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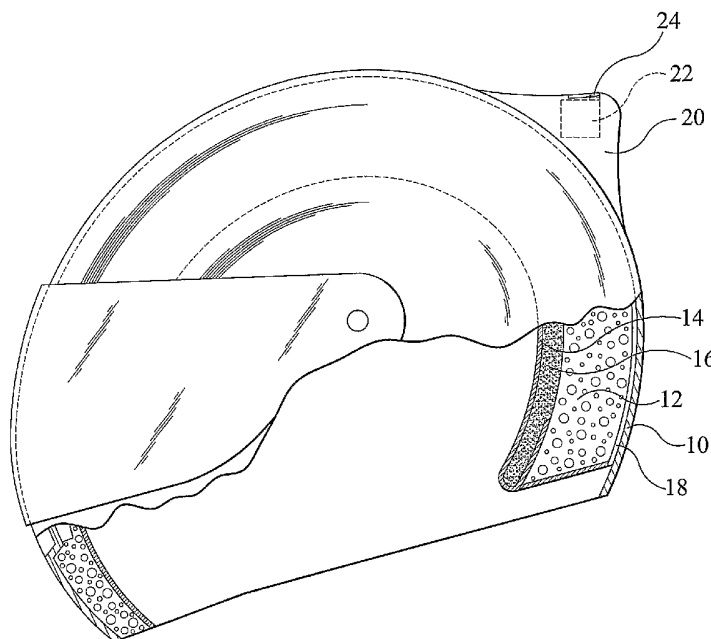
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(54) Title: SAFETY HELMET



(57) Abstract: A safety helmet is described which includes means to allow the impact status or history of the helmet to be determined. The means may comprise an electrical sensor or alternatively may be arranged to provide a visible indication in the event of an impact.

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SAFETY HELMET

This invention relates to a safety helmet.

Safety helmets are commonly worn by, for example, horse riders, cyclists and motor cyclists, with the aim of reducing injury to the wearer's head in the event that he falls, crashes or, for horse riders, is thrown. Safety helmets are also commonly worn when participating in certain other sports or activities. A typical safety helmet design incorporates a layer or pieces of a compressible or deformable material located such that, in the event of the wearer's head impacting upon an object, or an object hitting the helmet, the compressible or deformable material will deform to absorb at least some of the impact forces thereby lessening the risk of injury to the wearer. As the deformation of the compressible or deformable material can be permanent, it is usually recommended that after such an impact has occurred, the helmet is disposed of as its ability to absorb future impact forces may be reduced. Alternatively, the helmet may be repaired.

Although disposal or repair is recommended, there are often situations where the wearer may consider the impact to be of insufficient severity to require the helmet to be replaced or repaired, and so a helmet may be used which is not capable of serving its intended purpose. There are also situations where helmets are shared or used by a number of individuals none of whom may know whether an impact has

occurred whilst the helmet was being used by another. It is an object of the invention to provide a helmet user with the ability to determine the impact history or impact status of a helmet. One way of achieving this is to provide a mechanism whereby a record can be kept of the impacts experienced by a helmet.

5           According to one aspect of the invention there is provided a helmet comprising an impact sensor and a memory arranged to store impact data from the impact sensor.

          It will be appreciated that by appropriate interrogation of the memory, a user can determine whether or not the helmet has been involved in an impact of  
10 magnitude sufficient to impair the subsequent performance thereof.

          The memory may be arranged to store the impact information in a range of ways. For example, it may record the time and magnitude of each impact experienced by the helmet. Alternatively, some form of filtering may be applied so that only data representative of impacts exceeding a pre-determined threshold value  
15 are recorded. Although the time of the or each impact may be recorded, there may be occasions when this information is not required and so this data may not be stored. In a simple embodiment, the memory may be bistable and arranged to switch between a first, normal, state and a second, warning, state upon the occurrence of an impact or series of impacts greater than a pre-determined value.

The helmet may further include a warning device adapted to be controlled using the data stored in the memory.

For example, a warning may be triggered in the event that an impact is sensed the magnitude of which is greater than a predetermined threshold.

5 The predetermined threshold may be set by, for example, the helmet manufacturer, so as to be tailored to, for example, the helmet design and the intended use thereof.

The warning preferably comprises a visible warning, for example an appropriately controlled liquid crystal display. Alternatively, a warning light, for  
10 example an LED arranged to be illuminated in the event of the occurrence of a large impact, may be provided. However, other warnings could be used. For example, a light may be switched off in the event of an impact, rendering the helmet fail-safe. Another possibility is to provide an audible warning.

The impact sensor may take a range of forms. In one arrangement it  
15 comprises a layer of a material sensitive to the occurrence of an impact.

The said layer of material may be incorporated into the helmet but could, alternatively, be retrofitted thereto, if desired. Where intended to be retrofitted, the layer may be fitted by, a manufacturer or repairer. Alternatively, a suitable kit may be supplied to allow the user to fit the layer to the helmet.

The layer of material conveniently comprises a layer of quantum tunnelling composite material. The electrical insulating/conducting properties of such a material vary when the material is pressed, squashed, twisted or stretched thus by measuring the electrical resistance across the layer, a measurement of whether or not an impact is occurring and the magnitude of any such impact can be made. The material may be in sheet form or alternatively may comprise granules mixed with and incorporated into the material of part of the helmet. The layer is preferably continuous, but could alternatively be discontinuous, for example in the form of a plurality of isolated regions or pads.

Although the sensor may take the above described form, it will be appreciated that this need not be the case and a range of other sensors could be used.

For example, the sensor could be capacitance based. In such an arrangement, a pair of electrically conductive layers are separated by an electrically insulating material. In the event of an impact, the electrically insulating material will deform, allowing the electrically conductive layers to be forced closer to one another thereby changing the capacitance therebetween. A plurality of discrete, self-contained sensor capacitors may be used instead of a single, larger sensor capacitor, if desired. Other possibilities, include the use of piezo electric materials, the application of a force to which results in a measurable change in the electrical properties thereof.

Other forms of strain gauge could also be used.

Although the provision of a suitable sensor and memory allows a user, by appropriate interrogation of the memory, to ascertain information relating to impacts experienced by a helmet and thus determine whether or not he considers it to be safe  
5 for use, it will be appreciated that other techniques are possible.

In accordance with another aspect of the invention, therefore, there is provided a helmet, and means associated with the helmet capable of providing an indication of the impact status or history of the helmet.

The means may take the form of a sensor and memory as described  
10 hereinbefore. Alternatively, the means capable of providing an indication could comprise a component the state of which will change in the event of an impact exceeding a pre-determined threshold, the state of the component being apparent to a user of the helmet. By way of example, the component may be arranged to change colour in the event of a large impact, the change of colour providing an indication  
15 to a user that the helmet has been involved in an impact. Alternatively, the component may be designed to break, crack, shatter or otherwise deform in the event of an impact in such a manner as to provide an indication that an impact has occurred. Preferably the component is encased, for example within or behind a suitable transparent material layer, so as to be contained but visible to a user.

Another possibility is to provide one or more reservoirs containing an ink or dye in the helmet, the reservoirs being arranged to rupture, break, leak or overflow in the event of an impact, the escaped ink or dye providing an indication to a user of the helmet's involvement in an impact.

5           The invention will further be described, by way of example, with reference to the accompanying drawings, in which:

          Figures 1 and 2 are views illustrating helmets in accordance with embodiments of the invention.

          Figure 1 illustrates a helmet of the type commonly worn by motor cyclists  
10   which comprises an outer shell 10, an impact absorbing layer 12 and an inner liner 14. Between the liner 14 and the layer 12 is a layer 16 of a compressible material intended to improve the fit of the helmet on the wearer and to improve comfort. Although a range of different materials may be used in the helmet, the shell 10 is typically of a plastics material, for example a fibre reinforced plastics material. The  
15   impact absorbing layer 12 is typically of a cellular material, for example a foamed plastics material. The layer 16 may be of urethane foam.

          When the wearer of the helmet experiences an impact which, in the absence of the helmet would be an impact to the head, the impact absorbing layer 12 deforms, thereby absorbing at least some of the impact force and reducing the risk

of injury to the wearer.

In accordance with the invention, in order to allow monitoring of the occurrence of such impacts, an impact sensor in the form of a layer 18 of a material sensitive to the occurrence of such impacts is provided. In the arrangement  
5 illustrated the layer 18 is located between the outer shell 10 and the impact absorbing layer 12. It will be appreciated, however, that the layer may be provided elsewhere, for example on the outside of the outer shell 10.

The layer 18 is formed from a so-called quantum tunnelling composite material. Such a material has the quality that its electrical resistance varies as the  
10 mechanical load applied thereto varies. The electrical resistance across the layer 18 is, under normal circumstances, high. However, in the event of an impact resulting from, for example, the wearer being involved in a road traffic accident and his head impacting upon the road surface or another hard object, the impact force will temporarily squash or compress the layer 18 thus causing a temporary reduction in  
15 the electrical resistance across the layer 18.

The top, rear part of the helmet is shaped to define a projection 20 adapted to house a monitoring unit 22. The unit 22 is an electronic unit arranged to monitor the electrical resistance across the layer 18. This may be achieved by providing electrically conductive layers on each major surface of the layer 18, the conductive



layers being isolated from one another by the layer 18, and by providing electrical connections between the unit 22 and the conductive layers, the unit 22 monitoring the electrical resistance between the connections using any suitable circuitry. The unit 22 includes a storage device or memory which is used to store data  
5 representative of the measured resistance values, and hence of the impact state of the helmet, over time. It will be appreciated, therefore, that by appropriate interrogation of the storage device, a history of events or impacts experienced by the helmet can be derived. Such interrogation may be achieved by connecting a suitable device to the unit 22 to download data from the storage device.

10 In addition to storage of the resistance data, the unit 22 is arranged to compare the resistance data with a stored threshold value to determine whether or not an impact has occurred of a magnitude sufficient to render the helmet unsuitable for further use. The stored threshold value may be set by the helmet manufacturer and will depend, to some extent, upon the helmet design and the intended use  
15 thereof. In the event that the comparison of the resistance data with the stored threshold indicates that the helmet has experienced an impact great enough to render the helmet unsuitable for further use, a warning is triggered. In the illustrated arrangement, the warning takes the form of a display device 24 in the form of a liquid crystal display which is controlled to display a suitable message. As

illustrated, the device 24 is located so as to define part of the wall of the projection 20 so as to be clearly visible. Alternatively, the warning could make use of a warning light in the form of a LED operable in the event that an impact has occurred.

5           The unit 22 conveniently includes an internal power source in the form of, for example, a battery. Obviously, where a warning light is used, there is the risk that if the battery runs flat, no warning signal is produced. It may be preferred to operate on a failsafe system whereby the impact warning is triggered by, for example, switching off (rather than on) a warning light. In the event of a flat  
10 battery, no warning light would be illuminated, and so no impression that the helmet is safe would be given. A similar operating technique may be used where the warning is displayed on a liquid crystal display.

Further possibilities include arranging for the warning light or display to be illuminated or operated only when, for example, a test button is pressed. With such  
15 an arrangement, a user could test the helmet before use and note whether or not a warning indicative of the impact state of the helmet is produced. Further, it may be possible to provide an audible warning instead of or in addition to the visible warning.

In the arrangement described hereinbefore, the layer 18 is a separate layer.

However, this need not be the case. Quantum tunnelling composite materials are available in granular form which can be incorporated into other materials. For example, the material may be incorporated into the plastics material of the outer shell 10, if desired. Further, in the arrangement described hereinbefore the layer 18 is continuous, providing information relating to the occurrence of impacts on any part of the helmet. However, provided a reduction in the sensitivity of the system is acceptable, the layer 18 may be discontinuous or may comprise a number of separate sensor regions or "pads".

A further alternative arrangement is shown in Figure 2. In this arrangement, a helmet of conventional form having a shell 10 and layer 12 is modified by the fitting thereof of a layer 18 of quantum tunnelling material and a housing 20 containing a monitoring unit 22 and warning device 24. The layer 18, unit 22 and device 24 may be permanently or semi-permanently secured in position using any suitable technique, for example by a suitable adhesive, or may be removably secured to the helmet, for example using a drawstring, and operate as described hereinbefore to allow monitoring of impacts experienced by the helmet.

The helmet impact monitoring techniques described hereinbefore make use of electronic sensors and memory units, for example using solid state components. It will be appreciated that a number of other electrically operated sensor techniques

could be used. For example, piezo electric components could be mounted upon the helmet and arranged to act like a strain gauge. In the event of an impact, the electrical properties of the components would change and this could be used to indicate that an impact has occurred. Other types of strain gauge could be used.

5           Another possibility is to use one or more capacitors to sense the occurrence of an impact. By way of example, one or more sensor regions of the helmet may be provided with a pair of spaced electrically conductive layers, an electrical insulator being located between the conductive layers. In the event of an impact, the layers will be forced closer together, the insulator deforming to allow such movement, with  
10 a consequent change in the capacitance between the conductive layers. The capacitors may take the form of fairly small, discrete, self-contained components, if desired. Although the capacitance may be continuously monitored and readings stored in a memory, the device may be arranged to be inactive whilst in use, and arranged to be connected, periodically, to a reader unit arranged to determine the  
15 measured capacitance and thereby determine whether or not the helmet is safe for use.

It will be appreciated that there is a wide range of other possible ways of enabling a user to determine whether or not a helmet has been involved in an impact which could impair the impact absorbing properties thereof. For example, a number

of ink or dye containing packets or cells may be incorporated into the helmet and arranged to rupture to allow the ink or dye to bleed therefrom in the event of a large impact. The ink or dye would then provide an indication to a user that the helmet has been involved in an impact. The packets or cells could be provided at or close  
5 to the surface of the helmet or located within, for example, the shock absorbing layer thereof. Where not located at the surface of the helmet, it may be desirable to incorporate, for example, a wicking material to allow passage of the ink or dye to a location in which it can be viewed. If desired, a transparent element may be provided in the helmet to allow inspection to determine whether or not the helmet  
10 is safe for use.

Alternatively, a component may be incorporated into the helmet, the component being adapted to change state in the event of an impact, the state of the component providing an indication to the user of whether or not the helmet has been involved in an impact. By way of example, the component may be of a material  
15 arranged to break, shatter, crack or otherwise deform in a noticeable manner in the event of an impact. Alternatively, the component may be arranged to undergo a change of colour in the event of an impact. In such an arrangement, it may be desirable to encase or enclose the component, for example within or beneath a layer of a transparent material.

As with the electronic arrangements, the components which enable impact information presentation may be incorporated upon initial manufacture or may be subsequently added to the helmet, either by a manufacturer or by the use of, for example, a kit of components.

5        Although the description hereinbefore is primarily of a helmet intended for use in motor cycling, it will be appreciated that the invention may be incorporated into helmets intended for use in a wide variety of applications, such as horse riding, cycling, motor racing or other applications in which helmets are worn to reduce the risk of head injury.

CLAIMS

1. A helmet comprising a shock absorbing element and means associated therewith to provide an indication of the impact status or history of the helmet.
2. A helmet according to Claim 1, wherein the said means comprises an  
5 electrical impact sensor.
3. A helmet according to Claim 2, wherein the electrical impact sensor comprises at least one capacitor, the electrical capacitance of which changes in the event of an impact.
4. A helmet according to Claim 2, wherein the electrical impact sensor  
10 comprises a strain gauge sensitive to the occurrence of an impact.
5. A helmet according to Claim 4, wherein the strain gauge incorporates a piezo electric component.
6. A helmet according to Claim 2, wherein the electrical impact sensor comprises a quantum tunnelling material, and monitoring means arranged to monitor  
15 the electrical properties of the quantum tunnelling material.
7. A helmet according to any one of Claims 2 to 6, further comprising a memory arranged to record data representative of the occurrence of impacts.
8. A helmet according to any one of Claims 2 to 7, further comprising a monitoring unit arranged to monitor the output of the impact sensor.

9. A helmet according to Claim 8, wherein the monitoring unit is connected to the impact sensor periodically.
10. A helmet according to any one of Claims 2 to 9, further comprising a warning device arranged to trigger a warning in the event that the impact sensor has detected the occurrence of an impact of magnitude greater than a predetermined magnitude.
11. A helmet according to Claim 1, wherein the said means comprises a component the state of which changes in the event of an impact exceeding a predetermined threshold, the state of the component being apparent to a user of the helmet.
- 10 12. A helmet according to Claim 11, wherein the change in state of the component is visibly apparent.
13. A helmet according to Claim 12, wherein the helmet includes a transparent element to allow the state of the component to be determined.
14. A helmet according to any one of Claims 12 and 13, wherein the colour of the component changes in the event of an impact.
- 15 15. A helmet according to Claim 12 or Claim 13, wherein the component is arranged to break, crack, shatter or otherwise visibly deform in the event of an impact.
16. A helmet according to Claim 12 or Claim 13, wherein the component



includes at least one rupturable ink or dye reservoir arranged to rupture, break, leak or overflow in the event of an impact.

17. A helmet substantially as hereinbefore described with reference to the accompanying drawings.

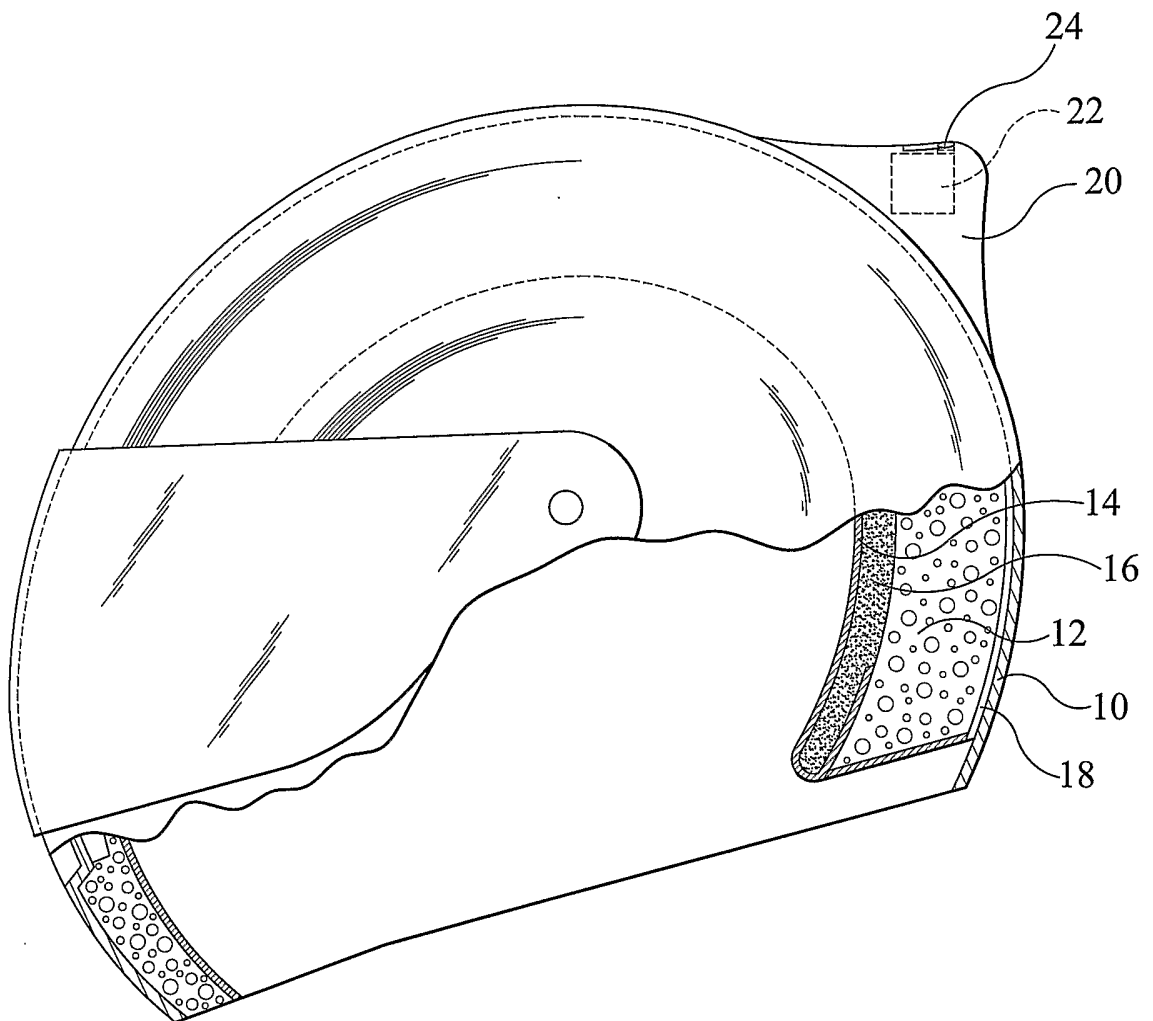


FIG 1

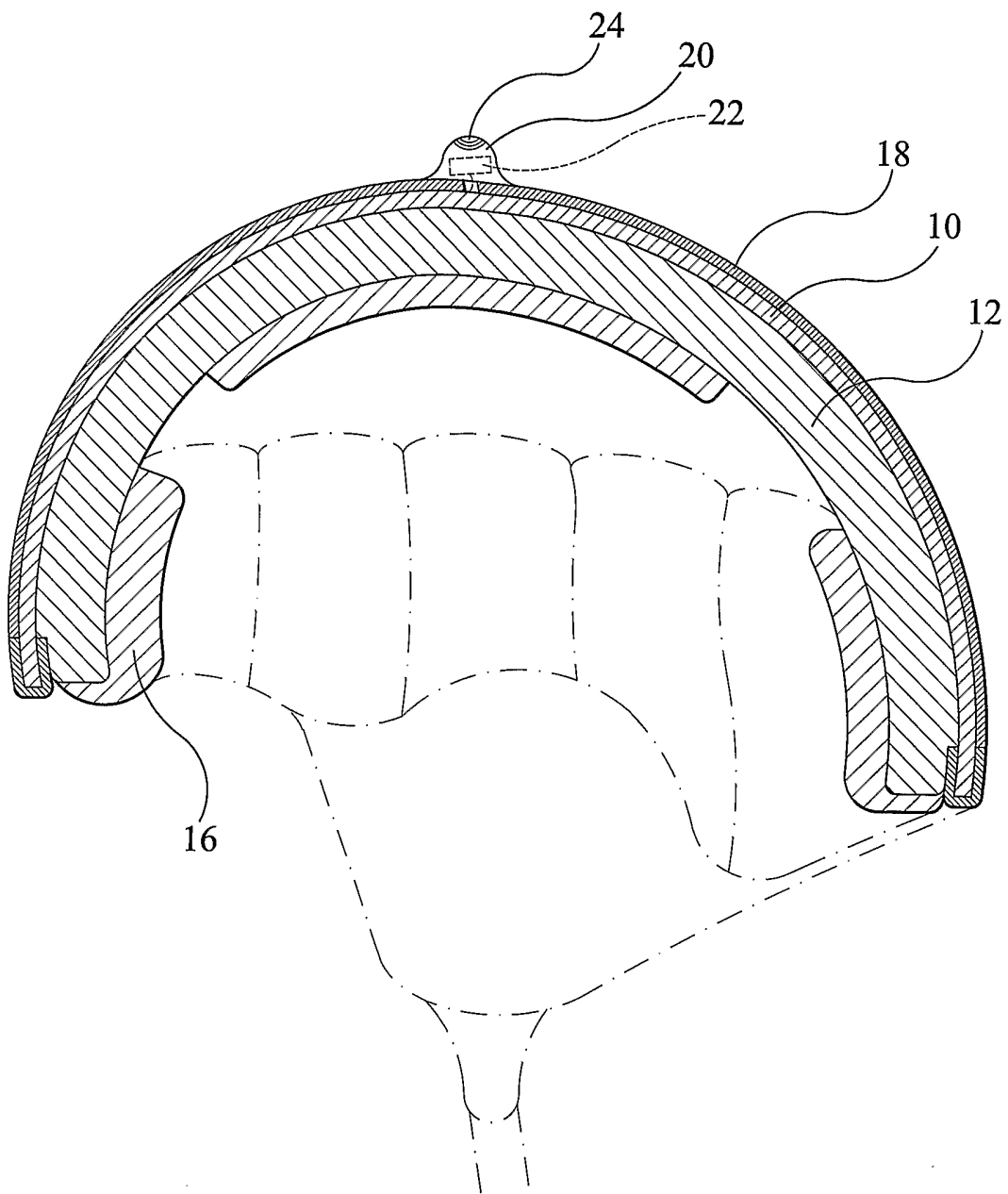


FIG 2

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB2004/004229

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 A42B3/04 A42B3/12

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 A42B G01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 332 226 B1 (RUSH III GUS A) 25 December 2001 (2001-12-25) claims 1,2,5	1,11-17
X	US 6 301 718 B1 (RIGAL JEAN-PIERRE) 16 October 2001 (2001-10-16) claims 1,2	1,11-14, 16,17
X	US 5 343 569 A (ASARE EDNA M ET AL) 6 September 1994 (1994-09-06) claim 1	1,11-14, 16,17
A	US 4 883 271 A (FRENCH BARRY J) 28 November 1989 (1989-11-28) claims 1,2	1-10

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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## INTERNATIONAL SEARCH REPORT

International Application No

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