (Cl. 128—203)

This invention relates to an oxygen breathing apparatus and more particularly to a respiratory device which is designed to be used by a person to obtain an adequate supply of oxygen at all altitudes at substantially constant pressure and constant volume, with a substantially constant proportion of oxygen to inert gases.

It is the object of the present invention to provide a rugged apparatus of simple construction which may be used at high altitudes as well as at sea level for the purpose of furnishing a person with a sufficient amount of life-sustaining oxygen without waste thereof.

It is a further object of the invention to provide an automatically operating respiratory apparatus which is controlled by the breathing cycle of a person, and which automatically provides a measured minor proportion of oxygen at each breath inhalation in conjunction with a major proportion of previously exhaled breath, part of the latter of which is eliminated from the apparatus to accommodate the necessary addition of fresh oxygen.

It is another object of the invention to provide for the adjustment of the lung capacity of different users, and to vary, within suitable limits, the proportion of the fresh oxygen supply in each breathing cycle.

The invention proceeds upon the principle of feeding only a minor proportion of oxygen to the person in each breathing cycle in order to economize on the supply of oxygen as well as to better simulate normal breathing conditions of air which contains only a minor proportion of oxygen. Thus, the invention contemplates a breathing appliance which may fit only over the head of the user or which may form part of a pressurized suit enclosing the entire body of the person if use is made of the breathing apparatus at such altitudes where the protection of the body against swelling is necessary. The breathing appliance is connected to a storage chamber for the exhaled breath having a capacity for limited adjustment. The breathing appliance is also connected to a double-celled container having a pair of expansible and collapsible chambers therein in the form of bellows devices, one of which communicates with a fresh oxygen supply as well as with the breathing appliance, while the other one communicates with the storage chamber for the exhaled breath and with a vent to the exterior atmosphere. Valve mechanisms are associated with the conduits and the collapsible chambers and are operated automatically in accordance with the breathing cycle of the user so that at each inhalation of breath the user breathes in approximately one-fifth of a breath of oxygen in conjunction with approximately four-fifths of a previously exhaled breath, while during exhalation approximately four-fifths of the breath is stored for re-use while one-fifth passes to one of the collapsible chambers for discharge to the atmosphere in the course of the following exhalation cycle.

The collapsible chambers operate automatically to perform their measuring, admission and exhaust operations in response to the suction and pressure of the

breathing cycle of the user and the pressure of the oxygen supply.

Other objects and purposes will appear from the detailed description of the invention following hereinafter taken in conjunction with the drawing, wherein is shown a layout of the apparatus with certain parts in section.

In the drawing is shown a breathing appliance H which may assume the form of a helmet adapted to be worn over the head of the user or which may form part of a pressurized suit completely enclosing the wearer, if the use of this apparatus is designed for extremely high altitudes where such pressurized suits are required.

A double-celled container 1, formed of any suitable material such as metal, plastic or wood, is divided into two compartments 2 and 3 with a pressure equalization port 30 therebetween. A collapsible bellows chamber 4, extending from a casing 6, for receiving and measuring a minor proportion of the exhaled breath, is contained within the compartment 2. The second collapsible bellows chamber 5, extending from a casing 7, is disposed in compartment 3. The casing 6 is provided with mouth 8, and casing 7 is provided with mouth 9, which open into the valve housings V and V', respectively.

The pressurized helmet is provided with an oxygen breathing conduit 31 which extends from its terminal 32 in the valve housing V' to its terminal 33 in the helmet whereat it is closed by a one-way spring-biased flap valve 34. A breath conduit 35 also extends from the end 36 in the breathing helmet to a terminal 37 in the valve housing V and is provided with the branch 38 leading to the exhaled breath storage chamber 40, as described in greater detail below. A conduit 48, having an end 49 disposed in valve housing V, discharges to atmosphere, as shown in the drawing. An oxygen supply tank T, operating at constant pressure independent of the altitude at which it is used, is connected by means of conduit 50 to the valve housing V' at outlet 51. The supply of oxygen and the regulated pressure thereof may be controlled by valve 52 on the oxygen supply tank T.

A flap valve 10 is pivotally mounted in the valve housing V and is adapted to alternately cover the end 37 from the breath conduit 35 or the end 49 of the conduit 48 which communicates with the atmosphere. Likewise, a flap valve 11 is pivotally mounted in valve housing V' and is adapted to alternately close off the end 51 of the oxygen conduit 50 or the end 32 of the oxygen breathing conduit 31 leading to the helmet.

A system of lever interconnections and linkages is provided to operate valves 10 and 11 conjointly and automatically in accordance with the breathing cycle. This system comprises a longitudinally extending lever 14 pivotally connected to an intermediate point of lever 12 supporting flap valve 10, and lever 14 is in turn pivotally connected to one end of lever 18 which is supported for pivotal mounting at an intermediate point 20 thereof on post 16 provided on the external wall of the container 1. The opposite end of the lever 18 is pivoted at 22 to lever 23 which is disposed within compartment 3 of the container and extends longitudinally thereof for a limited amount of travel in opening 26' of guide lug 26 and through the opening 25 in the end wall of the container. The opening 25 in the end of the container is sealed from the exterior by a suitable sealing member 24, which permits the movement of lever 23.

In a manner similar to that described above, lever 15 is pivotally connected to lever 13 which supports the flap valve 11 in valve housing V'. Lever 15 is also connected to one end of lever 19, the opposite end of which is connected to lever 23 at point 22. The lever 19 is mounted for pivotal movement on post 17 at pivot point 21.

The member 29 is mounted on the end wall of the

bellows 5 and is provided with an opening 29' to permit member 29 to ride along longitudinally extending lever 23 as the bellows 5 executes its collapsing and expanding movements. The lever 23 is provided with stops or abutments 27 and 28 at displaced points therealong, which are actuated by member 29 near the end of the strokes of this member in opposite directions. Thus, when the bellows 5 is actuated in the direction of the arrow, that is, when the bellows is collapsed in response to the inhalation of breath by the user, member 29 strikes member 27 and moves rod 23 therewith, which in turn carries pivot 22 to the right to cause the valves 10 and 12 to assume positions indicated by the arrows conversely from that shown in the drawing. Upon the reverse expanding movement of the bellows 5, the end member 29 strikes the abutment 28 to move it into the position shown in the drawing, which causes the lever 23 to move to the left and thereby to actuate the flap valves 10 and 11 into the positions occupied by these valves as shown in the drawing.

As described above, the exhaled breath conduit 35 is provided with a branch pipe 38 which communicates with a flexible storage chamber 40 housed in casing 41. This storage chamber may be formed of any suitable flexible material and has the volumetric capacity of a major proportion of a breath, or more specifically, approximately 80% thereof. The casing 41 is provided with an adjustable wall 42 for the purpose of varying the volumetric capacity of the storage chamber 40 in its fully expanded state. This adjustment is made by means of a threaded bolt 43 which is effective to move the wall 42 either inwardly, to reduce the capacity of the storage chamber 40, or outwardly, to expand the capacity of this storage chamber 40. A bellows seal 45 surrounds the adjusting bolt 43 in all of its positions.

The conduits 31, 35 and 50 may be of flexible hose and preferably the capacity of the bellows 4 and 5 approximates one-fifth of a breath while the exhaled breath storage chamber 40 has a capacity of approximately four-fifths of a breath. It is understood that these specific percentages may be varied by adjusting the volumetric capacities in accordance with specific needs.

The apparatus specifically described above operates in the following manner:

In the position of the parts shown in the drawing, which represents the start of the inhalation of a breath, the bellows chamber 5 is in its fully expanded position and contains an amount of oxygen equivalent to approximately one-fifth of a breath. The oxygen supply from the tank T is cut off by the closure of opening 51 by the valve 11. Valve 10 in valve housing V closes the opening 37 leading from the breath storage chamber 40, which permits the exhaled breath content in bellows 4 to vent through opening 49 in discharge conduit 48. Upon inhalation, the suction exercised by the user opens flap valve 34 to admit the oxygen contained within the bellows 5 as the same collapses. At the same time 80% of the previously exhaled breath passes from storage chamber 40 through conduits 38 and 35 through opening 36 in the helmet for mixture with the 20% of oxygen to provide a comfortable and adequately life-sustaining breath.

Near the close of the inhalation cycle, member 29 of the bellows 5 strikes abutment 27 to move lever 23 to the right, which rocks the valves 10 and 11 into their converse positions. When this takes place, valve 10 closes opening 49 to enforce the exhalation of breath to storage chamber 40 and to bellows 4 in approximately the division of their respective volumetric capacities. Thereafter the bellows 4 expands to accommodate approximately 20% of a breath, while storage chamber 40 accommodates the remainder of the breath. In valve housing V', the closure of opening 32 by valve 11 prevents the user from drawing oxygen directly from the oxygen tank T and enforces the supply of oxygen to the interior of the bellows 5 which expands to its position shown in the drawing. Near the conclusion of the expansion movement of bellows 5, member 29 strikes abutment 28 to throw the valves 10 and 11 back to the position shown in the drawing in preparation for the next inhalation cycle.

The operation of the valves is executed automatically by the reciprocating movements of the bellows 5 which is in turn controlled by the breathing cycles of the user.

The component parts of the system are rugged and simple in construction and are not subject to failure or faulty operation.

While I have described my invention as embodied in a specific form and as operating in a specific manner for purpose of illustration, it should be understood that I do not limit my invention thereto, since various modifications will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

I claim:

1. A respiratory apparatus utilizing oxygen while rebreathing a portion of previously exhaled air which comprises a breathing appliance applied to the head of the breather, a pair of collapsible chambers each having in its expanded state a capacity of a minor proportion of the volumetric capacity of a single breath, a storage chamber having the volumetric capacity of the major proportion of the volumetric capacity of a single breath, a breathing conduit extending from said breathing appliance to said storage chamber and to one of said collapsible chambers, a vent to atmosphere connected to said last-mentioned collapsible chamber, valve means alternately closing communication from said last-mentioned collapsible chamber to said breathing conduit and to said vent, an oxygen supply conduit connected to the other one of said collapsible chambers, an oxygen breathing conduit extending from the latter to said breathing appliance, second valve means alternately closing communication from said last-mentioned collapsible chamber to said oxygen supply conduit and to said oxygen breathing conduit, and interconnections between said valve means for venting said first-mentioned collapsible chamber to atmosphere and cutting off communication between said second collapsible chamber and the oxygen supply conduit during inhalation of breath, and conversely operating said valve means during exhalation of breath.

2. A respiratory apparatus utilizing oxygen while rebreathing a portion of previously exhaled air which comprises a breathing appliance applied at least to the head of the breather, a pair of collapsible bellows chambers each having in its expanded state a capacity of approximately twenty percent of the volumetric capacity of a single breath, a storage chamber having the volumetric capacity of approximately eighty percent of the volumetric capacity of a single breath, a breathing conduit extending from said breathing appliance to said storage chamber and to one of said collapsible bellows chambers, a vent to atmosphere connected to said last-mentioned collapsible bellows chamber, valve means alternately closing communication from said last-mentioned collapsible bellows chamber to said breathing conduit and to said vent, an oxygen supply conduit connected to the other one of said collapsible bellows chambers, an oxygen breathing conduit extending from the latter to said breathing appliance, second valve means alternately closing communication from said last-mentioned collapsible bellows chamber to said oxygen supply conduit and oxygen breathing conduit, and interconnections between said valve means for venting said first-mentioned collapsible bellows chamber to atmosphere, and cutting off communication between said second collapsible bellows chamber and the oxygen supply conduit during inhalation of breath, and conversely operating said valve means during exhalation of breath.

3. An apparatus as set forth in claim 2 wherein a housing is provided for said bellows chambers with a

partition therebetween, said partition having an opening therein to equalize the pressure on the outside of said bellows chambers.

4. An apparatus as set forth in claim 2 wherein said storage chamber is formed of expansible material, a confining casing therefor, and an adjustable wall in said casing for varying the volumetric capacity of said storage chamber in its expanded state.

5. A respiratory apparatus utilizing oxygen while rebreathing a portion of previously exhaled air which comprises a breathing appliance applied to the head of the breather, a pair of collapsible chambers each having in its expanded state a capacity of a minor proportion of the volumetric capacity of a single breath, a storage chamber having the volumetric capacity of the major proportion of the volumetric capacity of a single breath, a breathing conduit extending from said breathing appliance to said storage chamber and to one of said collapsible chambers, a vent to atmosphere connected to said last-mentioned collapsible chamber, valve means alternately closing communication from said last-mentioned collapsible chamber to said breathing conduit and to said vent, an oxygen supply conduit connected to the other one of said collapsible chambers, an oxygen breathing conduit extending from the latter to said breathing appliance, second valve means alternately closing communication from said last-mentioned collapsible chamber to said oxygen supply conduit and to said oxygen breathing conduit, lever interconnections between said valve means for venting said first-mentioned collapsible chamber to atmosphere and cutting off communication between said second collapsible chamber and the oxygen supply conduit during inhalation of breath, and conversely operating said valve means during exhalation of breath, and means for operating said lever interconnections by the alternating expanding and contracting movements of one of said collapsible chambers.

6. A respiratory apparatus utilizing oxygen while rebreathing a portion of previously exhaled air which comprises a breathing appliance applied at least to the head of the breather, a pair of collapsible bellows chambers each having in its expanded state a capacity of approximately twenty percent of the volumetric capacity of a

single breath, a storage chamber having the volumetric capacity of approximately eighty percent of the volumetric capacity of a single breath, a breathing conduit extending from said breathing appliance to said storage chamber and to one of said collapsible bellows chambers, a vent to atmosphere connected to said last-mentioned collapsible bellows chamber, valve means alternately closing communication from said last-mentioned collapsible bellows chamber to said breathing conduit and to said vent, an oxygen supply conduit connected to the other one of said collapsible bellows chambers, an oxygen breathing conduit extending from the latter to said breathing appliance, second valve means alternately closing communication from said last-mentioned collapsible bellows chamber to said oxygen supply conduit and oxygen breathing conduit, lever interconnections between said valve means for venting said first-mentioned collapsible bellows chamber to atmosphere, and cutting off communication between said second collapsible bellows chamber and the oxygen supply conduit during inhalation of breath, and conversely operating said valve means during exhalation of breath, and automatically operable means for operating said lever interconnections by the alternating expanding and contracting movements of the second collapsible bellows chamber which is connected to the oxygen supply under pressure controlled by the breathing cycles of the user.

7. An apparatus as set forth in claim 6 wherein said lever interconnections and last-mentioned means comprise pivoted levers connected to each of said valve means, and a common actuating rod therefor, abutments on said rod at displaced points therealong, and a member on said second collapsible bellows chamber for striking said abutments near the limits of its travel in each direction for actuating said valve means to their alternate positions.

8. An apparatus as set forth in claim 7 wherein said last-mentioned member is mounted on the end wall of said second collapsible bellows chamber with an aperture therein to receive said common actuating rod for relative movement thereon.

No references cited.