Feb. 2, 1971 E. G. VAIL 3,559,209

SPACE SUIT PROTECTIVE ASSEMBLY

Filed March 17, 1967 3 Sheets-Sheet 1

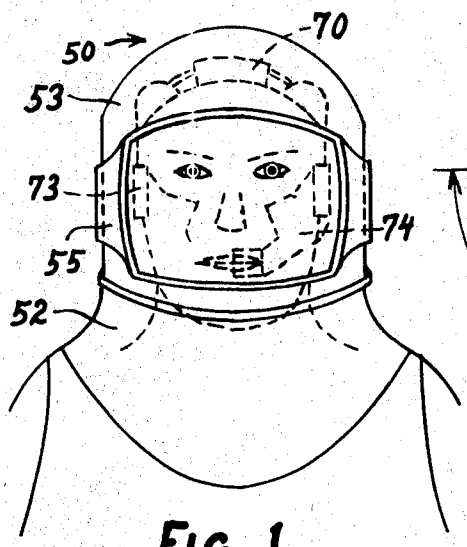


FIG. 1

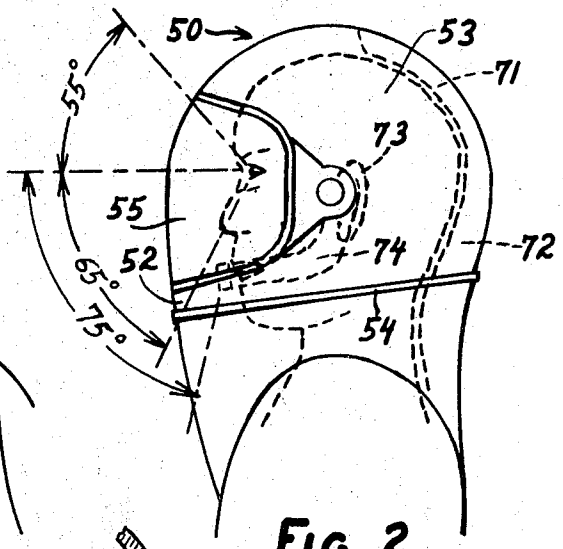


FIG. 2

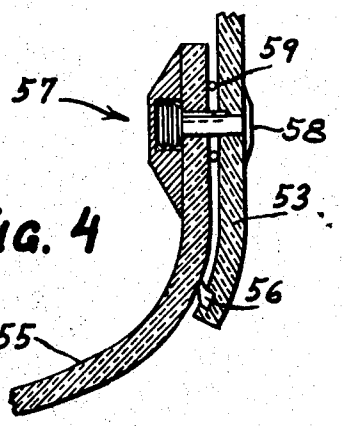


FIG. 4

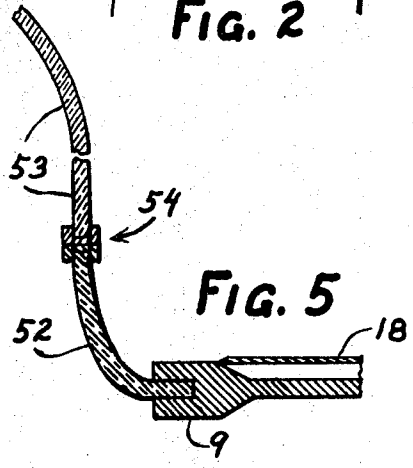


FIG. 5

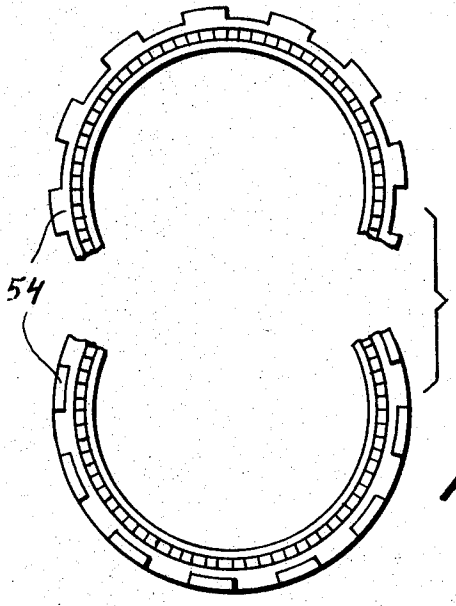


FIG. 3C

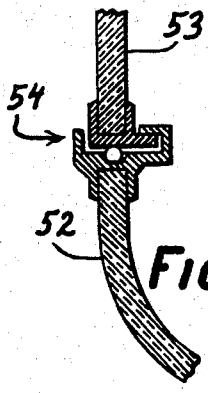


FIG. 3A

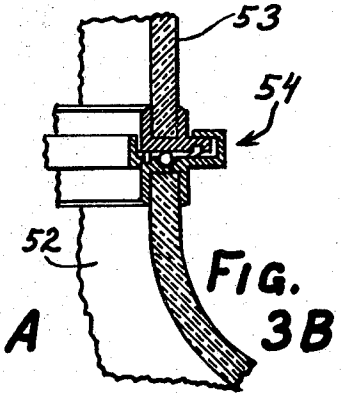


FIG. 3B

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SPACE SUIT PROTECTIVE ASSEMBLY

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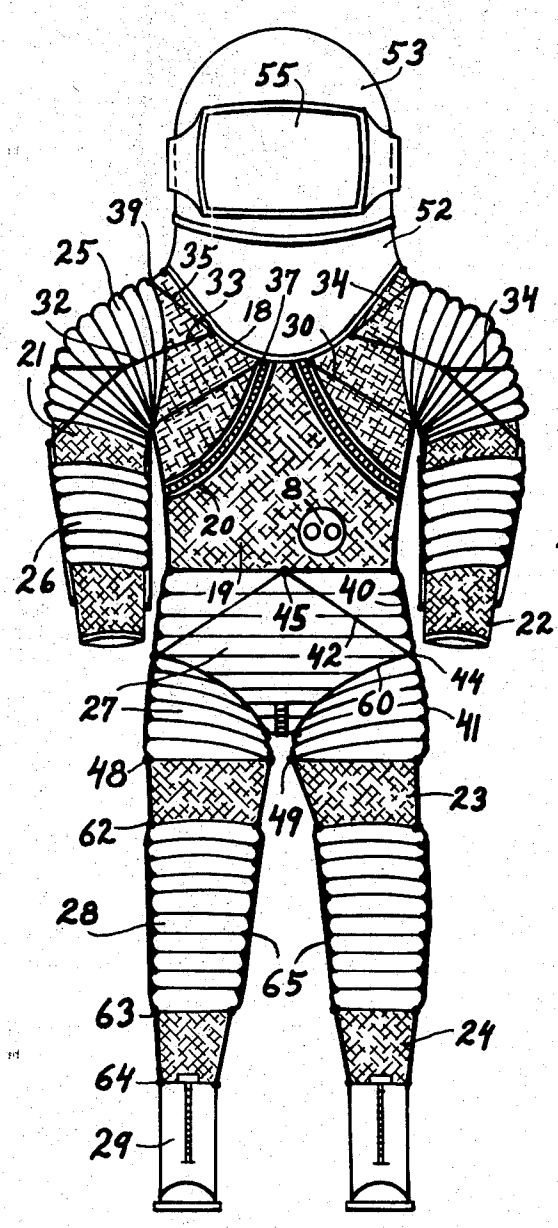


FIG. 6

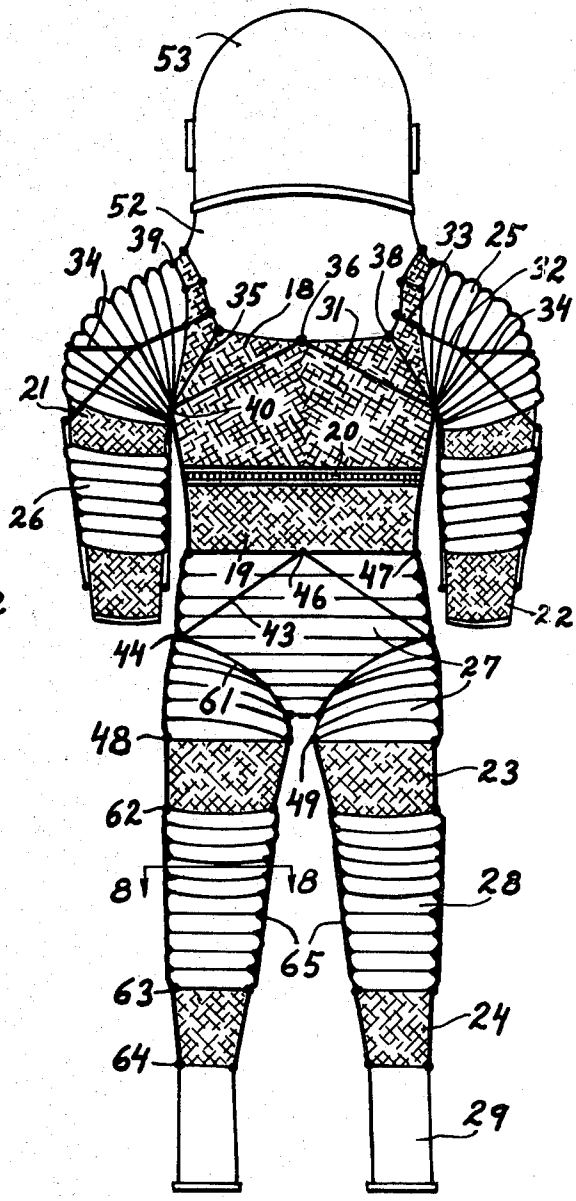


FIG. 7

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SPACE SUIT PROTECTIVE ASSEMBLY

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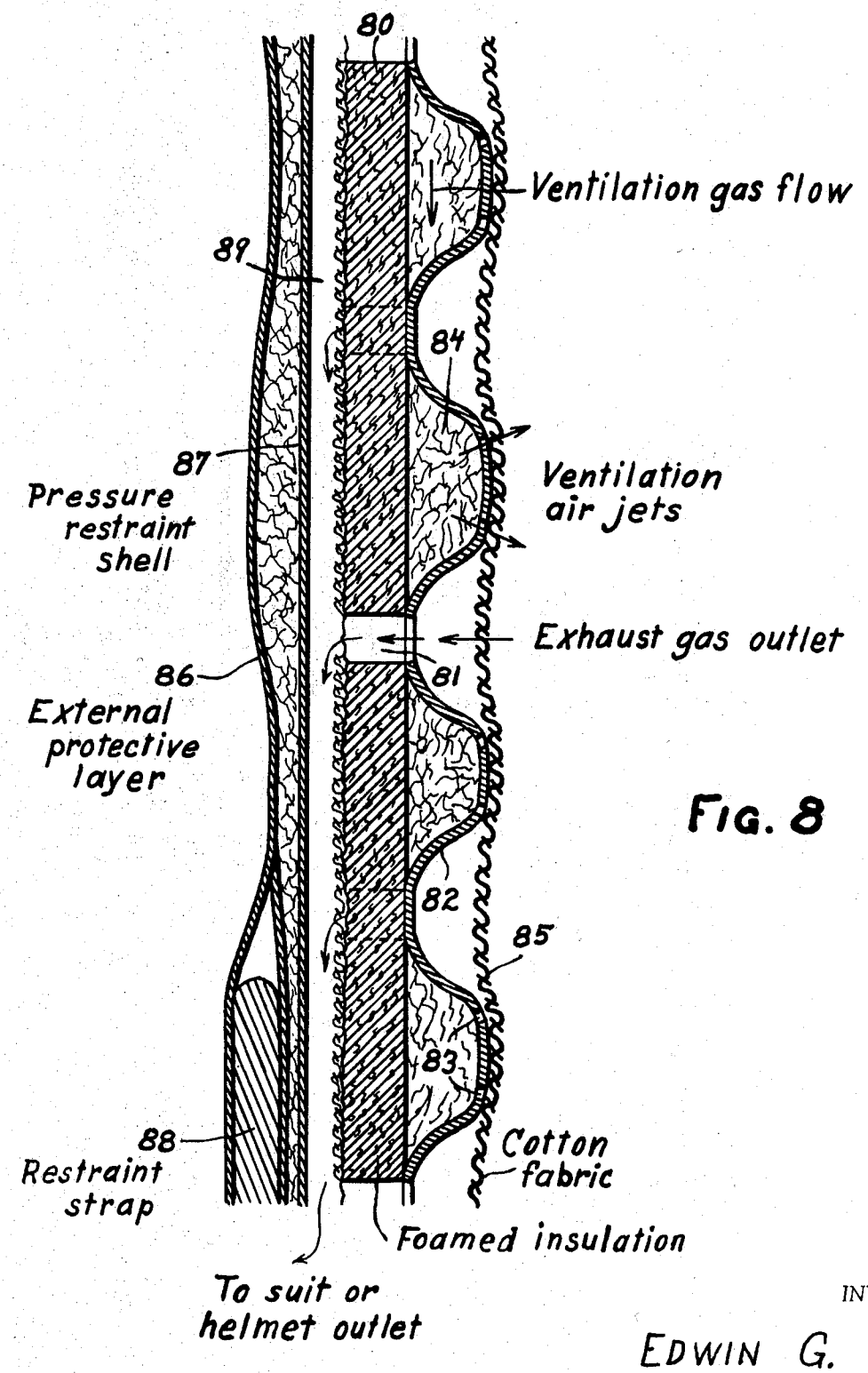


FIG. 8

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United States Patent Office

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Patented Feb. 2, 1971

3,559,209

SPACE SUIT PROTECTIVE ASSEMBLY

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Filed Mar. 17, 1967, Ser. No. 624,028
Int. Cl. A62b *17/00*
U.S. Cl. 2—2.1 6 Claims

ABSTRACT OF THE DISCLOSURE

A space suit comprising a helmet formed of an upper and a lower section with a fluid-tight detachable connection in the region of the neck, an upper torso section permanently joined to the lower helmet section and provided with arm coverings, a lower torso section joined to the upper torso section by a detachable fluid-tight zipperlike junction extending horizontally around the rear of the body and converging upwardly in front, the upper torso section being formed of a woven fabric positioned on a bias, the lower torso section being formed of an upper portion of woven fabric and a lower corrugated portion covering the waist and hip joint region, the lower corrugated portion carrying leg coverings, an integrated system of tensile members connecting each arm covering with the lower edge of the lower helmet section and another integrated system of tensile members connecting each leg covering with the junction between the fabric portion and the corrugated portion of the lower torso section.

BACKGROUND OF THE INVENTION

The field of the invention is guard and protective apparel for use under variable atmospheric conditions. The invention is particularly related to new devices and improvements in space suit protective assemblies for use by aviators or astronauts in extreme altitude or orbiting space vehicles such as Dyna Soar to provide emergency and mission completion capability. Integrated protection is provided against extremes of low barometric pressure, high and low temperatures, ionizing and nonionizing radiation, multiple accelerations, whole-body restraint, and buffeting and anti-gravity effects. An object of the invention is to provide improved comfort and mobility under the above pressurized operating conditions.

In some of the prior inflatable garments for the above and similar purposes, the pressure medium is admitted within a pressure container. All such garments tend to become very rigid upon inflation, tending to immobilize the wearer, resist the use and flexure of any joint such as the shoulder, neck, elbow, waist-hip, knees and wrist. In any such pressurizing garment, the fact that pressurization increases the circumference and length of the garment, makes it difficult for the wearer to maintain the body position and stability required to effectively perform a variety of tasks within or without aerospace vehicles.

The state of the prior art may be determined by reference to U.S. Pats. 2,401,632; 2,834,965 and 2,954,562.

SUMMARY OF THE INVENTION

Having in mind the limitations of the prior art, it is an object of the present invention to provide an inflatable garment that is designed on an anatomical basis with integration of the required multiple protection devices. Such a design approach incorporates aeronautical engineering principles of stressed skin construction utilizing to a maximum the forces inherent in the pressure containing material and vectoring these forces in such a manner that they contribute to coordinated movement, stability and comfort of the space suit protective assembly under non-pressurized as well as pressurized conditions.

This invention provides a pressurized garment for operation under an external pressure of from 0 to 5 p.s.i., which meets all the requirements for protection in outer space, without encountering the difficulties and disadvantages of previous pressure suit designs. This improved garment, as described below, creates through its own inflation multiple cooperative tensile and lever systems supported by composite joints which aid the astronaut in accomplishing more nearly normal body movement while in the pressurized garment.

It is intended that this garment be donned before take-off and worn during the entire mission, or may be donned before take-off and worn during launch and entry into a programmed orbit or trajectory and then removed during orbiting but maintained as a stand-by emergency garment, or may be donned during orbital flight for purposes of leaving the vehicle to accomplish scientific experiments or to inspect hostile or friendly satellites, to assemble space stations or platforms, and to repair, service or maintain space vehicles, and may then be again donned for re-entry and landing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of the helmet attached to the upper portion of the space suit;

FIG. 2 is a profile of FIG. 1;

FIGS. 3A, 3B and 3C are fragmentary views of the helmet disconnecting ring;

FIG. 4 is a fragmentary view in cross-section of the pivotal mounting of the visor;

FIG. 5 is a fragmentary view in cross-section of the transition from the helmet to the space suit;

FIGS. 6 and 7 are front and rear views of the space suit in its entirety; and

FIG. 8 is a cross-section through a portion of the wall of the space garment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Some of the presently available pressurized garments have joints which restrict the normal movements of the shoulder, neck, hip-waist, knee and elbows, thereby limiting their adaptability. This invention provides for greater mobility in the joint areas in relation to the skin surface and distance changes of a man during normal joint movement in each area. The dimensional changes indicated below are the changes in inches between the designated anatomical points during normal movement and are provided for in the fundamental design of each joint area.

TABLE 1

	Mean (change, inches)
(A) Shoulder movement:	
Anterior:	
Suprasternal—acromion:	
Protrusion	—.87
Abduction, horizontal	—.48
Sternum to scye:	
Protrusion	—1.13
Retraction	—1.09
Abduction, horizontal	.97
Scye to mid-arm:	
Protrusion	—.33
Retraction	.72
Abduction, horizontal	.58
Posterior:	
Cervical to acromion:	
Protrusion	—.21
Retraction	—1.01
Abduction, horizontal	—1.94
Abduction, overhead	—3.44
Vertebra to scye:	
Protrusion	—3.66
Abduction, horizontal	.79
Abduction, overhead	2.27
Posterior scye to mid-arm:	
Protrusion	1.88
Abduction, horizontal	.61
Abduction, overhead	1.81
Lateral—acromion to mid-arm:	
Protrusion	—1.25
Retraction	—.96
Abduction, horizontal	—1.46
Abduction, overhead	—2.25
(B) Hip movement:	
Anterior (ant. sup. spine level to ¾ thigh):	
Hyperextension	.52
Hanging, sitting, 90°	—2.64
Posterior:	
Flexion, forced, sitting	6.00
Hyperextension	—.36
Hanging, sitting, 90°	3.40
Lateral—abduction	—1.23
(C) Trunk movement:	
(Coccyx tip to cervical, sitting):	
Flexion, full anterior	3.98

Consideration will now be given to the mean difference of dimensional changes in the shoulder joint and to the movement required under pressurized conditions at 5 p.s.i. operating pressure. For anterior movement of arm and shoulder, (1) protrusion of the arm and shoulder results in a decrease of —0.87 inch in the distance from the suprasternal notch to the acromion; (2) horizontal abduction of the arm and shoulder results in a change of —0.48 inch between the suprasternal notch and the acromion; simultaneously, (3) protrusion of the arm and shoulder results in a change of —1.13 inches between the sternum at scye level and the arm scye point. Similarly, (4) retraction of the arm and shoulder results in a change of 1.09 inches between the sternum at scye level and the arm scye point while, (5) horizontal abduction results in a change of 0.97 inch between the sterum at scye level and the arm scye point.

These dimensional changes must integrate with the changes occurring between the anterior and posterior arm scye points and the mid-arm line. The following mean changes occur anteriorly: (1) protrusion of the arm and shoulder results in a —0.33 inch change between the anterior arm scye point and the mid-arm line; (2) retraction of the arm and shoulder results in a mean change of 0.72 inch between anterior arm scye point and the mid-arm line; while (3) horizontal abduction of the arm and shoulder results in a mean change of 0.58 inch between the anterior arm scye point and the mid-arm line. On the lateral surface pertinent changes occur between the acromion to mid-arm line. During (1) protrusion the distance changes —1.25 inches; during (2) retraction the distance changes —0.96 inch; during (3) horizontal abduction the lateral distance change is —1.46 inches; and during (4) overhead abduction the distance change is —2.25 inches.

Simultaneously, posterior surface changes must be considered. These are referenced from the cervical-to-acromion distance changes and from the vertebra at arm scye level to the posterior arm scye point. (1) Protrusion of the arm and shoulder results in a change of —0.21 inch between the cervical and the acromion while (2) retraction results in a change of —1.01 inches between the cervical and the acromion. During (3) horizontal abduction the change is —1.94 inches between the cervical and the acromion, and (4) overhead abduction results in a change of —3.44 inches between the cervical and the acromion.

Simultaneously the following mean changes occur between the vertebra-at-scye level to the posterior scye point. During (1) protrusion of the arm and shoulder a change of 3.66 inches occurs, while (2) horizontal abduction results in a change of 0.79 inch and in (3) overhead abduction the distance change is 2.27 inches. Simultaneously, the distance changes between the posterior scye point and the mid-arm lines as follows: (1) protrusion results in a distance change of 1.88 inches, while (2) in horizontal abduction the change is 0.61 inch and in (3) overhead abduction the change is 1.81 inches.

This invention comprises an integrated composite joint design to simulate the specific skin changes during normal arm and shoulder movement while the inside of the garment is pressurized at 5 p.s.i. This is accomplished by integrating the characteristics of a modified convoluted type joint, distorted angle fabrics and cooperating restraint systems vectoring the surface forces into a multiple movement upper arm-shoulder joint.

The shoulder joint provides for arm-shoulder movement from —1.25 inches to 1.88 inches during protrusion for anterior, posterior and lateral movement, during horizontal abduction from —1.94 inches to 0.97 inch for anterior, posterior and lateral movement, during retraction from —1.01 inches to 1.09 inches, and for overhead abduction from —3.44 inches to 2.27 inches for anterior, posterior and lateral movement. These dimensional changes are now related to the composite joint design in the following manner: the points of reference for all joint movements are related to the landmarks indicated in FIGS. 6 and 7 on (1) the suit-helmet interface, (2) the arm scye line of suit, (3) the mid-arm line of the suit, (4) the acromion reference point on the suit, (5) the anterior reference point of the arm scye, (6) the sterno clavicular anatomical notch, (7) the sternal reference point at level of arm anatomical scye, and (8) the fishbowl type helmet shell.

The maneuvers of overhead abduction, protrusion, horizontal abduction and retraction requiring simultaneous increase and decrease of dimensional changes are provided for in the anterior and posterior areas of the shoulder joint by modified convolute areas **25**, and distorted angle fabrics **18** attached to the solid helmet base **52** and supported by nonstretchable cables **30–35** connected to anchorages **36–39** to provide sufficient geometric control and surface change for free forward movement of the pressurized suit in the posterior shoulder area. The modified convolutes provide for internal volume compensation preventing internal pressure surges during movements.

TABLE II.—ARM-SHOULDER CHANGES, SUMMARY

	Protrusion	Horizontal abduction	Retraction	Overhead abduction
Anterior:				
Sup.-acro	−0.87	−0.48		
Sern. to scye	−1.13	0.97	1.09	
Scye to mid-arm	−0.33	0.58	0.72	
Posterior:				
Cerv. to acro	−0.21	−1.94	−1.01	−3.44
Vert. to scye	−3.66	0.79		2.27
Post. scye to mid-arm	1.88	0.61		1.81
Lateral: Acro.-mid-arm	−1.25	−1.46	−0.96	−2.25

The waist-hip **27** and knee joints are shown in FIGS. 6 and 7 in the standing position. This joint system must provide for the dimensional changes shown in Table III for all planes of motion while maintaining the overall geometry of the pressurized space suit.

The waist from over the buttocks to the posterior knee point has the greatest dimensional change, amounting to 6 inches during forced flexion. Integrated anchorages comprising cables **40–43** with attachment points **44–48** provide the transitional force lines and give support to the modified hip-waist convoluted system. The geometry of the thigh is maintained by support material **23** which vectors the surface forces by orientation of the warp and fill of the fabric so that when located as shown, it tends to shorten as the circumferential dimension increases under increased pressure. Proper balance of the hip-waist system provides transitional force lines down the leg through anchor points **48** and **44** and through the support material **23** to the thigh-calf anchor points and into the calf support material. These forces are then integrated into the thermal jump boot **29**.

TABLE III.—WAIST-HIP CHANGES, SUMMARY

	Abduction	Hyperextension	Hanging sitting 90°	Flexion
Anterior: Ant. sup spine level to ¾ thigh		0.52	−2.64	
Posterior		−0.36	3.40	[1] 6.00
Lateral	−1.23			
Knee				
Anterior			2.36	[1] 4.09
Trunk-sitting				
Full anterior coccyx trip to cervical				3.98

[1] Forced.

It will be noted in FIGS. 6 and 7 that an integrated system of anchorages and support material provides for the control of longitudinal and circumferential forces of the pressurized suit by transisting these forces from the bottom of the feet to the lower helmet base. The change of longitudinal dimension from the unpressurized to pressurized condition is less than ¾ inch, making optimal head-helmet relationships for both comfort and vision.

The helmet is shown in FIGS. 1–5 as consisting of transparent upper and lower sections **52** and **53**, detachably connected to each other by a two-piece ring **54** in the form of a sealed bayonet junction, as shown in FIGS. 3A, 3B and 3C. The lower or base section **52** is rigid and molded accurately to fit the shoulders of the astronaut and is permanently attached to the torso of the space suit, as shown at **9** in FIG. 5, to prevent the helmet from rising when the suit is pressurized. The helmet is of the smallest size possible that is consistent with head dimensions and which will permit sufficient head movement for the required visual field. The front area of the lower helmet section **52** provides a supplementary visual field for maximum downward and lateral vision, as shown in FIG. 2. The ring **54** should be as narrow as possible to provide maximum vision, and may be of either the simple pressure-cooker type shown in FIG. 3A or of the more elaborate form shown in FIG. 3B.

There is provision for access to the face by opening a visor **55** which provides the primarly visual area. It can be closed using only one gloved hand. The construction shown permits either internal or external movements of the visor. Internal movement (see FIG. 4), provides a simple, rugged, positive seal against leakage, when closed and will remain open or closed as positioned by the wearer. For external movement, a positive lock-compression seal can be used outside in the region **56** and the visor is then orientated outside of the shell shown in FIGS. 1 and 2. The helmet shell is constructed of stretched acrylic plastic, or equivalent, molded optically pure. It will withstand a 10 p.s.i. static pressure test. An automatic closure (FIG. 4) in the form of a small aneroid **57**, releases a lock pin **58** permitting coil spring **59** to close the visor. Internal suit seals the visor at **56** by positive pressure against this seal. The visor is provided to cover requirements for eating, adjusting head phones and microphone, comfort and psychological acceptability.

The visual field that is provided without head movement is 150° in a horizontal plane and 50° above and 65° below the horizontal in a vertical plane. With head movement, the horizontal visual field is 250° and the vertical visual field is 65° above and 75° below the horizontal. This design provides lines of sight for lateral, upward or downward vision with head movement and at least one-eye vision around the visor seal and helmet disconnecting ring through the secondary visual areas. The optical characteristics of the central unobstructed area of the visual field provide a minimum diopter effect on binocular vision.

A head harness **70** (FIG. 1) is provided to support the earphones and microphone and protect the head from injury due to acceleration and buffeting. The open construction shown allows for head ventilation. In addition, contoured pads **71, 72** firmly attached to the inner surface of the rear of the helmet shell provide head support during launch acceleration.

A communications set for use with the USAF AN/AIC–10 system or its equivalent is also provided. The earpieces **73** serve as sound attenuation devices which provide adequate protection from external noise up to 169 db. The high frequency attenuation (2,000 c.p.s. or above) is at least 40 db or better and low frequency attenuation (500 c.p.s. or below) is 15 db or better. Communication performance using the H–143 earphone and the M–98/AIC microphone **74** or its equivalent is adequate for military use. There is also provision in the helmet pad area for the installation of a space transceiver system.

The torso section of the garment extends vertically from the helmet base to the groin of the legs and horizontally to the pivotal points of the shoulders. This includes the upper portion **18** and lower portion **19** of the waist joint area, shown in FIGS. 6 and 7. The orientation of the support fabric on a bias in the two torso sections **18** and **19** provides for pressurized geometric control. The design provides for the integration of the translation of tensile system and for permanent attachment of the helmet base, leg, and arm sections. This design provides a soft joint construction minimizing hard metal load points which may cause body damage under high acceleration, escape, and landing impact. The materials used in the nonmobile parts are orientated warp and fill, preferably at about 108° to the horizontal so that forces tending to increase the circumferential size will balance out the longitudinal forces tending to lengthen the suit when pressurized. In this manner, suit dimensional changes are kept below 4% from the non-pressurized to pressurized condition.

The closure **20** proposed for use is the BDM type zipper or its equivalent which will seal and prevent gas leakage or water entry in any plane or radius required by sloping body contours. Optional provision is made for urinary relief, as shown in FIG. 6. The closures must have at least a 200 pound cross pull capability.

The arm sections extend from the pivotal points of

the shoulders to the finger tips. The shoulder joints have been described above. The elbow joint is a simple modified convolute hinge joint **26** with lateral tensionable supports providing force transmission into the upper and lower arm support material at **21** and thence to the wrist and above connections **22**. An adequate glove and glove connection for use with this space suit has been developed for military use by the David Clark Company, Worcester, Mass., so that description thereof will not be included here.

The leg sections extend from the groin **49** to the bottom of the boots. The transitions to the groin and the waist are shown in FIGS. 6 and 7, which show the anchor points **44–49** and the tensile systems of cables or straps **40–63**, **60** and **61** to vector the forces through the functional joint areas. The knee joints at **23** and lateral anchor points **44** provide for transmission of forces from the mid-thigh support material to the calf support material and thence to the thermal boot. The lower support material merges into the socks with upper attachments **63–65** such as zippers, to transmit forces into the thermal boots. Adequate thermal boots for use with this space suit are available from commercial and military sources.

The ventilation system covering the entire body proposed for this design is a modified and improved Mauch system integrated with an insulation layer **80** (FIG. 8) which provides moderate radiation protection.

Ventilation gas previously conditioned enters the suit through the vent air inlet **8** (FIG. 6) in the central torso area for distribution from either the vehicle or back pack supply. Internally the ventilation gas travels through the vent air channels and is spread over the body surface through small orifices **83** in an impervious corrugated layer **82**. The gas then flows laterally over the body surface, removing heat and moisture. The gas escapes through exhaust holes **81** and through space **89** to the helmet outlet. This particular system used the ventilation gas as a double heat exchanger, first by passing the coolest gas over the body surface and second by flowing it externally to the insulation layer **80** which prevents the passage of heat or cold to the body from the surface of the space suit. This effect acts in both directions, i.e. with either a high or a low external temperature. Heat balance is maintained by an adequate rate of flow of ventilation gas. High external temperatures require a flow rate of 8–14 c.f.m. while low external temperatures will maintain body comfort at flow rates of 2–6 c.f.m.

The basic design of this space suit system provides for operation with the vehicle environmental control system and/or a back pack unit for operation externally of the vehicle. The environmental control systems may be either open or closed. The open type dumps ventilating and pressurizing gases overboard, while the closed system recirculates the gas within the suit controller system after reconditioning.

The insulation material can be any one of the flexible foamed plastics having a large absorptive ability. To function as a moderate radiation protective device, the foamed plastic is soaked in compounds of metals such as cobalt or lead and then dried to form a layer of high molecular density to absorb alpha, beta and low energy X-rays. Every effort has been made in this space suit design to eliminate unnecessary metal parts which may under high energy particle bombardment produce secondary radiations with injurious biological effects. Such a suit should ordinarily provide sufficient protection for external work periods of several hours. It is tailored as a one-piece assembly, covered internally by a light cotton foundation material **85**. This garment can then be donned as an underwear unit, or can be used as an intravehicular flight coverall garment. The inner cotton fabric serves as a wicking material to prevent sweat from running over the surface of the body, thereby increasing the effectiveness of the ventilation cooling over the entire body surface. Tailoring of this garment must be carefully controlled over functional joint areas to keep its bulk and movement restraint in relation to skin surface area as low as possible. Since excessive bulk can decrease normal mobility, design and tailoring techniques must take into consideration the dimensional changes specified in Tables I, II and III.

Insulation and spacer material **84** such as Trilock is included in the ventilation channels and wherever compression can occur, such as under the restraint harness and in the buttock area, to prevent strangulation of ventilation gas flow.

The space suit assembly contains an integrated external protective layer **86** for protection against wind blast, snag-abrasion, flash fire, infra-red and ultra-violet radiation, and also as a foundation for an integrated harness for restraint-work or parachute connection. As shown in FIG. 8 at **88**, this harness is fitted into channels sewn into the protective layer. This harness strap system may be a separate unit or may be sewn in at proper points with freedom for adjustment. The primary reason for this feature is to prevent chock loads from adversely affecting the basic suit-pressure retaining shell. Hardware attachments are exposed at proper point for attachment to seat straps, parachute risers, survival kit straps, work harness straps and the back-pack environmental control system.

Windblast protection is provided by the weight of the external protective material which, not being itself part of the under-layers, will not transfer the vibrational effects of windblast to the under garments. A failure of this layer during supersonic escape, for the short time of blast exposure, has no effect on the other protective features of this garment. Snag-abrasion protection is afforded by the smooth protective layer and is related to the weight of the material used. Flash-fire, infra-red and ultraviolet protection can be afforded by a metallized surface on the protective layer. Aluminized fabric or its equivalent will give flash-fire protection up to 2500° F. for 28 seconds before the basic fibers of the material will char or melt. Infra-red and ultra-violet protection is a function of the emissivity of the metallized surface. Aluminized or metallized fabrics having an emissivity of 0.7 are used for this purpose.

The intermediate support material shown in the various drawings can be any one of a number of commercially available fabrics. The characteristic feature of these fabrics is its orientation in the suit, such that the warp and fill of the material are orientated in the longitudinal and circumferential directions with a maximum angle of 108°, to counteract any dimensional changes while the suit is pressurized.

Since the circumferential stress of a cylindrical object is about twice the longitudinal stress, the warp and fill of a fabric can, by proper tailoring, be so orientated that the space suit shortens slightly when pressurized.

The tensile system presented in this invention can be formed by many techniques. The tensile members may be welded cables, fabric tapes, or reinforced seam lines. Welded cables must be carefully anchored to the material comprising the pressurized container for the space suit. The most successful technique is to use fabric tapes, integrated and sewn into the space suit as indicated in the various figures above.

Provisions are included for the integration of an anti-gravity suit, within the space suit, to provide added protection to the crewmen against adverse physiological effects of acceleration. This protection may be required during the launch and reentry phases of space vehicle operation.

Damage to vision during external vehicle operation is prevented by a detachable and adjustable visor which is contoured over the surface of the helmet and snapped in place at the pivotal point of the helmets visor (see FIG. 4).

From the above description it can be seen that I have provided a comparatively simple but highly efficient integrated space suit design. It will, of course, be understood

that various changes may be made in the form, details, arrangement and proportions of the various parts without departing from the scope of my invention.

I claim:

1. A space suit comprising a helmet formed of an upper and a separate rigid lower section adapted to extend to the shoulder area for support on the wearer's shoulders, fluid-tight detachable connection means in the region of the neck extending completely around and joining said upper and lower sections, an upper torso section permanently joined to the lower helmet section and provided with arm coverings, a lower torso section, a detachable fluid-tight zipperlike junction between said lower and upper torso sections, said junction extending horizontally around the rear of the space suit and converging upwardly in front, the upper torso section being formed of a woven fabric positioned on a bias, the lower torso section being formed of an upper portion of woven fabric and a lower corrugated portion adapted to cover the waist and hip joint region with an integrated system of separate elongated tensile means, joined one into another, connecting the upper and lower torso sections, the lower corrugated portion carrying leg coverings, an integrated system of separate elongated tensile means, joined one into another, connecting each arm covering with the lower edge of the lower helmet section for supporting at least a major portion of the arm coverings directly from said rigid lower section and another integrated system of separate elongated tensile means, joined one into another, connecting each leg covering with the junction between the fabrc portion and corrugated portion of the lower torso section for support, with said means of integrated systems of separate elongated tensile means, joined one into another, as described herein, forming total support throughout the upper torso, lower torso, arm sections, and leg sections without interfering with the joint mobility of the space suit assembly.

2. The space suit of claim 1, in which each arm covering is provided with separate elbow and shoulder corrugated portions adapted to cover the shoulders and elbows, and an intermediate woven fabric portion connected between said separate elbow and shoulder corrugated portions.

3. The space suit of claim 1, in which the leg coverings are provided with knee joint corrugated portions adapted to cover the knee joints and woven fabric portions connecting said knee joint corrugated portions with the lower corrugated portion.

4. The space suit of claim 1, in which the lower helmet section is of transparent material between said connection and the shoulder area to permit vision by the astronaut downwardly through the front portion thereof.

5. The space suit of claim 4, in which the upper helmet section carries a visor having upward swinging movement on a horizontal axis to allow free access to the interior, with fluid-tight sealing means between the visor and the upper helmet section.

6. The space suit of claim 1, comprising an outer impermeable protective layer, an intermediate impermeable insulating layer spaced from the outer layer to form a first gas chamber therebetween, an inner impermeable corrugated layer adhered to the insulating layer to form a second gas chamber therebetween, orifices for ventilation extending through said corrugating and insulating layers and sealed with respect to said second gas chamber, a gas-permeable layer of woven fabric adhered to the corrugated layer on the opposite side from said outer layer, means to conduct a current of ventilating air to said second gas chamber between the insulating layer and the corrugated layer, means for discharging air through said corrugated layer toward said woven fabric for passage through said woven fabric, around the body of a wearer, back through said woven fabric, through said orifices and into said first gas chamber for removal.

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