

[54] **HEADGEAR STRUCTURE**

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Related U.S. Application Data

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[52] U.S. Cl. **2/3 R**

[51] Int. Cl. **A42b 3/00**

[58] Field of Search 2/3, 6, 5, 202, 205, 209; 179/156 R, 156 A

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Primary Examiner—James R. Boler

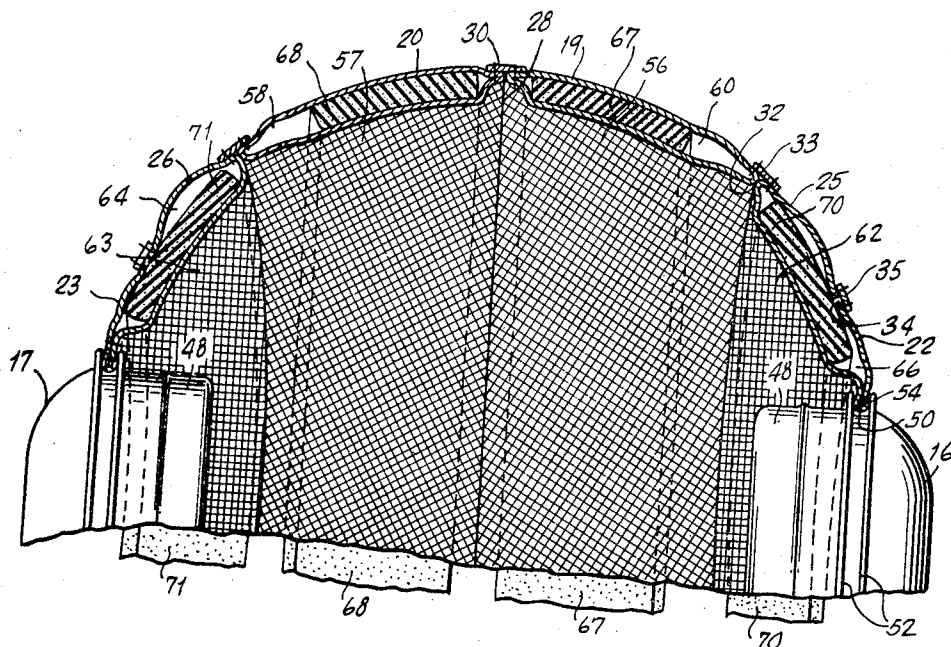
Attorney, Agent, or Firm—Shenier & O'Connor

[57] **ABSTRACT**

A flexible helmet having plural inner and outer panels

of woven fabric cut and assembled so as to conform closely to heads of different shapes and sizes, and plural pads for protecting the wearer's head against impacts, the pads being removably carried in separate pockets formed by the inner and outer panels. The pads may be fabricated of resilient energy-absorbing material and/or may include a layer of flexible ballistic material for protection against blows from sharp objects. The helmet panels may be made of open mesh fabric, and the pads may be perforated for ventilation of the helmet; also, the inner surfaces of the pads may be so shaped or lined as to provide ventilation spaces between the pads and the wearer's head. Sound-attenuating earcups are carried by the helmet in position for close-fitting engagement with the head. Size adjustment of the helmet is effected by means of a variable length nape strap at the rear of the helmet. In addition, the helmet may carry communications equipment, including earphones within the earcups, and a microphone, with a switch for the microphone sealed in a watertight enclosure within one of the earcups. An elongated flap extending across the lower inner margin of the rear of the helmet may be folded over and fastened to provide a passage for holding the wiring of the communications equipment. For further protection of the head, a rigid outer shell may be placed over and detachably secured to the flexible helmet, being stabilized in position relative thereto by means of cooperating, complementary pressure-actuable surface contact fastening elements respectively carried on the crown portions of the outer surface of the flexible helmet and the inner surface of the rigid shell.

24 Claims, 16 Drawing Figures



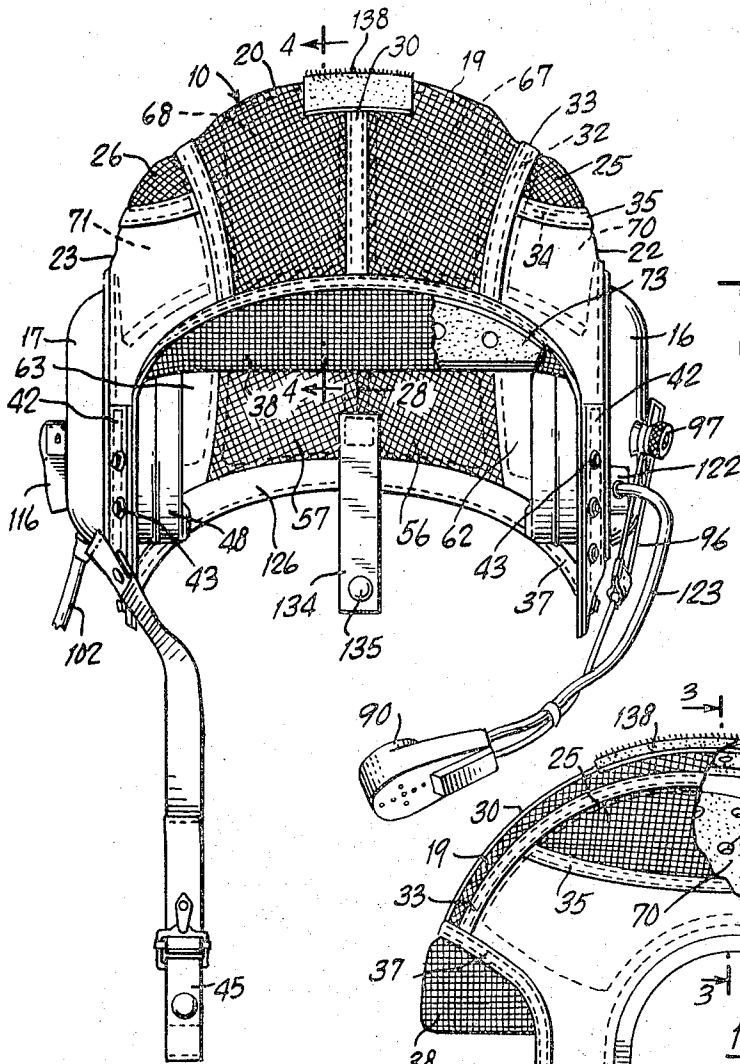


Fig. 1.

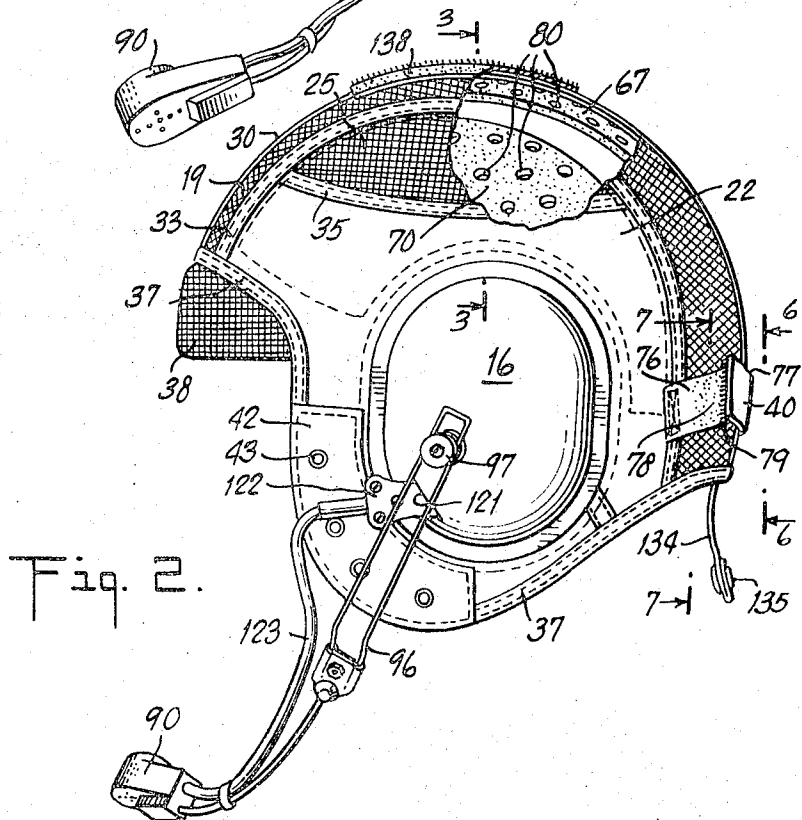


Fig. 2.

Fig. 3.

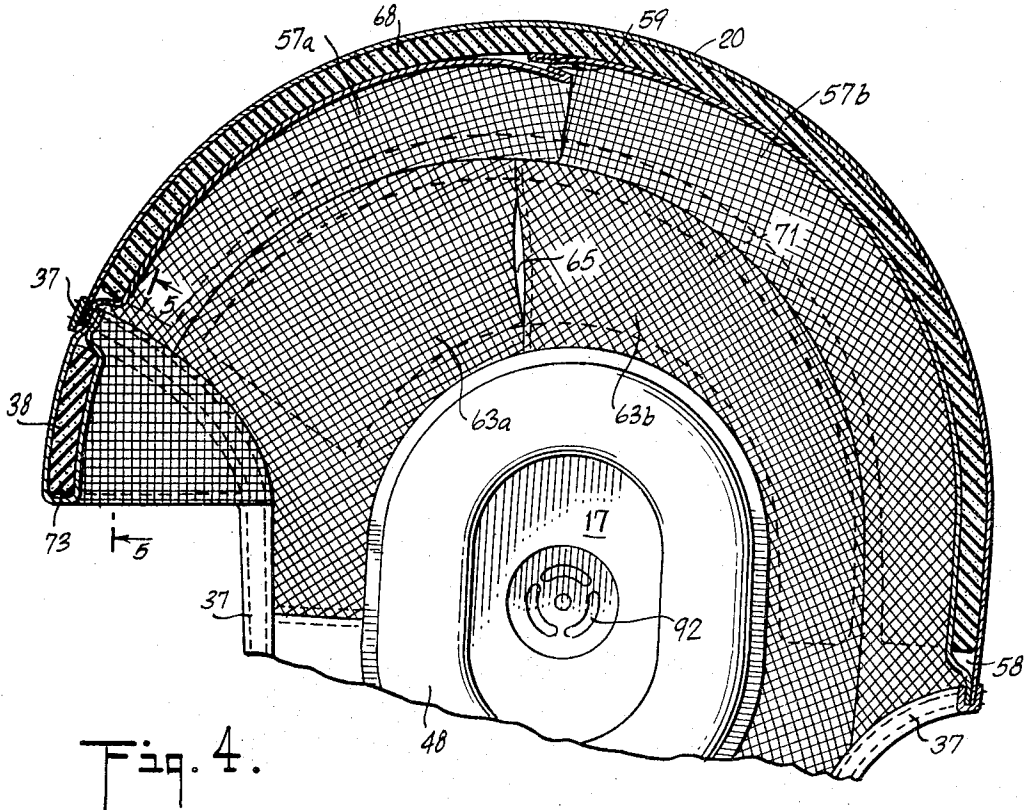
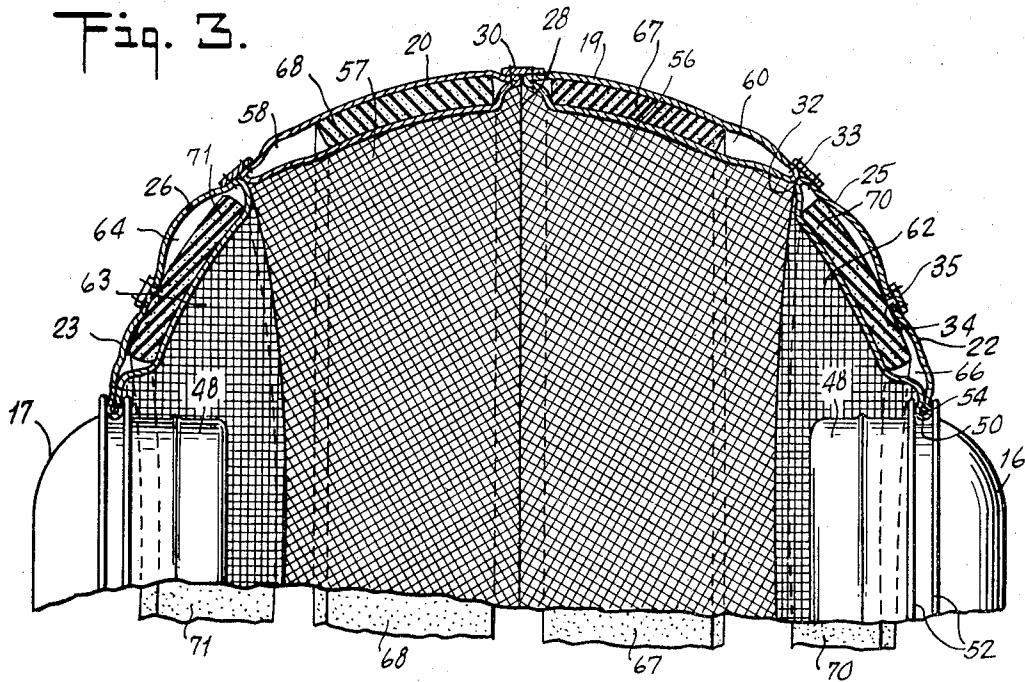


Fig. 5.

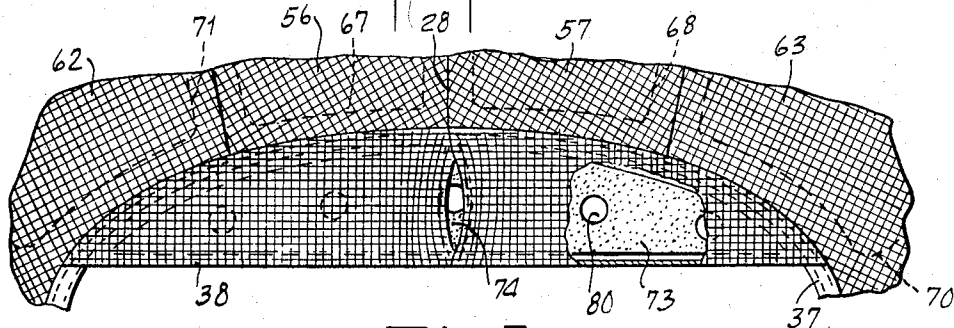
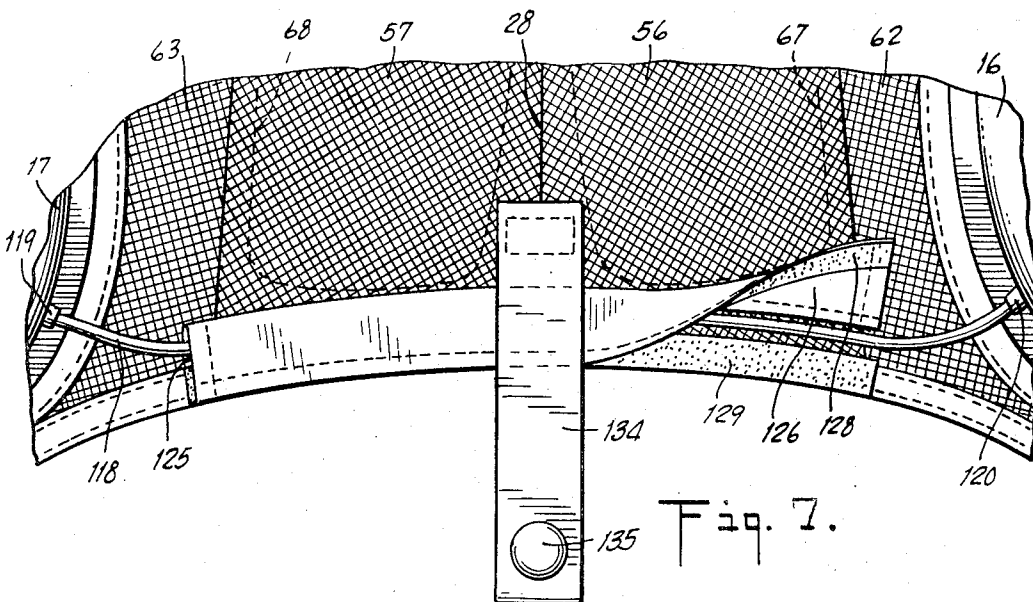
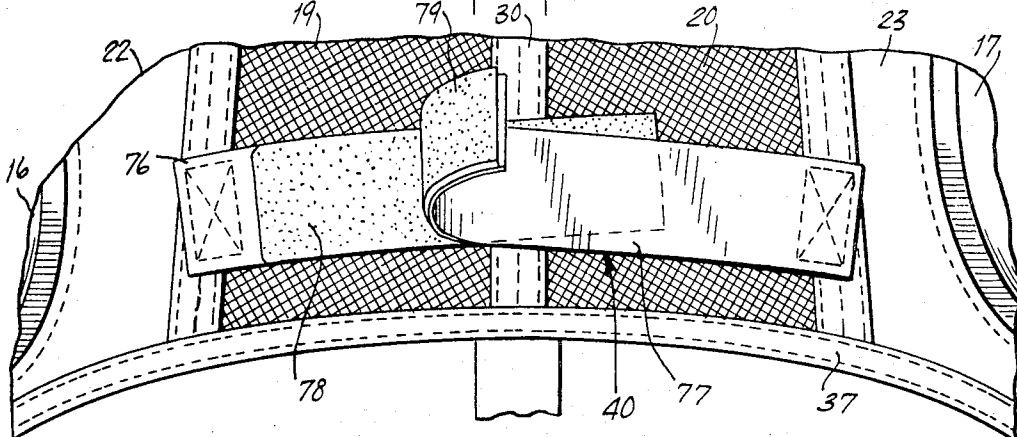


Fig. 6.



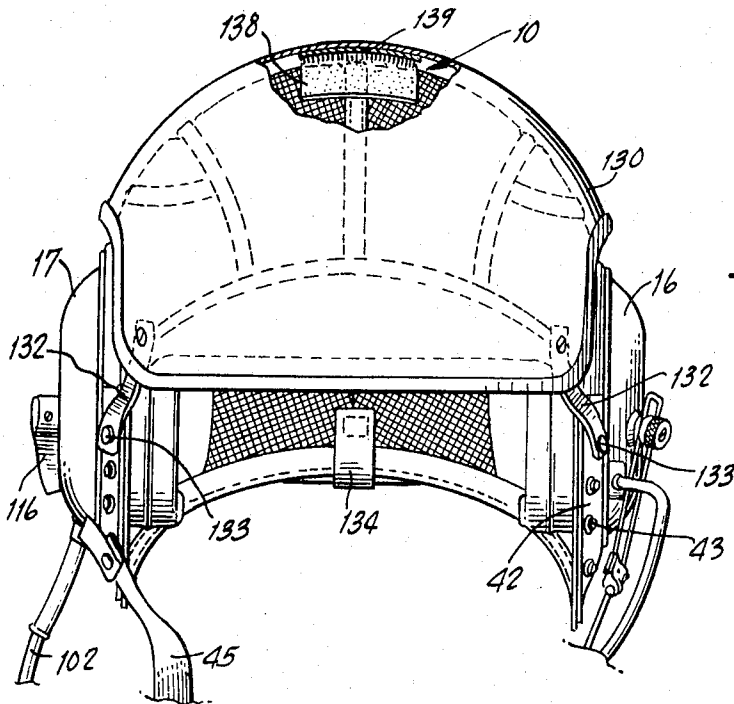


Fig. 8.

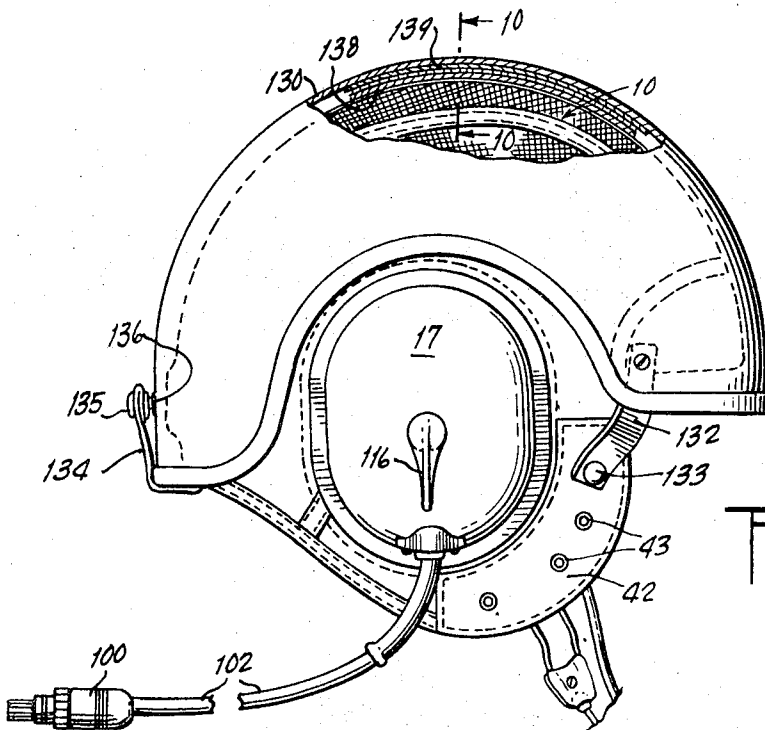


Fig. 9.

Fig. 10.

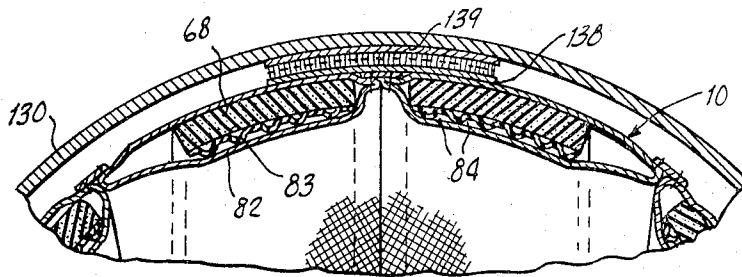


Fig. 11.

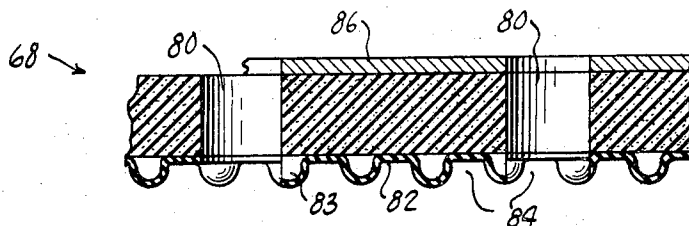
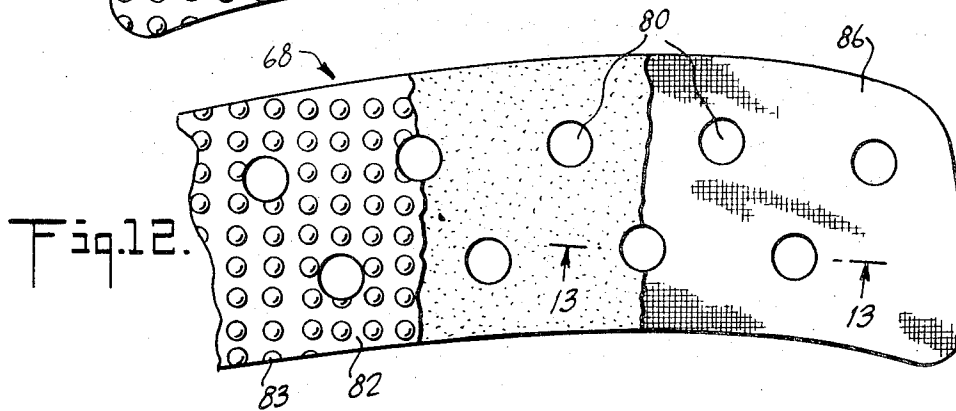
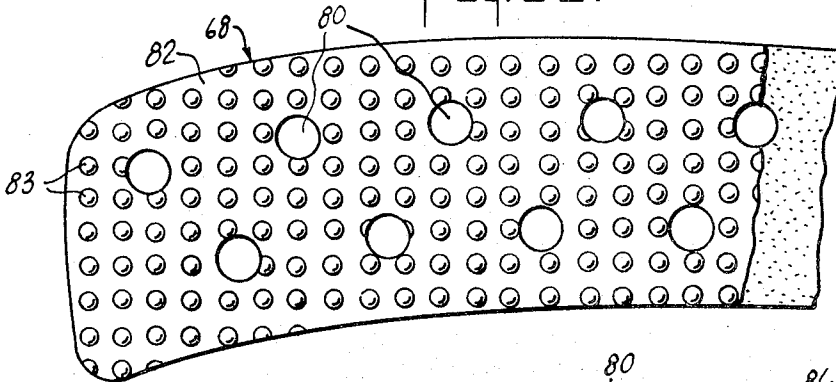


Fig. 13.

Fig. 14.

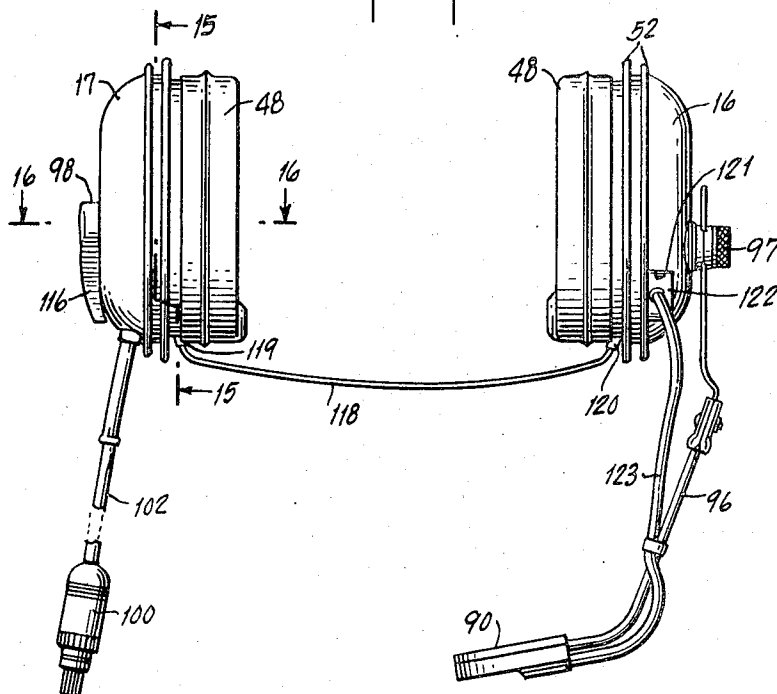


Fig. 15.

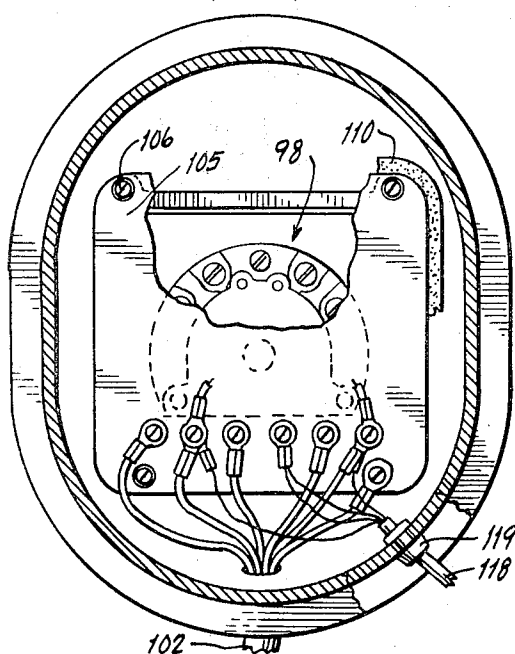
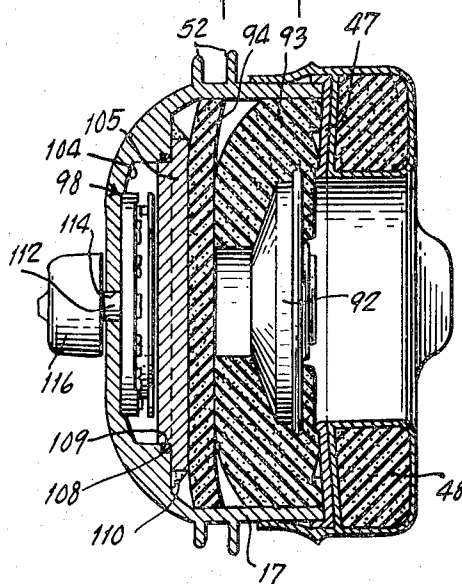


Fig. 16.



HEADGEAR STRUCTURE

This is a division of application, Ser. No. 88,823, filed Nov. 12, 1970.

BACKGROUND OF THE INVENTION

This invention relates to protective headgear structures, and particularly to headgear structures incorporating communications equipment such as microphone and earphones and/or sound-attenuating means for shielding the wearer's ears against ambient noise. In a more particular sense, the invention is directed to headgear structures comprising or including a flexible, soft, close-fitting helmet.

Personnel engaged in occupations involving exposure to high levels of ambient noise are often provided with equipment for shielding the ears against such noise and/or for permitting two-way voice communication through earphones and microphones. Conveniently, the sound-attenuating and/or communications equipment may be supported on the user's head by means of a flexible, close-fitting fabric helmet. Examples of such helmets, adapted to fit comfortably in closely conforming relation to heads of different shapes and sizes, are disclosed in U.S. Pats. of Water S. Finken and Jackson A. Aileo, Nos. 2,810,022 and 2,871,484.

Soft helmets of the type described do not in themselves provide any substantial measure of protection against bumps or other impacts on the wearer's head, such as may be encountered by military tank crewmen, aircraft carrier flight deck personnel, aircraft pilots, and others. Heretofore, protection of the head against blows or bumps has commonly been provided by a rigid shell helmet having a flexible internal rigging for supporting the shell in space relation to a wearer's head. Communications and/or sound-attenuating equipment may be mounted directly within the rigid shell, or alternatively the rigid shell may be placed on the wearer's head over a soft helmet as shown and described in the aforementioned patents.

In some instances, however, it is desirable to use a more or less flexible headgear even under circumstances presenting a substantial hazard of injury to the head from bumps or other impacts. Flexible headgear structures have been proposed having a lining of energy-absorbent material, but these structures have not been capable of fitting closely a variety of different head sizes, and have not been adapted to permit ventilation of the helmet interior as desired for comfort of the wearer.

Especially from the standpoint of convenience and economy in manufacture, it is desirable to provide in a single headgear structure the capability of fitting closely and comfortably a variety of different sizes and shapes of heads. It is also desirable to provide a headgear structure capable of ready modification by the wearer for use under a variety of different conditions, e.g. conditions requiring protection of the head against different types of impacts. Further, it is desirable to provide in any type of headgear structure adequate ventilation for the head. The known types of flexible helmets do not in general provide all of these desired features.

Another difficulty heretofore encountered in the provision of headgear-supported communications equipment is that the switch employed to enable selective use of different modes of communication (e.g. local

communication over wires and longer-distance communication by radio) has been bulky, cumbersome and at the same time inadequately protected against damage from ambient conditions such as moisture. A commonly used type of switch is enclosed in a housing that is sometimes mounted on one side of the helmet, but the weight of this housing tends to unbalance the helmet on the head and in addition the housing does not provide a waterproof seal. Compactness in design of such a switch, and its incorporation into a headgear structure having the aforementioned desired characteristics, together with adequate protection of the switch against moisture, would be very advantageous.

SUMMARY OF THE INVENTION

The present invention broadly contemplates the provision of a headgear structure for protection against impacts and noise comprising in combination a flexible fabric envelope shaped to extend over a wearer's head, one or more bodies of flexible impact-resistant material disposed within the envelope for protecting at least a portion of the head, a substantially rigid earcup secured to the envelope in position to surround an ear of the wearer, and a body of sound-attenuating material disposed within the earcup. The body or bodies of impact-resistant material may be one or more energy-absorbing pads inserted between inner and outer fabric layers constituting the envelope.

In one particular aspect, the invention contemplates the provision of a protective headgear structure comprising a flexible close-fitting helmet and means carried by the helmet for protecting the head of a wearer against impacts, wherein the protecting means includes at least two separate pads of energy-absorbing material disposed side by side in position to protect the crown portion of the wearer's head and individually supported by the helmet in a sufficiently spaced relation so as to be movable relative to each other to conform to the size and shape of the wearer's head.

In specific embodiments, the two pads may extend from the front to the rear of the helmet in generally parallel relation over the crown of the head on opposite sides of the center line of the helmet. In addition, the structure may include a further pair of pads, respectively disposed on opposite sides of the two first-mentioned pads and curved to extend over and behind the ear areas of the wearer's head, for protecting the opposite sides of the head. This second pair of pads, like the two first-mentioned pads, are individually supported by the helmet in sufficiently spaced relation to the first-mentioned pads so as to be movable relative to the first-mentioned pads. Such provision of plural pads separately mounted on a flexible helmet facilitates the fitting of the helmet in comfortable and conforming relation to heads of a variety of different shapes and sizes, while affording desired protection for the head.

In accordance with further particular features of the invention, at least the central portion of the helmet may comprise an outer layer of open mesh or netting (made of synthetic or natural fibers) overlying the two first-mentioned pads, and may further include a second layer of open mesh or netting underlying those pads, the pads being held between the inner and outer layers, which may be stitched together along seams extending between the pads to form separate pockets for the pads. Such use of netting material in the helmet affords ventilation of the helmet interior as desired for the

wearer's comfort. To aid further in ventilation, the pads themselves may be perforated and/or may be provided with an inner surface configuration that provides ventilation spaces or channels between the pads and the wearer's head so that air may pass through such channels and thence outwardly through the netting of the helmet between and/or through the perforations of the pads.

The pads may be fabricated of a resilient energy-absorbing material adapted to protect the head against bumps or other impacts with relatively flat or smooth objects. For protection against impacts with sharp objects or shrapnel, the pads may also comprise or include one or more layers of a flexible ballistic material, such as a multiple ply interwoven and/or laminated ballistic fabric, for example a fabric of the type disclosed in U.S. Pat. No. 2,816,578. In one embodiment, each pad comprises a multiple ply layer of ballistic fabric bonded to the outer or inner surface (preferably the outer surface) of a layer of resilient energy-absorbing material.

In embodiments of the invention wherein the pads are held in pockets formed by inner and outer layers of fabric (such as netting) stitched together at seams between the pads, the inner layer of each pocket may be slit at its central portion to enable removal and replacement of the pads, which are sufficiently flexible to be inserted or removed through such slits. Thus for example, pads comprising a layer of resilient energy-absorbing material alone may be used interchangeably with pads including or comprising a layer of flexible ballistic material to provide different protective characteristics for the helmet under different conditions of employment.

As a still further particular feature of the invention, the helmet itself may be of the general type disclosed in U.S. Pat. No. 2,810,022, and may include a pair of outer panels of flexible and more or less yieldable netting extending side by side from a front edge adjacent the wearer's forehead over the head to a rear edge at the base of the wearer's skull, the netting of each of the outer panels being biased with respect to the netting of the other such panel with the warplike threads of the two nettings parallel at that point of the common boundary of the outer panels adjacent the crown of the wearer's head and intersecting elsewhere along that common boundary at acute angles which increase from the crown toward both extremities of the outer panels. The helmet may further include side panels of relatively inelastic but flexible material such as a fabric, attached to the sides of the aforementioned outer panels of netting adjacent the front and rear ends thereof, and a pair of segments of flexible, more or less yieldable netting between the central portions of the side panels and the aforementioned outer panels, the netting of each segment being biased with respect to the netting of the adjacent outer panel, with the warplike threads of the outer panel and segment nettings parallel adjacent the middle of their common boundary and intersecting elsewhere along their common boundary at acute angles which increase toward both extremities thereof. A visor panel of fabric extends across the front of the helmet for engaging the wearer's forehead.

The outer panels, segments and side panels just described together constitute the outer layer of material of the helmet, and the inner layer is provided by inner central and side panels of flexible and more or less

yieldable netting respectively underlying and stitched to the outer panels and slit to form pockets for receiving the energy-absorbing pads. The visor strip of the helmet is similarly fabricated of a double layer of netting slit on its inner surface to form a pocket for receiving a brow pad of energy-absorbing material to protect the wearer's forehead.

A pair of rigid earcups each having a generally ellipsoidal outer wall and having an inward opening shaped and disposed to receive the wearer's ear are respectively mounted in elliptical openings in the two side panels, in such manner as to be adjustable in angular orientation relative to the panels for optimum comfort and close fit. The helmet may further include a nape strap comprising a pair of flexible strips stitched to the rear surface of the helmet and having overlapping free ends respectively bearing cooperating, complementary pressure-actuable surface contact fastening elements.

In this structure, the bias out of the outer panels and netting segments of the helmet provides desired conformity and close fit of the helmet to different shapes and sizes of heads, and the individual mounting of the energy-absorbing pads already described affords protection of the wearer's head in a manner that does not interfere with the action of the biased netting panels and segments in providing the desired close fit. The nape strap permits ready adjustment of the helmet size to a particular wearer's head. Preferably, for optimum closeness of fit and securing of the earcups in closely conforming relation to the ear areas of the wearer's head, the two strips comprising the nape strap slope slightly upwardly toward each other. The particular fastening elements used to secure the overlapping ends of the strips permit such upwardly sloping disposition of the strips.

Each earcup preferably bears an elliptically annular pad surrounding the earcup opening so as to engage the wearer's head surface around the ear and from a sound-attenuating seal. These earcups serve to shield the wearer's ears against ambient noise and may also carry earphones for voice communication to the wearer. To support the wire or wires interconnecting the two earphones, a flap of material extends longitudinally along the rear lower edge of the helmet and has a free longitudinal edge. This edge, and the inner lower margin of the helmet, bear cooperating, complementary fastening elements such that when the flap is folded over so that its free edge engages the rear lower edge of the helmet, the flap free edge is secured to the helmet and the flap itself forms a pocket or channel for holding the wires that extend between the earcups.

As a still further feature of the invention, the helmet may be provided with a microphone and a switch enabling selective use of the microphone and/or earphones for different modes of communication. The switch may be mounted in a watertight compartment within one of the earcups and may have a movable switch lever or knob disposed on the outer surface of that earcup.

If desired, a rigid protective shell may be mounted over the described helmet and secured thereto as by means of snap fasteners. The crown portions of the outer surface of the flexible helmet and the inner surface of the rigid shell may bear cooperating, complementary pressure-actuable surface contact fastening elements that serve, when pressed together, to secure the flexible helmet to the rigid shell in a stable position.

Further features and advantages of the invention will be apparent from the detailed description hereinbelow set forth, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of a headgear structure embodying the present invention in a particular form;

FIG. 2 is a side elevational view of the structure of FIG. 1;

FIG. 3 is an enlarged fragmentary sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is a fragmentary sectional view taken along the line 4—4 of FIG. 1;

FIG. 5 is a fragmentary view, partly broken away, taken along the line 5—5 of FIG. 4;

FIG. 6 is an enlarged fragmentary view taken along the line 6—6 of FIG. 2;

FIG. 7 is an enlarged fragmentary view taken along the line 7—7 of FIG. 2;

FIG. 8 is a view similar to FIG. 1, showing a rigid shell mounted on the headgear structure of FIG. 1;

FIG. 9 is a side elevational view of the structure of FIG. 8;

FIG. 10 is an enlarged fragmentary view taken along the line 10—10 of FIG. 9;

FIG. 11 is an enlarged fragmentary view, partly broken away, of one form of energy-absorbing pad embodying particular features of the present invention;

FIG. 12 is a fragmentary view, partly broken away, of an alternative form of energy-absorbing pad in accordance with the invention;

FIG. 13 is an enlarged fragmentary sectional view taken along the line 13—13 of FIG. 12;

FIG. 14 is a front elevational view of the earcups and associated communications equipment incorporated in the structures of FIGS. 1 and 8;

FIG. 15 is an enlarged sectional view of one earcup, taken along the line 15—15 of FIG. 14; and

FIG. 16 is an enlarged sectional view of the same earcup, taken along the line 16—16 of FIG. 14.

DETAILED DESCRIPTION

Referring to the drawings, the invention is illustrated as embodied in a helmet particularly adapted for use by military tank crewmen or others (e.g. aircraft carrier flight deck personnel) engaged in occupations involving exposure to relatively high levels of ambient noise and at least some hazard of bumps or other impacts on the head. The structure shown broadly includes a soft, flexible close-fitting helmet 10 carrying a plurality of individually supported energy-absorbing pads and a pair of sound-attenuating earcups 16, 17.

As particularly shown in FIGS. 1 - 7, the helmet 10 includes a pair of central outer panels 19 and 20, a pair of side panels 22 and 23 and a pair of segments 25 and 26 respectively disposed between the middle portions of the side panels and the middle portions of the adjacent central panels. The central panels 19, 20 and the segments 25, 26 are formed of a flexible and more or less yieldable or elastic netting, such as nylon mesh, while the side panels 22 and 23 may be formed of a suitable closely woven, substantially inelastic fabric.

The two central outer panels 19 and 20 extend in side-by-side relation from the forward edge of the helmet over the crown of the wearer's head to the rearward edge of the helmet, being joined at a seam 28

which extends along the fore and aft center line of the helmet. A tape 30, of inelastic woven fabric, is stitched over the seam 28 and extends along that seam from the front to the rear of the helmet.

The panel 19 is joined to the segment 25 and to the forward and rearward portions of the side panel 22 (which portions meet the panel 19 respectively forwardly and rearwardly of the segment 25) along a single continuous fore and aft seam 32 which is covered externally by a tape 33 similar to the tape 30. The segment 25 is joined to the side panel 22 along a seam 34 which is likewise covered by a fabric tape 35. On the right-hand side of the helmet, the central panel 20, side panel 23 and segment 26 are joined in the same manner as the corresponding elements on the left-hand side of the helmet described above.

Another tape 37 extends around the periphery of the helmet, being stitched to the forward edges of panels 19 and 20, the forward, lower and rear edges of panel 22, the rear edges of panels 19 and 20, and the rear, lower and forward edges of panel 23. The front edges of panels 22, 19, 20 and 23 have a continuous arcuate contour so that the tape 37 recedes somewhat above the wearer's forehead toward the crown of the head. A gore 38 is attached to the tape 37 so as to extend across the wearer's forehead. The gore 38 has an arcuate upper edge to correspond with the edge of tape 16, while its lower edge is substantially straight.

A nape strap 40 extends across the outer rear surface of the helmet between the side panels 22 and 23 at the base of the wearer's skull. This nape strap, hereinafter further described, is adjustable in effective length for varying the head size of the helmet. Heavy leather segments 42 are attached to the forward portions of the side panels 22 and 23 and are provided with snap fasteners 43 to which may be attached a generally conventional chin strap 45 for aiding in securing the helmet to the head, if desired. The snap fasteners 43 may also be utilized for attachment of auxiliary equipment such as an oxygen mask or the like.

It should be noted that the nettings of the central panels 19 and 20 are out on the bias with respect to each other so that the warplike threads of the two nettings are parallel at that part of the common boundary of the panels adjacent the crown of the wearer's head, and that these warplike threads intersect elsewhere along that common boundary at acute angles which increase toward both the forward and rearward extremities of the central panels. Similarly, the warplike threads in the segments 25 and 26 are parallel to the adjacent central panel threads at a locality near the crown of the head and these threads intersect at increasing angles from that locality toward both extremities of the segments. The described bias cut arrangement and assembly of the central panels and segments of the helmet affords desirably close conformity of the helmet to the wearer's head and enables attainment of such close fit on heads of various different shapes and sizes.

The helmet as thus far described is generally similar in construction and arrangement to that disclosed in the aforementioned U.S. Pats. Nos. 2,810,022 and 2,871,484.

Each of the earcups 16 and 17 comprises a rigid, hollow and generally ellipsoidal shell having an outer domed wall and bearing, on its inner rim, an elliptically annular flange 47 (Fig. 16) defining an opening posi-

tioned for register with the ear of the wearer. Mounted on the flange 47, and extending inwardly therefrom for contact with the wearer's head in the area surrounding the ear, is a relatively soft resilient elliptically annular pad 48. When the earcup is pressed against the head, the engagement of this pad with the head forms a sound-attenuating seal around the ear. Thus the earcup and pad constitute a structure for shielding the wearer's ear from ambient noise.

The earcups 16 and 17 may be mounted in the side panels 22 and 23 in the manner disclosed in U.S. Pats. Nos. 3,005,203 and 3,190,973. As best seen in FIG. 3, the side panel 16 has an elliptical opening 50 for receiving the earcup. A pair of parallel flanges 52, extending around the earcup 16 and formed integrally therewith, define a channel into which is inserted the edge of the panel 22 around the opening 50. The panel edge that is inserted into this channel may be of double thickness and/or may be reinforced with a resilient wire or like element 54 to aid in holding the earcup in place. This engagement of the panel 22 with the channel formed between flanges 52 secures the earcup to the helmet and also retains the earcup in any selected angular position relative to the panel 22 but permits manual rotation of the earcup relative to the panel so as to permit orientation of the earcup in the position most comfortable for the wearer. As will be clear from FIG. 3, the earcup 17 is mounted in the side panel 23 in the same manner, the pads 48 of both earcups facing inwardly toward the wearer's head. In assembling the helmet, the earcups are initially placed within the helmet and are then pushed outwardly through the opening 50 in panel 22 and the corresponding opening in panel 23 until the opening-defining edges of the respective panels are received within the channels formed by the earcup flanges.

The central panels 19 and 20, side panels 22 and 23, and segments 25 and 26 together constitute the outer layer of the helmet 10. In accordance with the invention, in its illustrated embodiment, the helmet further includes an inner layer comprising panels of a flexible and more or less yieldable or elastic netting (which may be the same netting material as that used in the panels 19 and 20 and segments 25 and 26) stitched to the outer layer of the helmet and extending over substantially the entire interior of the helmet. As hereinafter described, the inner and outer layers cooperatively constitute an envelope for receiving energy-absorbing pads.

Specifically, there are provided two central inner panels 56 and 57, each fabricated of the described netting material and respectively underlying the central outer panels 19 and 20. Each of the central inner panels comprises two separate pieces of netting material; thus panel 57 comprises a first piece 57a extending from the forward edge of the helmet upwardly to the crown thereof, and a second piece 57b extending from the crown of the helmet to the rear edge, inwardly of and immediately beneath the outer panel 20. The forward margin of piece 57a is stitched to the tape 37 beneath the forward edge of panel 20, and the side edges of piece 57a are respectively stitched to the outer panel 20 along the longitudinal seams at which the panel 20 is stitched to panels 19 and 23. The rear edge of piece 57a at the crown of the helmet is free and overlies the similarly free forward edge of the rear piece 57b. The side edges of piece 57b are stitched to the aforemen-

tioned longitudinal seams, and the rear edge of piece 57b is stitched to the tape 37 inwardly of the rear edge of panel 20. The two pieces 57a and 57b, together comprising the inner panel 57, cooperate with the superadjacent outer panel 20 to define a pocket 58 for receiving an energy-absorbing pad as hereinafter described. Access to the interior of this pocket is provided through the slit 59 defined between the rear edge of piece 57a and the forward edge of piece 57b within the helmet. As most clearly seen in FIG. 4, the slit 59 extends transversely of the fore and aft center line of the helmet.

The central inner panel 56 is similarly constituted of forward and rearward pieces underlying the forward and rearward portions of the outer panel 19, and assembled in the same manner as pieces 57a and 57b so as to cooperate with the panel 19 to define a pocket 60 for receiving an energy-absorbing pad, access to the pocket being provided by a central transverse slit similar to slit 59 between the forward and rearward pieces comprising panel 56 on the inside of the helmet.

The inner layer of the helmet additionally includes a pair of side panels 62 and 63 also fabricated of the aforementioned netting material and respectively disposed on opposite sides of the central inner panels 56 and 57. The right-hand side panel 63, as best seen in FIGS. 3 and 4, underlies the right-hand outer side panel 23 and the right-hand segment 26, extending over and behind the opening for the earcup 17 in side panel 23. Like panels 56 and 57, the inner side panel 63 consists of two separate pieces 63a and 63b. Panel piece 63a extends from the forward edge of the helmet to a locality above the earcup 17, being secured to the tape 37 at its forward edge. One side edge of the panel piece 63a is secured to the seam joining the central outer panel 20 to the side panel 23 and segment 26, while the other side edge of the panel piece 63a is secured to a seam extending along the edge of the earcup opening in panel 23. The rearward edge of piece 63a is free and abuts or overlies the similarly free forward edge of the panel piece 63b. Piece 63b extends rearwardly from piece 63a to the rear edge of the helmet, having opposite side edges respectively stitched to the last-mentioned seams. The rearward edge of panel piece 63b is stitched to the tape 37. The panel 63, in cooperation with the panel 23 and segment 26, defines a pocket 64 for receiving an energy-absorbing pad, this pocket accessible through the slit 65 defined between the adjacent free edges of the panel pieces 63a and 63b.

The left-hand inner side panel 62 is constructed and arranged in the same manner as the panel 63, comprising forward and rear panel pieces which cooperate with the outer side panel 22 and the segment 25 to define a pocket 66, accessible through a slit defined between the adjacent free edges of the panel pieces, for receiving an energy-absorbing pad.

The pieces comprising the inner panels 56, 57, 62 and 63 are also preferably bias cut in a manner similar to the outer panels 19 and 20 so that along the seam connecting the side edges of any two adjacent panel pieces (such as the forward panel piece 63a and the adjacent forward panel piece of panel 62), warplike threads of the adjacent panel pieces are substantially parallel to each other at a central portion of the seam and intersect elsewhere along the common seam at acute angles which increase toward both the forward and rearward extremities of the adjacent panel pieces.

Further in accordance with the invention, a pair of energy-absorbing pads 67 and 68 are respectively contained within the two central pockets 60 and 58 of the helmet structure. Each of these pads may be an elongated strip of a suitable energy-absorbing material such as a slowly resilient expanded vinyl extending from the front to the rear of the helmet over the crown of the wearer's head, the pads being disposed in substantially parallel relation on opposite sides of the fore and aft center line of the helmet and spaced apart by the seam 28 that divides the two pockets 58 and 60. Two further pads 70 and 71, of the same material as pads 67 and 68, are respectively contained in the side pockets 66 and 64, for protecting the sides of the wearer's head against impacts. As particularly shown in FIG. 4, the right-hand side pad 71 extends from a locality forwardly of the earcup 17 over and behind that earcup, having a progressively decreasing width from front to rear. This pad is spaced away from the adjacent central pad 68 by the seam which separates the pockets 58 and 64. The pad 70 on the left-hand side of the helmet is similarly shaped and similarly disposed in relation to the earcup 16 and pad 67.

The gore 38 is fabricated of the same netting material as the panels 19 and 20 and forms a pocket for receiving a lune-shaped energy-absorbing pad 73 having a curved upper edge conforming to the contour of the tape 37 above the wearer's forehead. The pad 73 is inserted in this pocket through a slit 74 (FIG. 5) formed on the inner side of the gore. Conveniently the pad 73 is formed of the same material as the pads 67, 68, 70 and 71, and serves to protect the wearer's forehead against impacts.

The pads 67, 68, 70, 71 and 73, in their described disposition, provide effective protection of the crown, sides and rear and forward portions of the wearer's head against bumps or other impacts. At the same time, because they are individually supported in separate pockets and spaced in relation to each other so as to be movable relative to each other, the helmet readily conforms to heads of a variety of different shapes and sizes; i.e. the pads, being relatively movable, do not interfere with the effect of the bias-cut arrangement of panels 19 and 20 and segments 25 and 26 in providing desired close conformity of the helmet to heads of different shapes and sizes.

Precise fit of the helmet on a particular wearer's head is achieved through adjustment of the nape strap 40. As shown in FIGS. 2 and 6, this nape strap comprises two strips 76 and 77, respectively stitched to the side panels 22 and 23 and extending toward each other from the side panels across the rear outer surface of the helmet. The two strips bear on their facing surfaces a pair of co-operating complementary pressure-actuable surface contact fastening elements 78 and 79, one of these elements comprising a continuous plurality of small flexible hooks and the other comprising a continuous plurality of small flexible loops engageable by the hooks. Such fastening elements are commercially available under the trade name "Velcro." The two strips 76 and 77 have overlapping free ends which are secured to each other by interengagement of the fastening elements 78, 79. The effective length of the nape strap may be varied, to adjust the size of the helmet, by varying the extent of overlap of the two strips; the fastening elements are of the type that permits continuous varia-

tion in effective length of the nape strap over a substantial range of dimensions.

With the helmet placed on the head and the nape strap properly adjusted (preferably in such manner that the two strips 76 and 77 slant slightly upwardly toward each other as shown in FIG. 6), the helmet closely conforms to the head of the wearer and the two earcups are pressed lightly but firmly against the wearer's head so that the earcup pads 48 are in sealing contact with the head as desired to shield the wearer's ears from ambient noise. If desired, a chin strap 45 may be fastened to the snap fasteners 43 to aid in holding the helmet on the head, but the chin strap is not necessary to provide the desired comfortable but yet closely conforming fit of the helmet on the head.

The use of netting to constitute the inner layer of the helmet (i.e. panels 56, 57, 62 and 63) as well as the outer panels 19 and 20 and segments 25 and 26, affords ventilation of the helmet interior, further contributing to the comfort of the wearer. To aid in such ventilation, each of the energy-absorbing pads 67, 68, 70, 71 and 73 may be perforated, as shown in FIGS. 2 and 5. These perforations 80 permit passage of air through as well as between the pads.

For still further aid in ventilation, the inner surfaces of the energy-absorbing pads may be shaped or lined in such manner as to provide air passages between the pads and the wearer's head. For example, as shown in FIGS. 10 and 11, each of the pads may bear on its inner surface a lining or layer 82 of a flexible material, such as urethane film, having molded therein an array of small flexible protrusions 83 which serve to hold the pads spaced away from the wearer's head, providing spaces 84 for flow of air between the head and the pads. Thus, air can circulate through the spaces 84 and thence out through the perforations 80 and the spaces between adjacent pads for ventilation.

The energy-absorbing pads described above provide effective protection of the head against bumps or other impacts with relatively smooth, e.g. flat, objects. However, for use under circumstances presenting a hazard of impacts from relatively sharp objects, the pads may comprise or include a layer of flexible ballistic material, such as the multiple ply laminated ballistic cloth disclosed in U.S. Pat. No. 2,816,578. For example, a layer 86 of this ballistic cloth may be bonded to one surface (preferably the outer surface) of each of the energy-absorbing pads, as shown in FIGS. 12 and 13. Pads of the type shown in FIGS. 12 and 13 may be used interchangeably with pads e.g. of the type shown in FIGS. 10 and 11, depending on the particular hazards expected to be encountered by the wearer. The slits in the pockets that hold the pads permit removal and replacement of the pads either for substitution by other pads having different protective characteristics or for other purposes, the pads being sufficiently flexible so as to be readily removable and insertable through these slits. At the same time, owing to the central position of the slits in the pockets, the pads when inserted cannot become accidentally dislodged from the pockets.

In addition to the foregoing features, the helmet supports equipment for two-way voice communication, including a microphone 90 and a pair of earphones or receivers 92 respectively mounted within the earcups 16 and 17. As particularly shown in FIG. 16, the receiver 92 is disposed within the interior of the earcup 17 and is surrounded and backed by cushions 93, 94 also con-

tained within the interior of the cup and fabricated of a suitable sound-absorbent material such as a foam plastic material. The receiver faces the wearer's ear so that he can hear voice communication through it. A similar receiver is mounted in the same manner in the left-hand earcup 16. The microphone 90 is carried on a boom 96 which is adjustably secured as by a clamp 97 to the external surface of the earcup 16 so as to be positioned forwardly of the wearer's mouth.

A switch 98 for controlling the communications equipment is housed within the interior of the right-hand earcup 17, between the receiver 92 and the external wall of the earcup. The switch mechanism itself may, for example, be of a generally conventional type known as a double pole double throw switch including plural fixed and movable contacts having three positions. For instance, the switch may have a first position connecting the equipment for radio communication, a second position connecting the equipment for local phone communication (i.e. over wires, as between tank crewmen within the same vehicle), and an intermediate position which permits the wearer to monitor both the radio and the local phone communications systems. Appropriate connections are made from the switch to the receivers 92 and microphone 90, and to an external jack 100 which is carried on an extended lead 102 for insertion into external communications apparatus.

The switch contacts are contained within a recess 104 formed within the interior of the earcup 17, in the rear wall thereof. A cover plate 105, secured to the earcup as by screws 106, extends over the recess 104 to enclose the switch contacts. A gasket 108, received within a groove 109 formed around the mouth of the recess 104, is pressed between the cover plate and the earcup shell to provide a seal for protection of the enclosed switch contacts from moisture. In addition, the joint between the cover plate and the earcup wall may be covered with a waterproofing material 110, such as a microcrystalline wax that remains stable at the temperature encountered in use, to provide further assured protection of the switch contacts against moisture.

An axially rotatable shaft 112, connected to the movable switch contacts, projects outwardly through a bore 114 in the earcup wall. Mounted on the outer extremity of this shaft is a knob 116 which is disposed outwardly of the external surface of the earcup but in closely adjacent relation thereto so as to prevent objects from snagging under the knob. Change in switch positions is effected by manual turning of the knob by the wearer.

The described switch assembly, contained within the earcup 17, is highly compact, light in weight, and protected against damage by the elements.

Heretofore, receivers in helmet earcups have conventionally been low impedance dynamic earphones, i.e. having an impedance very much lower than that required for impedance matching with the external circuit to which the earphones are connected. Impedance matching has been achieved by incorporating with the earphones a suitable transformer commonly located either on the external lead from the earphones or in a switch box assembly mounted on one side of the helmet. Presence of the bulky transformer on the helmet or the lead is awkward and inconvenient.

In the structures of the present invention, it is preferred to use as the receivers 92 dynamic earphones having a relatively high impedance selected to match impedance of the circuit to which the earphones are

connected, thereby obviating the use of an impedance matching transformer. For example, high-impedance dynamic earphones may be used to constitute a headset having an impedance of about 1,000 ohms, far higher than the conventional impedance of dynamic earphones. The use of such high impedance earphones and the consequent elimination of the transformer contribute to the realization of the advantages (i.e. with respect to compact construction and elimination of bulky external elements) afforded by provision of the switch 98 within the earcup 17. That is to say, because the switch assembly need not be associated with a transformer, both the switch assembly and a high-impedance receiver or earphone can readily be mounted in an earcup without impairment of the sound attenuation capability of the earcup.

The wires leading from the switch contacts to the receiver 92 within earcup 17 are themselves entirely contained within the earcup. The wires leading to the corresponding receiver in the earcup 16, and to the microphone supported by earcup 16, are contained in a common flexible sheath 118 that extends outwardly from earcup 17 through a grommet 119 and thence across the rear of the helmet to the earcup 16, entering that earcup through a further grommet 120. The microphone wires are connected to a socket 121 opening through the outer wall of the earcup 16 and adapted to receive a plug 122 which is connected by a lead 123 to the microphone 90. This wiring arrangement permits the microphone to be disconnected and detached from the helmet if desired.

The wires in sheath 118 are supported on the helmet within an elongated and open-ended pocket 125 that extends along the inner rear margin of the helmet. As best seen in FIG. 7, this pocket comprises a flap 126 of a suitable woven fabric that is stitched to the inner rear surface of the helmet adjacent the rear edge of the helmet so as to extend longitudinally along that edge. The flap 126 has a free longitudinal edge. The facing surfaces of the free edge of the flap and the inner rear low margin of the helmet bear cooperating, complementary pressure-actuable surface contact fastening elements 128, 129 (e.g. made of the same material as the fastening elements 78 and 79 described above) which interengage when the flap is folded over, to secure the flap free edge to the rear lower edge of the helmet and thus to provide the pocket 125.

This arrangement facilitates assembly of the helmet since the wires in sheath 118 may be permanently mounted to the earcups before the earcups are themselves mounted in the helmet. As already mentioned, the earcups are inserted outwardly through the openings in the side panels 22 and 23; thus if the wires are preconnected to the earcups, the sheath must be supported along the inner surface of the helmet. The sheath is simply placed within the pocket while the flap is open, and the flap is then folded over and secured to the helmet inner edge as described, to hold the sheath securely in place.

For some purposes, it is desirable to provide, as further protection for the head, a rigid outer helmet shell. Desirably, the shell should be readily attachable and removable so as to permit use of the helmet with or without the protective outer shell. For example, when the helmet is used by a military tank crewman, it may be worn without the rigid shell when the wearer is within a tank, and the shell may be placed on the hel-

met for added protection during excursions of the wearer outside the vehicle.

One suitable form of rigid shell, designated 130, is shown in FIGS. 8 and 9. This shell may be molded of a polycarbonate resin, or it may be fabricated of a suitable laminate or other material conventionally employed for rigid helmet shells. In the form shown, the shell 130 is shaped to extend over the crown of the wearer's head, having front and rear edges conforming generally in position to the front and rear edges of the helmet 10, but having side margins shaped to expose the earcups 16 and 17. Adjacent the opposite sides of its front edge, the shell bears a pair of flexible straps 132 each carrying a snap fastener 133 adapted to interengage with one of the snap fasteners 43 on the adjacent leather segment 42 of the helmet 10. Stitched to the rear of the helmet 10 is an elastic strap 134 bearing at its outer end a snap fastener 135 which engages with a cooperating fastener element 136 mounted on the rear outer surface of the shell 130. The three straps just described, with their associated snap fasteners, provide a secure three-point connection of the rigid shell to the flexible helmet.

To stabilize the position of the rigid shell and flexible helmet, a pair of cooperating, complementary pressure-actuable surface contact fastening elements 138 and 139 (which, again, may be of the same material as the elements 78 and 79 described above) are respectively stitched to the outer surface of the crown of the helmet 10 and bonded to the inner surface of the shell 130 so as to interengage, when pressed together, to secure the crown of the helmet 10 in fixed position relative to the shell 130.

For simplicity of illustration, the male snap fastener elements shown in the drawings e.g. at 43 and 136 are represented as associated with single female snap fastener elements carried on parts of the structure which are to be secured to the parts bearing the male fasteners. However, in place of the single female fastener elements, double sets of female snap fastener elements may be employed to further enhance the adjustability of the various interconnecting parts of the structure.

It is to be understood that the invention is not limited to the features and embodiments hereinabove specifically set forth but may be carried out in other ways without departure from its spirit.

I claim:

1. A headgear assembly for protecting the head of a wearer against injury from bumps including in combination, a flexible helmet adapted to fit relatively closely to the wearer's head, a plurality of discrete bodies of impact resistant energy-absorbing material extending over the area of said helmet covering the portion of the wearer's head outside the wearer's ear and means for individually supporting said bodies on said helmet to permit relative movement therebetween to cause said helmet to conform closely to the shape of the wearer's head.

2. An assembly as in claim 1 in which said bodies comprise first and second bodies extending from the front to the rear of the helmet over the crown of the wearer's head and being arranged symmetrically with reference to the fore-and-aft centerline of the helmet.

3. An assembly as in claim 2 in which said bodies comprise respective third and fourth bodies located at the sides of said helmet alongside said first and second bodies.

4. An assembly as in claim 3 in which each of first and second bodies extends downwardly over the back of the wearer's head.

5. An assembly as in claim 4 in which said third and fourth bodies extend downwardly behind said earcups and over the mastoid processes of the wearer's head.

6. An assembly as in claim 1 in which said supporting means comprises pockets in said helmet for readily removably receiving said bodies.

7. An assembly as in claim 1 including a substantially rigid shell disposed outwardly of and extending over said helmet carrying said bodies and readily releasable means for securing said helmet to said shell.

8. An assembly as in claim 7 in which said helmet is an envelope having pockets for removably receiving said bodies.

9. An assembly as in claim 7 including pressure actuable interengageable means on the inside of said shell and on the outside of said helmet in the region of the crown of said assembly for stabilizing the position of said helmet relative to said shell.

10. An assembly as in claim 1 in which said helmet is a fabric envelope and in which said bodies are inserts located within said envelope.

11. An assembly as in claim 1 including manually operable means for drawing said helmet into conformity with the wearer's head.

12. An assembly as in claim 1 including a relatively rigid outer shell and means for releasably securing said shell over said helmet.

13. An assembly as in claim 12 including means for positioning said helmet within said shell.

14. An assembly as in claim 1 including means for spacing said bodies from the wearer's head to ventilate said assembly.

15. An assembly as in claim 14 in which said spacing means comprises protrusions formed on said bodies.

16. An assembly as in claim 15 in which said bodies are formed with holes extending from the inner surfaces to the outer surfaces thereof.

17. An assembly as in claim 1 in which said plurality of bodies include a pair of crown pads extending from the front to the rear of said helmet on opposite sides of the fore-and-aft centerline of the helmet.

18. An assembly as in claim 17 in which said plurality of bodies include a pair of side pads located at the sides of said crown pads and adapted to extend from the temple areas rearwardly toward the back of the head and above the ears of the wearer.

19. An assembly as in claim 18 in which said plurality of bodies include a front pad extending across the wearer's forehead.

20. An assembly as in claim 19 in which said helmet is an envelope formed with pockets for receiving said pads.

21. A protective headgear structure comprising a flexible close-fitting helmet and means carried by said helmet for protecting the head of a wearer against impacts, said protecting means comprising at least two separate pads of energy-absorbing material disposed side by side in position to protect the crown portion of the wearer's head, and individually supported by said helmet in a sufficiently spaced relation so as to be movable relative to each other to conform to the size and shape of the wearer's head comprising a pair of outer panels of flexible, yieldable netting extending side by side from a front edge adjacent the wearer's forehead

over the head to a rear edge at the base of the wearer's skull, the netting of each of said outer panels being biased with respect to the netting of the other outer panel with warplike threads of the two nettings parallel at the point of the common boundary of the outer panels adjacent the crown of the wearer's head and intersecting elsewhere along that common boundary at acute angles which increase from the crown toward both extremities of the outer panels; side panels of relatively inelastic but flexible material attached to the sides of said outer panels adjacent the front and rear ends thereof; and a pair of segments of flexible, yieldable netting respectively disposed between the central portions of said side panels and said outer panels, the netting of each said segment being biased with respect to the netting of the adjacent outer panel with warplike threads of the outer panel and segment nettings parallel adjacent the middle of their common boundary and intersecting elsewhere along their common boundary at acute angles which increase toward the extremities thereof, said two pads respectively underlying said outer panels, extending from the front to the rear of the helmet in generally parallel relation over the crown of the wearer's head on opposite sides of the center line of said helmet, said headgear including a second pair of pads respectively underlying said side panels and the adjacent segments on opposite sides of said two first-mentioned pads and curved to extend over and behind the ear areas of the

wearer's head, for protecting the opposite sides of the head, said second pair of pads being individually supported by said helmet in sufficiently spaced relation to said two first-mentioned pads so as to be movable relative to said two first-mentioned pads.

22. Structure as defined in claim 21, wherein said helmet further includes an inner layer of flexible, yieldable netting extending over the interior of said helmet and stitched to said outer panels and segments to cooperatively define therewith individual pockets for holding said pads, said inner layer having plural slits respectively positioned at central portions of said pockets for insertion and removal of said pads.

23. Structure as defined in claim 22, wherein said pads are perforated for ventilation of the interior of the helmet, and wherein each of said pads bears on its inner surface a layer of material having formed therein plural flexible protrusions for holding the inner surface of the pads spaced away from the wearer's head to permit passage of air between the pad and the head.

24. Structure as defined in claim 22, further including a gore of flexible yieldable netting secured to and extending below the forward edges of said outer panels for engaging the wearer's forehead, said gore comprising a pocket, and further including an energy-absorbing pad inserted within the gore for protecting the wearer's forehead.

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