Jan. 10, 1961 R. F. WHITE ET AL 2,967,305

FULL PRESSURE FLIGHT SUIT

Filed March 25, 1959 2 Sheets-Sheet 1

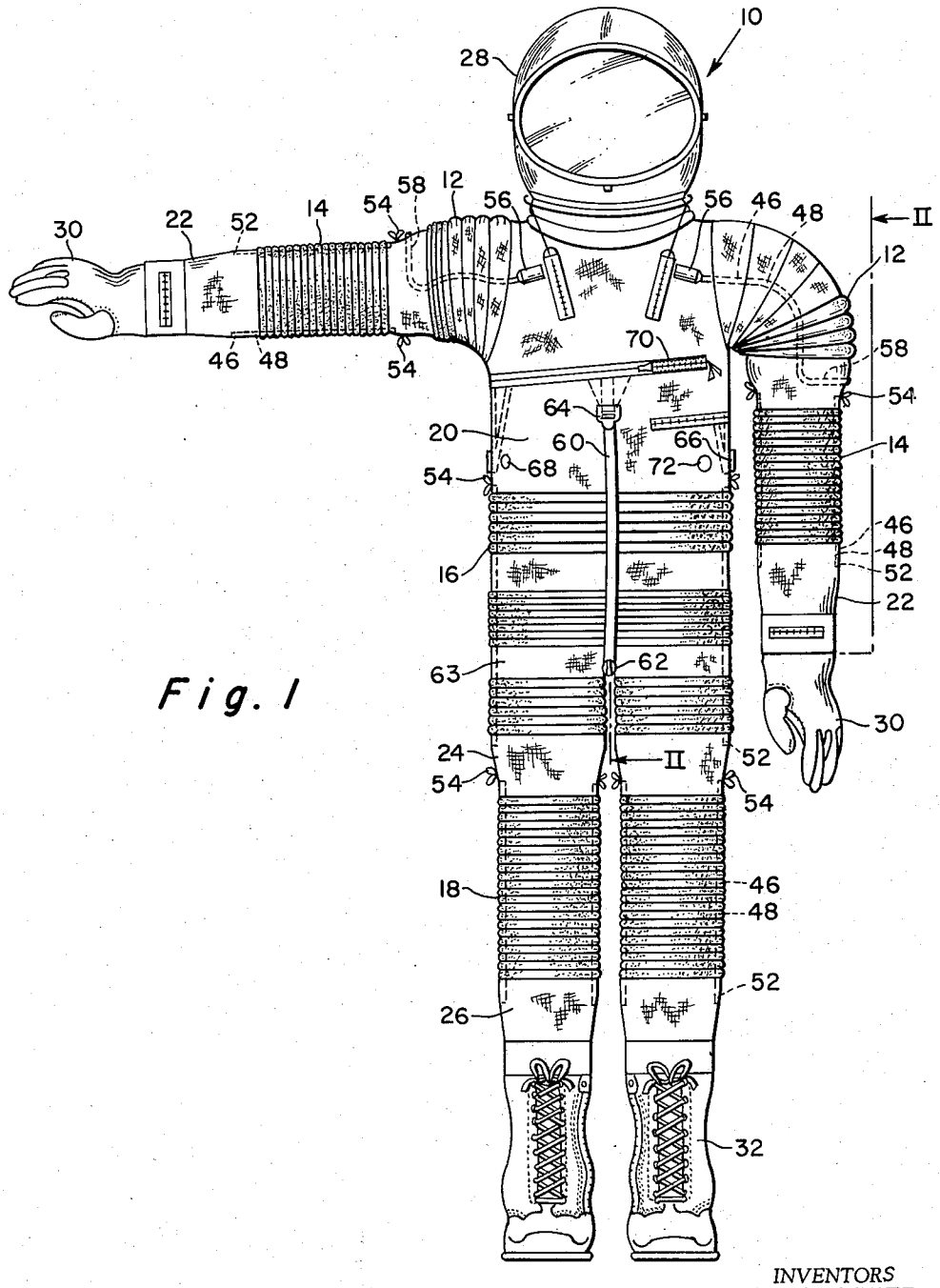


Fig. 1

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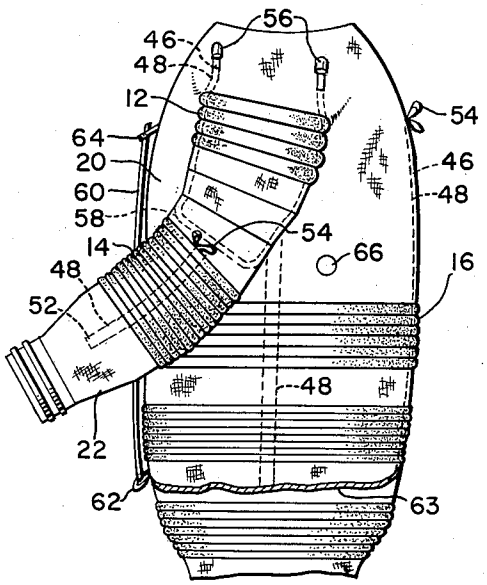


Fig. 2

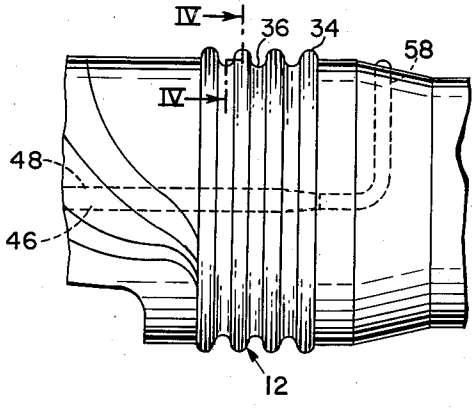


Fig. 3

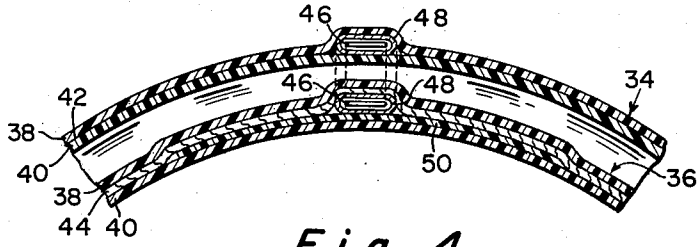


Fig. 4

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United States Patent Office 2,967,305
Patented Jan. 10, 1961

2,967,305

FULL PRESSURE FLIGHT SUIT

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Filed Mar. 25, 1959, Ser. No. 801,978

5 Claims. (Cl. 2—2.1)

This invention relates to flight suits and more particularly to a full-pressure flight suit having optimum mobility and adjustability at the principal body joints of the occupant.

One of the well-known hazards in high altitude aircraft and space flights is the rapid reduction of pressure on the body surface of the occupants with increasing altitude.

A partial solution to this problem has been the development of pressurized cabins and cockpits. However, since pressure can be lost by accidental blowout or puncturing of the cabin, or should the pilot be forced to bail out, the need for individual pressure flight suit protection has been long recognized.

As can be expected, many different pressure flight suits have been developed, however, one important requirement has restricted progress, namely, mobility. To be effective, a pressure suit, besides affording protection, must provide the pilot with the necessary freedom of motion at the various body joints to perform his complex tasks, as well as being comfortable during sitting, standing, and walking. Furthermore, in the event of ditching, the suit must afford the occupant sufficient mobility for survival in water, which may include removal of the suit. It is apparent that a high degree of mobility ensures maximum comfort to the occupant, and avoids some of the psychological factors involved in such an environment.

The present invention comprises a suit of flexible material having a plurality of spaced nonconvoluted tubular sections joined by a plurality of convoluted tubular sections at the principal joints of the occupant, such as the shoulders, elbows, waist, and knees. Each of the smaller diameter folds of the convoluted sections has a nylon cord secured around the periphery thereof to restrain any ballooning effect of the section when the suit is subjected to internal pressure.

Each convoluted section has a pair of oppositely disposed, longitudinal tubes through which are threaded a corresponding flexible tape or the like. One end of each tape is anchored to the suit, the opposite end extending freely beyond the tube for attachment to a respective anchor tie means on the suit whereby the length of the respective convoluted section can be varied according to the size of the user. In the shoulder, a similar pair of tubes are connected together at one end by a rigid or semirigid U-shaped tube. A continuous tape or the like extends through the connected tubes, and the adjacent ends of the tape are attached at the neck portion of the suit. Although the total length of the tape is fixed, the tape is freely slidable through the tubes to afford universal adjustability of the shoulder in perpendicular planes. That is, when one leg of the tape is lengthened by a particular shoulder movement, the other leg is correspondingly shortened to permit the desired shoulder movement.

A principal object of this invention is to provide a

flight suit having optimum mobility and flexibility at the major joints of the occupant.

Another object is to provide such a suit whereby flexible and adjustable tubular sections of the suit are provided at the body joints.

Still another object is to provide a suit having flexible joint at the shoulder which affords a universal movement.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a front elevation view of the novel flight suit showing one arm extended laterally in a plane parallel to the shoulders;

Fig. 2 is a side elevation of the upper torso taken along line II—II of Fig. 1 with one arm swung forward in a plane perpendicular to the shoulders;

Fig. 3 is a partial front elevation of a shoulder and arm portion; and

Fig. 4 is a partial enlarged cross-section of the small and large pleats of a convoluted section taken along line IV—IV of Fig. 3.

Referring to the drawing where like reference numerals refer to the same parts throughout the drawing there is shown in Fig. 1, a full-pressure flight suit **10** made of flexible material having a plurality of hollow convoluted sections, one each at the major body joints, namely, shoulders **12**, elbows **14**, waist **16**, and knees **18** connected together, such as by bonding, by a plurality of, preferably, nonconvoluted hollow sections at other portions of the body, namely, chest **20**, arms **22**, thighs **24**, and legs **26**. The details of the helmet **28**, gloves **30** and shoes **32** and the manner of connection to the suit do not form a part of this invention.

As shown in Figs. 3 and 4, the cylindrical wall of each convoluted section comprises a series of accordion-like pleats of two different diameters alternately disposed, namely, a large diameter pleat **34** and a small diameter pleat **36**. The pleats may have a concentric or spiral relationship. The number and size of the convolutes are optional and depend on the body portion to be accommodated. Each convoluted section, for example shoulder **12** as illustrated in Fig. 4, includes the basic construction of all the convoluted sections differing in a detail to be described.

The suit comprises an inner and outer plies of nylon fabric **38** and **40**, respectively, impregnated and bonded together in a single integral watertight fabric layer by a sandwiched neoprene coating or other suitable sealing material **42**. To prevent ballooning of the convoluted sections by internal air pressure in the suit, a ring of nylon cord **44** is bonded between the layers of the suit around the periphery of each small diameter pleat, as shown in Fig. 4.

Longitudinal expansion of the pleats in each convoluted section is restrained by a pair of oppositely disposed elongate elements, such as nylon tapes **46**, freely threaded through a pair of corresponding flexible tubes **48**. Tubes **48** are securely embedded between fabric layers **38** and **40**. Each tube is flexible to assume the pleated configuration of the convoluted section. Cord **44** encompasses tubes **48** to restrain any ballooning effect on both the tubes and the small diameter pleats. As shown in Fig. 4, an additional reinforcing fabric strip **50** may be embedded between the layers adjacent tube **48**.

The tapes in the torso, arm, and leg convoluted sections extend freely through their respective tubes, one end of each tape being anchored to the suit, such as at point **52**, and the other end extending freely beyond the tube and adapted to be adjustably secured to a

tie means 54 so that the length of the respective convoluted section may be varied to accommodate the size of the occupant. The adjustability in the length of the convoluted sections is an important feature to insure maximum comfort and mobility.

Each pair of tubes 48 of the torso, arm and leg convoluted sections lie in a plane passing through the center of the respective section and perpendicular to a plane in which the respective jointed member moves. For example, the tubes of convoluted arm section 14 of Fig. 1 lie in a plane of the sheet containing the drawing being perpendicular to a plane (normal to the sheet) in which the arm pivotally moves about the elbow.

As heretofore described the convoluted sections of the torso, arm, and leg are substantially identical in construction, except for size, because the joints require a simple pivotal movement of the respective body portion. Shoulder section 12 (Fig. 4) is also similar to the other joints differing only in that a universal movement is required, and the respective tubes and tapes are made continuous to afford such movement as presently described.

In Fig. 1 the ends of shoulder tubes 48 and tapes 46 are anchored to the suit at 56 adjacent the neck, the opposite ends of the tubes being connected together by a U-shaped, semicylindrical tube 58. Connecting tube 58 is preferably made of stainless steel having an inner Teflon tube liner, or Teflon tubing only, to reduce the friction with continuous tape 46 which slides therein. Tube 58 may also be disposed between the fabric layers of the suit.

Shoulder tubes 48 in the embodiment of Figs. 1–4 are aligned with the center of the shoulder section and, when laterally extended lie in a plane perpendicular to a longitudinal plane containing the shoulders. When the arms move in a plane perpendicular to the plane containing the shoulders, see Fig. 2, the forward leg of the tape is decreased the corresponding amount that the rear leg is increased, this movement requiring only enough applied force to cause the tape to slide through the tube. When the arms move laterally in the plane of the shoulers, the continuous tape construction offers free mobility. However, tubes 48 can be located in various other locations depending upon the plane that the least amount of effort is desired.

In addition to the side tapes in the body section, a continuous frontal tape 60 extends from front to back passing through a ring 62 attached to a crotch insert section 63 sewn in the suit. A latch fastener 64 is provided on the frontal portion of tape 60 for shortening this tape when the suit is in the seated position. This shoftening is necessary to keep the body length properly adjusted in the seated position, and to eliminate helmet rise and leg straddle.

Air inlet and outlet 66 and 68, respectively, anti "G" suit fitting 72, and access zipper 70, are provided in chest portion 20 of the suit.

This invention provides a lightweight full-pressure flight suit having convoluted sections, maximum mobility at the various body joints of the pilot to enable him to perform his complex tasks in comfort and to enable him to survive when ditched in water. The convoluted sections are provided with straining cords to prevent a spread-eagle effect on the arms. The convoluted shoulders are constructed to provide a universal movement of the arms at the shoulder joint. Not only do the convoluted sections provide maximum mobility, but they are made adjustable to ensure a better fit, eliminating a custom construction, and accommodating a larger group of pilots, an important consideration in logistics.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. A pressure flight suit comprising a plurality of convoluted cylindrical sections at each of the principal flexure joints of an occupying human body, said convoluted sections each made of a piece of flexible material, flexible longitudinal tubes attached to the flexible material on diametrically opposite sides of the convoluted section and lying in a plane passing through the center thereof, an adjustable flexible elongate restraining member slidably and freely passing through each of said tubes, and means for adjusting the length of the elongate member whereby the corresponding convoluted section may be adjusted in size to accommodate the length of the respective body member of the occupant.

2. The flight suit of claim 1 wherein said convoluted sections are concentric and said flexible material comprises two plies of fabric bonded together, and said tubes are embedded therebetween.

3. The flight suit of claim 1 wherein one of said convoluted sections is for the shoulder, and the ends of the corresponding tubes furthest from a neck portion are connected together by a rigid tube of substantially U-shaped configuration, a single elongate member freely passing through said tubes, and means for securing the ends of the elongate member to the suit adjacent the shoulder.

4. The flight suit of claim 1 wherein one of the convoluted sections is at the waist and said respective elongate members and tubes are positioned at the sides, said waist having an additional flexible tube extending from the back to and through a crotch portion, and an elongate member extending from back to front and being completely free in the front to enable a greater adjustment of the waist portion in any intermediate position between the suit in an erect position and a setting position.

5. A pressure flight suit comprising a plurality of nonconvoluted cylindrical sections connected by convoluted cylindrical sections at each of the principal flexible joints of a human body, said convoluted sections each made of a continuous piece of flexible material formed of at least two layers of fabric bonded together by a sealing material, a tube embedded in the flexible material between said layers on diametrically opposite sides of the section and lying in a plane passing through the center thereof, a tape freely passing through each tube, one end of each tape being secured to a nonconvoluted section, and having a free end, anchor means mounted on another nonconvoluted section for securing the free ends of the tapes whereby the length of an elongate member and the corresponding convoluted section may be adjusted to accommodate the respective body member of the occupant, said suit having a convoluted shoulder joint in which the tubes are connected together by a curved rigid tube of substantially U-shaped configuration, a continuous tape freely extending through said tubes and secured to the suit adjacent a neck section whereby universal movement of the shoulder in perpendicular planes is afforded by slippage of the tapes in the shoulder tubes.

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