Aug. 21, 1956 E. R. DYE 2,759,186

PNEUMATIC SUSPENSION FOR SAFETY HELMET

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Fig. 1.

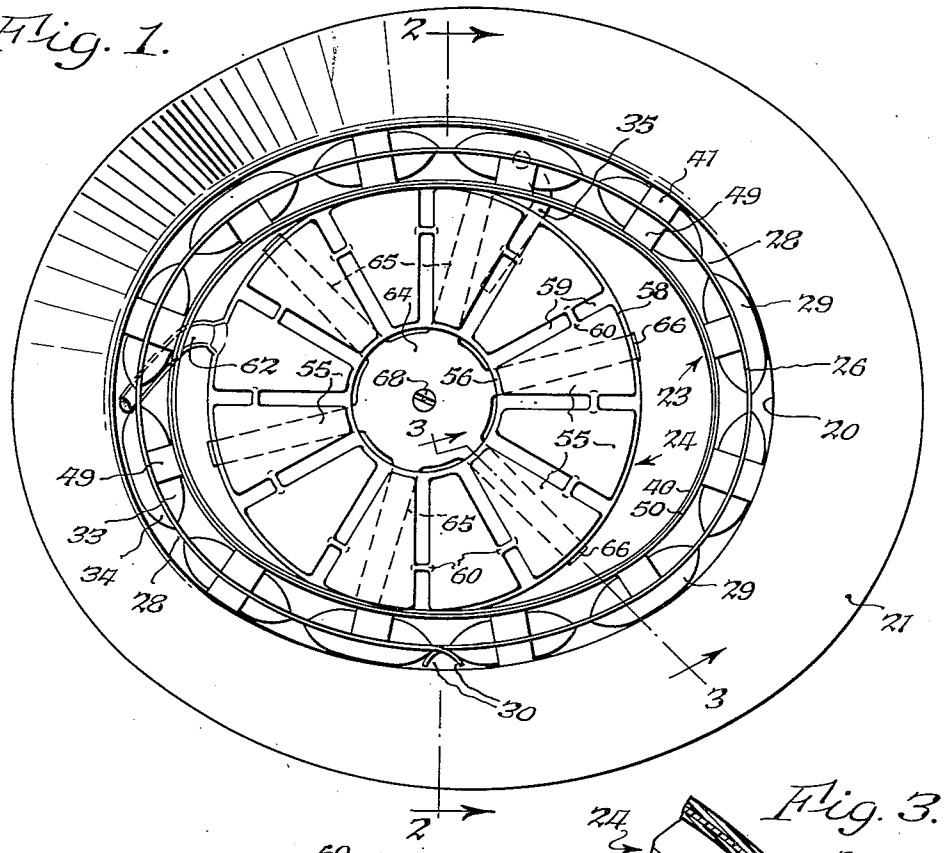


Fig. 2.

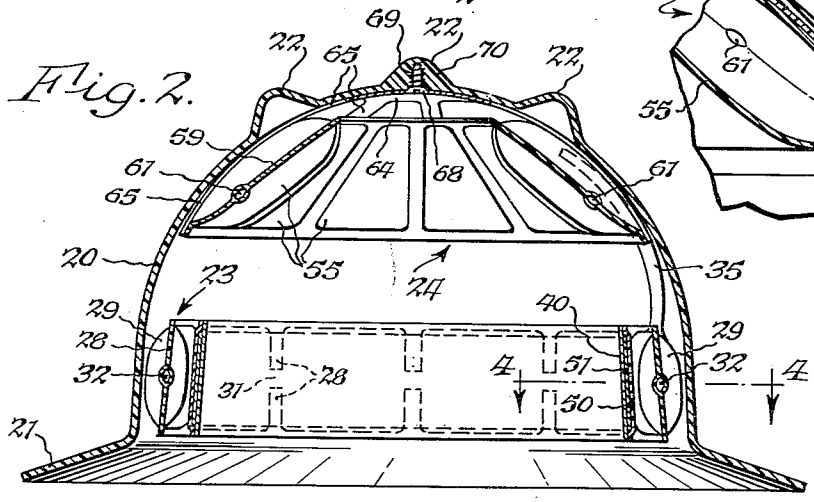
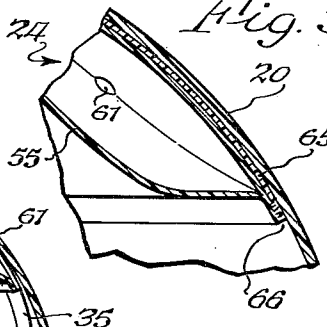


Fig. 3.



INVENTOR.
Edward R. Dye
BY Popp and Sommer
Attorneys.

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Fig. 4.

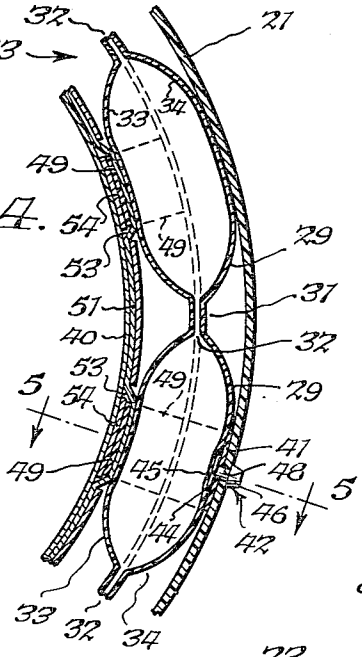
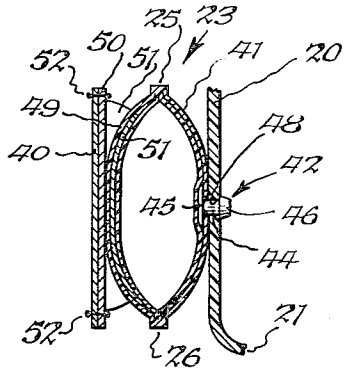


Fig. 5.



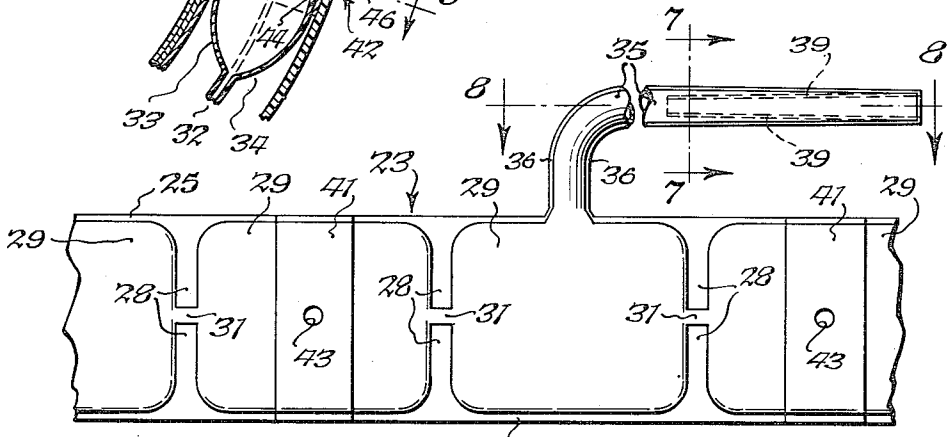


Fig. 6.

Fig. 7.

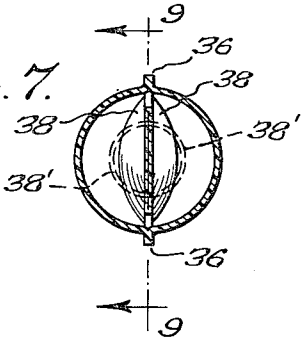


Fig. 8.

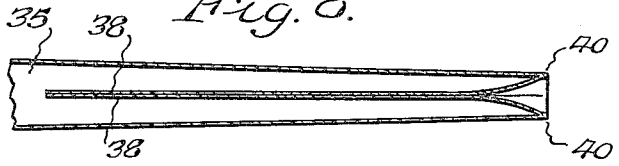
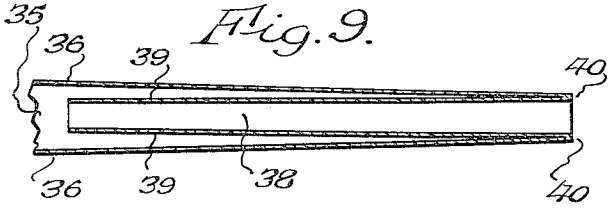


Fig. 9.



INVENTOR.
Edward R. Dye
BY Popp and Sommer
Attorneys.

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PNEUMATIC SUSPENSION FOR SAFETY HELMET

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Fig. 10.

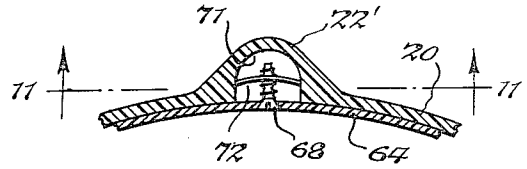
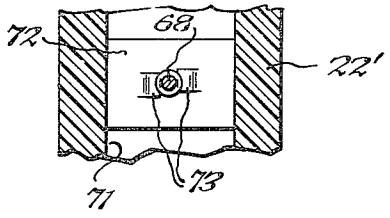


Fig. 11.



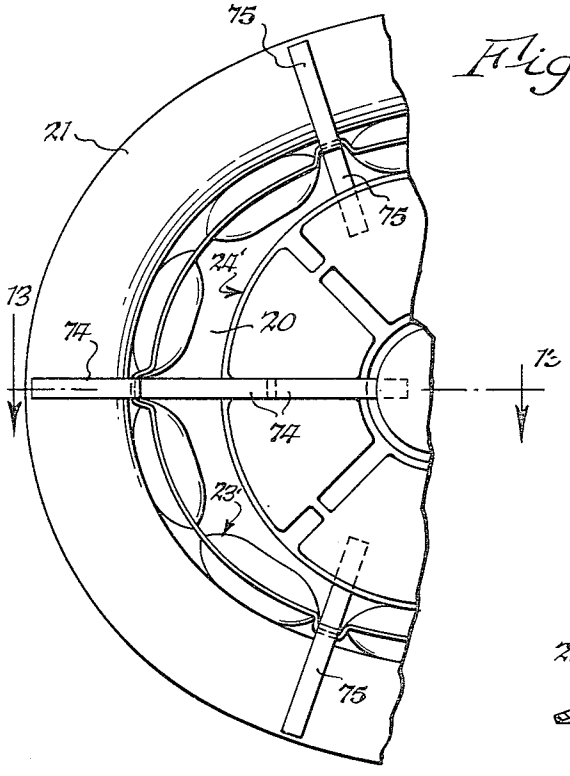


Fig. 12.

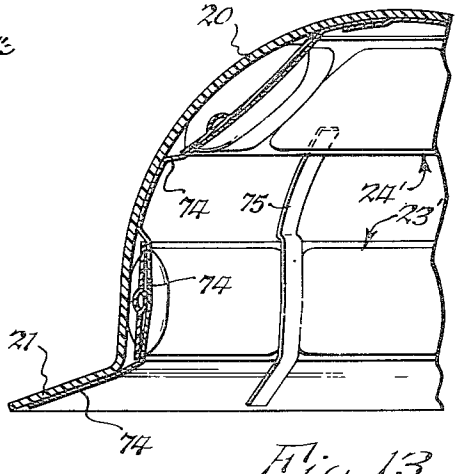
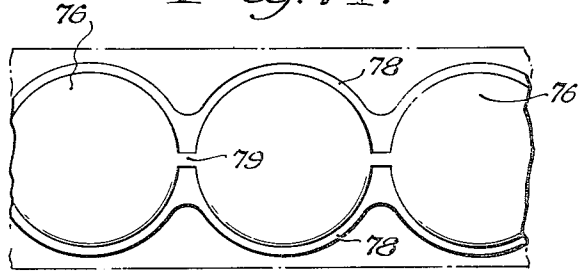


Fig. 13.

Fig. 14.



INVENTOR.
Edward R Dye
BY Popp and Sommer
Attorneys.

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2,759,186

PNEUMATIC SUSPENSION FOR SAFETY HELMET

Edward R. Dye, Orchard Park, N. Y., assignor to Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., a corporation of New York

Application July 7, 1953, Serial No. 366,460

4 Claims. (Cl. 2—3)

This invention relates to protective helmets and more particularly to a pneumatic suspension for such a helmet.

The type of helmet with which the invention is concerned is that which is worn by miners, construction workers and the like and generally comprises a relatively hard shell, the purpose being to protect the head of the worker against injury from falling objects and contacts with objects occasioned by low or restricted head room.

The principal object of the present invention is to provide a suspension for such a safety helmet which effectively protects the head of the wearer against blows to the helmet, particularly impact blows such as might be occasioned by an object falling on the helmet or movement of the helmet while worn into striking contact with some object.

Another object is to provide such a suspension which cushions the head against blows to the helmet in such manner that the force of the blow is not merely distributed over an area of the head but the energy of the blow is dissipated in large measure and not merely stored so that rebound forces are minimized.

A further object is to provide such a suspension which gives effective protection for the top and side portions of the head.

A further object is to provide such a suspension which is comfortable to the wearer and is adjustable to his desires.

A further aim is to provide such a pneumatic suspension which can be readily inflated and deflated.

A further aim is to provide such a suspension which adds very little to the weight of the helmet per se, is simple in construction and inexpensive to manufacture, and durable.

Other objects and advantages of the invention will be apparent from the following description and drawings in which:

Fig. 1 is a bottom elevational view of a helmet equipped with a suspension embodying one form of my invention.

Fig. 2 is a vertical transverse sectional view thereof taken on line 2—2 in Fig. 1.

Fig. 3 is an enlarged fragmentary vertical transverse sectional view thereof taken on line 3—3 in Fig. 1.

Fig. 4 is an enlarged fragmentary horizontal sectional view thereof taken on line 4—4 in Fig. 2.

Fig. 5 is a fragmentary vertical sectional view thereof taken on line 5—5 in Fig. 4.

Fig. 6 is a fragmentary elevational view of that face of the lower row of cells shown in Fig. 2 which face lies against the inner surface of the helmet, and also showing the air filling stem for this row of cells.

Fig. 7 is an enlarged cross-sectional view of the aforesaid filling stem taken on line 7—7 in Fig. 6.

Fig. 8 is an enlarged fragmentary longitudinal horizontal sectional view of the filling stem and showing the valve arranged therein.

Fig. 9 is a view similar to Fig. 8 but showing the filling stem and valve in vertical section, this view being taken on a reduced scale on line 9—9 in Fig. 7.

Fig. 10 is a fragmentary vertical sectional view of the upper central portion of a helmet and showing a different way of mounting the upper row of cells to the helmet than shown in Fig. 2.

Fig. 11 is a sectional view thereof, on a slightly enlarged scale, taken on line 11—11 in Fig. 10.

Fig. 12 is a fragmentary bottom elevational view, similar to Fig. 1, and showing a helmet equipped with a suspension embodying a modified form of my invention.

Fig. 13 is a vertical cross sectional view thereof, on a reduced scale, the view being taken on line 13—13 in Fig. 12.

Fig. 14 is a fragmentary view similar to Fig. 6 and showing a modified shape of cells.

The safety helmet illustrated in Figs. 1 and 2 is representative of the type of helmet for which my suspension is suited. As shown such helmet is in the form of a shell having a cup-shaped crown portion 20 which covers the head of the wearer and a brim portion 21. The crown portion is shown as having three corrugations or ribs 22 which run in a fore-and-aft direction. The helmet may be made of any suitable metal or non-metal material depending upon the purpose for which worn. The helmet illustrated is intended to be made of a suitable rigid plastic material.

In accordance with my invention the interior of the crown portion 20 of the helmet is equipped with a suspension which is shown in Figs. 1 and 2 as comprising a lower row of pneumatic pillows indicated generally at 23 which encircle the head of the wearer at brow level, and an upper arrangement or row of pneumatic pillows indicated generally at 24 which engage the top portion of the head. The pillows 23 are adapted to accommodate blows to the helmet applied in a substantially horizontal direction and the pillows 24 resist blows applied in a substantially vertical direction.

The pillows are made of a flexible substantially inextensible material such as polyvinyl although any other suitable material may be employed. Polyvinyl material was selected as the preferred material of which to construct the pillows 23 and 24 because it possesses the ability to bond or weld with itself under heat and pressure, or, in other words, to be heat sealed. This facilitates the construction of the pillows.

Referring to Fig. 6, the row of pillows 23 is formed of two strips of polyvinyl sheet material joined together or heat sealed along their upper and lower margins, as indicated at 25 and 26 respectively, and also joined together or heat sealed in a transverse direction at intervals along their length, as indicated at 28, to thereby define a series of inflatable cells 29 each preferably of uniform size and of generally rectangular outline in plan. The sealed ends of the strips, indicated at 30 in Fig. 1, are preferably adjustably joined by reducing one in width and passing it through a slot in the other.

Each area or narrow band of transverse sealing indicated at 28 is interrupted at about its center, at the place indicated by 31 in Fig. 6, so as to leave a narrow portion of the plys unbonded and thereby provide a narrow passage 32 as shown in Fig. 2. Thus each cell 29 has an inner and outer wall 33 and 34 respectively (see Figs. 4 and 5), adjacent pillows being connected by webs provided by the sealing at 28 (see Fig. 2) and the interiors of all cells are in communication with one another through the interconnecting restricted passages 32.

Referring to Fig. 6, one of the pillows or cells 29 has a tubular stem 35 extending upwardly from the upper margin thereof for introducing and exhausting air from the cells to control the degree of inflation of the same. As shown the stem 35 is formed by integral extensions of the plies which form the pillow to which this stem is

connected and heat sealing these extensions along their longitudinal meeting edges, as indicated at 36, so as to form a tubular stem.

While any suitable closure may be provided for the stem 35, that shown in Figs. 6–9 has been found particularly advantageous and comprises an internal check valve formed of polyvinyl sheet material. This valve consists of two superposed elongated sheets 38—38 each of tapered outline and heat sealed along their meeting longitudinal edges as indicated at 39 so as to form normally a flattened tube open at its opposite ends. This valve tube is arranged within the stem 35 adjacent the free end thereof, the narrow end of the valve tube being innermost and the broader end thereof being heat sealed to the mouth of the stem, as indicated at 40—40. The thickness of the polyvinyl sheet material used for the valve tube is preferably thinner than that used for the stem 35, although this is not essential. For example, if the length of the stem 35 were made longer and tapered as shown in Fig. 6, the outer portion could be turned inwardly of the stem to provide the equivalent of the fabricated valve stem shown and this would eliminate the transverse heat sealing 40 at the mouth of the stem 35 although such an arrangement would be more bulky at the stem mouth than the arrangement shown.

When air is introduced into the stem 35 as by blowing into it by mouth, the air separates or spreads apart the walls 38—38 along their central portions and form a passage through which the air flows into the stem 35 and thence into the cell 29 to which this stem is connected and into the other cells through the connecting passages 32. Very little pressure need be maintained within the cells 29 to give satisfactory inflation for protective purposes, as more fully explained later herein, the pressure not exceeding in the order of one inch of water. When air ceases to be forced through the dilated valve, the walls 38—38 thereof collapse against each other under the pressure of the air confined within the cells and stem 35. This pressure effectively forces the walls 38—38 against each other and it has been found to provide an effective self closing valve. It will be noted that the higher the pressure surrounding the valve walls 38—38 the more these walls will be forced against each other.

Should it be desired to deflate the cells 29, either completely or partially, this can be readily achieved by inserting a suitable elongated object (not shown) such as a match stick or nail into the crevice of the valve so as to separate the walls 38—38 thereof. When this is done, these walls will assume the position shown by broken lines and represented by the numeral 38'—38' in Fig. 7. Air escapes outwardly of the stem past the inserted object (not shown) to the atmosphere. In this manner the cells 29 can be quickly and easily deflated to the degree desired.

Referring to Figs. 1, 2 and 4, the lower row of pillows 23 is shown as arranged within the crown portion 20 of the helmet adjacent the mouth thereof and extending the full perimeter thereof. In this embodiment the row of pillows is mounted on the helmet and is faced on its head engaging side with a flexible sweat band 40 made of any suitable material such as leather, real or imitation.

The means for mounting the row of pillows on the helmet comprises a strap 41 and button 42 as shown in Figs. 4 and 5. The strap 41 extends vertically over the bulge of the pillow and is heat sealed along its opposite ends to the longitudinal edges 25, 26 of the pillow. This strap has a central hole 43 through which the button 42 projects. The button is shown as having a shank 44, an enlarged flat head 45 at one end and a frusto-conical enlarged head 46 at its opposite end. The flat head 45 lies between the outer wall 34 and strap 41; the shank 44 extends through the hole 43 in this strap and also a hole 48 in the helmet; and the frusto-conical head 46 is arranged exteriorly of the helmet, the inwardly facing

shoulder on the button engaging the outer face of the helmet surrounding the hole 48 and thereby preventing dislodgement of the button. The length of the shank 44 is such that the strap 41 is compressed against the inner face of the helmet shell. In this manner the various straps 41 are firmly held to the helmet, and in turn the row of pillows 23.

When mounting the row of pillows 23 on the helmet the buttons 42 are first arranged on the straps 41 and thereafter the frusto-conical heads 46 are pressed through the holes 48 in the helmet. The buttons are made of a suitable flexible resilient material so that the frusto-conical heads will compress to pass through the holes 48 and thereafter expand into the locking condition shown in Figs. 4 and 5.

Referring to Fig. 6, a strap 41 is shown as provided on every other cell 29. This is merely illustrative. A strap may be provided on every cell or fewer than the alternate ones shown, as desired.

The means for mounting the sweat band 40 on the row of pillows 23 include straps 49 on the pillows, a backing 50 on the sweat band and a band 51 laced between these straps and backing.

The straps 49 are similar to the straps 41 and are preferably provided on every cell 29. Thus, referring to Figs. 4 and 5, each strap 49 extends over the bulge of its cell and is heat sealed at its opposite edges to the longitudinal edges 25, 26 of the pillow.

The backing 50 is in the form of a band of substantially the same width as the sweat band 40 and lies against its inner face, being suitably secured thereto along its longitudinal edges as by rows of stitching 52—52. Adjacent the vertical edges of each strap 49, the backing is provided with vertical slots 53 so as to leave a portion 54 intermediate these slots.

The band 51 is laced between the sweat band 40 and backing 50, on the one hand, and the strap 49 and outer wall 33 of the cell 29, on the other hand, the band 51 passing through the slots 53 as shown in Fig. 4. The lacing band 51 is substantially as wide as the spacing between the rows of stitching 52. In this manner the sweat band is securely mounted on the row of pillows 23 and will not slip vertically with respect to the same.

The pillows, indicated generally at 24, are arranged against the inside surface of the crest or dome portion of the helmet to protect the top of the head of the wearer of the helmet. These pillows are in the form of an annular row of cells 55 each of isosceles trapezoidal outline as viewed in Fig. 1. They are formed in the same manner as the pillows 23. That is, two sheets of polyvinyl sheet material, each annular in form are heat sealed along their meeting edges, as indicated at 56, 58 and divided from each other by radiating bonded portions 59. The portions 59 are interrupted to leave on unbonded portion 60 which provides a narrow passage 61 which connects adjacent cells 55. One of these cells along its outer edge is formed with a filling stem 62 which is shown as constructed similar to the filling stem 35 and contains the same internal check valve previously described. In this connection, when the filling stems are not being used, the free end portion of the filling stem 62 is inserted behind the lower row of pillows 23 in the space between adjacent cells therein, and the filling stem 35 is inserted in the space between adjacent cells 55 in the upper row of pillows 24, as shown in Fig. 1. To be used, either stem is merely pulled out of its tucked away position so that its free end is accessible for inflation or deflation of the respective row of pillows.

The means for mounting the upper row of pillows 24 are shown as comprising a frame in the form of a spider having a central part 64 and a series of radiating arms 65. One such arm 65 is shown as provided for every other cell 55, although a fewer or greater number of such arms may be provided, as desired. The spider frame is preferably made of a flexible sheet plastic material so that the

free ends of the arms **65** may be cemented or heat sealed to the outer flange **58** where it crosses the same, as shown at **66**.

The central part **64** of the spider frame may be secured to the helmet in any suitable manner. As shown in Fig. 2, the central part **64** of the spider frame is held to the helmet by a screw **68** screwed into a threaded recess **69** provided in the central corrugation **22** of the helmet which corrugation has been filled in with material, preferably during its formation, to provide a body **70** in which the recess **69** may be formed.

Instead of filling in the central corrugation and tapping the hole **70** therein to receive the screw **68**, the arrangement shown in Figs. 10 and 11 may be employed. As there shown the central corrugation **22'** has an enlarged groove **71** which is traversed by a bowed plate **72**. The opposite ends of this plate **72** engage the side walls of the groove **71** and this plate is centrally provided with an opening and offset fingers **73—73** which are struck out from the body of the plate. These fingers form an interrupted female thread to receive the male thread on the screw **68**. It will be seen that by tightening the screw **68** the upwardly bowed plate **72** will tend to flatten or straighten out which will force the ends of this plate into firmer engagement with the walls of the groove **71**. If desired the ends of the plate **72** may be toothed or serrated to dig into the helmet and assure an even more positive anchorage.

It will be further noted that the spider frame, on which the upper row of pillows **24** is mounted, has its arms **65** lying against and conforming to the inner surface of the crown portion **20** of the helmet, as shown in Fig. 2. Because of the geometry of this row of pillows there is no need to secure the inner and upper flange thereof to the arms **65**, although this may be done if desired.

A different mode of attaching the rows of pillows **23'** and **24'** is illustrated in Figs. 12 and 13. As there shown a series of long strips **74** pass over the webs connecting adjacent cells in the lower and upper rows, each such strip being cemented to the portion of the helmet over which it extends and contacts, as best shown in Fig. 13. Inasmuch as the lower row of pillows **23'** is shown as having more cells in it than the upper row, additional strips **75** may be employed between the longer strips to secure only the lower row of pillows to the helmet. The strips **75** are cemented to the helmet as in the case of the longer strips **74**. This manner of mounting the upper and lower rows of pillows **23'** and **24'** is advantageous in that it requires less adaptation of the helmet and there are no holes required in the helmet to receive the buttons as in the case of the arrangement shown in Figs. 1–5. It will be noted that a sweat band is not shown in the construction shown in Figs. 12 and 13, the head of the wearer engaging directly with the inner side walls of the pillows or cells.

The contour of the pillows or cells may be of any suitable form other than as shown in Fig. 6. As an example, a circular form of pillow **76** is illustrated in Fig. 14. These may be formed from two sheets of heat sealable material, bonded together along marginal portions having their inner edges undulating. Thereafter the heat sealed margins may be trimmed leaving the flanges **78, 78**. The portion indicated at **79** is unbonded and leaves a restricted passage connecting adjacent cells.

The cells or pillows are resistive to the displacement of air therefrom, the size of the passages therebetween serving as throttling orifices to dissipate energy absorbed by compression of any cell by the application of the impact force to the helmet from a direction which will tend to compress or flatten this particular cell.

It is to be noted that the annular row of cells **23** or **23'** provides a pneumatic headband cushion in which the cells are so proportioned with the circumferential length of each cell being less than twice its height such that they present substantially their full areas on the inner side of the row for effective engagement with the wearer's head at brow level and on the outer side of this row the cells present substantially their full areas for effective engagement with the helmet shell. Likewise, the annular row of cells **24** or **24'** is so proportioned as to present substantially the full area of each cell on opposite sides thereof for effective engagement with the top of the head on the inner side of this row and the dome portion of the helmet shell on the outer side of this row. Since both rows of cells are adapted to be inflated by breath of mouth the cells may contain a low pressure. When the helmet receives an impact blow which tends to flatten those cells interposed between the shell and the wearer's head generally in the line of force of such blow, the air within such interposed cells is compressed further without bottoming since the cells are dimensionally inextensible and the compressed air is throttled through the restricted passages connecting such interposed cells with other cells in the same row thereby to dissipate the energy of the impact blow. The increased pressure in the adjoining cells causes them to hug the head and distribute the impact of the blow over a large area. Thus the force of the impact is effectively absorbed and distributed and rebound effects are dampened.

While the row of cells **23** or **23'** encircling the head at brow level is essential, and it is also essential to provide a means for protecting the top of the head of the wearer, such means need not necessarily be of the pneumatic type illustrated by the cells **24** and **24'** but may be a strap arrangement shown in my copending application Serial No. 254,757 filed November 3, 1951 and entitled Geodetic Strap Suspension for Helmets, now Patent No. 2,679,046 dated May 25, 1954.

I claim:

1. In a safety helmet having a shell including a cup-shaped crown portion adapted to cover the head of the wearer, the combination therewith of a pneumatic headband cushion for supporting the helmet on the head of the wearer in spaced relation thereto and to protect the head from lateral impact blows against the helmet comprising an annular row of air cells made of a flexible substantially inextensible material and mounted within said crown portion of said shell adjacent the mouth thereof and extending the full perimeter thereof, means interconnecting said cells by restricted passages arranged between adjacent cells, said cells being so proportioned with the circumferential length of each cell being less than twice its height such that they present substantially their full areas on the inner side of said row for effective engagement with the wearer's head at brow level and on the outer side of said row said cells present substantially their full areas for effective engagement with said shell, and means for inflating said cells by breath of mouth, whereby said cells may contain a low pressure and, when the helmet receives a generally horizontally directed impact blow which tends to flatten those of said cells interposed between said shell and the wearer's head generally in the line of force of such blow, the air within such interposed cells is compressed further without bottoming and the compressed air is throttled through the said restricted passages connecting such interposed cells with other of said cells thereby to dissipate the energy of the impact blow.

2. In a safety helmet having a shell including a cup-shaped crown portion adapted to cover the head of the wearer, the combination therewith of a pneumatic headband cushion for supporting the helmet on the head of the wearer in spaced relation thereto and to protect the head from lateral impact blows against the helmet comprising a head encircling flexible sweat band, an annular row of air cells made of a flexible substantially inextensible material and arranged between said sweat band and said crown portion of said shell and extending the full perimeter thereof, means interconnecting said cells by restricted passages arranged between adjacent cells, said cells being so proportioned with the circumferential length of each cell being less than twice its height such that they present

substantially their full areas on the sweat band side thereof for effective engagement with the wearer's head at brow level and on the opposite side said cells presenting substantially their full areas for effective engagement with said shell, and means for inflating said cells by breath of mouth, whereby said cells may contain a low pressure and, when the helmet receives a generally horizontally directed impact blow which tends to flatten those of said cells interposed between said shell and the wearer's head generally in the line of force of such blow, the air within such interposed cells is compressed further without bottoming and the compressed air is throttled through the said restricted passages connecting such interposed cells with other of said cells thereby to dissipate the energy of the impact blow.

3. In a safety helmet having a shell including a cup-shaped crown portion adapted to cover the head of the wearer, the combination therewith of means for supporting the helmet on the head of the wearer in spaced relation thereto to protect the same from impact blows against the helmet, comprising a pneumatic headband cushion including an annular row of air cells made of a flexible substantially inextensible material and mounted within said crown portion of said shell adjacent the mouth thereof and extending the full perimeter thereof and adapted to encircle the head of the wearer at brow level and interconnected by restricted passages to control the flow of air between adjacent cells, a pneumatic crown cushion arranged within said crown portion at the dome thereof for engaging and protecting the top portion of the wearer's head including an annular row of air cells made of a flexible substantially inextensible material and interconnected by restricted passages to control the flow of air between adjacent cells, the cells in each of said rows being so proportioned that the circumferential length of each cell is less than twice its height, and means for inflating both rows of said cells by breath of mouth, whereby the cells may contain a low pressure and, when the helmet receives an impact blow which tends to flatten those cells interposed between said shell and the wearer's head generally in the line of force of such blow, the air within such interposed cells is compressed further without bottoming and the compressed air is throttled through the restricted passages connecting such interposed cells with other cells in the same row thereby to dissipate the energy of the impact blow.

4. In a safety helmet, means for pneumatically supporting the helmet on the head of a wearer in spaced relation thereto and to protect the head from impact blows against

the helmet, comprising a pneumatic headband cushion including an annular row of air cells made of a flexible substantially inextensible material and adapted to encircle the head of the wearer at brow level and interconnected by restricted passages to control the flow of air between adjacent cells, a pneumatic crown cushion including another annular row of air cells made of a flexible substantially inextensible material and arranged above said first row and adapted to engage and protect the top portion of the wearer's head and interconnected by restricted passages to control the flow of air between adjacent cells, the cells in each of said rows being so proportioned that the circumferential length of each cell is less than twice its height, means for inflating the cells in both rows by breath of mouth, whereby said cells may contain a low pressure and, when the helmet receives an impact blow which tends to flatten those cells interposed between the helmet and the wearer's head generally in the line of force of such blow, the air within such interposed cells is compressed further without bottoming and the compressed air is throttled through the restricted passages connecting such interposed cells with other cells in the same row thereby to dissipate the energy of the impact blow, means for mounting said headband cushion on said helmet, and means for mounting said crown cushion on said helmet comprising a spider-like frame having a central part and arms radiating from said central part and connected at their outer ends to the outer edges of said crown cushion and a fastening securing said central part to said helmet.

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