



(51) International Patent Classification:

A41D 1/00 (2018.01)

A41F 1/00 (2006.01)

(21) International Application Number:

PCT/IB2022/057363

(22) International Filing Date:

08 August 2022 (08.08.2022)

(25) Filing Language:

Italian

(26) Publication Language:

English

(30) Priority Data:

102021000021743

11 August 2021 (11.08.2021)

IT

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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, CV, CZ, DE, DJ, DK, DM,

DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, 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,

(54) Title: A COUPLING SYSTEM ENSURING ELECTRICAL CONTINUITY BETWEEN AN ELECTRICAL DEVICE AND A TEXTILE ELECTRODE

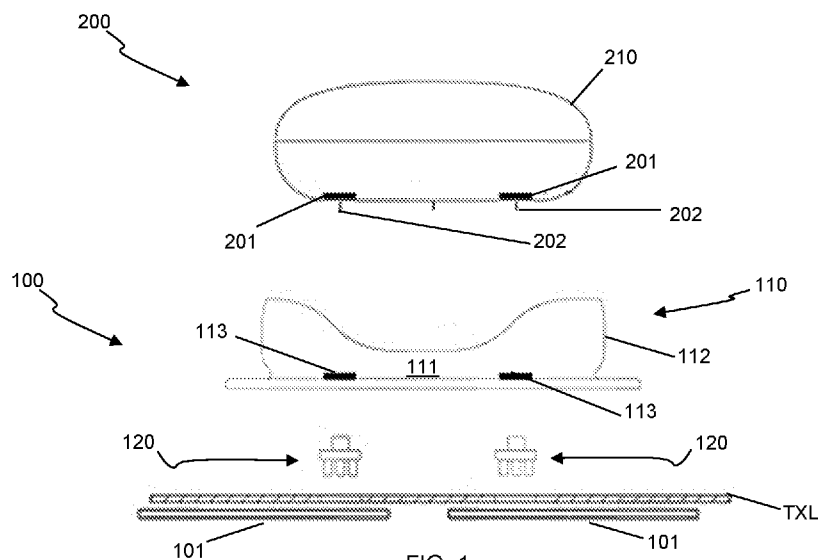


FIG. 1

(57) Abstract: Described herein is a coupling system (100) ensuring electrical continuity with textile electrodes (101), said coupling system comprising: - a container body (110) comprising a seat (111) adapted to receive an electronic device and at least one metallic connector (120); wherein the metallic connector comprises: - an upper part (121) having a substantially elongated shape and extending through the bottom of the seat, said upper part being adapted to be electrically connected to said electronic device (200); - a substantially flat central part (122) engaged with one end of said upper part, said central part being adapted to mechanically fix the metallic connector between a textile (TXL) and the container body; - a lower part (123) comprising a plurality of cylindrical elements (123'), wherein each cylindrical element extends from said central part in the direction opposite to said upper part; wherein each cylindrical element is configured to penetrate a textile sensor (101), thereby establishing an electrical and mechanical connection.

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).

Published:

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

A coupling system ensuring electrical continuity between an electrical device and a textile electrode

5 Field of the invention

The present invention relates, in general, to the integration of an electronic device on a textile. In particular, the present invention relates to a coupling system adapted to connect an electronic device to a textile sensor positioned on an article of clothing.

Background art

10 As is known, the integration of electronic devices on textiles has gained increasing importance in recent times.

For example, several electronic devices are available which can be associated with articles of clothing and/or accessories that, apart from their traditional functions, such as thermal or protective effects, also provide additional functions such as health monitoring, thus increasing safety or permitting the monitoring of a number of parameters during sporting activities.

The Applicant observes that the integration of electronic components on a textile results in a considerable deterioration of the properties of use of the textile.

20 Moreover, the Applicant observes that the integration of an electronic device into an article of clothing makes washing, cleaning and ironing operations more difficult.

Furthermore, coupling systems are known which permit inserting/removing the electronic device into/from the textile. For example, coupling systems are known which comprise a seat engaged with the textile by means of pressure-operated buttons.

25 For this type of connection, common snap buttons for textile use are usually employed, or flexible circuits are implemented whereon the textile yarns are welded and/or fixed. Such solutions suffer from several drawbacks in the presence of multiple electrical connections and small spaces. In fact, the use of a snap button for each electrical connection results in a considerable increase in the dimensions

of the whole system, considering that each snap button has a diameter of approximately 1 cm. The Applicant observes that such a coupling system does not permit a large number of connections without substantially increasing the volume of the seat that houses the electronic device. Moreover, in the case of flexible circuits
5 integrated into or engaged with the textile, notable problems arise in terms of mechanical and electrical resistance and reliability of the circuits, which after some dozens of coupling/decoupling operations may lose their functionality because of a broken circuit board and/or broken conductive tracks.

The Applicant also observes that electrical connections obtained by welding
10 and/or crimping techniques considerably increase production costs and times.

Summary of the invention

The Applicant has tackled the problem of providing a coupling system ensuring electrical continuity with textile sensors which represents an alternative solution capable of overcoming the above-described problems.

15 Furthermore, the Applicant has tackled the problem of providing an electronic device with a textile sensor positioned on an article of clothing which ensures continuous data detection, washability and ease of use, while preventing any positioning errors.

In particular, according to a first aspect, the present invention provides a coupling
20 system ensuring electrical continuity with textile electrodes.

Said coupling system comprises:

- a container body comprising:
 - a seat adapted to receive an electronic device;
 - at least one metallic connector.

25 The metallic connector comprises:

- an upper part having a substantially elongated shape and extending through the bottom of said seat; said upper part being adapted to be electrically connected to said electronic device;
- a substantially flat central part engaged with one end of said upper part, said
30 central part being adapted to mechanically fix the metallic connector between a textile and the container body;

- a lower part comprising a plurality of cylindrical elements, wherein each cylindrical element extends from said central part in the direction opposite to said upper part;

wherein each cylindrical element is configured to penetrate a textile sensor,
5 thereby establishing an electrical and mechanical connection.

Preferably, said coupling system comprises a plurality of magnets arranged on the bottom of said seat.

Even more preferably, each magnet is housed in a respective cavity formed on the bottom of the seat; each cavity formed on the bottom of said seat being adapted
10 to mate with a respective upper part of a respective metallic connector.

Preferably, said respective upper part crosses a respective cavity formed on the bottom of the seat and a respective magnet.

Preferably, the lower part of each metallic connector comprises at least three cylindrical elements, said cylindrical elements being mutually equidistant.

15 According to a further aspect, the present invention provides an article of clothing provided with at least one textile sensor, comprising:

- an electronic device comprising a box-like body, a battery, an electric circuit, a memory-equipped processor and one or more connectors;

wherein each connector of said electronic device extends outside said box-
20 like body;

- a coupling system according to any one of the preceding claims;
wherein said textile sensor is positioned on an inner surface of said article of clothing;

wherein a metallic connector of said coupling system comprises:

25 - an upper part extending through the bottom of the seat, said upper part being adapted to be electrically connected to a respective connector of the electronic device;

- a substantially flat central part engaged with one end of said upper part, said central part being interposed between the external surface of the
30 article of clothing and the external surface of the seat of the container body;

- a lower part comprising a plurality of cylindrical elements, wherein each cylindrical element extends from said central part in the direction opposite

to said upper part;

wherein each cylindrical element crosses the surface of said article of clothing and is inserted, at least partly, in a textile sensor, thereby establishing an electrical and mechanical connection.

5 Preferably, said electronic device comprises a plurality of magnets. Each magnet of the electronic device is positioned on the bottom surface of the electronic device so as to be coupled with a respective magnet of the coupling system.

Preferably, each connector of the electronic device is a spring-type connector arranged in a position matching a respective magnet of the electronic device.

10 Brief description of the drawings

The present invention will become more apparent in the light of the following detailed description, wherein reference will be made to the annexed drawings, provided merely by way of non-limiting example, wherein:

- 15 - Figure 1 is an exploded view of a coupling system and an electronic device according to the present invention;
- Figure 2 shows the coupling system of Figure 1 in the assembled condition;
- Figure 3 is a side view of a metallic connector according to the present invention;
- Figure 4 is a perspective view of the metallic connector of Figure 3.

20 In the drawings, those items which perform substantially the same function are designated by the same reference numerals.

The drawings are not in scale.

Detailed description of some embodiments

25 The present invention provides a coupling system 100 for establishing a connection, preferably a multi-point one, between an electronic device 200 and textile sensors (or textile electrodes) 101.

According to the present invention, as shown in Figure 1, the electronic device 200 comprises a box-like body 210 adapted to contain the elements necessary for acquiring a signal generated by at least one textile sensor 101; for example, the
30 electronic device 200 may comprise:

- a battery;
- an electric circuit;
- a memory-equipped processor;
- one or more connectors 202 adapted to be connected to respective textile electrodes 101.

It should be noted that the electric circuit, the battery, the memory-equipped processor and the connectors 202 are connected to one another and are housed inside the box-like body 210 of the electronic device 200 in any known manner.

Preferably, the electronic device 200 comprises magnets 201. Each magnet 201 of the electronic device 200 is positioned on the underside of the electronic device 200. For example, if the box-like body 210 has a flattened oval shape having a top surface and a bottom surface opposite to each other, said bottom surface is provided with respective recesses housing respective magnets 201; preferably, each magnet 201 is positioned within the box-like body 210.

Preferably, each connector 202 is a spring-type connector. Preferably, each spring-type connector 202 extends outside the box-like body 201 and is coupled to a respective magnet 201 of the device 200. In particular, with reference to a single magnet 201 coupled to a respective connector 202, the connector 202 is positioned in proximity to the respective magnet 201 (e.g. beside the respective magnet 201); preferably, the connector 202 is positioned at the center of the magnet 201. For example, the magnet 201 may have a substantially toroidal shape, and the connector 202 is positioned at the center of the magnet 201.

As will be further explained in detail below, the connector 202 permits obtaining a stable and long-lasting electrical connection.

According to the present invention, the terms "textile sensor" or "textile electrode" refer to any textile component that can be used as, or associated with, a sensor.

For example, a textile sensor 101 may be selected among: electrocardiography electrodes, electromyography electrodes, electroencephalography electrodes, impedentiometry electrodes, pressure sensors, temperature sensors and/or force sensors or the like.

It should therefore be noted that the term textile sensor 101 denotes a component that allows detecting a signal generated by a physiological apparatus, whether at

basal level or as a function of an action, or a pressure, exerted on the textile sensor 101 during a movement of a subject.

The signal generated by the textile sensor 101 – for example, an electrocardiographic signal ECG in the case of a textile electrode 101, or a pressure
5 signal in the case of a sensor 101 – is acquired by the electronic device 200.

According to the present invention, each textile sensor 101 is positioned on a textile TXL. The textile TXL substantially corresponds to the substrate on which a coupling system 100 is engaged.

For example, the textile TXL may be the fabric of an article of clothing, such as a
10 sensorized jersey, i.e. a jersey whereon one or more electronic devices are to be installed in order to monitor one or more parameters of the user wearing it. Alternatively, the article of clothing TXL may be any type of garment, such as an elastic belt, or a pair of trousers, or a T-shirt, or a piece of underwear, or any other garment in contact with the body.

15 The Applicant observes that the textile TXL may be advantageously used as an insulating material between adjacent textile electrodes 101. For example, the textile TXL may also be placed under the textile sensor 101 or, as an alternative, may be replaced with thermo-adhesive materials, thus insulating the textile sensor 101 from any other textile sensors 101 adjacent thereto.

20 According to the present invention, the coupling system 100 comprises a container body 110. The container body 110 allows the device 200 to be electrically connected to at least one textile sensor 101.

The container body 110 is preferably made from non-conductive flexible/elastic materials. For example, the container body 110 is made of rubber or silicone.

25 The Applicant observes that the use of rubber-based materials permits obtaining a container body 110 having different elasticity/flexibility according to the intended use.

The container body 110 has a shape suitable for receiving the electronic device 200. In other words, the container body 110 may have different geometric
30 conformations depending on the geometric shape of the box-like body 210 of the electronic device 200. For example, if the box-like body 210 of the electronic device 200 has a substantially rectangular shape, then the container body 110 is provided

with an internal seat 111 whose shape substantially matches the shape of the box-like body 210.

Preferably, the container body 110 comprises sidewalls 112 adapted to removably retain the electronic device 200 after it has been inserted in the seat 111.

- 5 For example, the sidewalls 112 may be deformable walls extending from the seat 111, which allow the box-like body 210 of the electronic device 200 to be removably locked in position when it has been positioned in the seat 111.

Preferably, the container body 110 comprises a plurality of magnets 113. Preferably, each magnet 113 is positioned on the bottom of the seat 111. In
10 particular, the seat 111 comprises suitable cavities (not shown) formed on the bottom thereof and suitable for receiving a respective magnet.

It should be noted that the outer surface of the seat 111, once in position, will face towards – or abut against – the textile TXL. Preferably, said outer surface of the seat 111 is a substantially flat surface.

- 15 The magnets 113 of the container body 110 and the magnets 201 of the electronic device 200 have an inverse magnetic field polarization. In other words, the magnets 113 of the container body 110 and the magnets 201 of the electronic device 200 are positioned in a manner such as to generate a mutually attractive magnetic field, thereby improving the retention of the electronic device 200 in position once it has
20 been inserted in the seat 111.

With reference to Figures 2, 3 and 4, the container body 110 comprises at least one metallic connector 120.

- Each metallic connector 120 is made from a single metallic material or from a material composed of different metal types. For example, each metal connector 120
25 may comprise one or more of the following metals: steel, silver, copper, brass.

According to the present invention, each metallic connector 120 of the container body 110 essentially comprises three parts:

- an upper part 121 having a substantially elongated shape and extending through the bottom of the seat 111;
- 30 wherein the upper part 121 is adapted to be electrically connected to the electronic device 200;

- a substantially flat central part 122 engaged with one end of said upper part 121, said central part 122 being adapted to mechanically fix the metallic connector 120 between a textile TXL and the container body 110;

- a lower part 123 comprising a plurality of cylindrical elements 123', wherein each cylindrical element 123' extends from the central part 122 in the direction opposite to the upper part 121;

wherein each cylindrical element 123' is configured to penetrate a textile sensor 101, thereby establishing an electrical and mechanical connection.

Preferably, the upper part 121 is substantially frustum-shaped, wherein the minor base is engaged with the central part 122.

Preferably, each cylindrical element 123' is substantially a micro-needle preferably having a rounded head.

Preferably, the cylindrical elements 123' of a respective metallic connector 120 are all equal (i.e. they have the same length, width and geometric shape).

Preferably, as shown in Figures 3 and 4, the lower part 123 of each metallic connector 120 comprises at least three cylindrical elements 123'.

Even more preferably, the cylindrical elements 123' of a respective lower part 123 are mutually equidistant. For example, when the lower part 123 comprises three cylindrical elements 123', each cylindrical element 123' is positioned substantially at a respective vertex of an equilateral triangle.

Preferably, the upper part 121 has a substantially cylindrical shape extending along a longitudinal axis.

Preferably, the central part 122 is engaged with one end of the upper part 121, so that the surface of the central part 122 is perpendicular to the longitudinal axis of the upper part 121.

For example, as shown in Figures 3 and 4, each metallic connector 120 of the container body 110 essentially comprises:

- a substantially frustum-shaped upper part 121, wherein the minor base has a diameter D1 of 0.5 mm to 7 mm and the major base has a diameter D2 which is greater than the diameter D1 of the minor base;

- a substantially disc-shaped central part 122, engaged with the upper part 121 at the minor base thereof, and having a diameter D3 of 1 mm to 10 mm and a thickness S of 0.5 mm to 4 mm;
- a lower part 123 comprising three cylindrical elements 123', each cylindrical element 123' having a maximum diameter D4 of 1 mm and a length L of at least 1.5 mm, preferably at least 1.75 mm.

Preferably, each metallic connector 120 is positioned at a respective magnet 113 of the container body 110. In particular, the upper part 121 of the metallic connector 120 extends through a respective magnet 113 to provide electric contact with the connector 202 of the electronic device 200. Alternatively, the upper part 121 of the metallic connector 120 is positioned beside a respective magnet 113, in such a way as to provide electric contact with the connector 202 of the electronic device.

For example, considering a magnet 113 of the container body 110 coupled with a respective metallic connector 120, such magnet 113 may have a substantially toroidal shape and the upper part 121 of such metallic connector 120 is inserted at the center of the magnet 113.

As shown in Figure 2, the container body 110 is engaged with the textile TXL by means of the metallic connectors 120.

In particular, considering a textile sensor 101, the upper part 121 of each metallic connector 120 is inserted in the seat 111 of the container body 110 so that the central part 122 is interposed between the textile TXL and the external surface of the container body 110. The lower part 123, i.e. each cylinder 123', crosses the textile TXL and is mechanically engaged into a respective electric contact of the textile sensor 101, thereby establishing an electrical and mechanical connection between the textile sensor 101 and the upper part 121.

In particular, considering a textile electrode 101, the upper part 121 of each metallic connector 120 is inserted in the seat 111 of the container body 110 so that the central part 122 is interposed between the textile TXL and the external surface of the container body 110. The lower part 123, i.e. each cylinder 123', crosses the textile TXL and is mechanically engaged into a respective textile sensor 101, thereby establishing an electrical connection between the textile sensor 101 and the upper part 121.

When the electronic device 200 is inserted into the seat 111, a respective connector 202 of the electronic device 200 comes in electrical/mechanical contact with at least a portion of the upper part 121 of a respective metallic connector 120 of the container body 110, thereby being electrically connected to a respective textile sensor 101. The device 200 can thus acquire signals generated by textile electrodes 101 electrically connected thereto.

The Applicant observes that the lower part 123 of each metallic connector 120, as it crosses the textile TXL and is mechanically and electrically coupled with a respective textile sensor (or textile electrode), creates a rigid connection surface that ensures good stability of the container body 110 while at the same time minimizing the overall volume thereof.

The present invention also offers additional advantages.

In particular, improved retention of the electronic device 200 can be attained, which is ensured by the magnets 201 of the device 200 and by the magnets 113 of the container body 110.

Moreover, the presence of spring-type connectors 202 (spring probes) and of said magnets 113, 201 ensures a stable and durable electrical connection between the electronic circuit and the textile sensor 101 (or the textile electrode 101) even during the fast movements that are typical of sporting activities. Such stability improves the quality of the signal acquired by the device 200.

Furthermore, the coupling system 100 has low production costs and times, is small in size, and allows for intuitive positioning and/or removal of the device 200 on/from the garment TXL.

CLAIMS

1. A coupling system (100) ensuring electrical continuity with textile electrodes (101), said coupling system (100) comprising:

- a container body (110) comprising:

- 5 - a seat (111) adapted to receive an electronic device (200);
 - at least one metallic connector (120);

wherein the metallic connector (120) comprises:

- 10 - an upper part (121) having a substantially elongated shape and extending through the bottom of the seat (111), said upper part (121) being adapted to be electrically connected to said electronic device (200);
 - a substantially flat central part (122) engaged with one end of said upper part (121), said central part (122) being adapted to mechanically fix the metallic connector (120) between a textile (TXL) and the container body (110);
15 - a lower part (123) comprising a plurality of cylindrical elements (123'), wherein each cylindrical element (123') extends from said central part (122) in the direction opposite to said upper part (121);
 wherein each cylindrical element (123') is configured to penetrate a textile sensor (101), thereby establishing an electrical and mechanical connection.

20 2. The coupling system (100) according to the preceding claim, wherein said coupling system (100) comprises at least one magnet (113) arranged on the bottom of said seat (111); said at least one magnet (113) being adapted to retain said electronic device (200) in said seat (111).

25 3. The coupling system (100) according to the preceding claim, wherein each magnet (113) is housed in a respective cavity formed on the bottom of the seat (111);

 wherein said respective cavity formed on the bottom of the seat (111) is adapted to mate with a respective upper part (121) of a respective metallic connector (120);
 wherein said respective upper part (121) crosses said cavity formed on the bottom
30 of the seat (111) and said respective magnet (113).

4. The coupling system (100) according to any one of the preceding claims, wherein the lower part (123) of each metallic connector (120) comprises at least three cylindrical elements (123'), said cylindrical elements (123') being mutually equidistant.

5. An article of clothing (TXL) provided with at least one textile sensor (101), comprising:
- an electronic device (200) comprising a box-like body (210), a battery, an electric circuit, a memory-equipped processor and one or more connectors (202); wherein each connector (202) extends outside said box-like body (201);
 - 10 - a coupling system (100) according to any one of the preceding claims; wherein said textile sensor (101) is positioned on an inner surface of said article of clothing (TXL); wherein a metallic connector (120) of said coupling system (100) comprises:
 - 15 - an upper part (121) extending through the bottom of the seat (111), said upper part (121) being adapted to be electrically connected to a respective connector (202) of the electronic device (200);
 - a substantially flat central part (122) engaged with one end of said upper part (121), said central part (122) being interposed between the external surface of the article of clothing (TXL) and the external surface of the seat (111) of the container body (110);
 - 20 - a lower part (123) comprising a plurality of cylindrical elements (123'), wherein each cylindrical element (123') extends from said central part (122) in the direction opposite to said upper part (121); wherein each cylindrical element (123') crosses the surface of said article of clothing (TXL) and is inserted, at least partly, in a textile sensor (101),
 - 25 thereby establishing an electrical and mechanical connection.

6. The article of clothing (TXL) according to the preceding claim, wherein said electronic device (200) comprises a plurality of magnets (201); wherein each magnet (201) of the electronic device (200) is positioned on the bottom surface of the electronic device (200) so as to be magnetically coupled with a respective magnet (113) of the coupling system (100), which has an inverse polarity;
- 30

wherein each magnet (201) of the electronic device (200) and each magnet (113) of the coupling system (100) keep said electronic device (200) in contact with said seat (111) of said container body (110).

- 5 7. The article of clothing (TXL) according to any one of claims 5 or 6 when dependent on claim 3, wherein each connector (202) is a spring-type connector arranged in a position matching a respective magnet (201) of the electronic device (200).

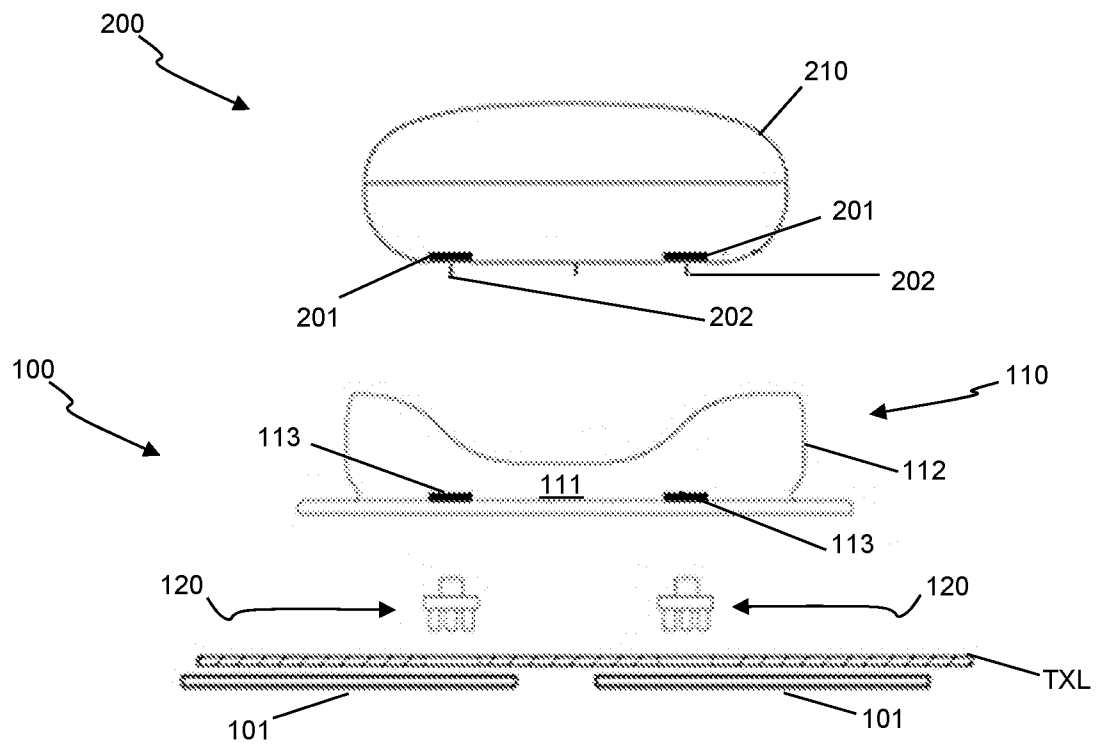


FIG. 1

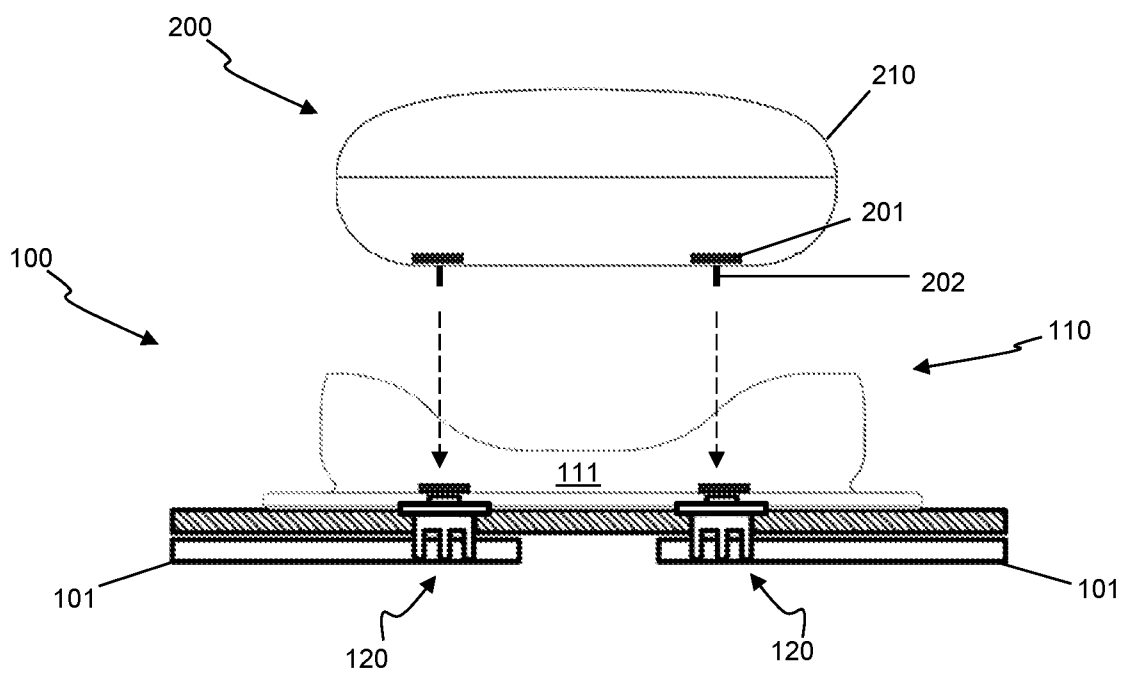


FIG. 2

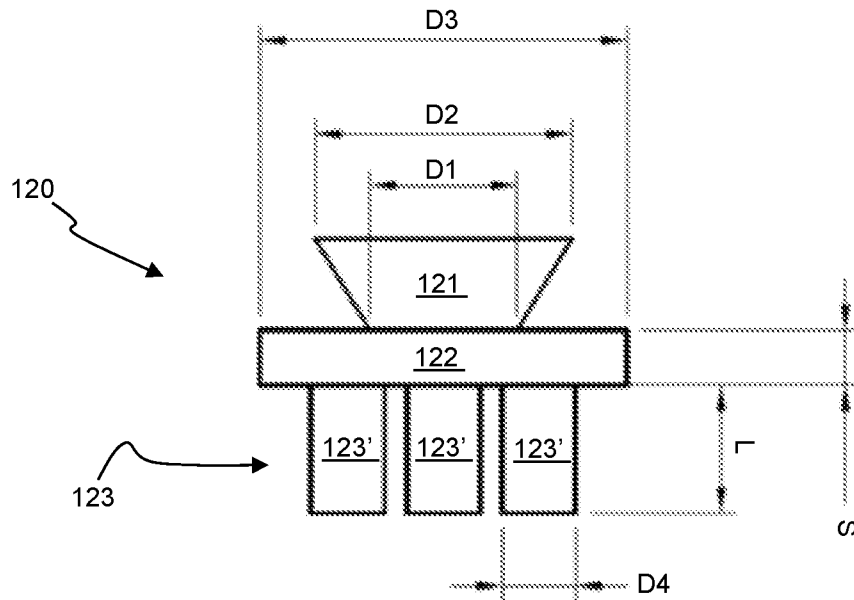


FIG. 3

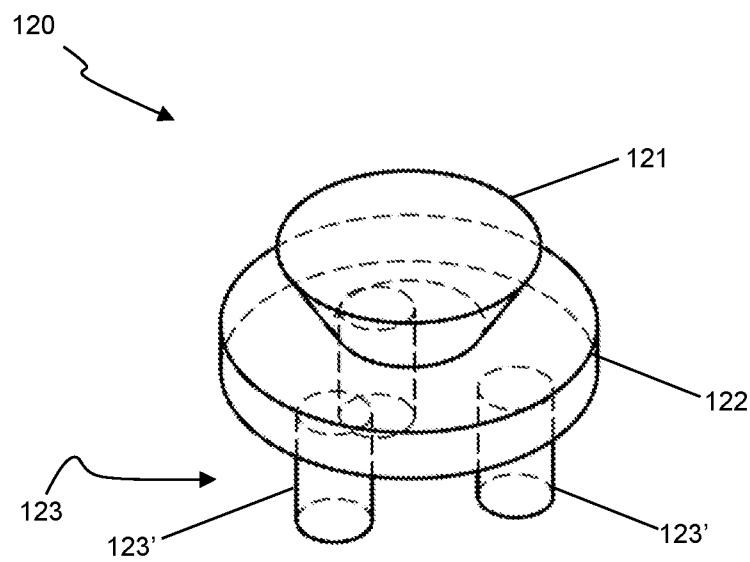


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2022/057363

A. CLASSIFICATION OF SUBJECT MATTER

INV. A41D1/00 A41F1/00

ADD.

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 A41F

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 591 453 A (PREVAYL LTD [GB]) 4 August 2021 (2021-08-04) figures 3, 9 -----	1-7
A	US 9 627 804 B2 (INTEL CORP [US]) 18 April 2017 (2017-04-18) figure 5 -----	1-7
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Date of the actual completion of the international search

17 October 2022

Date of mailing of the international search report

10/11/2022

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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