United States Patent [19]

Savornin

[11] **3,777,750**

[45] **Dec. 11, 1973**

[54] **PROTECTIVE CLOTHING UNIT FOR CONDUCTING WORK IN A DELETERIOUS ATMOSPHERE**

[75] Inventor: **Jacques Savornin,** Gif-sur-Yvette, France

[73] Assignee: **Commissariat a l'Energie Atomique,** Paris, France

[22] Filed: **July 21, 1971**

[21] Appl. No.: **164,778**

[52] **U.S. Cl.** **128/142.5,** 2/2.1

[51] **Int. Cl.** **A62b 7/00**

[58] **Field of Search** 128/142.5, 142.7, 128/142; 2/2.1

[56] **References Cited**

UNITED STATES PATENTS

1,760,512	5/1930	McBride	128/142.5
1,991,601	2/1935	Lasaux	2/2.1 R
2,335,474	11/1943	Beall	128/142.5

FOREIGN PATENTS OR APPLICATIONS

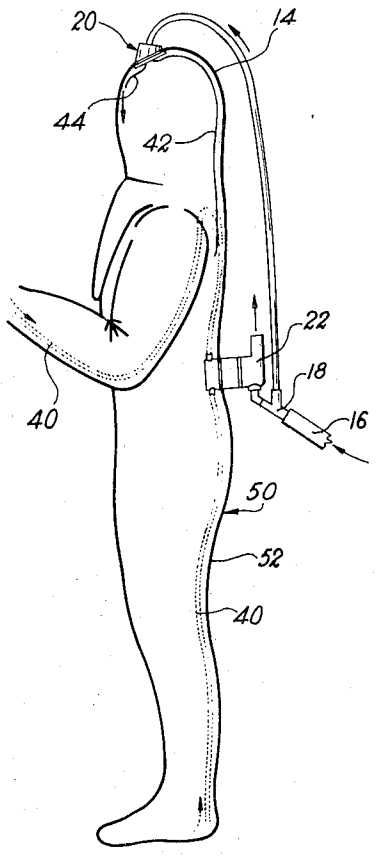
609,660	2/1935	Germany	128/142.5
1,111,227	4/1968	Great Britain	2/2.1 R

Primary Examiner—Richard A. Gaudet
Assistant Examiner—G. F. Dunne
Attorney—Lane, Aitken, Dunner & Ziems

[57] **ABSTRACT**

A protective clothing unit for work conducted in a tritiated atmosphere comprising a frogsuit made at least partly of substantially leak-tight flexible fabric, an ejector for removing vitiated air to the exterior of the frogsuit and a single air-supply pipe through which the flow is directed parly into the frogsuit for supplying fresh air and partly to the ejector from which the flow is discharged to the exterior and carries with it the vitiated air.

2 Claims, 4 Drawing Figures



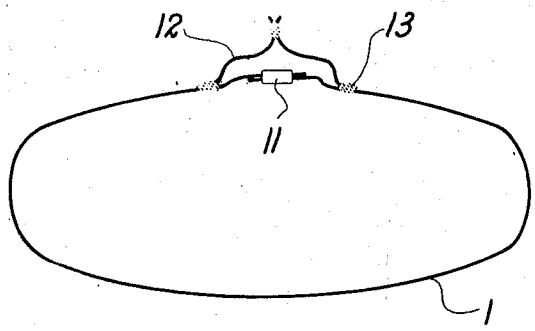


FIG. 1

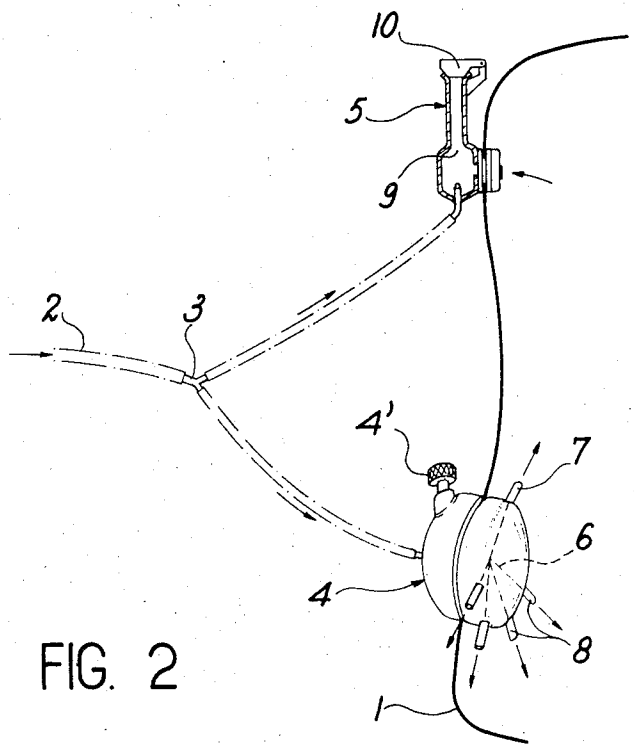


FIG. 2

INVENTOR
JACQUES SAVORNIN

BY Lane, Aitken, Dunner & Ziems
ATTORNEYS

FIG. 3

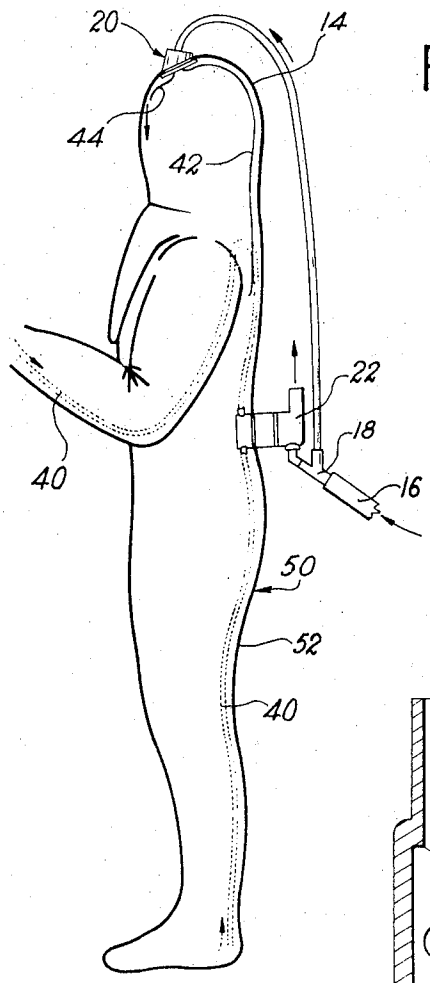
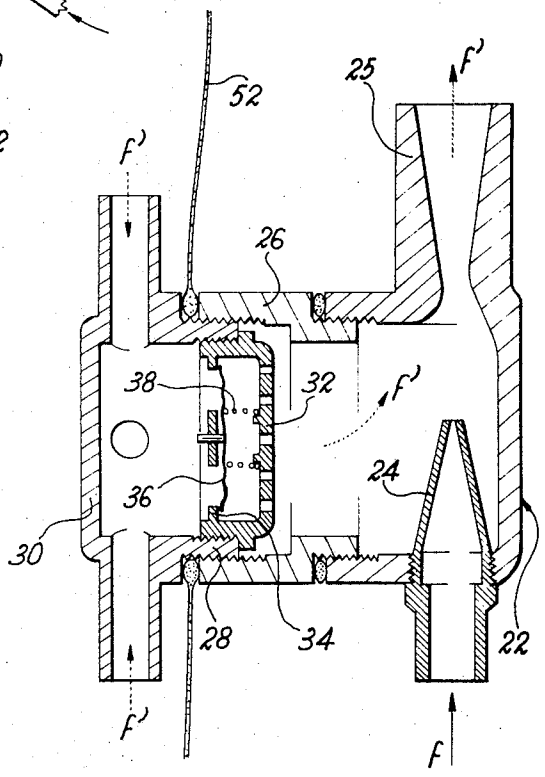


FIG. 4



INVENTOR
JACQUES SAVORNIN

BY Lane, Aitken, Dunner & Ziems
ATTORNEYS

PROTECTIVE CLOTHING UNIT FOR CONDUCTING WORK IN A DELETERIOUS ATMOSPHERE

This invention is concerned with the protection of personnel working in a deleterious atmosphere and especially an atmosphere which is highly contaminated with tritium.

It is known that tritium is a radioactive gas which diffuses in air at a very high rate (more than 1 m/sec) and through practically all materials.

Protective suits or so-called frogsuits of the type in common use at the present time are made of fabrics which are rendered impermeable to aerosols; ventilation of these suits is effected by means of an air supply pipe whereas discharge is effected by means of one or a number of valves.

It is advisable to exercize the greatest possible caution in the use of equipment units of this type since it is known that, in a highly tritiated atmosphere, tritium diffuses through the fabric and in countercurrent flow through the discharge valves, the outlet airstream velocity at the level of said valves being always lower than 1 m/sec.

The protective clothing unit comprises a frogsuit which is made at least partially of flexible fabric and ventilation means for said frogsuit comprising a single air-supply pipe which serves on the one hand to admit fresh air into the frogsuit and on the other hand to remove vitiated air to the exterior of the frogsuit through an ejector; it must obviously be understood that the term "air" is used in a wide sense extending to all the different breathing mixtures which are commonly employed.

A rose for collecting vitiated air is advantageously placed within the interior of the frogsuit and connected to the ejector by means of a leak-tight passage through the wall of the frogsuit.

The rose is advantageously connected to the extremities of the four limbs of the frogsuit by means of ducts for collecting air streams at substantially equal flow rates. In order to prevent admission of contaminated air into the frogsuit in the event that the supply of fresh air to the ejector is cut-off, a leak-tight valve of the automatic closure type is advantageously associated with the ejector: said valve which is placed by way of example between the ejector and the rose isolates the interior of the frogsuit from the ejector and therefore from the surrounding atmosphere as soon as the supply is cut-off.

The frogsuit can on the one hand be provided in the dorsal portion with a slit which permits the user to don the suit and which can be closed by means of a slide fastener and on the other hand with a plurality of elements which can be interassembled such as the frogsuit proper (which covers the user's trunk, legs, feet and arms), the helmet for protecting the user's head and the gloves.

The protective clothing unit can be provided on each side of the slit and/or of each junction between elements with lips of vinyl fabric which are joined to the frogsuit by bonding and have dimensions which permit partial overlapping, said lips being bonded to each other in order to form a substantially leak-tight junction beyond the mechanical joint.

Injection of fresh air into the frogsuit can be carried out at one or a number of points. In one particular embodiment of the invention, the fresh air is injected

along the eyepiece of the helmet, that is to say near the point at which the wearer of the frogsuit inhales air. Provision is advantageously made for a regulator which reduces the flow of air introduced into the frogsuit as soon as the overpressure within this latter relative to the surrounding atmosphere exceeds a predetermined value. Provision can be made for a second injection point which may be located by way of example in the back portion of the frogsuit and is supplied by the regulator until the predetermined overpressure is attained.

Two protective clothing units in accordance with the invention are illustrated by way of example and not in any limiting sense in the accompanying drawings, wherein:

FIG. 1 is a diagrammatic part-sectional view of the frogsuit of a first unit which illustrates the arrangement of two lips on each side of a junction and the assembly of said lips;

FIG. 2 is a diagrammatic part-sectional view of the frogsuit at the level of connection of this latter to the air-supply device and to the air-removing ejector;

FIG. 3 shows very diagrammatically the protective clothing unit as illustrated in elevation;

FIG. 4 is a diagrammatic part-sectional view on a large scale showing the rose and the ejector for removing vitiated air which are carried by the frogsuit of FIG. 3.

The unit which is illustrated in FIGS. 1 and 2 essentially comprises a frogsuit 1 of vinyl fabric and means for ventilating said frogsuit.

The ventilating means comprise a single air-supply pipe 2 which is connected on the one hand to a compressed-air source (not illustrated) and on the other hand to the frogsuit 1 by means of a Y-piece union 3. One of the branches of the Y is connected to a device 4 which constitutes the air supply and the other branch is connected to an air-removing ejector 5, both components being attached to the frogsuit 1.

The air-supply device comprises a metallic component which passes through the frogsuit 1 and is adapted to carry externally of this latter a valve 4' for regulating the flow rate of the air which passes through the device 4 and a rose 6 which is placed within the frogsuit and distributes the air which is admitted into this latter.

The rose 6 is connected to the helmet by means of a first length of tubing or branch 7 and to the "limbs" of the frogsuit by means of four other branches 8.

The air-removing ejector 5 is fixed directly on the frogsuit 1 and has an ejection tube 9 fitted with a leak-tight valve 10, the closure of which is caused by interruption of the air supply.

In those zones in which the frogsuit is formed of a number of elements, said frogsuit is provided with a slit as shown in FIG. 1, the edges of said slit being joined together by means of a slide fastener 11. Lips 12 formed by strips of the same material as the frogsuit 1 proper are joined to this latter (or to each of the frogsuit elements) by bonding at 13 and are also bonded to each other so as to form an additional covering which re-constitutes the leak-tightness of the frogsuit at the level of a joint or of the slit.

By virtue of the leak-tightness obtained as a result of a choice of material and the re-constitution of good protection at the level of the slits or joints, the frogsuit which has just been described makes it possible to ensure the maximum degree of safety for the user. Moreover, by carrying out the ventilation of the frogsuit

through a single connecting pipe and by increasing the rate of flow of vitiated air through the ejector, countercurrent diffusion of the tritium is prevented while reducing the weight of the frogsuit. The supply of air through a single pipe secures a further advantage over conventional frogsuits in that a rapid overpressure or pressure drop within the frogsuit as a result of stoppage of the air flow or of an accident condition in the pipes is not liable to arise.

The protective clothing unit which is illustrated in Figs. 3 and 4 essentially comprises a frogsuit **50** and means for ventilating this latter. The constructional design of the frogsuit can be identical with that of FIG. 1 or as described in other documents such as the article by F. Suter and published on pages 180 to 185 of the Review "Atom Praxis," volume 13, 1967. The frogsuit is made up of a body **52** of impermeable and flexible fabric and a helmet **14.** When the frogsuit is intended to be employed in a tritium-charged atmosphere, it is an advantage to make use of a vinyl fabric that consists of flexible vinyl on which is applied by countercalendering a thin film of plastic material having particularly low permeability to hydrogen. The rigid helmet **14** which completes the frogsuit is attached to this latter in leak-tight manner and provided with a transparent eyepiece (not shown in the drawings).

The means for ventilating the frogsuit comprise a single air-supply pipe **16** connected on the one hand to a source for the supply of compressed air or of a breathing mixture (not shown) and on the other hand to the frogsuit **50** by means of a Y-piece union **18.** The supply pressure must be higher than that which prevails within the enclosure in which the wearer of the frogsuit is working and is of the order of 4 bar, for example. One branch of the Y-piece union **18** is connected to a relief-valve regulator **20** carried by the helmet **14** in order to maintain the frogsuit at overpressure by regulating the flow of fresh air which is admitted. The other branch of the union **18** is connected to an air-removing ejector **22** which is attached to the body **52** slightly below the belt and forms part of a device for removing vitiated air from the frogsuit.

The air-removing device comprises outside the frogsuit the ejector **22,** the nozzle **24** of which is supplied with fresh air from the union **18** (arrow *f* of FIG. 4) and the diverging-tube **25** of which opens to the atmosphere. The ejector casing is screwed in leak-tight manner onto an adaptor **26** which is also placed outside the frogsuit. Said adaptor is in turn screwed onto an end-piece **28** forming part of a distribution rose **30** which is placed inside the frogsuit **50.** The edges of an opening formed in the skin of the frogsuit body **52** are clamped in leak-tight manner between an annular shoulder which is formed on the rose around the end-piece **28** and the end face of the adaptor **26.**

The end-piece **28** carries a diaphragm valve for isolating the frogsuit in the event of failure of the fresh-air supply. Said valve comprises a cup **32** provided with perforations or drilled holes through which the vitiated air is permitted to pass towards the ejector and the surrounding atmosphere (the path being shown by the arrows *f'*), said cup being screwed onto the end-piece **28.** The cup has an internal flange **34** which forms a seat for a flexible diaphragm **36** and a spring **38** tends to apply said diaphragm against the seat. The valve **36** lifts when the forces arising from the over-pressure within the frogsuit and from the negative pressure produced by the nozzle **24** of the ejector attain a sufficient value to overcome the action of the spring.

The rose **30** which is illustrated in FIGS. 3 and 4 is provided with four ducts **40** which have their openings at the ends of the frogsuit limbs and are intended to supply air streams to the rose at substantially equal flow rates. It is readily apparent that this last-mentioned condition is not essential and that the rose could collect the vitiated air from a greater number of locations.

The relief-valve regulator **20** of the protection unit which is illustrated is intended to supply the frogsuit at two points. A first outlet supplies the frogsuit at **42** at the back of this latter behind a lining which extends downwards to the level of the shoulder-blades. A second outlet is located at a point **44** against the eyepiece of the helmet **14.** The regulator is advantageously double in order to supply the outlet at the back only as long as the overpressure within the frogsuit relative to the surrounding atmosphere has not attained a predetermined value such as 1.5 g/cm^2, for example. Once this overpressure has been attained, the regulator supplies the frogsuit only at **44** at a lower rate of flow than before in order to maintain the overpressure. For example, it is possible to provide a total suppply rate of approximately 150 l/min. until an overpressure of 1.5 g/cm^{2}is obtained and a supply at a maximum flow rate of 60 l/min. beyond this point. The last-mentioned supply can be either maintained constant or modulated as a function of the over-pressure within the frogsuit. The regulator which serves to carry out this function can be of a wholly conventional type and need not therefore be described here. The use of a double regulator is not essential but nevertheless has many advantages: in particular, it prevents the movements of the wearer from causing excessive transient overpressures which take place if the maximum flow is continuously admitted into the frogsuit.

The operation of the protective clothing unit is apparent from the foregoing description and will therefore be mentioned only briefly: once the operator has donned the frogsuit the ventilation installation is started up and the leak-tight closure means (which comprise by way of example a slide fastener duplicated by lips which can be bonded together) are closed. The pressure increases within the frogsuit, initially at a fast rate (as long as the regulator supplies both outlets), then at a lower rate until an equilibrium is established between the admission flow and the flow which is removed by the ejector through the diaphragm valve. In the event of interruption of the supply, the diaphragm valve is closed again and isolates the interior of the frogsuit, thus preventing the interior of this latter from being exposed to a contaminated atmosphere.

I claim:

1. A protective clothing unit for use in contaminated atmosphere, comprising a frogsuit made at least partly of substantially impervious flexible fabric, an ejector having a suction inlet connected to the interior of the frogsuit, an air-supply pipe, means for directing part of the air flow from said pipe into the frogsuit for respiratory purposes and part of said flow to the ejector from which it is discharged to the exterior of the atmosphere and carries with it vitiated air from said frogsuit, a rose for the collection of vitiated air placed within the frogsuit and connected to the suction inlet of the ejector by a leak-tight passage through the frogsuit wall, a check valve between the ejector and the rose, said valve clos-

ing automatically in the event of interruption of the air supply to the ejector.

2. A protective clothing unit for use in contaminated atmosphere, comprising a frogsuit made at least partly of substantially impervious flexible fabric, an ejector having a suction inlet connected to the interior of the frogsuit, an air-supply pipe, means for directing part of the air flow from said pipe into the frogsuit for respiratory purposes and part of said flow to the ejector from which it is discharged to the exterior of the atmosphere and carries with it vitiated air from said frogsuit, said means for directing including a Y-piece union having an inlet connected to the single air supply, one outlet branch connected to means for distributing air in the frogsuit, a second outlet branch connected to the air-removing ejector, the ejector being provided with a non-return check valve which closes automatically in the event of interruption of the air supply.

* * * * *