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⑤④ **Decompression and toxic fume protection apparatus.**

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DE-C- 647 560
FR-A- 1 599 791
US-A- 3 565 068
US-A- 3 895 625
US-A- 3 906 945
US-A- 3 976 063
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⑦③ Proprietor : **E.I. DU PONT DE NEMOURS AND COMPANY**
1007 Market Street
Wilmington Delaware 19898 (US)

⑦② Inventor : **Werjefelt, Bertil**
277 Kaha Street
Kailua Hawaii 96734 (US)

⑦④ Representative : **Woodcraft, David Charles et al**
BROOKES & MARTIN High Holborn House 52/54 High Holborn
London, WC1V 6SE (GB)

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Description

A continuing concern for the aircraft industry is apparatus for the protection of passengers against either decompression in flight or toxic fumes resulting from onboard fires. Previously, oxygen masks and other apparatus have been provided for passenger use. However, previous apparatus do not satisfy the need for individual smoke protection of 30 minutes or more, and the size and weight of apparatus previously available has limited its use in aircraft. Typically the ratio of equipment poundage to minutes of protection was of the order of 1:0.5 to 1:3. In addition, much of the equipment previously available for decompression or toxic fume protection is complicated to use and might be of limited value to an aircraft passenger in an emergency situation. Accordingly, a continuing need exists for an uncomplicated, light-weight apparatus that will provide extended protection against toxic fumes in an aircraft environment. Similarly, a need exists for such an apparatus in a variety of other applications such as hotels and hospitals in which it may be necessary to escape from a smoke-filled environment with an apparatus that provides at least about 30 minutes of breathable air for the user.

FR-A-1 599 791 describes a protective hood which is constructed from flexible plastic sheet material and is given sufficient rigidity to form a bell-shaped helmet by a framework of a flexible inflatable tubing connected to the sheet material along the peripheral edges of the hood. Air is supplied from a remote source to the interior of the hood via the tubing and holes in the tubing communicating with the interior of the hood. Regenerating means are not provided in connection with this breathing hood.

US-A-3 895 625 discloses a self-contained protective hood having a rigid framework which supports a translucent, heat-resistant sheet material. The hood includes an elastic annular seal adapted to seal around the neck of the wearer and an oxygen regeneration device located within the hood.

The present invention provides an improved apparatus for protection against decompression and toxic fumes, particularly in an aircraft environment, which permits more complete utilization of available oxygen.

According to the present invention there is provided a breathing device, comprising an inflatable outer chamber surrounding and defining by its inner sidewall an inner chamber adapted to surround the head of the wearer, a gas reservoir, a gas inlet to the outer chamber and a valve permitting gas to flow from the outer chamber to the reservoir, and a passageway to permit gas to flow between the reservoir and the inner chamber through a CO₂ removal means, the outer chamber being inflatable to a rigidity sufficient to maintain substantially constant the volume of the inner chamber while the wearer is breathing.

The CO₂ removal means may be disposed within a ring around the neck of the wearer or alternatively in a container exterior to the body of the breathing device. Alkali metal hydroxides, e.g. lithium hydroxide and oxides and sodium carbonate are examples of suitable CO₂ removal means and may be employed in the breathing device in an amount of from 50 to 500 grams, preferably 75 to 150 grams.

Figure 1 is a cross-sectional view of a breathing device of the present invention having a CO₂ removal means in a circumferential configuration surrounding the neck of the wearer.

Figure 2 is a cross-sectional view of a breathing device of the present invention wherein the CO₂ removal means is positioned adjacent to the gas inlet.

Figure 3 is a planar view of the details of construction that can be used for the inflatable outer chamber of the present devices.

According to a preferred embodiment of the present invention a breathing device is provided having concentric inner and outer chambers. The outer chamber is inflatable to a rigidity sufficient to maintain a substantially constant volume of the inner chamber while the wearer is breathing. The device also includes a reservoir connected to the inner chamber by way of a carbon dioxide removal means.

A wide variety of materials can be used for CO₂ removal. These include for example, alkali metal hydroxides and oxides and sodium carbonate. Of these, the lithium salts and sodium salts are preferred, and lithium hydroxide in particulate form is particularly preferred. In addition, CO₂ absorbants in liquid or gel form can be used. The quantity of CO₂ absorbant used will vary according to the absorbant selected and the capacity of the hood. In general, about from 50 to 500 grams can be used in the present invention. It has been shown that about from 3 to 4 grams of lithium hydroxide are required for removal of carbon dioxide during each minute of closed circuit breathing in an environment of substantially pure oxygen. Preferably, about from 75 to 150 grams of CO₂ absorbant are used in the present devices.

The CO₂ removal means can be integrated into the present breathing device in a wide variety of configurations. The CO₂ removal means can be contained in a separate chamber positioned, for example, as a ring around the neck of the wearer. In another embodiment, the CO₂ removal means can be exterior to the remainder of the hood structure, for example, in a compartment, canister or hose adjacent to the inlet. The positioning of the CO₂ removal means exterior to the hood permits the replacement or renewal of the CO₂ removal means for reuse of the hood.

In accordance with a preferred embodiment of the present invention, a breathing device is provided which consists of three concentric chambers, the chambers being designated as an inner

chamber, an inflatable outer chamber and a reservoir. The inner chamber is nested within the inflatable chamber which is nested within the reservoir. In the operation of the breathing device, gas is passed from an outside source, such as the fresh air and/or oxygen supply on an aircraft, to the inflatable outer chamber of the breathing device. The outer chamber is inflatable to a rigidity sufficient to maintain substantially constant volume of the inner chamber within the breathing device while the wearer is breathing.

A valved mechanism is provided to permit passage of the gas, whether fresh air, oxygen enriched air, or pure oxygen, from the outer chamber to the reservoir. A passage is also provided from the reservoir, through a CO₂ removal means, to the inner chamber. Accordingly, with the breathing of the wearer, oxygen and/or air is drawn only from the reservoir. In this manner, the inflatable outer chamber is kept at substantially constant volume while the wearer is breathing.

In the breathing cycle, inhalation by the wearer draws air from the reservoir, through the CO₂ removal means, and into the inner chamber. The exhaling pressure of the wearer forces exhaust air through the carbon dioxide absorber, and back to the reservoir.

The invention can be more clearly understood by reference to the drawings, in which like numbers are used for like elements in the figures.

In Figure 1, gas is supplied through inlet 1, from a source, not shown, of fresh air, oxygen, or both, to inflatable outer chamber 2, surrounding the head of the wearer. When the inflatable outer chamber is substantially fully inflated, the gas passes through valve 3 into reservoir 4, here shown as an additional outer concentric chamber. Inhaling of the wearer causes flow from the reservoir through CO₂ removal means 5 to inner chamber 6. Exhaling by the wearer causes passage of exhaust breath back through the CO₂ removal means and to the reservoir. The CO₂ removal means is here illustrated as an annular ring, containing CO₂ absorbant 7, through which the air is circulated in its passage between the reservoir and the inner chamber. The hood is also provided with annular neck seal 8.

Another embodiment of the invention is illustrated in Figure 2, in which the CO₂ removal means is exterior to the inner, outer and reservoir elements surrounding the head of the wearer, and is in the form of canister 21 containing CO₂ absorbant 22.

The outer chamber is inflatable to a rigidity sufficient to maintain substantially constant internal volume while the wearer is breathing. A typical construction which can be used for this function is illustrated in Figure 3, in which the chamber is fabricated from two layers of thermoplastic material 31 and 32, the two layers being heat sealed at seams 33 to provide a plurality of pockets 34 having upper and lower portions 34A and 34B. Alternatively, the sheets can be adhesively bonded as required. The area between the

upper and lower portions is sealed together to provide visibility band 35. The visibility band is interrupted by full length air pockets 36 which increase the rigidity of the structure when inflated.

5 A wide variety of construction materials can be used for the breathing devices of the present invention. Particularly satisfactory are polymeric films, such as polyethylene, polypropylene, nylon, polyvinyl chloride, polyurethane, fluoropolymers and polyethylene terephthalate. Such films are particularly useful in forming the inflatable outer chamber. Heat resistant materials such as polyimide films are preferably used for the exterior wall of the breathing device. Those films commercially available from E. I. du Pont de Nemours and Company as Kapton polyimide films have been found to be particularly satisfactory. The exterior surface of the breathing device can be metalized for further heat reflectivity, using techniques well known in the art.

20 The breathing devices of the present invention provide several advantages over similar devices previously known in the art. The present devices permit, through the inflatable outer chamber, a constant volume while the wearer is breathing. Moreover, with the carbon dioxide removal means integrated into the breathing device, upon disconnecting the device from the gas supply, maximum utilization of the oxygen in the gas contained within the hood can be obtained. Without the CO₂ removal means, the available oxygen can be utilized to a substantially lesser extent, with increasing build-up of carbon dioxide.

35 The breathing devices of the present invention can be used in a wide variety of applications, including aircraft cabin interiors, hospitals, and residential and commercial interiors. When used in conjunction with a gas source, such as those available on an aircraft, the user can breathe in a toxic fume environment or in a decompression situation for virtually unlimited periods of time. Upon disconnection from a gas source, up to about 45 minutes of breathable and usable air, with the carbon dioxide removal means, are available.

45 The present hoods can be safely stored for extended periods without deterioration of their operating capabilities. However, it is preferred that the hoods be stored in a sealed container to insulate the devices from changes in environmental conditions.

50 The present apparatus makes more effective use of the oxygen supply systems currently in place on commercial aircraft for decompression protection. The oxygen masks previously provided on aircraft provide the user with a mixture of oxygen and ambient air, while the present devices provide the user with a substantially pure oxygen for decompression as well as smoke protection. Moreover, the present invention does not require a pump or pressure source for operation of the CO₂ removal means once the hood has been fitted.

Claims

1. A breathing device, comprising an inflatable outer chamber (2) surrounding and defining by its inner sidewall an inner chamber (6) adapted to surround the head of the wearer, a gas reservoir (4), a gas inlet (1) to the outer chamber and a valve (3) permitting gas to flow from the outer chamber to the reservoir, and a passageway to permit gas to flow between the reservoir and the inner chamber through a CO₂ removal means (5), the outer chamber being inflatable to a rigidity sufficient to maintain substantially constant the volume of the inner chamber while the wearer is breathing.

2. A breathing device according to claim 1, wherein the CO₂ removal means is disposed within a ring (7) around the neck of the wearer.

3. A breathing device according to claim 1, wherein the CO₂ removal means is in a container (21) exterior to the body of the breathing device.

4. A breathing device according to claim 1 or claim 2, comprising 50 to 500 grams of CO₂ removal means selected from alkali metal hydroxides and oxides and sodium carbonate.

5. A breathing device according to claim 4, wherein the CO₂ removal means comprises lithium hydroxide.

6. A breathing device according to claim 4 or 5, comprising 75-150 grams of particulate CO₂ removal means.

7. A breathing device according to any preceding claim, wherein the reservoir (4) comprises a chamber at least partially surrounding the inflatable outer member chamber (2).

8. A breathing device according to any one of the preceding claims, wherein the inner chamber (6), outer chamber (2) and reservoir (4) are arranged in three concentric chambers.

9. A breathing device according to any one of the preceding claims, wherein the outer chamber (2) is formed from two layers of thermoplastic material (31, 32) which are heat sealed at seams (33) to provide a plurality of pockets (34).

Patentansprüche

1. Atmungs Vorrichtung, die eine aufblasbare äußere Kammer (2), welche durch ihre innere Seitenwand eine innere Kammer (6) umgibt und diese begrenzt, welche derart ausgelegt ist, daß sie den Kopf des Trägers umgibt, einen Gasspeicher (4), einen Gaseinlaß zu der äußeren Kammer und ein Ventil (3) aufweist, welches gestattet, daß Gas von der äußeren Kammer zu dem Speicher strömt, sowie einen Durchgang aufweist, der gestattet, daß Gas zwischen dem Speicher und der inneren Kammer durch ein CO₂-Entziehungsmittel (5) strömt, wobei die äußere Kammer zu einer solchen ausreichenden Steifigkeit aufblasbar ist, daß während des Atmens des Trägers das Volumen der inneren Kammer im wesentlichen konstant gehalten wird.

2. Atmungs Vorrichtung nach Anspruch 1, bei

der das CO₂-Entziehungsmittel in einem Ring (7) um den Hals des Trägers angeordnet ist.

3. Atmungs Vorrichtung nach Anspruch 1, bei der das CO₂-Entziehungsmittel in einem Behälter (21) außerhalb des Körpers der Atmungs Vorrichtung vorgesehen ist.

4. Atmungs Vorrichtung nach Anspruch 1 oder Anspruch 2, welche 50 bis 500 g von dem CO₂-Entziehungsmittel aufweist, das aus der Gruppe gewählt ist, die Alkalimetallhydroxide und -oxide und Natriumcarbonat umfaßt.

5. Atmungs Vorrichtung nach Anspruch 4, bei der das CO₂-Entziehungsmittel Lithiumhydroxid aufweist.

6. Atmungs Vorrichtung nach Anspruch 4 oder 5, welche 75 bis 150 g von teilchenförmigem CO₂-Entziehungsmittel aufweist.

7. Atmungs Vorrichtung nach einem der vorangehenden Ansprüche, bei der der Speicher (4) eine Kammer aufweist, die wenigstens teilweise das Teil der aufblasbaren äußeren Kammer (2) umgibt.

8. Atmungs Vorrichtung nach einem der vorangehenden Ansprüche, bei der die innere Kammer (6), die äußere Kammer (2) und der Speicher (4) in Form von drei konzentrischen Kammern angeordnet sind.

9. Atmungs Vorrichtung nach einem der vorangehenden Ansprüche, bei der die äußere Kammer (2) von zwei Schichten aus thermoplastischem Material (31, 32) gebildet wird, welche an Säumen (33) zur Bildung einer Mehrzahl von Taschen (34) heißversiegelt sind.

Revendications

1. Un dispositif respiratoire, comprenant une chambre extérieure gonflable (2) entourant et définissant par sa paroi latérale intérieure une chambre intérieure (6) faite pour entourer la tête du porteur, un réservoir (4) à gaz, une entrée (1) de gaz menant à la chambre extérieure et une valve (3) permettant au gaz de s'écouler de la chambre extérieure au réservoir, et un passage permettant au gaz de s'écouler entre le réservoir et la chambre intérieure par l'intermédiaire d'un moyen (5) d'enlèvement du CO₂, la chambre extérieure pouvant être gonflée pour atteindre une rigidité suffisante pour garder sensiblement constant le volume de la chambre intérieure tandis que le porteur respire.

2. Un dispositif respiratoire selon la revendication 1, dans lequel le moyen d'enlèvement du CO₂ est disposé à l'intérieur d'un anneau (7) autour du cou du porteur.

3. Un dispositif respiratoire selon la revendication 1, dans lequel le moyen d'enlèvement du CO₂ se trouve dans un récipient (21) extérieur au corps du dispositif respiratoire.

4. Un dispositif respiratoire selon la revendication 1 ou la revendication 2, comprenant 50 à 500 grammes d'un moyen d'enlèvement du CO₂ choisi parmi les oxydes et hydroxydes de métaux alcalins et le carbonate de sodium.

5. Un dispositif respiratoire selon la revendication 4, dans lequel le moyen d'enlèvement du CO₂ comprend de l'hydroxyde de lithium.

6. Un dispositif respiratoire selon la revendication 4 ou 5, comprenant 75 à 150 grammes de moyen d'enlèvement du CO₂ en particules.

7. Un dispositif respiratoire selon l'une quelconque des revendications précédentes, dans lequel le réservoir (4) comprend une chambre entourant au moins partiellement la chambre extérieure gonflable (2).

8. Un dispositif respiratoire selon l'une quel-

conque des revendications précédentes, dans lequel la chambre intérieure (6), la chambre extérieure (2) et le réservoir (4) sont agencés en trois chambres concentriques.

5 9. Un dispositif respiratoire selon l'une quelconque des revendications précédentes, dans lequel la chambre extérieure (2) est formée à partir de deux couches de matière thermoplastique (31, 32) qui sont soudées à chaud suivant des lignes de soudure (33) pour constituer plusieurs
10 poches (34).

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F I G. 1

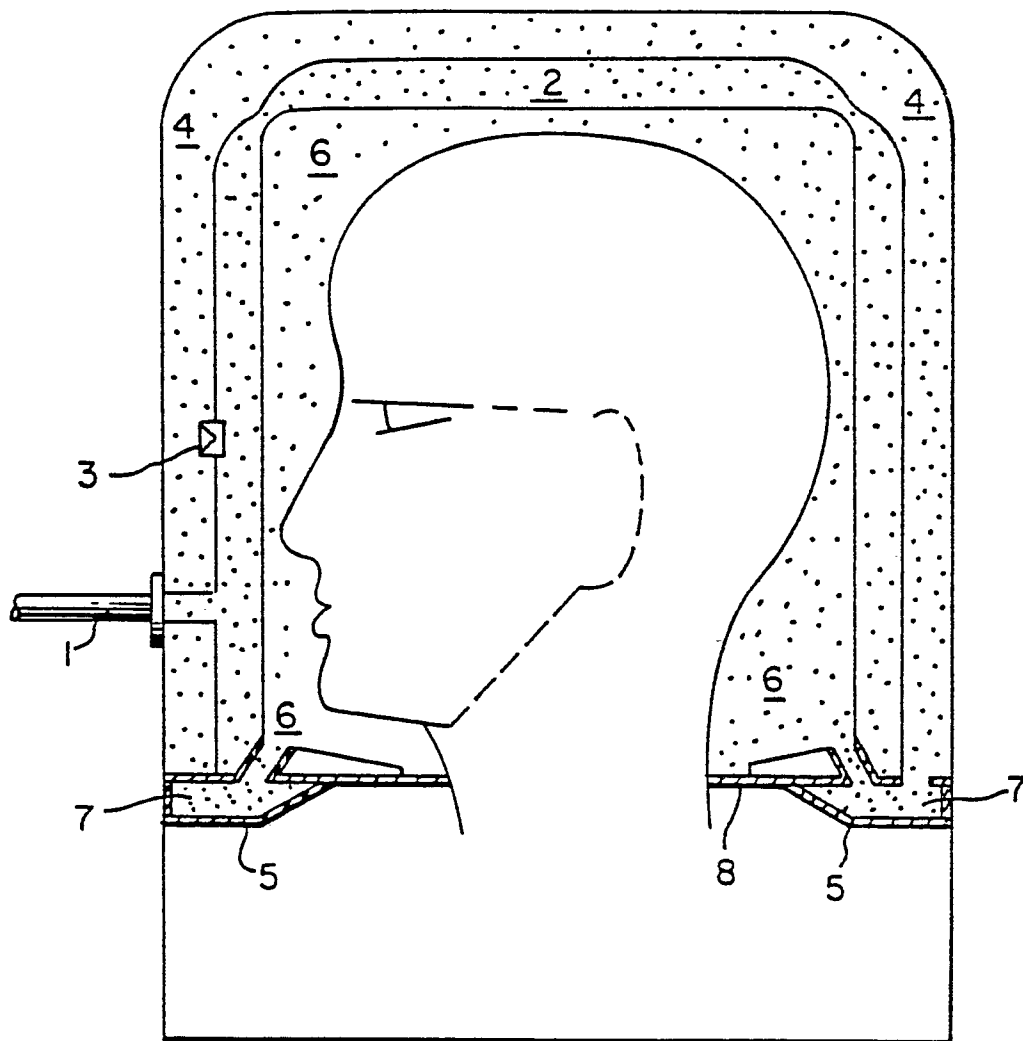


FIG. 2

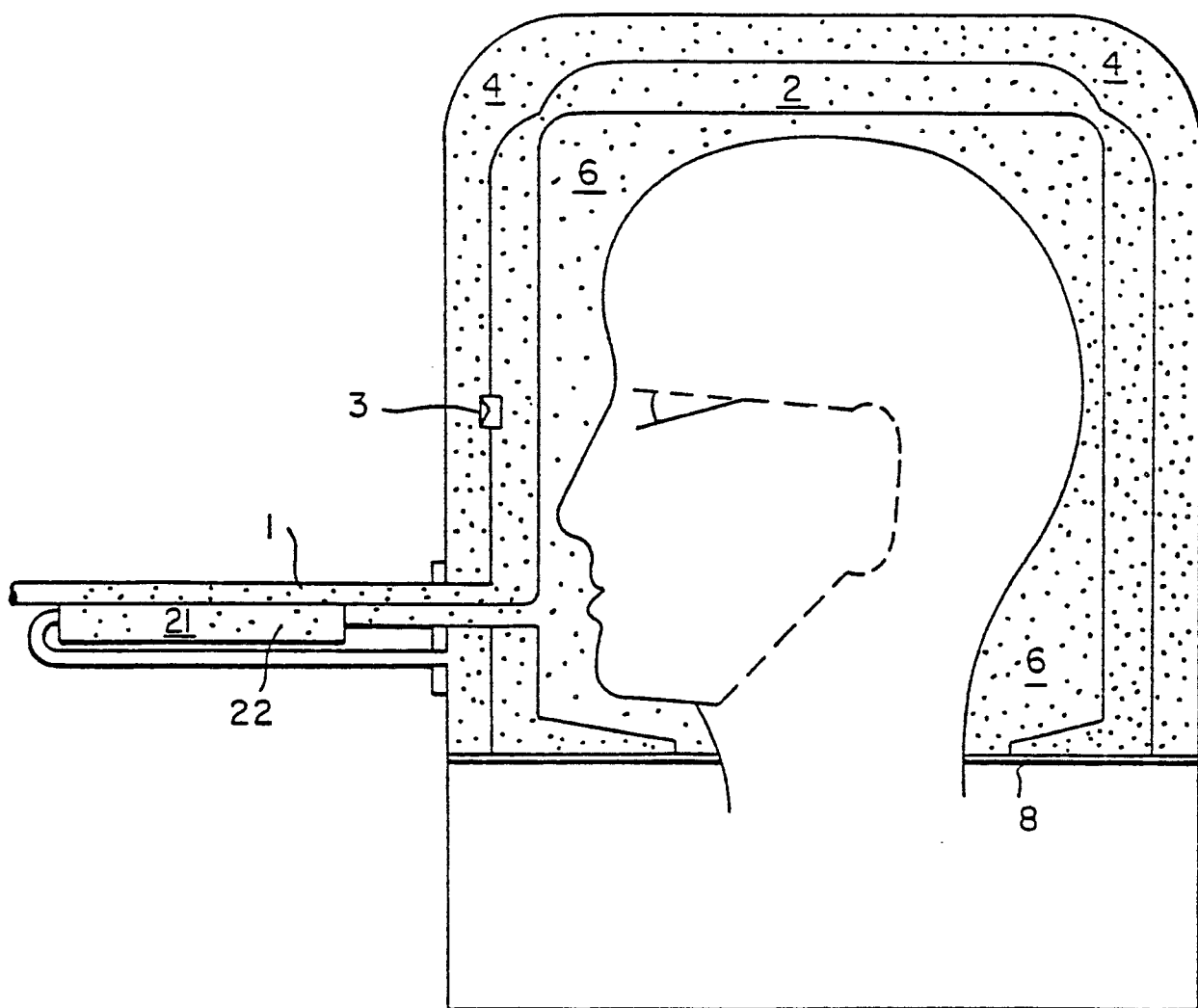


FIG. 3

