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- (71) Applicant: **THE SECRETARY OF STATE FOR DEFENCE** [GB/GB]; DSTL, Porton Down, Salisbury, Wiltshire. SP4 0JQ (GB).
- (72) Inventors: **BAXTER, Andrew George**; DSTL IP Group, G01-B Building 005, Porton Down, Salisbury Wiltshire SP4 0JQ (GB). **LIVESEY, Rebecca Louise**; DSTL IP Group, G01-B Building 005, Porton Down, Salisbury Wiltshire SP4 0JQ (GB). **HOLDEN, Simon John**; DSTL IP Group, G01-B Building 005, Porton Down, Salisbury Wiltshire SP4 0JQ (GB).
- (74) Agent: **FARNSWORTH, Alastair Graham**; DIPR Formalities Section, Poplar 2#2214, MOD Abbey Wood(South), Bristol BS34 8JH (GB).
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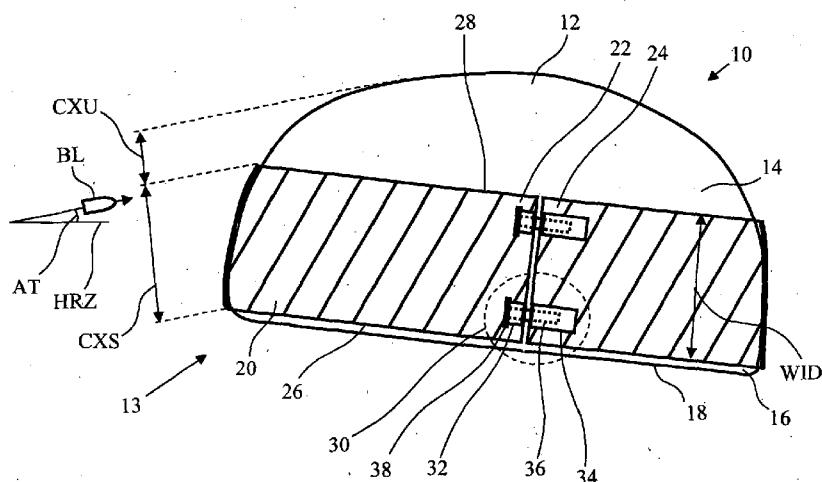


Fig. 1

(57) Abstract: There is provided an armour strip (20) configured to extend fully around a circumference of a helmet (10), to improve the protection offered by the helmet, wherein the armour strip (20) has a width (WID) of between 75mm and 125mm. There is further provided a helmet (10) fitted with the armour strip (20).

A HELMET APPLIQUE

Technical Field of the Invention

5 This invention relates to an applique for a helmet, for example for protecting the head of a person from projectiles.

Background to the Invention

10 Helmets are commonly used to provide protection to the head of a person, for example in military scenarios. The level of protection offered by a helmet is a trade off with the weight of the helmet. Heavy helmets may provide a high level of protection, however are very burdensome to the wearer.

15 Some known helmets provide protection against shrapnel and/or fragmentation, for example from explosions, but cannot protect against higher level threats such as pistol rounds or rifle rounds. To help improve the protection offered by such helmets, US 2013/0047309 discloses an applique element for a helmet, which can be attached to the helmet using hook-and-loop fasteners to improve the protection level offered by the helmet.

20 However, this requirement for a hook or a loop fastener on the helmet for the applique element to attach to, makes retro-fitting of the applique element to existing helmets which are not fitted with hook or loop fasteners problematic.

25 The applique element is designed to cover one or more areas of the helmet, rather than the whole of the helmet, to reduce the weight of the applique element. In one example, the applique element is designed to cover a frontal part of the helmet, leaving the rear of the helmet unprotected by the applique element. There is clearly a trade-off between the size of the area that the applique element covers, and the weight of the applique element.

30 It is therefore an aim of the invention to provide an applique element that gives a good compromise between the protection offered by the applique element and the weight of the applique element.

Summary of the Invention

Therefore, according to a first aspect of the invention, there is provided an armour strip configured to extend fully around a circumference of a helmet, to improve the protection offered by the helmet, wherein the armour strip has a width of between 75mm and 125mm. According to a second aspect of the invention, there is provided a helmet fitted with the strip of the first aspect.

The use of an armour strip that extends fully around a circumference of a helmet, means that the armour strip protects against attacks from substantially 360 degrees around a person wearing the helmet. Since the armour strip has a width of equal or greater than 75mm, most bullets emanating from rifles held by persons at ground level should impact a part of the helmet having the armour strip. Specifically, bullets that are fired from beneath the level of the helmet will have an upward trajectory, and so the natural curvature of the helmet towards its top, means that only a limited cross-section of the helmet above the strip when viewed from the direction the bullet is travelling in is available for the bullet to strike. Also, such bullets are more likely to glance off the helmet rather than penetrate the helmet, since due to the natural curvature of the helmet, the angle of approach of the bullet towards the helmet above the strip is reduced compared to the angle of approach of the bullet towards the part of the helmet having the strip. This is particularly true if the wearer of the helmet has tilted their head away from the direction of the incoming bullet, further reducing the angle between the approaching bullet and an uppermost region of the helmet above the strip.

Furthermore, since the armour strip also has a width of equal or less than 125mm, the weight of the armour strip is minimised. In particular, the range of 75mm to 125mm has been found to provide an optimum compromise between the area of the helmet that is protected by the armour strip and the additional weight of the armour strip. The strip may have a fixed width along its whole length, or its width may vary along its length, for example so that the lower edge of the strip aligns with the lower edge of a particular helmet. The width may vary within the limits of 75mm and 125mm along the length of the strip, and/or the average width of the strip may be between 75mm and 125mm. Preferably, the armour strip may have a width of between 90mm and 110 mm, and even more preferably a width of 0.1m.

The armour strip may be configured to extend substantially parallel to a lower rim of the helmet, for example a lower edge of the strip may coincide with the lower rim of the helmet to ensure that the lower regions of the helmet are protected by the strip. The armour strip may be configured to leave an uppermost portion of the helmet uncovered by the armour strip once the armour strip has been fitted to the helmet, for example the length of the armour strip may be such that it fits around the lower region of the helmet rather than the upper region of the helmet. The term "strip" as used herein refers to objects having a major surface with the length of the major surface being significantly greater than the width of the major surface, for example at least twice the width. Preferably, the armour strip has a length of at least four times its width.

Advantageously, the armour strip may be retained around the helmet by friction between the armour strip and the helmet, so that the helmet itself does not require any bespoke fasteners, and so that the armour strip can be easily added to existing helmets.

The armour strip preferably extends around an exterior surface of the helmet, so that it can be easily fitted to the helmet.

The armour strip may be repeatedly removable and attachable to the helmet, so that it can be added or removed from the helmet as desired according to the level of threat to the wearer of the helmet at the time. Opposite ends of the armour strip may be configured to connect to one another to secure the strip to the helmet, for example using a clip or clasp or buckle. Alternatively, the armour strip may be a continuous loop which is simply pushed downwardly over the top of the helmet until it is sufficiently tight around the circumference of the helmet to remain in place during use.

The armour strip may be shaped to help fit the helmet, specifically a lower edge of the strip may be longer than an upper edge of the strip to take account of the reduced circumference of the helmet at the upper regions of the helmet compared to at the lower regions of the helmet, so that the strip can conform to the curved exterior of the helmet. Clearly, upper regions of the helmet are closer to the top of the helmet than lower regions of the helmet, the top of the helmet for covering the top of the wearer's head.

The strip preferably has structural rigidity, in other words it can hold its own shape without collapsing under its own weight. Then, the strip is easier to fit to the helmet, and does not easily move once fitted to the helmet. Preferably, the material forming the strip has a Young's Modulus of greater than 0.6 GPa. The Young's Modulus is calculated as the ratio
5 between the stress and the strain of a material, as will be apparent to those skilled in the art.

To help provide a good level of protection without excessively increasing the weight of the helmet, the armour strip may have a thickness of between 10mm and 25mm, and may for example be made of a relatively lightweight armour material such as an ultra-high-
10 molecular-weight polyethylene (UHMWPE) composite material, an Aramid composite material, an Alumina Ceramic material, or a Silicon Carbide material.

Preferably, the armour strip is made of an armour material having a density of between 0.8 and 4.5 kg/m³, more preferably between 0.8 and 1.1 kg/m³. These ranges of
15 material density result in armour strips providing useful levels of protection, without the armour strip becoming excessively bulky or excessively heavy.

The thickness of the armour strip may be set according to the areal density that is required to give the desired level of protection. The areal density is defined as $\rho_A = m/A$,
20 wherein $\rho_A = \rho l$, and wherein ρ is the density of the material, l is the thickness of the armour strip, m is the mass of the armour strip, and A is the area of the armour strip, as will be apparent to those skilled in the art.

For example, the armour strip may have a thickness of between 10mm and 15mm if
25 the armour strip is made from a Ceramic Composite or composite material, the armour strip may have a thickness of between 15mm and 20mm if the armour strip is made from a UHMWPE material, or the armour strip may have a thickness of between 20mm and 25mm if the armour strip is made from UHMWPE or an Aramid composite.

30 The material and thickness of the armour strip may be set so that the armour strip is capable of protecting against pistol rounds, or rifle rounds. Or, the material and thickness of the armour strip may be set with reference to a particular type of helmet which the armour strip is designed to fit, so that the combined protection of the armour strip and the helmet is sufficient to protect against pistol rounds or rifle rounds, rather than just the strip in isolation.

This enables the strip itself to be made to a lower protection level, reducing the weight of the strip, since some of the required level of protection is considered to be provided by the helmet.

5 For example, the material and thickness of the armour strip may be set so that the armour strip provides a protection level of at least NIJ Type I. The material and thickness of the armour strip may be set with reference to a particular type of helmet, so that the combination of the strip and the helmet together provide a protection level of at least NIJ Type IIIA. These NIJ Types are as defined in the document "Ballistic Resistance of Personal
10 Body Armor", NIJ Standard-0101.04 Revision A, July 2001.

Brief Description of the Drawings

Embodiments of the invention will now be described by way of example only and
15 with reference to the accompanying drawings, in which:

Fig. 1 shows a schematic side view of a helmet fitted with an armour strip according to an embodiment of the invention;

Fig. 2 shows a schematic front view of the helmet and armour strip of Fig. 1;

20 Fig. 3 shows a schematic plan view from above the helmet and armour strip of Fig. 1;
and

Fig. 4 shows a schematic perspective view of the armour strip of Fig. 1 in isolation from the helmet.

25 The drawings are purely illustrative and are not to scale. Same or similar reference signs denote same or similar features.

Detailed Description

30 An embodiment of the invention will now be described with reference to the schematic diagrams of Figs. 1 to 4. Referring to Fig. 1, a helmet 10 comprises an uppermost portion 12 for covering the top of a person's head, and a lower rim 18 defining a base of the helmet. A chinstrap (not shown in figs for clarity) may extend from the lower rim 18 for securing the helmet to the person's head. The helmet 10 further comprises an upper region 14

towards the uppermost portion 12, and a lower region 16 towards the lower rim 18. In this embodiment, the helmet 10 is configured to protect against shrapnel and/or fragmentation, for example from explosions.

5 To improve the protection offered by the helmet 10, in particular to help offer protection against bullets, an armour strip 20 is fitted around an exterior of the helmet 10. The armour strip 20 extends around the helmet 10, between the uppermost portion 12 and the rim 18. The armour strip extends substantially parallel to the lower rim 18, and is fitted just above the highest point of the rim 18. The front of the helmet is generally designated by the
10 reference number 13.

The armour strip 20 has a lower edge 26 and upper edge 28, which each extend between first and second opposing ends 22 and 24 of the strip. As best seen in the plan view of Fig. 3, the armour strip 20 is curved along its length to fully extend around a
15 circumference CIR of the helmet 10, with the first and second ends 22 and 24 being joined together by clamps 30.

Referring again to Fig. 1, the distance between the lower edge 26 and upper edge 28 defines the width WID of the armour strip 20, and in this embodiment the width WID is
20 100mm. The width WID may vary between 75mm and 125mm in various embodiments. The use of an armour strip having such widths, instead of an armour plate extending fully over the uppermost portion 12, enables the weight of the armour to be reduced with minimal reduction in the ability of the armour to protect against bullets, as will now be described.

25 A bullet BL from a rifle of another soldier is shown heading towards the helmet 10. The bullet BL has an upward angle of trajectory AT with respect to the horizontal HRZ, because it has been fired from a rifle held by a person at ground level. The helmet 10 is tilted away from the direction of the rifle because the wearer of the helmet is looking in the direction of the person holding the rifle. In general, bullets that are heading towards the front
30 of the helmet with the angle of trajectory AT either strike the helmet within the cross section CXU of the helmet above the armour strip 20, or within the cross section CXS of the armour strip. Clearly, the cross section CXU of the helmet above the armour strip 20 is much smaller than the cross section CXS of the armour strip, and accordingly bullets having the angle of trajectory AT are much more likely to strike the cross section CXS having the armour strip

than the cross section CXU where the armour strip is absent. The front view of the helmet 10 and armour strip 20 shown in Fig. 2 is taken from the same direction in which the bullet BL is travelling, and shows how much larger the cross section CXS is than the cross section CXU. An interior 15 of the helmet is visible in Fig. 2, where the person's head would be located when the helmet was in use.

Bullets which are heading towards the cross section CXU with the angle of trajectory AT, will strike the exterior surface of the helmet at a significantly shallower angle than any bullets which are heading towards the cross section CXS with the angle of trajectory AT. The shallower angle means that bullets are more likely to deflect off the cross section CXU of the helmet, or be blocked by the longer distance that the bullet would have to travel through the helmet material to penetrate the helmet, or penetrate the helmet but still miss the head of the person due to the position of the head within the helmet. Therefore, there is less need to provide the cross-section CXU with armour than the cross section CXS.

Accordingly, the use of an armour strip rather than armour that fully covers the helmet, may reduce the weight of the armour by over 30%, and yet may only result in a small reduction in the overall effectiveness of the armour.

The length of the armour strip in this embodiment is 550mm, greater than four times the width of 125mm. The length of the strip is considered to be the average of the lengths of the lower and upper edges 26 and 28. In this embodiment, the length of the lower edge 26 is 580mm, and the length of the upper edge 28 is 520mm, although different length armour strips may be implemented to fit different size helmets.

There are two clamps 30 which serve to secure the armour strip 20 around the circumference CIR of the helmet, and each clamp 30 has a barrel 32 at the first end 22 of the strip, a corresponding barrel 34 at the second end 24 of the strip, and a screw 36 passing through both the barrels 32 and 34. Each screw 36 has a head 38 at an opposite side of the barrel 32 from the barrel 34. The barrels 32 are unthreaded and the barrels 34 are threaded, such that when the heads 38 of the screws 36 are rotated the threaded barrels 34 are drawn towards the barrels 32 to clamp the armour strip 20 around the helmet. If the armour strip is sometimes not needed, then the screws 36 can be unscrewed to allow the armour strip 20 to be lifted off the top of the helmet. Clearly, other types of clamp or tightening apparatuses

could be used in alternative embodiments, or the armour strip may simply be formed as a continuous loop and pressed down over the helmet 10 to fix the armour strip into place.

The schematic perspective diagram of Fig. 4 shows the armour strip 20 in isolation
5 from the helmet 10, for example prior to attaching it to the helmet 10 or after removing it from the helmet 10. This view enables the shape of the armour strip 20 to be more easily seen, and illustrates the thickness THK of the armour strip. In this embodiment, the thickness THK is 20mm

10 In this embodiment, the armour strip 20 is formed of a UHWMPE composite material, and the thickness THK is 20mm. This is sufficient to raise the protection level of the helmet 10 high enough to help protect against rifle rounds.

Various other embodiments falling within the scope of the appended claims will also
15 be apparent to the skilled person.

CLAIMS

1. An armour strip configured to extend fully around a circumference of a helmet, to improve the protection offered by the helmet, wherein the armour strip has a width of
5 between 75mm and 125mm.
2. The armour strip of claim 1, wherein the armour strip extends around an exterior surface of the helmet.
- 10 3. The armour strip of claim 1 or 2, wherein the armour strip is repeatedly removable and attachable to the helmet.
4. The armour strip of claim 1, 2, or 3, wherein opposite ends of the armour strip are configured to connect to one another to secure the strip to the helmet.
15
5. The armour strip of claim 4, wherein the opposite ends comprise a clip or clasp or buckle for securing the opposite ends to one another.
6. The armour strip of any preceding claim, wherein the armour strip is configured to
20 extend substantially parallel to a lower rim of the helmet.
7. The armour strip of any preceding claim, wherein the armour strip has a thickness of between 10mm and 25mm.
- 25 8. The armour strip of any preceding claim, wherein the armour strip offers a protection level of at least NIJ Type I, in addition to the protection offered by the helmet.
9. The armour strip of any preceding claim, wherein the armour strip is formed of a UHMWPE composite material, an Aramid composite material, an Alumina Ceramic material,
30 or a Silicon Carbide material.
10. The armour strip of any preceding claim, wherein the armour strip has a length of at least four times its width.

11. The armour strip of any preceding claim, wherein the armour strip is configured to leave an uppermost portion of the helmet uncovered by the armour strip once the armour strip has been fitted to the helmet.

5

12. The armour strip of any preceding claim, wherein the armour strip has a width of between 90mm and 110 mm.

10

13. The armour strip of any preceding claim, wherein the armour strip has a width of 0.1m.

14. The armour strip of any preceding claim, wherein a lower edge of the strip is longer than an upper edge of the strip, to take account of a reduced circumference of the helmet at an upper region of the helmet compared to a lower region of the helmet.

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15. A helmet fitted with the armour strip of any preceding claim.

16. An armour strip substantially as described herein with reference to the accompanying drawings.

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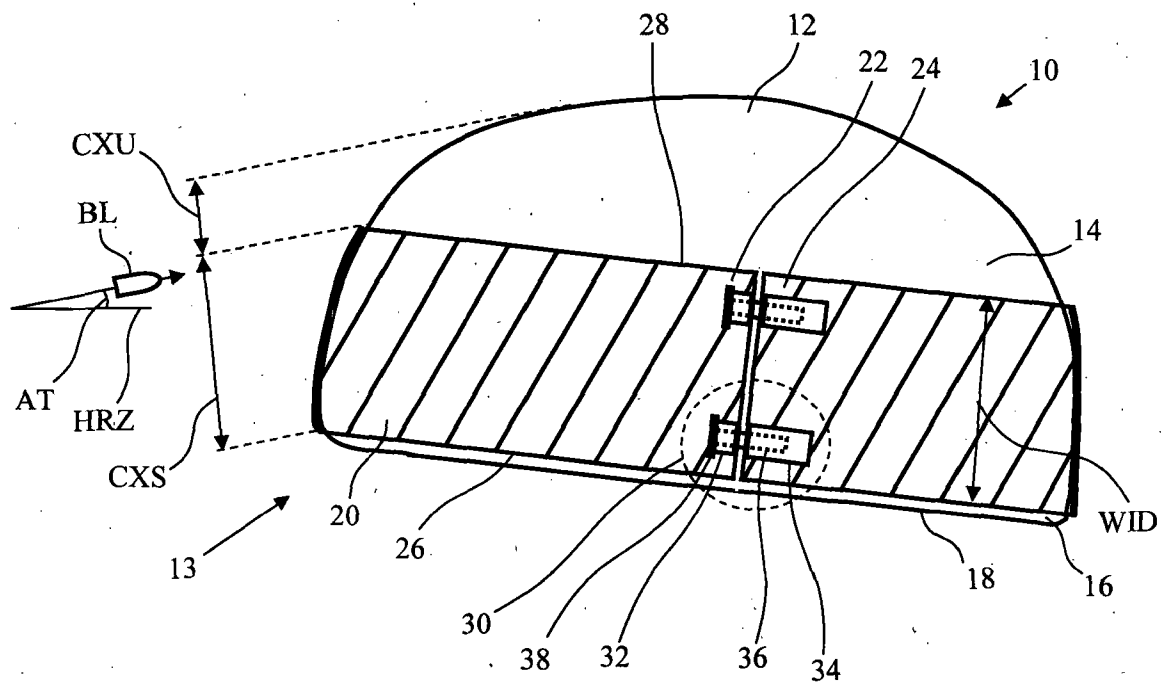


Fig. 1

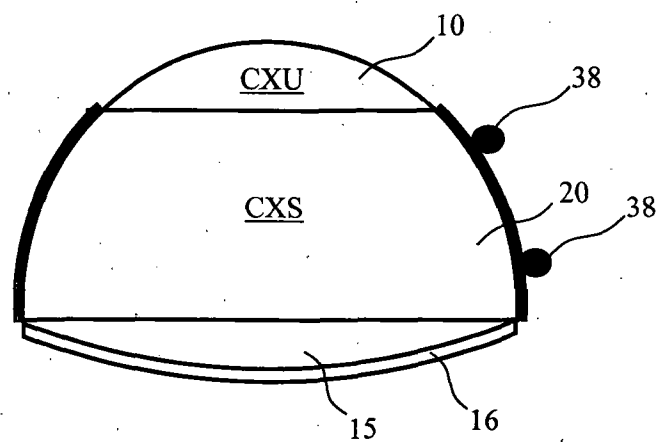


Fig. 2

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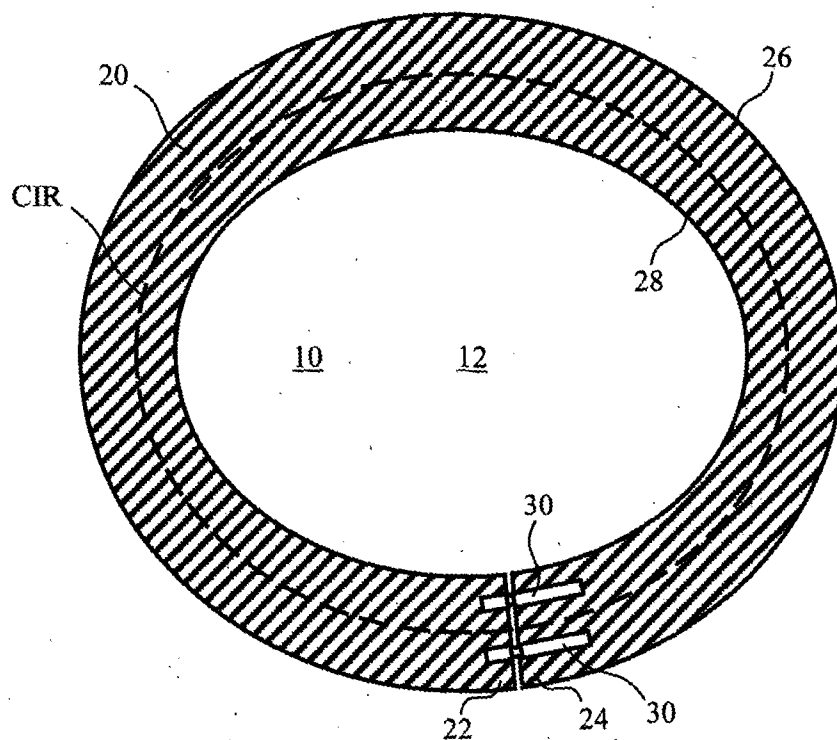


Fig. 3

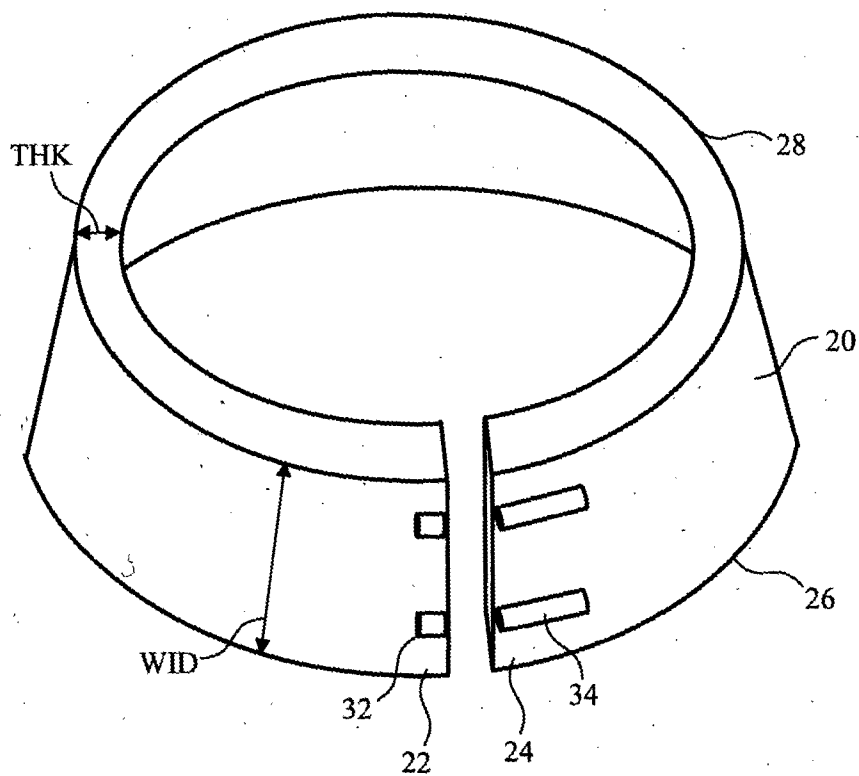


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER INV. F41H1/06 F41H1/00 F41H1/08 ADD.		
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) F41H		
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 practicable, 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	WO 2009/046979 A1 (DSM IP ASSETS BV [NL]; MARISSSEN ROELOF [NL]; HOEFNAGELS HEN [NL]) 16 April 2009 (2009-04-16) abstract page 6, line 22 - page 7, line 30 figures	1-16
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 2 July 2015		Date of mailing of the international search report 09/07/2015
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Vermander, Wim

INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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