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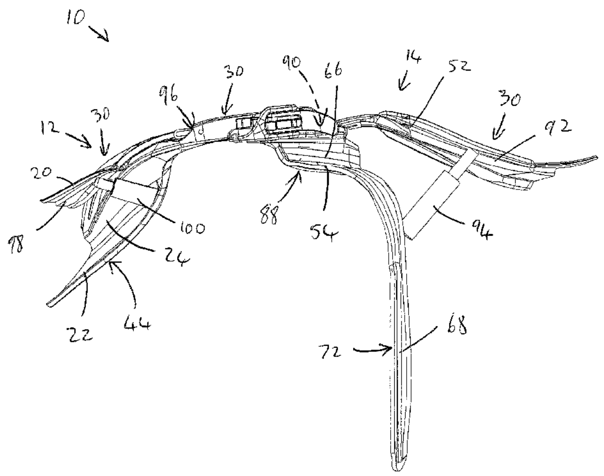

Fig2

(57) Abstract: A neck brace (10) is provided, which has an impact surface (30) which that can limit movement of a helmet by contacting an underside of the helmet, bearing surfaces (44,72,88) configured for bearing on the body of a wearer, and a structure (24,66,94,100) between the impact surface (30) and the bearing surfaces (44,72,88), that can transfer impact loads of the helmet on the impact surface (30), to the wearer's body. Parts (92,98) of the neck brace (10) that defines part of the impact surface (30) are displaceable towards the wearer s body and the structure (94,100) is configured to permit the displacement at rates slower than a predetermined rate, but to resist displacement if the rate exceeds the predetermined rate. The displacement of the parts (92,98) allow the wearer to move the helmet to positions not otherwise permitted by the impact surface (30), but the resistance to displacement ensures that impact loads can still be transferred from the helmet to the body, during impacts.

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NECK BRACE

FILED OF THE INVENTION

This invention relates to protective equipment for inhibiting neck injuries while wearing a helmet. In particular, the invention relates to a neck brace.

BCKGROUND TO THE INVENTION

A device in the form of a neck brace is disclosed in International Patent Application No. PCT/ZA04/00148, which is intended to be worn around the neck and to receive impact loads from the bottom edge of a full face helmet and to transfer these loads to the wearer's body along a load path. The main purpose of this earlier neck brace is to inhibit excessive movement of the helmet and thus of the wearer's head during impact, e.g. during a collision in motor sport.

The neck brace described in PCT/ZA04/00148 was designed to inhibit head and neck movement as little as possible during normal operation and it has largely achieved that purpose. However, in some exceptional cases, notably in high speed road motorcycling, the wearer needs to tilt his head more severely during normal operation than what is allowed by this earlier neck brace, typically to achieve higher aerodynamics.

The present invention seeks to inhibit excessive neck movement during impact, similar to the earlier neck brace and yet to permit more movement of the wearer's head during normal operation of the neck brace.

SUMMARY OF THE INVENTION

According to the present invention there is provided a neck brace comprising:

at least one impact surface which, when said brace is used with a helmet, limits movement of said helmet by contacting an underside of said helmet;

at least one bearing surface which is shaped and configured for bearing on the body of a wearer of said brace; and

a structure that extends between said impact surface and said bearing surface, said structure being sufficiently resilient to transfer impact loads of said helmet on said impact surface, to said wearer's body;

wherein at least one part of said neck brace, defining at least part of said impact surface is displaceable towards an adjacent part of said bearing surface and at least part of said structure is configured to permit said displacement, but to resist said displacement selectively.

The structure may be configured to permit said displacement at rates slower than a predetermined rate of displacement and to resist said displacement if the rate of displacement exceeds said predetermined rate. Instead or in addition, the structure may be configured to resist said displacement in the event of an impact. In this context, “impact” refers to a situation when the neck brace, the wearer, the helmet and/or equipment such as a vehicle used by the wearer experiences rapid acceleration or deceleration. The term “impact” in this context does thus not necessarily refer to something making contact with the neck brace.

Said brace may include at least one pivotal joint between said displaceable part and the remainder of said neck brace and said pivotal joint may be configured to permit pivotal, as well as sliding displacement of said displaceable part relative to the remainder of said neck brace.

Said neck brace may include a rear displaceable part at the rear of said neck brace which is downwardly pivotable towards the upper back of a wearer of said neck brace and may include a front displaceable part at the front of said neck brace which is downwardly pivotable towards the chest of said wearer and which may be configured to slide rearwards towards said wearer’s chest during said pivotal movement.

Said support structure may include at least one impact brake element extending between said displaceable part and the remainder of said neck brace.

Said impact brake element may comprise:

a first component which defines a first brake surface;

a second component which defines a second brake surface and which is displaceable relative to said first component when said displaceable part is displaced relative to the remainder of said neck brace, said first and second braking surfaces extending at an acute angle relative to each other; and

at least one lock element disposed between said first and second brake surfaces;

said lock element being configured to allow movement between said first and second components at rates lower than a predetermined rate and to engage said first and second brake surfaces in a taper lock, when displacement between said two components occurs at a rate exceeding said predetermined rate.

Said first brake surface may be a cylindrical surface and said second brake surface may be a frusto-conical surface. Said first component may be an outer cylindrical sleeve and said second component may be elongate in shape and may be longitudinally displaceable with at least part of said second component inside said sleeve, said second component including a protuberance that protrudes outside said sleeve, at least at times. An annular recess may be defined around the second component of at least one said lock element and said second brake surface may be defined on the inner circumference said annular recess and at least one, but preferably a plurality of lock elements are held captive inside said annular recess.

The impact brake element may include a catch connected to a first component of the impact brake element and a recess defined on a second component of the brake element, said catch being receivable in the recess, at least in part, to lock the first and second components against movement relative to each other, e.g. if the displacement between the displaceable part and the rest of said neck brace, exceeds said predetermined rate. In some embodiments, a plurality of said recesses is defined in the second component, to allow variable lockout positions.

The impact brake element may include a first component and a second component that is received inside the first component, at least in part, with a fluid between the first and second components, to dampen movement between these components, e.g. if this movement exceeds the predetermined rate mentioned above. The fluid may have a viscosity that can be varied by applying an electrical charge to the fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show how the same may be carried into effect, the invention will now be described by way of non-limiting example, with reference to the accompanying drawings in which:

Figure 1 is a three dimensional view from the front and from above, of a first embodiment of a neck brace in accordance with the present invention;

Figure 2 is a side view of the neck brace of Figure 1;

Figure 3 is a three dimensional view of the neck brace of Figure 1, taken from the front at an oblique angle;

Figures 4A to 4C are sectional views through an impact brake element of the neck brace of Figure 1, in three different operational conditions;

Figure 5 is a sectional view of part of the neck brace of Figure 1, taken at V-V;

Figures 6A to 6F are schematic sectional views through alternative embodiments of impact brake elements of the neck brace of Figure 1;

Figure 7 is a side view of a second embodiment of a neck brace in accordance with the present invention; and

Figures 8A to 8E are schematic views of alternative embodiments of impact brake elements of the neck brace of Figure 7.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to Figures 1 to 5, the first embodiment of a neck brace in accordance with the present invention is generally indicated by reference numeral 10.

The neck brace 10 includes a front section 12 and a rear section 14 which can be secured together at lateral hinge connectors 16 to form a ring that can extend around the neck of a wearer. The front section 12 is U-shaped in plan view and includes a top flange 20 defining part of a generally upwardly facing impact surface

30 that can receive impact loads from the bottom of a full face helmet worn by the wearer, a bottom flange 22 defining a cushioned chest bearing surface 44 that is configured to bear on the wearer’s chest, and a structure in the form of a wall 24 that extends between the top and bottom flanges to transfer the impact loads from the helmet to the wearer’s body.

The rear section 14 is also U-shaped in plan view and includes a top flange 52 that is generally a continuation of the top flange 20 of the front section, with an upwardly facing impact surface 30, and bottom flange 54 that is generally a continuation of the bottom flange 22 and that defines padded shoulder bearing surfaces 88 where it is configured to bear on the shoulders of the wearer. A structure in the form of a wall 66 extends between the top flange 52 and the bottom flange 54. The rear section further includes two bars 68 that each extends from the rear of the bottom flange 54 along the upper back of the wearer with a padded back bearing surface 72 for bearing on the back of the wearer.

The purpose of the top flanges 20 and 52 is to limit movement of the wearer’s helmet during impact, e.g. during high speed motor sport accidents, by contacting the underside of the helmet with the impact surface 30 and transferring the impact load to the wearer’s body via the chest, shoulder and back bearing surfaces 44,88,72 to reduce the risk of injury to the neck and upper spine of the wearer.

Apart from the provision of two bars 68 instead of one, the features of the neck brace 10 that have been described thus far, are substantially similar to the corresponding features of the earlier neck brace described in International Patent Application No. PCT/ZA04/000148, the content of which is included herein in its entirety, by reference. Similar reference numerals have also been used in the present description, for ease of reference to said earlier international patent application.

Referring further to Figures 1 to 3 and as can best be seen in Figure 5, in the present invention, a rear part of the top flange 52 is pivotally connected to the remainder of the rear section 14 at pivotal joints 90, so that it forms a rear displaceable part 92 that can pivot downwards towards the upper back of the wearer, i.e. towards the shoulder and/or back bearing surfaces 88,72. Two impact brake elements 94 extend between the displaceable part 92 and each of the bars 68, to permit some pivotal movement in the joints 90, but to inhibit undesirable pivotal movement, as described in more detail below.

Similarly, a front part of the top flange 20 is pivotally connected to the remainder of the front section 12 at pivotal joints 96, so that it forms a front displaceable part 98 that can pivot downwards towards the chest of the wearer, i.e. towards the chest bearing surface 44. In addition, the pivotal joints 96 are configured to allow the rear ends of the displaceable part 98 to slide rearwards relative to the remainder of the front section 12 to allow the displaceable part to slide rearwards and/or pivot downwards. Two impact brake elements 100 extend between the displaceable part 98 and lateral locations on the bottom flange 22 to permit some pivotal and/or sliding movement in the joints 96, but to inhibit undesirable pivotal and/or sliding movement, as described in more detail below.

Referring to Figures 4A to 4C, each of the impact brake elements 94,100 includes a first component in the form of an outer cylindrical sleeve 102 which defines a first, cylindrical brake surface 104 on the inside of the sleeve and a second component in the form of an elongate probe 106, most of which is receivable inside the sleeve and which is longitudinally (i.e. axially) displaceable relative to the sleeve. The probe 106 has an elongate protuberance 108 at its upper end that protrudes outside the sleeve 102 by a degree that varies depending on the position of the probe inside the sleeve. The probe 106 defines an annular recess 110 on its circumference, with a second, tapered (i.e. frusto-conical) brake surface 112 defined on the inner circumference of the annular recess.

The inner circumference of the annular recess (i.e. the tapered brake surface 12) is tapered at a very small angle with the result that the recess is not strictly “annular” in shape, but for the purposes of this description, the term “annular” is to be interpreted to include an annulus with a slightly tapered inner wall.

A number of lock elements in the form of balls 114 are held captive inside the annular recess 110 by the wall of the sleeve 102, i.e. between the cylindrical and tapered brake surfaces 104,112. The brake element 94,100 is shaped and dimensioned such that the balls 14 fit inside the recess 110 with a slight clearance at the wider, lower end of the recess, such that the balls fit inside the recess with an interference fit higher in the recess.

The impact brake element 94,100 is shown in Figure 4A in a fully extended condition, with the protuberance 108 extending far outside the top of the sleeve 102. A compression coil spring 118 is provided inside the sleeve 102, below the probe 106, to urge the probe upwardly towards its fully extended position. The lower end of the sleeve 102 is attached to the bottom flange 22 or one of the bars 68, as the case may be, and the top end of the protuberance 108 can be attached to the relevant displaceable part 92,98 or can simply be positioned so that the underside of the displaceable part can press longitudinally against the end of the protuberance.

Each of the impact brake elements 94,100 is normally in this extended condition and is held in this condition by its coil spring 118, but as the relevant displaceable part 92,98 is displaced relative to the remainder of the brace 10, it presses the probe 106 towards the sleeve 102, to slide further inside the sleeve against the bias of the spring.

Referring to Figure 4B, if the probe 106 is caused to slide longitudinally downwardly into the sleeve at a relative low rate, the balls 114 are held at the lower end of the recess 110 by gravity and there is thus a clearance between the balls and the respective braking surfaces 104,112, so that the sliding movement can continue without interference.

However, referring to Figure 4C, if the probe 106 is caused to slide longitudinally downwardly into the sleeve 102 at a relative high rate, e.g. under an impact load, the inertia of the balls 114 cause them not to follow the rapid downward movement of the probe at the same rate, with the result that the balls slide upwardly relative to the recess 110 (because the probe and balls are sliding downwardly at different rates). At the higher position of the balls 114 in the recess 110, the circumference of the tapered brake surface 112 is wider and the balls are urged outwardly by the tapered brake surface to become locked between the tapered and cylindrical brake surfaces 112,104 in a taper lock.

The dimensions and particularly the tolerances and clearances of the balls 114 and brake surfaces 104,112 can be dimensioned to allow downward movement of the probe 106 relative to the sleeve 102 without interference if the rate of relative movement between the probe and the sleeve is below a predetermined rate and to activate the taper lock as described herein above, when the rate of relative movement of the probe into the sleeve exceeds the predetermined rate.

It is to be understood that in the illustrated example of the present invention, the balls 114 are biased downwardly towards the wider end of the annular recess 110 by gravity. It is possible to enhance this bias or to replace it by using another biasing element such as a flexible element in the annular recess 110 that presses against the balls 114. However, the simplicity of the illustrated configuration is preferred.

Referring to Figures 1 to 5, in use, when a wearer needs to tilt his head far backwards, e.g. when a motorcyclist is tucking into an aerodynamic position on the motorcycle and needs to get his torso as low as possible on the motorcycle, the head can be tilted backwards at a moderate (safe) rate so that the bottom edge of the motorcyclist's helmet presses the rear displaceable part 92 to pivot downwardly at a rate lower than a predetermined rate, while pressing the probes of the rear impact brake elements 94 into their respective sleeves without interference, as described above with reference to Figure 4B. If the rider tilts his head forward again, the impact brake elements 94 are extended by their coil springs 118 and the rear displaceable part 92 pivots upwards.

However, in the event that the rider's head is tilted backwards rapidly, e.g. during a rear impact collision, whether the impact brake elements 94 are fully extended or only partly extended, the downward impact of the bottom of the helmet on the rear displaceable part 92 will cause the rapid downward movement of the displaceable part and of the probes 106, at a rate that is higher than the predetermined rate, and the downward movement of the probes relative to the sleeves 102 will be stopped by the taper lock as described above, with reference to Figure 4C. The result is that the impact load from the helmet is transferred from the displaceable part 92 along a load path via the locked rear impact brake elements 94 to the bars 68 and thus to the rider's body, to inhibit excessive head movement and to reduce the risk of injury to the rider's neck and upper spine.

The same applies to the front displaceable part 98 that can be pivoted downwardly and slid rearwards at rates lower than a predetermined rate by a pressing the bottom edge of the helmet against the front displaceable part. In the event of an impact, e.g. a front impact collision that tends to cause the rider's head to rotate forward, the front displaceable part 98 will be pressed towards the wearer's chest at a rate exceeding the predetermined rate and the front impact brake elements 100 will be locked by their taper lock and will transfer the impact load along a load path from the helmet and displaceable part 98 to the chest bearing surface 44 and to the chest of the rider, to inhibit excessive head movement and to reduce the risk of injury to the rider's neck and upper spine.

In addition to the advantages of the neck brace 10 mentioned above, the provision of two bars 68 spaced from the centre of the wearer's back, allows the brace to be worn comfortably with clothing such as motorcycling apparel that includes an aerodynamic protuberance or "hump" on the wearer's back, for preventing a vacuum behind the wearer's helmet at high speed. Further, the front bottom flange 22 defines a recess 116 which allows the wearer easy access to zippers or the like, that is often positioned centrally on the front of garments such as motorcycling apparel and/or to prevent discomfort by pressing on such zippers or the like.

Referring to Figures 6A to 6F, alternative embodiments of impact brake elements are shown that can be used in the neck brace 10, instead of the impact brake elements 94,100 shown in Figures 4A to 4C. The same reference numerals are used in different embodiments of the impact brake elements, for features common to those shown in Figures 4A to 4C.

The impact brake element 94,100 of Figure 6A includes an arcuate outer sleeve 102 and an arcuate probe 106 that can slide in the sleeve. The probe 106 defines a tapered recess 110 in which one or more balls 114 are held. The working of this impact brake element is practically the same as that described with reference to Figures 4A to 4C, in that the probe 106 can slide gradually up and down inside the sleeve 102, but if it is moved rapidly (faster than a predetermined rate), the inertia of the ball 114 causes it to move downwards in the sleeve at a lower rate than the probe, i.e. to move upwards relative to the taper of the recess 110 and to lock the probe relative to the sleeve in a taper lock, between a cylindrical brake surface 104 on the inside of the sleeve and a tapered brake surface 112 in the recess. The arcuate shape of the probe 106 and sleeve 102 allows the brake element to be fixedly attached to pivoting parts (the bars 68 and rear displaceable part 92) of the neck brace 10, without a need for pivotal attachment which is required in the case of a linear impact brake element as shown in Figures 4A to 4C.

The impact brake element 94,100 of Figure 6B includes a cylindrical sleeve 102 and a cylindrical probe 106 and a magnetic particle charged fluid 120 inside the sleeve. The probe 106 can slide axially inside the sleeve 102 while the fluid 120 flows around the lower end of the probe. However, the sleeve 102 is provided with electrodes 122 that are configured to apply an electrical charge to the fluid 120 that increases the viscosity of the fluid so that it cannot flow around the lower end of the probe 106 at the same rate. In use, the probe 106 is allowed to slide up and down inside the sleeve 102, but in the event of an impact, which could be determined in a variety of manners, including mechanical and/or electronic instruments or switches, a change is applied to the fluid 120 via the electrodes 122 and movement of the probe 106 into the sleeve 102 is inhibited by the higher viscosity of the fluid, to prevent the probe from sliding into the sleeve at a rate higher than a predetermined rate. The charge applied by the electrodes 122 and thus the extent to which movement of the probe 106 into the sleeve 102 is dampened, can also be variably controlled, if required.

The impact brake element 94,100 of Figure 6C includes a cylindrical sleeve 102 and a cylindrical probe 106. The lower end of the probe 106 forms a top piston 124 that can slide inside the sleeve 102 with clearance and that is submerged in oil 121. Below the oil 121, a bottom piston 126 seals against the inside of the sleeve 102, with the oil held above the bottom piston and an air pocket 127 maintained below the bottom piston. The air pocket 127 is compressible and performs the same function as the coil spring 118 shown in Figures 4A to 4C, while the oil 121 can slide through the clearance between the top piston 124 and the sleeve 102 at a rate limited by the viscosity of the oil and the size of the clearance, so that the oil acts as a damper, allowing sliding movement of the probe 106 relative to the sleeve, but limiting the maximum rate of the sliding movement, thus resisting sliding movement if it exceeds a predetermined rate.

The impact brake element 94,100 of Figure 6D includes a cylindrical sleeve 102 and a cylindrical probe 106 with a compression coil spring 118 inside the sleeve, functioning in the same way as their counterparts shown in Figures 4A to 4C. Further, a displaceable catch 128 is provided in wall of the sleeve 102 and a number of axially spaced recesses 130 are defined along the length of the probe 106, in which the catch can be received, in part. In use, the catch 128 remains in a retracted position as shown in Figure 6D and the probe 106 is free to slide inside the sleeve 102, against compression of the spring 118. However, in the case of an impact, the catch 128 is urged (with suitable means such as a released spring, solenoid, etc.) inwardly and engages the first of the recesses 130 with which it comes into alignment, to lock the probe 106 against further sliding relative to the sleeve 102.

The impact brake element 94,100 of Figure 6E is identical to that of Figure 6D, except that instead of multiple recess 130, the lower edge of the probe 106 acts as a recess in that the catch 128 does is not received in part in a recess when it is activated, but engages the lower end of the probe and prevents the probe from sliding downwards past the catch. Accordingly, unlike the brake element of Figure 6D that can be locked at various lockout positions, the brake element of Figure 6E can only be locked out at a single (absolute) position.

The impact brake element 94,100 of Figure 6F includes a cylindrical sleeve 102 and a cylindrical probe 106 and inside the sleeve, below the lower end of the probe, there is a small pyrotechnic charge 132. The probe 106 can slide relative to the sleeve 102 and in the event of an impact, the charge 132 is detonated and expanding gasses from the detonation causes the probe to be pushed upwards relative to the sleeve.

Referring to Figure 7, the second embodiment of a neck brace in accordance with the present invention is shown and parts that are common between this neck brace and the neck brace 10 shown in Figures 1 to 5, are identified by the same reference numerals with a suffix ".2".

The neck brace 10.2 is identical to the neck brace 10 shown in Figures 1 to 5, except that the pivot joint 90 and rear impact brake elements 94 are replaced by a cylindrical pivot structure 134 on each side of the neck brace 10.2, pivotally connecting the rear displaceable part 92.2 to the rest of the rear section 14.2. Each pivot structure 134 has a cylindrical housing 136 with impact brake elements 94.2 inside the housing, which serve the same function as the impact brake elements of the embodiments of the invention described with reference to Figures 1 to 6, of allowing pivotal movement between the displaceable part and the rest of the rear section of the neck brace during normal use and inhibiting such pivotal movement in the case of an impact.

Referring to Figures 8A to 8E, five different embodiments of impact brake elements 94.2 are shown and in each case, the elements include a body 138 that can rotate inside the housing 136 to allow the required pivotal movement. The housing 136 can be connected to the rest of the rear part 14.2 of the neck brace 10.2 and the body 138 can be connected to the rear displaceable part 92.2, or vice versa.

The impact brake elements of Figure 8A has a body 138 with an outer profile that defines tapered recesses 110.2 in which balls 114.2 are housed with clearance to allow free pivoting movement at low rates. However, in the event of rapid pivoting, e.g. during an impact, the inertia of the balls 114.2 causes them to move slower than the body 138, so that they move towards the narrower parts of their respective recesses 110.2 and engage the inside of the housing 136, and the tapered surface of the recess, which act as brake surfaces, to lock the body and housing against further pivotal movement, in a taper lock. This mechanism is effectively a rotational equivalent of the impact brake elements 94 shown in Figures 4A to 4C.

The impact brake elements of Figure 8B has a body 138 with an outer profile that defines a recess 130.2 and a catch 128.2 that is connected to the housing 136 and is radially displaceable. The catch 128.2 is normally in a retracted position in which it is clear from the circumference of the body 138, to allow pivotal movement. However, in case of an impact, the catch 128.2 is activated, e.g. by releasing a spring or with a solenoid, to slide radially inwardly so that its end engages the recess 130.2 and locks the body 138 against rotation relative to the housing 136. It is to be understood that the catch 128.2 needs to be aligned with the recess 130.2 before it can engage it and the body 138 will typically be allowed to rotate until the catch and recess are aligned.

The impact brake elements of Figure 8C are identical to those of Figure 8B, except that a number of circumferentially spaced recesses 130.2 are defined in the body 138. As a result, when the catch 128.2 is activated, the body 138 only needs to rotate through a small angle before the catch is aligned with one of the recesses 130.2. The end of the catch 128.2 and the recess 130.2 can be shaped at an angle, to allow the catch to engage the recesses in a ratchet fashion, when the catch has been activated and thus to allow upward pivoting of the rear displaceable part 92.2, but not downward pivoting.

The impact brake elements of Figures 8D and 8E are functionally identical to those of Figures 8B and 8C, respectively, with the only difference that the respective catches 128.2 are displaceable in axial directions, rather than radial directions, relative to the respective bodies 138.

Referring to Figures 4A to 4C, 6A to 6F and 8A to 8E, the principles of the present invention can be implemented using a variety of impact brake elements 94, of which the illustrated embodiments are mere examples. Suitable impact brake elements can operate by linear displacement and/or rotation, can operate as a result of its inherent geometry, can operate using built-in or external trigger mechanisms, can have absolute or variable lockout positions, and the like.

CLAIMS

1. A neck brace (10) comprising:

at least one impact surface (30) which, when said brace (10) is used with a helmet, limits movement of said helmet by contacting an underside of said helmet;

at least one bearing surface (44,72,88) which is shaped and configured for bearing on the body of a wearer of said brace (10); and

a structure (24,66,94,100) that extends between said impact surface (30) and said bearing surface (44,72,88), said structure (24,66) being sufficiently resilient to transfer impact loads of said helmet on said impact surface (30), to said wearer's body;

characterised in that at least one part (92,98) of said neck brace (10), defining at least part of said impact surface (30) is displaceable towards an adjacent part of said bearing surface (44,72) and at least part of said structure (94,100) is configured to permit said displacement, but to resist said displacement selectively.

2. A neck brace (10) as claimed in claim 1, **characterised in that** said structure (94,100) is configured to permit said displacement at rates slower than a predetermined rate of displacement and to resist said displacement if the rate of displacement exceeds said predetermined rate.

3. A neck brace (10) as claimed in claim 1 or claim 2, **characterised in that** said structure (94,100) is configured to resist said displacement in the event of an impact.

4. A neck brace (10) as claimed in any one of the preceding claims, **characterised in that** said neck brace (10) includes at least one pivotal joint (90,96,134) between said displaceable part (92,98) and the remainder of said neck brace (10).

5. A neck brace (10) as claimed in claim 4, **characterised in that** said pivotal joint (90,96) is configured to permit pivotal, as well as sliding displacement of said displaceable part (92,98) relative to the remainder of said neck brace.

6. A neck brace (10) as claimed in any one of the preceding claims, **characterised in that** said neck brace (10) includes a rear displaceable part (92) at the rear of said neck brace (10) which is downwardly pivotable towards the upper back of said wearer.

7. A neck brace as claimed in any one of the preceding claims, **characterised in that** said neck brace (10) includes a front displaceable part (98) at the front of said neck brace (10) which is downwardly pivotable towards the chest of said wearer.

8. A neck brace (10) as claimed in claim 7, **characterised in that** said front displaceable part (98) is configured to slide rearwards towards said wearer's chest during said pivotal movement.

9. A neck brace (10) as claimed in any one of the preceding claims, **characterised in that** said support structure includes at least one impact brake element (94,100,134) extending between said displaceable part (92,98) and the remainder of said neck brace (10).

10. A neck brace (10) as claimed in claim 9, **characterised in that** said impact brake element (94,100) comprises:
a first component (102,136) which defines a first brake surface (104);
a second component (106,138) which defines a second brake surface (112) and which is displaceable relative to said first component when said displaceable part (92,98) is displaced relative to the remainder of said neck brace (10), said first and second braking surfaces (104,112) extending at an acute angle relative to each other; and
at least one lock element (114) disposed between said first and second brake

surfaces (104,112);

said lock element (94,100) being configured to allow movement between said first (102,136) and second (106,138) components at rates lower than a predetermined rate and to engage said first and second brake surfaces (104,112) in a taper lock, when displacement between said two components occurs at a rate exceeding said predetermined rate.

11. A neck brace (10) as claimed in claim 10, **characterised in that** said first brake surface (104) is a cylindrical surface and said second brake surface (112) is a frusto-conical surface.

12. A neck brace (10) as claimed in claim 11, **characterised in that** said first component is an outer cylindrical sleeve (102) and said second component (106) is elongate in shape and is longitudinally displaceable with at least part of said second component inside said sleeve, said second component (106) including a protuberance (108) that protrudes outside said sleeve (102), at least at times.

13. A neck brace (10) as claimed in claim 10, **characterised in that** an annular recess (110) is defined around the second component (106) of at least one said lock element (94,100) and said second brake surface (112) is defined on the inner circumference said annular recess (110) and at least one lock element (114) is held captive inside said annular recess (110).

14. A neck brace (10) as claimed in claim 9, **characterised in that said** impact brake element (94,100,134) includes a catch (128) connected to a first component (102,136) of said impact brake element (94,100,134) and a recess (130) defined on a second component (106,138) of said brake element, said catch (128) being receivable in said recess (130), at least in part, to lock said first and second components against movement relative to each other.

15. A neck brace (10) as claimed in claim 14, **characterised in that** a plurality of said recesses (130) are defined in said second component (106,138).

16. A neck brace (10) as claimed in claim 9, **characterised in that said** impact brake element (94,100) includes a first component (102) and a second component (106) received inside said first component (102), at least in part, with a fluid (120) between said first and second components (102,106), to dampen movement between said components.

17. A neck brace (10) as claimed in claim 17, **characterised in that** said fluid (120) has a viscosity that can be varied by applying an electrical charge to said fluid (120).

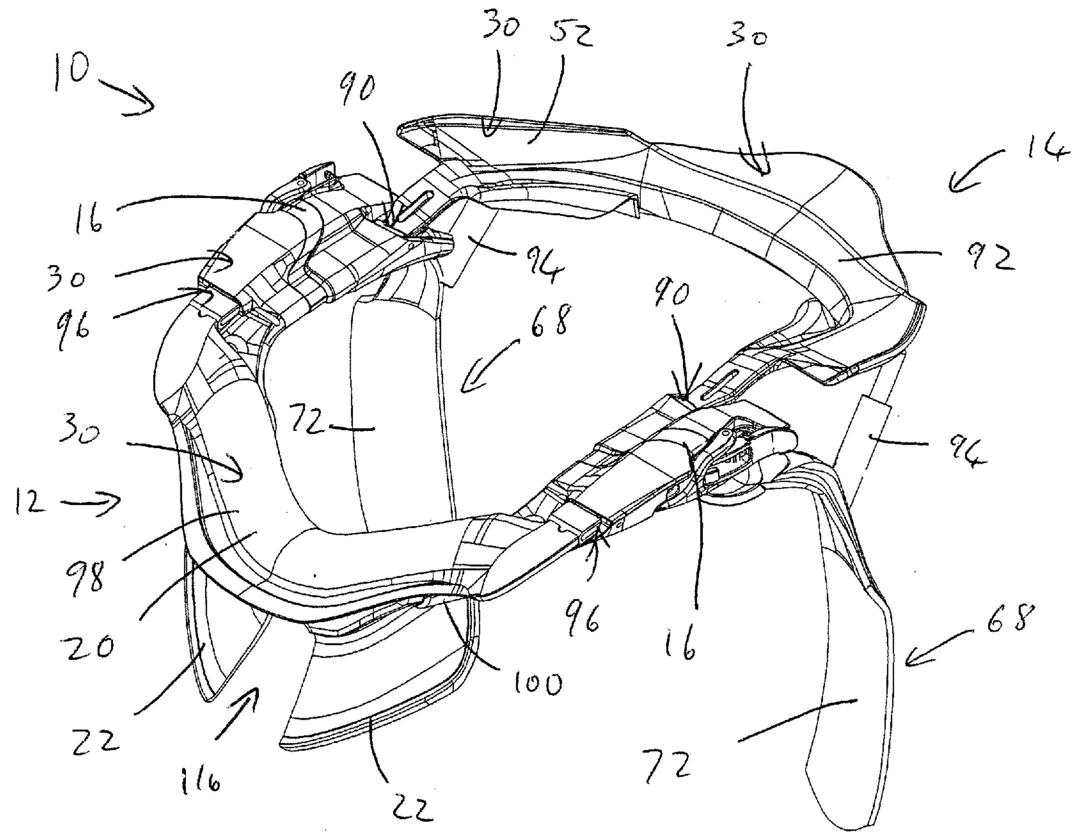
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Fig 1

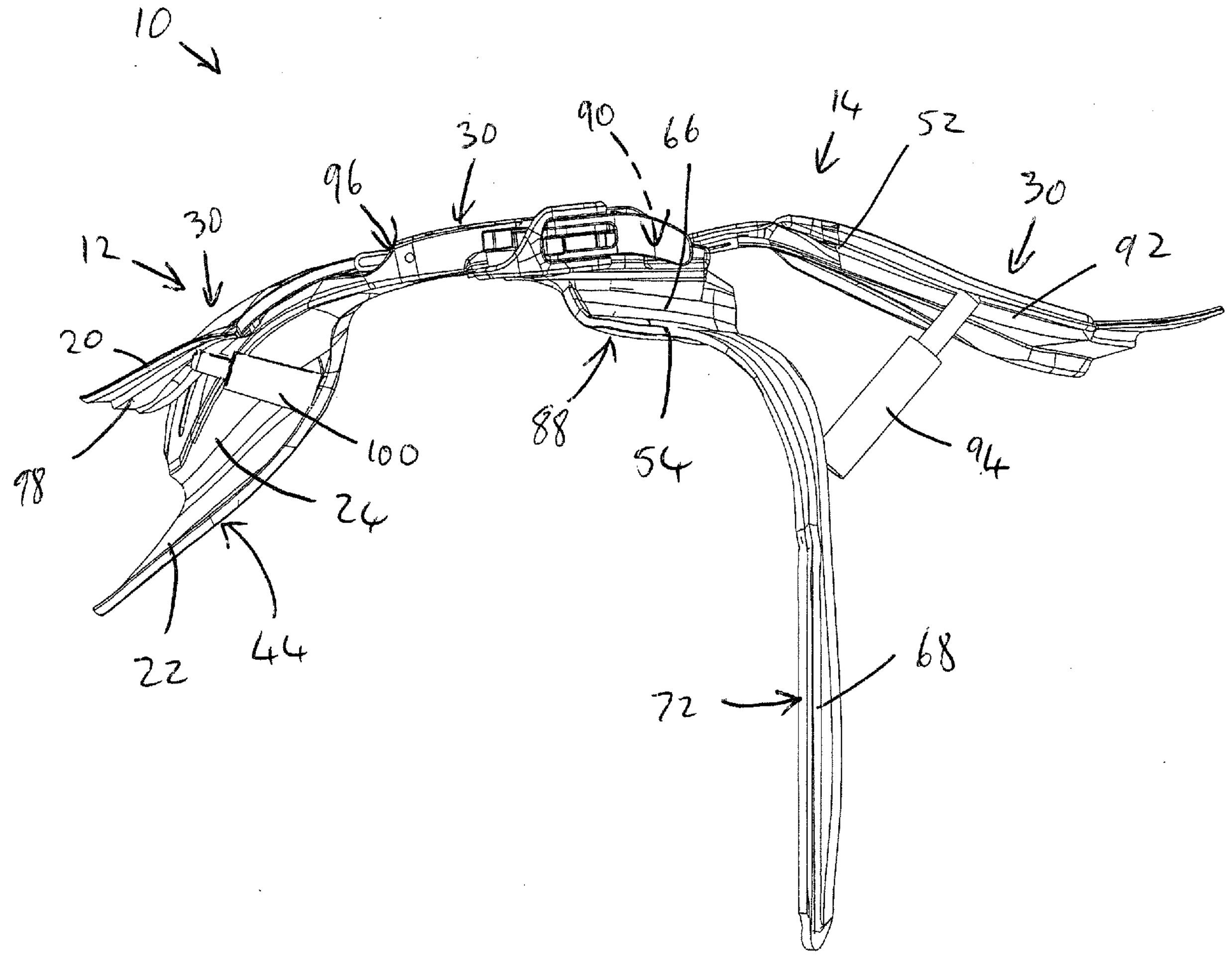

Fig 2

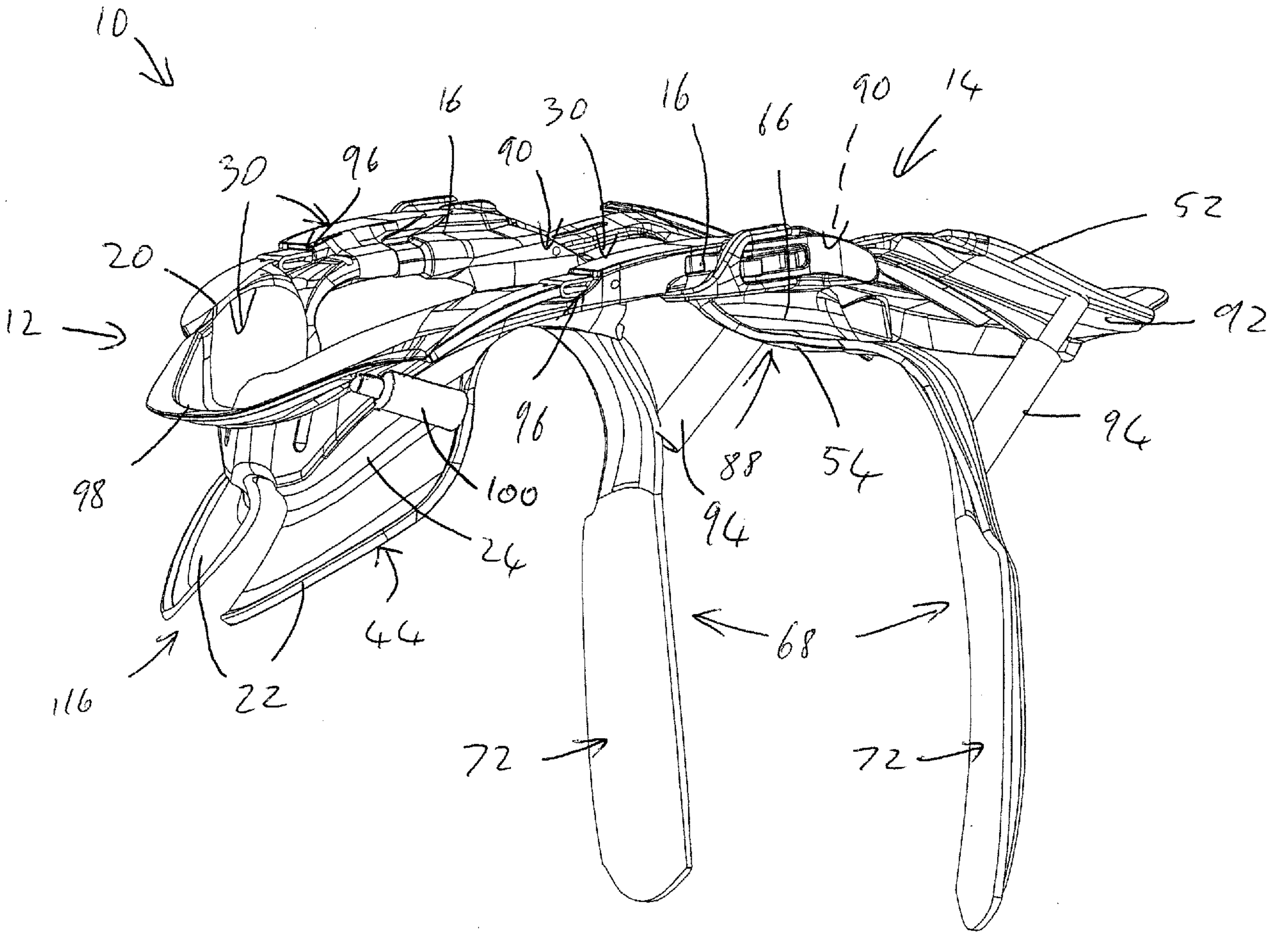
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Fig 3

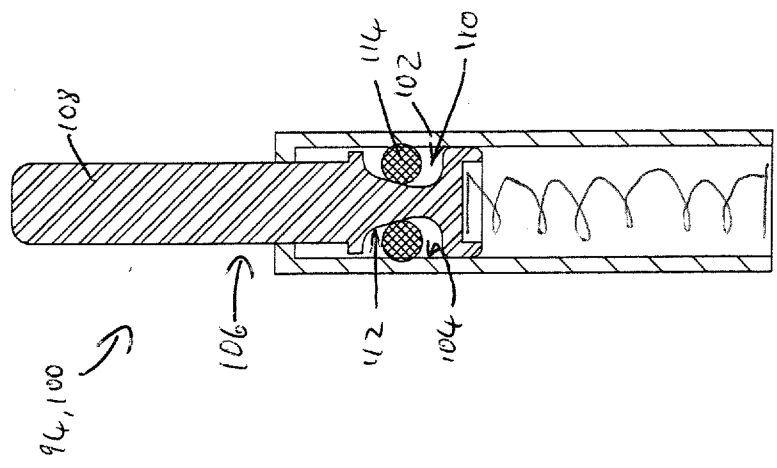


Fig 4C

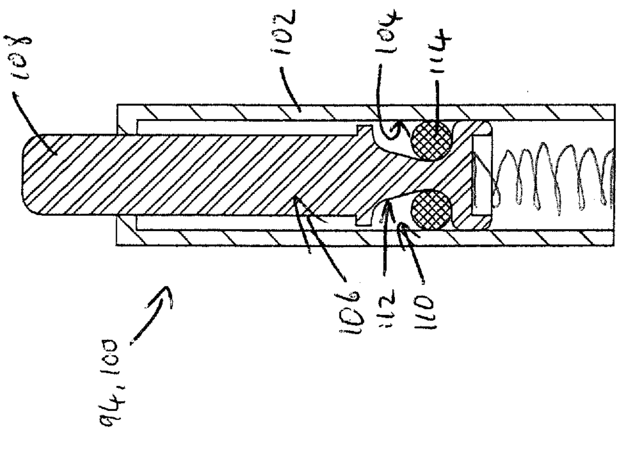


Fig 4B

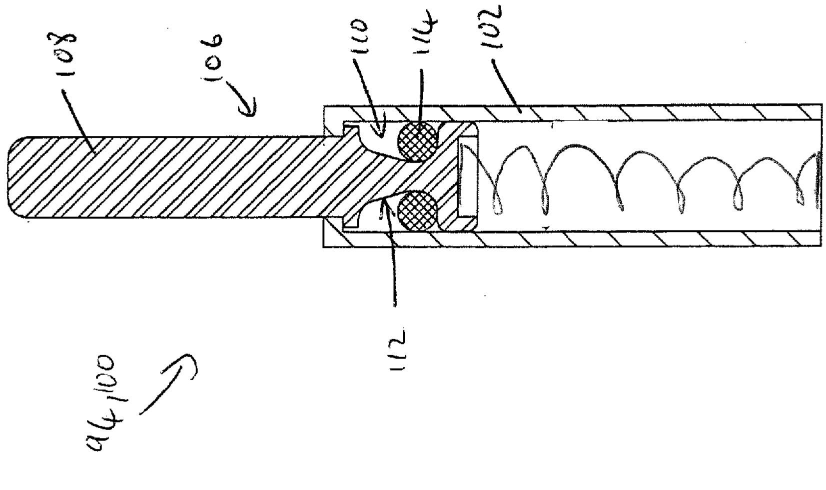


Fig 4A

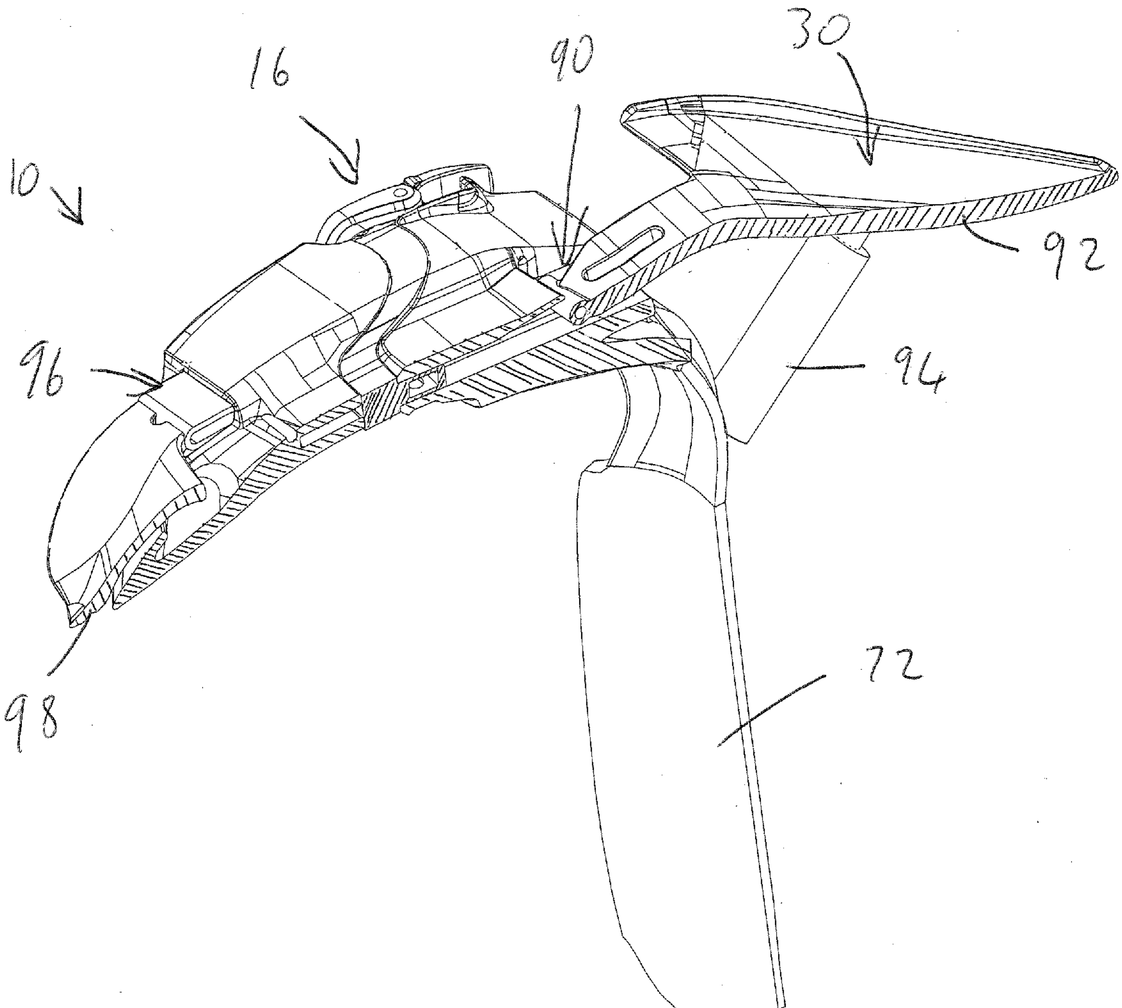


Fig 5

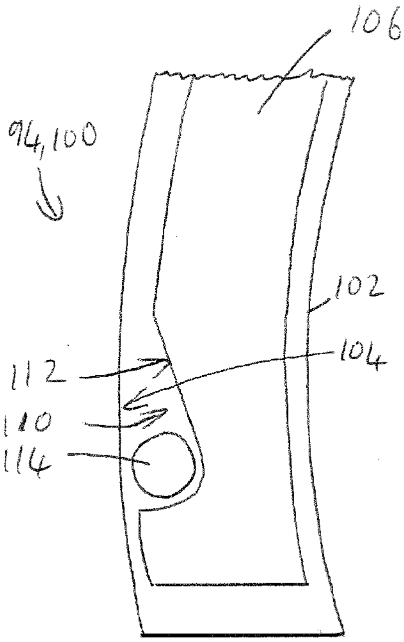


Fig 6A

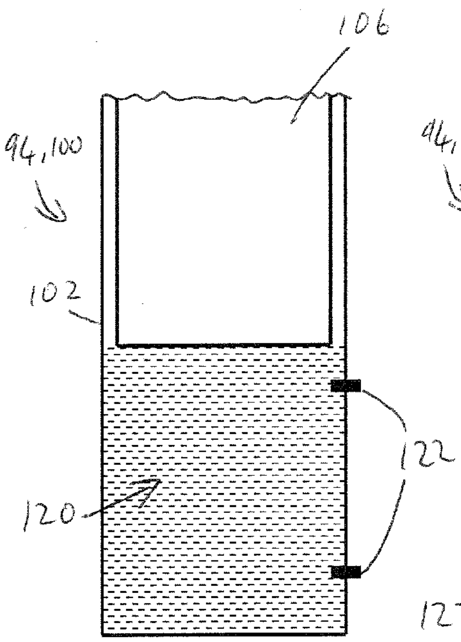
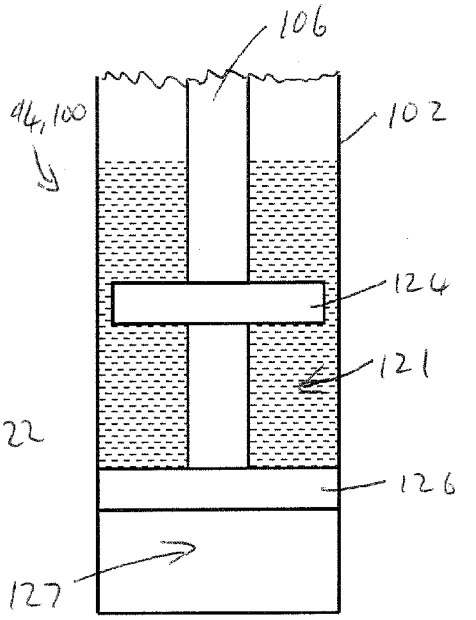


Fig 6B



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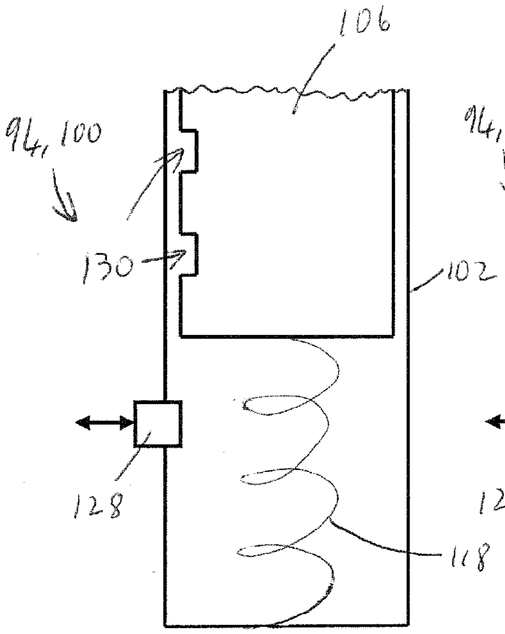


Fig 6D

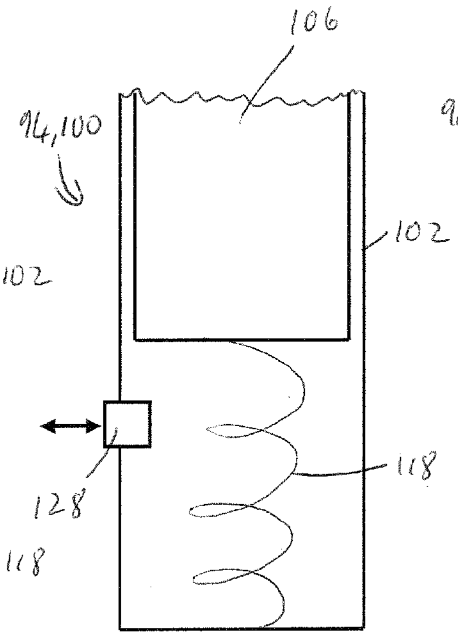


Fig 6E

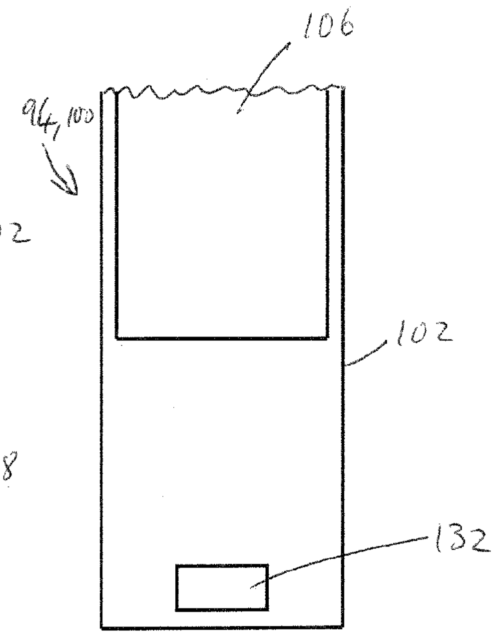


Fig 6F

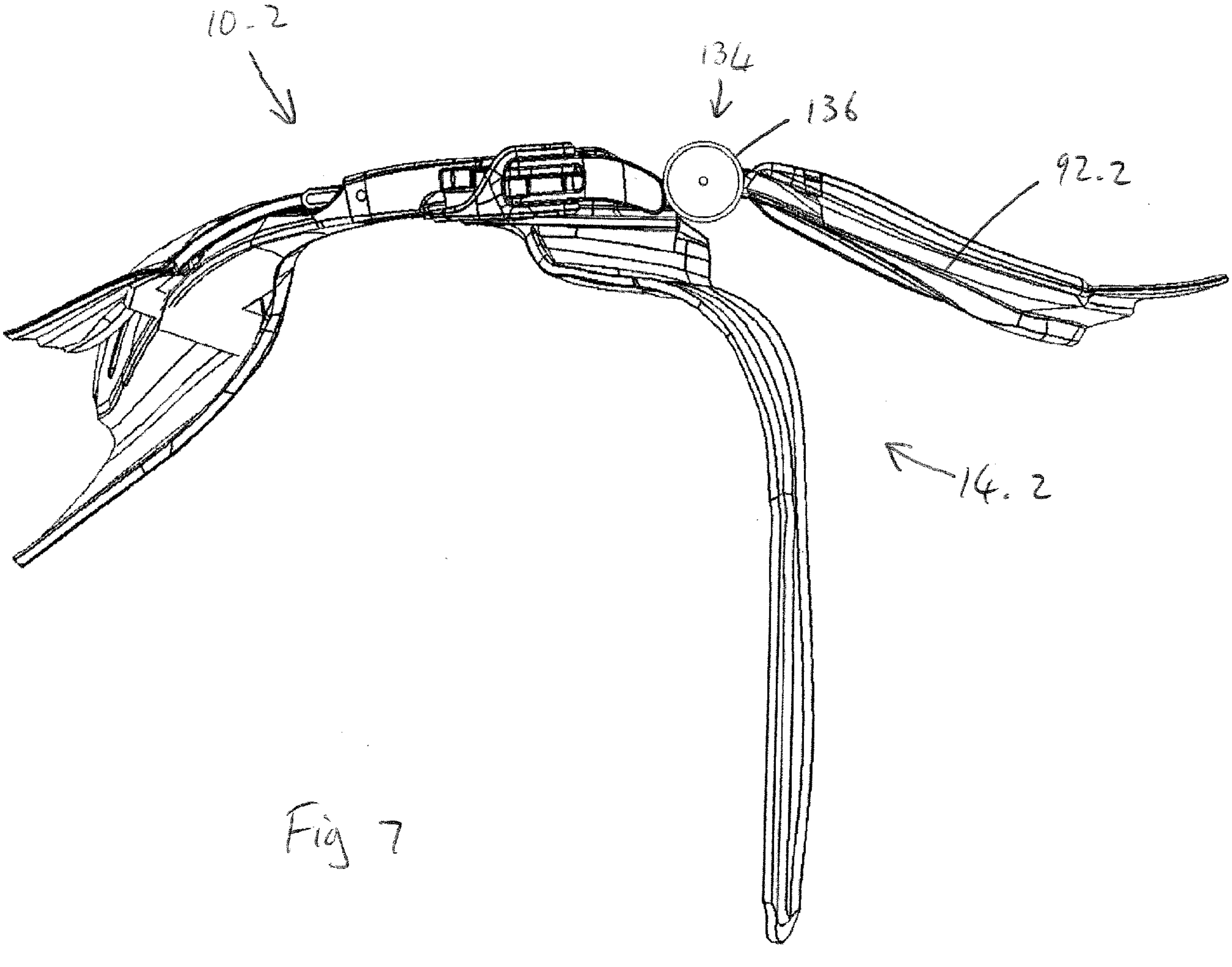


Fig 7

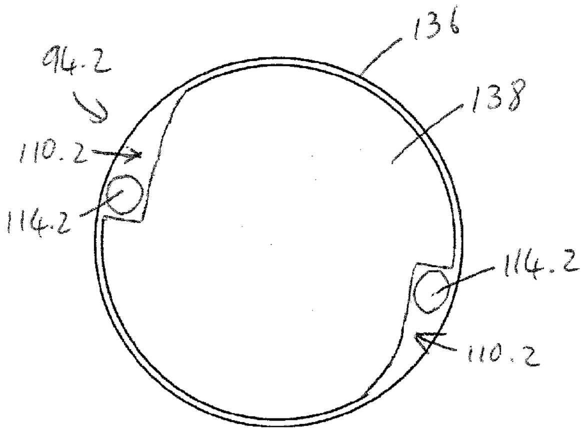


Fig 8A

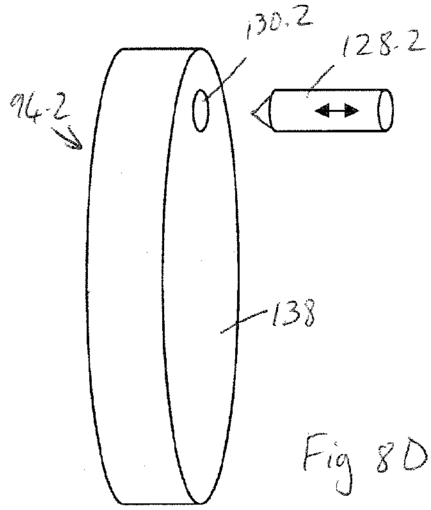
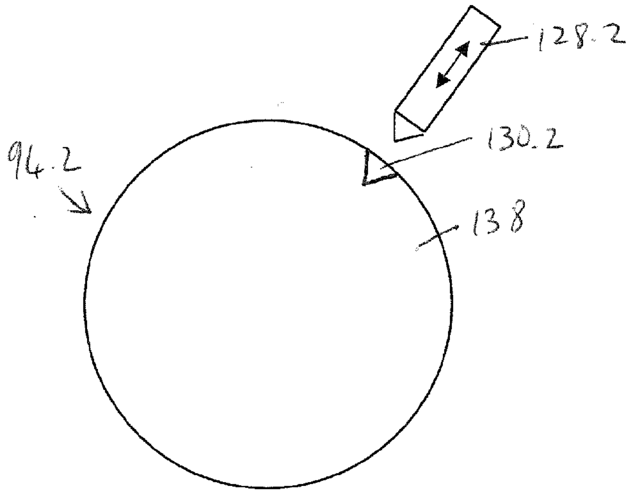


Fig 8D



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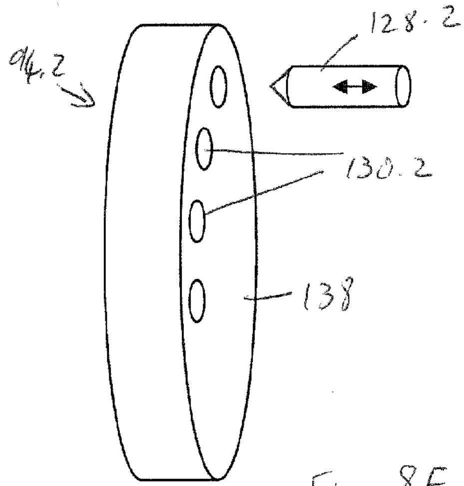

Fig 8E

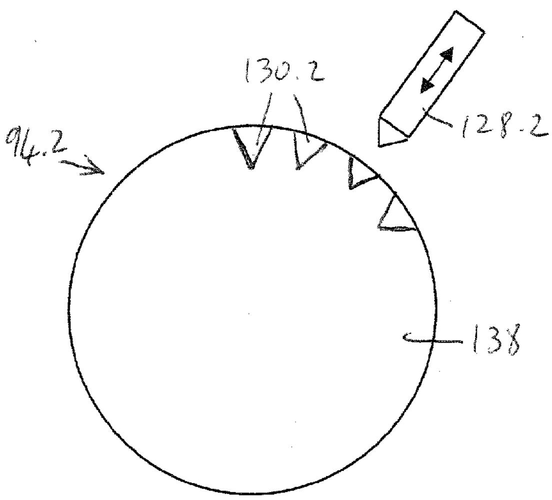

Fig 8C