



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for
Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,537,107

Government or Corporate Employee : United Aircraft Corporation
Hartford, Connecticut 06108

Supplementary Corporate Source (if applicable) : N/A

NASA Patent Case No. : NMS-09637-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes No

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of

Elizabeth A. Carter

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Enclosure
Copy of Patent cited above

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3,537,107

FORESHORTENED CONVOLUTE SECTION FOR A PRESSURIZED SUIT

Filed Dec. 20, 1968

FIG. 1 N71-24730 FIG. 3

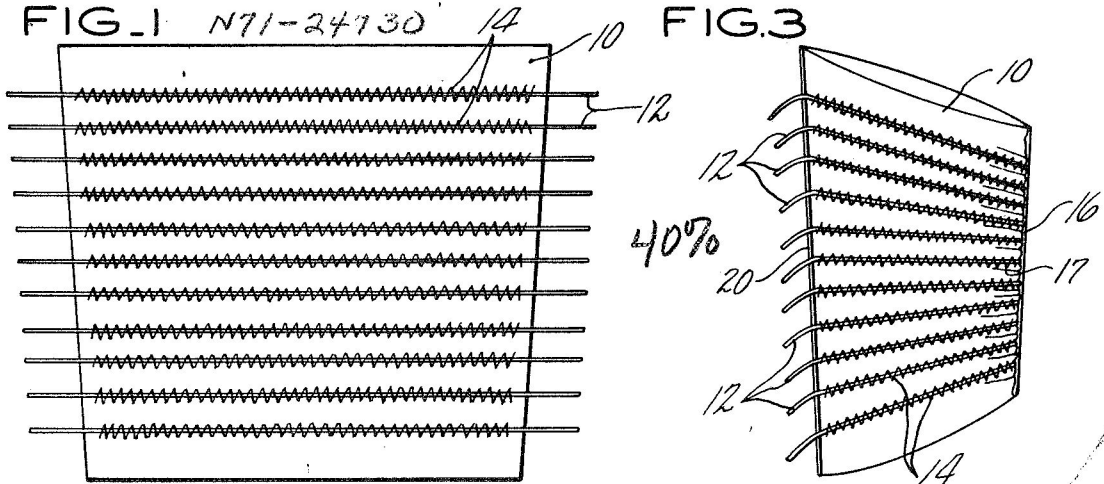


FIG. 2

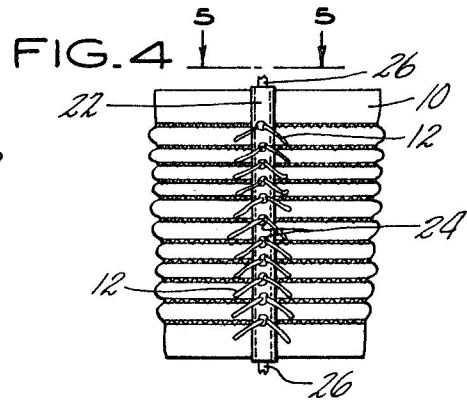
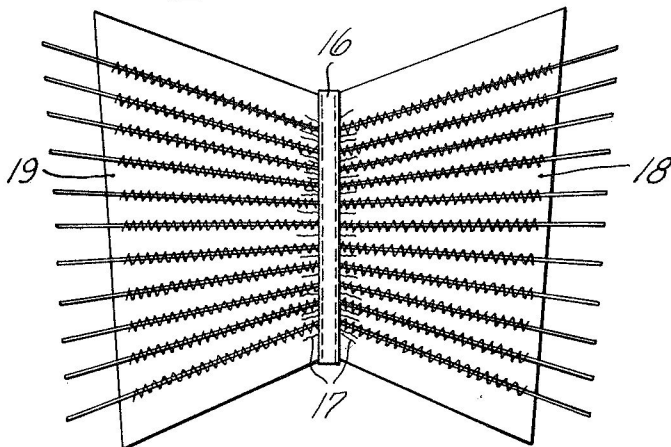


FIG. 6

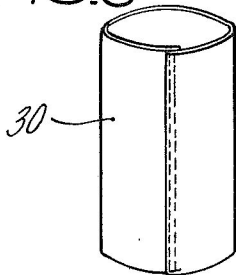


FIG. 7

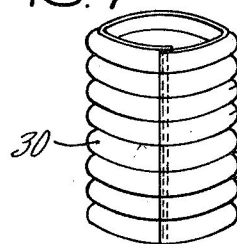


FIG. 8

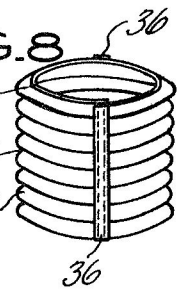
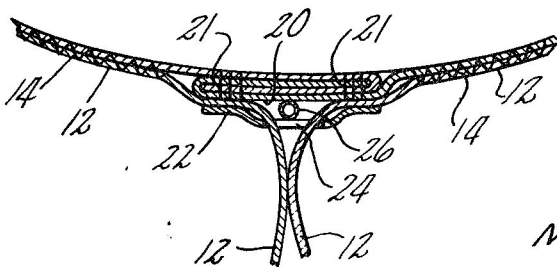


FIG. 5



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3,537,107

**FORESHORTENED CONVOLUTE SECTION
FOR A PRESSURIZED SUIT**

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mesne assignments, to the United States of America as
represented by the Administrator of the National Aero-
nautics and Space Administration

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Int. Cl. A62b 17/00

U.S. Cl. 2—2.1

2 Claims

ABSTRACT OF THE DISCLOSURE

In a first embodiment, root cords are laid on an appropriately shaped piece of flat cloth, and each cord is zigzag stitched to the cloth. Thereafter, a piece of restraint tape stitched to the cloth over the root cords along the middle thereof, the restraint tape being perpendicular to the root cords. As the stitching of the restraint tape proceeds, the cloth, together with the root cords, are bunched underneath the restraint tape so as to foreshorten the entire piece by a desired amount. Thereafter, the piece is bent into a generally cylindrical shape and appropriate edges of the cloth are sewn together. The ends of the root cords are then fitted through appropriately positioned holes in a second restraint tape, and a plastic tube is laid along the seam with the restraint tape over it. Then the second restraint tape is sewn to the seam with bunching of material occurring as the sewing proceeds so as to foreshorten the seam in the same fashion as the midsection was foreshortened. The cords may then be drawn up somewhat and tied so as to form convolutes in the completed assembly.

In the second embodiment, a generally cylindrically shaped piece of restraint cloth has pre-sized root cords or rings.

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

BACKGROUND OF THE INVENTION

Field of invention

This invention relates to pressurized suits such as the type used in high altitude aviation and space exploration, and more particularly to a foreshortened convolute section and methods of making the same.

Description of the prior art

In the art of pressurized suits, formation of convolutes utilizing restraint cloth with suitably disposed restraining root cords or rings is known. In accordance with the teachings of the art heretofore, such convolutes were made by having cords or rings of a pre-established diameter inserted over the cloth in which the convolutes are to be formed. Thereafter, with the application of pressure, the convoluted shape would be assumed.

Such sections are useful as convolute sections for portions of a space suit which do not undergo acute flexion, but merely require a small amount of rotation or minor flexion. Such sections may, for instance, be used in the thigh. On the other hand, convolute sections known to

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the prior art are not useful for portions of the suit such as knees and elbows which require vastly different amounts of cloth along one dimension when the joint is flexed in contrast with the amount of cloth which is required when the joint is in the unflexed condition. In an attempt to overcome this, various solutions have been tried. One such solution is a formation of a convoluted section in which convolutions occur in one direction, but not in the transverse direction. For instance, with such a convolute section, the front and rear of the knee would be convoluted, but the sides of the knee would be substantially flat. However, this type of convolute section can be formed only of moldable materials, such as rubber and the like, and cannot be fashioned of cloth in accordance with the present teachings of the art. Furthermore, such sections are relatively stiff when under pressure, and do not provide the required degree of flexure and ease of flexure in order to permit maximal mobility with a minimum amount of fatigue as required in the utilization of pressurized suits.

SUMMARY OF INVENTION

The object of the present invention is to provide an improved convolute section for a pressurized suit, such section being capable of a high degree of mobility including acute flexure, in response to a minimum of applied torque.

According to the present invention, a cloth convolute section is provided with extra material so as to accommodate large angles of flexure by foreshortening of the section by means of lateral restraints disposed on each side, the cloth to which the lateral restraints are affixed being puckered in order to foreshorten the assembly.

The present invention not only provides a cloth convolute section capable of a high degree of flexion as a result of relatively low torque, but it is capable of manufacture in accordance with an extremely simple method, and is capable of incorporating improved pressurized suit features.

The foregoing and other objects, features and advantages of the present invention will become more apparent in the light of the following detailed description of preferred embodiments thereof as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation of a flat piece of restraint cloth having root cords disposed thereon as a result of the first steps of manufacture of a foreshortened convolute in accordance with one embodiment of the present invention;

FIG. 2 is a side elevation of the embodiment of the invention shown in FIG. 1 after an additional step of foreshortening the convolute assembly with a restraint tape;

FIG. 3 is a front perspective view of the embodiment of the invention shown in FIGS. 1 and 2 after being joined so as to assume a generally cylindrical shape;

FIG. 4 is a side elevation of the embodiment of the invention as illustrated in FIGS. 1-3 after the cylinder-forming seam is foreshortened by being stitched with a restraint tape;

FIG. 5 is a section taken on the line 5-5 of FIG. 4;

FIG. 6 is a perspective of a basic cloth section of a second embodiment of the invention;

FIG. 7 is a perspective of the embodiment of FIG. 6 after convolutes have been formed thereon;

FIG. 8 is a perspective of the embodiment illustrated in FIGS. 6 and 7 after it has been foreshortened by being stitched with a restraint tape in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1-5, one embodiment of the invention utilizes a piece of flat cloth 10, which may be rectangular if a cylindrical convolute section is desired, or may be slightly rhombic as shown in FIG. 1 in order to provide a somewhat tapered tubular section. As a first step in the preparation of a convolute section in accordance with the present invention, a plurality of root cords 12 are stitched to the restraint cloth 10 by zigzag stitches 14 which are sufficiently loose to enable sliding of the cords 12 beneath the stitches 14, as is described more fully hereinafter. In FIG. 2, a restraint tape has been placed along the center of the cloth 10 over the cords and stitches 12, 14 and substantially parallel to the edges 18, 19 of the cloth 10. The restraint tape 16 has been sewed to the cloth 10 as portions 17 of cloth 10 are puckered under it, so as to more or less uniformly foreshorten the cloth 10 underneath the restraint tape 16, while securing the tape 16 to the puckered cloth 17. Thus, if the cloth 10 were initially ten inches long, it may, for instance, become seven inches long as a result of puckering under the stitching of the restraint tape 16. The next step is illustrated in FIG. 3; the cloth 10 has been closed upon itself so as to form a cylinder, the edges 18 and 19 (FIG. 2) have been joined at a seam 20 (FIG. 3) so as to form a generally cylindrical or tubular tapered section which is, however, skewed due to the fact that the side underneath the restraint tape 16 has been foreshortened, whereas the side along the seam 20 has not been foreshortened.

In FIG. 4, an additional restraint tape 22 has been sewn over the seam 20 so as to foreshorten the assembly along the seam 20. In this case, the restraint tape 22 is provided with a plurality of holes 24, one for each of the root cords 12. In a restraint tape made of woven nylon, or other plastic-like material, the holes 24 are conveniently formed by burning, such as with a soldering iron; this not only is an easy way to form a hole, but fuses the edges of the hole so as to prevent ravelling of the cloth. In the process of securing the restraint tape 22 to the convolute assembly, the root cords 12 are fed through appropriate holes, and then a tube of polyfluorocarbon (such as that sold under the trade name "Teflon") or other suitable plastic tube 26 may be positioned along the seam 20 as shown more clearly in FIG. 5. Thereafter, the restraint tape 22 can be sewn (21) to the seam 20 thus capturing the tube 26. Note that the seam 21 along the restraint tape 22 is intermittent, so that the root cords 12 are not stitched down as a result of stitching the restraint tape 22 to the seam 20. This permits the cords 12 to be drawn up tightly, sliding underneath the portions of the restraint tape 22 and sliding within the zig-zag stitching 14. To complete the convolute assembly utilizing the method outline with respect to FIGS. 1-5 herein, each of the root cords may be drawn until it is the proper length, and a square knot tied therein. The tubing 26 is disposed underneath the restraint tape 22 in order to permit sliding a restraint cable, which may comprise plastic coated stainless steel or other suitable material, through the tube 26. This cable may terminate at opposite ends of the convolute assembly in accordance herewith, or may be part of a longer restraint system that terminates remotely from the convolute assembly in accordance herewith, as necessary to suit any utilization of the present invention.

A second embodiment of the invention may include a basic cylindrical structure 30 formed of a piece of flat cloth as illustrated in FIG. 6. Thereafter, root cords 32

or rings of a lesser circumference than that of the cylindrical cloth 30 may be slipped over the cloth 30 so as to form convolutes 34 in the cloth 30. Thereafter, the convolute section illustrated in FIG. 7 may have a pair of mutually parallel restraint tapes 36 (FIG. 8) sewn on opposite sides thereof concurrently with puckering of the cloth so as to foreshorten the section as illustrated in FIG. 8. In this embodiment, the foreshortening of both sides may preferably be performed after the cloth is formed into a generally cylindrical section and the root cords applied, as illustrated in FIGS. 6-8.

The result of the present invention is to provide convolutes which are much deeper (that is, with the root being of a significantly lesser diameter than the outer diameter of the section) than is obtainable with prior art convolute sections. Sufficient material is thereby provided so that when the convolute assembly is flexed (such as bending the top to the right or left in FIG. 4 or 8) the degree of flexure will not be limited by the ultimate amount of available cloth along the long side of the bend. As an example, in the case of a knee or an elbow, when the joint is flexed, a large amount of cloth is required at the outside of the bend. This cloth on the other hand must be provided from a convolute section which is not too long for the other design criteria when in the unflexed condition. A foreshortened convolute section in accordance with the present invention thus accommodates a general length of convolute section and sufficient material for acute flexure.

Although the invention has been shown and described with respect to a pair of preferred embodiments thereof, it should be understood by those skilled in the art that the general shape (cylindrical or tapered) of the convolute section made in accordance herewith, the size of the section, or the precise method of manufacture of the section are not germane to the present invention. Also, it should be understood that other changes and omissions in the form and detail thereof may be made therein without departing from the spirit and the scope of the invention.

Having thus described typical embodiments of my invention, that which I claim as new and desire to secure by Letters Patent of the United States is:

1. In the method of manufacturing a cloth convolute section capable of flexure through large angles, the steps of:

- disposing a plurality of root cords on a cloth;
 - positioning a first restraint tape adjacent to said cloth substantially perpendicularly with respect to said root cords;
 - simultaneously stitching said first restraint tape to said cloth and bunching said cloth underneath said stitching so as to foreshorten the cloth in its dimension parallel with said restraint tape;
 - joining together the two edges of said cloth which are parallel with said first restraint tape so as to form said cloth into a generally cylindrical section;
 - positioning a second restraint tape adjacent to said cloth substantially parallel with respect to said first restraint tape, and substantially diametrically opposite to said first restraint tape; and
 - simultaneously stitching said second restraint tape to said cloth and bunching said cloth underneath said stitching so as to foreshorten the cloth in its dimension parallel with said second restraining tape.
2. A foreshortened cloth convolute section for a pressurized suit comprising:
- a generally cylindrical cloth member;
 - a plurality of root cords causing said cloth to form convolutes;
 - a plurality of restraint members on opposite sides of said cloth member and disposed parallel to the axis thereof, said cloth member being puckered underneath said restraining members;
 - and means securing the puckered portions of said cloth member to said restraining members to shorten said generally cylindrical cloth member in a direction

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parallel to the axis thereof, thereby forming the fore-shortened cloth convolute section.

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U.S. Cl. X.R.

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