June 23, 1970 F. R. SPROSS 3,516,404

BIOLOGICAL ISOLATION GARMENT

Filed Sept. 9, 1969

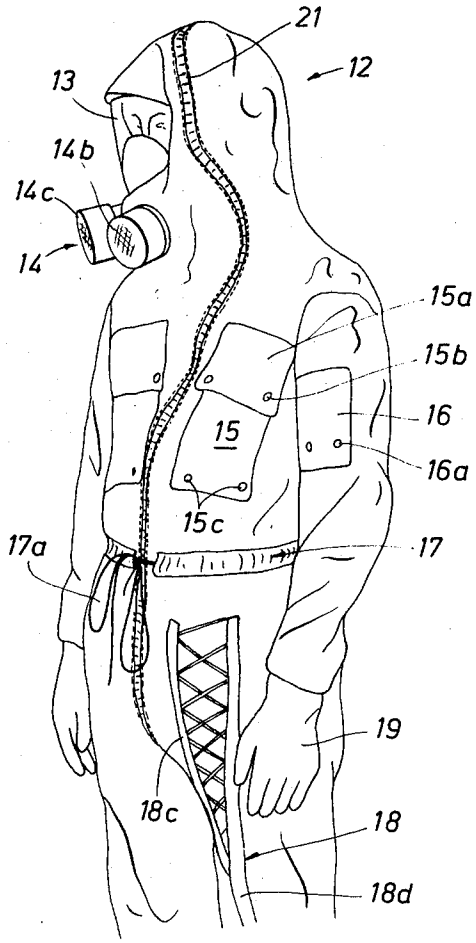
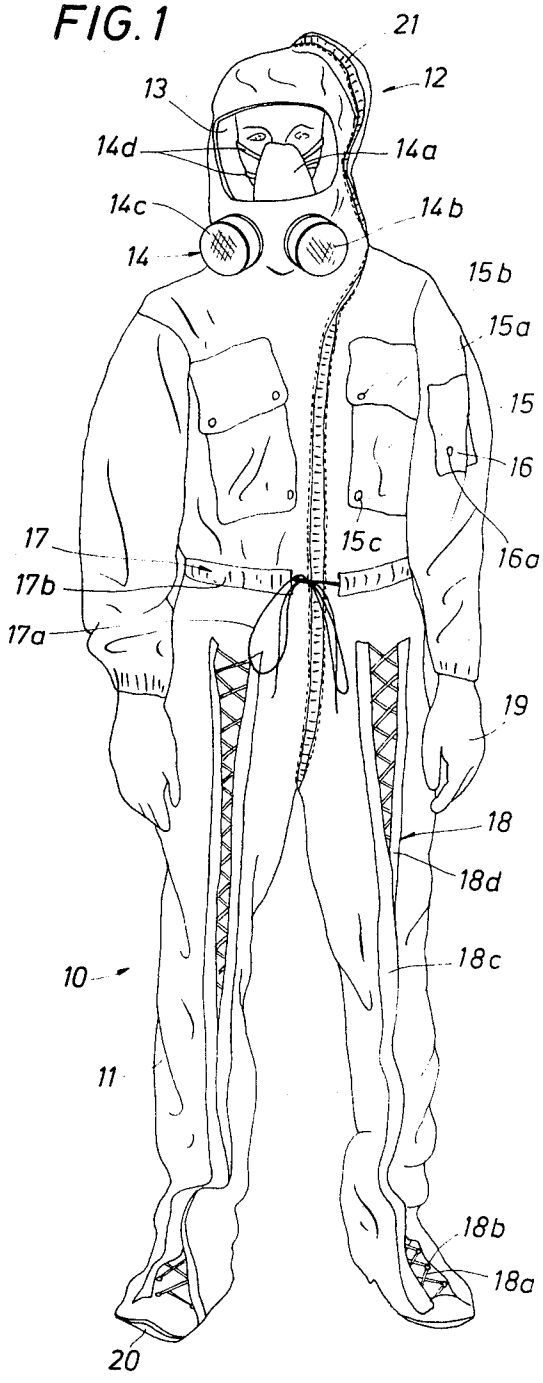


FIG. 2

FIG. 1



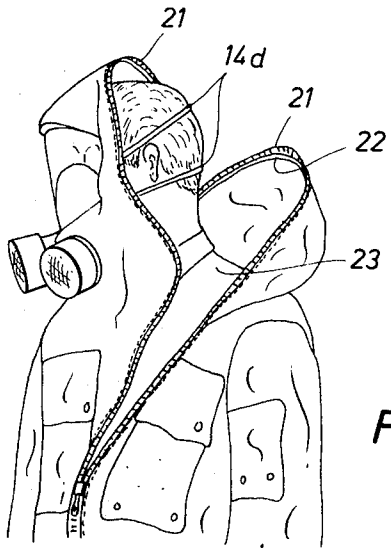


FIG. 3

Fred R. Spross
INVENTOR

BY Edward K. Fein
ATTORNEY

United States Patent Office 3,516,404 Patented June 23, 1970

3,516,404

BIOLOGICAL ISOLATION GARMENT

Fred R. Spross, Pasadena, Tex., assignor to the United States of America as represented by the Administrator of the National Aeronautics and Space Administration

Filed Sept. 9, 1969, Ser. No. 856,258
Int. Cl. A62b 7/00
U.S. Cl. 128—142.5 10 Claims

ABSTRACT OF THE DISCLOSURE

A completely enclosable, one piece human garment fabricated primarily from a tightly woven, permeable cotton fabric with all fabrication seams being internally sealed. Medical rubber gloves are sealed to the ends of the arms for hand coverings and the headpiece includes a full width visor for wearer vision and an integral oronasal respirator for filtering the wearer's inspired and expired breath. Sizing adjustments are provided on the legs and torso for adaptation of the garment to different size wearers and a pressure-sealing closure zipper extends diagonally from the crotch across the chest and curves over one ear to the top of the headpiece for donning and removing the garment.

The invention described herein was made by an employee of the U.S. Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates generally to contamination proof wearing apparel. More specifically, the present invention relates to a new and improved, single piece garment designed to prevent possible back-contamination of the terrestrial atmosphere by non-earth life forms in the minimum diameter range of 0.3–0.5 micron which may be carried by astronauts returning from the surface of extraterrestrial bodies such as the moon.

Brief description of the prior art

In the current Apollo programs as in previous NASA programs, astronauts returning to earth from space missions land their crafts in the sea where they and their craft are subsequently retrieved by a supporting task force of helicopters and ships. While the accuracy of spacecraft landings has been extremely good in many of the missions, there continues to be a possibility that the crew of a returning spacecraft may have to spend extended periods of time awaiting the arrival of a distant pick-up task force. During such waiting periods, it may become necessary for the crew to exit the spacecraft; and it is, therefore, desirable to prevent any contamination of the earth's atmosphere from extraterrestrial life forms which may be carried by the astronauts.

The most effective means for preventing such contamination would be a sterile, completely enclosed, non-porous suit which would be donned by the astronauts before leaving the spacecraft to contain any contamination until a suitable processing facility could be reached. As a practical matter, however, a non-porous suit would be unendurable for any extended periods of time without some means for providing ventilation and cooling.

The prior art discloses various protective suits which for the most part are designed to protect the wearer from external environment rather than to protect the external environment from contamination by the wearer. Such suits generally include a relief valve which permits unfiltered air within the suit to be expelled into the external

environment but prevents the entrance of untreated matter from the external environment into the suit. Many of the suits designed for protective use in chemical warfare or where work is required to be done in noxious or poisonous environments fall into the latter category.

In those applications where it has been necessary to protect the surrounding environment from contamination, suits designed for this purpose have generally required complex sealing means and external support equipment for conveying air to and from the suit. Such external support equipment is not desirable or practical for use by astronauts who may have to endure extended periods afloat in the sea. The storage limitation within the spacecraft also make it undesirable to carry the equipment required for a separate oxygen and cooling system for the suit even assuming such a system could be employed for extended periods in a small, unprotected life raft. In addition, since it may be necessary to don or remove a protective suit rapidly, a quick acting seal is essential in any garment to be employed by the astronaut.

SUMMARY OF THE INVENTION

The suit of the present invention is designed to completely enclose the wearer so as to contain viable particles in the minimum diameter range of 0.3–0.5 micron and to maintain a habitable environment without the use of an external ventilation and breathing system.

The suit is a one-piece, loosely fitting garment fabricated from a tightly woven, permeable, 100 percent cotton fabric which permits normal body ventilation while maintaining the required biological containment. Medical rubber gloves are sealed to the ends of each arm to form hand coverings to ensure ample dexterity. The headcovering includes a full width visor to provide adequate vision for the wearer and further includes an integrally formed oronasal respirator which is provided with filters which filter both inspired and expired breath.

All fabrication seams are sealed on the inside of the garment with a suitable cement and rubber impregnated fabric tape to ensure the required biological containment. A quick acting zippered closure extends diagonally from the crotch across the chest and along one side of the helmet to the top of the headpiece to permit easy donning and removal of the suit. The closure is pressure sealed to maintain the required suit containment. Sizing adjustments are provided along the torso and the front of each leg to conform the suit to the body of the wearer.

From the foregoing, it may be appreciated that the suit of the present invention provides the desired degree of biological containment without the use of an external life support system. The suit permits complete freedom of movement and may be quickly and easily donned or removed by means of the pressure sealing zippered closure.

Other features and advantages of the suit of the present invention will become apparent from the following description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a full length, front view of the suit of the present invention;

FIG. 2 is a partial side view of the suit illustrated in FIG. 1; and

FIG. 3 is a partial side view of the suit illustrated with the zippered closure partially open.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The Biological Isolation Garment of the present invention indicated generally at **10** in FIG. 1 is a single piece, loosely fitting suit which completely encloses the wearer. The material employed in fabricating the suit is preferably a tightly woven, 100% cotton fabric such as

that manufactured by the Angelica Uniform Company of St. Louis, Mo., under the trade name "Bar Bac."

The suit **10** includes a head piece indicated generally at **12** having a full view visor **13** constructed of any suitable transparent material to provide external vision for the wearer. An oronasal respirator indicated generally at **14** is provided as an integral part of the head piece and acts to filter the wear's inspired and expired breath. The preferred form of the respirator **14** is a full face mask assembly of the type manufactured by the Scott Aviation Corp. under the trade name "Scottaramic." The respirator **14** includes a nose and mouth cup **14***a* which extends internally of the suit to cover the wearer's nose and mouth and direct inspired and expired breath through the mask assembly. Cup **14***a* is held snugly in place by means of a head strap assembly **14***d*. The "Scottaramic" mask assembly is preferably modified to incorporate two American Optical Company R57, 0.3 micron filters which are disposed in filter containers **14***b* and **14***c* for providing free breathing and ensuring adequate filtration of the wearer's inspired and expired breath.

Two breast pockets **15** are provided on the front of the suit and may be employed for storage of survival equipment and other objects. The pockets include a covering flap **15***a* which may be secured over the pocket **15** by means of snap fasteners **15***b*. Eyelets **15***c* are provided at the lower corner of each of the pockets **15** for providing a drainage outlet for water or fluid entering the pockets. An arm pocket **16** is provided on the left arm of the suit and is also provided with a draining eyelet **16***a*.

A sizing adjustment indicated generally at **17** is provided about the torso of the suit and includes a draw string **17***a* which extends through a continuous loop **17***b* formed about the waist of the suit. Sizing adjustments indicated generally at **18** are also provided along the front of each leg covering of the suit and include draw strings **18***a* which extend through loops **18***b* secured at spaced locations along the front of the suit from the waist to the toe. The loops and draw strings of each of the leg sizings **18** are protected by overlying flaps **18***c* and **18***d* which prevent snagging of the sizing elements and lend a neater general appearance to the suit.

Conventional medical rubber gloves **19** are sealed to the end of each of the arms to provide ample dexterity for the wearer while still maintaining the desired biological containment. The foot covering of the suit includes a sole portion **20** which may be fabricated of any durable material such as rubber and may contain nonskid grooves or abrasive means to prevent slipping while the wearer is maneuvering in a wet life raft.

Access into and exit from the suit **10** is provided by means of a zippered, pressure sealing entrance closure **21** of the type manufactured by the B. F. Goodrich Co. The entrance closure **21** extends from the top of the head piece **12** along the left ear down to the shoulder and diagonally across the chest to the crotch of the suit to permit easy donning and removal of the garment.

In fabricating the biological isolation garment of the present invention, all fabrication seams are sealed on the inside of the garment with a suitable cement such as Neoprene cement and rubber impregnated fabric tape to ensure the required biological containment. An example of such internal sealing may be seen by reference to FIG. 3, which illustrates a fabrication seam **22** securing the zipper closure **21** to the suit.

The suit **10** is preferably worn over a one-piece suit of underwear **23** which is partially illustrated in FIG. 3.

The suit **10** is contemplated for use by Apollo flight crews during helicopter or pararescue recoveries where there is an anticipated delay until ship retrieval and the crew is required to man a life raft. It is also anticipated that the crew will don the suit for transfer from the spacecraft to a mobile guarantine facility where the craft is recovered with the crew aboard.

In tests conducted on the suit of the present invention, it was found that the garment was capable of 98 percent containment of living spores of 0.45 micron diameter carried on the body of a test subject and was also capable of protecting the subject to the same degree from spores existing externally of the suit. Since the garment is impervious to particle passage in either direction, its applicability as a garment to protect a wearer in contaminated areas is evident. Thus, the garment may also be worn by the recovery crew who must come into contact with the returned flight crew and their spacecraft.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

What I claim is:

1. A biological isolation garment comprising:
- (a) a single piece suit of flexible, porous material having substantially the shape of the human for completely enclosing a human body and for preventing the passage through said suit of viable particles of approximately .3 to .5 micron size;
- (b) a head piece means included in said suit for positioning over the head of the wearer;
- (c) transparent means included in said head piece means for permitting vision through said head piece;
- (d) an oronasal respirator integrally formed in said head piece and including nose and mouth covering means for confining the wearer's inspired and expired breath and directing it through said head piece;
- (e) filter means of approximately .3 micron size included in said respirator for filtering the inspired an expired breath flowing through said respirator; and
- (f) re-sealable closure means formed in said suit for providing entry to and exit from said suit.

2. The biological isolation garment as described in claim **1** further including:
- (a) sleeves for covering the arms of the wearer; and
- (b) rubber gloves sealed to the lower end of each of the arms of said suit for covering the hands of said wearer and for permitting manual dexterity.

3. The biological isolation garment as defined in claim **1** further including sizing means for adjusting the size of said suit to conform to the body of the wearer.

4. The biological isolation garment as defined in claim **1** wherein said closure means extends substantially from the crotch of the suit, diagonally across the chest, up one side of the head piece and terminates at the top of the head piece.

5. The biological isolation garment as defined in claim **1** wherein:
- (a) the material of said suit is a tightly woven fabric; and
- (b) said suit is constructed with internally sealed fabrication seams.

6. The biological isolation garment as defined in claim **2** further including sizing means for adjusting the size of said suit to conform to the body of the wearer.

7. The biological isolation garment as defined in claim **6** wherein said closure means extends substantially from the crotch of the suit, diagonally across the chest, up one side of the head piece and terminates at the top of the head piece.

8. The biological isolation garment as defined in claim **7** wherein:
- (a) the material of said suit is a tightly woven fabric; and
- (b) said suit is constructed with internally sealed fabrication seams.

9. The biological isolation garment as defined in claim **8** wherein said sizing means include means for adjusting suit size about the waist of said suit and sizing means for

adjusting the size of the legs of such suit substantially along the entire length of said legs.

10. The biological isolation garment as defined in claim 9 further including:

(a) pocket means formed externally of said suit; and

(b) drainage means formed in said pocket means for permitting fluid to drain from said pocket means.

References Cited

UNITED STATES PATENTS

1,931,562	10/1933	Thompson	128—142.5
2,066,706	1/1937	Watters	128—142.5 XR
2,779,331	1/1957	Trexler	128—140
2,886,027	5/1959	Henry	128—1
3,049,896	8/1962	Webb	62—384
3,185,149	5/1965	Rentsch	128—142.5
3,284,805	11/1966	Seeler	2—2

RICHARD A. GAUDET, Primary Examiner

G. F. DUNNE, Assistant Examiner

U.S. Cl. X.R.

128—146.6