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(54) **PROTECTIVE DEVICE FOR MOTORCYCLISTS**

SCHUTZVORRICHTUNG FÜR MOTORRADFAHRER

DISPOSITIF DE PROTECTION POUR MOTOCYCLISTES

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(73) Proprietor: **Futura S.p.a.**
20121 Milan (IL)

(72) Inventor: **LONGHINI, Fabrizio**
I-20135 Milan (IT)

(74) Representative: **Carloni, Franco**
**c/o Calvani, Salvi & Veronelli S.r.l., Piazza Duca
d'Aosta, 4**
20124 Milano (IT)

(56) References cited:
EP-A- 0 043 990 **FR-A- 2 677 856**
GB-A- 2 099 687 **US-A- 4 870 706**
US-A- 5 362 098

EP 0 981 285 B1

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DescriptionTechnical Field

5 **[0001]** The present invention generally relates to protective devices for use by motorcyclists and, more particularly, a device capable of minimizing the risk of injuries to the spinal column and, above all, to the lumbar region of the motorcyclist's body in the occurrence of a fall.

Background Art

10 **[0002]** Many examples of devices capable of protecting a motorcyclist when he is thrown from the motorcycle in an accident are given in the art. Besides the conventional protective headgears or crash-helmets, there are known protective garments which are provided with paddings and reinforcements located at the articulations of the motorcyclist's body or have elements or compartments which are automatically inflated in case of an emergency and cover or wrap up nearly all the motorcyclist's body and are intended to decrease the intensity of an impact against the ground or an obstacle.

15 **[0003]** Referring particularly to the latter, the solutions of the problem which have been developed till now are susceptible to important improvements since the number of accidents which cause severe injuries as paralysis or death is unfortunately high even in the case the motorcyclist is wearing this kind of garment.

20 **[0004]** The ineffectiveness of the above mentioned garments is partly due to the fact that, in the occurrence of an accident, when the garments are in an inflated condition the motorcyclist wearing them is virtually wrapped up by these garments and thus can easily bounce or roll on the ground thereby running into more severe injuries.

[0005] In addition to their ineffectiveness, these garments have the disadvantage of being very cumbersome in the ordinary use conditions.

25 **[0006]** In order to overcome these disadvantages, protective devices or garments have been designed with parts or compartments which are automatically inflatable in case of an accident and, instead of covering or wrapping up nearly all the motorcyclist's body, they only protect those body parts which in case of an accident may undergo lethal damages or injuries for the user, for example the spinal column and the organs contained in the abdominal region, particularly the loins.

30 **[0007]** The European Patent 0 043 990 (upon which the preamble of claim 1 is based) gives an example of such protective devices. Specifically, the patent describes a protective device for motorcyclists which comprises an element intended to protect the spinal column and provided with a protective element for motorcyclist's nape in its upper end, and with a belt in its lower end. The device is substantially formed of an airtight envelope and is provided with automatically triggered inflating means. The protective device is worn as a harness by means of straps or it can be embodied in a garment.

35 **[0008]** Although till now this device has proved to be the most effective for reducing the risk of a severe injuries to the spinal column, to the nape and to the loins in the case of an accident, it is affected by at least three disadvantages.

40 **[0009]** Firstly, the protection given by an inflatable element arranged along but directly over the spinal column determines a concentration of the shear force and of the bending moment. As it is known, the former can cause displacements of the vertebrae, while the latter can cause discopathy or vertebral fractures. In both cases, the detrimental effects to the spinal marrow can be irrecoverable.

[0010] Secondly, upon an impact against the ground or an obstacle-the inflatable element can move to the left or to the right with respect to spinal column and does not assure protection any longer.

45 **[0011]** Thirdly, the inflation of the element intended to protect the nape can dangerously stretch the cervical portion of the spinal column because the vertical component of the inflation pressure exerts a violent traction on the cervix and, in the case the crash-helmet is incorrectly fastened, such inflation pressure could even cause its coming off.

[0012] FR-A-2677856 discloses a protection garment for motorcyclists similar to that of EP-A-0043990. In this garment the substantially tubular inflatable element arranged along the spinal column is only one and is placed directly in correspondance of the spinal column area. Therefore, this garment shows the same drawbacks as those described in EP-A-0043990.

50 **[0013]** US-A-4.870.706 discloses a sport protection garment to protect an athlete's upper body by cushioning it with three tubular inflatable elements along the spinal column. However this garment is not specifically for motorcyclists (i. e. without automatically triggered inflating means), nor the tubular elements are arranged adjacent both sides of the spinal column. Also this document is affected by the same drawbacks as EP-A-0043990.

55 Disclosure of Invention

[0014] The main object of the present invention is thus to provide a protective device capable of reducing the intensity

of the shear force and of the bending moment acting in the spinal column of the motorcyclist during an impact against the ground, and to distribute as much as possible these actions over the muscular and skeletal portions which are adjacent to the spinal column therealong.

Another object of the present invention is to provide a protective device which is capable of decreasing the violent lateral and backward movements of the motorcyclist's head caused by impacts during an accident.

[0015] Another object of the present invention is to provide a protective device which is ergonomic and attachable to the motorcyclist's body in a steady way.

[0016] Still another object of the present invention is to provide a protective device to be worn with a harness or embodied in a garment such as a waistcoat or a jacket and that is particularly light, comfortable to wear and also inexpensive.

[0017] These and other objects of the present invention are achieved by the provision of a protective device, specifically suited for motorcyclists, of the type comprising at least one inflatable element arranged substantially along the spinal column of the user, fastening straps secured to said at least one inflatable element and intended to cooperate with the user's body and automatically triggered inflating means for inflating said at least one inflatable element, characterized in that said at least one inflatable element comprises at least two tubular elements, each of which is arranged adjacent to the spinal column of the user in opposite positions and extends for almost all the length thereof.

[0018] According to a feature of the invention, also the fastening straps are provided with inflatable elements intended to protect the head against violent lateral movements caused by impacts during an accident.

[0019] According to still another feature of the invention, the at least two inflatable tubular elements are arranged so as to be in a pneumatic communication.

[0020] According to still another feature of the invention, the walls of the two tubular elements are formed of two or more layers having different physical properties.

[0021] The present invention will be now described more in detail with reference to the accompanying drawings, wherein:

Figure 1 is a plan view of the front side of the device according to the invention in the flat condition and with a portion cut-away for showing the inside;

Figure 2 is a plan view of the rear side of the device according to the invention;

Figures 3A,3B are sectional views of the device according to the invention taken along line III-III of Figure 2 with the device in the flattened and inflated condition, respectively;

Figures 4A, 4B diagrammatically show a front and rear view of a motorcyclist wearing the device of the present invention, respectively.

Figures 5A,5B show the diagram of the shear force acting in the spinal column during a test simulating the fall of a motorcyclist;

Figures 6A,6B show the diagram of the bending moment acting in the spinal column during a test simulating the fall of a motorcyclist.

[0022] The device according to the present invention results from meticulous studies and researches made for the purpose of determining the best position with respect to the spinal column for arranging the inflatable protective elements. As a matter of fact, it resulted from said studies and researches that the tubular element causes a concentration of the shear force and of the bending moment in the spinal column and does not permit such forces to be uniformly distributed over the muscular and skeletal portions adjacent to the spinal column if it is directly arranged over the spinal column and lengthwise thereof. On the contrary, it resulted that the shear force and the bending moment can be reduced and better distributed if the inflatable elements are arranged adjacent to the spinal column each on a side thereof.

[0023] Referring to Figures 1 and 2, there is shown a protective device according to the invention, generally indicated by 10 which comprises as a feature two inflatable tubular elements 11 and 12, intended not to be arranged over the spinal column, but adjacent and on opposite sides thereto, and substantially extending for almost all the length thereof. The spinal column is diagrammatically indicated by a dashed line V.

[0024] The tubular elements 11 and 12 of the protective device 10 are obtained by joining two substantially similar laminated strips A and P so as to enclose two air chambers 13 and 14, respectively, which are in a pneumatic communication through passages 15. The joining points of the two laminated strips A and P are indicated by S. The junction is perfectly airtight and is made by using known techniques such as high frequency welding.

[0025] In Figures 3A and 3B there is shown a section of the protective device 10 of the invention in the flattened and inflated conditions, respectively. As can be seen, each laminated strip A and P is preferably formed of at least two layers, namely an internal layer 16 made of impervious material and an external layer 17 also made of plastic material but reinforced so as to resist to abrasion, cutting and heat. Of course, various materials can be used and also the number of layers of synthetic fabric can be more than two according to the requirements and the intended and desired results.

[0026] Figures 4A and 4B illustratively show a way to apply the device to a user's body, in this case a motorcyclist. As can be seen, the protective device 10 is secured to a cover garment 18 made of an impervious and resistant material by means of a seam or a welding along the dashed line C and is carried on the user's shoulders and held steadily in position by means of adjustable straps 19 and a belt 20.

[0027] The protective device 10 of the invention is provided with external fastening means (not shown) which permit it to be fastened to a harness or to be applied to a garment worn by the user.

[0028] Alternatively, the protective device 10 can be directly attached to a cover garment by means of a welding or a seam.

[0029] At least one of the tubular elements is in pneumatic communication through a check valve in a known manner with a compressed gas supply, for example with a cylinder containing CO₂ or any other suitable gas, which is to be carried by the user and connected to automatic trigger means intended to be operated in case of an accident when the motorcyclist is thrown from the motorcycle. Said automatic trigger means, known *per se*, are preferably formed of a lever with a perforating needle actuated by a short rope or the like connected to a selected portion of the motorcycle. When the motorcyclist is thrown from the motorcycle, the perforating needle actuated by the short rope perforates the compressed gas cylinder and, thus, causes the inflation of the protective device 10. The short rope has a predetermined breaking load so as to break after the perforating needle is operated and permit the motorcyclist to be separated from the motorcycle. The inflation is nearly instantaneous since it occurs within a few tenths of a second. Alternatively, a pyrotechnic trigger device with a small charge actuated by a signal in a fiber optics which is interrupted when the motorcyclist is thrown from the motorcycle can be used. In this case, the inflation time would be less than one tenth of a second.

[0030] It is to be pointed out that the protective device 10 can be flattened by operating the check valve so as to permit the device to be used again.

[0031] Provision could be made for the slow automatic deflation of the protective device 10 by means of the valve through which it is in communication with the compressed gas supply. For this purpose a valve with a controlled leakage could be used. In order to speed up the deflation the user would only need to unscrew the gas cylinder.

[0032] Advantageously, the inflatable elements of the device can extend up to the upper portion of the straps 19 wrapped around the user's shoulders and, when in the inflated condition, be located at the sides of the user's head, but separated from it in order to dampen the lateral movements.

[0033] Furthermore, the at least two inflatable tubular elements of the device in the inflated condition could extend also up to the nape area while being separated therefrom in order to dampen the violent backward movements of the user's head caused by a fall.

[0034] For evaluating its effectiveness, the protective device of the invention was subjected to tests at the Aerospace Engineering Department of the Polytechnical Institute of Milan. In order to conduct such tests which were inspired by favourable results of earlier numerical simulations made on computer by using a calculation code specifically designed for studying the biomechanics of impacts, an anthropometric manikin HYBRID III weighing 75 kg and provided with a crash-helmet was used. The protective device of the invention was applied to the back of the manikin by means of a harness. The tests were intended to reproduce a simple but significant impact condition, i.e. a fall on the back on a corner step from a predetermined height and without horizontal velocity component. The criterion adopted for measuring the effectiveness of the protective device was to value the reduction of the intensity of the shear force and of the bending moment in the lumbar portion of the spinal column with respect to the case of a fall without protection. For measuring these physical quantities a stress measuring device was placed in the lumbar region of the manikin. The inflation of the protective device was shooted with a high-speed electronic camera type NAC E-10 in order to determine the inflation time. The results of such tests are summarized in Table 1 and illustrated in the diagrams of Figures 5A, 5B and 6A,6B wherein on the abscissae axis time in seconds can be read and on the ordinates axis the shear force T in kilograms and the bending moment M in kilogrammeters can be read, respectively. The diagrams of Figure 5A and 6A refer to the fall of a manikin without the protective device 10, whereas those shown in Figure 5B and 6B refer to the fall of a manikin provided with the device 10.

Table 1

Height of the step	150 mm
Height from ground	1000 mm
Inclination w.r.t. ground	0 deg
Max. shear force	
- without the device	690 kg
- with the device in the inflated condition	420 kg
Max. bending moment	

Table 1 (continued)

- without the device	32.7 kgm
- with the device in the inflated condition	28,8 kgm
Gas pressure	0.4-0.5 bar
Inflation time	0.75 s

[0035] From the foregoing, it will be apparent that the protective device according to the present invention represents an important improvement with respect to the solutions till now proposed because it has the following advantages:

- the protective device can protect the spinal column by providing in the lumbar portion thereof a reduction in the shear force and in the bending moment approximately of 40% and 12%, respectively,
- the protective device can be worn with a harness or embodied in a waistcoat or a jacket,
- the protective device can be resetted so as to be used again if it is not damaged after a fall.

[0036] Although the protective device has been described and illustrated with reference to its application to the motorcycle field, it is apparent that it can also be used in other fields, e.g. bicycle riding and horse riding and racing, where protective devices which can offer an effective protection in case of falls are specifically required.

Claims

1. Protective device (10), specifically suited for motorcyclists, of the type comprising:

- at least one inflatable element arranged substantially along the spinal column of the user,
- fastening straps (19) secured to said at least one inflatable element and intended to cooperate with the user's body, and
- automatically triggered inflating means for inflating said at least one inflatable element,

characterized in that said at least one inflatable element comprises at least two tubular elements (11,12) each of which is arranged adjacent to the spinal column of the user in opposite positions and extends for almost all the length thereof.

2. Protective device according to claim 1, **characterized in that** also said fastening straps (19) are provided with inflatable elements intended to protect the user's head against violent lateral movements caused by impacts during an accident.

3. Protective device according to claim 1, **characterized in that** said at least two inflatable tubular elements (11,12) extend up to the nape area while being separated therefrom in order to dampen the violent backward movements of the user's head caused by a fall.

4. Protective device according to claim 1, **characterized in that** said at least two inflatable tubular elements (11,12) are arranged so as to be in a pneumatic communication therebetween.

5. Protective device according to claim 1, **characterized in that** the walls of said at least two tubular elements (11,12) are formed of two or more layers (16,17) having different physical properties.

Patentansprüche

1. Schutzvorrichtung (10), insbesondere für Motorradfahrer geeignet, von der Art bestehend aus :

- mindestens einem im wesentlichen entlang der Wirbelsäule des Benutzers angeordneten Aufblaselement,
- Befestigungsgurten (19), die mindestens an dem einen Aufblaselement befestigt sind und dazu bestimmt sind, mit dem Körper des Benutzers zusammenzuarbeiten, und
- automatisch auslösbaren Aufblaselementen zum Aufblasen von mindestens dem einen Aufblaselement,

dadurch gekennzeichnet, daß mindestens ein Aufblaselement aus mindestens zwei rohrförmigen Elementen

EP 0 981 285 B1

(11,12) besteht, wobei jedes rohrförmige Element seitlich der Wirbelsäule des Benutzers in gegenüberliegenden Stellungen angeordnet ist und sich nahezu über seine gesamte Länge erstreckt.

- 5 2. Schutzvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** auch die Befestigungsgurte (19) mit Aufblaselementen versehen sind, um den Kopf des Benutzers vor heftigen, durch Aufprall bei einem Unfall verursachten Seitenbewegungen zu schützen.
- 10 3. Schutzvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** mindestens zwei rohrförmige Aufblaselemente (11,12) sich nach oben in den Nackenbereich erstrecken, während sie getrennt davon sind, um die heftigen, beim Sturz verursachten Rückwärtsbewegungen des Kopfes des Benutzers abzuschwächen.
- 15 4. Schutzvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** mindestens zwei rohrförmige Aufblaselemente (11,12) derart angeordnet sind, dass sie in einer pneumatischen Verbindung miteinander stehen.
5. Schutzvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** die Wände von mindestens zwei rohrförmigen Aufblaselementen (11,12) aus zwei oder mehr Lagen (16,17) mit unterschiedlichen physikalischen Eigenschaften gebildet sind.

20 Revendications

1. Dispositif (10) de protection, spécifiquement approprié pour des motocyclistes, du genre comportant :

25 au moins un élément pouvant être gonflé disposé sensiblement le long de la colonne vertébrale de l'utilisateur, des bandes (19) de fixation fixées audit au moins un élément pouvant être gonflé et destinés à coopérer avec le corps de l'utilisateur, et des moyens de gonflement déclenchés automatiquement destinés à gonfler ledit au moins un élément pouvant être gonflé,

30 **caractérisé en ce que** ledit au moins un élément pouvant être gonflé comporte au moins deux éléments (11, 12) tubulaires qui sont chacun agencés adjacents à la colonne vertébrale de l'utilisateur dans des positions opposées et s'étendent sur presque toute la longueur de celle-ci.

- 35 2. Dispositif de protection suivant la revendication 1, **caractérisé en ce que** les bandes (19) de fixation sont munies également d'éléments pouvant être gonflés destinés à protéger la tête de l'utilisateur contre des mouvements latéraux violents créés par des impacts lors d'un accident.
- 40 3. Dispositif de protection suivant la revendication 1, **caractérisé en ce que** lesdits au moins deux éléments (11, 12) tubulaires pouvant être gonflés s'étendent jusqu'à la zone de la nuque tout en étant séparés de celle-ci afin d'amortir les mouvements violents vers l'arrière de la tête de l'utilisateur créés par une chute.
- 45 4. Dispositif de protection suivant la revendication 1, **caractérisé en ce que** lesdits au moins deux éléments (11, 12) tubulaires pouvant être gonflés sont disposés de manière à être en communication pneumatique l'un avec l'autre.
5. Dispositif de protection suivant la revendication 1, **caractérisé en ce que** les parois desdits au moins deux éléments (11, 12) tubulaires sont formés de deux couches (16, 17) ou plus ayant des propriétés physiques différentes.

FIG. 1

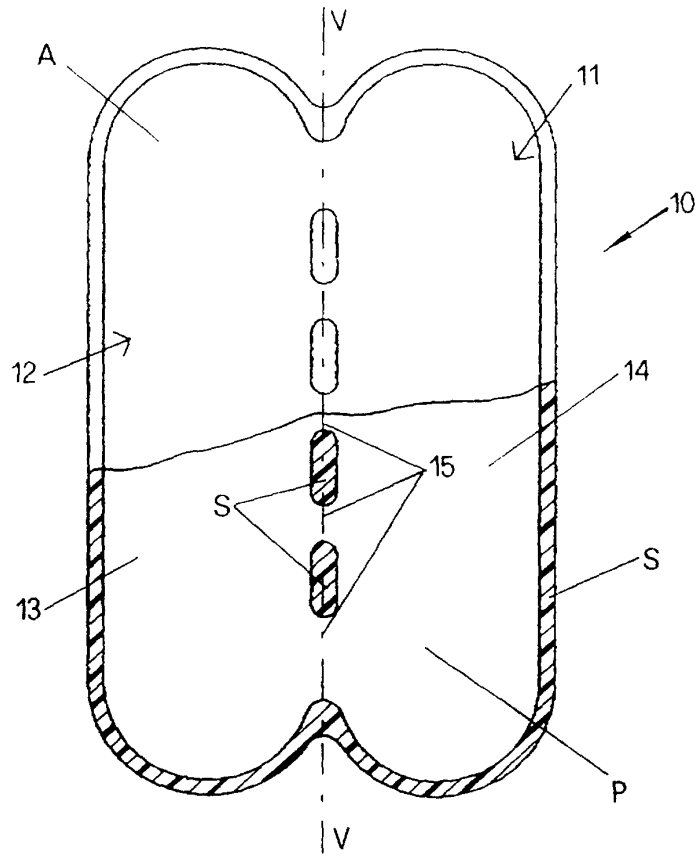


FIG. 2

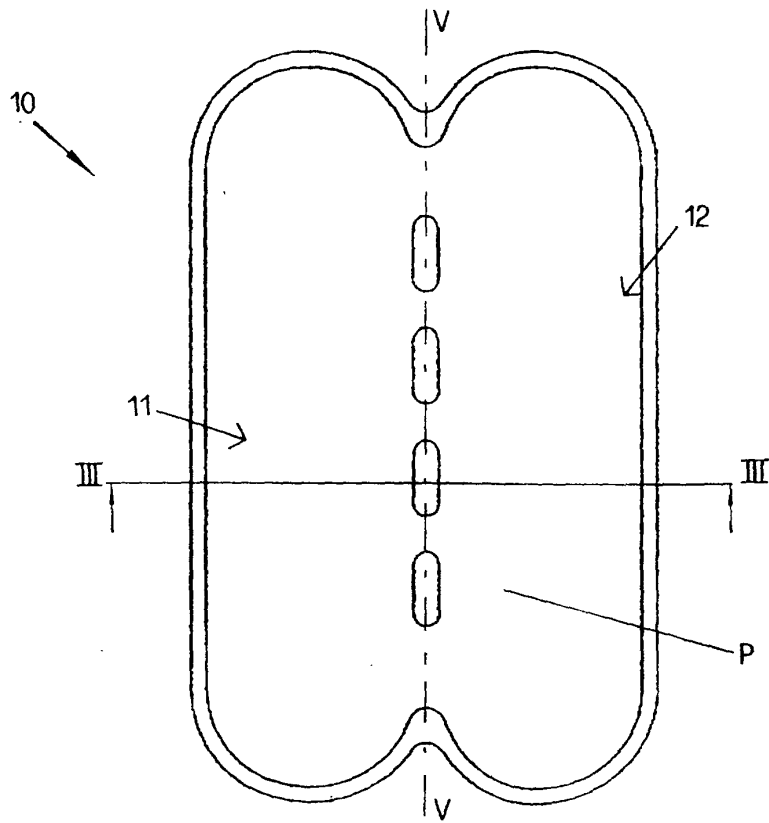


FIG. 3A

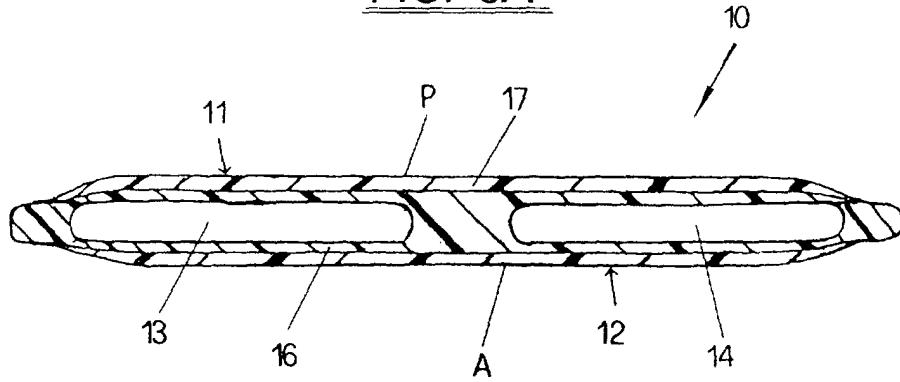


FIG. 3B

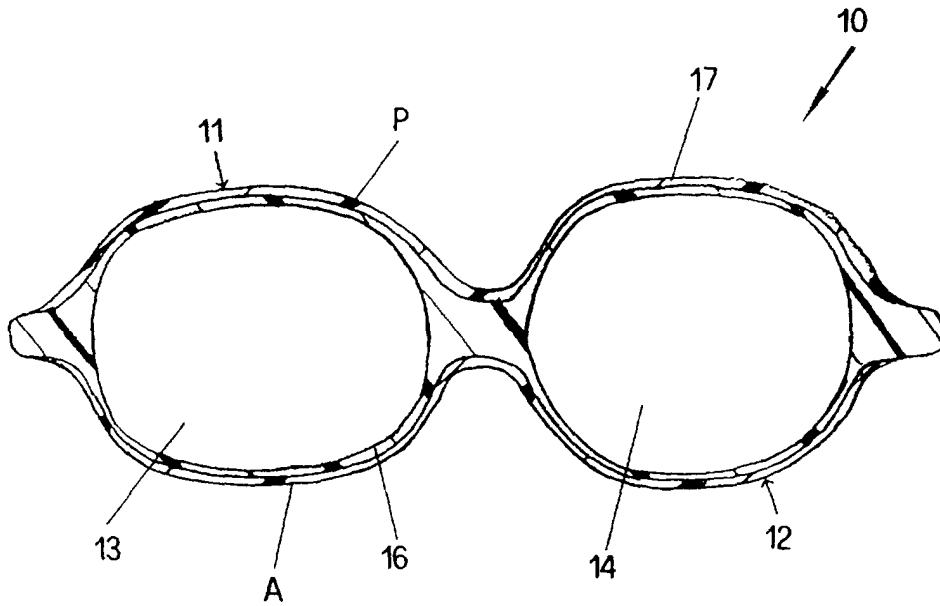


FIG. 4A

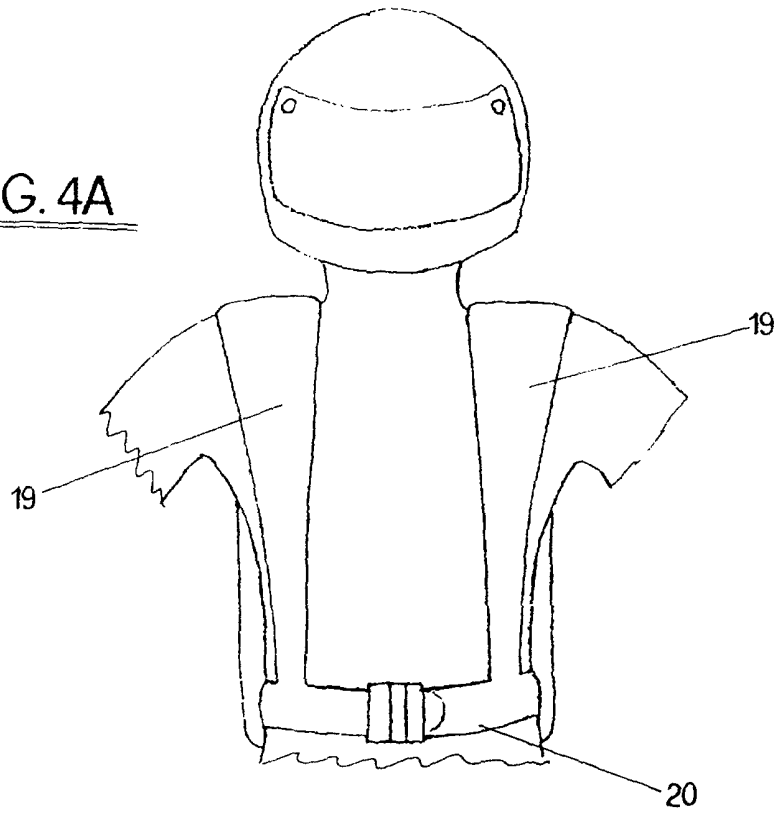


FIG. 4B

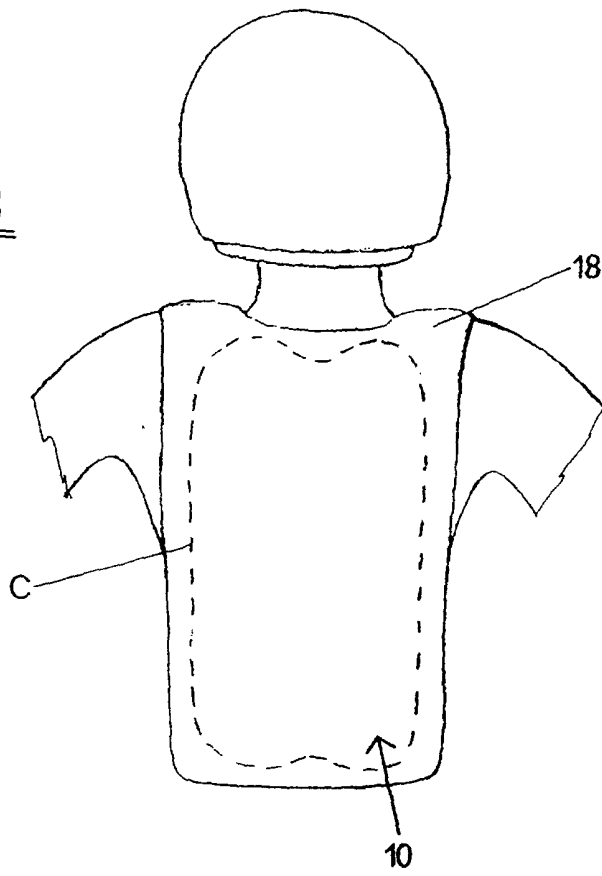


FIG. 5A

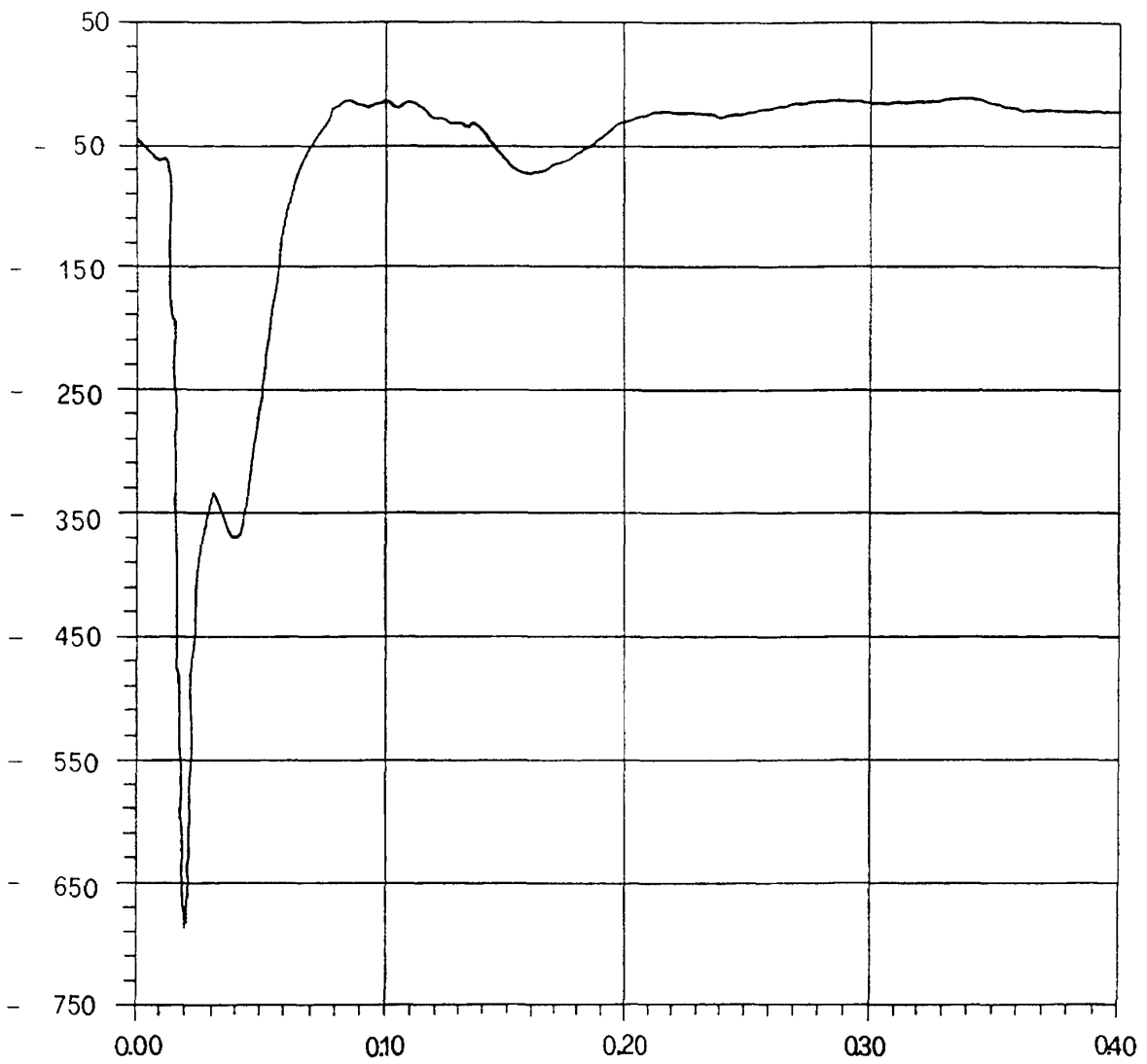


FIG. 5B

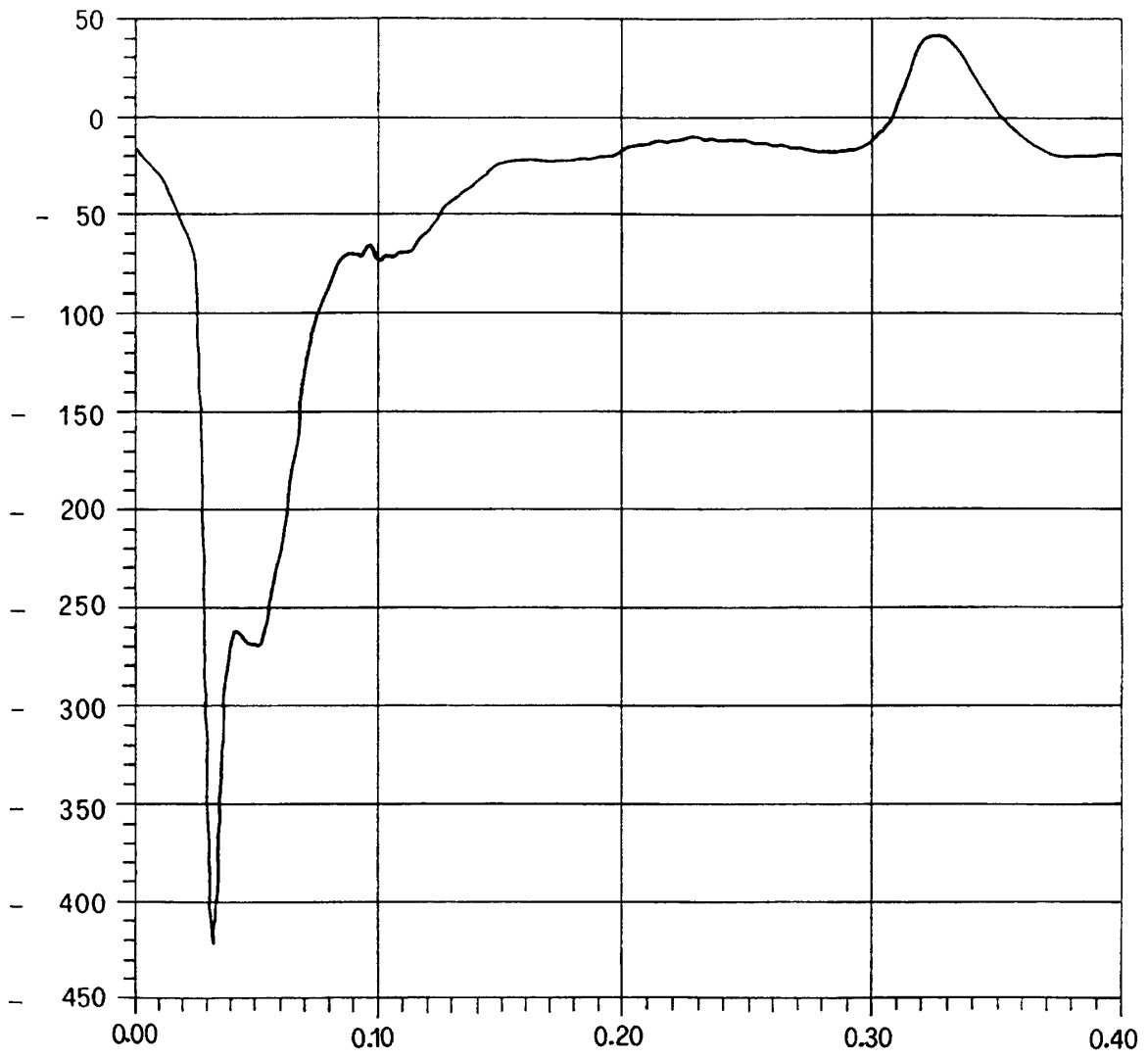


FIG. 6A

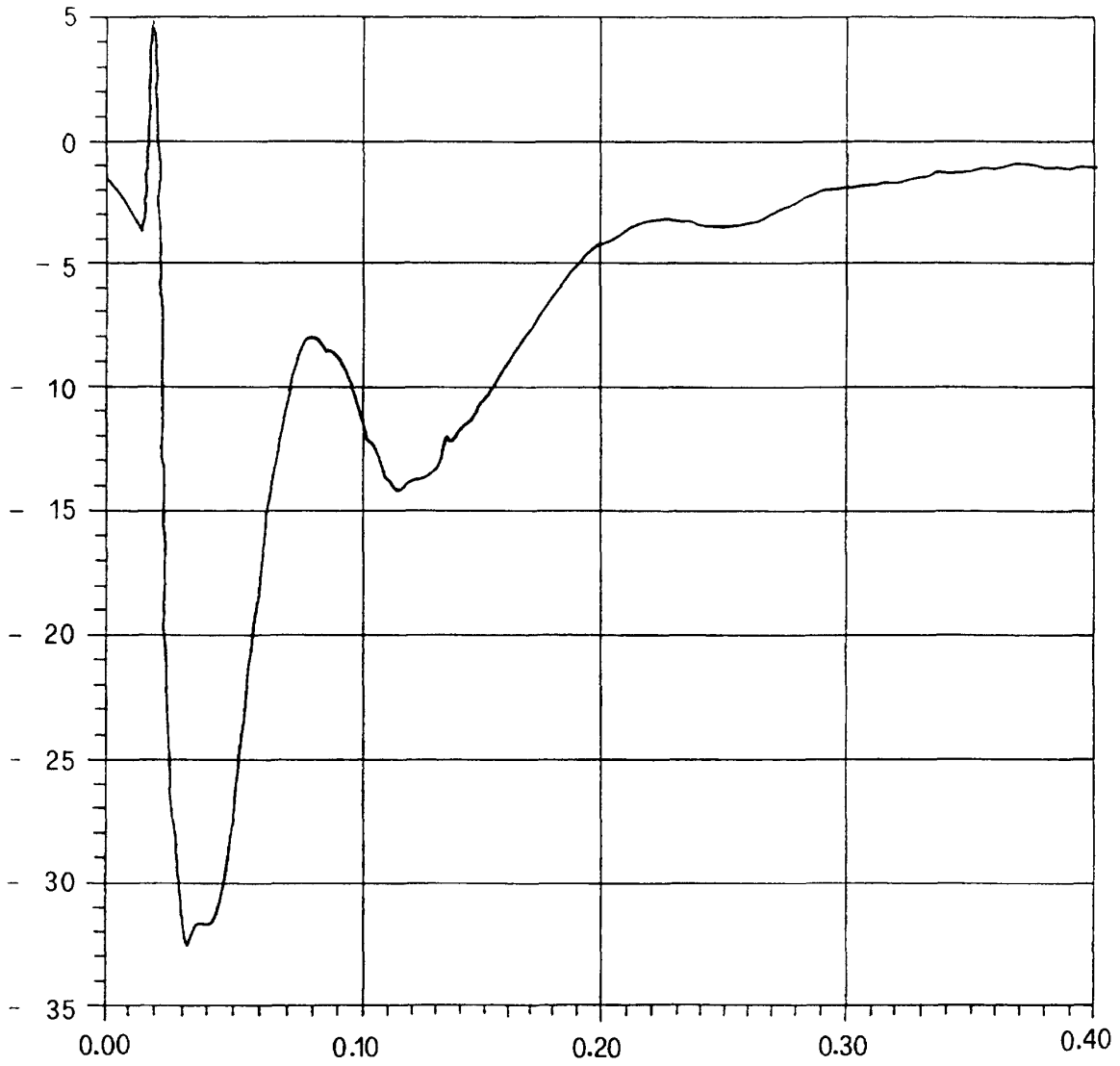


FIG. 6B

