



(51) International Patent Classification:
A42B 3/30 (2006.01)

(21) International Application Number:
PCT/US2015/024240

(22) International Filing Date:
3 April 2015 (03.04.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/974,736 3 April 2014 (03.04.2014) US

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,

[Continued on next page]

(54) Title: PROTECTIVE HELMETS FOR DISASTER SITUATIONS

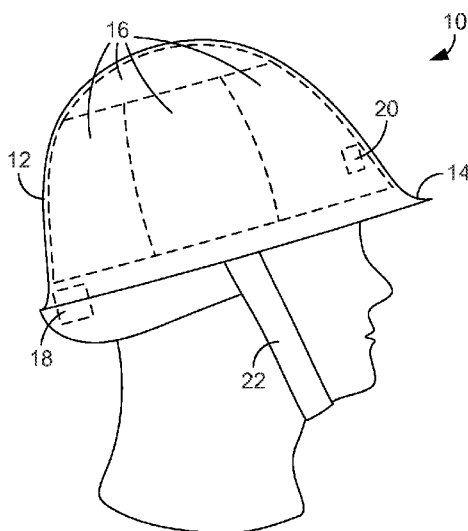


FIG. 1

(57) Abstract: In one embodiment, a protective helmet for disaster situation includes a rigid outer shell and an electronic system in-
tegrated into the helmet that includes an electronic location system configured to transmit electromagnetic signals that can be used to
locate the wearer of the helmet.



LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

— *of inventorship (Rule 4.17(iv))*

Published:

Declarations under Rule 4.17:

— *with international search report (Art. 21(3))*

— *as to the applicant's entitlement to claim the priority of
the earlier application (Rule 4.17(iii))*

PROTECTIVE HELMETS FOR DISASTER SITUATIONS

Cross-Reference to Related Application

5 This application claims priority to co-pending U.S. Provisional Application serial number 61/974,736, filed April 3, 2014, which is hereby incorporated by reference herein in its entirety.

Background

10 When a disaster, such as a hurricane, tornado, or earthquake occurs, persons are often exposed to flying or falling debris. In such circumstances, it is of utmost importance to protect one's head. Because of this, some governmental bodies recommend that persons who are in danger of being affected by such a disaster wear helmets to prevent head injury. While it is a good idea to wear a helmet in such
15 situations, there are no helmets on the market that are specifically designed for protecting the wearer's head from the debris that he or she may encounter in a disaster. As such, persons may have no better option than to wear a sports helmet, such as a football or cycling helmet, which is designed to protect the head in very different circumstances.

Even if a sports helmet can prevent or reduce head injury in a disaster, the wearer may still may be in danger. For example, if the wearer has sustained one or more life-threatening injuries and/or is buried under debris created by the disaster, there is a chance that the victim will not be located and treated in time to prevent
5 death or a permanent injury. While personal locator devices have been developed for special applications, such as mountain climbing, no such devices are available for disaster situations.

From the above discussion, it can be appreciated that it would be desirable to have means to both protect the head of a disaster victim and facilitate the victim's
10 location and treatment.

Brief Description of the Drawings

The present disclosure may be better understood with reference to the following figures. Matching reference numerals designate corresponding parts
15 throughout the figures, which are not necessarily drawn to scale.

Fig. 1 is a side view of an embodiment of a protective helmet as worn by a user (wearer).

Fig. 2 is a detail view of a syntactic foam material that can be used to construct an outer shell of the helmet shown in Fig. 1.

20 Fig. 3 is a block diagram of an embodiment of an electronic system that can be integrated into the helmet shown in Fig. 1.

Fig. 4 is a side view of an embodiment of a scent-release mechanism of the electronic system of Fig. 3.

Fig. 5 is a top view of a chinstrap that can be used with the helmet shown in
25 Fig. 1.

Detailed Description

As described above, it would be desirable to have means to both protect the head of a disaster victim and facilitate the victim's location and treatment. Described herein are protective helmets that are specifically designed for these purposes. In some embodiments, the helmets comprise an outer shell that is made of a syntactic foam material that is well suited for protecting the wearer's (user's) head from flying or falling debris. In some embodiments, the helmets further include an electronic location system that is configured to transmit one or more electromagnetic signals that can be used to locate the victim. In some embodiments, the helmets further include one or more sensors that monitor body parameters of the victim (e.g., vital signs) and/or the severity of impacts to the helmet. In some embodiments, the helmets further include a scent-based location system that emits an odor "signal" that can be detected by search dogs and, in some cases, humans.

In the following disclosure, various specific embodiments are described. It is to be understood that those embodiments are example implementations of the disclosed inventions and that alternative embodiments are possible. All such embodiments are intended to fall within the scope of this disclosure.

Fig. 1 illustrates an embodiment of a protective helmet 10 that is specifically configured for use in situations in which a disaster may be imminent. Such a disaster can be, for example, a hurricane, a typhoon, a tornado, an earthquake, a landslide, an avalanche, a flood, a tsunami, a severe rain or snow storm, a collapsing structure, or a terrorist attack. More generally, however, the disaster can be any situation in which there is potential for the wearer to receive a head injury and/or be placed in a position in which he or she is in need of rescue. As shown in Fig. 1, the helmet 10

comprises a rigid outer shell 12 that is designed to protect the wearer from impacts to the head, which may be the result of flying or falling debris. The shell 12 covers the top and sides of the wearer's head and, in some embodiments, includes an outwardly extending brim 14 that extends along the peripheral lower edge of the
5 shell.

The outer shell 12 can be made of one or more appropriate materials, such as thermoplastic polypropylene, polyethylene, polyamide, poly ethylene terephthalate, polyurethane, or polycarbonate. In some embodiments, the outer shell 12 is made out of a rigid, energy-absorbing foam material that is approximately 3 to 6 mm thick.

10 The foam material can be a syntactic foam material that comprises a plurality of microspheres (also referred to as cenospheres or microballoons) that are compounded with a thermoplastic resin. Such a construction is schematically depicted in Fig. 2, which shows a foam material 30 that comprises microspheres 32 compounded with a resin 34. As is apparent from Fig. 2, the microspheres 32 are
15 very small, hollow spherical elements having an interior void 36 that is enclosed by a thin outer shell 38. Because much of the volume of the microspheres 32 is void space (e.g., air), the foam material 30 is very lightweight. By way of example, the foam material 30 has a density of approximately 0.3 to 0.9 g/cc, and the microspheres 32 comprise approximately 30% to 35% of the foam material by
20 volume percentage. In some embodiments, the microspheres 32 have a nominal outer diameter of approximately 0.1 mm to 1.0 mm and the shells 38 can have a thickness of approximately 20 μ m to 200 μ m. The microsphere shells 38 can be made of substantially any material that can be formed (e.g., blown) into very small hollow spheres. By way of example, the microspheres shells 38 can be made of a
25 polymeric, ceramic, glass, or metal material.

The resin 34 can comprise a polymeric resin. In some embodiments, the resin is a thermoplastic resin comprising one or more of polypropylene, polyethylene, polyamide, poly ethylene terephthalate, polyurethane, or polycarbonate.

With reference back to Fig. 1, the helmet 10 further comprises an inner liner
5 that can include one or more compressible pads or webbing 16 that cushion the wearer's head for fit, comfort, and impact absorption. In some embodiments, the pads 16 can be made of one or more of syntactic foam, polystyrene beaded foam, lightly cross-linked ethylene vinyl acetate, expanded polypropylene, or polyethylene.

As is further shown in Fig. 1, the helmet 10 can also include an electronics
10 module 18 that, as described below, can include several components of an electronic system that assists search and rescue personnel in locating the wearer and, in some embodiments, assessing the wearer's physical condition. As indicated in the figure, the electronics module 18 can be attached to the outer shell 12 at the rear of the helmet 10 near the brim 14. It is noted, however, that this module 18 can
15 be placed anywhere on or in the helmet 10 where it is protected and does not interfere with the fit of the helmet on the wearer's head. The electronic system can also include a body parameter sensor 20 that can be, as shown in Fig. 1, positioned on a pad 16 at the front of the helmet 10 so as to be in a position to make direct contact with the wearer's forehead. As described below, the sensor 20 can collect
20 data relevant to the wearer's health, such as one or more of the wearer's vital signs.

With further reference to Fig. 1, the helmet 10 also includes a chin strap 22 that extends downward from the shell 12 and can be used to secure the helmet to the head. As described below in relation to Fig. 5, the chin strap 22 can, in some embodiments, include further electronics.

Fig. 3 is a block diagram of an electronic system 40 that can be integrated into the helmet 10 to assist search and rescue personnel in locating the wearer and assessing the wearer's physical condition. This system 40 can be, for instance, comprised of the electronics module 18 and the body parameter sensor 20 identified in Fig. 1.

As illustrated in Fig. 3, the electronic system 40 comprises a microcontroller 42 that is in communication with the other components of the system. In some embodiments, the microcontroller 42 comprises an advanced embedded processor with at least a 20 MHz clock rate. Generally speaking, the microcontroller 42 receives data from sensors of the system 40 and, based upon this data, determines what actions should be taken, if any. Examples of data that is received include impact data that identifies the severity of a head impact the wearer sustained, as well as data concerning the physical health of the wearer, such as one or more vital signs. Examples of actions that can be taken include transmitting a global distress signal that will aid search and rescue personnel in identifying the approximate geospatial location of the wearer, transmitting a local homing signal that will aid search and rescue personnel in pinpointing the wearer's location within the identified geospatial location, releasing a scent that will likewise aid search and rescue personnel in pinpointing the wearer's location within the identified geospatial location, illuminating one or more lights of the helmet 10 to signal to medical personnel the severity of an impact to the head that was sustained, and recording data about the impact or the wearer's physical health.

In the illustrated embodiment, the other components of the electronic system 40 include a body parameter sensor 44, an impact sensor 46, a scent-release

mechanism 48, a power source 50, non-volatile memory 52, one or more indicator lights 54, and an electronic location system 56, each of which is described below.

The body parameter sensor 44 is configured to measure one or more parameters that pertain to the body's basic functioning and therefore, are particularly relevant in triage situations in which multiple individuals may be injured. Example parameters include the wearer's vital signs, such as body temperature, blood pressure, and heart rate. In some embodiments, the body parameter sensor 44 comprises a pulse oximeter that is applied to the wearer's forehead and is capable of measuring each of those parameters. In other embodiments, the body parameter sensor 44 can comprise individual sensors that separately measure each of the body parameters.

The impact sensor 46 is configured to measure impacts to the helmet 10 for the purpose of helping medical personnel gauge the potential severity of head injury that the wearer may have sustained. In some embodiments, the impact sensor 46 comprises an inertial measurement unit (IMU) that comprises both an accelerometer and a gyroscope. By way of example, the accelerometer can comprise a triaxial accelerometer that measures linear acceleration in three different linear directions and the gyroscope can comprise a triaxial gyroscope that measures angular velocity in three different angular directions.

The scent-release mechanism 48 is part of a scent-based location system and is adapted to release a unique scent when deemed appropriate by the microcontroller 42. This scent can then be detected by search and rescue dogs, and possibly humans, and therefore can be used to pinpoint the location of the wearer, who could be trapped under rubble or other debris. Situations in which the microcontroller 42 may activate the scent-release mechanism 48 include those in

which the microcontroller detects an impact to the helmet that exceeds a particular threshold (as determined from data collected by the impact sensor 46) at a time when the helmet was being worn on the wearer's head (as determined from data collected by the body parameter sensor 44), as well as those in which the wearer's
5 body parameters (as determined from data collected by the body parameter sensor 44) are indicative of significant injury and, therefore, risk of death. In some embodiments, the scent-release mechanism 48 can additionally or alternatively be manually activated by the wearer when desired by, for example, pressing a scent release button (not shown).

10 Fig. 4 illustrates an example configuration for the scent-release mechanism 48. As shown in this figure, the mechanism 48 include an outer housing or frame 70 that supports a scent capsule 72 and a piercing mechanism 74. The scent capsule 72 contains a fluid having a unique odor that is relatively easy to detect. In some embodiments, the fluid comprises a sulfoxide, such as dimethyl sulfoxide (DMSO),
15 which has a strong garlic-like odor. The piercing mechanism 74 comprises a sharp-tipped piercing element 76 that is adapted to pierce the scent capsule 72 to release its contents. In some embodiments, the piercing element 76 can be electromagnetically actuated to extend and pierce the scent capsule 72.

With reference back to Fig. 3, the power source 50 supplies power to the
20 microcontroller 42 and the other electronic components of the electronic system 40. In some embodiments, the power source 50 comprises one or more batteries, which can be conventional non-rechargeable batteries, such as alkaline batteries, or rechargeable batteries, such as a nickel-metal hydride (NiMH) batteries. In the latter case, the helmet 10 further comprises means (not shown) for connecting the power
25 source 50 to an appropriate external power source, such as a wall outlet.

The non-volatile memory 52 enables storage of information that may be relevant to search and rescue or medical personnel. This information can include, for example, personal information about the wearer, such as name, age, etc., as well as medical information, such as medical conditions, allergies, etc., which may be relevant to someone who is going to treat the wearer for his or her injuries. In addition, the memory 52 can be used to store other information, such as the data measured by the body parameter sensor 44 or the impact sensor 46.

The one or more indicator lights 54 can be integrated into the exterior of the outer shell 12 and can be used to convey to search and rescue and medical personnel information that is relevant to assessing the severity of a head injury. In some embodiments, multiple lights 54, such as light-emitting diodes (LEDs) can be used to provide an indication of the severity of the impact that the helmet sustained. For example, each light 54 can be associated with a particular impact threshold and can be illuminated by the microcontroller 42 when that threshold has been reached. In such a case, a single illuminated light 54 may indicate a low threshold impact was sustained, two illuminated lights may indicate a medium threshold impact was sustained, and three illuminated lights may indicate a high threshold impact was sustained. The severity of the impact can be correlated with the likely severity of a head injury that the wearer may have sustained because of the impact. Such information enables medical personnel to quickly assess the wearer's need for medical assistance due to a head injury, which is useful for triage purposes. Although indicator "lights" have been discussed, it is noted that any other appropriate indicator can be used to convey the impact information.

With continued reference to Fig. 2, the electronic location system 56 is used to transmit electromagnetic signals to search and rescue personnel. As with the

scent-release mechanism 48, the electronic location system 56 can be activated in situations in which the microcontroller 42 detects a hard impact to the helmet at a time when the helmet is on the wearer's head, as well as those in which the wearer's body parameters are indicative of significant injury. In some embodiments, the
5 electronic location system 56 can additionally or alternatively be manually activated by the wearer by, for example, pressing an activation button (not shown).

In the illustrated embodiment, the electronic location system 56 includes a satellite beacon 58, a homing beacon 60, and a global positioning system (GPS) receiver 62. The satellite beacon 58 is a radio frequency (RF) transmitter that is
10 configured to transmit an RF distress signal to one or more satellites, such as the satellites of the Cospas-Sarsat satellite system. By way of example, the distress signal comprises 0.5 second, 406 MHz pulses that are transmitted once every 50 seconds. Once received by the satellite(s), the distress signal can be forwarded to the relevant search and rescue personnel, who can be dispatched to locate and
15 assist the wearer. In cases such as that illustrated in Fig. 3 in which the electronic location system 56 includes a GPS receiver 62, the GPS coordinates of the helmet 10 can be included in the distress signal. This enables the search and rescue personnel to identify the geospatial location of the wearer with good accuracy. In cases in which no GPS receiver is provided, however, the geospatial location of the
20 wearer can be approximated through satellite triangulation.

While the satellite beacon 58 is intended to identify the geospatial location of the wearer to a centralized rescue organization such as Cospas-Sarsat, the homing beacon 60 is intended to identify the precise location of the wearer to local search and rescue personnel who are within the identified geospatial location. In some
25 embodiments, the homing beacon 60 is a further RF transmitter that is configured to

transmit a low-frequency RF homing signal that can be detected by handheld receivers carried by search and rescue personnel within the vicinity of the wearer. In some embodiments, the homing signal comprises a 0.5 second, 87 kHz pulse that is transmitted every 30 seconds and that can be detected by a handheld receiver from
5 a distance of up to approximately 100 yards. In some embodiments, the homing signal can be modulated to carry information about the wearer, such as the data collected by the body parameter sensor 44 and/or the impact sensor 46. In other embodiments, the homing beacon 60 can be an electromagnetic device that generates magnetic wave signals that more easily pass through obstructions, such
10 as rubble and other debris. Like the RF homing signal, the magnetic wave signal can be detected using an appropriate handheld receiver and can be modulated to carry information about the wearer.

It is noted that the helmet 10 can include further electronics, if desired. For example, the helmet 10 can include an alternative chinstrap that incorporates such
15 electronics. Fig. 5 shows an example of such a chinstrap 80. As illustrated in this figure, the chinstrap 80 includes multiple flexible lateral straps 82 that include fasteners 84 that can be used to secure the chinstrap 80 to the outer shell 12 of the helmet 10. Attached to one or more of these straps 82 are force sensors 86 that can measure tension in the strap and, therefore, can provide an indication as to whether
20 the helmet 10 is being worn or not.

The illustrated chinstrap 80 further includes flexible central straps 88 with which the chinstrap 80 can be fastened below the jaw. A buckle 90 is provided to attach the central straps 88 together and includes a sensor 92 that can detect when the chinstrap 80 is fastened or not. Also attached to one of the central straps 88 is a
25 microphone 94 that can be used by the wearer to communicate with search and

rescue personnel. In alternative embodiments, the microphone 94 can be mounted to the helmet shell 12. In some embodiments, the chinstrap 80 or helmet shell 12 can also be provided with a speaker (not shown) to enable two-way communications. In further embodiments, one or more of the body parameters described above as
5 being captured by the body parameter sensor 20 can be captured by one or more sensors incorporated into the chinstrap 80.

CLAIMS

Claimed are:

1. A protective helmet for disaster situations, the helmet comprising:
a rigid outer shell; and
an electronic system integrated into the helmet that includes an electronic location system configured to transmit electromagnetic signals that can be used to locate the wearer of the helmet.
2. The helmet of claim 1, wherein the outer shell is made of a syntactic foam material that comprises a plurality of microspheres that are compounded with a thermoplastic resin.
3. The helmet of claim 2, wherein the microspheres are hollow spherical elements having an interior void that is enclosed by a thin outer shell.
4. The helmet of claim 3, wherein the thermoplastic comprises one or more of polypropylene, polyethylene, polyamide, poly ethylene terephthalate, polyurethane, or polycarbonate.
5. The helmet of claim 1, wherein the electronic location system comprises a satellite beacon configured to transmit a radio frequency distress signal to one or more satellites.
6. The helmet of claim 5, wherein the electronic location system further comprises a global positioning system receiver configured to determine a geospatial

location of the wearer and wherein the distress signal includes an indication of that location.

7. The helmet of claim 5, wherein the electronic location system further comprises a homing beacon configured to transmit a homing signal that can be detected by handheld receivers carried by search and rescue personnel within the vicinity of the wearer.

8. The helmet of claim 7, wherein the homing signal includes data about the wearer.

9. The helmet of claim 7, wherein the homing signal is a radio frequency signal.

10. The helmet of claim 7, wherein the homing signal is a magnetic signal.

11. The helmet of claim 1, further comprising a body parameter sensor configured to measure at least one body parameter of the wearer that is indicative of the wearer's health.

12. The helmet of claim 11, wherein the at least one body parameter includes body temperature, blood pressure, and heart rate.

13. The helmet of claim 11, wherein the body parameter sensor comprises a pulse oximeter.

14. The helmet of claim 1, further comprising an impact sensor configured to measure data indicative of the severity of an impact to the helmet.

15. The helmet of claim 14, wherein the impact sensor comprises an inertial measurement unit.

16. The helmet of claim 14, further comprising an indicator light that provides an indication as to the severity of the impact.

17. The helmet of claim 1, further comprising a scent-based location system configured to release an odor that can be used to locate the wearer.

18. The helmet of claim 1, further comprising non-volatile memory that stores information about the wearer.

19. A protective helmet for disaster situations, the helmet comprising:
a rigid outer shell made of a syntactic foam material; and
an electronic system integrated into the helmet that includes:

a body parameter sensor configured to measure at least one body parameter of the wearer that is indicative of the wearer's health,

an impact sensor configured to measure data indicative of the severity of an impact to the helmet,

an electronic location system configured to transmit electromagnetic signals that can be used to locate the wearer of the helmet, the signals including a radio frequency distress signal that can

be received by one or more satellites and a homing signal that can be detected by handheld receivers within the vicinity of the wearer, and

a microcontroller configured to collect data from the body parameter and impact sensors and, when justified by the collected data, automatically activate the electronic location system.

20. The helmet of claim 19, further comprising a scent-based location system configured to release an odor that can be used to locate the wearer, wherein the microcontroller also automatically activates the scent-based location system when justified by the collected data.

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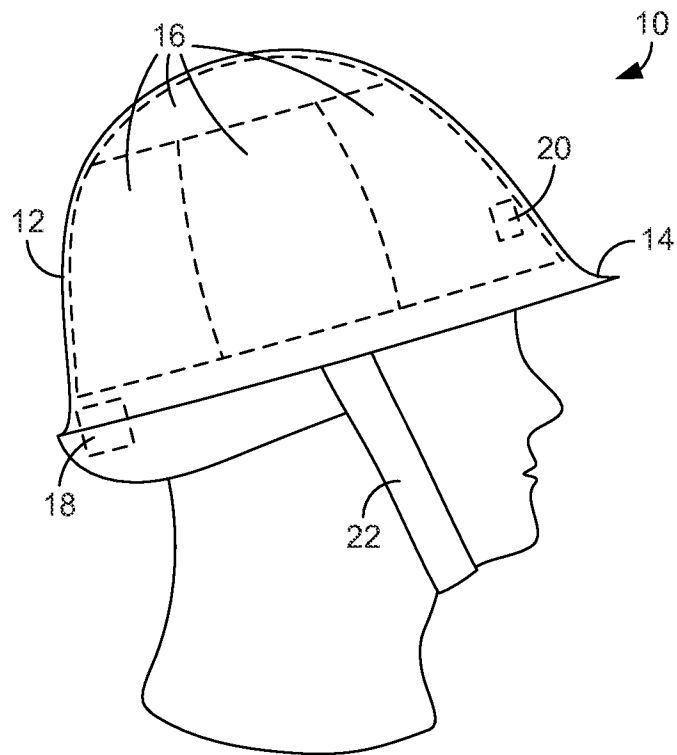


FIG. 1

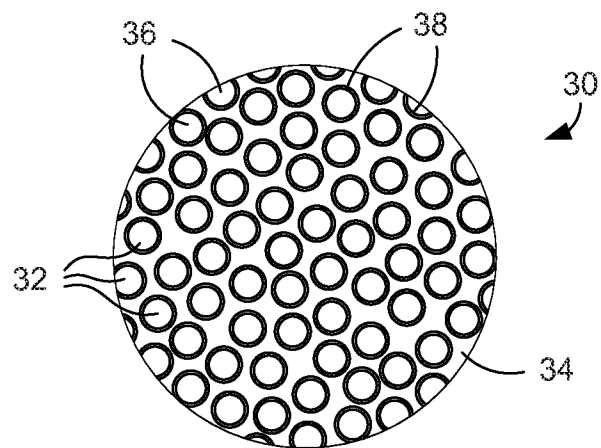
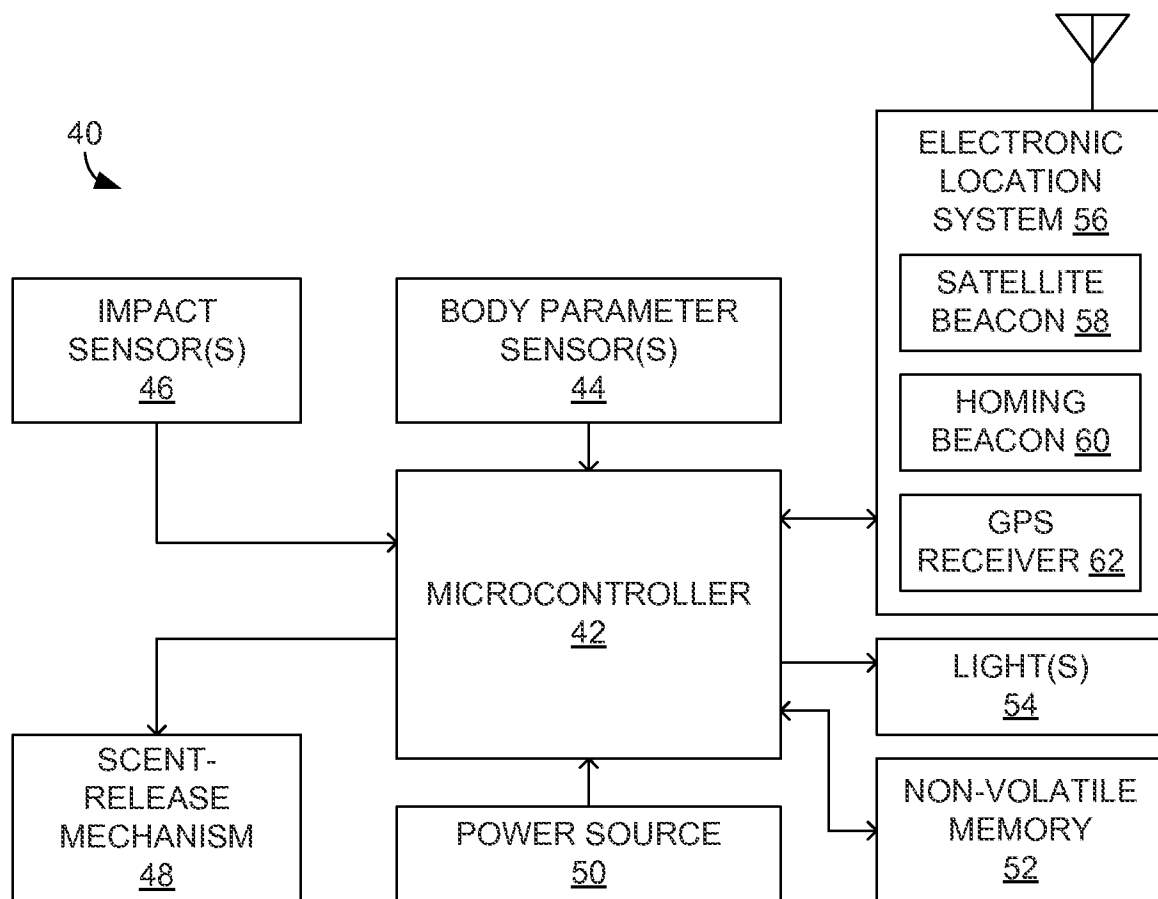
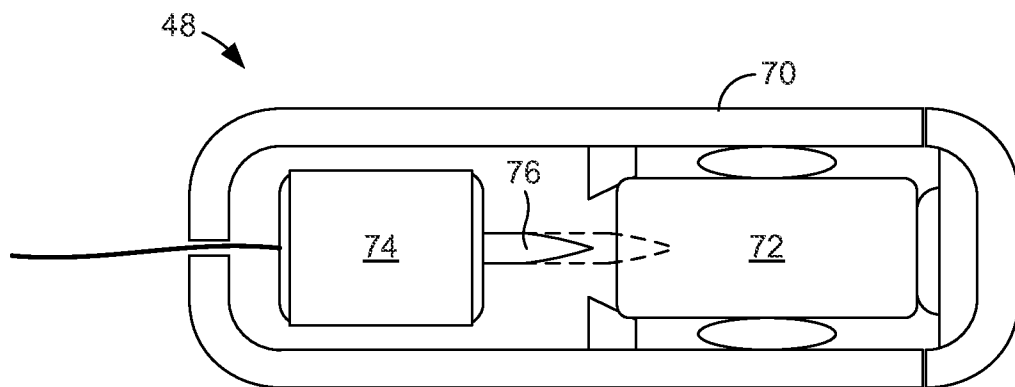


FIG. 2

**FIG. 3****FIG. 4**

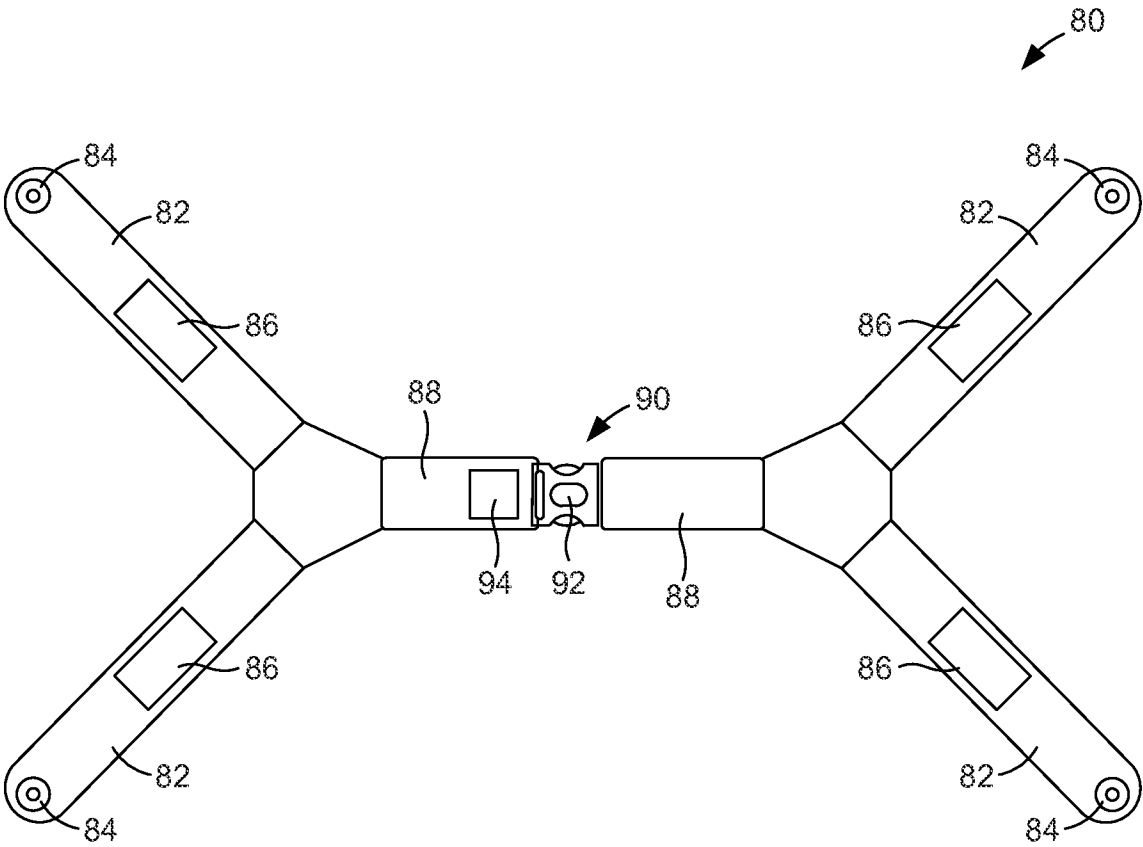


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2015/024240

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A42B 3/30 (2015.01)

CPC - A42B 3/30 (2015.04)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - A42B 3/00, 3/04, 3/30; G01B 7/00; G01S 1/02, 5/02; G01V 3/08; G06F 3/011, 3/012; G08B 21/02 (2015.01)

USPC - 2/5, 6.1, 410, 455; 345/8

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

CPC - A42B 3/00, 3/04, 3/30; G01B 7/00; G01S 1/02, 5/02; G01V 3/08; G06F 3/011, 3/012; G08B 21/02 (2015.04) (keyword delimited)

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

Orbit, Google Patents, Google Scholar, Google.

Search terms used: helmet, disaster, shell, electronic, electromagnetic signal, locate, microspheres, thermoplastic, GPS, global positioning signal, homing signal, synthetic foam

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/0198603 A1 (GERTSCH et al) 09 August 2012 (09.08.2012) entire document	1,18
Y		2-17
Y	WO 2014/031169 A1 (VAIDYA et al) 27 February 2014 (27.02.2014) entire document	2-4,19,20
Y	US 2008/0256687 A1 (SPENCER) 23 October 2008 (23.10.2008) entire document	5-10,14-16,19,20
Y	US 6,121,881 A (BIEBACK et al) 19 September 2000 (19.09.2000) entire document	7-13,16,19,20
Y	US 2005/0266967 A1 (CONSIDINE et al) 01 December 2005 (01.12.2005) entire document	15
Y	US 2010/0243756 A1 (AUERBACH et al) 30 September 2010 (30.09.2010) entire document	17,20

☐ Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

08 June 2015

Date of mailing of the international search report

29 JUN 2015

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PCT OSP: 571-272-7774