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(54) **PROTECTIVE HEAD SUPPORT ASSEMBLY**

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A63B 71/12	(2006.01)
A41D 13/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A41D 13/0512*** (2013.01); ***A42B 3/046*** (2013.01); ***A42B 3/0433*** (2013.01); ***A42B 3/0473*** (2013.01); ***A63B 71/1291*** (2013.01)

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See application file for complete search history.

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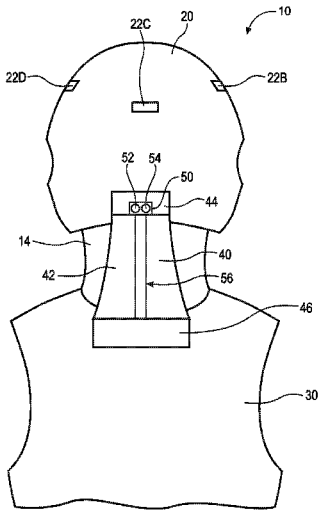
(57) **ABSTRACT**

A protective head support assembly, including a helmet having one or more sensors, a vest, at least one stabilizer tube filled with a fluid, including a first end connected to the helmet, and a second end connected to the vest, and a transducer arranged to receive a signal from the one or more sensors and introduce a magnetic field to the fluid.

21 Claims, 7 Drawing Sheets



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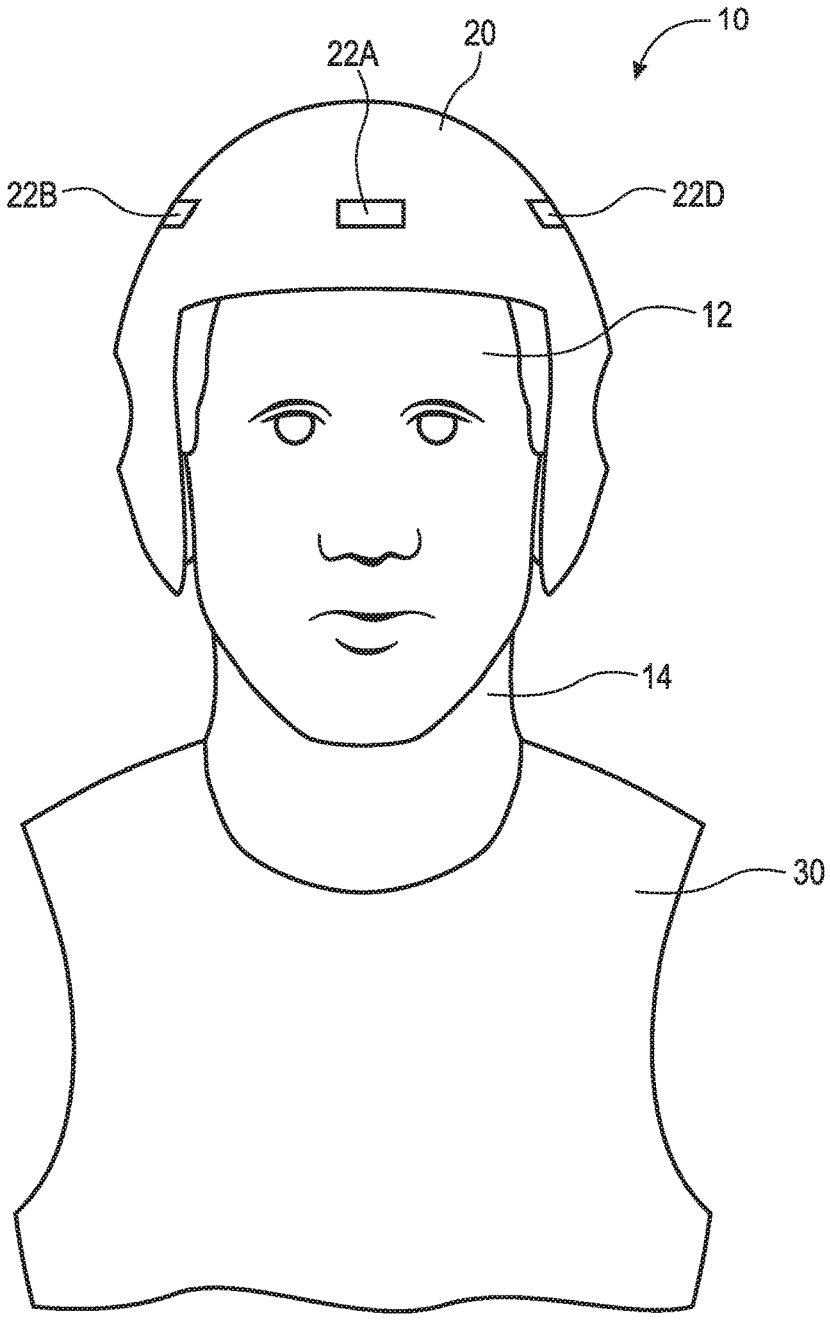

Fig. 1

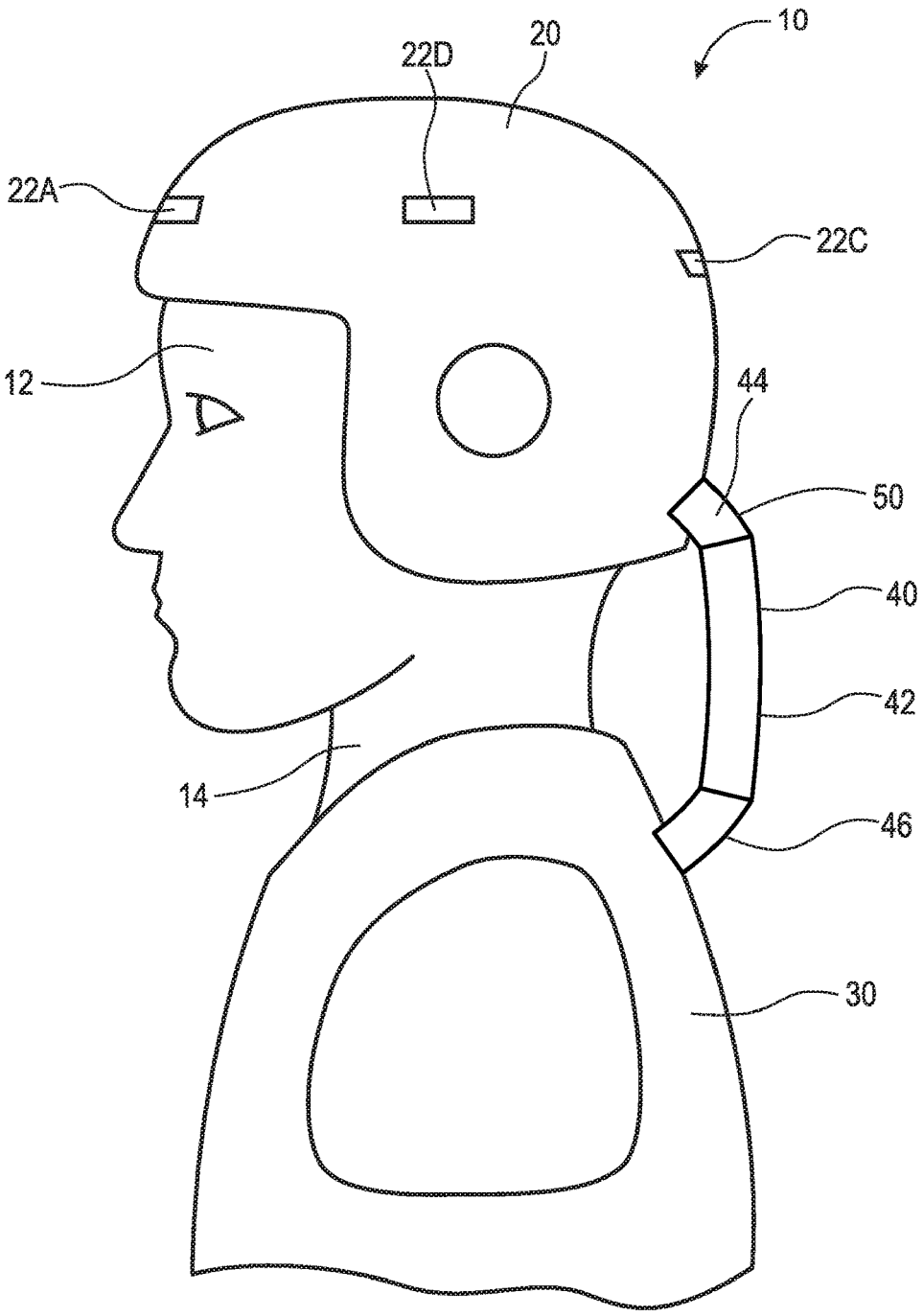

Fig. 2

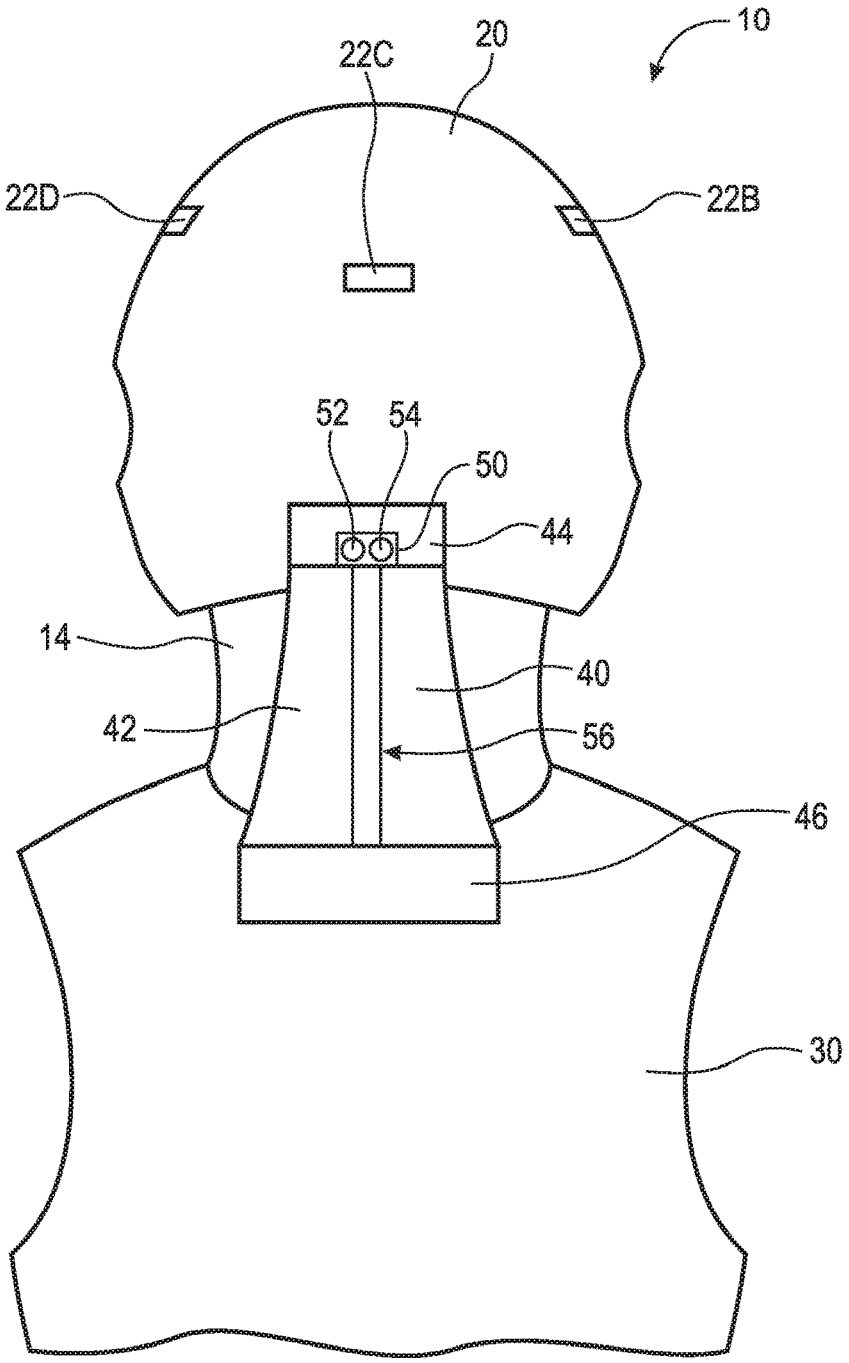

Fig. 3

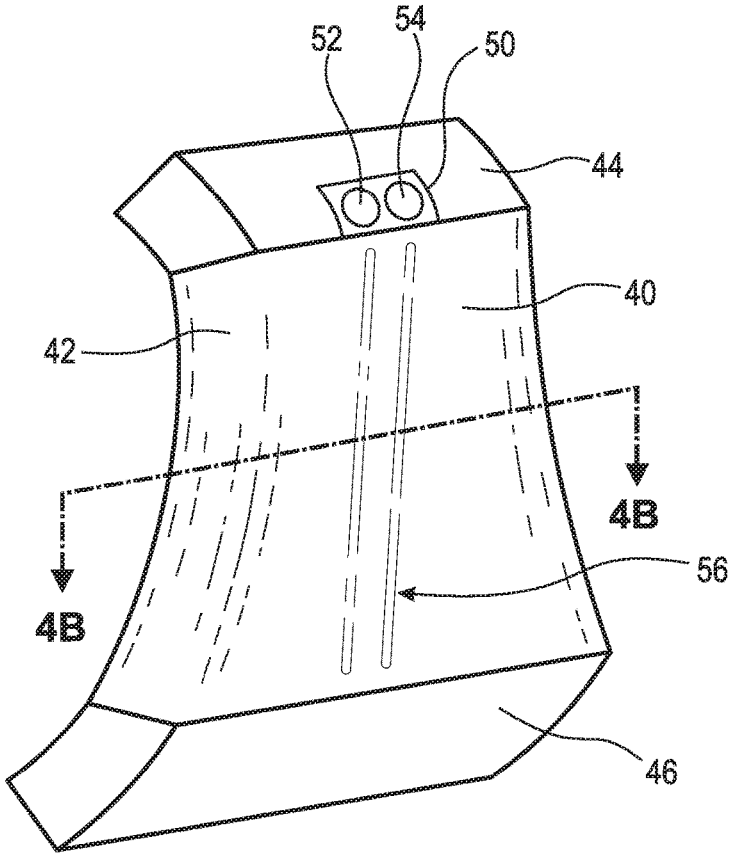

Fig. 4A

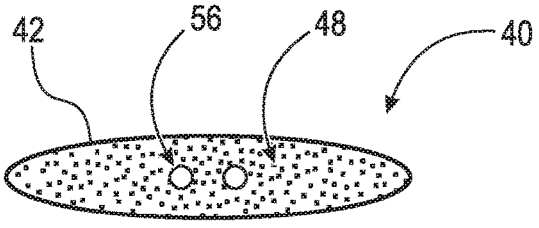

Fig. 4B

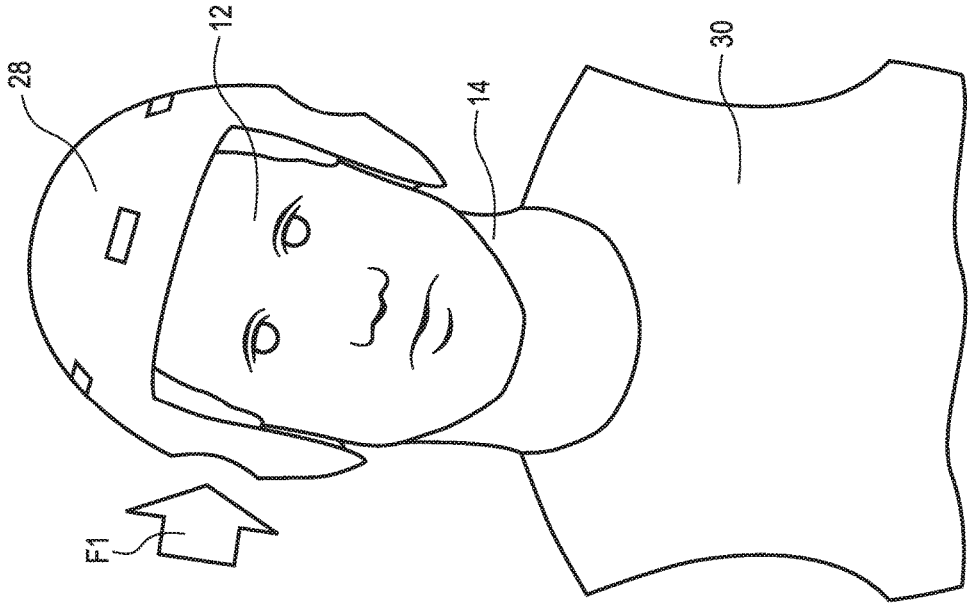

Fig. 5B

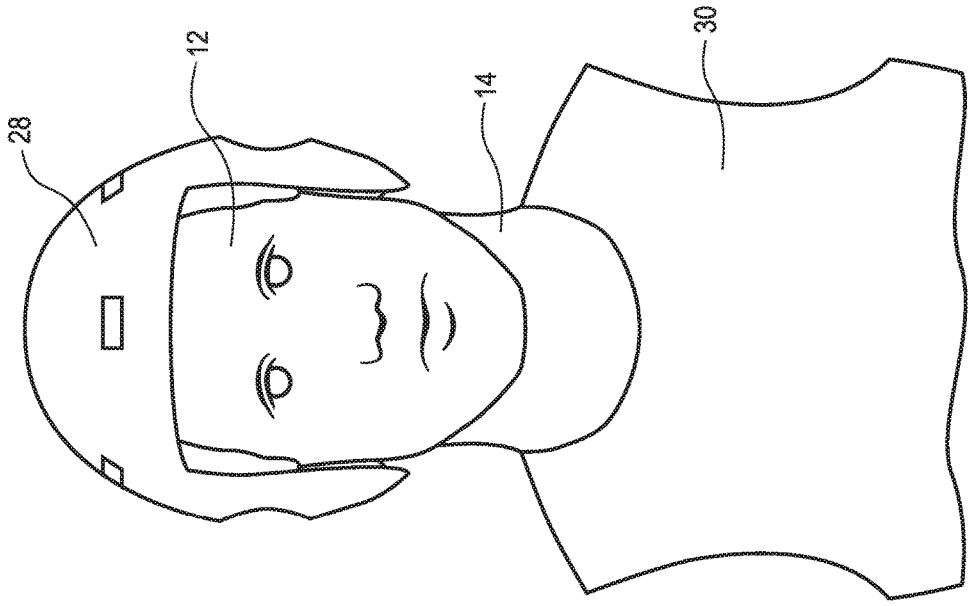

Fig. 5A

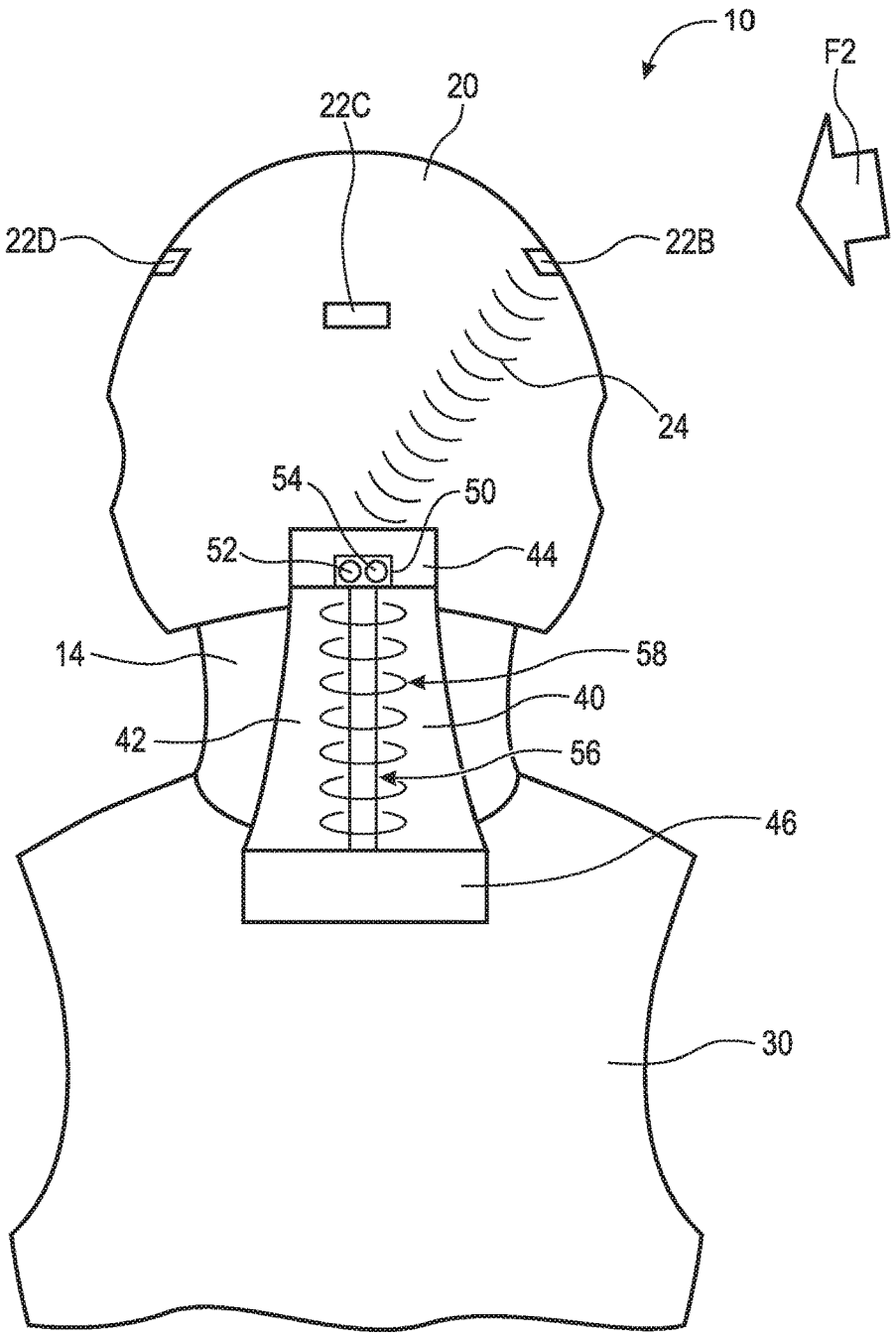

Fig. 6

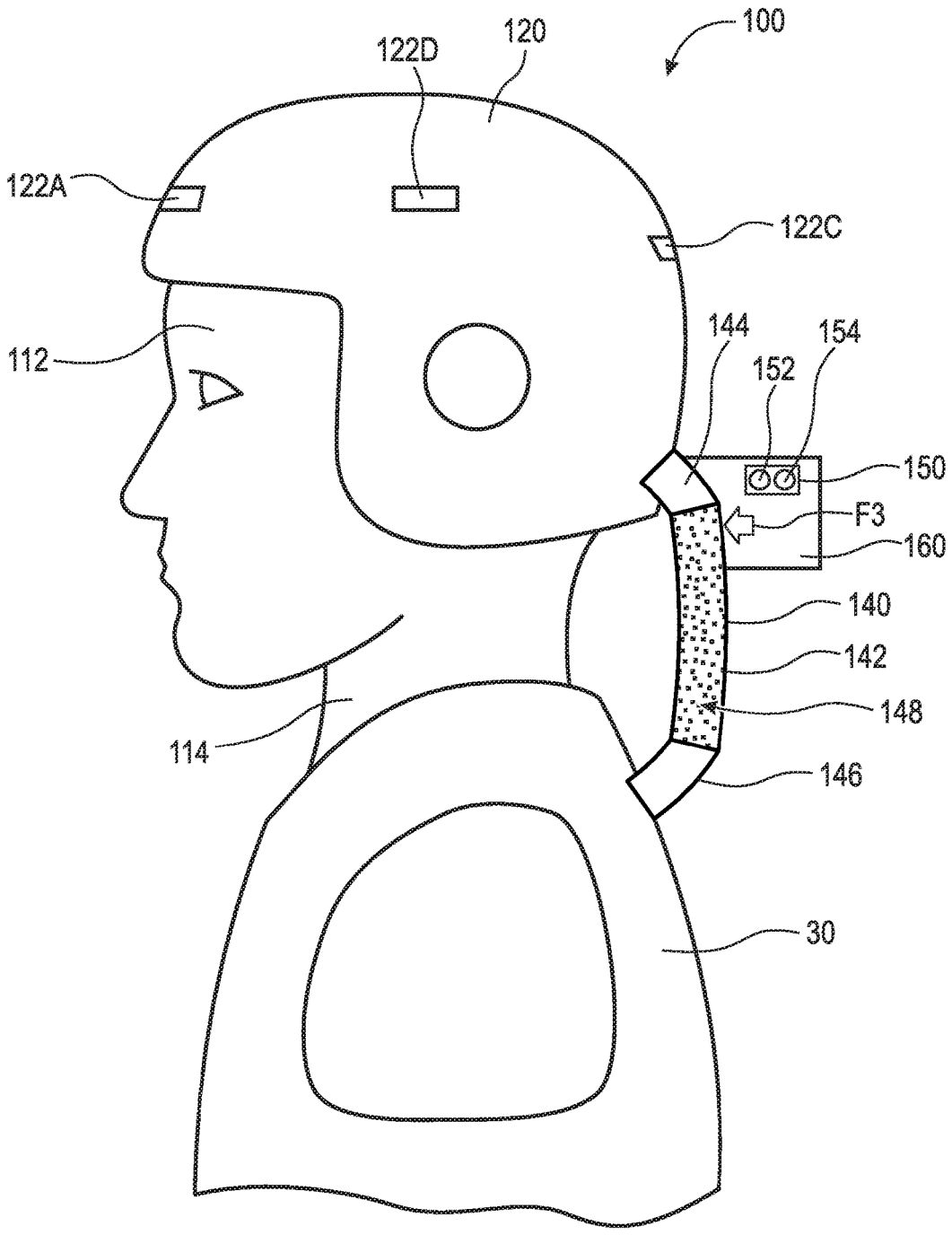
100
120
122D
122A
122C
112
144
154
152
150
F3
160
140
142
148
146
114
30

Fig. 7

PROTECTIVE HEAD SUPPORT ASSEMBLY

FIELD

The present invention relates to personal protective equipment, and, more particularly, to a protective head support assembly to prevent neck injury in contact sports.

BACKGROUND

Neck injury from sudden acceleration or deceleration force is extremely common. The term "whiplash" was initially coined in 1928 and describes damage to both bone and soft tissue in the neck when the head and body are accelerated, each from the other, causing severe hyperflexion, hyperextension, or lateral bending of the cervical spine. While whiplash injury is most commonly seen in motor vehicle accidents, contact sports are also a frequent cause of such injuries. Many contact sports require the use of protective headgear, which has been implicated as a cause of increased neck injury because of the increase in mass or weight of the head when protective headgear is worn. While rarely lethal, whiplash injuries result in substantial morbidity and economic loss.

While much has been done to design protective headgear in professional sport, little has been done to prevent concomitant neck injury which occurs with similar frequency. Indeed, because of the increased weight of protective head gear, many have speculated that the wearing of a helmet may actually increase the risk of neck injury in both athletic and motor sports. Clearly, there is a need to protect not only the head but also the neck in any contact sport or other sporting endeavors where helmet wearing is a must.

SUMMARY

According to aspects illustrated herein, there is provided a protective head support assembly, comprising a helmet comprising one or more sensors, a vest, at least one stabilizer tube filled with a fluid, including a first end connected to the helmet, and a second end connected to the vest, and a transducer arranged to receive a signal from the one or more sensors and introduce a magnetic field to the fluid.

According to aspects illustrated herein, there is provided a protective head support assembly, comprising a helmet including one or more sensors, a vest, at least one stabilizer tube filled with a fluid, including a first end connected to the helmet, and a second end connected to the vest, an impact element arranged proximate the at least one stabilizer tube, the impact element operatively arranged to provide a concussive force to the at least one stabilizer tube, and a transducer arranged to receive a signal from the at least one sensor and transmit a signal to the impact element.

These and other objects, features, and advantages of the present disclosure will become readily apparent upon a review of the following detailed description of the disclosure, in view of the drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments are disclosed, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, in which:

FIG. **1** is a front elevational view of a protective head support assembly;

FIG. **2** is a side elevational view of the protective head support assembly shown in FIG. **1**;

FIG. **3** is a rear elevational view of the protective head support assembly shown in FIG. **1**;

FIG. **4**A is a rear perspective view of the stabilizer shown in FIG. **3**;

FIG. **4**B is a cross-sectional view of the stabilizer shown in FIG. **4**A, taken generally along line **4**B-**4**B;

FIG. **5**A is a front elevational view of a normal helmet assembly before impact;

FIG. **5**B is a front elevational view of a the normal helmet assembly shown in FIG. **5**A after impact;

FIG. **6** is a rear elevational view of the protective head support assembly shown in FIG. **1** before impact; and,

FIG. **7** is a side elevational view of a protective head support assembly.

DETAILED DESCRIPTION

At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements. It is to be understood that the claims are not limited to the disclosed aspects.

Furthermore, it is understood that this disclosure is not limited to the particular methodology, materials, and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the claims.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure pertains. It should be understood that any methods, devices, or materials similar or equivalent to those described herein can be used in the practice or testing of the example embodiments. The assembly of the present disclosure could be driven by hydraulics, electronics, and/or pneumatics.

It should be appreciated that the term "substantially" is synonymous with terms such as "nearly," "very nearly," "about," "approximately," "around," "bordering on," "close to," "essentially," "in the neighborhood of," "in the vicinity of," etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term "proximate" is synonymous with terms such as "nearby," "close," "adjacent," "neighboring," "immediate," "adjoining," etc., and such terms may be used interchangeably as appearing in the specification and claims. The term "approximately" is intended to mean values within ten percent of the specified value.

Referring now to the figures, FIG. **1** is a front elevational view of protective head support assembly **10**. FIG. **2** is a side elevational view of protective head support assembly **10**. FIG. **3** is a rear elevational view of protective head support assembly **10**. Protective head support assembly **10** generally comprises helmet **20**, vest **30**, and stabilizer **40**.

Helmet **20** is a hard or padded protective hat, various types of which are worn by soldiers, police officers, firefighters, motorcyclists, athletes, and others. Helmet **20** is fitted over a user's head **12**. Helmet **20** comprises one or more sensors **22**A-D. Sensors **22**A-D are any sensors capable of detecting an incoming impact and transmitting a signal to transducer **50**, as will be discussed in greater detail below. Sensors **22**A-D may be, for example, active Light Detection and Ranging (LIDAR) sensors, Radio Detection and Ranging (RADAR) distance sensors, motion detectors, proximity sensors, passive infrared sensors, alarm sensors,

or any other suitable optical, light, imaging, photon, proximity, or presence sensor. In the embodiment shown, helmet **20** comprises four sensors **22**A-D. However, it should be appreciated that any number of sensors suitable for detecting incoming impact from any position. In an example embodiments, sensors **22**A-D are located on vest **30**. It should be appreciated that sensors **22**A-D can be located at any location of a user's body suitable for detecting incoming contact.

Vest (or shoulder pads) **30** is a piece of protective equipment used in many contact sports such as American football, Canadian football, lacrosse, and hockey. With respect to the present disclosure, vest **30** is any garment that is securely worn on the upper torso of a user. It should be appreciated that vest **30** does not actually need to be a vest, but rather may be a shirt and comprise sleeves. It should also be appreciated that vest **30** does not need to be a protective piece of equipment.

Stabilizer **40** comprises wall **42**, base **44**, base **46**, fluid **48**, and transducer **50**. Stabilizer **40** is generally an elliptical tube having wall **42** filled with fluid **48** that extends between helmet **20** and vest **30** along neck **14** of a user. It should be appreciated that stabilizer **40** can be any shape suitable to stiffen and promote alignment of head **12** and neck **14**. For example, stabilizer **40** may be a frusto-conical tube, a rectangular tube, a square tube, a circular tube, or a triangular tube. Because of its positioning, stabilizer **40** does not interfere with the user's vision. Stabilizer **40** is sealed at a top end by base **44** and at a bottom end by base **46**. Stabilizer **40** is secured to helmet **20** at base **44** and vest **30** at base **46**. Wall **42** is made of a material that can be suitably stiffened, such as a substantially non-elastic rubber. In the embodiment shown, protective head support assembly **10** comprises one stabilizer tube. In an example embodiment, protective head support assembly **10** comprises two stabilizer tubes. In an example embodiment, protective head support assembly **10** comprises a plurality of stabilizer tubes. However, it should be appreciated that protective head support assembly **10** may comprise any number of stabilizer suitable to stiffen and support the user's neck.

Transducer **50** is arranged to receive a signal from any of sensors **22**A-D and transmit a magnetic field proximate fluid **48**, as will be discussed in greater detail below. As is known in the art, a magnetic field is created as an effect of electric current. In the embodiment shown, transducer **50** is arranged adjacent stabilizer **40** in base **44** and comprises receiver **52**, power source **54**, and conductor **56**. In an example embodiment, transducer **50** is arranged in base **46**. It should be appreciated that transducer **50** can be located at any position suitable to detect a signal and transmit an electric current proximate stabilizer **40**. For example, transducer **50** may be located as a transducer pack on a user's waist belt and have an electrical conductor, such as a wire, connected to stabilizer **40**. Transducer **50** is capable of transmitting a variable amount of electric current through conductor **56**, thereby creating a variable strength magnetic field proximate fluid **48**. For example, if sensor **22**B determines, based on the velocity and mass of the incoming object, that a very large collision is about to occur, then transducer **50** will transmit a large amount of current though conductor **56** and thus large magnetic field proximate fluid **48** such that stabilizer **40** is stiffer. On the other hand, if sensor **22**B determines, based on the velocity and mass of the incoming object, that a small to moderate collision is about to occur, then transducer **50** will only transmit a small amount of current through conductor **56** and thus small magnetic field proximate fluid **48** such that the user is protected but head **12** and neck **14** are not overly inhibited. The amount of electric current transmitted based on velocity and mass of the incoming object can be calibrated. Conductor **56** is arranged proximate stabilizer **40** and may be any suitable material or shape for conducting electricity and creating a magnetic field (e.g., a copper wire or rod). In an example embodiment, conductor **56** runs through fluid **48** within stabilizer **40**. In an example embodiment, conductor **56** is arranged outside of stabilizer **40** adjacent to wall **42**. In addition, conductor **56** may be a set of two or more wires or rods (i.e., a lead conductor and a return conductor). Power source **54** is any electronic device that supplies electric energy to an electric load, for example, a lead-acid or lithium-ion battery. Power source **54** may also be located in vest **30** or in another suitable location, such as a waste pack for example.

FIG. **4**A is a rear perspective view of stabilizer **40**. FIG. **4**B is a cross-sectional view of stabilizer **40**, taken generally along line **4**B-**4**B in FIG. **4**A. Stabilizer **40** is filled with fluid **48**. In one embodiment fluid **48** is preferably a magneto-rheological fluid (MR fluid). A MR fluid is a type of smart fluid in a carrier fluid, usually a type of oil. When subjected to a magnetic field, the fluid greatly increases its apparent viscosity, to the point of becoming a viscoelastic solid. Importantly, the yield stress of the fluid when in its active ("on") state can be controlled very accurately by varying the magnetic field intensity. The upshot is that the fluid's ability to transmit force can be controlled with an electromagnet, which gives rise to its many possible control-based applications. In another embodiment, fluid **48** is a ferrofluid. MR fluid is different from a ferrofluid, which has smaller particles. MR fluid particles are primarily on the micrometer-scale and are too dense for Brownian motion to keep them suspended (in the lower density carrier fluid). Ferrofluid particles are primarily nanoparticles (i.e., nanometer-scale) that are suspended by Brownian motion and generally will not settle under normal conditions. It should be appreciated that any other suitable fluid that stiffens once an electric current is introduced therein may be used. Additionally, and as discussed above, the amount of current introduced through conductor **56** is directly related to the strength of the magnetic field proximate fluid **48**, and controls the amount of stiffening of stabilizer **40**. For example, as the current introduced through conductor **56** and the magnetic field proximate fluid **48** increases, the stiffer stabilizer **40** gets. This is useful, for example, if a larger impact is about to occur and increased protection is required. It should be appreciated that vest **30** may also contain a MR fluid or a ferrofluid or any other fluid that stiffens when a magnetic field is applied proximate thereto.

FIG. **5**A is a front elevational view of a user wearing helmet **28** and vest **20** before an impact. Helmet **28** is a normal helmet with no sensors. The user does not have stabilizer **40** extending between helmet **28** and vest **20**. FIG. **5**B is a front elevational view of the normal helmet assembly shown in FIG. **5**A after impact. As shown in FIG. **5**B, force F**1** hits helmet **28**, and the user's head **12** and neck **14** are displaced such that they are forced away from the impact of force F**1**. Such an impact and displacement of head **12** and neck **14** can cause serious injury. Stabilizer **40** of protective head support assembly **10** prevents this displacement and thus the serious injuries that accompany such impacts.

FIG. **6** is a rear elevational view of protective head support assembly **10** before impact. As shown, an impact represented by force F**2** is incoming from the right side of helmet **20**. Sensor **22**B detects force F**2** and sends signal **24** to transducer **50**. Receiver **52** of transducer **50** receives signal **24**. Using power source **54**, transducer **50** then sends

an electric current through conductor **56**, which creates magnetic field **58** proximate fluid **48** and stabilizer **40**. Magnetic field **58** stiffens fluid **48** and stabilizer **40** prior to impact and thus prevents head **12** and neck **14** from displacing as illustrated in FIGS. **5**A and **5**B. It should be appreciated that, when no impact is imminent, and an electric current is not being transmitted through conductor **56**, stabilizer **40** is generally flaccid. In the flaccid state, stabilizer **40** does not substantially inhibit movement of head **12** or neck **14**. However, when one of sensors **22**A-D senses that contact will occur, it sends signal **24** to transducer **50**, which sends electric current through conductor **56**, creates magnetic field **58** proximate fluid **48**, and stiffens stabilizer **40**.

FIG. **7** is a side elevational view of protective head support assembly **100**. Protective head support assembly **100** comprises helmet **120**, vest **130**, stabilizer **140**, and impact element **160**. Protective head support assembly **100** is substantially similar to protective head support assembly **10**.

Helmet **120** is a hard or padded protective hat, various types of which are worn by soldiers, police officers, firefighters, motorcyclists, athletes, and others. Helmet **120** is fitted over a user's head **112**. Helmet **120** comprises one or more sensors **122**A-D. Sensors **122**A-D are any sensors capable of detecting an incoming impact and transmitting a signal to transducer **150**, as will be discussed in greater detail below. Sensors **122**A-D may be, for example, active LIDAR sensors, RADAR distance sensors, motion detectors, proximity sensors, passive infrared sensors, alarm sensors, or any other suitable optical, light, imaging, photon, proximity, or presence sensor. In the embodiment shown, helmet **120** comprises four sensors **122**A-D. However, it should be appreciated that any number of sensors suitable for detecting incoming impact from any position. In an example embodiments, sensors **122**A-D are located on vest **130**. It should be appreciated that sensors **122**A-D can be located at any location of a user's body suitable for detecting incoming contact.

Vest (or shoulder pads) **130** is a piece of protective equipment used in many contact sports such as American football, Canadian football, lacrosse, and hockey. With respect to the present disclosure, vest **130** is any garment that is securely worn on the upper torso of a user. It should be appreciated that vest **130** does not actually need to be a vest, but rather may be a shirt and comprise sleeves. It should also be appreciated that vest **130** does not need to be a protective piece of equipment.

Stabilizer **140** comprises wall **142**, base **144**, base **146**, fluid **148**, and transducer **150**. Stabilizer **140** is generally an elliptical tube having wall **142** filled with fluid **148** that extends between helmet **120** and vest **130** along neck **114** of a user. It should be appreciated that stabilizer **140** can be any shape suitable to stiffen and promote alignment of head **112** and neck **114**. For example, stabilizer **140** may be a frusto-conical tube, a rectangular tube, a square tube, a circular tube, or a triangular tube, or indeed, multiple tubes. Because of its positioning, stabilizer **140** does not interfere with the user's vision. Stabilizer **140** is sealed at a top end by base **144** and at a bottom end by base **146**. Stabilizer **140** is secured to helmet **120** at base **144** and vest **130** at base **146**. Wall **142** is made of a material that can be suitably stiffened, such as a substantially non-elastic rubber. Stabilizer **140** is filled with fluid **148**. Fluid **148** is a non-Newtonian fluid or any other fluid that stiffens once an impact force has been applied thereto. It should also be appreciated that vest **130** may also contain non-Newtonian fluid or any other fluid that stiffens once an impact force has been applied thereto. In the embodiment shown, protective head support assembly **100** comprises one stabilizer tube. In an example embodiment, protective head support assembly **100** comprises two stabilizer tubes. In an example embodiment, protective head support assembly **100** comprises a plurality of stabilizer tubes. However, it should be appreciated that protective head support assembly **100** may comprise any number of stabilizer suitable to stiffen and support the user's neck.

Transducer **150** is arranged to receive a signal from sensors **122**A-D and transmit a force to stabilizer **140**, as will be discussed in greater detail below. In the embodiment shown, transducer **150** is arranged adjacent stabilizer **140** in impact element **160** and comprises receiver **152** and power source **154**. It should be appreciated that transducer **150** can be located at any position suitable to detect a signal and transmit an electric current to stabilizer **140**. For example, transducer **150** may be located as a transducer pack on a user's waist belt and have an electrical conductor, such as a wire, connected to impact element **160**. Impact element **160** is any device capable of introducing a concussive impact to stabilizer **140**. For example, impact element **160** can be a hammer or other mechanical device, or an air gun or other pneumatic force providing mechanism.

Similar to protective head support assembly **10**, when one of sensors **122**A-D detects an incoming impact they transmit signal **126** (not shown) to transducer **150**. Receiver **152** of transducer **150** receives the signal, and transducer **150**, using power source **154**, transmits a signal to impact element **160**. Impact element **160** then provides concussive force F**3** to impact stabilizer **140**. Force F**3** causes fluid **148** to stiffen within stabilizer **140** and causes head **112** and neck **114** to remain substantially aligned. The use of non-Newtonian fluid requires that a separate concussive force be applied to stabilizer **140** in order to stiffen the fluid therein. This separate concussive force must be applied prior to the incoming impact in order to protect the user.

It will be appreciated that various aspects of the disclosure above and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

REFERENCE NUMERALS

10 Protective head support assembly
12 Head
14 Neck
20 Helmet
22A Sensor
22B Sensor
22C Sensor
22D Sensor
24 Signal
28 Helmet
30 Vest
40 Stabilizer
42 Wall
44 Base
46 Base
48 Fluid
50 Transducer
52 Receiver
54 Power source

56 Conductor
58 Magnetic field
100 Protective head support assembly
120 Helmet
122A Sensor
122B Sensor (not shown)
122C Sensor
122D Sensor
124 Signal (not shown)
130 Vest
140 Stabilizer
142 Wall
144 Base
146 Base
148 Fluid
150 Transducer
152 Receiver
154 Power source
160 Impact element
F**1** Force
F**2** Force
F**3** Force

What is claimed is:

1. A protective head support assembly, comprising:
a helmet comprising one or more sensors;
a vest;
at least one stabilizer tube filled with a fluid, including:
a first end connected to the helmet; and,
a second end connected to the vest;
a transducer operatively arranged to receive a signal from the one or more sensors and introduce a magnetic field to the fluid; and,
a conductor electrically connected to the transducer and arranged at least partially within the fluid, wherein the transducer is operatively arranged to sends an electrical current through the conductor to introduce the magnetic field to the fluid.

2. The protective head support assembly as recited in claim **1**, wherein when the magnetic field is introduced to the fluid the at least one stabilizer tube stiffens.

3. The protective head support assembly as recited in claim **2**, wherein the fluid is a magneto-rheologic fluid.

4. The protective head support assembly as recited in claim **2**, wherein the fluid is a ferrofluid.

5. The protective head support assembly as recited in claim **2**, wherein the transducer comprises:
a receiver;
a power source; and,
a transmitter.

6. The protective head support assembly as recited in claim **2**, wherein the one or more sensors are Light Detection and Ranging sensors.

7. The protective head support assembly as recited in claim **2**, wherein the one or more sensors are Radio Detection and Ranging distance sensors.

8. The protective head support assembly as recited in claim **2**, wherein:
the first end of the at least one stabilizer tube is sealed by a first base, the first base being secured to the helmet; and,
the second end of the at least one stabilizer tube is sealed by a second base, the second base being secured to the vest.

9. The protective head support assembly as recited in claim **8**, wherein the transducer is arranged in the first base.

10. The protective head support assembly as recited in claim **8**, wherein the transducer is arranged in the second base.

11. A protective head support assembly, comprising:
a helmet including one or more sensors;
a vest;
at least one stabilizer tube filled with a fluid, including:
a first end connected to the helmet; and,
a second end connected to the vest;
an impact element arranged proximate the at least one stabilizer tube, the impact element operatively arranged to provide a concussive force to the at least one stabilizer tube; and,
a transducer arranged to receive a signal from the at least one sensor and transmit a signal to the impact element.

12. The protective head support assembly as recited in claim **11**, wherein when the concussive force is introduced to the at least one stabilizer tube, the fluid and the at least one stabilizer tube stiffen.

13. The protective head support assembly as recited in claim **12**, wherein the fluid is a non-Newtonian fluid.

14. The protective head support assembly as recited in claim **12**, wherein the transducer comprises:
a receiver;
a power source; and,
a transmitter.

15. The protective head support assembly as recited in claim **12**, wherein the at least one sensor is a Light Detection and Ranging sensor.

16. The protective head support assembly as recited in claim **12**, wherein the at least one sensor is a Radio Detection and Ranging distance sensor.

17. The protective head support assembly as recited in claim **12**, wherein:
the first end of the at least one stabilizer tube is sealed by a first base, the first base being secured to the helmet; and,
the second end of the at least one stabilizer tube is sealed by a second base, the second base being secured to the vest.

18. The protective head support assembly as recited in claim **17**, wherein the transducer is arranged in the first base.

19. The protective head support assembly as recited in claim **17**, wherein the transducer is arranged in the second base.

20. The protective head support assembly as recited in claim **17**, wherein the transducer is arranged in the impact element.

21. The protective head support assembly as recited in claim **1**, wherein the at least one stabilizer tube further comprises a wall including rubber.

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