(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 October 2021 (28.10.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/214522 A1

(51) International Patent Classification:
A61F 5/058 (2006.01)

(21) International Application Number:
PCT/IB2020/053847

(22) International Filing Date:
23 April 2020 (23.04.2020)

(25) Filing Language: English

(26) Publication Language: English

(72) Inventors; and

(71) Applicants: **KHAN AHMADI, Nikoo** [IR/IR]; Montazeri St. - Sehri Square - 92 Alley, Esfahan, 8413775758 (IR). **ABBASI, Masoud** [IR/IR]; Unit 8, No. 10, Pourmanshadi Alley, phalsaphy Street, Ekbatan Town, Tehran, 1393865919 (IR).

(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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, 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, 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).

(54) **Title:** SMART VACUUM ELECTRONIC SPLINT WITH THE ABILITY TO COAGULATE AND CONTROL BLOOD SUPPLY

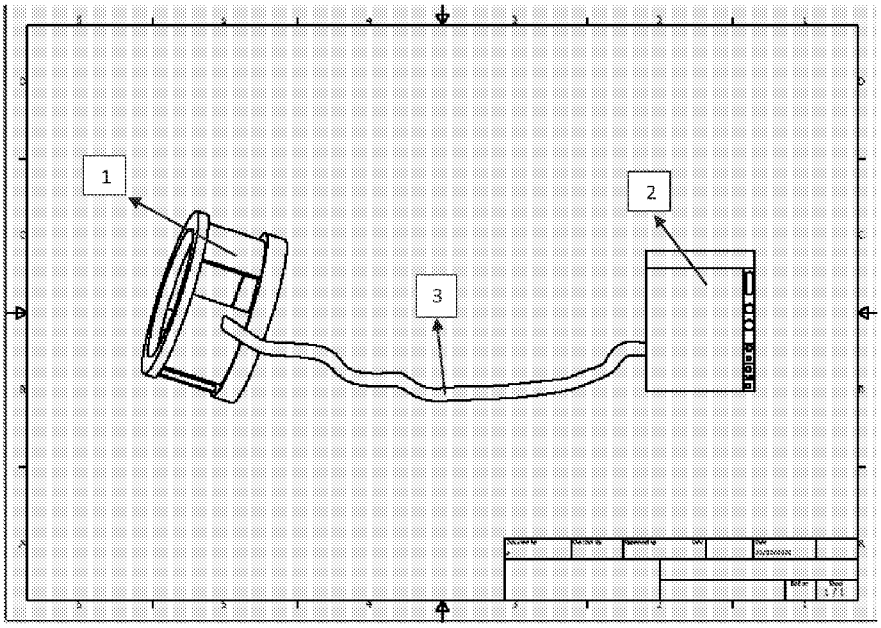

Figure 1-1

(57) **Abstract:** This device is an intelligent vacuum Splint that is used to fix broken and damaged bones in all areas of the skeletal body. It has several sensors for measuring air pressure inside the splint. Other sensors measure heart rate, blood pressure and detecting the bleeding process. The second process is after splinting on the limb and is discharged and retracted by an air pump. The advantage of this device is that, this splint fixes the affected limb in the same manner and It has the ability to coagulate faster in bleeding areas as well as displaying the 3D shape of the splint

WO 2021/214522 A1

[Continued on next page]

Published:

— *with international search report (Art. 21(3))*
— *with amended claims (Art. 19(1))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

1- Title:

SMART VACUUM ELECTRONIC SPLINT WITH THE ABILITY TO COAGULATE AND CONTROL BLOOD SUPPLY

2- **Technical and practical field:** Mechanics and Electronics / Biomedical Engineering/ Orthopedics

3- Background and Summary of Invention:

Project Summary: The device is a type of smart vacuum Splint used to fix broken and damaged bones in all areas of the skeletal body and has several sensors to measure the indoor air pressure, heart rate sensor, blood pressure sensor and also an infrared sensor for detecting post-splenectomy bleeding and with the help of an air pump, the wind blows and then discharges. The advantage of this device is that it has separate air cushions that come together and it fixes the affected limb in the same way, and has the ability to coagulate faster in bleeding areas and display the 3D shape of the splint on the embedded LED.

Background: According to my studies on fixation of the damaged limbs in the upper and lower limb bones, the following have some similarities with my invention, which include:

1) Splint with patent number GB2171603 which has only one thing in common with my invention is the wind pump and it's not smart like my invention and doesn't have blood pressure and heart rate monitoring options, and it is not capable of measuring the air pressure and forming the splint according to the shape of the limb and is applicable only to the lower body.

2) Splint with Patent Number US20120277644A1, which is a vacuum splint that attaches to injured limbs with ropes and it's not like my invention, and it doesn't have blood pressure, heart rate, blood pressure and 3D splint screens and for the upper and lower limbs there is a separate splint for each part, and it doesn't apply to all parts, like my invention.

3) This patent is a vacuum splint with Patent No. WO2004030573A3, that like the two patents above, it can only hold the affected limbs by inflating the splint and attaching it to the limbs and it's not smart like my invention.

4- **Description:** As is known, bones form the skeleton of the body, and the soft tissue is usually stick to bone structures. Any type of bone slit is called a fracture. In principle, fracture should be considered as a potentially serious injury as it affects not only the skeleton, but also its adjacent soft tissues such as vessels, nerves, tendons, ligaments, muscles and skin. A fracture may be the result of a direct blow such as a leg injury or the result of an indirect blow such as a fall caused by balance disturbance. One of the solutions to keep broken bones, is the use of splint. Splint is a flexible or rigid device used in emergency situations to stabilize fractured and dislocated limbs or in other words, a splint is a device in which the body is inserted to protect it and to block one or more joints. Splints help to relieve common fractures and dislocation associated with musculoskeletal trauma in a variety of ways.

The purpose of stabilizing musculoskeletal injuries is to :

1. Reduce the likelihood of any further injury during patient care.
2. Giving the right position to the injured limb.
3. Without moving the injured limb.
4. Splint usually relieves pain and minimizes the common complications of bone and joint injuries.

Splints are generally used to:

• To temporarily block the location of the fracture or dislocation of the limb. Temporarily from the site of the accident until the patient arrives at the first medical center or temporarily from the patient's arrival to the emergency room, until a definitive medical treatment is performed.

• For definitive treatment of bone fractures or torsions or dislocations.

• To immobilize bone or joint after surgery.

The splint should be high enough to move not only the fractured member but also the joints at the top and bottom of the fracture.

Therefore, one of the most important reasons for splinting, is to prevent breakage of critical bone tissue around the site of injury. Nerves - blood vessels, are very sensitive and with a slight impulse may increase the rupture and depth of the accident. When it is more sensitive to bone fractures in the spine, neck or head. That can be done by making a proper splint of the injured person's health or depriving the person of a lifetime of walking. Splint has different shapes and types. Frequently splinting and immobilizing a fractured member with bleeding, can stop the bleeding. This is because, after splinting and immobilizing the injured member, the sharp edges of the broken bones, are in place and no longer damage the blood vessels of the injured position.

Splint Types:

- ✓ **Hard splint** : Splints made of wood, aluminum, plastic wire or pressed wood fibers.
- ✓ **Soft splint** : This type of splint uses a pad or air pressure to immobilize the injured organ.
- ✓ Traction Splint : This type of splint is a framework that, stretches the injured limb. It is very useful to use stretching when the thigh has a splint because, it is surrounded by a lot of muscles. There are two types of traction splint :
  1) bipolar splitter (heir).
  2) monopolar splitter (sagger).

- ✓ **Modular splinters**: These types of splinters, can easily take the form of angles of the limbs, such as aluminum and wired splines
- ✓ **Vacuum splinters**: These are soft, flexible splinters that are easily transformed into broken limbs. Then, by suctioning the air through these splinters, they tighten in place.

But the most common splinters are two types :

- Made of plastic or metal and pre-made in the form of an organ to be used and of plaster, or fiberglass made by the physician or other medical personnel, in the form of the organs desired.
- The splints have different types, each applied to a part of the hand or foot.

Types of splints for body parts to include:

- **Upper extremity splint** : Starting from the armpit and reaching down to the palm of your hand. It has a vertical angle so that, it holds the patient's elbow at 90 degrees.
- **Upper extremity short splint**: Extends from elbow to fingertip. It is positioned at the anterior surface of the forearm and palm, so that it covers the palm of the hand.
- **Alnar Gutter**: From elbow to fingertip but like a gutter in the forearm to the elbow bone, and palm to the small finger.
- **Finger splint**: Usually made of an aluminum strip, that fits all along one finger.
- **Lower extremity splint**: progresses from the hip joint to the soles of the foot. It is located on the back of the thigh and leg and on the soles of the foot. It is made to hold the ankle at an angle of 90 degrees.
- **Lower extremity splint**: From the knee to the soles of the foot. On the back of the leg and soles of the foot, and it is made to hold the ankle joint at an angle of 90 degrees.

Available Split Limitations :

- The newest type of splint is the wind splint, which can also be used to control internal and external bleeding of the hand or foot. This splint is operated by direct pressure. These splints are usually effective when an acute injury strains the entire injured organ. But as these splinters blow through the mouth, the pressure they create is limited and, may fail to control arterial bleeding and the limitation of these splints is that it covers only the calf and, more recently, the pelvis only and it is not able to bend the member like a patient's elbow.

• One of the limitations of the dipole splint (Haier) the seat cushion is a device that creates an unpleasant sensation in the injured limb. This is due to the pressure it places on the cushion of the femur and the sciatic bump and creates an incorrect angle in the bone.

- Another disadvantage of traction splints is the inability to stabilize the pelvis.

• Traction splints are prohibited in near-knee fractures, and they cannot completely cover the fractured limbs.

• Some existing splinters that immobilize the injured limb are not adjustable for limbs of different length sizes.

• Some existing splinters have straps to fix the splint to the extremities, which may be inappropriate by varying the length of the injured organ.

• It is not possible to fix the affected limb at the same time keeping the transactional state and function and covering the limb thoroughly.

• Existing splints can only perform one operation or can fix the lower limb without hip fixation or can only transact without fixing the lower limb completely.

• Splints in the hospital emergency system are unable to fix the lower extremities simultaneously, and a splint should be used for each organ.

Splinting rules :

- Be sure first that the splint is healthy, and secondly that it does not have any lesions (such as sharp or nail extensions).

- The splint should be high enough to immobilize not only the fractured member, but also the joints at the top and bottom of the fracture.

- After the splint it is necessary to fill the parts left between the splint and the limb, with cotton or cloth, then fasten with a band or, if not, with a rope, a tie, etc.

- In splinting it should be bandaged from the extremities to the beginning.

- Examine the fractured pulse before and after splinting to determine if the circulatory pathway is closed during splinting.

- In the case of vacuum splinters, the air pressure inside the splint should be constantly monitored to avoid necrosis of the tissue due to high pressure.

In general, and considering the principles of splinting in some of the splinters in the system, and observing the defect of these principles in fixing the affected organs in the splint. It was decided to design a splitter based on the collective advantages of existing splints, and not to the extent possible of defects of splinting principles. This splint is designed to eliminate the defects in other splinters and is capable of fixing the upper and lower extremities appropriately. This splint is a type of smart vacuum splint that has the ability to adjust air pressure, blood coagulation, blood pressure and heart rate, and the ability to display limb fixation and shape splinting for greater confidence.

The device uses several pressure sensors to detect air pressure inside the splint, and includes segmented areas that increase precision and efficiency of the device. It has a hip and a neck and can be resized. As such, the splint is made of flexible, elastic and tough polymer that is sized for all parts and takes the form of tissue with a split, and small cushions and by controlling and adjusting the air pressure inside each wind cell, as well as adjusting the speed and amount of wind pump air, It reduces the risk of using it for vital organs such as the neck and spinal cord, and after stopping the site of bleeding by stopping further pressure on the area, it stops bleeding and cools it faster. In addition, it detects excessive pressure on the organ and the possibility of limb necrosis, and prevents further damage to the tissue by calculating the appropriate pressure to fix the limb. At the base of the splint, a blood pressure sensor, and a pulse sensor are used, all of which can be viewed by a monitor.

Method of construction: This device is a special flexible and retractable splitter, consisting of two resize circular boxes (Figure 1-2, Part 1) connected to each other at the base this connection, is made through parallel strips (Fig. 1-2, Part 2) and can be applied to any member in the fracture region of the affected region. Specific and coded with the help of a microcontroller (Figure 2-1, Part 1) as such, these fragments contain interconnected air cells that each cell divides itself, into smaller sections in the form of small circular air cushions (Figs. 1-5 and Fig. 1-6), and like 3D printers, they form the affected limb. A circular-shaped airbag, such as a 3D printer, forms the limb shape and displays the 3D shape of the display by activating the code within the microcontroller and the amount of pressure applied to it. These sections are joined together and pressurized into circular boxes by resizing them along the length of each member and releasing the splint, leaving the corresponding packs open and the rest remaining under pressure. The open packet code is activated in the micro and after being sized and tightened by the user, the air pump (Figure 2-1 Part 2) and through a transparent silicone hose (Figure 1-2 Part 4) start to blow . After each circular packet is

fully impacted, different parts of the body shape and texture are applied to the air splitter and through the activated codes the 3D spline form appears on the embedded LCD (Figure 1-2 Part 3) for this device. By measuring the blood pressure sensor (Fig. 2-1, Section 4) and the patient's heart rate sensor (Fig. 2-1, Section 5), at the same time, the patient's heart rate and blood pressure are monitored, and this blood pressure sensor and heart rate sensor are placed at the base of the splint. (Figure 1-7, Part 1 and 2). When there is bleeding, the amount of wind and pressure applied to the area is increased, and a cold capsule is applied to the area at the same time, causing the blood to rapidly coagulate. It is important to help the blood coagulate and the temperature of the cold is taken care of in this machine and a timer is used to measure the amount of cold time as well as its temperature since the maximum cooling time is 20 minutes and the temperature should drop to a maximum of zero degrees Celsius, that this temperature is measured by a temperature sensor.(Figure2-1,part18 / Figure1-8 part 8).These circular lattice cushions are connected to each other through a common inlet of air, pumped into the air by means of an air pump, simultaneously measuring the air pressure inside the splint, and the display can adjust the required air pressure at the appropriate time. And view and adjust the package. The microcontroller analyzes this air pressure at any moment and displays it on the LCD. Inside each cell, there is an infrared sensor (Fig. 2-1, Section 6), which illuminates the space inside each cell to increase the air pressure which reduces bleeding and bleaching of the underlying tissue, and on the display of air pressure status Show so that if you reduce the amount of squeeze inside each cell yellow, in case of proper pressure with the shape of the limb in green and in the case of increased pressure that reduces blood supply, it will be displayed in red. At this time, the user can adjust the wind level via the buttons on the LCD and, if the pressure is too high on each part, through the valve embedded in each wind cell (Figure 2-1, Section 7), the air Extra extras. The method of adjusting the wind is to matrix by addressing the cells, the cells that are needed (the cells that are on the bleeding part) to the maximum, and the other cells to have the appropriate amount of wind. The density of the blood is good and the color of the tissue is not white. this is visible through the infrared sensor and the transparent sex of this splint. In addition to coding calculations and display in red, the device can also be controlled visually. The power supply of this device is supplied both by battery (Fig. 2-1 Section 8) and by electricity, which makes it easy to operate in sensitive and emergency situations. The microcontroller used in this device also provides the ability to transmit information to mobile phones and computers, and transmit and receive data wirelessly to sensors.

Benefits of this invention: The advantages of using this device include:

1) The invention consists of several parallel wind cells, each of which has a specific code inside the device memory that, displays the status of each part within the LCD.
2) The device uses a monitor that displays the compressive rate of each cell and the speed and intensity of pump aeration, the time and temperature of the cold, the amount of battery charge, and the shape of the charge in 3D.
3) In this device all the parts are interconnected, but the air outlet is operated separately by an electric valve.
4) In this invention with a hear rate sensor and a blood pressure sensor, the patient's heart rate and blood pressure are displayed.
5) In the special structure of this device, the wind cells, takes the shape and size of the user's body and is capable of holding the body.
6) This device can after detect bleeding, using a cooling capsule causes blood to coagulate and stop bleeding.

7) The temperature of the cooling capsule, should be maximum 0 degrees Celsius and, the maximum time of cold is 20 minutes, because too much of this temperature will damage tissue and limb necrosis.
8) All elements including pressure, temperature and time of cold, wind speed and intensity of the air pump and selection of wind cell codes can be adjusted using some keys.
9) The splint is inflated by an air pump and discharged by an electric valve with the opening of the desired additional valve.
10) To increase the accuracy of the device, the air pressure of each part can be displayed by the display in a specific color.
11) The space inside each wind cell is illuminated by an infrared sensor and display shows the status of each cell if the air pressure is too high and the blood supply decreases.
12) In case of excessive pressure and pressure on the tissues and organs to prevent blood clotting and tissue necrosis, the air pressure level is discharged and then adjusted to reach the specified limit.
13) The power supply of the device is provided by both battery and electricity.
14) This device is capable of sending information to your PC or phone.
15) The microcontroller used in this device transmits information and processes wirelessly from the sensors to the microcontroller and upside down.

This device is used to keep the body tissue stable during accidents, fractures, as well as to fix and prevent nail displacement after orthopedic surgery.

Device instruction: This device is used to fix the damaged organ so that first, turn on the device, and cut the limb into the rotating part of the spine, and determine the desired area and size the two upper and lower rings. After pressing the spline pump button, the cell becomes cellular and slowly inflates to form the limb. In case of detecting the cell bleeding in that area, the microcontroller instructs the pump to inflate more than appropriate pressure, to put more pressure and prevent further bleeding, and in addition, through the inlet with a cooling capsule, the zero-degree cold wind enters the cell and stops the bleeding.

5- Explain the figures, diagrams, maps and ...

• **Figure 1-1: Mechanical and technical map of the device including:**

1) The main part of the vacuum Splint, which can be changed in size and length, and all the sensors are fitted within it.
2) The body of the device with the electronic elements.

3) Hose to transfer air from air pump to vacuum splint.

• **Figure 1-2)** Map of device manufacturing including:

1) The two-circle circular shape of the vacuum spline which can be resized and pressed with small airbags and they are interconnected by flexible parallel strips.
2) parallel strips with small air cushions on them and connect the two circular parts, each of which is a wind cell and they have a separate air inlet and a separate valve.
3) LCD that displays sensor 's information and 3D spline shape.
4) Hose transfer from air pump to splint body and airbags.
5) Parameter setting buttons.

• **Figure 1-3)** Splint main body including:

1) Sizeable and flexible circular sections, including sensors.

2) The section of elastic and flexible parallel strips, which is a wind cell and contains small air cushions.

• **Figure 1-4)** View of a wind cell that they include small airbags.

1) Wind cushions

• **Figure 1-5)** A closer view of a wind cell containing:

1) A circular-shaped air cushion that resembles a 3D printer with a limb shape and activates the code and the amount of pressure applied to it and displays the 3D shape of the splint on the LCD.

2) Elastic and flexible parallel strips

• **Figure 1-6)** Wind cells and cushions in another view

• **Figure 1-7)** An image of a blown splint when placed on an organ and forming the shape of the organ, including:

1) Blood pressure sensor
2) Heart rate sensor

3) Infrared sensors
4) Wind cells
5) Splint rules, or circular sections, consisting of air cushions and compressed parallel strips.

- **Figure 1-8: Body of the device , including:**

1) LCD
2) Power button of device
3) Air pump start button and wind splint
4) Activate button for blood pressure and heart rate sensor
5) The button to adjust the time of cold and the amount of compression in each cell
6) Buttons to select the code for each air cushion
7) Inlet hose to the device
8) Temperature sensor

- **Figure 2-1): Electronic circuit map of the device including:**

1) Microcontroller
2) Wind Pump
3) LCD
4) Blood pressure sensor
5) Heart rate sensor
6) Infrared sensor
7) Solenoid valve
8) Battery
9) Air pressure sensor
10) Analog to Digital Converter
11) LCD IC
12) push bottom button
13) Battery Charging Circuit
14) IC
15) Relay
16) IC relay driver
17) Servomotor for compressor cooling spray
18) Temperature sensor

Claim 1: This invention is a type of electronic smart wind splint, that completely covers and fixes the injured limb and reduces the risk of using the splint by measuring and adjusting a number of parameters.

Claim 2: In this device , parameters such as fixation of damaged tissues and bones, pressure detection method, pressure display method, battery cooling and charging time, limb size down, wind splash, control and discharge of air in each cell Inflation, diagnosis of heart rate and blood pressure have been considered.

Claim 3: According to claim 2, a fixed body splint is used to hold the injured limb in place to hold the damaged limb structure supported by small airbags.

Claim 4: According to claim 2, a hybrid pressure sensor is used to measure the air pressure, inside each cell. (Positive pressure and vacuum pressure)

Claim 5: According to claim 2, an LCD is used to display the parameters.

Claim 6: According to claim 2, elastic bands are used to create a stretch on the splint.

Claim7: According to claim 2, used to inflate the wind cells by a 12V lighter air pump.

Claim8: This device uses a charging circuit to charge the battery.

Claim9: According to claim 2, in which an electric valve is used to discharge air into each wind cell.

Claim10: According to claim 2, in which a heart rate sensor is used to detect the patient's heart rate.

Claim 11: According to claim 2,in which a blood pressure sensor is used to detect the patient's blood pressure.

Claim 12: According to claim 2, a pressure sensor with a range of 5 to 15, is used to detect the pressure inside each cell.

Claim 13: Relay is used to command each valve.

Claim 14: The microcontroller used in this device, is ESP type which is capable of Bluetooth and WiFi.

Claim 15: The battery used in this device is a 12V, and 15A / h.

AMENDED CLAIMS
received by the International Bureau on 26 September 2020

Independent claims

Claim 1: This invention is a type of electronic smart wind splint, that completely covers and fixes the injured limb and reduces the risk of using the splint by measuring and adjusting a number of parameters.

Claim 2: In this device , parameters such as fixation of damaged tissues and bones, pressure detection method, pressure display method, battery cooling and charging time, limb size down, wind splash, control and discharge of air in each cell Inflation, diagnosis of heart rate and blood pressure have been considered.

Claim 3: Relay is used to command each valve.

Claim 4: The microcontroller used in this device, is ESP type which is capable of Bluetooth and WiFi.

Claim 5: The battery used in this device is a 12V, and 15A / h.

Affiliate claims

Claim 2-a: According to claim 2, a fixed body splint is used to hold the injured limb in place to hold the damaged limb structure supported by small airbags.

Claim 2-b: According to claim 2, a hybrid pressure sensor is used to measure the air pressure, inside each cell. (Positive pressure and vacuum pressure)

Claim 2-c: According to claim 2, an LCD is used to display the parameters.

Claim 2-d: According to claim 2, elastic bands are used to create a stretch on the splint.

Claim 2-e: According to claim 2, used to inflate the wind cells by a 12V lighter air pump.

Claim 2-f: This device uses a charging circuit to charge the battery.

Claim 2-g: According to claim 2, in which an electric valve is used to discharge air into each wind cell.

Claim 2-h: According to claim 2, in which a heart rate sensor is used to detect the patient's heart rate.

Claim 2-i: According to claim 2,in which a blood pressure sensor is used to detect the patient's blood pressure.

Claim 2-j: According to claim 2, a pressure sensor with a range of 5 to 15, is used to detect the pressure inside each cell.

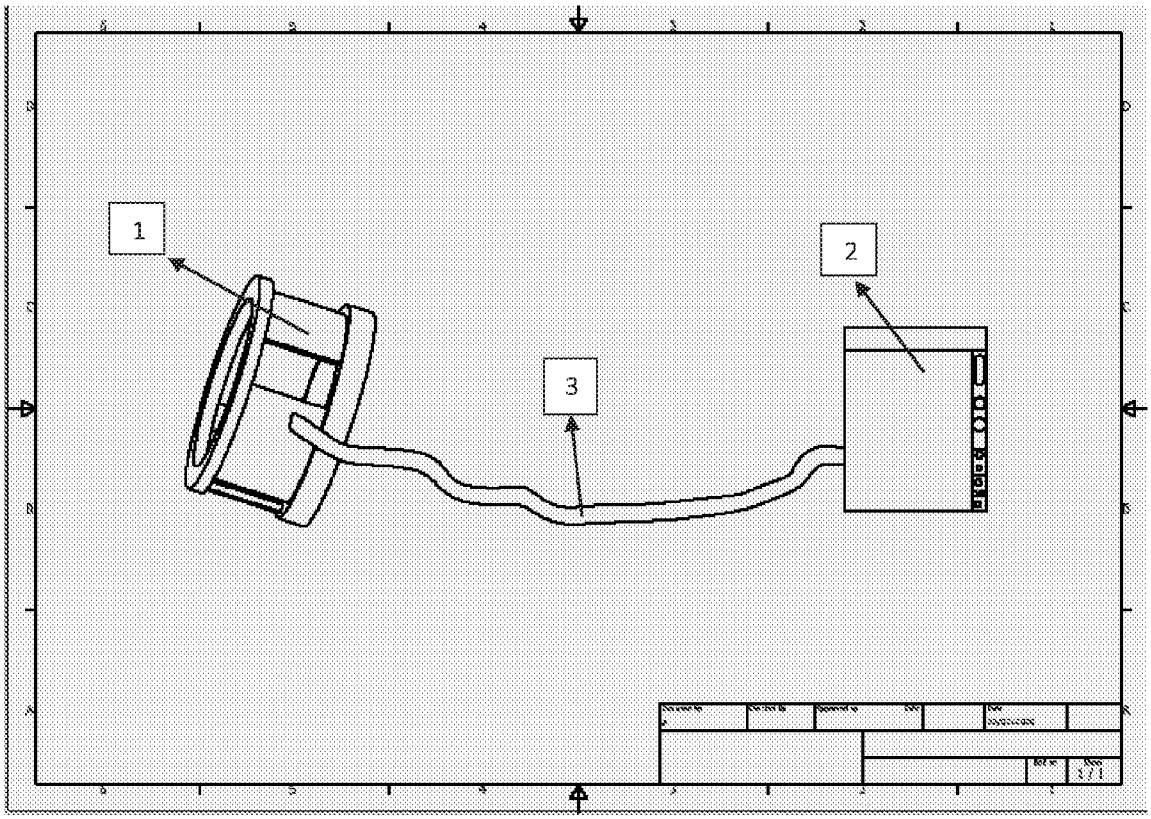

Figure 1-1

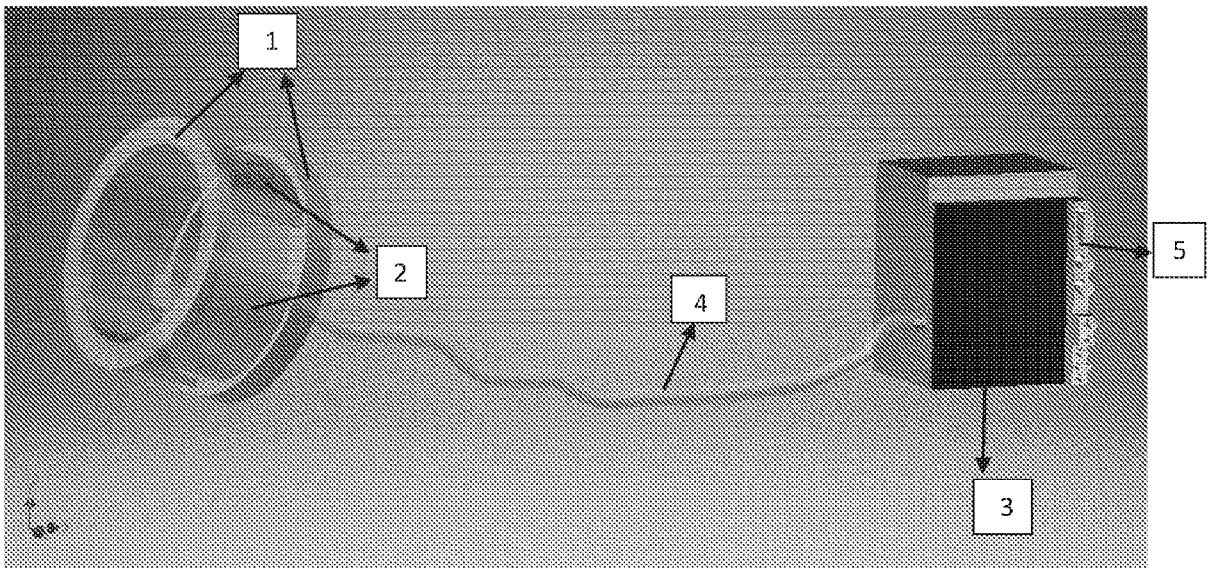

Figure 1-2

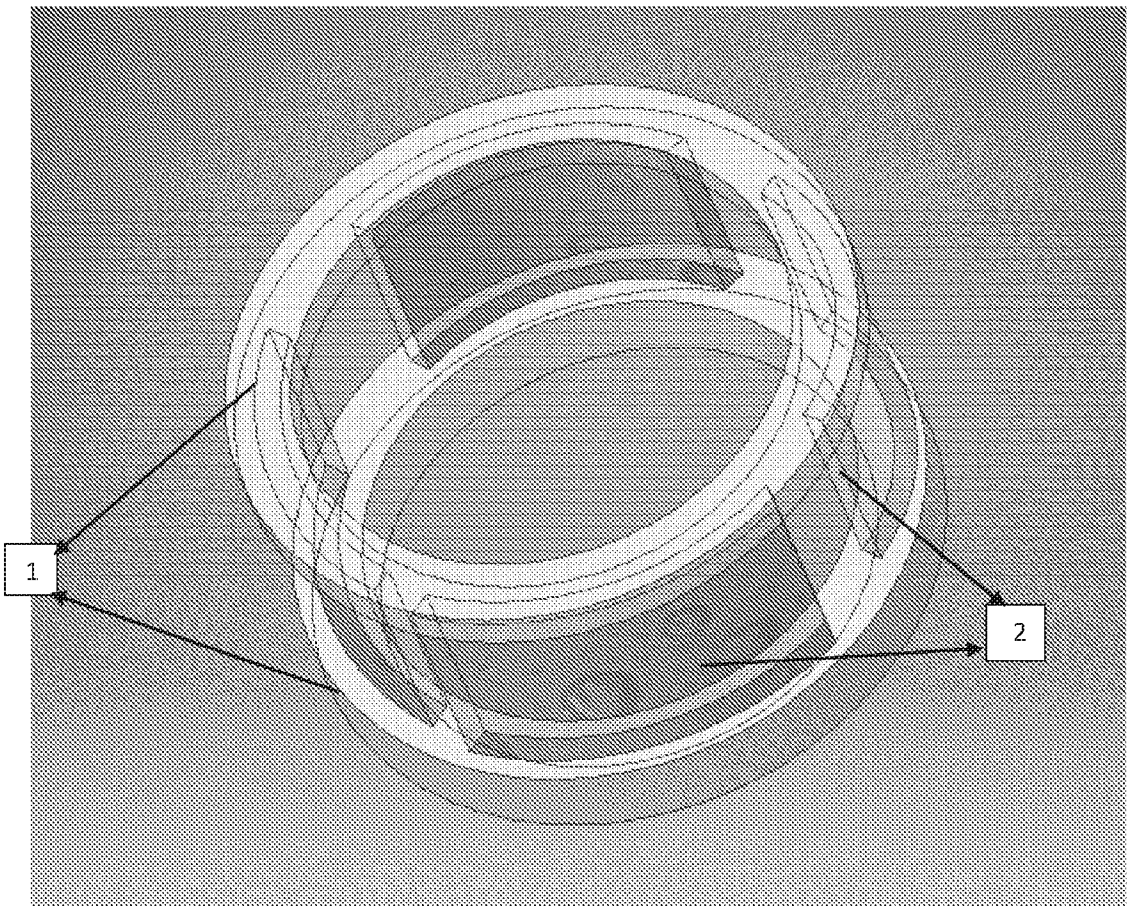

Figure 1-3

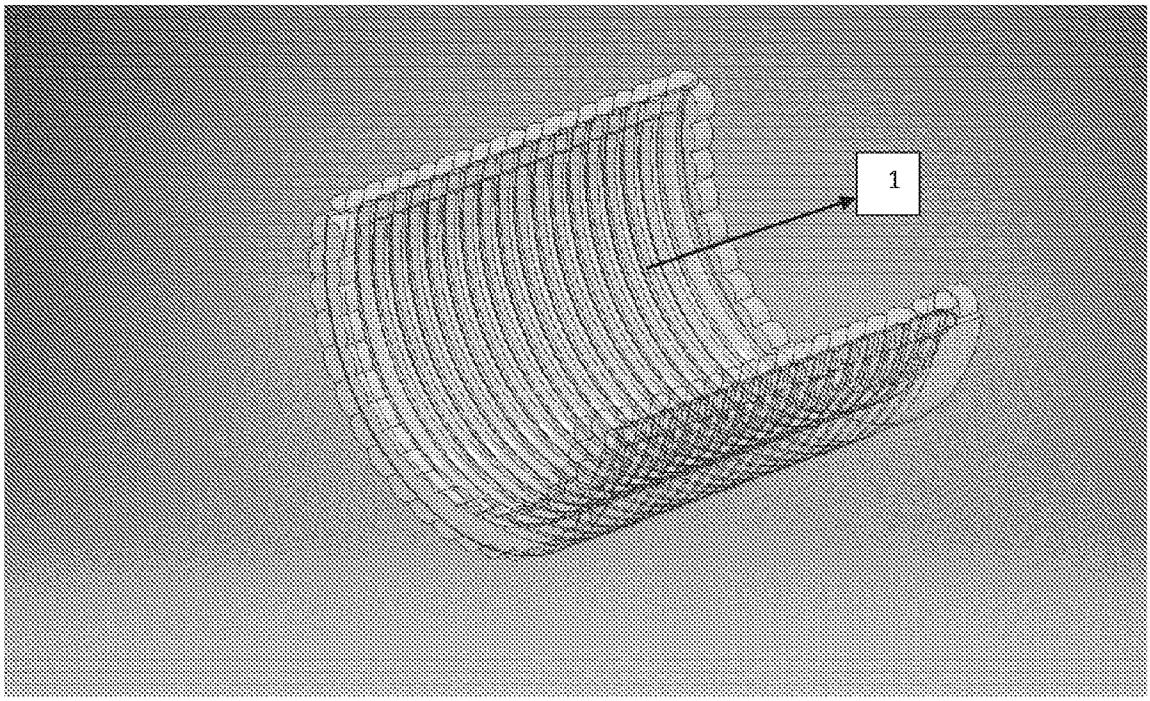

Figure 1-4

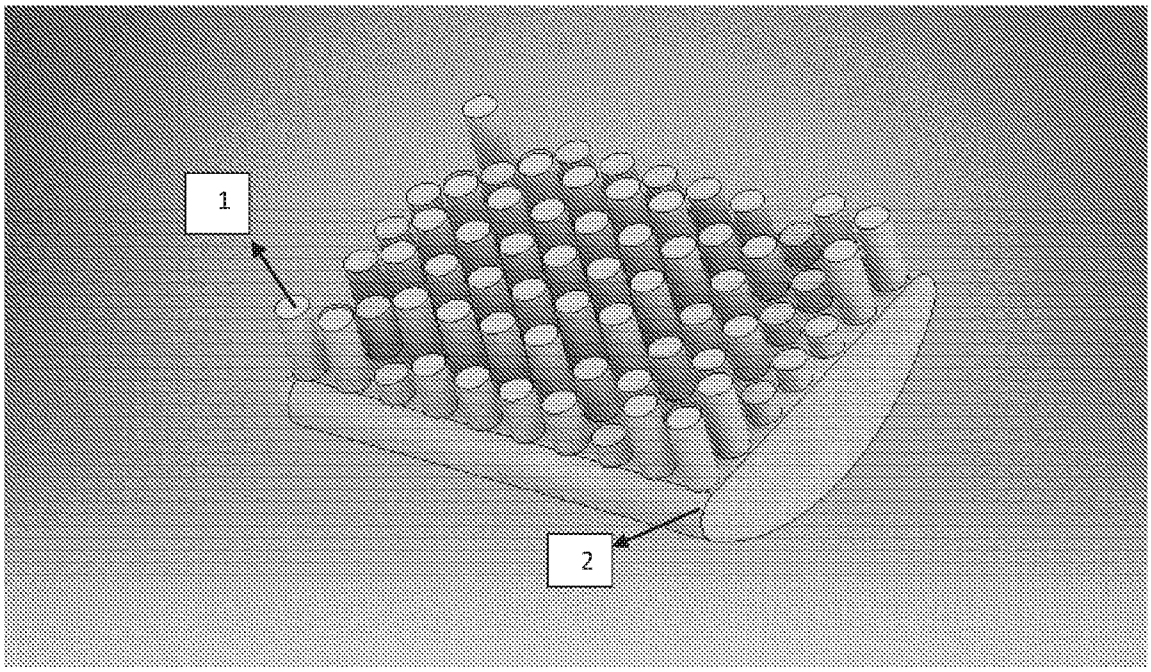

Figure 1-5

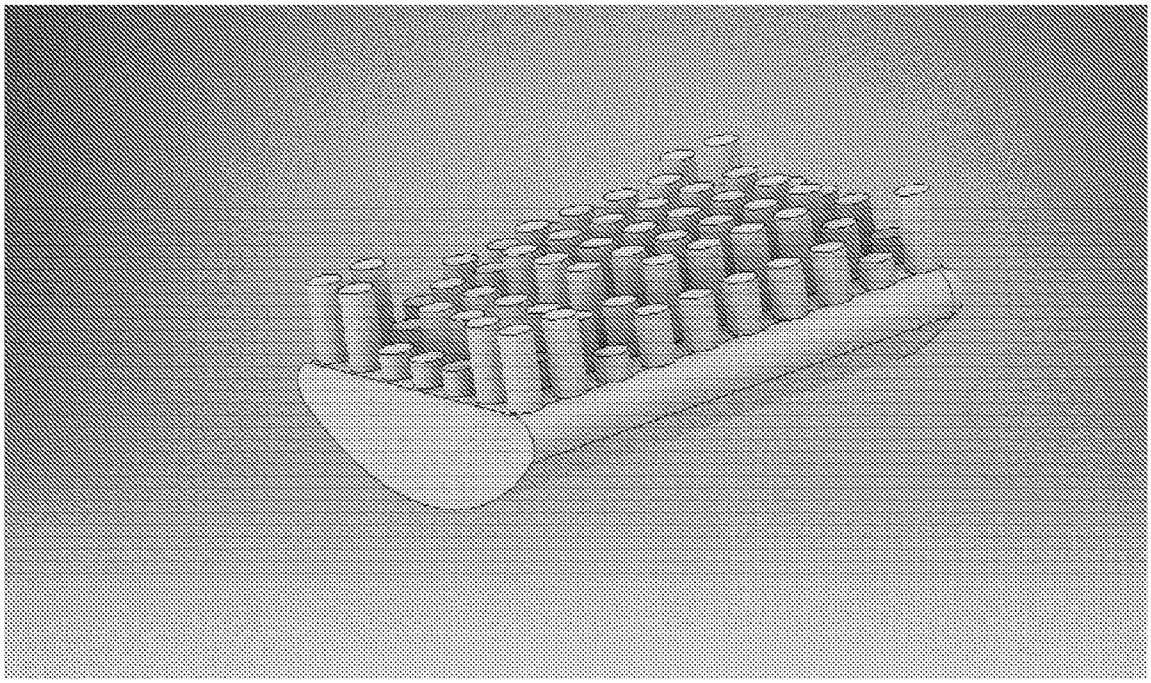

Figure 1-6

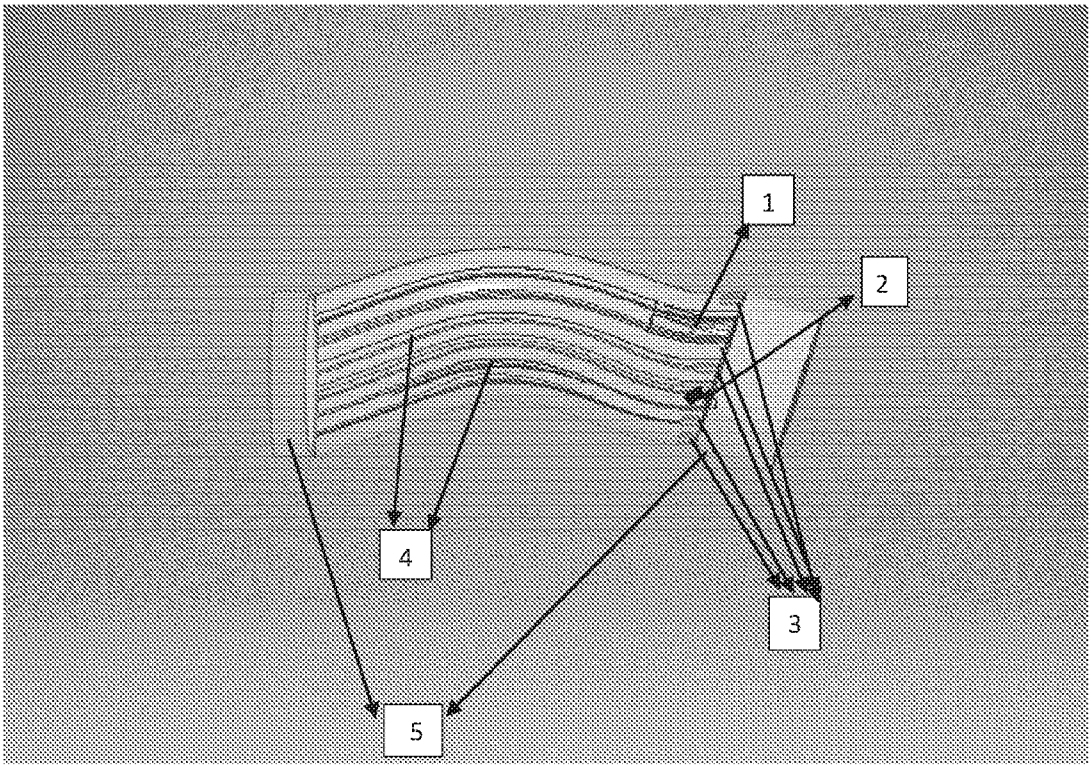

Figure 1-7

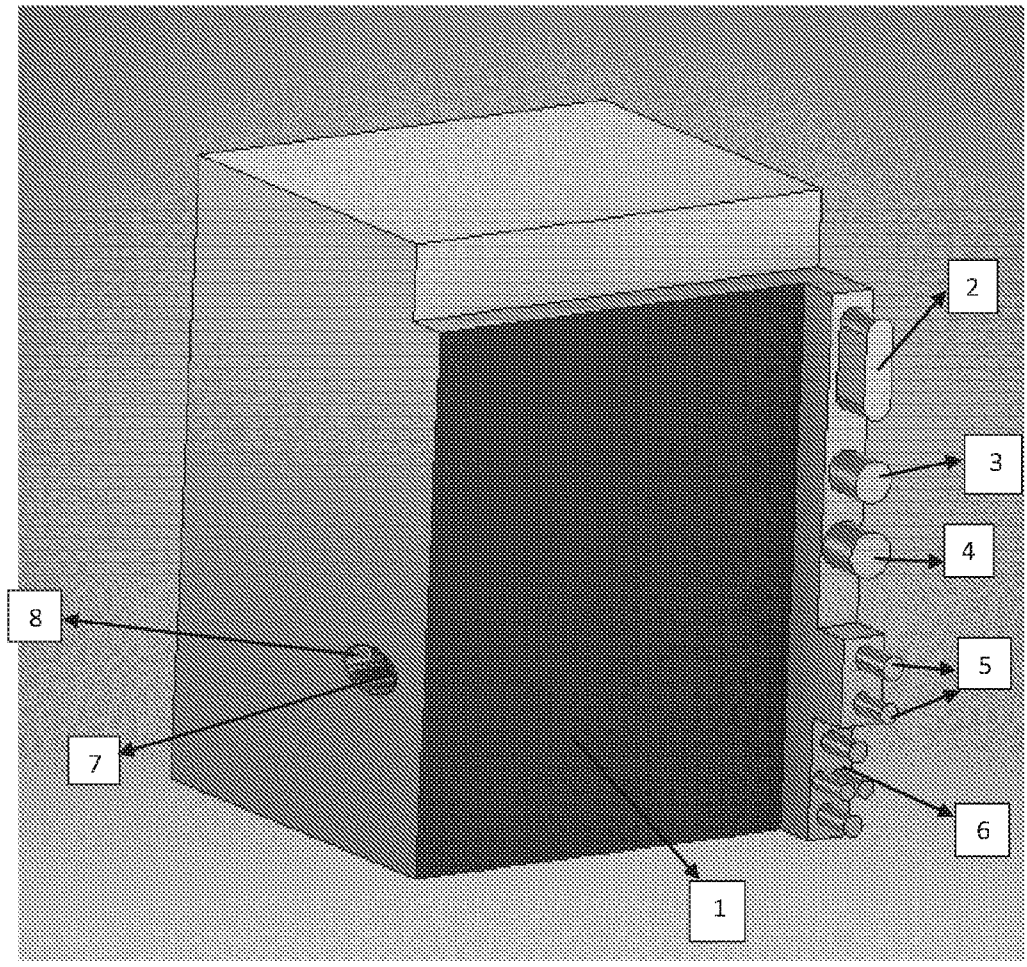

Figure 1-8

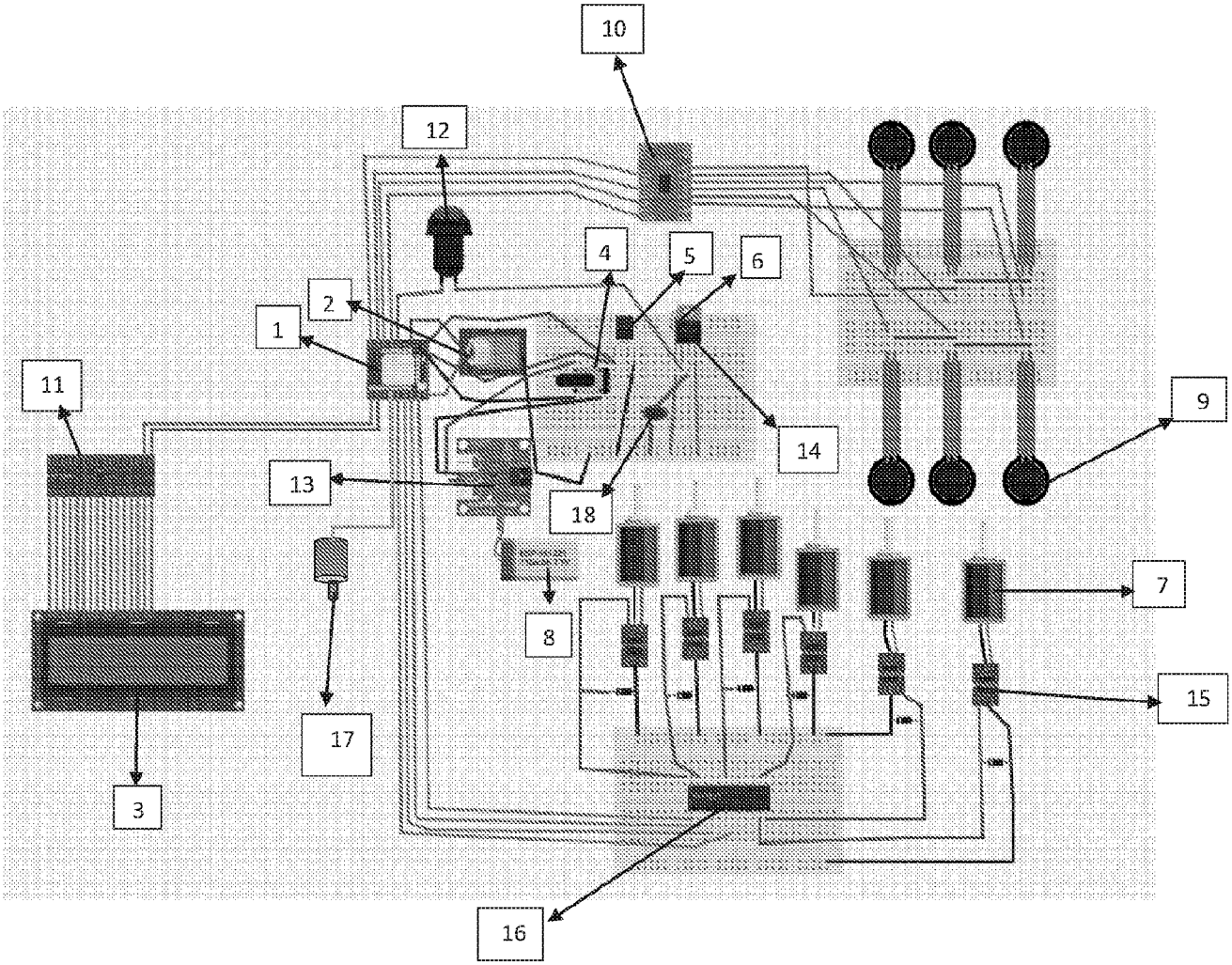

Figure 2-1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2020/053847

A. CLASSIFICATION OF SUBJECT MATTER
A61F5/058 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)

A61F

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: Total Patent One, IPO Internal Database
Keywords: Splint, force sensor, 3D orthosis, Smart

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US10029394B2(HERMO MEDICAL SOLUTIONS S L [ES]) 24 July 2018 (24-07-2018) Whole document	1-15
Y	US2017224520A1 (OSTEOID SAGLIK TEKNOLOJILERI A S [TR])10 August 2017 (10-08-2017) Whole document	1-15
Y	US2018317847A1(RIPPERGER III FRANK J [US])08 November 2018 (08-11-2018) Whole document	1-15
Y	WO2019224844A2 (IRI MOSHTAGH [IR]) 28 November 2019 (28-11-2019) Whole document	1-15

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24-07-2020	24-07-2020

Name and mailing address of the ISA/	Authorized officer
Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Devendra Kumar Deshmukh Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/053847

Citation	Pub.Date	Family	Pub.Date
US 10029394 B2	24-07-2018	WO 2016191331 A1	01-12-2016
		US 2016339607 A1	24-11-2016
US 2017224520 A1	10-08-2017	CN 107106088 A	29-08-2017
		EP 3215013 A2	13-09-2017