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(54) Title: ELECTRONIC SAFETY BELT AT HIGH ALTITUDES TO PREVENT INJURY AND SHOCK

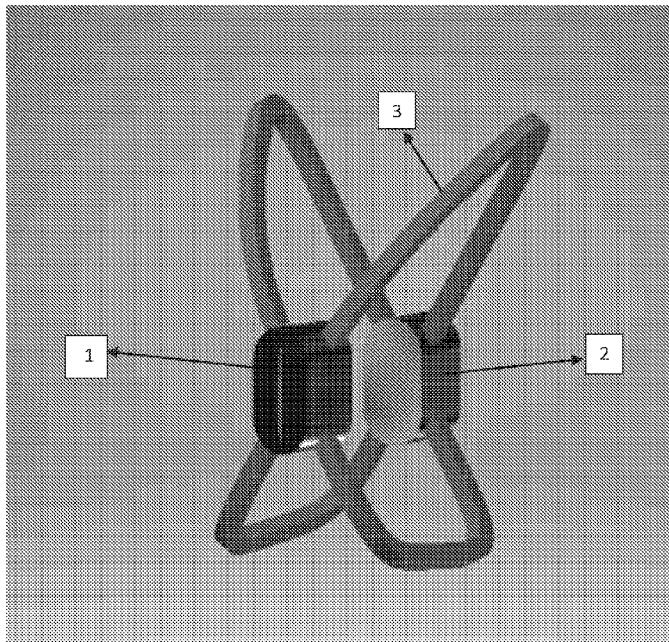


Figure 1-2

(57) Abstract: This invention is a type of shoulder strap and belt that recognizes the speed, acceleration, direction of rotation and movement of the body when falling and by blowing a damper protector out of the nitrogen gas from an explosive reaction, it avoids impact and injury before a person hits the ground. It also alerts with an ultrasonic distance sensor when the user is on the edge of the precipice. This belt can be used on a variety of clothing and for people of different sizes. It is also waterproof and the electronic board and its elements are transformed from solar cells.



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1- Title:

Electronic safety belt at high altitudes to prevent injury and shock

2- Technical and analytical field of invention:

Mechanics and Electronics- Safety equipment and work at altitudes

In the construction sector as well as in the workshop environment to protect workers from falling

3- Background and summary of invention

Summary: This invention is a type of shoulder strap and belt that recognizes the speed, acceleration, direction of rotation and movement of the body when falling and by blowing a damper protector out of the nitrogen gas from an explosive reaction, it avoids impact and injury before a person hits the ground. It also alerts with an ultrasonic distance sensor when the user is on the edge of the precipice. This belt can be used on a variety of clothing and for people of different sizes. It is also waterproof and the electronic board and its elements are transformed from solar cells.

Background: Due to the conducted studies in the area of deaths and injuries caused by falls from heights and the existing equipment, the findings are as follow which do not resemble our invention

3.1 Harns (safety harness) or the safety belt in case of falling down (patent number:

US08657166 and US4508045) is one of the examples which cannot fully guarantee the user's safety. In the situation of non-standardization it may disturb the workers during work or induce false confidence in the user. Also the excessive adjusting buckles and metal fittings will make the harness heavier and being stuck to the surrounding structures and installations as well as increasing the risk of electric shock

3.2 Lanyards or elastic ropes are for climbing the heights, and the use of Lanyards without protector will increase the damage rate of the rope and there is no guarantee of preventing the user from falling. These are used along with a helmet to prevent damage to the user which in none of the above items is no guarantee to prevent fall from altitudes and the resulting fatalities and deaths. The only similar case that is not registered yet is a parachute which in an emergency, one can wear it right on the back side and after sitting on the edge sliding down from the back of the body by pulling a lever. This device is very heavy and expensive and it cannot protect the person from sudden collapse, because the method of use is voluntary and does not guarantee that someone will be thrown out in an emergency. Whereas our invention is completely intelligent, economic and automatic which can significantly save lives.

Also in the section of inflation of protective part of this invention, the following items have some similarities:

- ✓ An invention called Hip' Air, the pelvis area of the person who wears, will be protected from the damage caused by falling. This product protects the hips bone only at low

altitude and low speed while, our invention can be used for high altitude and is totally smart and it can protect the whole upper body by only one protector.

- ✓ A vest which is called Dainese that this vest is an airbag which is shaped like a suit. The user wears it underneath or on his cloths and if he crashes or falls and the vest detects a fall, I will be inflated quickly and become an airbag to protect the body from damage. As it is obvious from the definition, this product is a kind of clothing whereas our invention is a type of belt and shoulders strap which does not restrict the user. Not only our product protects the upper body but also prevents the body from colliding with the ground in all parts.
- ✓ The design of the bike and motorcycle airbag is shaped like a hat that this hat is the airbag cap called Hövding which is equipped some sensors that by detecting the smallest danger will be activated and powerful airbag opens and covers the cyclist's brain, head and neck area. As the above product, this device has some limitations and only protects the head area. While our invention protects all parts of the body which is designed to work at heights and it is also equipped with an alarm system.
- ✓ A protector for mobile phone which is called the phone's airbag. This phone protector has a function as a car airbag and when the danger happens, the guards will be activated to protect the phone against impact. As it is said, this device is designed for the phone and does not have to do with the person's body. Mechanically, it opens like a rake which is totally different with inflating rapidly caused by electric explosion.

4- Description

This invented element is a sort of smart belt made of elastic fabric extending from the upper part of the shoulder to the lower back of the spin and from the from to the shoulder to the lower rib. In the center part of this belt, there is a small chamber in both the front and the back encompassing an accelerometer sensor, a number of gyroscope sensors, several solar cells and an explosive electric detonator with a trapezoidal protective bag which is very compact. In case of sudden redirection of the person with acceleration and speed beyond the range specified for the device, it detects the falling by a microcontroller and by quickly inflating the damper-like protector it prevents the user from being hit.

The calculations performed on this machine are conducted using the free fall equations and we know that the acceleration of the free fall is a bit different in any part of the world and this difference does not exceed 3.5%. In experiments where very precise measurements are not considered, this difference is ignored. On average the value of g can be assumed to be 0.8 (the acceleration of free fall in different points varies from 9.787 to 9.808). By measuring the velocity of the object at different times it is known that, its speed increases by 9.8 meters per second. In other words, we conclude that in free fall, the constant acceleration is 9.8 m/s^2 .

The operation of this device is very smart so that it can discriminate when the user bends from falling down and just in case of a sense of acceleration and speed with a sudden shift in direction, the guard will quickly inflate using explosion of electric detonator and the use of nitrogen gas from a chemical reaction between similar gases found in the car's airbag (potassium nitrate, sodium azide and silicon dioxide). The method of operation of this invention is in such a way that the acceleration and velocity of the movement of user body is

assumed to be an initial constant value by a microcontroller and this value is measured continuously by the accelerometer sensor. The gyroscope sensor also measures angular acceleration or sudden shift in direction around different axes and if this value changes abruptly, the result of this calculations results in the crash of the user (forward or backward). It should be noted that all of these calculations are will be done in a fraction of a second. Immediately after that the microcontroller detonates the electric detonator, the guard will be inflated rapidly by nitrogen gas and will be thrown out of the slot inside the chamber (these steps take about 0.04 seconds) preventing a person from being hit and seriously injured the moment the person hits the ground or any other surfaces. Inside this electric detonator like a car's airbag, reaction of potassium nitrate, sodium azide and silicon dioxide occurs which leads to nitrogen production. For activating the detonator with low voltage (5 volts), because the detonator needs more current, we use a small capacitor (about 3 microfarads) which is always in charge. This capacitor is behind an electronic switch (transistor) which transmit the electric current to the detonator and the explosion takes place. These steps include measuring the speed and acceleration of the person's movement and opening the bodyguard both in front and behind the user's body. Since the accelerometer sensor and the gyroscope can detect the person's angular rotation and movement, depending on the direction and amount of rotation, it detects falling from forward or backward and the body protector will be opened on that side to prevent the damage to one's body. In addition, an ultrasonic distance sensor is used which is located in the back of the belt and it starts to warn the user by an audio siren if the person is on the edge of the building and his falling is possible. The device is powered by a 5v lithium battery which is being charged continuously by a number of solar cells mounted on the front and back of the belt. This section also uses an electrical module that stores the current produced by the solar cell inside the lithium battery, actually it receives 5 volts from the solar cell and converts it to 3.7 volts and charges the battery. This belt is very light and can be used for the people of different sizes and on cloths of different thickness. All the electronic parts of this belt are waterproof and if it is used in place where it is possible to get wet (like for the use of mountain climbers), there will be no danger. After each use and belt protector opening, the gases inside can be discharged and it can be folded and placed in the belt's chamber.

5. Description of shapes

Figure 1.1: technical figure of the device

Physical and schematic figure of the device includes the following:

- 1) Principal box of device
- 2) Shoulder and fastening straps
- 3) Open figure of damper protector of the device

Figure 1.2:

- 1) The trunk front box includes foldable electrical and protective elements
- 2) The trunk back box includes foldable electrical and protective elements
- 3) shoulder straps and straps connecting the boxes to the upper body area

Figure 1.3:

1) The groove of the outside of the box which automatically shuts off the protector after detecting a fall

Figure 1.4:

physical and schematic figure of the device after opening which includes:

- 1) Principal box of device
- 2) Open figure of damper protector of the device

Figure 2.1: electronic circuit of the device, including:

- 1) Microcontroller
- 2) Electric detonator
- 3) Accelerometer sensor
- 4) Distance sensor to detect the position of edge of cliff
- 5) Solar cells
- 6) Gyroscope sensor
- 7) Audio alert module
- 8) Lithium battery powered device

6- Advantages and innovations of the invention

- 6.1 This device uses a very elastic and waterproof fabric for the upper belt straps on the front and back of the body which can be easily used by any persons with any size and on any cloths.
- 6.2 This is the first device to protect persons from falling from a height which has a protector which is filled by nitrogen gas in a fraction of a second using the reaction between potassium nitrate, sodium azide and silicon dioxide protecting the user from injuries caused by falling.
- 6.3 The material of the compact bag used as a shield is a type of polyethylene which is resistant to rupture and perforation and it has the strength and elasticity against impact.
- 6.4 Unique shape and structure of this trapezoidal protective bag maintaining the balance and stability when falling so the user has the opportunity to pause and rise.
- 6.5 The sensors detect the rotation and movement of the person's body (front, rear and even slightly forward and backward) in result the falling and the guard (protector) opens in the same direction.
- 6.6 Solar batteries are used to supply power to the device which is cheap plus ensures user reliability from continuous charging and operation of the device.
- 6.7 The structure of the main belt compartment is such that the weight of the elements is divided and the user does not feel heavy.
- 6.8 After detecting the crash by microcontroller in less than a fraction of a second (about 0.04 seconds), the protective bag will be thrown out through chamber slot and filled with explosive gases.

6.9 The device utilizes an ultrasonic distance sensor that lies behind the person's body and warns by an audio siren if the person steps on the edge.

This invention is built to prevent serious injuries from falling and it can be used by construction workers, hikers, firefighters in multi-level buildings and anyone working at height. This device is so cheap and is one of the essential needed tools to work at height and jobs related to this field.

Claim 1: This invention is a type of intelligent electronic belt that is sensed by several sensors to perform specific calculations, speed, acceleration, direction and angle of rotation of the individual body and with a polyethylene shield, it fills the nitrogen gas after falling and before the user is hit by the ground (reaction of potassium nitrate, sodium azide and silicon dioxide) and prevents damage. It also detects a user's position on the edge of a precipice and alerts them with an alarm system, using an ultrasonic distance sensor.

Claim 2: According to claim 1, in which an LY510ALHTR gyroscope sensor is used to detect angular acceleration.

Claim 3: According to claim 1, wherein an MMA7361L triaxial accelerometer sensor is used to measure acceleration.

Claim 4: According to claim 1, wherein an instantaneous explosive electric detonator is used to create the explosion of nitrogen gas.

Claim 5: According to claim 1, wherein a 3 microfacad capacitor is used to supply the electric condensing current.

Claim 6: According to claim 1, wherein a 5V lithium battery is used to power the device.

Claim 7: According to claim 1, in which solar cells are used to charge a lithium battery.

Claim 8: Accordance with claim 1 ,wherein an interface module is used to convert solar cell electric current and battery charge.

Claim 9: According to claim 1, an ATMEGA16 microcontroller is used to control the electrical elements.

Claim 10: According to claim 1, wherein an ultrasonic distance sensor is used.

Claim 11: The method of claim 1, wherein the wind-shielding device is made of polyethylene.

Claim 12: According to claim 1, wherein an audio alert is used.

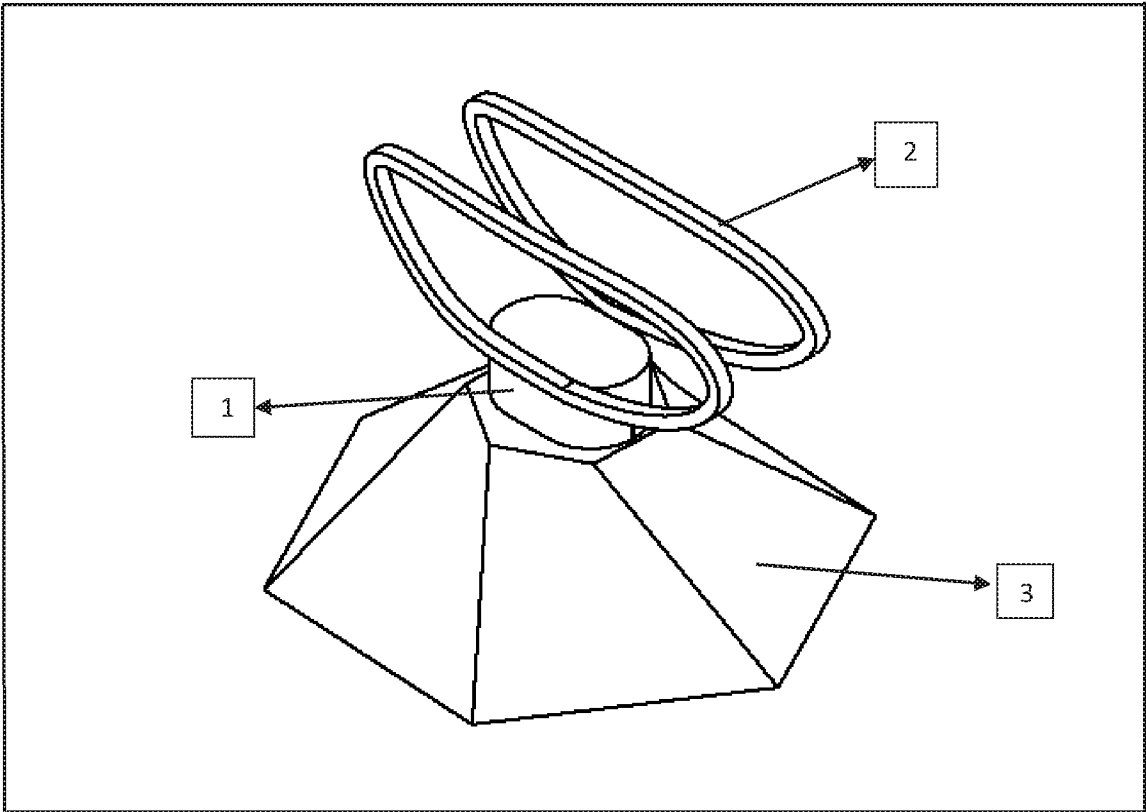


Figure 1-1

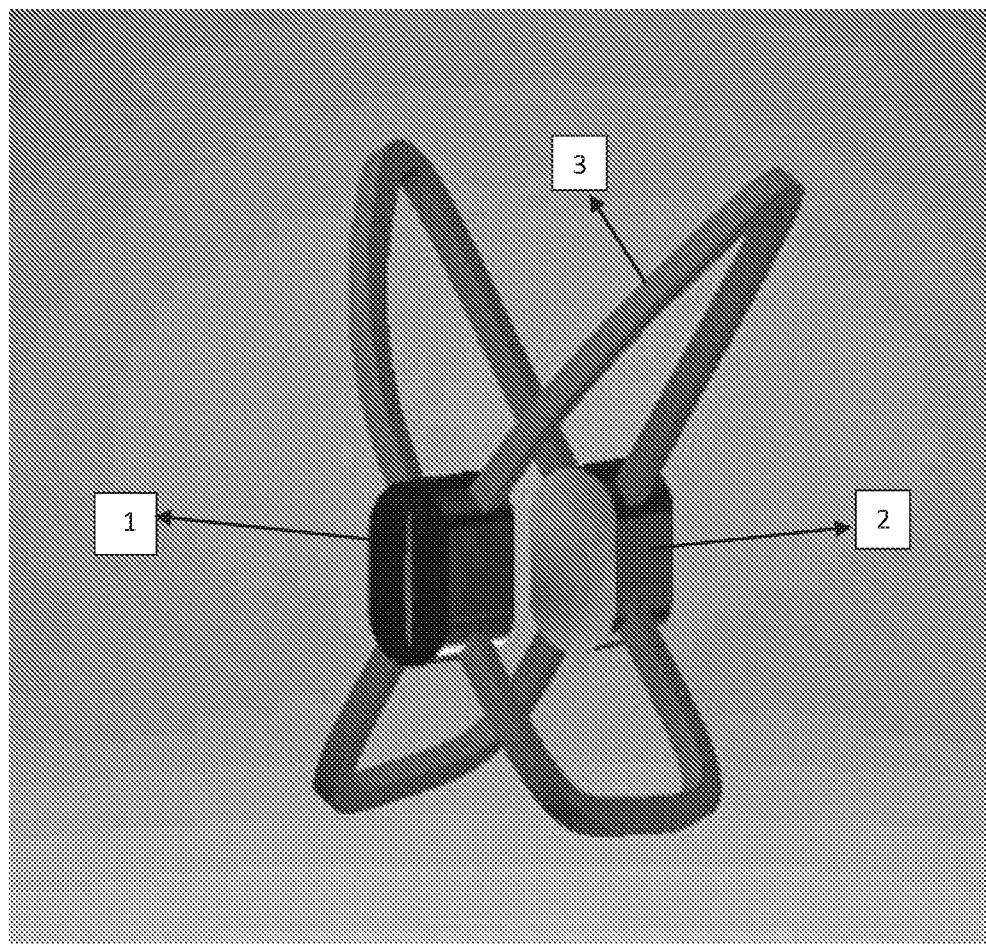


Figure 1-2

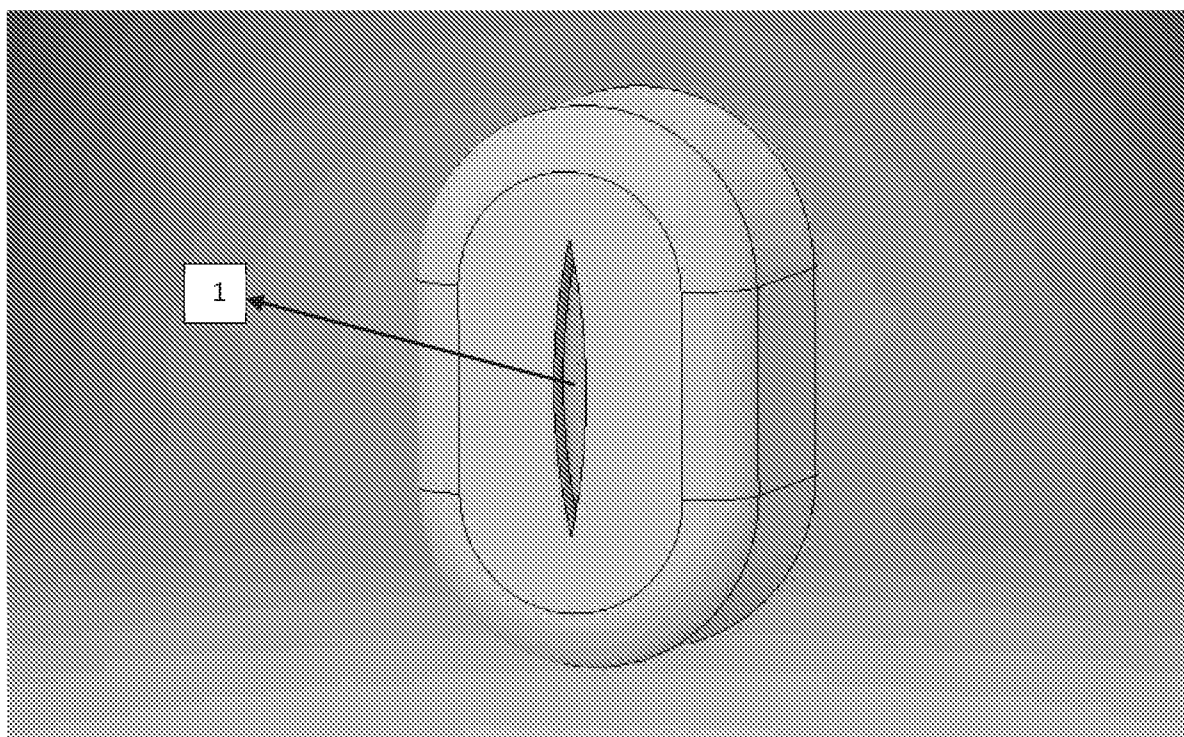


Figure 1-3

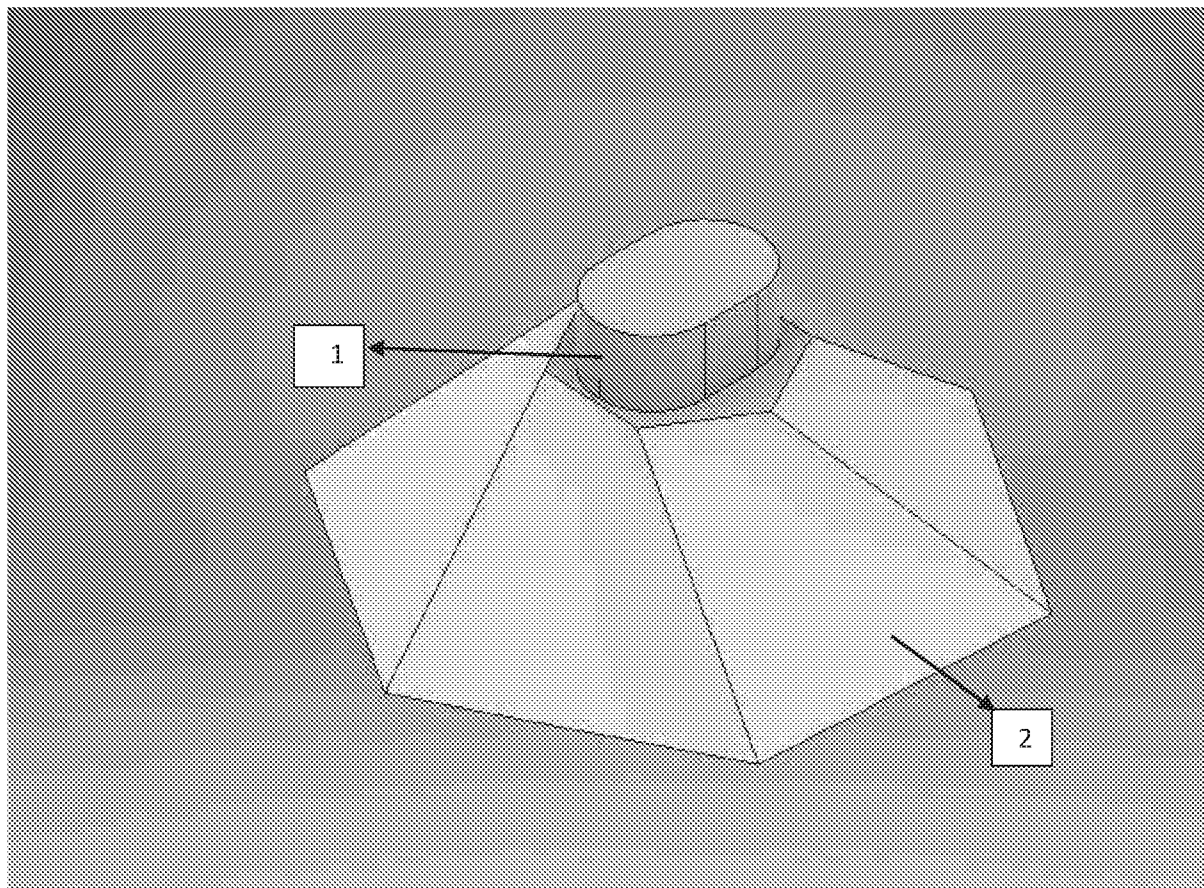


Figure 1-4

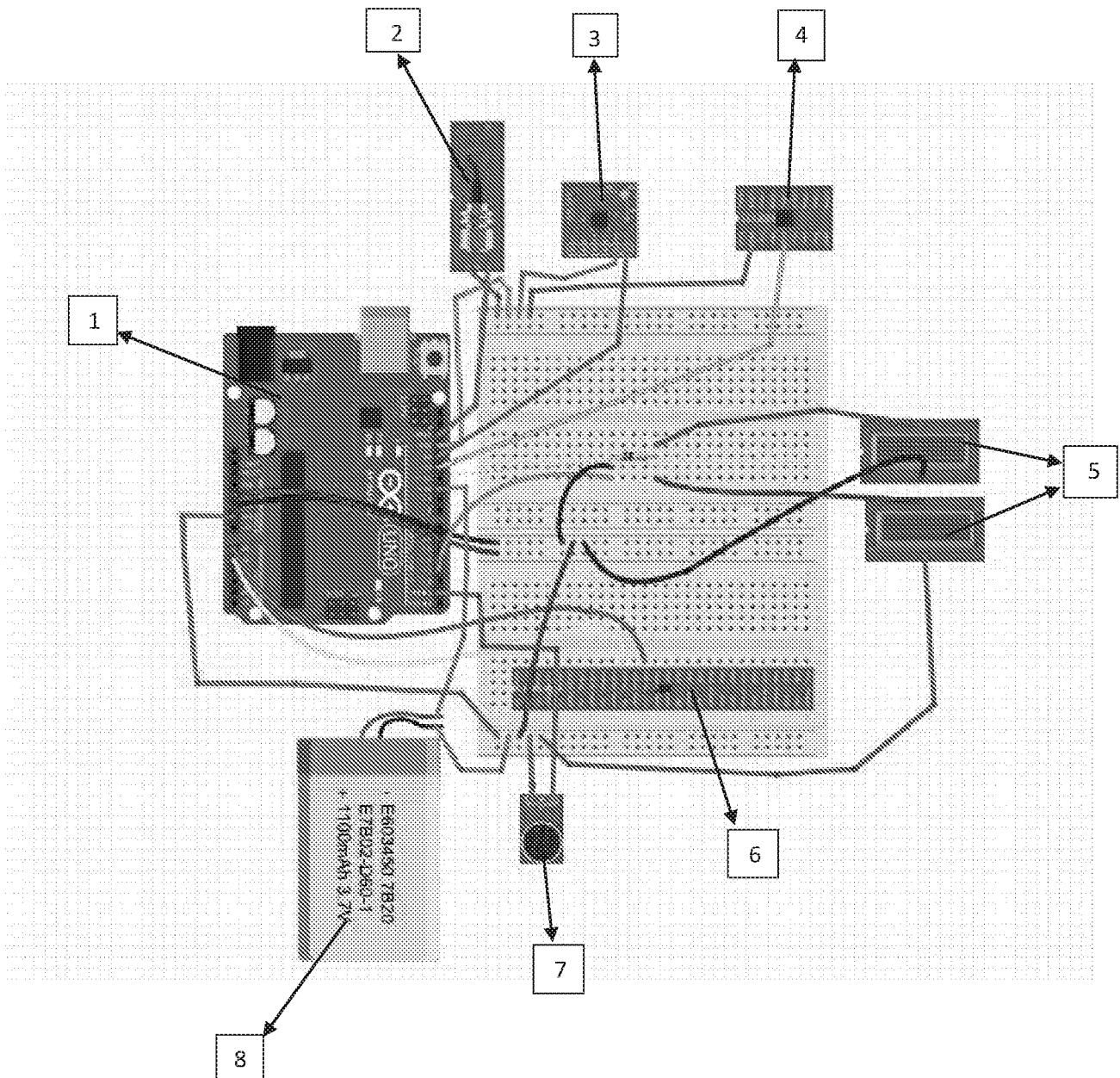


Figure 2-1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2020/051319

A. CLASSIFICATION OF SUBJECT MATTER
A41D13/018, G08B21/00 Version=2020.01

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)

A41D, G08B

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

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

Databases - TotalPatent One, IPO Internal Database.

Keywords Searched - airbag, sensor, fall detection, sensors, ultrasonic

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2017/0181485 A1 (XIN JIN), 29-06-2017 (29 June, 2017). Whole Document.	1-12
Y	US 2005/0067816A1 (ACTIVE PROTECTIVE TECHNOLOGIES INC), 31-03-2005 (31 March, 2005). Whole Document.	1-12
Y	EGBENIMI BEREDUGO ESKCA, KELVIN ESKCA "Enhancing the Human Robot Interface: The White Stick with Obstacle Avoidance and Depth Sensing", International Journal of Scientific & Engineering Research Volume 10, Issue 11, November-2019, 30-11-2019 (30 November, 2019) Pages 277-278.	1-12
A	Youtube video - SAFEWARE GLOBAL "Introducing Safeware Industrial Wearable Airbag", 13-03-2019 (13 March, 2019). Url--https://www.youtube.com/watch?v=1FY05M3gjLU. Whole Video	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search

01-07-2020

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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PCT/IB2020/051319

Citation	Pub.Date	Family	Pub.Date
US 2005067816 A1	31-03-2005	WO 2006009970 A3	15-06-2006