Feb. 23, 1971 J. C. HARDY ET AL 3,564,611

LOWER SHOULDER FOR A PRESSURIZED SUIT

Filed Dec. 20, 1968

FIG. 1

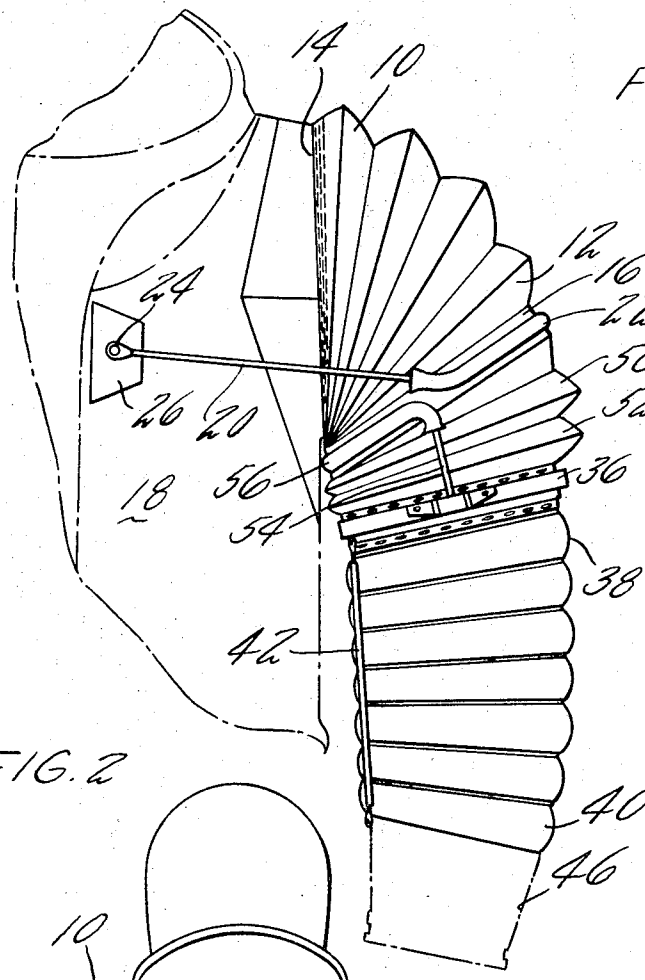


FIG. 4

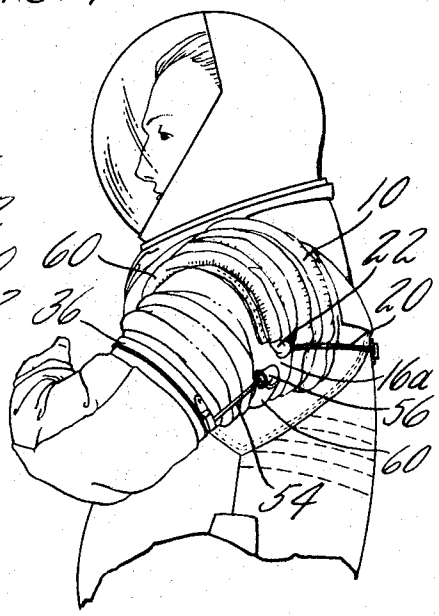


FIG. 2

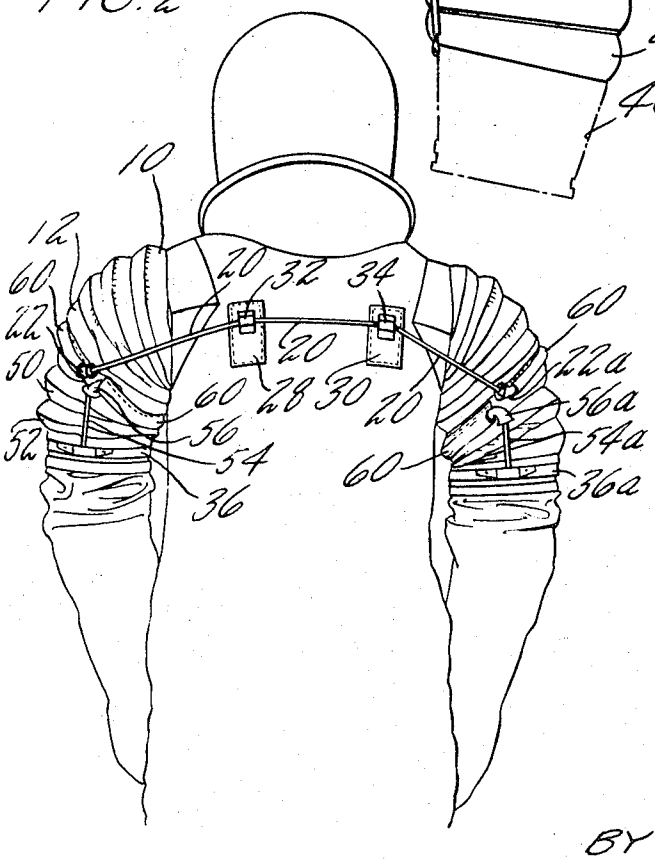
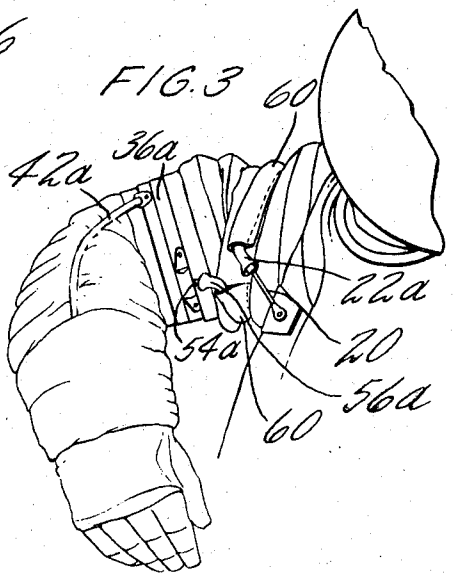


FIG. 3



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LOWER SHOULDER FOR A PRESSURIZED SUIT

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U.S. Cl. 2—2.1 2 Claims

ABSTRACT OF THE DISCLOSURE

Plug load restraints with a medial turnaround are located in the sagittal plane between a main shoulder turn-around guide and an arm bearing in the lower shoulder of a pressurized suit, thereby to increase mobility of the arm and the shoulder. The lower shoulder restraint system includes pre-shaped convolutes fabricated of restraint cloth.

BACKGROUND OF THE INVENTION

Field of invention

This invention relates to pressurized suits of the type utilized in high altitude aviation and space exploration, and more particularly to an improved lower shoulder restraint system therefor.

Description of the prior art

In the field of pressurized suits, it has long been known that suits become extremely stiff when under pressure. Additionally, the tendency toward growth must be restrained in order to prevent the entire suit from blowing outwardly and stretching, just as does a toy balloon. The restraints also tend to reduce mobility of the suit. Thus, between the restraints and the natural stiffness of the suit as a result of internal pressure, it is difficult to provide joints which allow a suitable degree of freedom of mobility of the wearer, and which do not require an excessive amount of exertion on the part of the wearer in order to flex, extend, stretch or rotate various parts of the body.

In order to overcome this, various innovations in joints and interfaces between the various parts of the suit have been developed. One innovation is the utilization of turnaround cable restraints at the upper shoulder. Such a restraint begins at a point of termination in the upper chest in the front, travels around the shoulder (high up on the bicep) to a point located near the center of the back. The cable passes through a turnaround located on the shoulder, so that as the shoulder is moved forwardly and backwardly the turnaround will slip along the restraint cable and allow the suit shoulder to follow the shoulder of the wearer. Similarly, up and down motion of the shoulder is relatively simple because the cable pivots at its termination points quite readily. Such a shoulder restraint section serves the basic need of shoulder motion, but does not allow a full degree of arm freedom in permitting a completely neutral or arms down position while at rest, or in full adduction of the arm (which occurs when the arm is stretched across the front of the chest).

SUMMARY OF INVENTION

The object of the present invention is to provide increased mobility for the arms and shoulders in a pressurized suit.

According to the present invention, a restraint system includes plug load restraints located in the sagittal plane of the upper arm or lower shoulder, with a medial turnaround joining the front and rear sections of the restraint. According still further with the present invention, a lower shoulder restraint system comprises pre-shaped convolutes fabricated of restraint cloth.

A lower shoulder in accordance with the present invention operates in conjunction with an upper shoulder, an arm bearing, and other parts of a pressurized suit so as to permit a completely neutral or arms down position of the arm, and to allow almost complete degree of freedom in rotation, flexion and extension. The invention is far less bulky than lower shoulders known to the prior art, and is readily manufactured and reliable.

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 a preferred embodiment thereof, as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a front elevation of arm and shoulder sections incorporating the present invention;

FIG. 2 is a partial back elevation of an actual pressurized suit illustrating the present invention;

FIG. 3 is a perspective illustration of extreme adductive flexion according to the present invention; and

FIG. 4 is a side elevation illustrating the rear of the lower shoulder when in extreme adductive flexion.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, an upper shoulder assembly comprises a number of convolutes **10–12** connected between the scye **14** and a substantially rigid member or ring **16**. The upper shoulder is stabilized with respect to the remainder of the suit due to its attachment to a torso portion **18** at the scye **14**, and due to restraint provided by a shoulder restraint cable **20** which passes through a turnaround guide **22** located on the rigid ring **16**. The shoulder restraint cable **20** is disposed to the torso **18** at a pivot point **24** which may be conveniently attached to a plate or other terminous **26** located on the torso **18**. The terminus or plate **26** may conveniently be sewn into the fabric of the restraint torso **18**. As is illustrated in FIG. 2, the upper shoulder restraint cable **20** may, if desired, extend from the pivot **24** around one arm, across the back, and around the other arm to a similar pivot on the opposite side of the chest. Alternatively, the cable **24** may terminate on each side of the upper back at respective plates **28**, **30** thus isolating each shoulder from the other. However, in the embodiment shown herein, the cable **20** passes through guides **32**, **34** located on the plates **28**, **30** and each shoulder is therefore stabilized in conjunction with the opposite shoulder. The upper shoulder restraint cable and turnaround assembly as illustrated in FIGS. 1 and 2 and described thus far are known to the art and do not form a part of the invention herein, except as part of a suitable environment for utilization of the present invention.

The arm of the space suit comprises an arm bearing **36** which is a ball bearing capable of allowing complete rotation of the lower arm about its axis relative to the upper arm, and vice versa. The lower arm includes a convolute section employing a number of convolutes **38–40** and may be provided with lateral plug load restraint cables **42** (FIG. 1) and **42***a* (FIG. 3). As shown in phantom, suitable transition means **46** may be provided in order to permit joinder of the arm with a glove assembly. It should be borne in mind that FIGS. 1 and 4 illustrate the left arm, and FIG. 3 illustrates the right arm. However, the right arm is entirely similar to the left arm, including an arm bearing **36***a*, and an upper restraint turn-around guide **22***a*. The ring **16** and bearing

36 may be joined by convolute sections, such as convolutes 50, 52.

An arm assembly as described thus far provides a fair amount of shoulder mobility, but does not permit a completely neutral, or arms down position, and is limited in the adduction of the arm. In providing shoulder motion, the turnaround guide 22 slides along the upper shoulder restraint cable 20 if the shoulder is flexed forwardly or backwardly, and the cable 20 pivots about the point 24 whenever the arm is raised and lowered.

To permit a completely neutral or arms down position, and to increase maximum angles of arm flexion, the present invention provides a sagittal restraint 54, 54*a* for each arm, each of which passes through a respective lower shoulder turnaround 56, 56*a* thus providing plug load restraint between the ring 16, 16*a* and the arm bearing 36, 36*a*, without limiting the degree of freedom of motion. It is to be noted that any restraint cable functioning in the lower shoulder (or upper arm area) of pressurized suits known to the art has been a lateral restraint (somewhat similar to restraint cables 42 and 42*a* herein). One aspect of the present invention is providing the plug load restraint for the lower shoulder in the sagittal plane (the plane running from front to back) rather than in the frontal plane (a plane running from side to side, as are the lateral restraints 42, 42*a*). With lower shoulder plug load restraints located in the frontal plane, it is impossible to achieve a fully neutral, arms-down position. Referring to FIG. 2, it can be seen that each of the arm bearings 36, 36*a* is substantially perfectly horizontal and therefore a completely neutral or arms down position is possible in accordance with the present invention. Note that FIG. 1 is semi-schematic in nature, and so the non-horizontal arm bearings 36, 36*a* are not indicative of the true capability of the invention. Thus the lower shoulder sagittal restraint cables 54, 54*a* are neutrally located within their respective turnaround guides 56, 56*a*. On the other hand, the present invention permits complete adduction of the arm, as is illustrated with respect to the right arm in FIG. 3 and with respect to the left arm in FIG. 4. It can be noticed that the lower shoulder sagittal restraint cable 54*a* is barely visible in FIG. 3 as a result of the cable restraint guide 56*a* having slid along it substantially to the terminal point of the cable 54*a* at the arm bearing 36*a*. Similarly, FIG. 4 illustrates that the cable 54 at the back of the left arm has become elongated (bearing in mind that FIG. 4 is partially perspective in the area of the lower shoulder as seen therein), the arm bearing 36 having been drawn a good distance away from the ring 16*a* to which the lower shoulder turnaround guide is disposed.

Although it appears unlikely that sagittal restraint cables will provide the motion required, it has been found that, as illustrated in FIGS. 2, 3 and 4 herein, provision of the plug load restraint in the sagittal plane, in accordance with the present invention, does indeed supplement the upper shoulder assembly and permits a complete degree of freedom of motion from full adduction of the arm to a completely neutral arms down position. Obviously, the sagittal restraint also aids in backward flexion and forward flexion of the arm.

A second aspect of the present invention is that the turnaround guides 56, 56*a* are located on the inside of the arm, and therefore are positionally complementary

to the turnaround guides 22, 22*a*. This reduces the bulk at the outside of the shoulder and tends to equalize the stress on the ring 16, 16*a* whereby its strength may be less than it would have to be if both sets of turnaround guides were located on the outside perimeter of the shoulder.

An additional feature of the present invention is the combination of the pre-shaped convolutes 50, 52 with the lower shoulder restraint, such as restraint 54 herein.

It should be noted that the turnaround restraint function can be achieved by providing termination of the restraint 54 on the proximal rigid member, such as the ring 16, both in the front and the back, and providing a turnaround guide on the distal rigid member, such as the bearing 36. This is possible because the function of the present invention is to limit the combined distance in the front and in the back of the ring 16 from the bearing 36.

As illustrated in FIGS. 2, 3 and 4, the turnaround guides 22, 22*a*, 56, 56*a* are shown with covers 60 thereon.

Although the invention has been shown and described with respect to a preferred embodiment thereof, it should be understood by those skilled in the art that the foregoing and various 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 a typical embodiment of our invention that which we claim as new and desire to secure by Letters Patent of the United States is:

1. In a pressurized suit, a lower shoulder and upper arm assembly comprising:

a convoluted fabric upper arm section;

a pair of annular, substantially rigid members secured to said upper arm section, each member circumscribing said upper arm section, said members being axially displaced along said upper arm section in relatively distal and proximal positions, respectively;

a turnaround guide means secured to a first one of said members and extending around substantially half the periphery thereof; and

a plug load restraint cable affixed at front and rear points, substantially within a plane extending from front to back and parallel with the longitudinal axis of said upper arm section, on a second one of said members and passing through said guide means, said guide means adapted to permit said restraint cable to slide therewithin.

2. The lower shoulder assembly according to claim 1 wherein one of said members comprises a stabilizing support ring adapted to receive an upper shoulder turnaround assembly and the other of said members comprises an arm bearing.

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