Dec. 27, 1966 L. F. SHEPARD 3,293,659

HIGH ALTITUDE HELMET

Filed May 1, 1964 3 Sheets-Sheet 1

Fig. 1

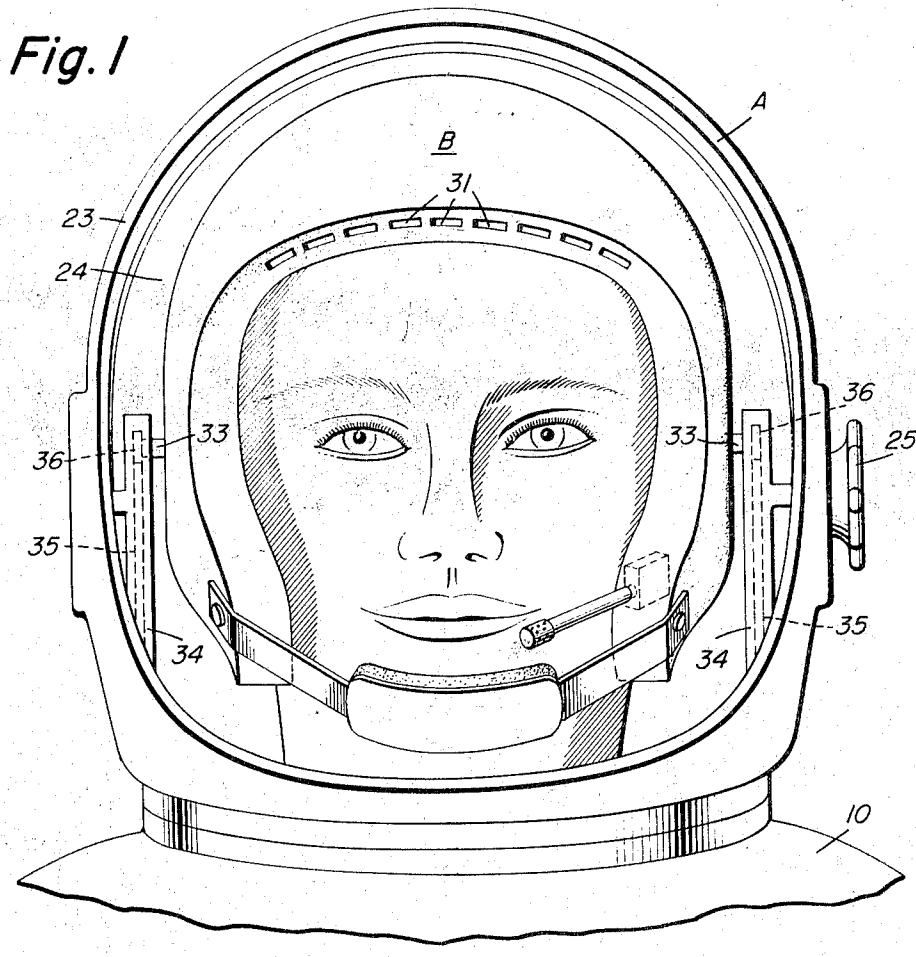
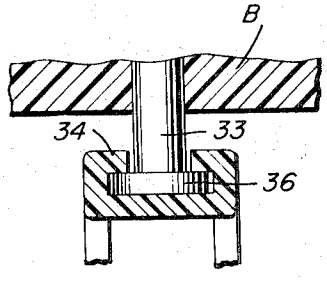


Fig. 5



HIGH ALTITUDE HELMET

Filed May 1, 1964 3 Sheets-Sheet 2

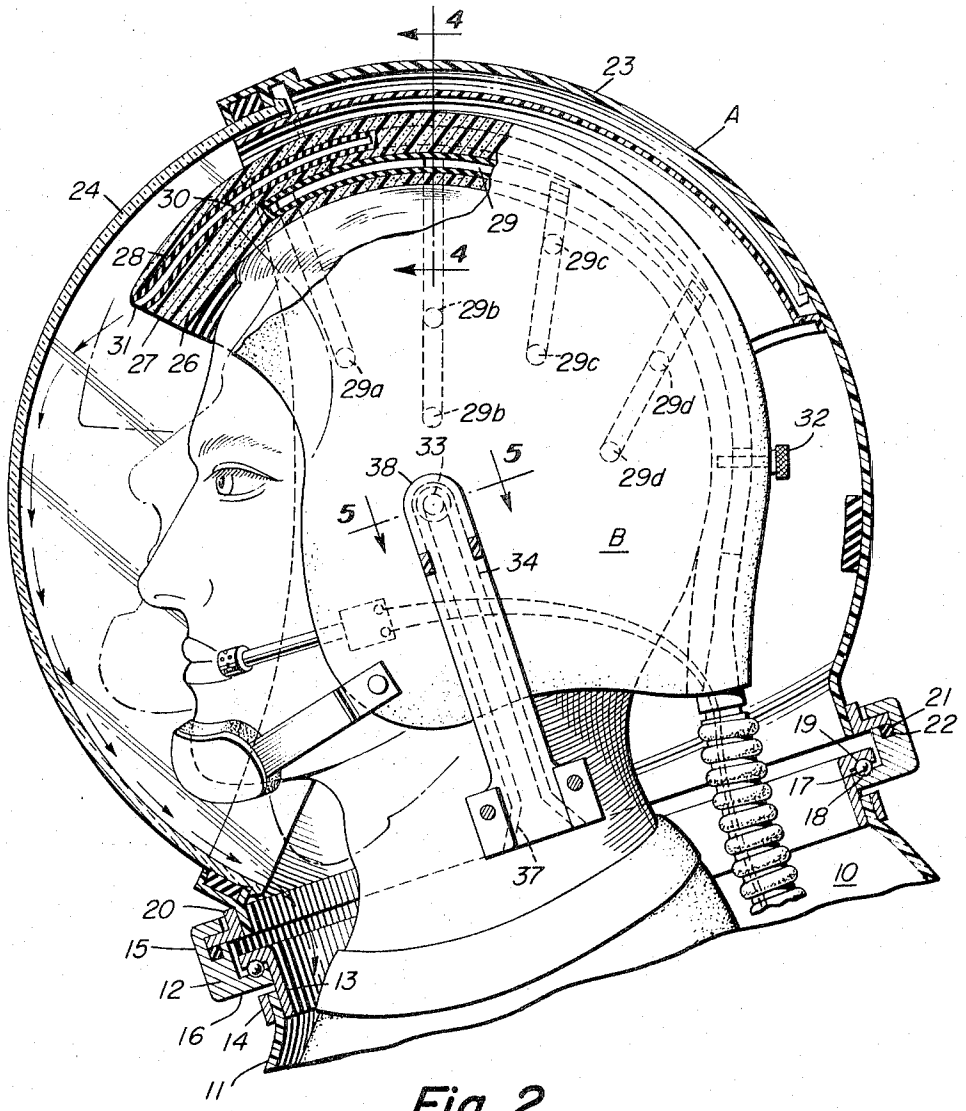


Fig. 2

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HIGH ALTITUDE HELMET

Filed May 1, 1964 3 Sheets-Sheet 3

Fig. 3

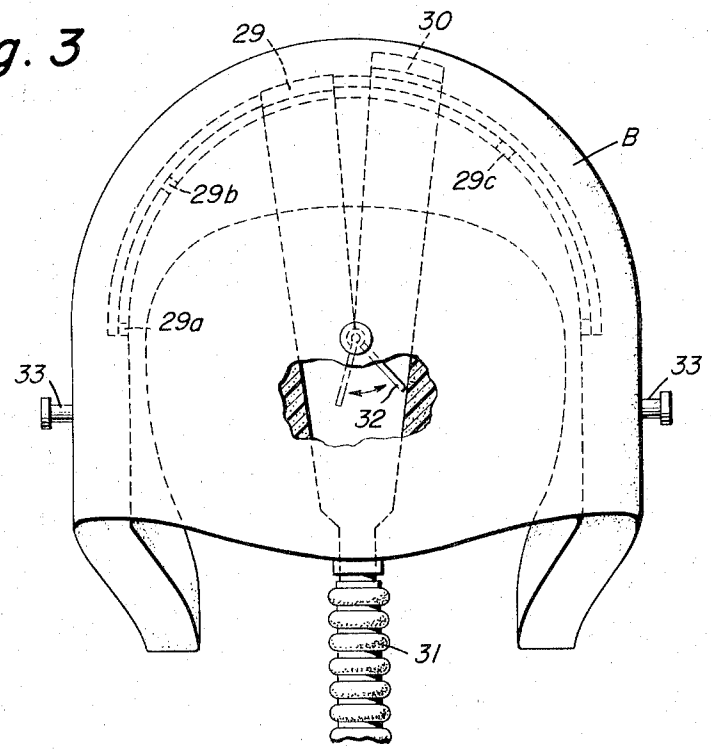
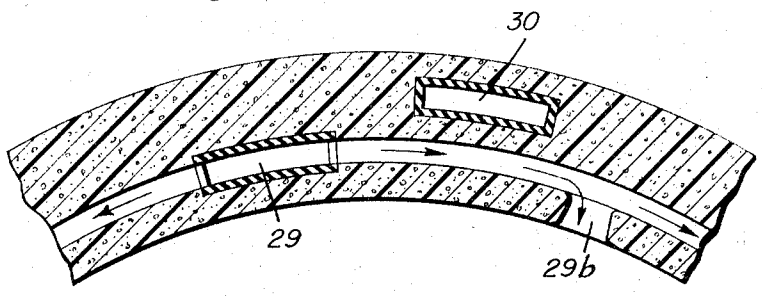


Fig. 4



United States Patent Office 3,293,659 Patented Dec. 27, 1966

3,293,659

HIGH ALTITUDE HELMET

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20 Claims. (Cl. 2—6)

This invention relates to an improvement in helmets for high-altitude flying. More particularly, the invention relates to an omni-directional helmet for a high-altitude flying suit, which permits a full range of head motion by the wearer and which offers protection for such wearer's head against anticipated impact conditions.

During high-altitude flying, space travel, and the like, the personnel of the air or space craft must be protected from loss of oxygen by the use of inflatable pressure suits. To assure safety of the personnel and the craft, the helmets of the suits must be constructed so that the wearer has at all times the maximum degree of view of the surroundings in the cabin of said craft. It is desirable, therefore, that the maximum degree of viewing be provided by assuring the wearer complete and normal head movement. Similarly, during flight at high altitudes and beyond the earth's environs, the personnel of the craft must also be protected against severe impact forces, especially those transmitted to the area of the wearer's head.

The present invention provides the maximum degree of viewing by assuring the wearer essentially complete and normal head movement while providing the wearer with protection against the forces of impact transmitted to the head. This full range of head movement and protection against the forces of impact are provided for by a helmet comprising two main parts: an inner helmet which fits directly on the wearer's head, and an outer shell helmet spaced away from the inner one. The fitting that connects the inner helmet and the outer helmet is a pair of pivots located approximately at the wearer's ears. These pivots have a common axis which is a straight line that runs transversely through the middle of the head of the wearer. Thus, in accordance with this invention, the inner helmet is attached to the outer helmet by means of studs affixed to the inner helmet which are engaged in vertical tracks positioned within the outer helmet. This arrangement allows the inner helmet to pivot an a horizontal axis and move vertically in relation to the external or outer helmet. Advantageously, the fitting which joins the two helmets is heavy and strong enough so that crash impact upon the outer helmet is transmitted through the connection between the two to the inner helmet which holds the head in place within the space of the outer helmet. Thus impact of the head or the inner helmet fitted thereon against the interior surface of the outer helmet is prevented.

It will be seen that the wearer of the helmet of this invention can nod his head, that is rock it up and down, by moving his neck forward and back. Accordingly, he does not have to make conscious effort to so move his neck forward and back; for as he rocks his head, it is held at the central pivot and thus the motion of the neck forward and back follows incidentally. An important advantage that emanates from this arrangement is that the wearer can tilt his head upwardly and get the full benefit of the high angle of vision that can be and is preferably incorporated in the outer shell helmet contemplated by this invention; he also can nod his head downwardly and obtain the benefit of the considerable downward angle of vision that is provided. By this means, the wearer can see the ground immediately in front of him, his feet, and the front portion of his space suit as well as any close-in instruments and work objects. The resulting great angle

of downward front vision can be incorporated into the outer helmet because it is no longer necessary to build a nodding collar," i.e. a bellows diaphragm, about the neck of the helmet. Thus, with the helmet of the present invention, the wearer is always capable of nodding his head directly up and down, with the head sweeping a vertical arc regardless of whether the wearer's head is facing straight ahead or whether the head is turned in relation to the body.

While the inner helmet provided for by this invention has certain freedoms for motion relative to the outer helmet which permits a full range of head motion by the wearer, there are certain advantageous restraints encountered. As stated above, the inner helmet has rotational freedom about an axis transverse to the wearer's head. It is restrained, however, against rotation relative to the outer helmet about a vertical axis and is also restrained against rotation relative to the outer helmet about a longitudinal axis. Further, it is restrained against translational movement along the longitudinal horizontal axis and it is also restrained against translational movement along an axis transverse to the wearer's head. With respect to the translational movement along the vertical axis, it is partially restrained and partially free. In accordance with this invention, the inner helmet is also restrained against moving upwardly far enough to hit the outer helmet. This is advantageous inasmuch as there are times when the body of the wearer of the helmet and the associated space suit tends to move downwardly somewhat within the space suit. For example, if the wearer is lying horizontally with respect to the craft he is in, feet forward, and the craft decelerates, his body slides somewhat forward within the space suit. This movement pulls his neck down somewhat relative to the neck portion of the helmet. If his head is held relative to the outer helmet, this movement can subject the wearer's neck to an intolerable stretching. The present invention, therefore, provides for the inner helmet to translate downwardly to a limited extent relative to the outer helmet.

In addition to the advantages of the present invention referred to above, other advantages are described below in connection with a specific embodiment shown in the drawings, it being understood that such embodiment is shown by way of illustration only, in which:

FIGURE 1 is a front view of the top portion of a pressure suit with the helmet thereof in a normal position;

FIGURE 2 is a side view of a top portion of a pressure suit with the helmet thereof in a normal position illustrating the upward and downward movement of the wearer's head with in said helmet;

FIGURE 3 is a front view of the inner helmet illustrating visor defogging means and ventilation ducts which are embodiments of this invention;

FIGURE 4 is a sectional view taken on the line 4—4 of FIGURE 2 illustrating said visor defogging means and ventilation ducts; and

FIGURE 5 is a sectional view taken on line 5—5 of FIGURE 2 which illustrates the fitting which connects the inner and outer helmets of this invention.

In the drawings, FIGURES 1 through 5 show a pressure flying suit for use in high-altitude flying, and the like, capable of maintaining the wearer under full pressure when required. The flying suit, not completely shown, has a body portion adapted to cover the legs, body, shoulders, and arms of the wearer with a neck opening 10 therein at the base of the neck. To the marginal edge 11 of the neck opening 10 is secured a rotatable neck seal 12 capable of joining the neck and the outer helmet portion A of the flying suit to the above-mentioned body portion.

The marginal edge **11** of the neck opening can have an inner ring **13** for clamping the marginal edge **11** of the neck opening to the neck seal **12**. Advantageously, the neck opening can also be formed from an outer attaching means or ring **14**, the inner periphery thereof being attached to the marginal edge of the neck opening as heretofore described. In addition to the use of the said inner ring and outer attaching ring, the marginal edge of the neck opening can be secured by cementing or the like.

In order to form a rotatable seal capable of allowing the neck and the outer helmet A to rotate about the shoulders of the suit while still maintaining pressure in the suit, the rotatable neck seal **12** is operatively connected to the inner or locking ring **13**. In this embodiment, rotatable neck seal **12** has an upwardly extending portion **15** and an inwardly extending bottom portion **16**. The bottom portion defines a lower race **17** adapted to receive a plurality of roller elements **18** such as metal balls, which ride against the surface of race **17** in rotatable neck seal **12** and in race **19** defined in inner locking ring **13**. In this arrangement the neck seal **12** is allowed to rotate about inner locking ring **13**.

In order to connect the helmet A to rotatable neck seal **12** in the neck opening of the suit so as to encase the head and neck of the wearer, an outer attaching or locking means **20** can be provided. A notch **21** is provided in rotatable neck seal **12** in order to retain annular O-ring **22** which is capable of contacting the lower surface of outer locking ring **20** when said outer locking ring is positioned within the rotatable neck seal so as to effect a seal between said outer locking ring **20** and said rotatable neck seal **12**. It is contemplated by the present invention that the lower outer portion of the outer locking ring **20** may be provided with equally spaced lateral extensions adapted to fit in spaces which may be provided in the rotatable neck seal and which are adapted to be in a position so that turning of the rotatable neck seal positions the extensions in locking engagement with each other.

The outer helmet A, which is affixed to outer locking ring **20** is in essence an external shell comprising a pressure retention unit fabricated from a strong, essentially undeformable material, such as a tough plastic, for example, a glass cloth-reinforced epoxy resin. The shell **23** portion of helmet A incorporates a pivoting internal visor **24** actuated by a mechanism **25** located in the vicinity of the wearer's ears. Such mechanism **25** may constitute a rotation-locking device actuated by an external knob or knurl which will cause the visor to close and lock with one motion of the hand. Unlatching and reversing the actuating member will unlock and open the visor. Obviously, the visor must be fabricated from a clear, shatterproof plastic material, for example a high-impact polycarbonate resin. It is contemplated that the visor **24** may incorporate a self-sealing port to facilitate insertion of feeding devices and the like during the pressurized mode of operation.

The inner helmet employed in this invention comprises an anti-buffet type helmet for constant-wear use when detached from the outer helmet. Accordingly, the inner helmet may be fitted with dual earphones and microphones. A combination of oxygen supply hose and telemetry lead may also be permanently attached to the rear of the inner helmet. A combination connector is advantageously used for connection to the mating lines in the space suit per se.

The construction of the inner helmet is such that provision is made for an inner comfort layer **26** of soft foam material; an intermediate layer **27** of energy absorptive material; and an outer layer **28** of strong essentially undeformable material capable of distributing impact forces. This outer layer **28** must also function as an anchor for the fitting which joins the outer helmet and the inner helmet in accordance with this invention as well as for the communications equipment contemplated.

Thus, the outer layer **28** is preferably a full shell of laminated thermosetting plastic or tough high impact thermoplastic material. It is also within the ambit of this invention that this tough outer layer **28** may be a composite of a plurality of small panels so arranged as to provide full head coverage and facilitate adjustment to suit the wearer's head.

In general the intermediate layer **27** is fabricated from an effective energy absorption, slow recovery form of material, such as, for example, closed cell vinyl ensolite. In a preferred embodiment of this invention, this layer is cored or channeled to accept the ventilation duct **29** and the defog duct **30** which are formed from a semi-rigid thermoplastic material. A flexible hose **31** is suitably employed to connect the two parallel ducts at the rear of the inner helmet. The ventilation duct shown at **29** may contain numerous branches or extensions which may direct the vent gas to outlets located at various positions **29***a, b, c,* etc., on the skull. The defog duct **30** runs unbroken to the top front of the inner helmet where it feeds a visor spray tube **31** which directs the escaping gas downward across the visor. This gas may be used both for the wearer's breathing and for defogging the visor. Inasmuch as the wearer's exhalation is naturally directed downward, the downward flow of incoming gas will purge the facial cavity of carbon dioxide. Adjustment or stoppage of either or both the vent gas or the fog gas may be effected by means of flutter valve means shown at **32** which may be adjusted from within said helmet or from the outside when said helmet is worn.

The inner layer **26** of the inner helmet B is suitably a soft, foamed material, e.g., a low density polyurethane foam and the like, containing holes coincident with the vent duct outlets **29***a, b, c,* etc., and preferably covered with an open mesh fabric. The ear regions of the inner layer **26** are shaped to accommodate the ears therein.

In accordance with this invention, the inner helmet and the external helmet are mechanically joined in such a manner that the aforementioned specific movements are permitted and the required restrictions are also effected. Further, the external helmet A and the connection means must be strong enough to transmit impact forces to the inner helmet and prevent internal bottoming. Accordingly, the connection between the two helmets is effected by a pair of pivot studs **33** affixed on the inner helmet in the approximate area of the wearer's ears; said pivot studs **33** are restrained in inverted U-shaped tracks **34** which are attached to the external or outer helmet A. Preferably, each of the pivot studs **33** has a configuration of a small cylindrical journal stud which fits into said track **34**. Suitably the tracks **34** comprise a socket having a generally cylindrical interior bearing surface which, as mentioned, opens downwardly thus giving it the inverted U shape. The closed end of said U-shaped socket may be, if desired, fitted with a resilient stop or the like so as to absorb suddent impact of the journal stud contained therein. The basic shape of the track, therefore, is a T-slot **35** which accommodates the head **36** of the journal stud **33** and which is open at the bottom end, preferably with a wide flare **37** so as to facilitate entry of the journal stud **33**, and which is closed at the top end **38** so as to control the upward movement of said journal stud and consequently of the inner helmet within the outer helmet. Suitably the track **34** is fabricated from a tough, high impact plastic having a low friction coefficient, such as, for example, nylon, delrin, and the like. In order to keep size and weight to a minimum, the material utilized is preferably a glass fiber-reinforced type so as to provide maximum strength. It is to be understood, of course, that there is a journal stud **33** on each side of the inner helmet and it has a matching track, i.e. bearing surface **34**, vertically positioned on the inner surface at each side of the outer helmet. Accordingly, the lower end of the track is attached to the inner surface of the outer helmet at a predetermined point while the

upper end of said track is located so as to accommodate the individual wearer's optimum pivot point. In practice, after being located, the top of the track is permanently fixed to the inner surface of the outer helmet. In accordance with this invention, the pivots, that is the joint between the inner helmet and the outer helmet, have a common axis running transversely through the ears of the wearer's head. The precise location of the pivots is determined for each individual for whom a specific helmet is sized. It should be noted, however, that if the head were a free body, the optimum location of said axis would be the center of gravity. Since the head obviously is not a free body, the location must be determined by subjective testing, evaluation, and observation. In this regard, although there is no single natural pivot point for the head and neck, observations by subjects who have wear-tested the design of the helmet unit of this invention, have indicated that the restriction created by a fixed point is not objectionable. It was found, however, that the point shifted for various subjects, depending on head and neck dimensions. In general, the location was established as a point slightly below the back of the tragion. As the subject nodded, his neck moved forward or backward to accommodate the fixed pivot. This arrangement permitted greater nodding capability than was possible with a neck convolute. Hence, it was found that the upward and downward visual range was restricted only by the limits of the visor opening. This design as tested herein gave a visibility range of 80 degrees upwardly and 90 degree downwardly.

In practice, it was found that the interaction of the studs positioned on the inner helmet with the external helmet tracks prevented the inner unit from rotating vertically in relation to the external outer helmet. Lateral bending of the neck was permitted to the extent allowed by horizontal clearance between the head of the stud and the lips provided in the track. The range of lateral bending permitted by this design was found to be from 15 to 20 degrees. Translation along the stud axis and front to back was not permitted. Because the inner track was closed, the inner helmet unit was restrained against upward movement far enough to avoid contact with the inner portion of the outer helmet. Thus, the inner helmet was suspended in such a manner that under the subjected impact conditions, it was impossible for the unit to bottom against the internal portion of the outer helmet. It was found advantageously that proper location of the pivot coincident with head center of gravity insured minimum movement of the head during impact.

In further testing of the helmet of the present invention it was found that the pivot, i.e. stud-track mechanism, would allow the inner unit to translate downwardly in relation to the outer helmet. As mentioned, this is of beneficial consequence, for at times when the body of the wearer tends to move downwardly within the space suit, as during acceleration or deceleration, as well as during torso bending or arm elevating motion, the neck moves down relative to said helmet. Should the head, however, not be free to move, the neck and chin would be subjected to possible damage. Thus, allowing the inner unit to move downwardly insures head impact protection and proper position of communication components at all times.

In operation, the suit is assembled on the wearer. The inner helmet B is fitted over the head. The outer helmet A is subsequently fitted over the inner helmet. Inasmuch as the bottom of the tracks are flared, easy entry of the studs **33** during donning is provided for. With the inner helmet B being worn as a constant-wear, anti-buffet helmet, donning the external or outer helmet requires only engaging the studs **33** in said tracks **34** and lowering the outer helmet until the outer locking ring **20** engages the rotatable neck seal **12**. In this position, the outer locking ring **20** fits within the rotatable neck seal **12** with the extensions of one meshed with the extensions of the other. When the extensions of the outer locking ring are passed downwardly through the spaces of the rotatable neck seal member and turned a distance equal to the width of a projection, the outer rotatable neck seal is in locked position with the O-ring **22** providing a seal between said outer locking ring **20** and said rotatable neck seal **12**. When the visor **24** is placed in sealed engagement with the front of the helmet, the flying suit is ready to be pressurized. The rotatable seal arrangement and the pivot means on each side of the helmet unit are advantageously free to rotate so as to provide a complete range of normal head motion.

Although the present invention has been described with particularity with reference to a preferred embodiment, it will be obvious to those skilled in the art after understanding the invention that various changes and modifications may be made therein without departing from the spirit and scope of the invention, and the appended claims should therefore be interpreted to cover such changes and modifications.

What is claimed is:

1. A helmet comprising an inner helmet for encasing the head of the wearer and an outer helmet covering said inner helmet, said inner helmet having an ear covering portion at each side thereof, each of said ear covering portions having pivot means affixed thereon, said outer helmet having corresponding pivot receiving means affixed thereon, said pivot receiving means respectively accepting said pivot means, whereby said inner helmet pivots within said outer helmet about an axis connecting said pivot means.

2. The helmet of claim **1** in which said inner helmet is provided with communications means.

3. The helmet of claim **1** in which means are provided for coupling gas to said helmet, and said inner helmet includes channels adapted to direct gas for ventilating and defogging said helmet.

4. The helmet of claim **3** in which at least one of said channels is a defog duct and the remaining channels are ventilating ducts.

5. The helmet of claim **4** in which said ventilation ducts comprise a plurality of outlets located at various positions throughout said inner helmet for directing gas to selected areas of said helmet.

6. The helmet of claim **4** in which the front portion of the helmet is provided with a transparent visor and a visor spray tube, said spray tube being connected to said defog duct for directing gas downwardly across said visor thereby adapted to purge said front portion of said helmet of gaseous residue.

7. The helmet of claim **4** in which said means for providing gas is a common duct which it adapted to feed gas to said ventilation and defog ducts.

8. The helmet of claim **7** in which said common duct includes valve means whereby said common duct is adjustable from within and without said helmet.

9. A pressure helmet comprising an inner helmet for encasing the head of the wearer and an outer helmet covering said inner helmet, said inner helmet having an ear covering portion at each side thereof, each of said ear covering portions having a cylindrical journal stud affixed thereon, said outer helmet having corresponding T-slotted tracks affixed thereon, said tracks accepting said journal studs, whereby said inner helmet pivots within said outer helmet about an axis passing through said journal studs.

10. A pressure helmet suitable for high-altitude flying which comprises an inner helmet for encasing the head of the wearer and an outer helmet covering said inner helmet, said inner helmet having an ear covering portion at each side thereof, said outer helmet being mechanically secured to said inner helmet by means of a fitting comprising a pair of pivot studs respectively mounted on the outer surface of the inner helmet in the approximate area of said ear covering portions and a pair of corresponding

tracks attached to the inner surface of said outer helmet, each of said pivot studs being restrained in its corresponding track said pivot studs having an axis defined by a line passing through said pivot studs, thereby allowing said inner helmet to pivot about said axis and to move within said tracks on said outer helmet.

11. The helmet of claim **10** in which each of said tracks is a T-slot which opens downwardly in an inverted "U" shape.

12. The helmet of claim **10** in which said tracks are fabricated by a tough, high impact plastic having a low friction coefficient.

13. A pressure helmet suitable for high-altitude flying which comprises an inner anti-buffet type helmet for encasing the head of the wearer and an outer helmet having visor means, said outer helmet and visor means covering said inner helmet, said inner helmet having ear covering portions at each side thereof, said outer helmet being mechanically secured to said inner helmet by means of a fitting comprising a pair of cylindrical journal studs respectively mounted on the outer surface of the inner helmet in the approximate area of said ear covering portions and corresponding inverted U-shaped tracks attached to the inner surface of said outer helmet, said journal studs being restrained in its corresponding track, said journal studs having an axis defined by a line passing through said journal studs, thereby allowing said inner helmet to pivot about said axis and to move within said tracks on said outer helmet.

14. The helmet of claim **13** in which the bottom end of each of said tracks has a wide flare thereby permitting easy journal stud entry.

15. A pressure suit for high-altitude flying which comprises a suit for covering the body of the wearer defining a neck opening therein, an inner helmet for encasing the head of the wearer, an outer helmet covering said inner helmet, said inner helmet having an ear covering portion at each side thereof, a rotatable attaching means connectively securing a lower edge of said outer helmet to said neck opening, said rotatable attaching means permitting rotation of the outer helmet about the base of the neck, and a pair of pivotable attaching means connectively securing said inner helmet to said outer helmet in the approximate area of said ear covering portions, said pivotable attaching means permitting pivoting of said inner helmet about an axis passing through said pivotable attaching means.

16. The suit of claim **15** in which each of said pivotable attaching means is a fitting comprising a pivot stud affixed to the outer surface of said inner helmet and a track

affixed to the inner surface of said outer helmet, thereby permitting said inner helmet to move relative to said outer helmet within said tracks.

17. The suit of claim **16** in which said pivot studs are cylindrical and said tracks have a substantially cylindrical bearing surface.

18. The suit of claim **16** in which said tracks open downwardly with said open end having a wide flare for permitting easy pivot stud entry.

19. A pressure suit for high-altitude flying which comprises a suit for covering the body of the wearer defining a neck opening therein, an inner helmet for encasing the head of the wearer, said inner helmet being provided with communication means and ventilation and defog means, an outer helmet covering said inner helmet, said inner helmet having an ear covering portion at each side thereof, a rotatable attaching means connectively securing the lower edge of said outer helmet to said neck opening, said attaching means permitting rotation of the outer helmet above the base of the neck, and a pair of pivotable attaching means connectively securing said inner helmet to said outer helmet in the approximate area of said ear covering portions, said pivotable attaching means permitting pivoting of said inner helmet about an axis passing through said pivotable attaching means.

20. The suit of claim **19** in which said inner helmet is connectively secured to said outer helmet by means of a fitting comprising a pair of cylindrical journal studs respectively mounted on the outer surface of the inner helmet in the approximate area of said ear covering portions and corresponding inverted U-shaped tracks attached to the inner surface of said outer helmet, said journal studs being restrained in their corresponding tracks, said journal studs having an axis defined by a line passing through said journal studs, thereby allowing said inner helmet to pivot about said axis and to move with respect to said outer helmet within said tracks.

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J. R. BOLER, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,293,659 December 27, 1966

Leonard F. Shepard

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 45, for "an" read -- on --; column 5, line 30, for "degree" read -- degrees --; column 6, line 53, for "it" read -- is --; column 8, line 20, for "above" read -- about --.

Signed and sealed this 21st day of November 1967.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents